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FINAL ENVIRONMENTAL ASSESSMENT

NATURAL RESOURCES CONSERVATION PROJECT
KANAIO NATURAL AREA RESERVE

Districts of Makawao and Hana
Island of Maui

In accordance with
Chapter 343, Hawai'i Revised Statutes

Proposed by:

State of Hawai'i
Department of Land and Natural Resources
Division of Forestry and Wildlife
Natural Area Reserves System

1151 Punchbowl Street, Room 224
Honolulu, Hawai'i 96813

November, 2003

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I. Summary

Project Name	Natural Resources Conservation Project, Kanaio Natural Area Reserve
Project Location	Kanaio, District of Makawao & Auwahi, District of Hana, Island of Maui TMK 2-1-003-054 Kanaio NAR mauka tract 2-1-003-050 State, Unencumbered land 1-9-001-006 Ulupalakua Ranch, Auwahi tract 2-1-002-002 Kanaio NAR makai tract
Proposing Agency	State Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW) Natural Area Reserves System (NARS)
Approving Agency	State Department of Land and Natural Resources
Land Use Classification	Agriculture and Conservation
Anticipated Determination	Finding of No Significant Impact (FONSI).
Agencies, Organizations, and Individuals Consulted	Federal: US Department of Agriculture, NRCS US Department of Interior, Fish and Wildlife Service US Department of Interior, National Park Service US Geological Survey, Biological Resources Division State: Department of Agriculture Department of Hawaiian Home Lands Department of Land and Natural Resources Division of Conservation and Resources Enforcement Division of Forestry and Wildlife Division of Historic Preservation Division of Land Management Division of State Parks Natural Area Reserves Commission Office of Conservation and Coastal Lands Department of Defense, Hawai'i Army National Guard Department of Health Land Use Commission Office of Environmental Quality Control

Office of Hawaiian Affairs
Office of Planning
State Representative Kika Bukoski
State Senator J. Kalani English
University of Hawai'i, Botany Department
University of Hawai'i, Environmental Center

County:
Maui County Department of Planning
Maui County Department of Public Works
Maui County Department of Water Supply

Private:
Bishop Museum, Hawaii Biological Survey
Central Maui Hawaiian Civic Club
Conservation Council of Hawaii
Earthjustice Legal Defense Fund
East Maui Watershed Partnership
Friends of Haleakala
Haleakala Ranch
Hawaii Audubon Society
Hawaiian Ecosystems at Risk (HEAR)
Historic Hawaii Foundation
Ilio'ulaokalani Coalition
Kahea – the Hawaiian Environmental Alliance
Kahikinui Game and Land Ohana
Ka Ohana o Kahikinui
Kaupo Wildlife Club
Leeward Haleakala Watershed Restoration Partnership
Living Indigenous Forest Ecosystems
Maui County Farm Bureau
Maui Land & Pineapple
Maui Invasive Species Committee
Maui Nui Botanical Gardens
Na Kupuna o Maui
Native Hawaiian Plant Society
The Nature Conservancy of Hawai'i
Sierra Club, Maui Group
Ulupalakua Ranch
West Maui Mountains Watershed Partnership
Dr. Robert Robichaux, Department of Ecology & Evolutionary Biology, University of Arizona
Jeffrey Derego
Bruce Faulkner
Kahu Charles Maxwell

Summary of Project Actions

The Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife in a cooperative effort with the US Fish and Wildlife Service and Ulupalakua Ranch, proposes to install fencing around the upper portion of the Kanaio Natural Area Reserve (NAR) on the island of Maui.

Introduced ungulates -- such as deer, pigs, goats, and cattle -- are one of the most significant threats to the continued survival of native species and ecosystems that Kanaio NAR was established to protect. Feeding and trampling by ungulates destroy individual plants and damage native forest systems by destabilizing soils, hastening erosion, and facilitating weed invasion. Until now, funding has not been available to support the active management needed to protect natural resources in the NAR. The proposed fencing will protect native plants and animals of the Kanaio NAR from further damage caused by non-native ungulates and will provide a protected area for restoration of this unique Hawaiian dryland forest and recovery of the endangered species associated with it.

The project involves fence construction in two phases to create a large ungulate free area. Phase I requires 5.25 miles of fencing to enclose approximately 850 acres. In Phase II, an additional 3.75 miles of fence will be constructed to enclose an additional 400 acres adjacent to Phase I. The fences will protect native dry forests and shrublands, and a unique assemblage of native plants and animals, including rare and endangered species.

The proposed action involves clearing of a corridor no more than 20 feet wide, constructing a road, and erecting a fence line. The planned fence will be approximately eight feet tall, made of wire mesh. The outside of the fence will be skirted along the base with a mesh wire apron. Management activities planned after the fence is completed include feral animal and weed control and outplanting of native species to restore the dryland forest. The anticipated start date for the project is the third quarter of 2003. Phase I is anticipated to take a maximum of two to three years to complete. There is no time estimate for completion of Phase II.

A Finding of No Significant Impact is expected, as anticipated effects of the project are predominantly positive, promoting the conservation of natural resources protected in the NAR and the surrounding area, without having significant negative impacts to the environment, archaeological features, or appropriate public use of the area.

II. Project Purpose and Need

In 1972, Chapter 195 of the Hawai'i Revised Statutes (HRS 195) established the Natural Area Reserve System to preserve and protect Hawai'i's unique flora and fauna,

as well as important geological features, for the benefit and enjoyment of future generations. Preservation of natural, self-sustaining habitats and ecosystems is the ultimate goal of the Natural Area Reserve System. In many cases, this requires active management to reduce threats to natural elements protected in the Reserves.

Kanaio Natural Area Reserve was created in 1990 to protect one of the most significant tracts of dryland forest remaining in the State. Lower elevation (below 3000 feet) dryland forests are the most threatened natural ecosystem in Hawai'i. These forests once supported the most botanically diverse plant assemblages in Hawai'i, but have been reduced to a tiny fraction of their original extent. Most of the former extent of this forest type has been converted to urban development, agriculture, or cattle pasture.

With 282 species listed as endangered by the State of Hawai'i and U.S. Fish and Wildlife Service, Hawai'i is home to more rare plants that any other state in the country. Kanaio NAR is known to contain at least 12 species listed as Endangered (E), Candidate Endangered (C), or Species of Concern (SOC); the area is suitable habitat for numerous other rare plants that may have grown there in the past and that could be reintroduced as part of recovery efforts. The first insect from Hawai'i to be officially listed as endangered, Blackburn's sphinx moth, is known to be seasonally abundant at Kanaio.

Over the past several hundred years, the natural ecosystem at Kanaio has been subjected to a variety of perturbations, the combination of which has resulted in a steady decline in the health of the dryland forest. The most obvious symptom of this ongoing forest decline is the lack of natural replacement for native trees. Establishment and survival of young plants is minimal; many species are represented by only a few scattered, unhealthy adults. As the older trees die and are not replaced, the original closed canopy forest has undergone a gradual conversion to shrubs or grassland, often dominated by non-native species.

A number of factors are responsible for this failure of the native forest to naturally regenerate, but hooved animals (ungulates) play a major role. Obvious impacts of ungulates include feeding and trampling, which kills young seedlings, and hastens the decline of older trees. Conservation efforts elsewhere in Hawai'i have repeatedly shown that removing ungulates is an important first step toward protecting and restoring Hawaiian ecosystems. Until the pervasive disturbance of hooved mammals is removed from the remnant native forest at Kanaio, one can expect to see the continuing decline of this unique natural resource. Once this has been addressed, additional actions to restore forest health (outplanting, rodent control, weed control, etc.) can be attempted.

Recognizing the value of the native forests for soil and water conservation on leeward Haleakala, a partnership of landowners and supporting agencies signed a Memorandum of Understanding for the establishment of the Leeward Haleakala Watershed Restoration Partnership (LHWRP) on June 2, 2003. Though the present Natural Area Reserve is located below the defined boundaries of the Partnership, the proposed fencing project is consistent with the goals and objectives of the LHWRP and

will contribute to the restoration of the watershed by protecting dryland forest. The proposed upslope extension of Kanaio NAR (Phase II of the fencing) will include lands within the LHWRP area. NAR program resources might then be used to support cooperative LHWRP projects.

The project as proposed involves the use of State-owned lands as well as State funds. This Environmental Assessment is prepared in accordance with the requirements of HRS Chapter 343 to disclose the project's potential environmental impacts.

III. Project Description

General

The Division of Forestry and Wildlife (DOFAW) proposes the construction of fencing to protect an important remnant tract of Maui's native dryland forest. The purpose of the fence is to permanently exclude hooved mammals such as goats, deer, cattle and pigs from the upper portion of the Kanaio NAR and the area directly north of the existing Kanaio NAR. This will allow for recovery of native vegetation and create a secure site in which restoration of rare and endangered plant species can be carried out.

This project is proposed in two phases. Phase I involves fencing the upper portion of the existing Kanaio NAR. It is planned in cooperation with the U.S. Fish and Wildlife Service, who has provided partial funding because the project will assist in the protection and recovery of listed species, and with neighboring landowner Ulupalakua Ranch. This fencing will create an ungulate free area of approximately 850 acres.

Phase II involves fencing an area adjacent to the tract enclosed by Phase I. This area is currently under the administration of the Land Division of DLNR, but has been nominated for inclusion as a Natural Area Reserve as an extension of Kanaio NAR. The area, located immediately to the north (uphill) of Kanaio NAR, contains a relatively intact native mid-elevation dry/mesic shrubland. Adding this land formally to the NAR will allow conservation of a significant area of natural vegetation that has no formal protected status at this time, and fencing will protect the biological resources found within this section.

Phase I

Several routes for the proposed fence line for Phase I were developed. After careful consideration, a fence line enclosing the portion of the Reserve above Highway 31 was selected as the preferred alternative, roughly following the actual boundaries of the NAR on the north, going outside the NAR boundaries to the east on private land owned by Ulupalakua Ranch, following the mauka side of Highway 31 to the south, and going outside the NAR boundaries to the west on State-owned unencumbered land.

The preferred alignment was selected based on topographical and geological considerations to select the most effective and cost-efficient fencing. Road building, fence installation and maintenance is easier and safer on the older substrate found to the west of the existing NAR boundary. Construction outside the actual NAR boundary avoids construction on the pahoehoe lava, reducing the likelihood of disturbing unknown lava tubes or caves. Placement of the fence outside the actual NAR boundary will also protect additional pockets of native vegetation without an increase in cost.

Where possible, the fence will be installed along roadways. This facilitates construction and allows for more efficient maintenance and repair of the fence once constructed. The fence alignment described as the preferred alternative for Phase I encloses a rough square. The lower (south) boundary follows Highway 31. In order to reduce the visual impact of the fence, and to reduce vandalism and potential damage from vehicle accidents, this fence segment will be set back approximately 50 feet from the road. This will also allow the continued use of roadside "pull-outs" used for parking areas along this stretch of highway.

The upper (north) boundary follows the four-wheel drive "pipeline road." The planned fence will be sited at the lower edge of the existing road, to allow vehicles to continue using the road, without requiring any new gates. Some widening or improvements to this road may need to be made before the fence is installed.

There are presently no roads along the proposed east and west fence segments. A bulldozer will be used to build 4WD roads to facilitate fence construction and maintenance. Gates or berms may be placed on these roads after the fence is completed, in order to prevent unauthorized vehicle traffic.

Phase II

The area above Kanaio NAR was nominated for addition to the existing Natural Area Reserve by the Natural Area Reserves System Commission in June 2003. It contains an intact example of native mid-elevation shrubland community that was formerly widespread on south Maui and enlarges the elevation and climate gradient represented in Kanaio NAR. The area is part of a larger TMK currently under the management of the Land Division of the Department of Land and Natural Resources. DOFAW is working with DLNR, Land Division, to identify the boundaries of the proposed addition and to gain approval from the Board of Land and Natural Resources and the Governor to formally add this area to the Natural Area Reserves System.

Management actions for this area after addition to the existing NAR include weed control and fencing to protect the natural resources (Phase II). It is uncertain when funding will be available to proceed with the Phase II fences. Because Chapter 343 encourages the development of an environmental assessment "at the earliest practicable time," a discussion of Phase II, and the potential environmental impacts, is included within this Environmental Assessment.

Phase II fences will enclose the area upslope (north) of the NAR. New roads will be constructed to allow the east and west sides of the Phase I exclosure fence to be extended upslope to approximately 3800 foot elevation. At this elevation, they will be connected by a fence to be built along an existing road. This will enclose an additional area of approximately 400 acres.

Specifications

The following specifications are applicable to both Phase I and Phase II:

The fence will be constructed of rust resistant, galvanized steel materials. "T" posts up to 10 feet in length will be driven into the ground to a depth of approximately one to two feet, at a spacing of roughly 10 to 15 feet. Larger diameter posts and/or braces made of treated wood or metal pipe, cemented in place, may be installed for reinforcement at larger intervals, at corners or sharp bends in the alignment, at abrupt changes in slope, or where gates are to be installed. Holes may need to be excavated or drilled into the ground to place the posts in rocky areas. Because much of the substrate along the fence route is exposed lava rock, it will likely require the use of a motorized hammer-drill for excavation of post holes.

Eight foot tall game fencing, with a mesh size of no more than six inches, will be attached to the posts with steel clips and staples. In order to block holes created where irregular ground surface does not match the bottom of the fence and to prevent animals from passing beneath the fence, an additional apron of 32" mesh wire will be attached to the bottom of the fence and draped over the ground along the entire length of the fence. Where appropriate, gates, stiles, ladders or similar structures will be installed to allow DOFAW staff and the public to enter the fenced enclosure.

Progression and Timeline

All variants of the proposed fence alignment for Phase I were marked with flagging, and potential staging areas for parking or material storage were identified. Preliminary surveys by DOFAW staff and cooperators located no obvious archaeological features or endangered plant species in these locations. Professional archaeologists walked the proposed fence line to verify that no historical sites would be damaged by fence construction.

For Phase II, the proposed fence alignment has not yet been identified with flagging. Preliminary visual surveys by DOFAW staff have located no obvious archaeological features or endangered plant species in the planned fence corridor. DOFAW will work with archaeologists, cultural specialists, and biologists to ensure that the Phase II fence alignment will not harm historical sites or rare native species.

Before actual construction activity begins on Phase I or Phase II, DOFAW staff will flag the final fence alignment. Another search will be made for endangered plants. Sensitive natural and cultural features will be marked in order to prevent damage during

fence construction. If necessary, minor changes in fence alignment will be made to avoid these features by a greater distance.

A bulldozer will be used to improve existing 4WD access roads, and to create new roads along the eastern and western fence segments. These new roadways will be approximately 16 to 20 feet wide. Bulldozing may also be necessary to improve portions of the southern unit boundary, where it parallels Highway 31. As much as possible, bulldozing will be restricted to previously disturbed areas, and will avoid sensitive natural and cultural features. A bulldozer scout will be used to ensure that machinery does not damage rare plants or archaeological sites. Division of Forestry and Wildlife Best Management Practices for Maintaining Water Quality will be followed to prevent runoff or erosion as a result of construction of these 4WD roads. Where the fence alignment deviates from the road corridor, vegetation may be cleared by hand (chainsaws) to create a clear path no more than 10 feet wide.

Wherever possible, native plants will be left in place. No native trees greater than six-inch stem diameter will be removed.

Fence material (posts and wire) will be transported to the site by truck and/or helicopter sling load. Materials may be delivered incrementally to prevent theft from stockpiles.

Fencing will be constructed within the 16 to 20 foot corridor cleared for the 4WD roadway. Fencing will be constructed on the outside edge of the road corridor, so that the 4WD roads are located within the fenced exclosure. Gates or berms will be installed along roadways as needed to prevent unauthorized vehicle access.

Fence posts will be installed in the ground, using powered drills and post pounders as necessary. Fence wire will be unrolled along the corridor, then stretched and clipped to the posts. Some minor movement of rocks and soil may be required at the base of the fence. Where the fence alignment does not closely follow roads, a helicopter may be used to unroll the wire. Additional structures such as aprons, braces, gates, etc. will be built as the fence progresses.

As the each phase of fencing nears completion, helicopter surveys of the area to be enclosed will be made to locate animals that may be trapped inside. If possible, they will be herded out before final closure. Once each phase of fencing is complete, DOFAW may use volunteer hunters to remove animals trapped inside the fence, followed by staff hunting if necessary.

On-going maintenance of the fence will include regular visits to repair damage, to check for animal incursion, and to control non-native weeds that may colonize the disturbed area along the fence corridor. Long-term management of the area inside the fence will include such actions as outplanting of appropriate native species (both rare and common), control of non-native weeds, and control of other non-native organisms

such as insects, rodents, plant disease, etc. that may be adversely affecting forest health and the regeneration process.

Costs

The cost estimates for each Phase are as follows:

Item	Phase I	Phase II **	Total
Linear feet of Fencing	28,000	21,000	49,000
Supplies/ Fencing Materials	$100,000	$75,000	$175,000
Fence line clearing	$20,000	$15,000	$35,000
Fence Construction	$140,000-$280,000*	$105,000 - $210,000	$245,000 - $490,000
Totals	$260,000 - $400,000	$195,000 - $300,000	$455,000 - $700,000

* Cost range reflects increased cost if the south and western sections are not bulldozed, but are constructed by hand.
** Phase II costs are projected based on Phase I costs due to similarities in terrain.

Most of the materials for Phase I have already been purchased through State funds. Fence clearing will be completed by DOFAW personnel in cooperation with Ulupalakua Ranch personnel and equipment. Funding for construction of the Phase I fencing is provided by the State and the U.S. Fish and Wildlife Service.

Construction of Phase I will proceed as soon as all necessary approvals have been granted and is estimated to commence in the third quarter of 2003. It is anticipated that it will take a maximum of two years to complete Phase I of the project. The timing of Phase II depends upon availability of additional funding.

IV. Description of the Affected Environment

Physical Characteristics

Kanaio NAR and the proposed extension to the NAR occupy a portion of the traditional Hawaiian land division (ahupua'a) of Kanaio, which extends from the ocean to approximately 6800 foot elevation. Kanaio NAR occupies 876 acres on the southwest slope of Haleakala volcano, on the island of Maui. It ranges in elevation from 1,100 to 2,780 feet. The proposed extension to the NAR ranges in elevation from 2,780 feet to 4,100 feet. The map in Appendix A show the general location of the NAR, as well as the proposed fence routes for Phase I and II.

Kanaio is located on the leeward side of Haleakala, in the rain shadow created by the massive volcano. The climate of the Reserve is generally arid and wind-swept

with a mean annual rainfall of approximately 30 inches (750 mm), typically ranging from 12 inches (320 mm) to 45 inches (1139 mm) per year. The weather pattern is typically dry during the summers, with winters being punctuated by periodic kona storms that generate heavy rainfall for a few days. Typically, 75 percent of the total precipitation falls between October and March. There are no known intermittent streams in Kanaio NAR, but one intermittent stream that is typically dry, is located on the eastern edge of the project area on Ulupalakua Ranch property.

The geologic substrate at Kanaio is of fairly recent lava flows, with localized pockets of cinder derived soil, especially in low-lying and flat areas. Pahoehoe lavas are typical along the western edge of the Reserve, grading into a'a flows farther east. This lava substrate is estimated to be less than 10,000 years old (Crandell 1983). Soils in the project area are a'a flows (rLW) and very stony land (rVS). The overall topography is gently sloping (<15%), with some trench-like channels formed by the downhill movement of flowing lava. Several deep lava tube entrances occur in the areas with pahoehoe substrate.

Lands adjacent to or near the NAR include other State lands, Ulupalakua Ranch, and other private landowners in the Kanaio Homesteads to the west. Some of these State lands were formerly leased to Ulupalakua Ranch for grazing. The area surrounding the Reserve is largely uninhabited with the exception of a few homes near the western boundary. The major economic use of the surrounding area is cattle ranching. While Kanaio NAR is not legally designated as a public hunting area, there is undoubtedly some poaching occurring on the Reserve and surrounding undeveloped lands of goat, deer, pig and game birds.

The NAR is bisected by Highway 31 (Pi'ilani Highway), which crosses it at approximately 1600 foot elevation. The highway divides the Reserve into two discrete sections; Parcel A above the road, of 595 acres, and Parcel B below, of 281 acres. Two former parcels of the "Kanaio Homesteads" subdivision were incorporated into the southeastern portion of the NAR. These are Parcel 16, which makes up approximately 80 acres of Parcel B, and Parcel 17, which makes up approximately 85 acres of Parcel A. An unimproved 4WD road (the "pipeline road") approximately follows the upper boundary of the Reserve at 2800 foot elevation.

Highway 31 also marks the boundary between land in the Agricultural District and land in the Conservation District. Land in the project area for the preferred alternative for both Phase I and II is in the Agricultural District. Land below (makai) Highway 31 is in the Conservation District.

Flora

The vegetation of the Reserve can be simply described as a mosaic of four different plant communities. These are: 1) groves of native trees; 2) native shrublands; 3) lava fields with sparse vegetation, and 4) areas dominated by a variety of non-native

grasses, herbs, and shrubs. The distribution of these communities is largely a function of the underlying geologic substrate and the degree of past disturbance.

It is within the native groves that the greatest diversity and biological value is found. The native dominated areas (1 and 2 above) can be subdivided to correspond to a classification system developed by Gagné and Cuddihy (in Wagner et al. 1990). They recognize a number of plant communities that would be the natural vegetation in low elevation, dry sites. Kanaio NAR contains examples of three of these communities: A'ali'i Lowland Shrubland, Lama Forest, and Wiliwili Forest.

Wiliwili Forest occurs in the lower elevations of the Reserve, typically in kipuka of older substrate. The forest canopy is dominated by Erythrina trees of moderate stature, with occasional Reynoldsia, Rauwolfia, and Nothocestrum. Understory vegetation is predominantly non-native, but shrubs such as Dodonaea, Wikstroemia and Sida persist in some areas, as well as the viny Boerhavia.

At lower elevations, Lama Forest is restricted to relic groves in protected sites such as the bottoms of lava flow channels. As elevation increases, the forest cover becomes more continuous, and increases in diversity. Species of the Wiliwili Forest occur here, as well as Myoporum, Pleomele, Nestegis, Xylosma, Alphitonia, Canthium and Santalum, to name a few. In the most pristine areas, the understory contains a variety of native grasses, sedges, and shrubs. This community is best developed in the northeastern corner of Parcel A, where the vegetation appears to have been least disturbed. "Lama Forest" may not be the most accurate description of this community. While Diospyros is a major component of the remnant canopy, the undisturbed state of this forest was likely a diverse mixture of trees, including many no longer extant at Kanaio. Diospyros may be dominant now simply because mature trees are more resistant to browsing by goats than other tree species. Despite their highly disturbed and altered condition, these scattered groves of trees are among the best examples of dryland forest left in the State and constitute an important component of Hawai'i's remaining native biodiversity.

The final native community recognized at Kanaio NAR, A'ali'i Shrubland, is the most widespread. It occurs throughout the Reserve, generally on exposed ridges and drier sites. A'ali'i is fire tolerant, and this shrubland may have replaced Lama or Wiliwili Forest in areas that were once burned. Also common in this community are shrubs such as Osteomeles, Wikstroemia, and Styphelia.

Over 166 species of vascular plant, 11 pteridophytes, and 155 flowering plants, have been recorded within the Kanaio NAR. Over 60 percent of the species listed for the Reserve are exotic introductions to Hawai'i. The remainder includes 22 indigenous plants, and 44 species endemic to Hawai'i. Of the native plant species, 14 have or are proposed for legal protection under the Endangered Species Act. A list of plants known from Kanaio is contained in Appendix B.

32 of the native species found in Kanaio NAR are trees or shrubs. They represent roughly one-third of the native woody species that originally comprised the forest canopy found on the southern slopes of Haleakala. Very few of these plants appear to be successfully replacing themselves through natural recruitment. In addition to direct herbivory and trampling by ungulates, another major reason for the lack of tree seedlings is the modification of the original habitat by decades of disturbance. The nearly complete removal of native understory vegetation has significantly changed the temperature, moisture and chemistry of the soil surface where tree seedlings germinate and become established. Non-native plants that have invaded these disturbed areas also can impede the establishment of seedlings, as in the case of the dense mats formed by kikuyu grass (Pennisetum clandestinum). Other potential factors affecting decreased seedling production may include the loss of native pollinators, lack of seed dispersers/scarifers, and the presence of non-native seed and seedling predators.

Sizable areas of the Reserve are dominated by alien grass, herb, and shrub species. This typically reflects the most intense levels of disturbance in the past. The near complete extirpation of native plants and their replacement by alien species in these areas largely reflects the combined effects of grazing and wildfire. For example, the thorny shrub Lantana camara forms extensive thickets that appear to suppress native plant species. This is a result of intense herbivory in this seasonally arid habitat. Continued pressure from ungulates favors quick-growing alien species, which are generally less palatable than native plants and are often fire tolerant. Numerous other non-native species considered pests have been observed in the Reserve. If not controlled, they will undoubtedly spread, and could potentially displace more of the native vegetation that remains at Kanaio. Many of these weeds were purposely introduced to the area as forage for cattle; others are escaped ornamental or crop species.

The area directly to the north of the existing NAR proposed for Phase II fencing is native dominated dry and mesic shrubland with scattered native trees. The vegetation of this area is dense shrubland comprised primarily of Styphelia, Dodonaea, and Osteomeles. Trees such as Metrosideros, Nestegis, Pouteria, Dispyros, Alphitonia, and Myoporum are scattered across the area, inhabiting sheltered sites such as the bottoms of lava channels. Native shrubs such as Chamaesyce and Wikstroemia are locally common; an understory of native sedges and ferns persist in undisturbed areas.

While some portions of the area proposed for fencing in Phase II have been disturbed by grazing and/or fire, the rough rocky nature of the underlying lava flow and the dense brushy vegetation have so far acted as a natural barrier to the incursion of cattle and other ungulates. As a result, the core of this area is essentially pristine, in contrast to the surrounding pasture lands.

Traditional Hawaiian practices, such as harvest of forest products and cultivation of dryland crops in areas with suitable soil, may have also contributed to deforestation at Kanaio. More recently, bulldozing to improve pasture and create access roads affected a small portion of the Reserve.

Fauna

As is typical of Hawai'i's lowlands, the fauna native to Kanaio has been largely extirpated. This is a result of habitat destruction, as well as disease, hunting, and competition from or predation by introduced species. There are a variety of animals that presently inhabit the area; however, they are almost all non-native species. A checklist of birds and mammals known from the area is included in Appendix C.

The Hawaiian owl (pueo), Pacific golden plover (kolea), and the Hawaiian goose (nene) are infrequently seen around the NAR. Ground nesting seabirds such as the dark-rumped petrel ('ua'u) inhabit the high mountain slopes of Haleakala. They may traverse the airspace above the Reserve, but are unlikely to land here, or fly near the tree canopy. It is unlikely that other native birds inhabit the Reserve.

Based on the work of Storrs Olson and Helen James of the Smithsonian Institution, it is now known that prior to arrival of the early Hawaiians, the islands supported a diverse avifauna. Classification of subfossil bird bones discovered in lava tube caves in nearby districts of East Maui provided evidence that leeward Haleakala was inhabited by an impressive assemblage of native birds. Included in the list of now extinct endemic birds discovered near the Kanaio NAR are two species of flightless ibis, three species of flightless geese, an eagle, three species of extinct flightless rails, a long-legged, bird-hunting owl, and a variety of small passerines, including nectar-feeding, seed-feeding, and fruit-feeding species. This complete loss of the native avifauna, many of which were likely important pollinators or seed dispersers, has undoubtedly had significant impacts on the composition of the native plant communities.

Game birds such as ring-necked pheasants are present but uncommon, presumably due to poor habitat. Brown francolins are common; Black francolins were reportedly introduced to the area within the last 15 years for hunting. Barn owls are frequently seen, and likely roost in lava caves throughout the Reserve. A variety of other small alien birds inhabit the Reserve, the most common being Japanese white-eye and common myna. Also present are rock dove, northern cardinal, nutmeg manikin, Eurasian skylark, house finch, mockingbird and house sparrow.

It is unknown whether the Hawaiian bat ('ope'ape'a) occurs within Kanaio NAR. This poorly studied species has been observed near the Reserve at Ulupalakua and Kaupo.

A variety of ungulate species have been introduced to Hawai'i since 1800, many of which have gone feral and inhabit "wilderness" areas such as Kanaio. Feral pigs usually associated with wet forest areas are present at low numbers throughout the Reserve, especially in areas with better-developed soil. The damage they cause to native vegetation is relatively limited due to their low population levels, but the soil disturbance caused by their digging favors the establishment of non-native weeds. Pigs

may also be transporting the seeds of fleshy-fruited species such as Passiflora and Cucumis.

Feral goats are a ubiquitous part of the landscape of Haleakala's southern slope. The huge herds recorded in the past undoubtedly had a severe impact on the forest. While no longer occurring in such large numbers, sizeable herds still freely roam the landscape. The animals tend to inhabit more remote areas where hunting pressure is minimal. The Kanaio NAR does not appear to support a large resident herd, but groups of up to a dozen animals are often seen, especially on the lava fields below the highway.

Because there is no boundary fence around Kanaio NAR, domestic cattle from nearby ranches enter the Reserve, especially during the winter when green forage is available. Rough 'a'a lava is somewhat of a barrier to cattle; activity tends to be concentrated in areas with older soils and on pahoehoe substrate. These areas have generally been converted to non-native vegetation; some Wiliwili Forest remains here and is being impacted. Cattle grazing and trampling take a heavy toll on native vegetation, especially seedlings that come up with winter rains. Thus, construction of the fence segment that will separate Kanaio from the Auwahi pastures is of high priority for this project.

Axis deer were first introduced to Maui in 1960. Populations are reported to be growing quickly in size and the range of the deer has increased to include most of Maui. Small groups of deer are often observed in the pastures of Auwahi immediately adjacent to the Reserve, and occasionally in the NAR as well. Deer will traverse rugged 'a'a flows, and it is likely that as populations grow, they will increasingly seek forage within and above the Reserve.

There is ample evidence that these ungulates are contributing to the decline of the native forest at Kanaio. While systematic hunting (from ground or air) may reduce their numbers, the best long-term solution to this problem is to permanently exclude them from the Reserve with fences.

Besides ungulates, Kanaio NAR contains a variety of other alien mammals. These include feral cats, dogs and mongoose, as well as several kinds of rodent. The introduced black rat and the house mouse are present and seasonally abundant in the Reserve. The Polynesian rat may also inhabit Kanaio. Hawaiian ecosystems evolved without rodents, and rodent predation on seeds has been documented for numerous native plant species. This may be one of the primary causes of the endangerment of some rare taxa. Rats and mice are also documented to consume native Hawaiian invertebrates (Hadfield et al. 1993; Sugihara 1997; Cole et al. 2000).

In addition to the vertebrate taxa, Kanaio contains a diverse and poorly studied invertebrate fauna, including many unique native species that persist despite predation by alien species and the alteration of suitable habitats.

Hawai'i has no native species of ants, an important group of insect predators. As a result, there is a general lack of adaptations in the native insects to cope with the fierce predation of many introduced ant species. One of the worst of the ant predators, the bigheaded ant (Pheidole megacephala), has caused great destruction of native insect life in the Hawaiian Islands to about the 4,000 foot elevation. The native invertebrates of Kanaio NAR have apparently been heavily impacted by predation by this ant, which is common and widespread throughout the Reserve. Their predation on native pollinator insects may be affecting seed production and the regeneration of native plants.

Other introduced insects may be affecting forest health through seed destruction, herbivory, or in the case of termites, by making them susceptible to wind breakage. Numerous observations have been made of wind throw of otherwise healthy adult Reynoldsia, Erythrina and Pleomele trees weakened by termite feeding at the base.

Despite the abundance of introduced ants, the Reserve still contains many native invertebrate taxa, some uncommon, rare, or not occurring elsewhere. Native species of insects include the yellow-faced bees, Hylaeus (Colletidae), which are pollinators in many native coastal and high elevation plant communities. Other native Hymenoptera include the endemic wasps Odynerus spp. (Vespidae) and Ectemnius spp. (Sphecidae). Important collections of rare native spiders in the families Thomisidae and Tetragnathidae have been made in neighboring Auwahi; these animals may also be present at Kanaio.

The Kanaio NAR is important habitat for the rare Hawaiian Blackburn's sphinx moth (Manduca blackburni: Sphingidae), the first Hawaiian insect listed as endangered by the U.S. Fish and Wildlife Service. The larvae of this moth feed on plant foliage of the tomato family (Solanaceae) and survive in the Kanaio area despite the presence of the bigheaded ant. Their persistence is likely attributable to the large population of Nothocestrum trees, on which the larvae of the moth feed.

Several deep lava tubes are known within the Kanaio NAR. While they remain unsurveyed, it is possible that these caves contain habitats occupied by a native invertebrate fauna, as has been described from other Hawaiian lava tubes in adjacent areas and throughout the islands (Howarth 1987).

Significant and Sensitive Habitats

The entire project area is considered to be sensitive habitat and was included in the area designated as Federal critical habitat for nine threatened and endangered plants on Maui and for the Blackburn's Sphinx Moth. Appendix D contains a list of species with designated critical habitat in the project area. The project area also hosts several other native plants are rare enough to warrant monitoring and protective management around the Reserve. Finally, the project area includes dryland forest and shrubland, which is increasingly rare in Hawai'i.

In addition, Phase II falls within the newly formed Leeward Haleakala Watershed Restoration Partnership area. The Leeward Haleakala Watershed Restoration Partnership is a watershed partnership of landowners and supporting agencies working towards the restoration of native ecosystems on Haleakala from Makawao to Ulupalakua to Kaupo above the 3500 foot elevation.

Archaeological Resources

Staff from the U.S. Fish and Wildlife Service's (FWS) Region 1 cultural resources division in Sherwood, Oregon, conducted literature and field research to obtain information on the cultural history and known cultural resources in or near the initial project area of the Phase I fencing. These efforts documented both previously recorded and newly-identified cultural resources within a ½ mile radius of the initial project area. The Cultural Resources Investigation is included in Appendix E, and a full report of the *field inventory and record search results was placed on file* at the State Historic Preservation Division. Because of the use of Federal funding, a section 106 consultation will be conducted for this project.

To ensure that all potential cultural and archaeological impacts were included, the Draft Environmental Statement was also distributed to the following agencies and organizations for review and comment: Office of Hawaiian Affairs, Department of Hawaiian Home Lands, DLNR State Historic Preservation Division, Central Maui Hawaiian Civic Club, Historic Hawaii Foundation, Kahu Charles Kauluwehi Maxwell, Na Kupuna o Maui, Ulupalakua Ranch, Kahea – the Hawaiian Environmental Alliance, Ilio'ulaokalani Coalition, Ka Ohana o Kahikinui, Living Indigenous Forest Ecosystems, Kahikinui Game and Land Ohana, and Kaupo Wildlife Club. In addition, two public informational meetings were held on Maui, in May 2002 and October 2003, to gather community input on the project. No new or additional information about archaeological sites or cultural practices in Kanaio NAR was gathered during this process. However, two comments were raised at the public meeting: 1) bulldozing on lava is an affront to Pele and Native Hawaiians and 2) the project interferes with Native Hawaiian land claims, specifically that of Mr. Edward 'Uwekoolani over Parcel 17 located within the existing NAR.

Cultural Setting

Available ethnographic data and previous archaeological investigations indicate that the earliest settlement of the dry leeward areas of south Maui occurred after settlement of the valleys and windward coasts and then was focused around the fertile upland slopes with access to water and arable soils (Eble 1999). While not enough data has been collected to develop a precise chronological sequence, Erkelens suggests that initial settlement of southeast Maui occurred sometime between A.D. 1450 and 1800 (1995). These dates correspond to the late-Expansion (A.D. 1100-1650) and Proto-Historic (A.D. 1650-1795) periods as proposed by Kirch (1985).

For purposes of modeling settlement and land use patterns, researchers have defined three geographic zones in south Maui: the uplands, the mid-elevations, and the coast. Erkelens posits that:

> *"Upper elevation sites exploited the agricultural potential of the fog drip precipitation region while the coastal settlements made use of the abundant marine resources. The specific placement for mid-elevation habitation site clusters is probably related to the availability of water, a centralized location between large coastal and inland settlements, and a viable route connecting the coast with the uplands. These mid-elevation locations were able to exploit the resource potential of both productive zones due to their central location."* (Erkelens 1995).

Archaeological site density is high in the 200-350 meter wide coastal zone. The mid-elevations, which range from the edge of the coastal zone to 250-300 meters above sea level (masl) [to approx. 820-980 fasl], exhibit low site density. Density increases again in the dense upland zone, which falls between approximately 250 to 750 masl [from approx. 820 to 2460 fasl] (Kirch 1997). With an elevation ranging from approximately 1700 to 2800 fasl, the portion of the NAR above Pi'ilani Highway where the fence is proposed would fall generally into the upland zone.

Archaeological research in the uplands of Kanaio *ahupua'a* has been too limited to contribute substantially to an understanding of the area's settlement patterns. Nearby, an extensive inventory of the adjacent *moku* of Kahikinui exhibited dense site distribution in the upland zone, with few sites observed in the intermediate region and virtually no archaeological remains above 2800 fasl (Kirch 1997). That study also noted a correlation between upland archaeological features and the substrate on which they were located, with a higher density of structures located on pahoehoe lava substrates where sparse soil development resulted in limited agricultural value (Kirch 1997). Such a building strategy may have been practiced to keep clear for agricultural purposes those areas where soil was more fertile (i.e. the older, weathered a'a substrates with suitable soil deposition) (1997). On the NAR, the substrate is predominantly rough *a'a* lava with some overlying soil (Medeiros et al. 1993), but only on its eastern boundary and the adjacent Ulupalakua Ranch has significant soil development occurred. Because Kanaio has experienced different geological processes than the neighboring Kahikinui *moku* and the available body of archaeological data is still relatively small, the value in applying the settlement pattern established at Kahikinui as a model for site distribution within the NAR is limited.

Late nineteenth century maps suggest that the Kanaio Homesteads adjacent to and within a portion of what is now the NAR were one focus of upland settlement during the early post-Contact period (Erkelens 1995). The Great Mahele of 1848, during which King Kamehameha III facilitated wholesale land redistribution, effectively abolished the traditional system of land tenure, making way for the sale or lease of large tracts of land to foreigners. In the District of Honua'ula, Kamehameha III claimed and then relinquished to the Hawaiian Government 22 ahupua'a, including Kanaio. Based on

representations on current tax maps, the State of Hawai'i continues to own approximately 8,370 acres in Kanaio, including Kanaio NAR.

It was during this time period that ranching was introduced to the slopes of Haleakala by Euroamericans on a massive scale. The history of what has become the Ulupalakua Ranch began in 1845 when Linton Torbert purchased 2000 acres. In 1856, James Makee bought and expanded the property, which he called Rose Ranch, and built 40 miles of rock walls. By 1922, during the ownership of James Raymond, the ranch had grown to include Kahikinui Ranch in neighboring district of Kahikinui. The name Ulupalakua was first applied when the Baldwin family owned the ranch between 1922 and 1963. The current owners, the Erdman family bought the ranch in 1963, and today it encompasses 58,000 acres.

The Ranch developed a grazing program incorporating both ranch-owned land and lands leased from the State, including much of the area now encompassed by the NAR. The degradation of the dryland forest native to Haleakala's south slope has been linked to the effects of cattle ranching as well as the invasion of other non-native animals, alien plants, and wildland fires (Medeiros et al.1993). To protect the remnants of the native dryland forest, the 876 acre NAR was established in 1990 from two parcels of State lands carved out of an existing lease to Ulupalakua Ranch. In 1994, after nearly 150 years of grazing, the Ulupalakua Ranch returned the balance of its lease to the State (B. Evanson, 2002). Since that time, feral ungulates have continued to inhabit the area, causing a threat not only to the habitat but to cultural resources as well.

Summary of Cultural Resources – Previously Recorded Sites

The site and feature types represented reflect early agricultural, habitation and religious activities as well as post-Contact ranching practices. While limited archaeological research has been conducted in the vicinity of the NAR, there are a number of known archaeological sites in or adjacent to the NAR boundaries. Winslow Walker's inventory of major sites (primarily heiau) in the 1920s included two heiau. The first, Kohala Heiau (#189), appears to be within the NAR boundaries and was characterized as a rough platform of basalt blocks on a high ridge overlooking the sea. The second, Kauhuka Heiau (#188), is described as a small platform of rough basalt blocks on top of a rocky knoll, and based on available maps, this heiau appears to be situated mauka of what is now the northwestern boundary of the NAR.

The NAR was included in dissertation fieldwork conducted by Bordner in the mid-1990s. While his survey methods focused as much on vegetation patterns and evidence of recent activity as on archaeological sites, he noted three cultural resources which appear to be located within or immediately adjacent to the NAR. He also observed that the upper section of the NAR showed evidence of having been cleared during the last 100 years, in likelihood flattening archaeological sites that might have been present (Bordner 2002). The sites Bordner identified were characterized as a stacked *a'a* enclosure and C-shaped enclosure (#243) (outside the east boundary of the NAR on the Ulupalakua Ranch), a small habitation-style enclosure with a view reminiscent of those associated with heiau (#244) (also on Ulupalakua Ranch land), and

a C-shaped enclosure on a knoll with *ili'ili* paving (#245) within the NAR boundaries (Bordner 1995).

Remnants of land development associated with the early 1990s homestead claim of the 'Uweko'olani family occur in Parcel 17, in the southeast corner of the NAR above Pi'ilani Highway. At that time, Edward 'Uweko'olani established a semi-permanent residence and cleared land for 4-wheel drive roads, fences, and an outhouse (Medeiros et al. 1993). After researching land title histories, the State concluded that Mr. 'Uwekoolani's claim was not valid, and he was removed from the property. Part of the stone wall system parallel to and radiating from the Pi'ilani Highway dates to this period. Mr. 'Uweko'olani has identified a walled rectangular enclosure documented during the 2002 survey as a *ko'a*, but he does not know for what it was used (Maxwell 2002).

Two historic linear features in the vicinity of the NAR are still in use in varying forms today. Pi'ilani Highway (Highway 31), which forms the southern boundary of the proposed fence line, follows generally the same route as the upland route of an original Hawaiian trail and subsequent nineteenth century road, referred to on Alexander's 1894 map as the "Hana Road" (Erkelens 1995). The highway was paved in 1972 and again in 1999. On the northern boundary of the NAR runs a dirt road which was built as a trail to access and service the Waikamoi pipeline in the early 1900s. Both trails were extensively modified over time, evolving into the modern linear features utilized today. The pipeline itself, located on the north side of the road outside the NAR, continues to be propped up by wooden crutches and rockpiles.

As a result of an ethnographic study conducted in relation to a proposed large-scale geothermal power project, Matsuoka et al. (1996) determined that "the scenic view corridor Kanaio – Luala'ilua Hills" is a significant scenic and cultural district with reference to National Register Criteria a, b, c-3, d, and e, and consequently should be protected. The report does not include a map delineating the boundaries for such a district, but it can be inferred that the NAR, midway between Kanaio and Luala'ilua Hills, would be contained in the district. There is no evidence that the proposed district has been subsequently nominated to the National Register of Historic Places.

The Department of Land and Natural Resources (DLNR) State Historic Preservation Division has recognized Ulupalakua Ranch as a significant cultural landscape (Matsuoka et al. 1996). While the Ranch does not appear on the State's official Register of Historical Places or on the National Register of Historic Places, its thousands of acres of uninterrupted pasture are identified by DLNR as representing the role of ranching in the development of Hawaiian economy (DLNR web page, accessed 9/02, http://www.state.hi.us/dlnr/hpd/hpcal94.htm).

Summary of Cultural Resources – Newly identified sites

The recent archaeological reconnaissance in anticipation of the fencing project resulted in the identification of ten stacked rock features recorded at four locations, three stacked rock wall systems probably associated with historic and modern ranching practices, and an isolated basalt hammerstone. Stacked rock feature types included:

rectangular enclosures, C-shapes, rock piles, possible garden clearings, poorly defined curved alignments, and C-shaped windbreak walls. One site incorporates stacked walls into a natural depression. In addition, a segment of a cobble-paved trail cuts down a hillside and disappears at a drainage – perhaps a remnant of a road dating to 1882-1894 which appears to bisect the NAR from west to east on a map prepared by Erkelens (1995). This feature is outside the west boundary of the NAR.

While it is likely that some of the features recorded in the current survey were initially noted during Bordner's survey, his documentation of the features' characteristics and locations is not detailed enough to make positive correlations. Site forms with temporary numbers are included with the survey report on file at the State Historic Preservation Division. No subsurface archaeological testing has been conducted at these sites to determine age or function.

Several collapsed lava tubes occur both inside and outside the western boundary of the NAR, most of which were so small in dimension as to render interior investigation unfeasible. While no evidence of cultural modification has been observed, this does not preclude the possibility that the lava tubes were used in the past, however, since efforts were often made to conceal burials within the natural rubble deposits associated with lava flows.

V. General Description of the Action Including Environmental and Socioeconomic Characteristics

Short-Term Environmental Impacts

The most obvious short-term impacts from this project will be those associated with the actual construction of the fence line and of four-wheel drive access roads along the east/western segments of the proposed fence. Periodic noise from helicopter flights, power tools, and other activity associated with fence building will be unavoidable during the construction period. These activities will take place only during daylight hours. Because of the remoteness of the project area and the distance from residences, noise is not anticipated to constitute a significant impact.

Local air quality may be temporarily impacted by the use of bulldozers, small power equipment, and hand tools, primarily from wind blown dust from the disturbance of the ground along the fence corridor. Due to the remoteness of the project area, the distance from residences, the nature of the terrain (a'a flows), and the limited corridor to be disturbed, air quality is not anticipated to be negatively impacted to any significant degree. Over the long-term, it is anticipated that air quality may be improved as increased vegetative cover within the protective fencing reduces wind erosion.

Because Highway 31 has minimal shoulders and sight lines are poor, construction of the lower fence segment may occasionally require that short sections of one traffic lane be closed for worker safety.

As the project will take place in a sparsely populated area, with minimal vehicle traffic, these effects are not expected to be significant.

Long-Term Environmental Impacts

The primary long-term impacts from this project are those associated with disturbance of vegetation along the actual fence line. Plants will be pruned or removed along the entire path, and the width of this corridor could range from 6-10 feet [hand clearing] to 16-20 feet [bulldozing]. While much of this vegetation is expected to eventually grow back, maintenance of the fence and access roads will require that the corridors be kept partially clear, resulting in a permanent alteration of some acreage. Under the Phase I preferred alternative, with 5.1 miles of perimeter fence and assuming that a 10 foot average path width is kept clear, approximately 6.2 acres of land would be affected. As the fence proposed as the Phase I preferred alternative will protect approximately 863 acres, this represents a "loss" of less than 1 percent of the total area involved.

A secondary, and hard to predict, long-term impact will occur as the result of vegetation (both native and non-native) recovery after the removal of grazing animals from within the fence. In some parts of the Reserve, exclusion of ungulates may result in an increase in biomass of alien grasses. The increased fuel loading may create the potential for wildfire posing a significant threat to native vegetation and the native animals that these plants support. Ungulate grazing may be suppressing certain non-native woody plants, such as Bocconia and Schinus. There is potential for these and other weeds to rapidly spread and increase in cover once animals are removed. However, if ungulates are excluded from the NAR, many native species should also increase in number. Common native woody species such as Dodonaea, Osteomeles and Erythrina will likely recover quickly after the removal of ungulates. Native ferns, grasses and sedges, such as Mariscus hillebrandii, are likely recover rapidly as well. Other native taxa, including Chamaesyce, Diospyros, Reynoldsia, Myoporum, Rauvolfia, Myrsine and Nothocestrum, are expected to respond positively to ungulate removal, but less noticeably due to their slower growth rates.

Disturbance of the ground surface along the fence line, and transport of material and equipment from off-site will create increased potential for colonization by introduced species. In order to prevent the establishment of noxious weeds, it will be important to ensure that items brought to the site are clean. Follow-up monitoring and weed control in the disturbed areas will also be important.

Bulldozing to create 4WD access roads across lava flows may impact drainage patterns and increase the likelihood of erosion or runoff. However, because these activities will occur over land that is primarily a'a lava flows, it is anticipated to generate very minimal dust and erosion during and after work. Due to the nature of the terrain and the distance of the project from the ocean, the bulldozing is not anticipated to have

an impact on drainage in the area or on adjacent properties and is not anticipated to result in any runoff to the ocean.

In addition to providing access for long-term maintenance of the fence line, the 4WD access roads may also serve as fire breaks and as access routes for firefighters, contributing to long-term protection from fire for the existing NAR as well as for the residential structures in the Kanaio Homesteads area.

Native wildlife (dark-rumped petrels and Hawaiian bats) may be impacted to some degree by the installation of this fence. There have been instances elsewhere of these animals being injured after flying into fences. Neither species is known for certain to inhabit the immediate area around Kanaio. However, petrels that overfly this area are thought to be traveling at heights greater than 8 feet. Bats often fly closer to the ground, and may have a greater chance of contacting the fence wire. However, their echolocation ability may allow them to detect the fence. Further, as barbed wire is not being used for the fencing, birds and bats are unlikely to be snagged if they brush against the fencing.

Economic Impacts

This project is not expected to have any major negative economic impacts. Positive impacts will result from the release of project funds into the Maui economy, through the purchase of goods and services from local vendors (fence material and bulldozer hire), as well as short-term employment for fence crew workers.

Funds for construction of the Phase I fencing are being provided by the U.S. Fish and Wildlife Service through their endangered species recovery program, and also from the State of Hawai'i, through the Natural Area Reserves System operating budget. Additional funds and employment may be generated for Phase II fencing construction and for restoration activities, such as tree planting and weed control, funded after the fence is completed.

Indirect economic impacts may result from a change in public perception of the area from "wasteland" to that of unique and valuable natural resource. Because the NAR is easily accessed from the highway, it has great potential for use as an outdoor classroom and will likely see increased use by Maui's growing eco-tour industry.

Societal Impacts

The visual character, and public perception, of the Kanaio NAR is likely to change as a result of this project. A fence visible from the highway may detract from the "wilderness" character of Kanaio. At the same time, regrowth of vegetation will gradually convert the barren, windswept lava flows to something that appears less desolate. This will be in marked contrast to the surrounding lands where cattle and goats continue to denude the landscape.

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Public use of the fenced area may be affected as well. While the fence is not intended to block pedestrian access in any way, convenient entry to the Reserve will be restricted to those locations where gates or climb-overs are installed. Construction of new roads could also encourage increased use of motorized vehicles in the area. Gates could be subject to vandalism and could easily be bypassed by motorcycles. New roads on State land could lead to increased trespassing on Ulupalakua Ranch property, as well as increased risk of fires or other damage to resources in the NAR.

Present NAR regulations prohibit the collection of plant, animal or mineral material (except by special permit). Also, taking of certain plant and animal species is further restricted by State and Federal endangered species laws. Construction of a fence will have no effect on existing regulations, and hence should not substantially affect Native Hawaiian gathering rights. However, as the intent of the fence is to protect and restore native natural resources, the long-term impact on gathering rights may be positive. As the forest recovers, it may eventually become possible to allow limited collecting of certain species for traditional practices.

While hunting (for birds or game mammals) is not presently permitted within the NAR, there is undoubtedly some level of poaching taking place. Exclusion of ungulates from the NAR will put an end to this and will have a negative impact on those individuals that do hunt illegally in the area. This project will have minimal effect on game animal populations on the south slope of Haleakala, as the area to be fenced is a tiny fraction of the available habitat for goats and deer. Hunters with permission to use private property and/or Hawaiian Homelands in the vicinity will be unaffected.

Overall, social impacts of this project are expected to be positive. The protection and restoration of a unique remnant of Hawai'i's natural heritage will create new opportunities for nature appreciation, education, and research. A similar (though smaller scale) project on-going at Auwahi has generated overwhelming volunteer response and provided an opportunity to educate many Maui residents about the importance of protecting Hawai'i's native species.

Cultural Impacts

New fence and related access road construction may have an adverse effect on the appearance of the lava flows. In traditional Hawaiian culture, lava flows such as those exposed at Kanaio are considered the kinolau, or physical embodiment, of the goddess Pele. Extensive modification of the flows may be considered by some to be an affront to Pele and is another reason that the preferred alternative for both the Phase I and Phase II fencing involves locating the fence to minimize bulldozing of lava flows.

As presently designed, the fence project is not anticipated to pose long-term impacts to significant cultural sites. It will have no effect on cultural resources eligible or potentially eligible to the National Register of Historic Places. Though there are locations where linear stacked rock wall features run perpendicular to and consequently intersect the new fence line, the post holes will not be situated in the vicinity of existing

cultural features and the wire strands comprising the exclusion fence will cause no impact.

The planned fencing could be viewed by some as interfering with Native Hawaiian land claims, specifically those of Mr. Edward 'Uwekoolani. In the early 1990s, Mr. Edward 'Uwekoolani occupied and built improvements on "Parcel 17," located within the existing NAR, under a claim that it was family land that had belonged to his uncle. After researching land title histories, the State concluded that Mr. 'Uwekoolani's claim was not valid, and he was removed from the property. Mr. 'Uwekoolani has not taken any further legal action to pursue his land claim since his removal from the property in 1992, and protective fencing of this area is not anticipated to affect the validity of any future appeals he may make.

Over the long term, the project may actually help to preserve archaeological resources in the area, by preventing soil disturbance and trampling of sites by hooved animals.

VI. Mitigation Measures

While this project is not expected to significantly harm the environment, the following items have been identified as possible areas of concern. Planned actions to mitigate possible negative effects are described below.

Native vegetation

As noted above, construction of the fence line will require removal and/or pruning of a certain amount of plant material. In order to minimize damage, the following guidelines will be followed for both Phase I and Phase II. First, multiple surveys of the fence corridor will be made to ensure that no rare or endangered species will be injured. Second, wherever possible, the fence will be aligned so that it passes through barren or sparsely vegetated areas, and through disturbed/weedy areas instead of intact native forest. Third, common species of native plants will be removed only when necessary, and no native plants greater than 6 inches in diameter will be removed. Rare species near the fence line will be marked with distinctive flagging so that fence crews do not accidentally damage them. It is expected that the natural recovery of plants within the fence, as well as planned outplanting, will more than compensate for any damage to common species incurred during fence construction.

Non-native vegetation

The non-native shrub Nicotiana glauca (tree tobacco) is present in the NAR and serves as habitat for the endangered native moth, Manduca blackburni. To minimize disturbance to the moth, the fence will be aligned so that it avoids this plant where possible. Where avoidance of tree tobacco is not possible, visual surveys will be conducted of the foliage for the presence of eggs or larvae. Where possible, the eggs

and/or larvae will be removed from the vegetation and moved to a host plant away from the cleared area.

The disturbance to the ground surface and vegetation involved with building a fence creates ideal conditions for establishment of weedy plants. The following practices are planned during both Phase I and Phase II to minimize the possibility of establishment. First, all heavy equipment, fence material, boots, etc. will be inspected for seeds, eggs, larvae, etc. prior to delivery and/or entry into the project area and cleaned as necessary to prevent introduction of weed seeds to the area. Second, regular maintenance of the fence line will include surveys to identify and eradicate incipient pests, and vegetation management practices such as herbicide spraying and/or weeding will be used to select for increase of desirable native species over non-native plants. Planned forest restoration activities within the fenced area are expected to involve a significant non-native plant control component, which should offset some of the anticipated increase in weed cover once grazing animals are removed.

Archaeological features

As noted above, the length of the planned Phase I fencing has been surveyed by professional archaeologists and the cultural features have been digitally mapped and photographed so that project coordinators can ensure that ground disturbing activities avoid them. The proposed fence route is not anticipated to impact significant archaeological sites located within or adjacent to the proposed fence boundaries. Before construction, DOFAW will consult with USGS, BRD and with the Hawaii Speleological Society to determine the probability of caves in the areas planned for bulldozing. Once construction begins, potentially sensitive features, including collapsed lava tubes, near the line will be temporarily marked in a similar fashion to rare plants, and fence crews will be advised to avoid these areas. Any time that a bulldozer is operated on the site, it will be accompanied by a scout specifically assigned to prevent damage to sensitive natural and cultural resources. Should evidence of any archaeological or culturally significant sites be encountered during construction, vegetation clearing and fence construction would immediately cease and the State Division of Historic Preservation, the Maui Island Burial Council, and other appropriate agencies will be consulted immediately. If necessary, the alignment will be adjusted to reduce or eliminate impact to any features located during construction. For construction of the Phase II fencing, these mitigation measures will be taken. In addition, DOFAW will work closely with the State Division of Historic Preservation and archaeological and cultural experts in finalizing the fence line for Phase II to ensure that the route avoids any historically significant features.

View plane and aesthetic considerations

A fence, and the new access roads that might be required for it, might be considered to be unsightly, or offensive in that they may alter the wilderness character of the Kanaio area. While it may not be possible to completely avoid these impacts, DOFAW will attempt to lessen these impacts by placing the segment of fence along the

highway farther upslope from the road, and possibly by painting this section of fence a dark color to make it less visible.

Public Access

There are presently no developed trails, signage or other amenities to encourage public use of the NAR. This has minimized human impacts to the area, and has restricted most "casual use" to the immediate vicinity of the roadside, such as tourists pulling over to take pictures of the coastline. A fence could further discourage public use of the NAR. Viewed strictly from the standpoint of resource protection, this may be a benefit. However, appropriate public uses of the area, such as hiking, nature study, etc., may continue as long as the resources protected in the Reserve are not harmed.

Gates, stiles or other means that allow people to easily cross the fence can be installed at strategic locations, such as near some of the existing vehicle pullouts along the highway. Because this will concentrate impacts from human traffic, DOFAW will select these locations carefully, considering the surrounding vegetation, archaeological features, and whether there was an existing pathway into the NAR at that location, to ensure that traditional access is maintained while the natural resources are protected.

Gates or climb-overs spaced approximately ½ mile apart should be sufficient for public access and management purposes. Because the majority of public access will be from the highway, three or four gates located at areas where vehicles can be parked safely off the road should be adequate for most users of the Reserve.

While installing gates creates the possibility that they may be deliberately or accidentally left open, allowing animals to enter the fenced area, a ladder or climb-over type of structure will be more difficult to use on the planned eight-foot fence and could potentially be hazardous for less agile people. Due to the sparseness and low stature of the forest canopy, animals that get into the fenced area will be fairly easy to spot from the air. For these reasons, it is most likely that DOFAW will install gates rather than ladders (trusting the public to be responsible about keeping them closed) and make periodic over-flights of the enclosure to ensure that animals have not been let in.

Wildfire

The increase in plant cover (both native and non-native species) that is expected to take place after removal of grazing animals will increase the threat that wildfire poses to this dry environment. As grasses and shrubs fill in the presently barren lava flows, the potential intensity and rate of spread of fire can be expected to increase. Wildfires are a real threat, having extirpated the dry forests from large areas of the island of Hawai'i and made protecting plants from grazing animals almost a moot point. The worst threat is from dense non-native grasses, and some of these problematic species (Melinis minutiflora in particular) are present in Kanaio.

The following steps will be taken to reduce probability of a major wildfire. First, the use of weed control efforts will be implemented during construction to prevent the introduction of the two worst culprits behind Big Island fires, fountain grass (Pennisetum setaceum) and beard grass (Schyzachrium condensatum).

Second, pre-suppression and pre-planning actions will be implemented to prevent potential fires from becoming severe. Natural and artificial fuel breaks can be developed to protect the NAR from fires that may start on adjacent lands, as well as to compartmentalize the area within the fence. The potential exists to improve the existing Ranch waterlines and develop new reservoirs or helicopter dip tanks in the area.

Third, setting the lower fence back from the highway approximately fifty feet will maintain a fuel break between the fenced enclosure and the most likely source of ignition, the highway. Goats are likely to continue to graze in this strip and will keep fuels from accumulating.

Finally, over the very long term, fire danger may gradually decrease as the native vegetation recovers. The increased shade that will result as the forest canopy recovers will retain moisture and suppress flammable grasses. Fires in leaf litter and duff on the forest floor spread more slowly, and burn at lower intensities than in grass, making them easier to extinguish.

Native wildlife

There have been instances of native sea birds and bats being injured after contacting wire fences. As these animals could be present in the project vicinity, there is a possibility that they may occasionally hit the fence. While there is no way to completely prevent this, the planned fencing is designed to reduce the impact to the bird or bat should they fly into the fence. Recognizing that many injuries to bats and birds are a result of snags on barbed wire, only barbless mesh wire will be used for the fencing, reducing the likelihood of animals being hooked on the fence.

After installation, maintenance of the fence line will include monitoring for the presence of injured animals. If a large number of strikes do take place, one mitigation measure would be to add a band of opaque material to the upper 1 foot or 2 feet of the fence, making it more visible to flying animals. If this is not successful, and large numbers of birds or bats continue to be injured by the fencing, it may be possible to lower the height of the fence from 8 feet to 6 feet. The taller fence is preferred and is necessary to completely exclude deer, but an increased level of aerial survey and hunting may be sufficient to remove animals that jump the 6 foot high wire should this be necessary to protect other native wildlife.

Vandalism

Construction of a new road and gates on the State land on the western side could be subject to vandalism and trespassing onto neighboring Ulupalakua Ranch and

State properties. To mitigate the impact of trespassing, DOFAW will evaluate whether the new road should be placed inside the planned fencing. Placement of the road inside the fencing would essentially prevent unauthorized use of the road to access neighboring land. However, because the existing road and gate controlled by Ulupalakua Ranch on the eastern side does not have significant vandalism problems, this mitigation measure may be unnecessary. Appropriate signage, posted at any gates, may be sufficient to deter vandalism and trespassing.

Erosion and runoff

The planned bulldozing of 4WD access roads to facilitate fence construction and maintenance may contribute to erosion or runoff. To minimize the possibility of this occurrence, the Division of Forestry and Wildlife's Best Management Practices for Maintaining Water Quality in Hawaii (1996) will be incorporated during construction. (A copy of these Best Management Practices is included in Appendix F). Specific Best Management Practices to be incorporated include: locating roads to fit topography and minimize alterations to the natural features; provision of dips and water bars to minimize road bed erosion; avoidance of diverting water from natural drainage ways; keeping road grades at less than 10%, except where terrain unavoidably requires a short, steep grade; and other measures as needed. The nature of the terrain, combined with these practices, should mitigate any potential erosion or runoff caused by construction.

VII. Alternatives Considered

Phase I
Preferred alternative

The preferred alternative for Phase I fencing involves enclosing the portion of the Reserve above Highway 31, roughly following the actual boundaries of the existing NAR on the north, going outside the NAR boundaries to the east on private land owned by Ulupalakua Ranch, following Highway 31 to the south, and going outside the NAR boundaries to the west on State-owned unencumbered land, for a total of approximately 850 enclosed acres. Because the pipeline road does not exactly follow the mauka NAR boundary, approximately 14 acres of the NAR above this road would be left outside the fence. Approximately 90 acres of State unencumbered land would be included within the fence line on the western side, and approximately 190 acres of private land would be included within the fence line on the eastern side.

The preferred alternative is located entirely within the Agricultural District and does not extend below Highway 31.

Fencing the upper part of the NAR mauka of the highway will focus management on the more biologically significant portion of the Reserve, which holds the better quality forest remnants. Restoration efforts directed at the upper portion of the Reserve may

be more successful due to the slightly wetter climate and availability of water from the pipeline at the top of the NAR.

The lava flow substrate characterizing most of the area along the boundary of the NAR is rugged. These flows extend laterally only a short distance outside the actual Reserve boundaries. Road building, fence installation, and future maintenance will be easier and safer on the older substrate outside the NAR boundaries than on the lava flows. Placement of the fence outside the actual NAR boundary will also protect sizeable "extra" tracts of native vegetation, without much increase in cost.

The western fence segment would be built along a new road to be constructed on the unencumbered State land adjacent to the NAR, avoiding the lava flow on this side. The lava flows on the west edge of the NAR are predominantly smooth pahoehoe. As a result, animals have grazed this area fairly intensively, and the diversity of native vegetation within this 90 acre tract is fairly low, characterized mostly by scrubby Dodonaea and Osteomeles bushes. However, the pahoehoe in this area is likely to contain caves, and placement of this area within the planned fencing may prevent damage to cave resources by eliminating goat traffic in the cave entrances and prevent inadvertent damage during fence construction. Beyond the lava, the substrate changes to well-developed soil that has been in pasture for decades. Here, there are fewer native plants, caves are unlikely, and archaeological features are largely visible on the ground surface and can be avoided.

The eastern fence segment would follow a new road built at the edge of the lava flow. The proposed route would enclose some private land owned by Ulupalakua Ranch. The Auwahi portion of the lava flow, extending onto private land, has a significant amount of high quality native vegetation remaining on the rugged 'a'a. Some rare plants have been located here; others are likely to be found with more survey work. While this area has been subject to a fair amount of grazing, there is excellent potential for recovery once animals are removed. In addition, including this area within the fencing creates an opportunity to preserve a little more of this rapidly vanishing Hawaiian dry forest through partnership with the adjoining landowner, Ulupalakua Ranch. Ulupalakua Ranch recognizes the value of the native resources on their land and is a willing participant in this project. Aligning the eastern fence so that Ranch lands are included will create a strong public-private partnership and will efficiently use resources to protect an area with biological importance similar to that inside the NAR.

The following alternatives were considered for Phase I, but were rejected for the reasons discussed further below:

1) Fencing the upper Reserve along the actual NAR boundary (approximately 580 acres);
2) Fencing the upper Reserve along the proposed alignment of the preferred alternative, but omitting Parcel 17 (approximately 750 acres);
3) Fencing the entire Reserve along the actual NAR boundary (approximately 876 acres);

4) Multiple smaller enclosures throughout the Reserve that protect the areas of highest biological value (total 100 to 200 acres); and
5) No-build alternative.

Fencing the upper Reserve along the actual NAR boundary

This alternative is not preferred because the NAR boundary lies on relatively recent lava flows that will increase the difficulty, danger, and expense of fence construction.

The lava flow substrate characterizing most of the area along the boundary of the NAR is rugged. Building fences on unmodified lava flows (as opposed to roads) is difficult and expensive because it requires that materials be transported to the site, and the fence wire unrolled, by helicopter. Power equipment such as rock drills and post-pounders must be hand carried along the fence line, rather than transported in a truck. More effort and expense are necessary to make fences conform to the irregular topography, and to prevent animals from exploiting gaps between the fence wire and the ground.

Building roads on recent lava flows, especially pahoehoe flows, can also be dangerous due to the presence of hidden caves that might collapse under the weight of a bulldozer. Bulldozing also increases the potential for damage to archaeological features, either on the surface or in lava tubes. Because the rugged, rocky nature of the Kanaio lava flows has kept the intensity of animal grazing lower than in the surrounding areas with deeper soil, in many places, intact native vegetation persists right to the edge of the lava, and then abruptly changes to non-native pasture grasses. Bulldozing on the flow will likely damage native plants, no matter how careful the equipment operator is.

Fencing the upper Reserve along the proposed alignment of the preferred alternative, but omitting Parcel 17

This alternative would avoid objections to the protective fencing that are based on the contention that Parcel 17 was improperly "taken" from a Native Hawaiian, Mr. Edward 'Uwekoolani. In the early 1990s, Mr. Edward 'Uwekoolani occupied and built improvements on "Parcel 17," approximately 85 acres located in the southeast corner of the existing NAR, under a claim that it was family land that had belonged to his uncle. After researching land title histories, the State concluded that Mr. 'Uwekoolani's claim was not valid, and he was removed from the property.

This alternative is not preferred because the primary purpose of the planned fencing project is for the protection of native ecosystems contained within Kanaio NAR, and Parcel 17 has significant biological value, containing one of the four endangered Bonamia menziesii plants known in the NAR as well as significant populations of Capparis, Reynoldsia, Nothocestrum, and Nesoluma, plant species considered for listing as endangered. The endangered plant Spermolepis hawaiiensis has been observed in other areas of the NAR and could possibly be located within Parcel 17 as

well. Nothocestrum trees found within Parcel 17 also constitute essential habitat for the endangered Blackburn's Sphinx Moth. In addition, in contrast to the rest of the NAR, Parcel 17 has well-developed soils, which when combined with the proximity to the highway and the gentle terrain, makes this area ideal for outplanting and restoration efforts.

Further, this alternative is not preferred because DOFAW needs to be able to administer and manage Kanaio NAR in the best interests of the entire NAR. Changing the fence alignment to exclude Parcel 17 would greatly increase the cost and complexity of the project, requiring an additional mile of fencing to be built over rough lava, rather than along the highway. This portion would cross through an area with a high density of archaeological sites, making use of a bulldozer inappropriate and further increasing the difficulty of the project. Additional archaeological and botanical surveys would be required, as this alignment was not covered during the original reconnaissance surveys.

Finally, Mr. 'Uwekoolani has not taken further legal action to pursue his land claim since his removal from the property in 1992. Unless and until a valid claim to Parcel 17 is made, treating Parcel 17 differently from the rest of the NAR by excluding it from the protective fencing and allowing further degradation of the biological resources of this area is not justified.

Fencing the entire Reserve along the actual NAR boundary

While this alternative would protect the entire NAR from ungulate browsing and grazing, clearly delineate the entire boundary of the NAR, and potentially positively affect more rare species, it is not the preferred alternative at this time for the following reasons.

Constructing a fence around the entire NAR boundary would enclose approximately 876 acres. Because Highway 31 bisects the NAR, fencing the entire NAR would require the installation of deer-guards where the fence intersects the roadway to ensure free movement of cars while preserving the integrity of the fence. Installing and maintaining "deer-guards" at the highway crossings will be costly and will inconvenience motorists. Although "cattle-guards" may be effective in controlling cows, pigs and goats, they may not work for more agile ungulates such as deer. An alternative to deer or cattle - guards would be to run fences along both sides of the highway, as well as around the NAR perimeter. This "twin unit" requiring an eight-foot fence along both sides of the highway, might be considered an eyesore, especially as fencing of the makai portion of the NAR could interfere with views of the ocean. The total amount of fence required would be approximately 9 miles.

Further, unless new roads are built around the entire NAR perimeter, a fence around the lower part of the Reserve will be built entirely on rough lava flows, which would delay completion of the project significantly and increase the cost and difficulty.

Because there are no existing 4WD roads along the lower Reserve, five or more miles of new road would be required to make a perimeter road around the entire Reserve.

Finally, a significant portion of the NAR below the highway is naturally barren lava flow or dominated by alien weeds and cannot be expected to show short-term "recovery" without intensive management. Excluding animals from this area may have little noticeable result. Initial restoration efforts (tree planting, weed control) are expected to take place at higher elevations, so building a fence around the entire NAR without conducting active management on the lower portion could create a negative perception of the project if improvements are not noticeable.

Multiple smaller enclosures throughout the Reserve that protect the areas of highest biological value

This alternative would target one or more discrete areas entirely within the NAR boundaries, such as a large stand of native dry forest trees present near the center of the Reserve and the upper/eastern corner of the Reserve, which contains many rare plants and appears never to have been burned. Some of the Auwahi tract lands might be included as well. While fencing small areas would focus recovery and restoration efforts on the most intact and biologically significant areas of the Reserve and reduce the amount of fencing visible from the highway, this alternative is not preferred because it would not protect the regional ecosystem from feral ungulates nor would it allow for large-scale outplanting or restoration efforts. Further, by allowing degradation of the rest of the Reserve, it could reduce the long-term viability of many species in the Reserve. Finally, access to these areas would be difficult, making the fences expensive to build and maintain.

No Build alternative

The no-build alternative maintains the status quo of no fence construction on any part of the Kanaio NAR. Under this Alternative, hunting (by DOFAW staff) would be the only method used to reduce animal populations within the NAR. Other actions such as weed control might still take place. This alternative would not protect the ecosystem from feral ungulates nor would it allow for large-scale outplanting or restoration efforts. Further, by allowing continued degradation of the Reserve by feral ungulates, it could reduce the long-term viability of many species in the Reserve. The no-build alternative is not preferred as it does not provide any significant long-term protection to the unique natural resources of the NAR.

Phase II
Preferred alternative

The preferred alternative for the Phase II fencing is to enclose the proposed expansion area, roughly following the boundary of the proposed addition. This alternative would connect to the Phase I fencing, so that no new fencing would be required along the south portion. Gates would be constructed where the fencing

crosses the existing pipeline road. On the north, the fencing would roughly follow an existing four-wheel drive road. To the east and the west, the fencing of Phase I would be extended north to connect with the northern section.

Multiple smaller exclosures

While fencing small areas could focus recovery and restoration efforts on smaller areas of biological significance within the proposed expansion area, it would not provide long-term protection for the native shrubland community which extends over most of the proposed expansion area. Fencing fragmented portions of this community would fail to fully protect this native dryland community, which possesses significant biological value through its size and intactness. Finally, access to these areas would be difficult, making exclosure fences expensive to build and maintain.

No-build alternative

The no-build alternative maintains the status quo and involves no fence construction. Under this Alternative, once the area is set aside as an expansion to the existing NAR, hunting (by DOFAW staff) would be the only method used to manage animal populations. Hunting alone is not sufficient to protect the ecosystem from feral ungulates nor would it allow for large-scale restoration efforts. The no-build alternative is not preferred because it does not ensure the long-term protection of the unique natural resources, including the native shrubland community.

VIII. Anticipated Determination

It is expected that this project will not have a significant negative impact to the surrounding environment, and a Finding of no Significant Impact (FONSI) is anticipated.

IX. Findings and Reasons Supporting the Anticipated Determination

This determination is based on the evaluation of the project in relation to the following criteria identified in the Hawai'i Administrative Rules § 11-200-12:

1) Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.

The intent of this project is to benefit natural resources (primarily native plants) protected in and around the Kanaio NAR. Some common native plants may be damaged during fence construction, but not to any significant degree. Regeneration of native plants after removal of grazing animals is expected to more than offset damage incurred during construction. Disturbance of the ground surface will be limited to areas where archaeological features are not present. The project may indirectly benefit the

preservation of sites in the area, as trampling and soil disturbance by feral animals will be stopped.

2) Curtails the range of beneficial uses of the environment.

Appropriate public access to and use of the area will not be affected. The site will remain open space, managed as a Natural Area Reserve. Gates will be constructed along the fence line to ensure continued public access into the Reserve. The only use of the area that will be curtailed will be hunting of feral mammals, which is not legally permitted at present.

3) Conflicts with the state's long term environmental policies or goals and guidelines as expressed in Chapter 344, Hawai'i Revised Statute

This project follows the mandate of the state Natural Area Reserve Law, HRS 195, which mandates that Reserves "...preserve in perpetuity specific land and water areas which support communities, as unmodified as possible, of the natural flora and fauna..." and is consistent with the State's long-term environmental policies, goals and guidelines.

4) Substantially affects the economic or social welfare of the community or state.

This project is not expected to have substantial impact on the economy, as there is no present economic use of the site, and funds for implementation are coming from normal government operational budgets. Social impacts are expected to be positive, as the community will benefit from the protection and restoration of this unique example of Maui's rapidly vanishing natural heritage, in the form of improved opportunities for nature appreciation, education, and research.

5) Substantially affects public health.

The project site is in a remote, rural area. Implementation is not expected to create any offsite effects that might affect public health, other than short-term generation of small amounts of windblown dust, noise generated by small power tools, and occasional use of bulldozers and helicopters.

6) Involves substantial secondary impacts, such as population changes or effects on public facilities.

The only facility impacted will be Highway 31; public use may be affected in the form of occasional lane closures while fence construction takes place along the highway. No change of population will result from this project.

7) Involves a substantial degradation of environmental quality.

The intent of the project is to improve environmental quality by restoring a natural forest system. Off-site benefits may include reduced soil erosion and watershed enhancement, and improvement of air quality, nearshore water quality, and the health of reef ecosystems.

8) Is individually limited, but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.

The preferred alternative is a stand-alone project that will affect only this one site. There are several other forest protection projects on-going or planned for the south Maui area, including some projects on adjacent private land. The recent formation of the Leeward Haleakala Watershed Restoration Partnership may lead to the development of a regional conservation plan that addresses all of these sites and allows for leveraging of resources. While the proposed fencing is planned independently of other conservation projects, the cumulative effect of potential projects is beneficial.

9) Substantially affects a rare, threatened or endangered species or its habitat.

The purpose of the project is to protect a native Hawaiian dry forest, a threatened natural community, and the plant and animal species found therein. At least 12 rare plant species are known from the area surrounding Kanaio NAR; all will benefit from increased protection, as will numerous other species that could potentially be reintroduced to the area. The proposed action would also create a secure site for future restoration efforts. Finally, the project area falls within the designated federal critical habitat for threatened and endangered plants and for the Blackburn's sphinx moth. Protection of this dry forest ecosystem is in accordance with the recovery plans for the species.

10) Detrimentally affects air or water quality or ambient noise levels.

Some noise will be generated during fence construction, primarily from small power equipment and hand tools, with occasional operation of bulldozers and helicopters. This activity will take place only during daylight hours, and far from any residential area. Local air quality may be slightly affected by windblown dust when soil is disturbed along the fence corridor. In the longer term, regional air and water quality may be improved when increased vegetative cover reduces soil erosion.

11) Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters.

The project area is not near any of the above features. The substrate is of moderate sloping, stable volcanic rock, in an area with low rainfall and no perennial streams. Fence alignments were chosen to avoid crossing gulches that carry water during winter storms.

12) Substantially affects scenic vistas or view planes identified in county or state plans or studies.

The view plane in the Kanaio-Luala'ilua area meets requirements for inclusion in the National Register, although there is no evidence that it has ever been nominated. The most visible portion of the project will be the section of fence installed along the mauka side of Highway 31. Construction of the fencing as proposed will not obstruct views of the ocean. Because the fencing will be set back from the road approximately 50 feet, it is not expected to interfere with views of the mountain. The primary land use in the surrounding area is cattle ranching; fences line much of the highway already, and although this fence will be slightly taller, it will not appear substantially different than the surrounding landscape. Finally, if needed to minimize the visual impact, DOFAW may paint this section of fence a dark color to blend better with the background.

13) Requires substantial energy consumption.

Energy will be consumed during fence construction by handheld power equipment, 4WD vehicles, and occasional operation of bulldozers and helicopters. After completion of the project, there will be minimal demand for energy use.

X. List of Permits Required

Construction of fencing and accessory roads within Kanaio NAR and on adjacent State unencumbered land will require approval of the Board of Land and Natural Resources, including a right of entry for installation of fencing on the unencumbered land. Formal expansion of the existing NAR will require approval by the Board of Land and Natural Resources and an Executive Order by the Governor. Construction of 4WD access roads through the use of a bulldozer will require a Grubbing/Grading permit from the County of Maui Department of Public Works.

XI. EA Preparation Information

This Environmental Assessment was prepared by:

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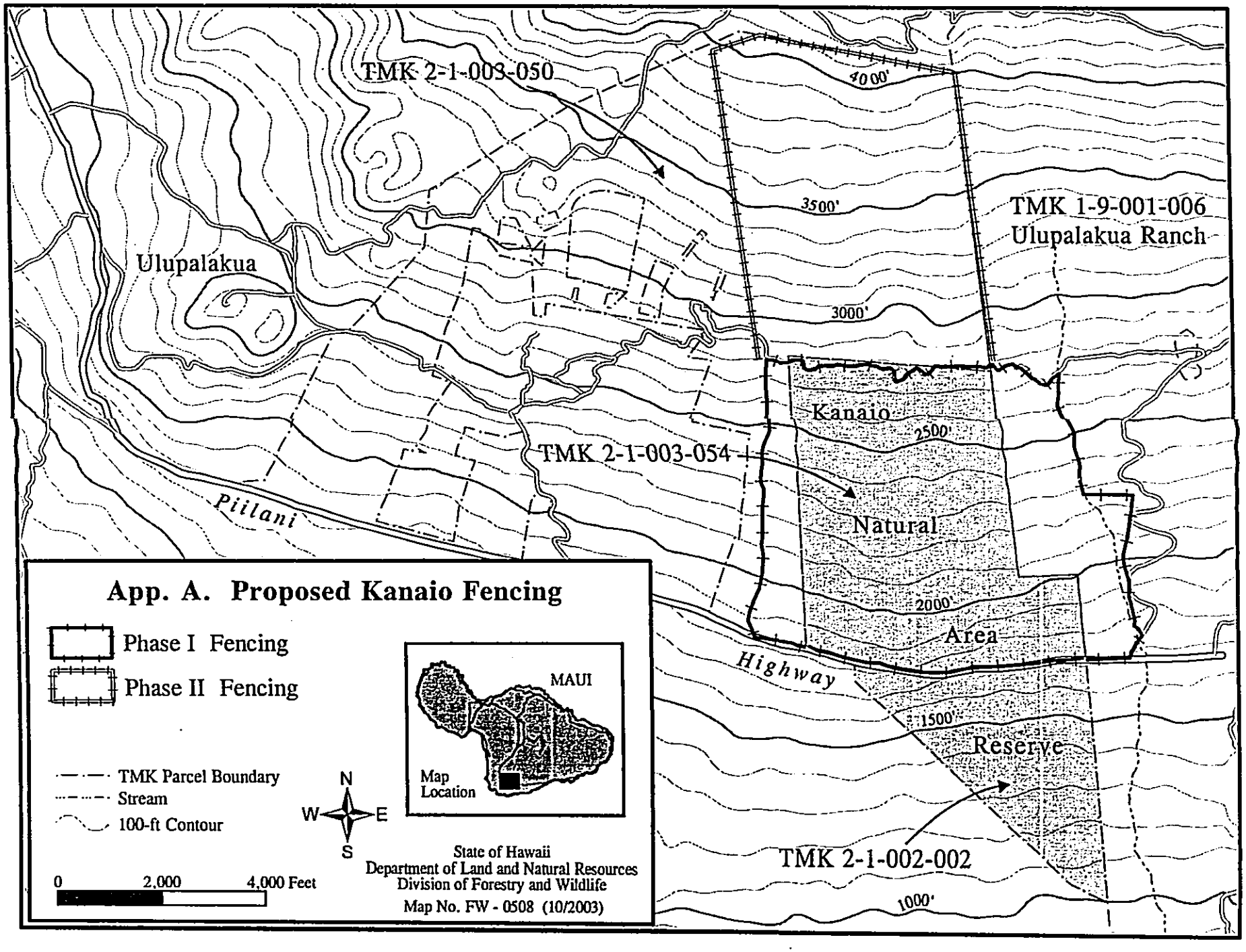
XIII. List of Appendices

Appendix A: Map of the Project Area
Appendix B: Plant Inventory List
Appendix C: Checklist of Birds and Mammals
Appendix D: Species with Designated Critical Habitat in the Project Area
Appendix E: Cultural Resources Investigation Report
Appendix F: Division of Forestry and Wildlife Best Management Practices for Maintaining Water Quality in Hawai'i
Appendix G: Comments Received During Public Comment Period and Responses

Appendix A

Map of the Project Area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TMK 1-9-001-006
Ulupalakua Ranch
Ulupalakua
3000'
Kanaio
2500'
TMK 2-1-003-054
Natural
Area
2000'
Piilani
Highway
1500'
Reserve
TMK 2-1-002-002
1000'
App. A. Proposed Kanaio Fencing
Phase I Fencing
Phase II Fencing
MAUI
Map Location
TMK Parcel Boundary
Stream
100-ft Contour
N
W
E
S
0
2,000
4,000 Feet
State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
Map No. FW - 0508 (10/2003)

Appendix B

Plant Inventory List

Kanaio Natural Area Reserve Plant Inventory

Based on Medeiros et. al. (1993) and NARS staff field notes
Taxonomy follows Wagner et. al. (1990) revised

Ferns and Fern Allies

	Scientific Name	Common Name	Distribution	Federal Status
Aspleniaceae				
	Asplenium adiantum-nigrum	'iwa'iwa, manawahua	IND	
	Asplenium praemorsum	'iwa'iwa a kane	IND	
Dennstaediaceae				
	Pteridium aquilinum var. decompositum	kilau	END	
Dryopteridaceae				
	Dryopteris unidentata	'akole	END	
	Nephrolepis multiflora	'okupukupu	NAT	
Polypodiaceae				
	Pleopeltis thunbergiana	pakahakaha, 'ekaha 'akolea	IND	
	Polypodium pellucidum	'a'e, 'a'ae, ae lau nui	END	
Psilotaceae				
	Psilotum nudum	moa	IND	
Pteridaceae				
	Doryopteris decipiens	kumuniu, 'iwa'iwa	END	
	Pellaea ternifolia	kalamoho	IND	
	Pityrogramma austroamericana	golden fern	NAT	

END = Endemic Hawaiian species
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T = Threatened
C = Candidate for listing
SOC = Species of Concern

Monocotyledonous Plants

Scientific Name	Common Name	Distribution	Federal Status
Agavaceae			
Pleomele auwahiensis	hala pepe, le'ie	END	
Cyperaceae			
Carex wahuensis		END	
Cyperus gracilis	McCoy grass	NAT	
Cyperus hillebrandii	umbrella sedge	END	
Poaceae			
Bothriochloa pertusa	pitted beardgrass	NAT	
Cenchrus agrimoniodes var. agrimoniodes	kamanomano, kumanomano	END	E
Cenchrus ciliaris	buffelgrass	NAT	
Cenchrus echinatus	common sandbur	NAT	
Digitaria ciliaris	Henry's crabgrass, kukaepua`a	NAT	
Eragrostis variabilis	kawelu, `emo loa	END	
Melinis minutiflora	molasses grass	NAT	
Panicum maximum	guinea grass	NAT	
Panicum pellitum	kai`oi`o	END	
Pennisetum clandestinum	kikuyu grass	NAT	
Pennisetum purpureum	elephant grass, Napier grass	NAT	
Rhynchelytrum repens	Natal redtop	NAT	
Sporobolus africanus	African dropseed	NAT	

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Dicotyledonous Plants

Scientific Name	Common Name	Distribution	Federal Status
Amaranthaceae			
Amaranthus spinosus	spiny amaranth	NAT	
Nototrichium sandwicense	kulu'i	END	
Anacardiaceae			
Schinus terebinthifolius	Christmasberry, wilelaiki	NAT	
Apiaceae			
Foeniculum vulgare	sweet fennel	NAT	
Petroselinum crispum	parsley	NAT	
Apocynaceae			
Alyxia oliviformis	maile	END	
Rauvolfia sandwicensis	hao	END	
Araliaceae			
Reynoldsia sandwicensis	'ohe, 'ohe kukuluae'o, 'ohe makai	END	SOC
Asclepiadaceae			
Asclepias curassavica	butterfly weed	NAT	
Asclepias physocarpa	balloon plant	NAT	
Asteraceae			
Ageratina adenophora	Maui pamakanai	NAT	
Ageratina riparia	Hamakua pamakani	NAT	
Ageratum conyzoides	maile honohono	NAT	
Bidens pilosa	ki nehe	NAT	

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Cirsium vulgare	bull thistle	NAT
Conyza bonariensis	hairy horseweed	NAT
Dubautia linearis subsp. linearis	na`ena`e	END
Emilia fosbergii	pualele	NAT
Galinsoga parviflora	galinsoga	NAT
Gamochaeta purpurea	purple cudweed	NAT
Gnaphalium japonicum		NAT
Heterotheca grandiflora	telegraph weed	NAT
Hypochoeris glabra	smooth cat's ear	NAT
Hypochoeris radicata	hairy cat's ear	NAT
Lactuca serriola	prickly lettuce	NAT
Pluchea symphytifolia	sourbush	NAT
Pseudognaphalium sandwicensium var. sandwicensium	`ena'ena	END
Sigesbeckia orientalis	small yellow crown-beard	NAT
Sonchus asper	prickly sow thistle	NAT
Synedrella nodiflora	nodeweed	NAT
Tridax procumbens	coat buttons	NAT
Verbesina encelioides	golden crown-beard	NAT
Vernonia cinerea	little ironweed	NAT
Wollastonia lavarum	nehe	END
Xanthium strumarium	cocklebur, kikania	NAT
Zinnia peruviana	pua pihi	NAT
ssieneeae		
Capsella bursa-pastoris	shepherd's purse	NAT
Lepidium virginicum	pepperwort, peppergrass	NAT
Sisymbrium officinale	hedge mustard	NAT

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Cactaceae				
	Opuntia ficus-indica	prickly pear, panini	NAT	
Capparaceae				
	Capparis sandwichiana	maiapilo, pilo, pua pilo	END	SOC
Caryophyllaceae				
	Arenaria serpyllifolia	thyme-leaved sandwort	NAT	
	Polycarpon tetraphylla	all seed	NAT	
	Silene gallica	small-flowered catchfly	NAT	
Chenopodiaceae				
	Chenopodium ambrosioides	Mexican tea, wormseed	NAT	
	Chenopodium oahuense	`aheahea, `aweoweo	END	
Convolvulaceae				
	Bonamia menziesii		END	E
	Ipomoea indica	koali `awa	IND	
	Ipomoea tuboides	Hawaiian moon flower	END	
	Jacquemontia ovalifolia	pa`u o Hi`iaka	END	
Crassulaceae				
	Kalanchoe pinnata	air plant, `oliwa ku kahakai	NAT	
Cucurbitaceae				
	Cucumis dipsaceus	hedgehog or teasel gourd	NAT	
	Momordica charantia	balsam pear	NAT	
	Sicyos pachycarpus	kupala	END	
Ebenaceae				
	Diospyros sandwicensis	lama, elama	END	

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Epacridaceae				
	Styphelia tameiameiae	pukiawe, 'a'ali'i mahu	IND	
Euphorbiaceae				
	Aleurites moluccana	kukui	POL	
	Antidesma pulvinatum	hame	END	
	Chamaesyce celastroides var. lorifolia	'akoko, koko	END	
	Chamaesyce hirta	garden spurge	NAT	
	Euphorbia peplus	petty spurge	NAT	
	Ricinus communis	castor bean, pa'aila	NAT	
Fabaceae				
	Acacia farnesiana	klu	NAT	
	Acacia koaia	koaia	END	SOC
	Chamaecrista nictitans	partridge pea, lauki	NAT	
	Crotalaria incana	fuzzy rattlepod, kukaehoki	NAT	
	Desmodium incanum	Spanish clover, ka'imi	NAT	
	Desmodium sandwicense	Spanish or chili clover, pua pilipili	NAT	
	Desmodium triflorum	tick trefoil, tick clover	NAT	
	Erythrina sandwicensis	wiliwili	END	
	Indigofera suffruticosa	indigo, 'iniko	NAT	
	Leucaena leucocephala	koa haole	NAT	
	Macroptilium lathyroides	wild bean, cow pea	NAT	
	Mimosa pudica	sensitive plant, pua hilahila	NAT	
	Neonotonia wightii		NAT	
	Sophora chrysophylla	mamane, mamani	END	
	Tephrosia purpurea	'auhuhu, 'auhola	POL	
	Trifolium repens	white clover	NAT	

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	Vigna o-wahuensis	O`ahu vigna	END	E
Flacourtiaceae				
	Xylosma hawaiiense	maua	END	
Gentianaceae				
	Centaurium erythraea	bitter herb, European centaury	NAT	
Lamiaceae				
	Plectranthus parviflorus	`ala`ala wai nui wahine	IND	
	Salvia coccinea	scarlet or Texas sage, lililchua	NAT	
	Salvia occidentalis	West Indian sage	NAT	
Lauraceae				
	Cinnamomum camphora	camphor tree	NAT	
Malvaceae				
	Abutilon grandifolium	hairy abutilon	NAT	
	Malva parviflora	cheese weed	NAT	
	Malvastrum coromandelianum	false mallow	NAT	
	Sida fallax	`ilima	IND	
	Sida rhombifolia		NAT?	
Menispermaceae				
	Cocculus orbiculatus	huehue	IND	
Myoporaceae				
	Myoporum sandwicense	naio, bastard sandalwood	IND	
Myrsinaceae				
	Myrsine lanaiensis	kolea	END	

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Myrtaceae			
	Metrosideros polymorpha	'ohi'a, 'ohi'a lehua	END
	Psidium guajava	common guava, kuawa	NAT
Nyctaginaceae			
	Boerhavia sp.	'alena	IND?
	Mirabilis jalapa	four-o'clock	NAT
Oleaceae			
	Nestegis sandwicensis	olopua	END
Oxalidaceae			
	Oxalis corniculata	'ihi 'ai, yellow wood sorrel	IND?
Papaveraceae			
	Argemone glauca	pua kala, prickly poppy	END
	Bocconia frutescens	tree poppy	NAT
	Hunnemannia fumariifolia	Mexican tulip poppy, golden cup	NAT
Passifloraceae			
	Passiflora subpeltata	white passion flower	NAT
Piperaceae			
	Peperomia leptostachya	'ala' ala wai nui	IND
	Peperomia tetraphylla	'ala'ala wai nui	IND
Plantaginaceae			
	Plantago lanceolata	narrow-leaved or English plantain	NAT
	Plantago major	broad-leaved or common plantain, laukahi	NAT
Plumbaginaceae			

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	Plumbago zeylanica	`ilie`e, hilie`e	IND	
Polygonaceae				
	Rumex acetosella	sheep sorrel	NAT	
Portulacaceae				
	Portulaca oleraceae	pigweed, `akulikuli kula	NAT	
	Portulaca pilosa	purslane	NAT	
Primulaceae				
	Anagallis arvensis	scarlet pimpernel	NAT	
Proteaceae				
	Grevillea robusta	silk oak	NAT	
Rhamnaceae				
	Alphitonia ponderosa	kauila, o'a	END	SOC
Rosaceae				
	Osteomeles anthyllidifolia	`ulei, u`ulei	IND	
Rubiaceae				
	Psychotria mauiensis	`opiko	END	
	Psydrax odoratum	alahe'e	IND	
Rutaceae				
	Melicope adscendens	alani	END	E
	Melicope hawaiensis	mancna, alani	END	SOC
	Melicope knudsenii	alani	END	E
	Melicope mucronulata	alani	END	E
Santalaceae				

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	Santalum ellipticum	`iliahialo`e, coast sandalwood	END	
	Santalum freycinetianum var. lanaiense	`iliahi	END	E
Sapindaceae				
	Dodonaea viscosa	`a`ali`i, kumakani	IND	
Sapotaceae				
	Nesoluma polynesicum	keahi	IND	SOC
	Pouteria sandwicensis	`ala`a, aulu	END	
Scrophulariaceae				
	Veronica arvensis	corn speedwell	NAT	
Solanaceae				
	Datura stramonium	jimson weed, la`au hano, kikania haole	NAT	
	Nicotiana glauca	tree tobacco, makahala	NAT	
	Nothocestrum latifolium	`aiea, halena	END	C
	Physalis peruviana	Cape gooseberry, poha	NAT	
	Solanum americanum	glossy nightshade, popolo	IND?	
	Solanum linnaeanum	apple of Sodom, popolo kikania	NAT	
Sterculiaceae				
	Waltheria indica	`uhaloa	IND	
Thymelaeaceae				
	Wikstroemia monticola	`akia, kauhi	END	
Tiliaceae				
	Triumfetta semitriloba	Sacramento bur	NAT	
Verbenaceae				
	Lantana camara	lantana, lakana, la`au kalakala	NAT	

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	Stachytarpheta cayennensis	nettle-leaved vervain	NAT
	Verbena littoralis	vervain, owi	NAT
Viscaceae			
	Korthalsella cylindrica	hulumoa, kaumahana	END

B-12

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Appendix C

Checklist of birds (both fossil and extant) and mammals, Kanaio NAR

(Reprinted from Medeiros, A.C., L.L. Loope and C.G. Chimera. 1993. Kanaio Natural Area Reserve Biological Inventory and Management Recommendations. Appendix 2).

Taxonomy and distributional information follows Pratt *et al.* (1987) and Olson and James (1991)

CLASS AVES – BIRDS
FAMILY PLATALEIDAE - Ibises
Apteribis brevis - Hawaiian flightless ibis
Extinct species known only from East Maui. Olson and James (1991:23-26)

Apteribis sp. (Maui) - Hawaiian flightless ibis
Olson and James (1991:26-28) Extinct species

FAMILY ANATIDAE - Swans, Geese, and Ducks
Branta hylobadistes
Olson and James (199 1:4547). Extinct species

Branta sandvicensis – Nene
Endangered species. Olson and James (1991:4245)

Ptaiochen pau
Olson and James (1991:3942). Extinct species

Thambetochen chauliodous
Olson and James (1991:37-38). Extinct species

FAMILY ACCIPITRIDAE - Kites, Eagles, and Hawks
Haliaeetus **sp.** – Hawaiian eagle
Olson and James (1991:62-64). Extinct species

FAMILY PHASIANIDAE - Gallinaceous birds
Alectoris chukar - Chukar
[Alien: uncommon in the reserve]

Francolinus francolinus – Black Francolin
[Alien]

Francolinus pondicerianus - Gray Francolin
[Alien]

Phasianus colchicus - Ring-necked Pheasant
[Alien]

FAMILY RALLIDAE - Rails, Gallinules, and Coots
Porzana keplerorum - *Moho*
Olson and James (199 1:55-56). Extinct species

Porzana severnsi - *Moho*
Olson and James (1991:60-62). Extinct species

Porzana **sp.** "medium Maui rail" - *Moho*
Olson and James (1991:57-59). Extinct species

FAMILY COLUMBIDAE - Pigeons and Doves
Columba livia - Rock Dove
[Alien]

FAMILY TYTONIDAE - BARN OWLS
Tyto alba - Common Barn Owl
[Alien]

FAMILY STRIGIDAE - TYPICAL OWLS
Asio flammeus - *PUEO*, Short-eared Owl
Species of Concern

Grallistrix erdmani
Olson and James (1991:8041). Extinct species

FAMILY ALAUDIDAE - LARKS
Alauda arvensis - Eurasian skylark
[Alien]

FAMILY EMBERIZIDAE - EMBERIZINE FINCHES AND THEIR RELATIVES
Cardinalis cardinalis - Northern Cardinal
[Alien]

FAMILY ESTRILDIDAE - WAXBILLS, MANNIKINS, AND PARROTFINCHES
Lonchura punctulata - Nutmeg Mannikin, Spotted Munia
[Alien]

FAMILY FRINGILLIDAE - GROSBEAKS, FINCHES, SPARROWS, AND BUNTINGS
Carpodacus mexicanus - House Finch
[Alien]

Paroreomyza montana – Maui Creeper
Historical

Himatione sanguine – Apapane
Historical

Telespiza ypsilon
Olsen and James (1991: No. 46) Extinct species.

Telespiza sp.
Olsen and James (1991: No. 46) Extinct species.

Telespiza sp.
Olsen and James (1991: No. 46) Extinct species.

Chloridops wahi
Olsen and James (1991: No. 46) Extinct species.
Chloridops sp.
Olsen and James (1991: No. 46) Extinct species.

Incertae Sedis – Unassigned Maui Finch
Olsen and James (1991: No. 46) Extinct species.

Rhodacanthis aff. palmeri
Rothschild, 1892 Extinct species
Rhodacanthis aff. flaviceps
Rothschild, 1892 Extinct species

Xestospiza fastigialis
Olsen and James (1991: No. 46) Extinct species.

Vangulifer mirandus
Olsen and James (1991: No. 46) Extinct species.

Vangulifer neophasis
Olsen and James (1991: No. 46) Extinct species.

Aidemedia lutetiae
Olsen and James (1991: No. 46) Extinct species.

FAMILY MIMIDAE - MOCKINGBIRDS AND THRASHERS
Mimus potyglottus - Mockingbird
[Alien]

FAMILY PASSERIDAE - OLD WORLD SPARROWS
Passer domesticus – House Sparrow
[Alien]

FAMILY STURNIDAE - STARLINGS AND MYNAS
Acridotheres tristis – Common Myna
[Alien]

FAMILY ZOSTEROPIDAE - WHITE-EYES
Zosterops japonicus – Japanese White-eye
[Alien]

CLASS MAMMALIA – MAMMALS
FAMILY VESPERTILIONIDAE - COMMON BATS
Lasiurus cinereus* ssp. *semotus – Hoary Bat, *'ope'ape'a*
Endangered species

FAMILY MURIDAE - OLD WORLD RATS AND MICE
Rattus rattus rattus – Black Rat, Roof Rat
[Alien]

Ratus exulans hawaiiensis – Polynesian Rat, *'iole*
[Polynesian introduction]

Mus domesticus – European House Mouse
[Alien]

FAMILY CANIDAE - WOLVES, JACKALS AND ALLIES
Canis familiaris familiaris – Domestic Dog, *'ilio*
[Alien]

FAMILY VIVERRIDAE - CIVETS AND ALLIES

Herpestes auropunctatus auropunctatus - Mongoose
[Alien]

FAMILY FELIDAE - CATS
Felis catus – House Cat
[Alien]

FAMILY SUIDAE - OLD WORLD SWINE
Sus scrofa scrofa – Pig, *Pua'a*

FAMILY CERVIDAE - ANTLERED RUMINANTS
Axis axis – Axis Deer
[Alien]

FAMILY BOVIDAE - HOLLOW-HORNED RUMINANTS
Bos taurus – Domestic Cattle
[Alien]

Capra hircus hircus – Feral Goat
[Alien]

Appendix D

Species with Designated Critical Habitat in the Project Area

Scientific Name	Common Name
Invertebrates	
Manduca blackburni	Blackburn's Sphinx Moth
Plants	
Alectryon macrococcus	Mahoe
Bonamia menziesii	None known
Cenchrus agrimoniodes	Kamanomano
Colubrina oppositifolia	Kauila
Flueggea neowawraea	Mehamehame
Melicope adscendens	Alani
Melicope knudsenii	Alani
Melicope mucronulata	Alani
Spermolepis hawaiiensis	None known

Appendix E

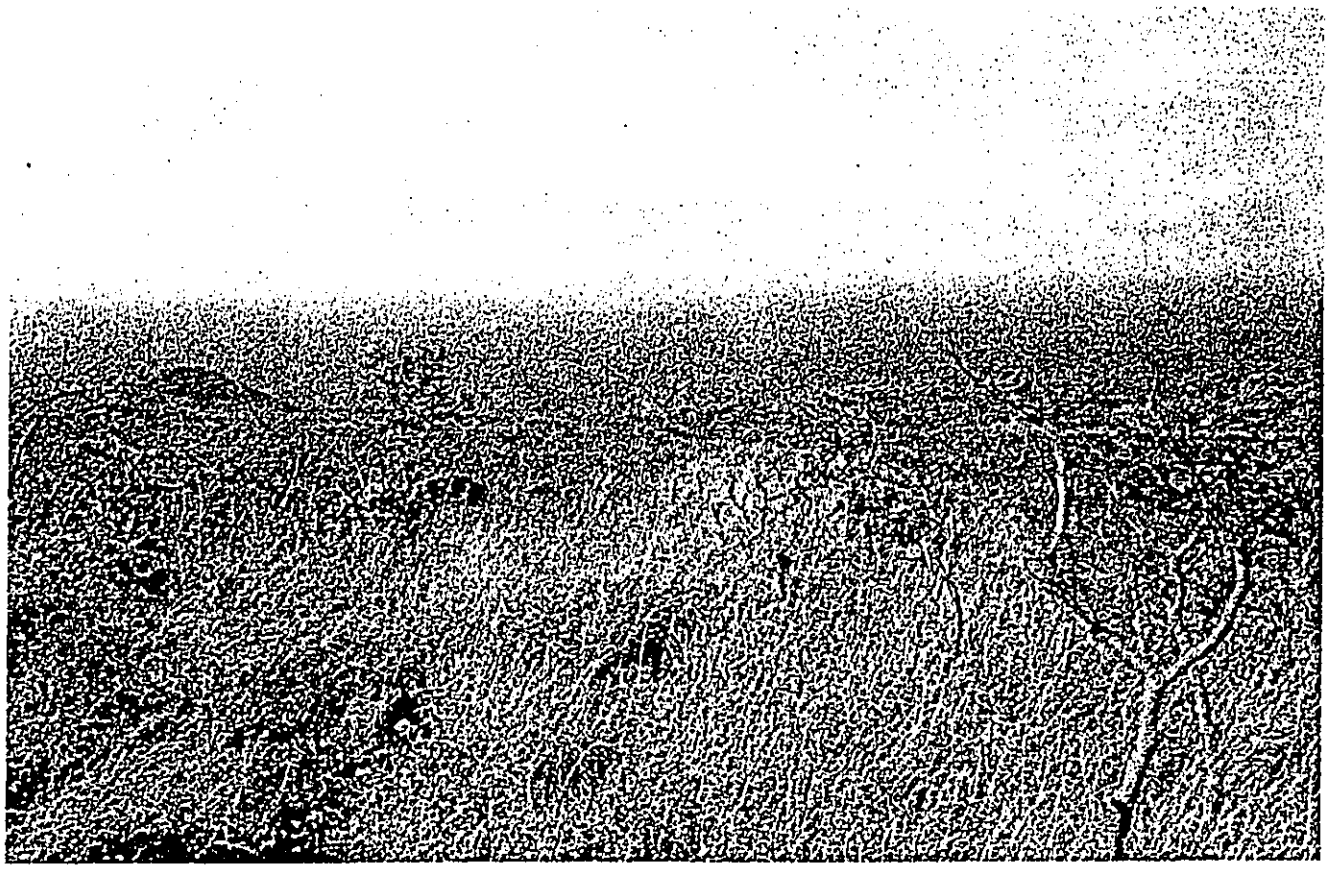
Cultural Resources Investigation Report

U.S. Fish & Wildlife Service

Kanaio Natural Area Reserve Ungulate Exclusion Fence Project

Cultural Resources Investigation

Prepared by:
Virginia Parks
U.S. Fish and Wildlife Service



Kanaio Natural Area Reserve
Ungulate Exclusion Fence Project

Cultural Resources Investigation

Prepared by:
Virginia Parks

February 2003

Cultural Resources Team
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Sherwood Oregon 97140
T: 503/625-4377 F: 503/625-4887

Contents

Appendices

Figures

INTRODUCTION

Purpose

The U.S. Fish and Wildlife Service has conducted archaeological investigation along the route of a proposed ungulate exclusion fence at the Kanaio Natural Area Reserve (KNAR), Makawao District, Kanaio Ahupua'a, Maui (moku of Honua'ula) (Figure 1). The purpose of the investigation was to identify previously recorded archaeological sites through historical background research and to locate and document potential cultural resources through pedestrian survey transects in the Area of Potential Effects (APE) in compliance with 36CFR800 Section 106 of the National Historic Preservation Act (NHPA).

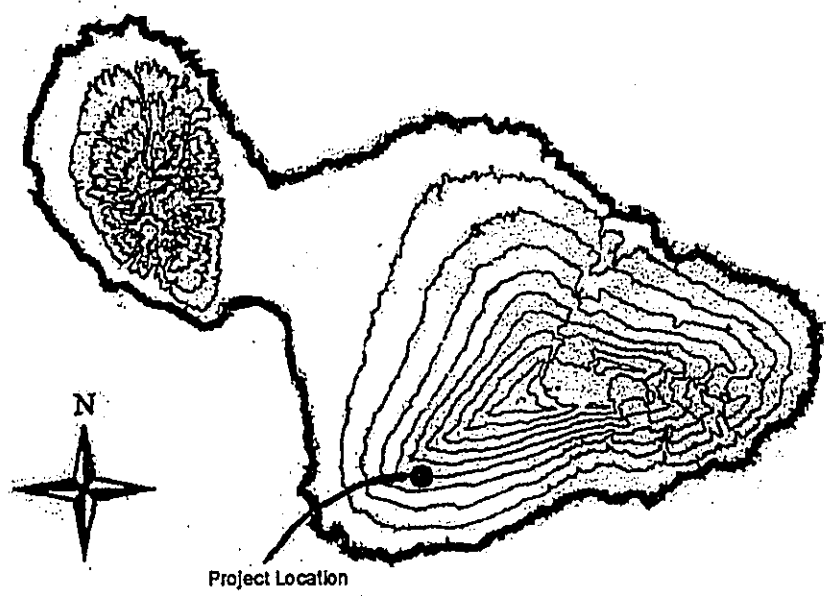
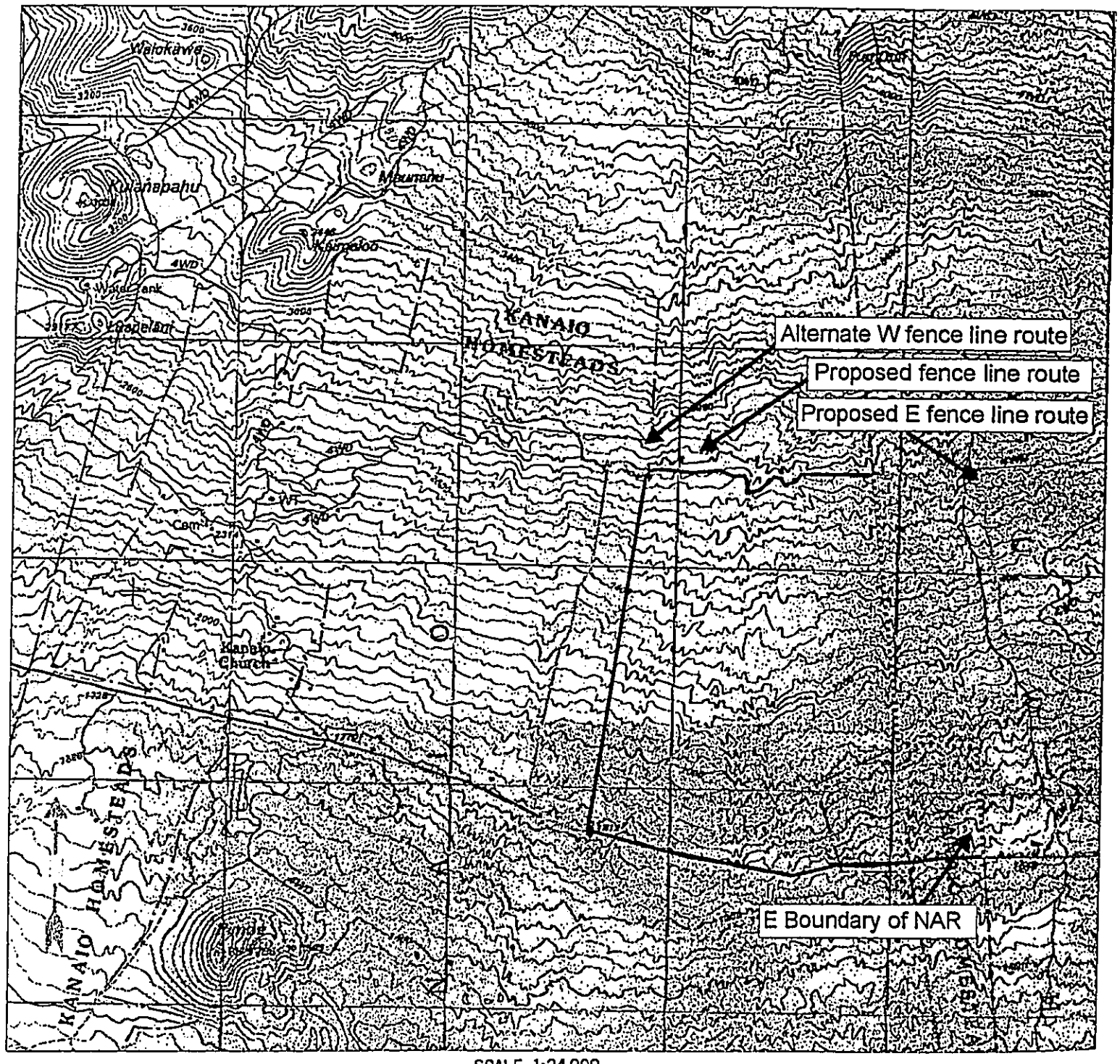


Figure 1. Project location.

Undertaking and Area of Potential Effects

The 876 acre KNAR is a state-owned parcel set aside for the conservation of a remnant native dryland forest. Due to the increasing damage caused by ungulates such as axis deer, goats, and pigs, the State, in partnership with the U.S. Fish and Wildlife Service and adjacent landowner Ulupalakua Ranch, is proposing to construct a 6 to 8 foot tall fence around the five-mile perimeter of the NAR north of the Pi'ilani Highway (Highway 31), TMK (2) 2-1-003:054 (Figure 2). On both the north and the south boundaries, the APE runs roughly parallel to existing roads, which will provide access for installation and future maintenance. In those locations where not prevented by the topography on east and west sides, bulldozing is proposed to clear equipment staging areas and an access corridor which will cause surface disturbance to a swath approximately 10-20' wide. Galvanized steel fence posts (8-10' tall) will be placed at 10 to 15' intervals and set at a depth of 2' into the ground with a 2" diameter. The proposed eastern fence line occurs on private land owned by Ulupalakua Ranch (TMK (2) 1-9-001:006). Because the east NAR boundary also forms the district and ahupua'a boundary, this portion of Ulupalakua Ranch lies in Auwahi ahupua'a. On the west side, an alternative fence line occurs on State Land (TMK (2) 2-1-003:050). Much of the substrate along the fence route is exposed lava rock and will require the use of a motorized hammer-drill for excavation of post holes. When complete, the fence will exclude ungulates from 595 acres of the NAR and 100 acres of the neighboring Ulupalakua Ranch.

Figure 2. Area of potential effects (APE) for the Kanaio NAR is the proposed fence line route around the perimeter of the NAR with the exception of the east side where the proposed fence extends onto a portion of Ulupalakua Ranch. On the west side an alternative line is proposed on State Land.



BACKGROUND

Environmental Setting

The project is on the dry leeward slope of Haleakala, Maui's eastern volcano. Located three miles inland at an elevation ranging from 1800 to 2780 feet, the APE experiences a mean annual rainfall of 30 inches which falls primarily from October to March. In geological terms, the landscape on this portion of Maui is relatively young, comprised primarily of a'a and some pahoehoe lava flows from the volcano's last major eruptive period known as the Hana Volcanic Series (Bordner 1995: 19). Lava tubes dotting the landscape are a byproduct of the flows. Soil development is variable, with isolated pockets of soil accumulating in broad expanses of barren rock outcrops. The eastern portion of the APE, where the NAR and Ulupalakua Ranch share a boundary, exhibits slightly more soil development and consequently a greater diversity of plant species.

A remnant dryland forest ecosystem, the NAR can be characterized by four basic land types consisting of: 1) groves of native trees, 2) native shrubland, 3) largely barren lava, 4) and alien grass, herb, and shrublands (HDLNR 2002: 13). It is within the native groves that the greatest diversity and biological value can be found. Decades of grazing and trampling by ungulates have degraded or destroyed the native habitat in many places. Invasion of alien plant, animal, and insect species, and the loss of native pollinators and seed dispersers have also contributed to the decline of the native dryland forest.

Cultural Setting

The project area is located in the Moku or District of Makawao (previously Honua'ula) in the Ahupua'a of Kanaio. The district names for Maui have been consolidated and redefined numerous times (Figure 3). Available ethnographic data and previous archaeological investigations indicate that the earliest settlement of the dry leeward areas of south Maui occurred after settlement of the valleys and windward coasts and then was focused around the fertile upland slopes with access to water and arable soils (Eble 1999:21). While not enough data has been collected to develop a precise chronological sequence, Erkelens suggests that initial settlement of southeast Maui occurred sometime between A.D. 1450 and 1800 (1995:106). These dates correspond to the late-Expansion (A.D. 1100-1650) and Proto-Historic (A.D. 1650-1795) periods as proposed by Kirch (1985:298-308).

For purposes of modeling settlement and land use patterns, researchers have defined three geographic zones in south Maui: the uplands, the mid-elevations, and the coast. Erkelens posits that:

> *"Upper elevation sites exploited the agricultural potential of the fog drip precipitation region while the coastal settlements made use of the abundant marine resources. The specific placement for mid-elevation habitation site clusters is probably related to the availability of water, a centralized location between large coastal and inland settlements, and a viable route connecting the coast with the uplands. These mid-elevation locations were able to exploit the resource potential of both productive zones due to their central location."* (Erkelens 1995:108).

Archaeological site density is high in the 200-350 meter wide coastal zone. The mid-elevations, which range from the edge of the coastal zone to 250-300 meters above sea level (masl) [to approx. 820-980 fasl], exhibit low site density. Density increases again in the dense upland zone, which falls between approximately 250 to750 masl [from approx. 820 to 2460 fasl] (Kirch 1997:43). With an elevation ranging from approximately 1700 to 2800 fasl, the portion of the NAR above Pi'ilani Highway where the fence is proposed would fall generally into the upland zone.

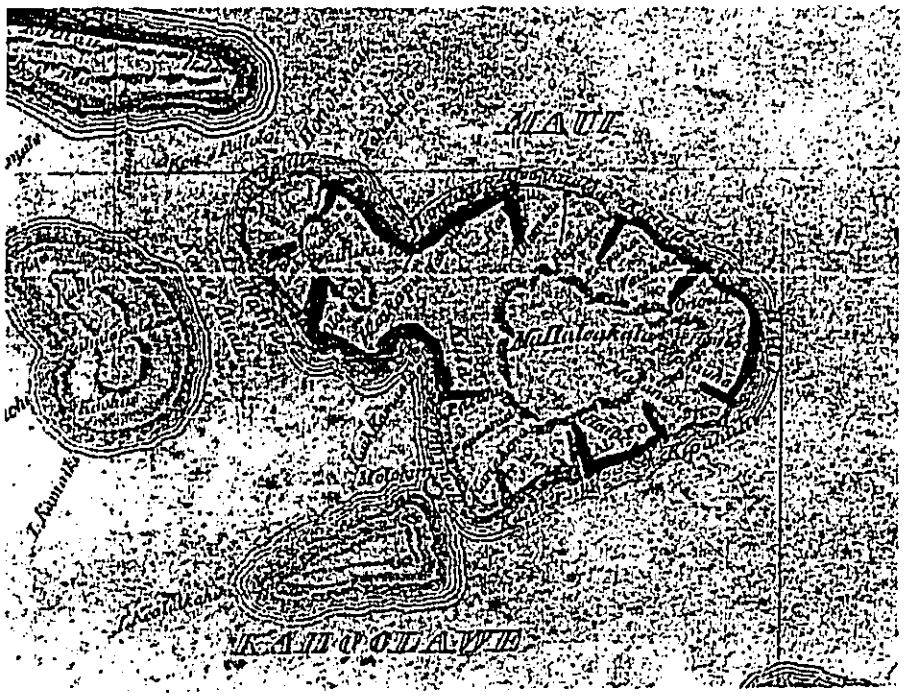


Figure 3. Detail of Map of the Hawaiian Islands showing land divisions for Maui in 1837, prior to the Mahele of 1848. Library of Congress.

Archaeological research in the uplands of Kanaio *ahupua'a* has been too limited to contribute substantially to an understanding of the area's settlement patterns. Nearby, an extensive inventory of the adjacent *moku* of Kahikinui exhibited dense site distribution in the upland zone, with few sites observed in the intermediate region and virtually no archaeological remains above 2800 fasl (Kirch 1997:18, 40). That study also noted a correlation between upland archaeological features and the substrate on which they were located, with a higher density of structures located on pahoehoe lava substrates where sparse soil development resulted in limited agricultural value (Kirch 1997:18). Such a building strategy, Kirch suggests, may have been practiced to keep clear for agricultural purposes those areas where soil was more fertile (i.e. the older, weathered a'a substrates with suitable soil deposition) (1997:18). On the NAR, the substrate is predominantly rough *a'a* lava with some overlying soil (Medeiros et al. 1993:8), but only on its eastern boundary and the adjacent Ulupalakua Ranch has significant soil development occurred. Because Kanaio has experienced different geological processes than the neighboring Kahikinui *moku* and the available body of archaeological data is still relatively small, the value in applying the settlement pattern established at Kahikinui as a model for site distribution within the NAR is limited.

Late nineteenth century maps suggest that the Kanaio Homesteads adjacent to and within a portion of what is now the NAR were one focus of upland settlement during the early post-Contact period (Erkelens 1995:18). In 1846, the newly established Land Commission determined that the western concept of land ownership be superimposed on the ancient system of land division whereby the land was commonly divided into three portions, one for the king, another for the chiefs and landlords, and the third for the common people. Land Commission Awards were made to those individuals who came forward to claim a particular piece of land. The Great Mahele of 1848, during which King Kamehameha III facilitated the wholesale land redistribution, effectively abolished the traditional system of land tenure, making way for the sale or lease of large tracts of land to foreigners.

In the District of Honua'ula, Kamehameha III claimed and then relinquished to the Hawaiian Government 22 ahupua'a, including Kanaio,. Within the ahupua'a of Kanaio, 5 kuleana lots totalling approximately 30 acres were awarded to native tenants as Land Commission Awards. Another 1400 acres were sold to 28 private parties with the issuance of Land Grants between 1853 and 1871. Based on representations on current tax maps, the State of Hawaii continues to own approximately 8370 acres in Kanaio, including the KNAR.

It was during this time period that ranching was introduced to the slopes of Haleakala by Euroamericans on a massive scale. The history of what has become the Ulupalakua Ranch (Figure 4)

Figure 4. Painting of Ulupalakua Ranch, artist and date unknown. Maui Historical Society negative #979.

began in 1845 when Linton Torbert purchased 2000 acres. Exhibits in the Tedeschi Winery's "history room" at Ranch headquarters provide a timeline of ranch ownership and a history of how the ranch has changed over the years. In 1856, James Makee bought and expanded the property, which he called Rose Ranch, and built forty miles of rock walls. By 1922, during the ownership of James Raymond (purchased in 1900 from James Isaac (1886-1900)), the ranch had grown to include Kahikinui Ranch. The name Ulupalakua was first applied when the Baldwin family owned the ranch between 1922 and 1963. The current owners, the Erdman family, bought the ranch in 1963, and today it encompasses 58,000 acres.

The Ranch developed a grazing program incorporating both ranch-owned land and lands leased from the State, including much of the area now encompassed by the NAR. The degradation of the dryland forest native to Haleakala's south slope has been linked to the effects of cattle ranching as well as the invasion of other non-native animals, alien plants, and wildland fires (Medeiros et al.1993:5). To protect the remnants of the native dryland forest, the 876 acre NAR was established in 1990 from two parcels of State lands carved out of an existing lease to Ulupalakua Ranch. In 1994, after nearly 150 years of grazing, the Ulupalakua Ranch returned the balance of its lease to the State (B. Evanson, 2/13/02, pers. communication). Since that time, feral ungulates have continued to inhabit the area, causing a threat not only to the habitat but to cultural resources as well.

Additional information about the cultural environment is included in a cultural assessment prepared separately for this project by Charles Maxwell (2002).

Previous Research within the APE

1931 - Winslow Walker, Archaeology of Maui
Winslow Walker's inventory of Maui's major archaeological sites in the late 1920s was among the first organized field efforts to locate and document the area's cultural resources. His island-wide survey was based on information compiled by Thomas G. Thrum in 1909, and later added to by John Stokes in 1916. Though his results were never published, the manuscript provides some useful background information for archaeological investigations on Maui. According to his notes:

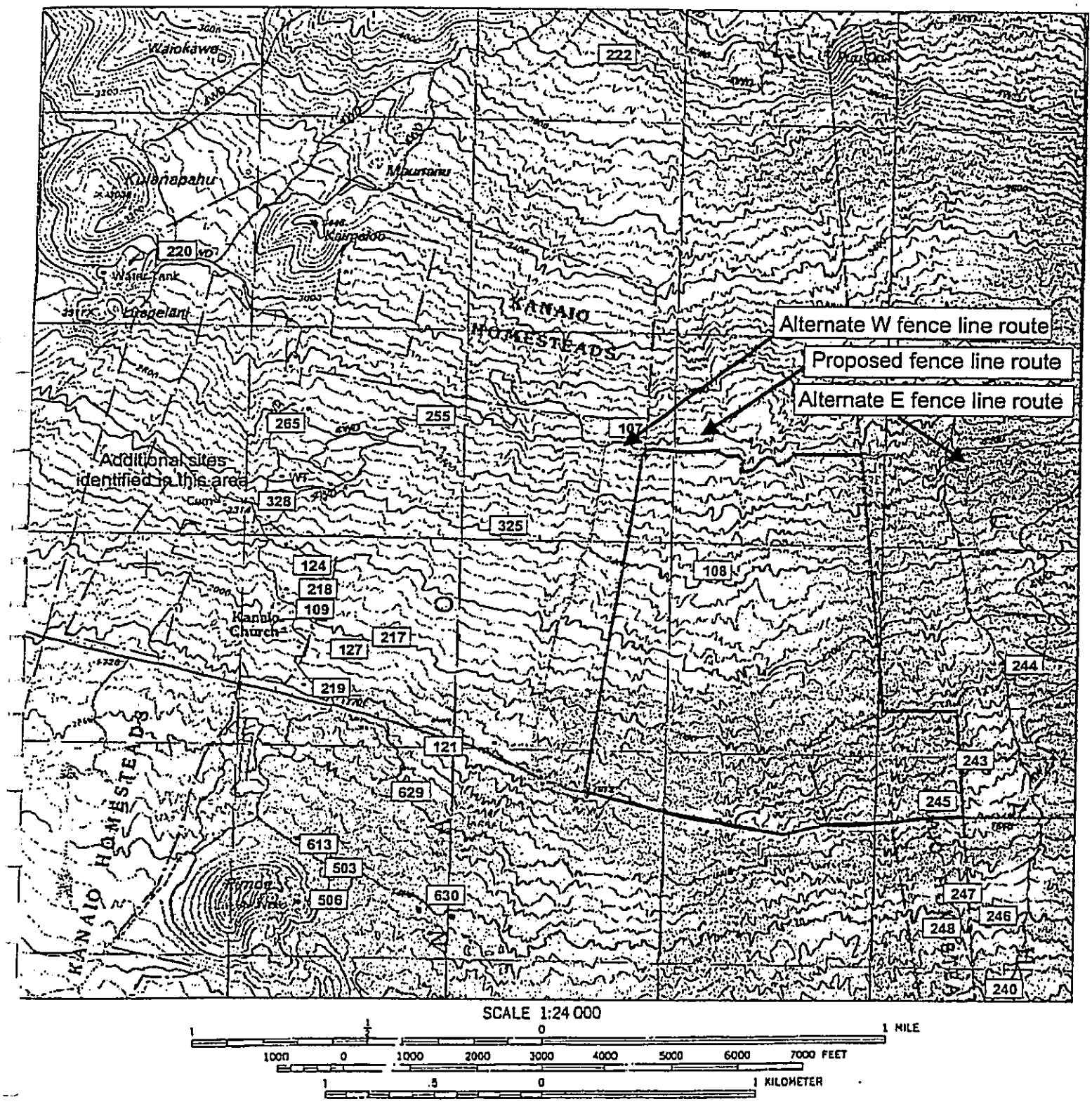
> *"Regions beyond the reach of the auto roads were covered on horseback or afoot, and in this manner all of the open country was seen in detail. All of the earlier mentioned sites were visited and many new ones found, so it is felt that the survey is now as complete as is possible. Very likely some small sites have been destroyed and their existence forgotten with the modern occupation of so much land by the sugar-cane and pineapple plantations."*
> (Walker 1931:2)

Erkelens points out, however, that most of Walker's sites are near roads or trails, suggesting he did not venture too far afield (Erkelens 1995:21). Based on available resources, it appears that one of Walker's heiau sites – the Kohala Heiau (#189) – is located within the NAR boundaries about 3/4 mile north ofthe Pi'ilani Highway. He described the site as a rough platform of basalt blocks, 53 by 34 feet, on a high ridge overlooking the sea (summarized in Sterling 1998:217). It was tentatively relocated during a 1972 statewide inventory of Walker's heiau sites (Bordner 1995: 202). Another Walker heiau site, the Kauhuka Heiau (#188), is documented to be situated close to the northwestern boundary of the APE at an elevation of 2700 feet and is described as a small platform of rough basalt blocks on top of a rocky knoll (Walker 1931: 258).

1960s - Elspeth P. Sterling, Sites of Maui
In the mid-1960s, Elspeth Sterling compiled a compendium of archaeological and ethnographic data on Maui which was ultimately published as "The Sites of Maui" in 1998. This resource includes information from historic accounts (including newspaper articles, early publications, and museum archives), interviews, and her own observations in the field. Particularly important for her documentation of the Kanaio ahupua'a was her work with Sam Po, who was the oldest living *kama'aina* of Kanaio in 1966 (Sterling 1998: ix). Sterling's documentation includes Walker's references for sites 188 and 189, but there is no indication that Sterling conducted field visits in the vicinity of the NAR.

1995 - Richard Bordner, Contested Images of Place in a Multicultural Context
Bordner's doctoral dissertation synthesized data from a variety of disciplines to explore the issues surrounding the cultural landscapes of the Kanaio and Auwahi ahupua'a. He conducted a survey of both ahupua'a, including the NAR. While his methods focused as much on vegetation patterns and evidence of recent activity as on archaeological sites, he noted three cultural resources which appear to be located within or immediately adjacent to the NAR. He also observed that the upper section of the NAR showed evidence of having been cleared during the last 100 years, in likelihood flattening archaeological sites that might have been present (R. Bordner, pers. communication 7/25/02).

Figure 5. Map identifying previously recorded archaeological sites in the vicinity of the APE extrapolated from Bordner (1995: 193, 194, 195).



The sites Bordner identified were characterized as a stacked *a'a* enclosure and C-shaped enclosure (#243) (outside the east boundary of the NAR on the Ulupalakua Ranch), a small habitation-style enclosure with a view reminiscent of those associated with heiaus (#244) (also on Ulupalakua Ranch land), and a C-shaped enclosure on a knoll with *ili'ili* paving (#245) within the NAR boundaries (Bordner 1995:222). Figure 5 illustrates the locations of these sites as extrapolated from Bordner's maps and notes. It also includes a cluster of sites that occur around the Kanaio Church in the Kanaio Homesteads area west of the NAR and the Winslow Walker heiau sites.

1996 - Matsuoka et. al., Native Hawaiian Ethnographic Study for the Hawai'i Geothermal Project
Prepared by the Cultural Advocacy Network for Developing Options (CANDO) under subcontract to Oak Ridge National Laboratory, this study collected background scientific data and ethnographic information from informants in both South Maui and Puna, Hawai'i. It was intended as part of a larger environmental impact statement (EIS) for the proposed Hawai'i Geothermal Project, which plan was ultimately terminated in 1994.

Matsuoka et al. determined "the scenic view corridor Kanaio – Luala'ilua Hills" to be a significant scenic and cultural district with reference to National Register Criteria a, b, c-3, d, and e, and consequently should be protected (1996:104) . The report does not include a map delineating the boundaries for such a district, but it can be inferred that the NAR, midway between Kanaio and Luala'ilua Hills, would be contained in the district. There is no evidence that the proposed district has been subsequently nominated to the National Register of Historic Places.

In addition, the report recommends that "several individual heiau at Makena, Kanahena, Keone'o'io, Kanaio, and Kaloi [be protected] for their religious, historical, and architectural significance (Criteria a, b, c-1, c-4, c-e)" (1996:104). No specifics are included to identify which Kanaio heiau is/are the subject of this recommendation.

Matsuoka et al. also referenced the Ulupalakua Ranch, which the Department of Land and Natural Resources (DLNR) State Historic Preservation Division has recognized as a significant cultural landscape (1996:98).While the Ranch does not appear on the State's official Register of Historical Places or on the National Register of Historic Places, its thousands of acres of uninterrupted pasture are identified by DLNR as representing the role of ranching in the development of Hawai'ian economy (DLNR web page, accessed 9/02, http://www.state.hi.us/dlnr/hpd/hpcal94.htm).

Research in the Vicinity
The sparse record of archaeological research within the NAR is supplemented by a slightly more developed body of research in the surrounding areas of South Maui. While not directly associated with the NAR or the current APE, these resources inform a broader understanding of the region's chronology and settlement patterns. The studies include:

1995 - C. Erkelens, Survey for Hawai'i Geothermal Project
Erkelens' survey corridor followed the proposed route of a geothermal powerline across the extent of South Maui from Huakini Bay on the east to Ahihi Bay on the west, generally paralleling or retreating downslope from the Pi'ilani Highway. Survey of the entire ahupua'a of Auwahi and Kanaio (as well as Kaloi, Kaunauhane, Kalihi, and Kulapa) were included in the original research design. However, according to the report:

> *"The remaining portion of the corridor from Luala'ilua to within 2 km of Ahihi Bay is leased from the State of Hawai'i by Ulupalakua Ranch. Permission to enter this area was denied and the landowner threatened arrest of any survey team members who inadvertently trespassed upon these landholdings....* (Erkelens 1995:85)"

As a result, that portion of the proposed pipeline running through the NAR was not surveyed. In its place, additional investigation, including excavation, was conducted at selected sites in the survey corridor. Erkelens does include on his map of the project corridor the routes of roads dating to 1882-1894 (Erkelens 1995: 3), one of which appears to bisect the NAR from west to east.

1997 - P. Kirch et al., Survey and Excavation in Kahikinui.
A collaborative effort of the University of California at Berkeley, Northern Illinois University, and the State of Hawai'i Historic Preservation Division, this project summarized the preliminary results of fieldwork in the Kahikinui District by the organizations. While it is separated from Kanaio by several miles and some differences in geological development, the amount of data collected provides a framework through which to analyze the largely unexplored cultural landscape of the NAR.

1997 - F. Eble and P. Cleghorn, Survey of Hawai'i National Guard Kanaio Training Area.
The subject of this report was the Kanaio Training Area, a 5948-acre parcel of State Land leased to Ulupalakua Ranch and used under permit by the Hawaii Islands Army Reserve National Guard (HIARNG) for training. The NE corner of the project area shares a boundary with the portion of the NAR which extends below the Pi'ilani Highway. The project, conducted via helicopter and pedestrian survey, identified or relocated 42 sites and 650 isolated features. The majority of sites discussed in the report were within the coastal region where pedestrian survey was conducted.

RESEARCH METHODS

Background Research

Background research was conducted using resources from the Hawaii State Archives, the Bishop Museum Archives, University of Hawai'i-Manoa Hamilton Graduate Library, the Bailey House Museum, Department of Land and Natural Resources Division of Land Management and State Historic Preservation Division. Online resources from the National Park Service, the National Archives, and the Library of Congress were also accessed.

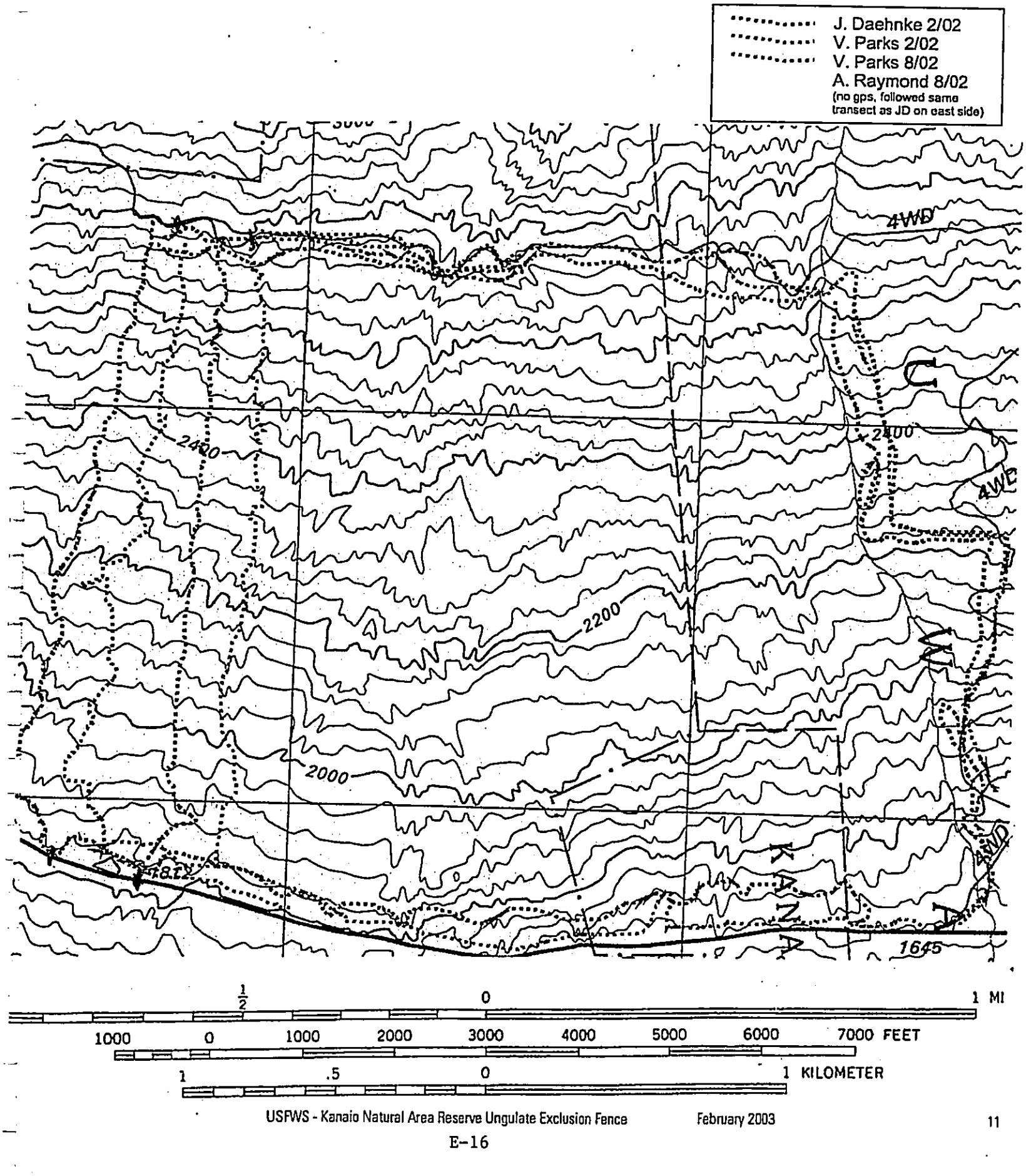
Field Survey

Pedestrian survey was conducted from 11 February through 13 February 2002, and 7 August through 8 August 2002. Crew members included U.S. Fish and Wildlife Service archaeologists Virginia Parks, Jon Daehnke (first survey), and Anan Raymond (second survey). During the first fieldwork session, a single pedestrian sweep consisting of a two-person transect spaced 20-30 meters apart followed the route of the proposed fence line around the 5-mile perimeter of the NAR which comprises the APE. The archaeologists were joined in the field intermittently by Service biologists David Hopper and Benton Pang, State botanist Vickie Caraway, NAR manager Bill Evanson, and Ulupalakua Ranch employee Mahealani Kaiaokamalie, who were surveying the same route for plants and wildlife species. On the west side of the project, an additional two-person sweep covered an alternative fence line outside of the reserve boundary which has been proposed but not approved. Survey of the eastern boundary was suspended due to dense vegetation, and was subsequently resurveyed during the second fieldwork session by a two-person transect spaced 10-15 meters apart. Service biologist Naomi Bentivoglio and Mahealani Kaiaokamalie accompanied.

While survey was aligned on a compass bearing to follow the fence line, intuitive meanders were made to include significant topographic features such as lava rock outcrops and ridge lines. Detailed coverage information was recorded using Global Positioning System (GPS) units in the field and is reproduced in this report (Figure 6).

Data collection included: recording the location of sites using GPS; assigning temporary site numbers; preparing site forms with descriptions of setting and size; and producing site maps using tape-and-compass. No artifacts were collected.

Figure 6. Survey transects of the APE recorded with GPS.



SURVEY RESULTS

South Boundary

The fence line along this boundary is proposed to run parallel to the Pi'ilani Highway adjacent to the road and within or near the prism originally disturbed by road construction. The transect was walked east to west. Cultural features identified included stacked rock walls running both parallel and perpendicular to the road (KNAR-02-2), a rectangular stacked rock enclosure (KNAR-02-3), and a large natural depression, possibly a collapsed lava bubble, reinforced with stacked rock walls (KNAR-02-4). Several lava tubes were observed on the west end of the transect, but no evidence of cultural modification or use was apparent. A segment of this transect near the NAR's eastern boundary with the Ulupalakua Ranch passes through a homestead area claimed by the 'Uweko'olani family. The stacked rock enclosure and a portion of the wall system are located within the claim area.

Figure 7. The south portion of the APE runs parallel to the Pi'ilani Highway. Especially on the west end, disturbance from heavy equipment was a prominent feature of the landscape. View looking east. USFWS.

If the fence is installed as proposed along the edge of the Pi'ilani Highway within the disturbed road prism, there will be no effect to the cultural resources as it will be installed downslope of the features. If concerns about terrain or visibility from the road necessitate moving the fence line upslope, it can be installed in a manner that causes no impact to the wall features adjacent to the road. The other stacked rock features identified on this transect are located at a distance from the proposed fence construction corridor. The fence will not impact the sight line toward Lualailua Hills, identified as a significant scenic and cultural district by Matsuoka et al (1996:104).

West Boundary Alternative 1

The first transect on the west boundary followed the proposed fence line which, because of its relatively flat terrain and weedy vegetation characteristics, is considered the preferred alternative. However, the line is outside the NAR boundary line on unencumbered State land and may not be a viable option. Proceeding from north to south, a remnant of an old east-west trending trail was visible from the transect (Figure 8).

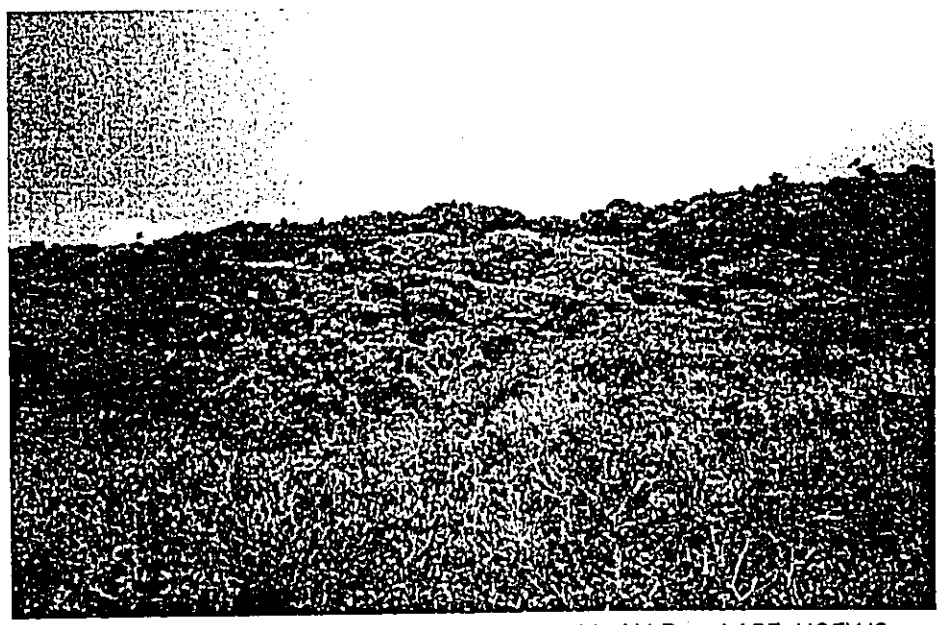


Figure 8. View looking west to graded trail outside NAR and APE. USFWS.

This feature may correspond to the late nineteenth-century "road" on Erkelens' map (see page 9 of this report). The trail is most visible as a cut descending a slope to the west of the APE, where it is characterized by cobbles stacked on the grade to create a relatively evenly sloping pathway approximately three meters wide. The trail disappears at the bottom of the grade, before it reaches the gully which forms the western boundary of the APE. The feature was identified as F6 during survey and photographs were taken, but was not formally recorded as it is outside the APE. Proceeding makai, the terrain became less vegetated with more exposed lava ridges. No cultural features were identified within the proposed fence construction corridor.

West Boundary Alternative 2

Transect proceeded from south to north. Near the northern end of the transect, a number of small apparently unmodified collapsed lava tubes were observed. No cultural features were identified within the proposed fence construction corridor. This portion of the APE is characterized by a predominance of a'a lava outcrops and rocks with little soil development, though vegetation is more dense on the north end.

North Boundary:

This fence line is proposed to parallel the Pipeline Road, which is an easement from the State of Hawaii to Ulupalakua Ranch. The dirt road was originally cleared as a trail to maintain the Waikamoi pipeline, constructed in the early 1900s (Figure 9). The pipeline and the road have been routinely repaired and reconfigured by Ulupalakua Ranch. Some areas adjacent to the road may be bulldozed as part of this project, but the pipeline itself will not be affected.

Figure 9. The Waikamoi Pipeline runs parallel to road that forms the north boundary of the APE.

The predominant cultural features on the northern boundary are stacked rock cattle walls associated with ranching operations, some of which could date back to the mid-1800s (KNAR-02-7). Like the road, these walls have been maintained and adapted over the years, in some places giving way to wire-strand fences. Remnants of walls run both parallel and perpendicular to the Pipeline Road. As designed, the fence will not have any effect on these features.

East Boundary

The eastern portion of the NAR exhibits greater deposition of soils, and consequently more vegetation and opportunities for agricultural use both past and present. Due to heavy precipitation in the weeks prior to the initial scheduled survey, vegetation was uncharacteristically dense along the route of the proposed eastern fence line. As on the west boundary, this line is designed to take advantage of topographical characteristics rather than land ownership boundaries, and thus much of the fence line occurs on land belonging to the Ulupalakua Ranch and will be constructed by them.

Survey began at the Pipeline Road and proceeded makai, but by the time a large rectangular stacked rock enclosure was encountered (KNAR-02- 8), it was determined that vegetation conditions could be

obscuring other features and the decision was made to suspend survey. The proposed fence line route on this boundary was not as firmly established at that time, forcing a wider survey corridor to incorporate the possible variance from the route identified in the field. It was proposed by the archaeologists that this boundary be revisited at a later date when vegetation was less likely to conceal features and the preferred fence line route had been decided upon.

Descending from that point, however, the survey encountered a major stacked rock wall trending E-W (KNAR-02-9). A second rock wall, with the appearance of a retaining wall, paralleled the first wall for about 30' before it ended. A wide flat swath to the mauka side of the major wall has the appearance of a disused farm road. The fence line will run parallel to this stacked rock wall for a distance of approximately 1/4 mile but in doing so will not disturb the wall.

The second survey was conducted in August 2002. As during the first survey, this two-person transect began on the north end of the fence line and proceeded makai. The preferred fence line was flagged by Ulupalakua Ranch employee M. Kaiaokamalie as we walked it. Vegetation was still dense, but in many places not as verdant as in February.

Because the revised fence line passes 30m to the west of the large structure identified above as KNAR-02-8, we had to make a slight detour to revisit and record it. The rock walls, which measure approximately 14 meters by 7m, were stacked up to 6 courses high in the NE corner. A flaked basalt core was noted on the interior floor surface of the structure (Figure 10), and a piece of coral was observed on the exterior of the east wall.

Figure 10. Flaked basalt core on floor surface of F8. USFWS.

An isolated hammerstone was identified on a knoll to the east of the proposed fence line. Site F1 occurs about .25 mile up the dirt road from the Pi'ilani Highway. It has seven associated rock features, which are described briefly below. The proposed fence line comes within 5 meters of four of the features associated with KNAR-02-1. However, at this point the fence will be installed within the prism of the existing dirt road and consequently the features will not be impacted.

SUMMARY OF CULTURAL RESOURCES

Previously Recorded Sites

The site and feature types represented reflect early agricultural, habitation and religious activities as well as post-Contact ranching practices (see Figure 6). While limited archaeological research has been conducted in the vicinity of the NAR, there are a number of known archaeological sites in or adjacent to the NAR boundaries. Winslow Walker's 1920s inventory included the Kohala Heiau (#189) within the NAR boundaries, and the Kauhuka Heiau (#188) which appears to be situated mauka of what is now the northwestern boundary of the NAR. Because they did not coincide with the APE for this project, no attempt was made to relocate either site.

As mentioned previously, the NAR was included in dissertation fieldwork conducted by Bordner in the mid 1990s. Bordner did not formally record the three sites he noted in the APE, but characterized them as a stacked *a'a* enclosure and C-shaped enclosure (#243), a small habitation-style enclosure with a view reminiscent of those associated with heiaus (#244), and a C-shaped enclosure on a knoll with *ili'ili* paving (#245) (Bordner 1995:222). While it is possible that some of the features recorded in the eastern portion of the current survey area were initially noted during Bordner's survey, his documentation of the features' characteristics and locations is not detailed enough to make positive correlations.

Remnants of land development associated with the early 1990s homestead claim of the 'Uweko'olani family occur in Parcel 17, in the southeast corner of the NAR above Pi'ilani Highway. At that time, Edward 'Uweko'olani established a semi-permanent residence and cleared land for 4-wheel drive roads, fences, and an outhouse (Medeiros et al. 1993:8). Part of the stone wall system parallel to and radiating from the Pi'ilani Highway dates to this period. Mr. 'Uweko'olani has identified a walled rectangular enclosure – which may be the same as that documented during the 2002 survey as KNAR-02-3) – as a *ko'a*, but he does not know for what it was used (C. Maxwell, personal communication 9/02).

Two historic linear features in the vicinity of the NAR are still in use in varying forms today. Pi'ilani Highway, which forms the southern boundary of the proposed fence line, follows generally the same route as the upland route of an original Hawaiian trail and subsequent nineteenth century road, referred to on Alexander's 1894 map as the "Hana Road" (Erkelens 1995:19-20). The highway was paved in 1972 and again in 1999. On the northern boundary of the NAR runs a dirt road which was built as a trail to access and service the Waikamoi pipeline in the early 1900s. Both trails were extensively modified over time, evolving into the modern linear features utilized today. The pipeline itself, located on the north side of the road outside the NAR, continues to be propped up by wooden crutches and rockpiles.

Newly-Identified Sites

The current archaeological reconnaissance resulted in the identification of ten stacked rock features recorded at four locations, three stacked rock wall systems (KNAR-02-2, KNAR-02-7, KNAR-02-9) probably associated with historic and modern ranching practices, and an isolated basalt hammerstone. Stacked rock feature types included: rectangular enclosures (KNAR-02-1a, KNAR-02- 3, KNAR-02- 8), C-shapes (KNAR-02-1c), rock piles (KNAR-02-1d), possible garden clearings (KNAR-02-1b), poorly defined curved alignments (KNAR-02-1f, KNAR-02-1g), and C/L-shaped windbreak walls (KNAR-02-1e). One site incorporates stacked walls into a natural depression (KNAR-02-4). In addition, the remnant of a cobble-paved trail cuts down a hillside and disappears at a drainage (F6). However, this is well outside the west boundary of the NAR and the APE and was not formally recorded.

Several collapsed lava tubes occur both inside and outside the western boundary of the NAR, most of which were so small in dimension as to render interior investigation unfeasible. While no evidence of cultural modification was observed, this does not preclude the possibility that the lava tubes were used in the past, however, since efforts were often made to conceal burials within the natural rubble deposits associated with lava flows.

Site forms for sites recorded during the current survey with temporary numbers are included as Appendix A. No subsurface archaeological testing has been conducted at these sites to determine age or function, though possible functions were speculated upon based on visible evidence. Because the proposed project activities will avoid cultural resources, formal evaluation of eligibility to the National Register of Historic Places (NRHP) was determined to be beyond the scope of the current investigation. All unevaluated sites must be considered potentially eligible until formal determination has been conducted.

RECOMMENDATIONS

All portions of the APE have been surveyed. The cultural features have been digitally mapped and photographed so project coordinators can ensure that ground disturbing activities avoid them. As presently designed, the fence project will have no effect on cultural resources eligible or potentially eligible to the NRHP. Potentially sensitive cultural resources will be flagged to prevent inadvertent damage and collapsed lave tubes will be avoided. Archaeological monitoring during access road construction in the vicinity of known sites will ensure that a buffer of at least 20 feet from archaeological sites is maintained where disturbance to the ground is necessary for fence construction. Though there are locations where linear stacked rock wall features run perpendicular to and consequently intersect the new fence line, the post holes will not be situated in the vicinity of existing cultural features and the wire strands comprising the exclusion fence will cause no impact.

The presence of cultural properties can never be predicted with certainty. If, despite the precautions taken above, cultural resources are inadvertently discovered during implementation of the project, ground disturbing activities should be halted and the FWS Regional Archaeologist notified immediately.

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Appendix F

Division of Forestry and Wildlife
Best Management Practices for Maintaining Water Quality in Hawai'i

BEST MANAGEMENT PRACTICES

FOR

MAINTAINING WATER QUALITY

IN HAWAII

State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
February 1996

BEST MANAGEMENT PRACTICES

1.0 Forest Roads

Standards and Use

Forest roads are managed to provide adequate access to lands for timber management, fire suppression, wildlife habitat improvement and a variety of dispersed and developed recreational activities. Generally, these are low volume roads that must carry heavy loads for short periods of time. The potential for adverse impacts from forest roads exists in areas where steep slopes, erodible soils, or where forest roads are located near water. Forest roads cause more erosion than any other forestry activity. Most of this erosion can be prevented by locating, constructing, and maintaining roads to minimize soil movement and pollution of streams. The need for higher standard roads can be alleviated through better road-use management. Design roads to the minimum standard necessary to accommodate anticipated use and equipment.

Planning, Design, and Location

A well planned access system is a sound method of reducing erosion and sedimentation in areas requiring frequent or temporary access. Proper location and construction of roads will provide for safety, longer operating periods, lower maintenance and operating costs, and minimal impacts to water quality. The value of the resource served and site characteristics will influence the choice of road construction standards and maintenance activities. The following practices are recommended:

(1) Use a design to minimize damage to soil and water quality.

(2) Roads should be designed no wider than necessary to accommodate the immediate anticipated use.

(3) Design cut and fill slopes to minimize mass soil movement.

(4) Provide culverts, dips, water bars, and cross drainages to minimize road bed erosion.

(5) Design bridge and culvert installations using stream flow data, with a margin of safety proportional to the importance of the road and the protected resources.

(6) Provide drainage where surface and groundwater cause slope instability.

(7) Avoid diverting water from natural drainage ways. Dips, water bars, and cross drainage culverts should be placed above stream crossings so that water can be filtered through vegetative buffers before entering streams.

(8) Locate roads to fit the topography and minimize alterations to the natural features.

(9) Avoid marshes and wetlands.

(10) Minimize the number of stream crossings.

(11) Cross streams at right angles to the stream channel.

(12) A road may not be located in a Streamside Management Zone (SMZ) except where access is needed to a water crossing, or where there is no feasible alternative. A road in any SMZ must be designed and located to minimize adverse effects on fish habitat and water quality.

Construction

Once the road's location and design is staked out, road construction begins. Timber is out, logs and vegetation are removed and piled along the lower side of the right-of-way.

Most forest roads are built by excavating a road surface. Road design and layout on-the-ground show machine operators the proper cut slopes and indicate cut slope steepness. The bulldozer starts at the top of the cut slope, excavating and sidecasting material until the desired road grade and width is obtained. Material from cuts is often pushed in front of the blade to areas where fill is needed. Road fill is used to cover culverts and build up flat areas. Since fill must support traffic, it needs to be spread and compacted in layers to develop strength. The following practices are recommended:

(1) Construct roads when moisture and soil conditions are not likely to result in excessive erosion or soil movement.

(2) The boundaries of all SMZs shall be defined on the ground prior to the beginning of any earth-moving activity.

(3) Construct a road sufficient to carry the anticipated traffic load with reasonable safety and with minimum environmental impact.

(4) When using existing roads, reconstruct only to the extent necessary to provide adequate drainage and safety.

(5) Avoid construction during wet periods, when possible, to minimize unnecessary soil disturbance and compaction.

(6) Road grades should be kept at less than 10%, except where terrain requires short, steep grades.

(7) Minimize the number of stream crossings. Stream crossing construction should minimize disturbance of the area in which the crossing is being constructed.

(8) As slope increases, additional diversion ditches should be constructed to reduce the damages caused by soil erosion; ditches, adequate culverts, cross drains, etc., should be installed concurrent with construction.

(9) To control erosion, cut and fill slopes should conform to a design appropriate for the particular soil type and topography.

(10) Stumps, logs, and slash should be disposed of outside of the road prism; in no cases should they be covered with fill material and incorporated into road beds.

(11) Stabilize the side banks of a road during construction to aid in the control of erosion and road deterioration; this may require mesh or other stabilizing material in addition to planting and/or seeding and other structural measures.

(12) Water bars should be located to take advantage of existing wing ditches and cross drainage. Water bars should be constructed at an angle of 30 to 45 degrees to the road. Water bars should be periodically inspected and damage or breeches should be promptly corrected. Install water bars at recommended intervals to provide the drainage. Water bar spacing recommendations are as follows:

Grade of Road	Distance Between Water bars
2%	250 ft.
5%	135 ft.
10%	80 ft.
15%	60 ft.
20%	45 ft.
25%	40 ft.
30%	35 ft.
40%	30 ft.

Water bars may need to be spaced closer together depending on soil type and rainfall.

(13) Bridges and overflow culverts should be constructed to minimize changes in natural stream beds during high water.

(14) Culverts on perennial streams should be installed low enough to allow passage of aquatic life during low water.

Maintenance

Maintenance of active and inactive roads shall be sufficient to maintain a stable surface, keep the drainage system operating, and protect the quality of streams. The following are recommended:

(1) Maintenance should include cleaning dips and crossdrains, repairing ditches, marking culverts inlets to aid in location, and clearing debris from culverts.

(2) Keep culverts, flumes, and ditches functional before and during the rainy season to diminish danger of clogging and the possibility of washouts. This can be done by clearing away any sediment or vegetation that could cause a problem. Provide for practical and scheduled preventative maintenance programs for high risk sites that will address the problems associated with high intensity rainfall events.

(3) Conduct road surface maintenance as necessary to minimize erosion of the surface and subgrade.

(4) During operations, keep the road surface crowned or outsloped, and keep the downhill side of the road free from berms except those intentionally constructed for protection of fill.

(5) Avoid using roads during wet periods if such use would likely damage the road drainage features.

(6) Water bars should be inspected after major rain storms and damage or breeches should be promptly corrected.

Harvesting - Temporary Access Roads and Landings

(1) The location of temporary access roads (logging roads) should be planned before operations begin.

(2) Road construction should be kept to a minimum.

(3) Landings should be located to minimize the adverse impact of skidding on the natural drainage pattern.

(4) Logging roads and landings should be located on firm ground.

(5) Landings should be kept as small an area as possible.

(6) When operations are completed, provisions should be made to divert water run-off from the landings and roads.

Appendix G

Comments Received During Public Comment Period and Responses

Written comments were received from the following agencies and organizations during the public comment period:

- State of Hawaii, Department of Land and Natural Resources, Historic Preservation Division
- State of Hawaii, Department of Land and Natural Resources, Land Division
- State of Hawaii, Land Use Commission
- State of Hawaii, Office of Environmental Quality Control
- State of Hawaii, Office of Hawaiian Affairs
- County of Maui Department of Planning
- County of Maui Department of Public Works and Environmental Management
- County of Maui Department of Water Supply
- Kahea – the Hawaiian-Environmental Alliance
- Mr. Chuck Chimera
- Mr. Bruce Faulkner

Verbal comments were received from the following during the public comment period:

- State of Hawaii, Department of Land and Natural Resources, Division of Conservation and Resources Enforcement

A public informational meeting was held on October 14, 2003. A summary of comments and responses made at the meeting is attached at the end of this Appendix.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

HAWAI'I HISTORIC PRESERVATION DIVISION REVIEW

Log #: 2003.1704
Doc #: 0309CD13

Applicant/Agency: Christen Mitchell
Address: Department of Land and Natural Resources
Division of Forestry
1151 Punchbowl Street, Room 224
Honolulu, Hawaii 96813

SUBJECT: Chapter 6E-8 Historic Preservation Review – Draft Environmental Assessment for the Proposed Natural Resources Conservation Project (Ungulate Exclusion Fence Project)

Ahupua`a: Kanaio
District, Island: Makawao and Hana, Maui
TMK: (2) 2-1-003:054; 2-1-003050; 2-1-002:002, and 1-9-001:006

1. We believe there are no historic properties present, because:
____ a) intensive cultivation has altered the land
____ b) residential development/urbanization has altered the land
____ c) previous grubbing/grading has altered the land
_✓_ d) an acceptable archaeological assessment or inventory survey found no historic properties
_✓_ e) other: We understand the requested minor revisions to the inventory survey are forthcoming.

2. This project has already gone through the historic preservation review process, and mitigation has been completed ___.

_✓_ Thus, we believe that "no historic properties will be affected" by this undertaking

Staff: Cathleen A. Dagher Date: 4 September 2003
Cathleen A. Dagher
Assistant Maui/Lana`i Island Archaeologist
(808) 692-8023

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DAN DAVIDSON
DEPUTY DIRECTOR FOR LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR FOR
THE COMMISSION ON
WATER RESOURCE MANAGEMENT

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND MANAGEMENT
STATE PARKS

Ms. Holly McEldowney
State Historic Preservation Officer
Department of Land & Natural Resources
Historic Preservation Division
601 Kamokila Boulevard
Kapolei, HI 96707

NOV 12 2003

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Ms. McEldowney:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve.

We appreciate your comment that "no historic properties will be affected" by this project because an acceptable archaeological assessment or inventory survey found no historic properties and because requested minor revisions to the inventory survey are forthcoming.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserve Specialist

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DAN DAVIDSON
DEPUTY DIRECTOR - LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

August 28, 2003

KANAIOREARES.RCM
LD-NAV

MEMORANDUM:

TO: Christen Mitchell, Planner
DLNR Division of Forestry and Wildlife

FROM: Dierdre S. Mamiya, Administrator
DLNR Land Division

SUBJECT: Natural Resources Conservation Project
Kanaio Natural Area Reserve

Thank you for the opportunity to review and comment on the subject matter.

Attached is a copy of the Maui District Land Office comment.

The Department of Land and Natural Resources' Land Division has no other comment to offer. If you have any questions, please contact Nicholas A. Vaccaro of the Land Division Support Services Branch at 587-0384 or Jason K. Koga of the Maui District Land Office at 1-808-984-8103.

C: MDLO

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

54 High Street, Room 101
Wailuku, Hawaii 96793
PHONE: (808) 984-8103
FAX: (808) 984-8111

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DAN DAVIDSON
DEPUTY DIRECTOR - LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR - WATER

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BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

August 21, 2003

Ref: KANAIOAREARES.CMT

MEMORANDUM

TO: Dierdre S. Mamiya, Administrator
Land Division

FROM: Jason K. Koga, District Land Agent
Maui District Land Office

SUBJECT: Natural Resources Conservation Project, Kanaio Natural Area Reserve, Draft Environmental Assessment

We have the following comments to offer:

The project appears to include the placement of the fence outside the existing NAR boundaries and within TMK: 2-1-003:050. A right of entry for the installation in this area may be granted following the Board's approval of said right of entry for construction and management control purposes, and a concurrent approval to recommend that the Governor issue an executive order setting aside all expansion areas, as agreed to between NARS and Land Division, for NARS.

The roads being created for installing and maintaining the fence should be located within the fence enclosure. The Land Division has experienced illegal dirt bike and off-road activities within TMK: 2-1-003:050. Although these trespassers apparently utilize other roadways and private properties to access the State unencumbered land, we should not encourage other access points which may further complicate the problem.

We have no further comments at this time. Thank you for the opportunity to review and comment on the matter.

c: N. Vaccaro
District Files

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DAN DAVIDSON
DEPUTY DIRECTOR FOR LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR FOR
THE COMMISSION ON
WATER RESOURCE MANAGEMENT

AQUATIC RESOURCES
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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND MANAGEMENT
STATE PARKS

NOV 12 2003

Ms. Dierdre Mamiya
Administrator
Department of Land and Natural Resources
Land Division
1151 Punchbowl Street
Honolulu, HI 96813

Re: Natural Resources Conservation Project, Kanaio Natural Area Reserve

Dear Ms. Mamiya:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We appreciate Land Division's cooperation in this project and assistance in coordinating Board approval of a right of entry for installation of fencing in TMK 2-1 -003-050 (State unencumbered land) and a concurrent approval to recommend that the Governor issue an executive order setting aside all expansion areas as agreed to between the Natural Area Reserve System and Land Division.

We appreciate your recommendation that the proposed 4 WD access roads be located inside the fence exclosure so as not to encourage illegal dirt bike and other off -road activities in the surrounding area and intend to place the roads inside the exclosure where possible.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

cc: Jason Koga, Maui District Land Office

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
P.O. Box 2359
Honolulu, HI 96804-2359
Telephone: 808-587-3822
Fax: 808-587-3827

September 3, 2003

TO: Christen Mitchell
Division of Forestry and Wildlife
Department of Land and Natural Resources

FROM: Anthony J. H. Ching, Executive Officer

SUBJECT: Natural Resources Conservation Project
Kanaio Natural Area Reserve
Makawao & Hana, Maui
TMK: 2-1-003-054; 2-1-003-050; 1-9-001-006; 2-1-002-002

We acknowledge receipt of your request received by the Land Use Commission on August 11, 2003, regarding the above subject project.

Given the location, scope, and nature of the proposed activity, the State Land Use Commission defers to the judgment of the State Department of Land and Natural Resources in this matter. We have no further comments to offer at this time.

Thank you for the opportunity to comment on the subject project. Please feel free to contact me at 587-3822, should you require clarification or any further assistance.

Sincerely,

ANTHONY J. H. CHING
Executive Officer

c: OEQC

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURC

DAN DAVIDSON
DEPUTY DIRECTOR FOR LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR FOR
THE COMMISSION ON
WATER RESOURCE MANAGEMENT

AQUATIC RESOURCES
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND MANAGEMENT
STATE PARKS

NOV 12 2003

Mr. Anthony Ching
Executive Officer
Land Use Commission
PO Box 2359
Honolulu, HI 96804

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Mr. Ching:

Thank you for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project in Kanaio Natural Area Reserve. We understand that given the location, scope and nature of the proposed activity, you defer to the judgment of the Department of Land and Natural Resources and that you have no further comments at this time. If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

4G2-01

LINDA LINGLE
GOVERNOR

GENEVIEVE SALMONSON
DIRECTOR

RECEIVED
'03 SEP -9 A10 :44
DEPT. OF LAND
& NATURAL RESOURCES
STATE OF HAWAII

PY

STATE OF HAWAII
OFFICE OF ENVIRONMENT QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

September 8, 2003

Mr. Peter Young, Chair
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawai'i 96809

Dear Mr. Young:

Subject: Draft Environmental Assessment for the Kanaio Natural Area Reserve Natural Resources Conservation Project

1. Please consult with the USGS Biological Resources Division and the Hawai'i Speleological Society to determine the probability of caves or lava tubes in the area where bulldozers will be used. Final construction techniques must take into account the impacts to caves or lava tubes and the safety of the equipment operators.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185.

Sincerely,

Genevieve Salmonson

Genevieve Salmonson
Director

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DAN DAVIDSON
DEPUTY DIRECTOR FOR LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR FOR
THE COMMISSION ON
WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

AQUATIC RESOURCES
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COMMISSION ON WATER RESOURCE
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CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE
COMMISSION
LAND MANAGEMENT
STATE PARKS

Ms. Genevieve Salmonson
Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, HI 96813

NOV 12 2003

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Ms. Salmonson:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We appreciate your recommendation to consult with the USGS Biological Resources Division and the Hawaii Speleological Society to determine the probability of caves or lava tubes in the area where bulldozers will be used. The Department of Land and Natural Resource, Division of Forestry and Wildlife plans to take all necessary precautions, including working with USGS, BRD and the Hawaii Speleological Society, to ensure the safety of equipment operators and the protection of caves and lava tubes, as well as any cultural resources contained within, while bulldozing. If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

PHONE (808) 594-1888 FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

RECEIVED
'03 AUG 20 P3:19
OFC. OF ENVIRONMENTAL QUALITY CONTROL

HRD#03-1089

August 13, 2003

Ms. Genevieve K.Y. Salmonson
Director
Office of Environmental Quality Control
State Department of Health
235 S. Beretania St. – Suite 702
Honolulu, HI 96813

SUBJECT: KANAIO NATURAL AREA RESERVE – NATURAL RESOURCE PROJECT

Dear Ms. Salmonson:

Thank you for the opportunity to review and comment on the above referenced project to install fencing around the upper portion of the Kanaio Natural Area Reserve (NAR) on the island of Maui. We understand that the U.S. Fish and Wildlife Service and the Ulupalakua Ranch are partners in this effort.

The Office of Hawaiian Affairs (OHA) requests that the *Archaeological features* section (page 23) be amended to reflect that if any human remains are encountered during activities on the project site, that both the Maui Island Burial Council and the State Historic Preservation Division be contacted immediately.

We note the project has received partial funding from the federal government through the U.S. Fish and Wildlife Service. Since federal funding will be expended, a NHPA Section 106 Consultation is required. A formal consultation does not begin until a written Request for Consultation is made by the respective Federal Agency to OHA. The request should be sent by mail to the following address:

Attn: Request for Section 106 Consultation
Administrator
Office of Hawaiian Affairs
711 Kapiolani Blvd. Suite 500
Honolulu, HI 96813-5349

The position of the OHA with regards to the propriety and adequacy of the Section 106 Consultation is that without proper identification of all potentially interested stakeholders at the beginning of the project, the consultation process will be flawed and insufficient. NHPA requires any federal agency contemplating an undertaking to

attempt identify all potentially interested stakeholders. You may wish to contact Ms. Thelma Shimaoka (234-5219) who serves as OHA's Community Affairs Coordinator on Maui. She may be able to assist you in identifying interested stakeholders who have knowledge of the area. You might also contact the Central Maui Hawaiian Civic Club at P.O. Box 483, Kahalui, HI 96733 for information on the area.

Should you have any questions, please contact Jerry B. Norris at 594-1847 or email him at jerryn@oha.org.

Sincerely,

Peter L. Yee
Director
Nationhood and Native Rights Division

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

DIVISION OF FORESTRY AND WILDLIFE

1151 PUNCHBOWL STREET

HONOLULU, HAWAII 96813

NOV 12 2003

Mr. Peter L. Yee
Nationhood and Native Rights
Office of Hawaiian Affairs
711 Kapiolani Blvd., Suite 500
Honolulu, HI 96813

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Mr. Yee:

Thank you for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We acknowledge your request to amend the Environmental Assessment to reflect that if any human remains are encountered during activities on the project site, both the Maui Island Burial Council and the State Historic Preservation Division will be contacted immediately, and will make the requested changes.

We acknowledge your request to be included in the NHPA Section 106 consultation conducted by the U.S. Fish and Wildlife Service due to the partial Federal funding and will share your request with them. The U.S. Fish and Wildlife Service has already begun the Section 106 consultation with the State Historic Preservation Division, based upon the Cultural Resources Investigation prepared by Virginia Parks and upon background information gathered by CKM Cultural Resources and summarized in A Native Hawaiian Traditional Cultural Practices Assessment for Kanaio Natural Area Reserve (2003).

In addition, to gather additional input on the potential impacts of the project on historic sites or traditional practices, the Division of Forestry and Wildlife distributed the Draft Environmental Assessment to the following agencies and organizations: Office of Hawaiian Affairs, Department of Hawaiian Home Lands, DLNR State Historic Preservation Division, Central Maui Hawaiian Civic Club, Historic Hawaii Foundation, Kahu Charles Kauluwehi Maxwell, Na Kupuna o Maui, Ulupalakua Ranch, Kahea – the Hawaiian Environmental Alliance, Ilio'ulaokalani Coalition, Ka Ohana o Kahikinui, Living Indigenous Forest Ecosystems, Kahikinui Game and Land Ohana, and Kaupo Wildlife Club. We received comment letters in response from the Office of Hawaiian Affairs, the State Historic Preservation Division, and Kahea. These comment letters did not provide any new or additional information about historic sites or cultural practices in the project area. As a result, we believe that the project will result in a determination of no impact to historic properties.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

ALAN M. ARAKAWA
Mayor

MICHAEL W. FOLEY
Director

WAYNE A. BOTEILHO
Deputy Director

COUNTY OF MAUI
DEPARTMENT OF PLANNING

September 2, 2003

Ms. Christen Mitchell (Fax 587-0064)
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 224
Honolulu, Hawaii 96813

Dear Ms. Mitchell:

RE: Draft Environmental Assessment (EA) for the Natural Resources Conservation Project, Kanaio Natural Area Reserve, Tax Map Key: 2-1-003:050 and 054, 1-9-001-006, and 2-1-002-002, West of the Makawao-Hana District Boundary Line, Piilani Highway (Kanaio-Kalama Park Road), Kanaio, Island of Maui, Hawaii

The Maui County Planning Department (Department) has reviewed the above subject EA. The Division of Forestry and Wildlife with the US Fish and Wildlife Service and Ulupalakua Ranch proposes to install fencing around the upper portion of the Kanaio Natural Area Reserve (NAR) on the island of Maui.

The project involves nine (9) miles of fence construction on approximately 1,250 acres of land in two phases to create a large ungulate free area to protect native dry forests and shrub lands. The proposed action involves clearing of a corridor no more than 20 feet wide, constructing a road, and erecting a fence line. The proposed fence will be about eight (8) feet tall, made of wire mesh. The outside of the fence will be skirted along the base with a mesh wire apron. Phase I is 850 acres with 5.25 miles of fencing and will take approximately two to three years to complete. There is no time estimate for Phase II. A Findings of No Significant Impact (FONSI) is anticipated.

The Department notes that the State Land Use and Kihei-Makena Community Plan map identifies all of the properties, except for a portion on TMK 2-1-002: 002 (Parcel 2) as Agricultural. The county zoning would also be Agriculture. The portion on Parcel two that is not in the Agricultural zone is in the State Conservation District. The county zoning would be interim. Parcel 2 is also located below the highway and

The county zoning would be interim. Parcel 2 is also located below the highway and is in the Special Management Area (SMA). An SMA Assessment and Permit will be required if any development occurs on Parcel 2. Appendix A, "Proposed Kanaio Fencing" showing the fence lines and mapping indicates that Parcel 2 will not be included in the fencing project.

The Department recommends that Appendix A be clarified to include all of the TMK numbers identifying the four parcels that are within the scope of the proposal.

The EA states that a bulldozer will be used to improve existing 4WD access roads and to create new roads along the eastern and western fence segments. Bulldozing will also be used to improve portions of the southern unit boundary where it parallels Highway 31. The EA states that as much as possible, bulldozing will be restricted to previously disturbed areas and avoid sensitive natural and cultural features.

The EA provides comprehensive details on the natural and cultural features and protection of them. However, the Department notes in the Kihei-Makena area that most of the runoff into the ocean is created by sediment and debris washed down by agricultural and natural areas at higher elevations. It is not clear in the EA if the new roads proposed are the same as the 20 foot-wide fence corridors. The EA did not provide any information or a map on the location of all of the 4WD access roads that will be improved and the new roads that will be created to access the subject properties. The EA should also identify existing drainage patterns, including nearby gulches or streams, the impact and effect on downstream properties, and runoff to the ocean particularly when the roadways are being improved and under construction. Will volunteers be utilized to improve and construct the 4WD access roads, or, will licensed contractors be hired? In addition, the EA should also identify and address proposed drainage and mitigative measures, including but not limited to BMP's, to prevent runoff and erosion during and after construction of the roadway improvements, including the proposed roadways or corridors.

As a result of these roadway improvements and new roads or corridors, the EA should also address noise and air quality during and after construction and mitigative measures, if any.

Should you have any further questions, please contact Julie Higa, Staff Planner, at 270-7814.

Sincerely,

MICHAEL W. FOLEY
Director of Planning

MWF:JH:sp
c: Clayton Yoshida, Planning Program Administrator
Gilbert Coloma-Agaran, Director of Public Works and Environmental Management
Neal Fujiwara, Natural Resources Conservation Service, Maui Office
Julie Higa, Planner
Project File
General File

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LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
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CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND MANAGEMENT
STATE PARKS

NOV 12 2003

Mr. Michael Foley
Director
County of Maui Department of Planning
250 South High Street
Wailuku, HI 96793

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Mr. Foley:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We appreciate your comments on the zoning and land use classifications of the project area and confirm that no fencing is planned on Parcel 2 (TMK 2-1-002:002) as part of the proposed action. We acknowledge that an SMA Assessment and Permit would be required if any development occurs on Parcel 2.

In response to your recommendation, we have made changes to the map in Appendix A to illustrate all TMK numbers of the parcels within the scope of the project.

We have also clarified that the proposed 4 WD access roads will be constructed within the 20-foot wide fence corridor. In addition, the Final EA includes additional discussion on the soils in the project area and the anticipated impact of the planned construction on drainage and the adjacent properties. In sum, the soils in the project area are a'a flows (rLW) and very stony land (rVS). The project area is generally arid and wind-swept with a mean annual rainfall of approximately 30 inches, typically ranging from 12 to 45 inches per year. Only one intermittent stream, which is typically dry, is located in the project area. Due to the nature of the terrain and climate conditions, the planned construction is not anticipated to have an impact on drainage in the area or on adjacent properties and is not anticipated to result in any runoff to the ocean.

Moreover, we intend to incorporate the Division of Forestry and Wildlife's Best Management Practices (BMPs) for Maintaining Water Quality in Hawaii (1996) during construction to further prevent runoff and erosion. Specific Best Management Practices (BMPs) to be incorporated include:

- Locating roads to fit topography and minimize alterations to the natural features;
- Provision of culverts, dips, water bars and cross drainage to minimize road bed erosion;
- Avoidance of diverting water from natural drainage ways;
- Keeping road grades at less than 10%, except where terrain unavoidably requires a short, steep grade;

- Incorporation of a stabilized construction entrance;
- Dust control measures as appropriate;
- Silt control as need to prevent silt runoff onto Highway 31;
- Sediment barriers as needed;
- Slope protection as needed;
- Inlet protection as needed;
- Temporary and permanent stabilization as needed; and
- Maintenance of roadway to maintain a stable surface and minimize any erosion.

In response to your question regarding the use of volunteers for road construction, we plan to work with our cooperator, Ulupalakua Ranch, to construct the access roads, utilizing their personnel with bulldozer operation experience. If necessary based upon the terrain and the circumstances, we will hire a licensed contractor to do bulldozing.

Finally, in response to your concerns, we have added information in the Final EA to address noise and air quality concerns during and after construction. We anticipate that some noise will be generated during fence construction through the use of bulldozers, small power equipment and hand tools. Because of the remoteness of the project area and the distance from residences, we do not anticipate that the noise will constitute a significant impact. To mitigate the impact of noise, construction activity will take place only during daylight hours. We anticipate that local air quality may be temporarily impacted by the use of bulldozers and small power equipment and hand tools, primarily from windblown dust from the disturbance of soil along the fence corridor. Due to the remoteness of the project area, the distance from residences, the nature of the terrain, and the limited corridor to be disturbed, we do not anticipate that air quality will be negatively impacted to any significant degree. Over the long term, it is anticipated that air quality may be improved when increased vegetative cover within the protective fencing reduces wind erosion.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

ALAN M. ARAKAWA
Mayor

GILBERT S. COLOMA-AGARAN
Director

MILTON M. ARAKAWA, A.I.C.P.
Deputy Director

Telephone: (808) 270-7845
Fax: (808) 270-7955

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS AND ENVIRONMENTAL MANAGEMENT
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAII 96793

RALPH NAGAMINE, L.S., P.E.
Development Services Administration

TRACY TAKAMINE, P.E.
Wastewater Reclamation Division

LLOYD P.C.W. LEE, P.E.
Engineering Division

BRIAN HASHIRO, P.E.
Highways Division

JOHN D. HARDER
Solid Waste Division

September 8, 2003

Ms. Christen Mitchell
DEPARTMENT OF LAND AND
NATURAL RESOURCES
DIVISION OF FORESTRY AND
WILDLIFE
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Ms. Mitchell:

SUBJECT: DRAFT ENVIRONMENTAL ASSESSMENT
NATURAL RESOURCES CONSERVATION PROJECT
KANAIO NATURAL AREA RESERVE
TMK: (2) 2-1-003:054, 2-1-003:050, 1-9-001:006, 2-1-002:002

We reviewed the subject draft environmental assessment and have the following comment:

1. Grubbing of areas greater than one (1) acre that are outside of the State Land Use Conservation District will require a grubbing permit and will need to comply with the provisions of the grading ordinance to provide best management practices to control erosion, sedimentation and dust.

If you have any questions regarding this letter, please call Milton Arakawa at (808)270-7845.

Very truly yours,

Milton Arakawa

for GILBERT S. COLOMA-AGARAN
Director

GSCA:RN:msc
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LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

NOV 12 2003

Mr. Gilbert Coloma-Agaran
Director
County of Maui Department of Public Works and Environmental Management
200 South High Street
Wailuku, HI 96793

Re: Natural Resources Conservation Project, Kanaio Natural Area Reserve

Dear Mr. Coloma-Agaran:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We appreciate your comment that grubbing of area greater than one acre outside the Conservation District requires a grubbing permit and will need to comply with the provisions of the grading ordinance to provide best management practices to control erosion, sedimentation and dust. We have made changes to the Final Environmental Assessment to reflect that this permit is required. In addition, we will work with your office to apply for this permit and will not begin construction until it has been received. If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
P.O. BOX 1109
WAILUKU, MAUI, HAWAII 96793-6109
Telephone (808) 270-7816 Fax (808) 270-7833

September 8, 2003

Ms. Christen Mitchell
Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 224
Honolulu HI 96813

Dear Ms. Mitchell:

Title of Project: Natural Resources Conservation Project, Kanaio Natural Area Reserve - install 9 miles of fencing to enclose approximately 1,250 acres on the upper portion of Kanaio Natural Area Reserve in order to protect native plants and animals, clearing of corridor no more than 20 feet wide and road construction
TMK: 2-1-003:050 & 054, 2-1-002:002, 1-9-001:006

Thank you for the opportunity to review the draft EA for this project.

We appreciate the applicant's effort in preserving natural, self-sustaining habitats and ecosystem as well as taking part in the restoration of our watershed.

The aquifer serving the project is Lualailua Aquifer which has an estimated sustainable yield of 11 MGD. In order to protect surface and ground water resources, we encourage the applicant to adopt Best Management Practices (BMPs) designed to minimize infiltration and run off from construction and vehicle operations. We have attached sample BMPs for principle operations for reference.

The project is located in the Maui County Planting Plan - Plant Zones 2, 3 & 4. Attached is a list of appropriate plants for the zones for you reference. Native plants adapted to the area conserve water and protect the watershed from degradation due to invasive alien species.

Should you have any questions, please call Edna Manzano of our Water Resources and Planning Division at: (808) 270-7199.

Sincerely,

George Y. Tengan
Director

eam
c: Engineering Division
Office of Environmental Quality Control
Applicant, with attachment:
Selected BMP's from "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters"-EPA

By Water All Things Find Life

United States
Environmental Protection
Agency

Office of Water
Washington, DC 20460

840-B-92-002
January 1993

EPA

Guidance Specifying Management Measures For Sources Of Nonpoint Pollution In Coastal Waters

Issued Under the Authority of
Section 6217(g) of the Coastal Zone Act
Reauthorization Amendments of 1990

VII. ROADS, HIGHWAYS, AND BRIDGES

NOTE: Management Measures II.A and II.B of this chapter also apply to planning, siting, and developing roads and highways.[6]

A. Management Measure for Planning, Siting, and Developing Roads and Highways

Plan, site, and develop roads and highways to:

(1) Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss;

(2) Limit land disturbance such as clearing and grading and cut and fill to reduce erosion and sediment loss; and

(3) Limit disturbance of natural drainage features and vegetation.

1. Applicability

This measure is intended to be applied by States to site development and land disturbing activities for new, relocated, and reconstructed (widened) roads (including residential streets) and highways in order to reduce the generation of nonpoint source pollutants and to mitigate the impacts of urban runoff and associated pollutants from such activities. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have some flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

The best time to address control of NPS pollution from roads and highways is during the initial planning and design phase. New roads and highways should be located with consideration of natural drainage patterns and planned to avoid encroachment on surface waters and wet areas. Where this is not possible, appropriate controls will be needed to minimize the impacts of NPS runoff on surface waters.

This management measure emphasizes the importance of planning to identify potential NPS problems early in the design process. This process involves a detailed analysis of environmental features most associated with NPS pollution, erosion and sediment problems such as topography, drainage patterns, soils, climate, existing land use, estimated traffic volume, and sensitive land areas. Highway locations selected, planned, and designed with consideration of these features will greatly minimize erosion and sedimentation and prevent NPS pollutants from entering watercourses during and after construction. An important consideration in planning is the distance between

[6] Management measure II.A applies only to runoff that emanates from the road, highway, and bridge right-of-way. This management measure does not apply to runoff and total suspended solid loadings from upland areas outside the road, highway, or bridge project.

a highway and a watercourse that is needed to buffer the runoff flow and prevent potential contaminants from entering surface waters. Other design elements such as project alignment, gradient, cross section, and the number of stream crossings also must be taken into account to achieve successful control of erosion and nonpoint sources of pollution. (Refer to Chapter 3 of this guidance for details on road designs for different terrains.)

The following case study illustrates some of the problems and associated costs that may occur due to poor road construction and design. These issues should be addressed in the planning and design phase.

CASE STUDY - ANNAPOLIS, MARYLAND

Poor road siting and design resulted in concentrated runoff flows and heavy erosion that threatened several house foundations adjacent to the road. Sediment-laden runoff was also discharged into Herring Bay. To protect the Chesapeake Bay and the nearby houses, the county corrected the problem by installing diversions, a curb-and-drain urban runoff conveyance, and a rock wall filtration system, at a total cost of $100,000 (Munsey, 1992).

3. Management Measure Selection

This management measure was selected because it follows the approach to highway development recommended by the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA) guidance, and highway location and design guidelines used by the States of Virginia, Maryland, Washington, and others.

Additionally, AASHTO has location and design guidelines (AASHTO, 1990, 1991) available for State highway agency use that describe the considerations necessary to control erosion and highway-related pollutants. Federal Highway Administration policy (FHWA, 1991) requires that Federal-aid highway projects and highways constructed under direct supervision of the FHWA be located, designed, constructed, and operated according to standards that will minimize erosion and sediment damage to the highway and adjacent properties and abate pollution of surface water and ground-water resources.

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

a. *Consider type and location of permanent erosion and sediment controls (e.g., vegetated filter strips, grassed swales, pond systems, infiltration systems, constructed urban runoff wetlands, and energy dissipators and velocity controls) during the planning phase of roads, highway, and bridges. (AASHTO, 1991; Hartigan et al., 1989)*

b. *All wetlands that are within the highway corridor and that cannot be avoided should be mitigated. These actions will be subject to Federal Clean Water Act section 404 requirements and State regulations.*

c. *Assess and establish adequate setback distances near wetlands, waterbodies, and riparian areas to ensure protection from encroachment in the vicinity of these areas.*

Setback distances should be determined on a site-specific basis since several variables may be involved such as topography, soils, floodplains, cut-and-fill slopes, and design geometry. In level or gently sloping terrain, a general rule of thumb is to establish a setback of 50 to 100 feet from the edge of the wetland or riparian area and the right-of-way. In areas of steeply sloping terrain (20 percent or greater), setbacks of 100 feet or more are recommended. Right-of-way setbacks from major waterbodies (oceans, lakes, estuaries, rivers) should be in excess of 100 to 1000 feet.

d. *Avoid locations requiring excessive cut and fill. (AASHTO, 1991)*

e. *Avoid locations subject to subsidence, sink holes, landslides, rock outcroppings, and highly erodible soils. (AASHTO, 1991; TRB, Campbell, 1988)*

f. *Size rights-of-way to include space for siting runoff pollution control structures as appropriate. (AASHTO, 1991; Hartigan, et al., 1989)*

Erosion and sediment control structures (extended detention dry ponds, permanent sediment traps, catchment basins, etc.) should be planned and located during the design phase and included as part of the design specifications to ensure that such structures, where needed, are provided within the highway right-of-way.

g. *Plan residential roads and streets in accordance with local subdivision regulations, zoning ordinances, and other local site planning requirements (International City Managers Association, Model Zoning/Subdivision Codes). Residential road and street pavements should be designed with minimum widths.*

Local roads and streets should have right-of-way widths of 36 to 50 feet, with lane widths of 10 to 12 feet. Minimum pavement widths for residential streets where street parking is permitted range from 24 to 28 feet between curbs. In large-lot subdivisions (1 acre or more), grassed drainage swales can be used in lieu of curbs and gutters and the width of paved road surface can be between 18 and 20 feet.

h. *Select the most economic and environmentally sound route location. (FHWA, 1991)*

i. *Use appropriate computer models and methods to determine urban runoff impacts with all proposed route corridors. (Driscoll, 1990)*

Computer models to determine urban runoff from streets and highways include TR-55 (Soil Conservation Service model for controlling peak runoff); the P-8 model to determine storage capacity (Palmstrom and Walker); the FHWA highway runoff model (Driscoll et al., 1990); and others (e.g., SWMM, EPA's stormwater management model; HSP continuous simulation model by Hydrocomp, Inc.).

j. *Comply with National Environmental Policy Act requirements including other State and local requirements. (FHWA, T6640.8A)*

k. *Coordinate the design of pollution controls with appropriate State and Federal environmental agencies. (Maryland DOE, 1983)*

l. Develop local official mapping to show location of proposed highway corridors.

Official mapping can be used to reserve land areas needed for public facilities such as roads, highways, bridges, and urban runoff treatment devices. Areas that require protection, such as those which are sensitive to disturbance or development-related nonpoint source pollution, can be reserved by planning and mapping necessary infrastructure for location in suitable areas.

5. Effectiveness Information and Cost Information

The most economical time to consider the type and location of erosion, sediment, and NPS pollution control is early in the planning and design phase of roads and highways. It is much more costly to correct polluted runoff problems after a road or highway has already been built. The most effective and often the most economical control is to design roads and highways as close to existing grade as possible to minimize the area that must be cut or filled and to avoid locations that encroach upon adjacent watercourses and wet areas. However, some portions of roads and highways cannot always be located where NPS pollution does not pose a threat to surface waters. In these cases, the impact from potential pollutant loadings should be mitigated. Interactive computer models designed to run on a PC are available (e.g., FHWA's model, Driscoll et al., 1990) and can be used to examine and project the runoff impacts of a proposed road or highway design on surface waters. Where controls are determined to be needed, several cost-effective management practices, such as vegetated filter strips, grassed swales, and pond systems, can be considered and used to treat the polluted runoff. These mitigating practices are described in detail in the discussion on urban developments (Management Measure IV.A).

B. Management Measure for Bridges

Site, design, and maintain bridge structures so that sensitive and valuable aquatic ecosystems and areas providing important water quality benefits are protected from adverse effects.

1. Applicability

This management measure is intended to be applied by States to new, relocated, and rehabilitated bridge structures in order to control erosion, streambed scouring, and surface runoff from such activities. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have some flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

This measure requires that NPS runoff impacts on surface waters from bridge decks be assessed and that appropriate management and treatment be employed to protect critical habitats, wetlands, fisheries, shellfish beds, and domestic water supplies. The siting of bridges should be a coordinated effort among the States, the FHWA, the U.S. Coast Guard, and the Army Corps of Engineers. Locating bridges in coastal areas can cause significant erosion and sedimentation, resulting in the loss of wetlands and riparian areas. Additionally, since bridge pavements are extensions of the connecting highway, runoff waters from bridge decks also deliver loadings of heavy metals, hydrocarbons, toxic substances, and deicing chemicals to surface waters as a result of discharge through scupper drains with no overland buffering. Bridge maintenance can also contribute heavy loads of lead, rust particles, paint, abrasive, solvents, and cleaners into surface waters. Protection against possible pollutant overloads can be afforded by minimizing the use of scuppers on bridges traversing very sensitive waters and conveying deck drainage to land for treatment. Whenever practical, bridge structures should be located to avoid crossing over sensitive fisheries and shellfish-harvesting areas to prevent washing polluted runoff through scuppers into the waters below. Also, bridge design should account for potential scour and erosion, which may affect shellfish beds and bottom sediments.

3. Management Measure Selection

This management measure was selected because of its documented effectiveness and to protect against potential pollution impacts from siting bridges over sensitive waters and tributaries in the coastal zone. There are several examples of siting bridges to protect sensitive areas. The Isle of Palms Bridge near Charleston, South Carolina, was designed without scupper drains to protect a local fishery from polluted runoff by preventing direct discharge into the waters below. In another example, the Louisiana Department of Transportation and Development specified stringent requirements before allowing the construction of a bridge to protect destruction of fragile wetlands near New Orleans. A similar requirement was specified for bridge construction in the Tampa Bay area in Florida (ENR, 1991).

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

Additional erosion and sediment control management practices are listed in the construction section for urban sources of pollution (Management Measure IV.A).

a. Coordinate design with FHWA, USCG, COE, and other State and Federal agencies as appropriate.

b. Review National Environmental Policy Act requirements to ensure that environmental concerns are met (FHWA, T6640.8A and 23 CFR 771).

c. Avoid highway locations requiring numerous river crossings. (AASHTO, 1991)

d. Direct pollutant loadings away from bridge decks by diverting runoff waters to land for treatment.

Bridge decks should be designed to keep runoff velocities low and control pollutant loadings. Runoff waters should be conveyed away from contact with the watercourse and directed to a stable storm drainage, wetland, or detention pond. Conveyance systems should be designed to withstand the velocities of projected peak discharge.

e. Restrict the use of scupper drains on bridges less than 400 feet in length and on bridges crossing very sensitive ecosystems.

Scupper drains allow direct discharge of runoff into surface waters below the bridge deck. Such discharges can be of concern where the waterbody is highly susceptible to degradation or is an outstanding resource such as a spawning area or shellfish bed. Other sensitive waters include water supply sources, recreational waters, and irrigation systems. Care should be taken to protect these areas from contaminated runoff.

f. Site and design new bridges to avoid sensitive ecosystems.

Pristine waters and sensitive ecosystems should be protected from degradation as much as possible. Bridge structures should be located in alternative areas where only minimal environmental damage would result.

g. On bridges with scupper drains, provide equivalent urban runoff treatment in terms of pollutant load reduction elsewhere on the project to compensate for the loading discharged off the bridge.

5. Effectiveness Information and Cost Information

Effectively controlling NPS pollutants such as road contaminants, fugitive dirt, and debris and preventing accidental spills from entering surface waters via bridge decks are necessary to protect wetlands and other sensitive ecosystems. Therefore, management practices such as minimizing the use of scupper drains and diverting runoff waters to land for treatment in detention ponds and infiltration systems are known to be effective in mitigating pollutant loadings. Tables 4-7 and 4-8 in Section II provide cost and effectiveness data for ponds, constructed wetlands, and filtration devices.

C. Management Measure for Construction Projects

(1) Reduce erosion and, to the extent practicable, retain sediment onsite during and after construction and

(2) Prior to land disturbance, prepare and implement an approved erosion control plan or similar administrative document that contains erosion and sediment control provisions.

1. Applicability

This management measure is intended to be applied by States to new, replaced, restored, and rehabilitated road, highway, and bridge construction projects in order to control erosion and offsite movement of sediment from such project sites. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have some flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

Erosion and sedimentation from construction of roads, highways, and bridges, and from unstabilized cut-and-fill areas, can significantly impact surface waters and wetlands with silt and other pollutants including heavy metals, hydrocarbons, and toxic substances. Erosion and sediment control plans are effective in describing procedures for mitigating erosion problems at construction sites before any land-disturbing activity begins. Additional relevant practices are described in Management Measures III.A and III.B of this chapter.

Bridge construction projects include grade separations (bridges over roads) and waterbody crossings. Erosion problems at grade separations result from water running off the bridge deck and runoff waters flowing onto the bridge deck during construction. Controlling this runoff can prevent erosion of slope fills and the undermining failure of the concrete slab at the bridge approach. Bridge construction over waterbodies requires careful planning to limit the disturbance of streambanks. Soil materials excavated for footings in or near the water should be removed and relocated to prevent the material from being washed back into the waterbody. Protective berms, diversion ditches, and silt fences parallel to the waterway can be effective in preventing sediment from reaching the waterbody.

Wetland areas will need special consideration if affected by highway construction, particularly in areas where construction involves adding fill, dredging, or installing pilings. Highway development is most disruptive in wetlands since it may cause increased sediment loss, alteration of surface drainage patterns, changes in the subsurface water table, and loss of wetland habitat. Highway structures should not restrict tidal flows into salt marshes and other coastal wetland areas because this might allow the intrusion of freshwater plants and reduce the growth of salt-tolerant species. To safeguard these fragile areas, the best practice is to locate roads and highways with sufficient setback distances between the highway right-of-way and any wetlands or riparian areas. Bridge construction also can impact water circulation and quality in wetland areas, making special techniques necessary to accommodate construction. The following case study provides an example of a construction project where special considerations were given to wetlands.

CASE STUDY - BRIDGING WETLANDS IN LOUISIANA

To provide protection for an environmentally critical wetland outside New Orleans, the Louisiana Department of Transportation and Development (DOTD) required a special construction technique to build almost 2 miles of twin elevated structures for the Interstate 310 link between I-10 and U.S. Route 90. A technique known as "end-on" construction was devised to work from the decks of the structures, building each section of the bridge from the top of the last completed section and using heavy cranes to push each section forward one bay at a time. The cranes were also used to position steel platforms, drive in support pilings, and lay deck slabs, alternating this procedure between each bay. Without this technique, the Louisiana DOTD would not have been permitted to build this structure. The twin 9,200-foot bridges took 485 days to complete at a cost of $25.3 million (*Engineering News Record*, 1991).

3. Management Measure Selection

This management measure was selected because it supports FHWA's erosion and sediment control policy for all highway and bridge construction projects and is the administrative policy of several State highway departments and local governmental agencies involved in land development activity. Examples of erosion and sediment controls and NPS pollutant control practices are described in AASHTO guidelines and in several State erosion control manuals (AASHTO, 1991; North Carolina DOT, 1991; Washington State DOT, 1988). A detailed discussion of cost-effective management practices is available in the urban development section (Section II) of this chapter. These example practices are also effective for highway construction projects.

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

Additional erosion and sediment control management practices are listed in the construction section (Section III) of this chapter.

a. *Write erosion and sediment control requirements into plans, specifications, and estimates for Federal aid construction projects for highways and bridges (FHWA, 1991) and develop erosion control plans for earth-disturbing activities.*

Erosion and sediment control decisions made during the planning and location phase should be written into the contract, plans, specifications, and special provisions provided to the construction contractor. This approach can establish contractor responsibility to carry out the explicit contract plan recommendations for the project and the erosion control practices needed.

b. *Coordinate erosion and sediment controls with FHWA, AASHTO, and State guidelines.*

Coordination and scheduling of the project work with State and local authorities are major considerations in controlling anticipated erosion and sediment problems. In addition, the contractor should submit a general work schedule and plan that indicates planned implementation of temporary and permanent erosion control practices, including shutdown procedures for winter and other work interruptions. The plan also should include proposed methods of control on restoring borrow pits and the disposal of waste and hazardous materials.

c. Install permanent erosion and sediment control structures at the earliest practicable time in the construction phase.

Permanent or temporary soil stabilization practices should be applied to cleared areas within 15 days after final grade is reached on any portion of the site. Soil stabilization should also be applied within 15 days to denuded areas that may not be at final grade but will remain exposed to rain for 30 days or more. Soil stabilization practices protect soil from the erosive forces of raindrop impact and flowing water. Temporary erosion control practices usually include seeding, mulching, establishing general vegetation, and early application of a gravel base on areas to be paved. Permanent soil stabilization practices include vegetation, filter strips, and structural devices.

Sediment basins and traps, perimeter dikes, sediment barriers, and other practices intended to trap sediment on site should be constructed as a first step in grading and should be functional before upslope land disturbance takes place. Structural practices such as earthen dams, dikes, and diversions should be seeded and mulched within 15 days of installation.

d. Coordinate temporary erosion and sediment control structures with permanent practices.

All temporary erosion and sediment controls should be removed and disposed of within 30 days after final site stabilization is achieved or after the temporary practices are no longer needed. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary controls should be permanently stabilized to prevent further erosion and sedimentation (AASHTO, 1991).

e. Wash all vehicles prior to leaving the construction site to remove mud and other deposits. Vehicles entering or leaving the site with trash or other loose materials should be covered to prevent transport of dust, dirt, and debris. Install and maintain mud and silt traps.

f. Mitigate wetland areas destroyed during construction.

Marshes and some types of wetlands can often be developed in areas where fill material was extracted or in ponds designed for sediment control during construction. Vegetated strips of native marsh grasses established along highway embankments near wetlands or riparian areas can be effective to protect these areas from erosion and sedimentation (FHWA, 1991).

g. Minimize the area that is cleared for construction.

h. Construct cut-and-fill slopes in a manner that will minimize erosion.

Cut-and-fill slopes should be constructed in a manner that will minimize erosion by taking into consideration the length and steepness of slopes, soil types, upslope drainage areas, and ground-water conditions. Suggested recommendations are as follows: reduce the length of long steep slopes by adding diversions or terraces; prevent concentrated runoff from flowing down cut-and-fill slopes by containing these flows within flumes or slope drain structures; and create roughened soil surfaces on cut-and-fill slopes to slow runoff flows. Wherever a slope face crosses a water seepage plane, thereby endangering the stability of the slope, adequate subsurface drainage should be provided.

i. Minimize runoff entering and leaving the site through perimeter and onsite sediment controls.

j. Inspect and maintain erosion and sediment control practices (both on-site and perimeter) until disturbed areas are permanently stabilized.

k. *Divert and convey offsite runoff around disturbed soils and steep slopes to stable areas in order to prevent transport of pollutants off site.*

l. *After construction, remove temporary control structures and restore the affected area. Dispose of sediments in accordance with State and Federal regulations.*

m. *All storm drain inlets that are made operable during construction should be protected so that sediment-laden water will not enter the conveyance system without first being filtered or otherwise treated to remove sediment.*

5. Effectiveness Information and Cost Information

The detailed cost and effectiveness information presented under the construction measure for urban development is also applicable to road, highway, and bridge construction. See Tables 4-15 and 4-16 in Section III.

D. Management Measure for Construction Site Chemical Control

(1) Limit the application, generation, and migration of toxic substances;

(2) Ensure the proper storage and disposal of toxic materials; and

(3) Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface water.

1. Applicability

This management measure is intended to be applied by States to new, resurfaced, restored, and rehabilitated road, highway, and bridge construction projects in order to reduce toxic and nutrient loadings from such project sites. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have some flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

The objective of this measure is to guard against toxic spills and hazardous loadings at construction sites from equipment and fuel storage sites. Toxic substances tend to bind to fine soil particles; however, by controlling sediment mobilization, it is possible to limit the loadings of these pollutants. Also, some substances such as fuels and solvents are hazardous and excess applications or spills during construction can pose significant environmental impacts. Proper management and control of toxic substances and hazardous materials should be the adopted procedure for all construction projects and should be established by erosion and sediment control plans. Additional relevant practices are described in Management Measure III.B of this chapter.

3. Management Measure Selection

This management measure was selected because of existing practices that have been shown to be effective in mitigating construction-generated NPS pollution at highway project sites and equipment storage yards. In addition, maintenance areas containing road salt storage, fertilizers and pesticides, snowplows and trucks, and tractor mowers have the potential to contribute NPS pollutants to adjacent watercourses if not properly managed (AASHTO, 1988, 1991a). This measure is intended to safeguard surface waters and ground water from toxic and hazardous pollutants generated at construction sites. Examples of effective implementation of this measure are presented in the section on construction in urban areas. Several State environmental agencies are using this approach to regulate toxic and hazardous pollutants (Florida DER, 1988; Puget Sound Basin,.1991).

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

The practices that are applicable to this management measure are described in Section III.B.

5. Effectiveness Information and Cost Information

The detailed cost and effectiveness data presented in the Section III.A of this chapter describing NPS controls for construction projects in urban development areas are also applicable to highway construction projects.

E. Management Measure for Operation and Maintenance

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.

1. Applicability

This management measure is intended to be applied by States to existing, restored, and rehabilitated roads, highways, and bridges. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measures and will have some flexibility in doing so. The application of measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

Substantial amounts of eroded material and other pollutants can be generated by operation and maintenance procedures for roads, highways, and bridges, and from sparsely vegetated areas, cracked pavements, potholes, and poorly operating urban runoff control structures. This measure is intended to ensure that pollutant loadings from roads, highways, and bridges are minimized by the development and implementation of a program and associated practices to ensure that sediment and toxic substance loadings from operation and maintenance activities do not impair coastal surface waters. The program to be developed, using the practices described in this management measure, should consist of and identify standard operating procedures for nutrient and pesticide management, road salt use minimization, and maintenance guidelines (e.g., capture and contain paint chips and other particulates from bridge maintenance operations, resurfacing, and pothole repairs).

3. Management Measure Selection

This management measure for operation and maintenance was selected because (1) it is recommended by FHWA as a cost-effective practice (FHWA, 1991); (2) it is protective of the human environment (Puget Sound Water Quality Authority, 1989); (3) it is effective in controlling erosion by revegetating bare slopes (AASHTO, 1991b); (4) it is helpful in minimizing polluted runoff from road pavements (Transportation Research Board, 1991); and (5) both Federal (Richardson, 1974) and State highway agencies (Minnesota Pollution Control Agency, 1989; Pitt, 1973) advocate highway maintenance as an effective practice for minimizing pollutant loadings.

Maintenance of erosion and sediment control practices is of critical importance. Both temporary and permanent controls require frequent and periodic cleanout of accumulated sediment. Any trapping or filtering device, such as silt fences, sediment basins, buffers, inlets, and check dams, should be checked and cleaned out when approximately 50 percent of their capacity is reached, as determined by the erodible nature of the soil, flow velocity, and quantity of runoff. Seasonal and climatic differences may require more frequent cleanout of these structures. The sediments removed from these control devices should be deposited in permanently stabilized areas to prevent further erosion and sediment from reaching drainages and receiving streams. After periods of use, control devices may require replacement of deteriorated materials such as straw bales and silt fence fabrics, or restoration and reconstruction of sediment basins and riprap installations.

Permanent erosion controls such as vegetated filter strips, grassed swales, and velocity dissipators should be inspected periodically to determine their integrity and continued effectiveness. Continual deterioration or damage to these controls may indicate a need for better design or construction.

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully apply to achieve the management measure described above.

- *a. Seed and fertilize, seed and mulch, and/or sod damaged vegetated areas and slopes.*

- *b. Establish pesticide/herbicide use and nutrient management programs.*

Refer to the Management Measure for Construction Site Chemical Control in this chapter.

- *c. Restrict herbicide and pesticide use in highway rights-of-way to applicators certified under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to ensure safe and effective application.*

- *d. The use of chemicals such as soil stabilizers, dust palliatives, sterilants, and growth inhibitors should be limited to the best estimate of optimum application rates. All feasible measures should be taken to avoid excess application and consequent intrusion of such chemicals into surface runoff.*

- *e. Sweep, vacuum, and wash residential/urban streets and parking lots.*

- *f. Collect and remove road debris.*

- *g. Cover salt storage piles and other deicing materials to reduce contamination of surface waters. Locate them outside the 100-year floodplain.*

- *h. Regulate the application of deicing salts to prevent oversalting of pavement.*

- *i. Use specially equipped salt application trucks.*

- *j. Use alternative deicing materials, such as sand or salt substitutes, where sensitive ecosystems should be protected.*

- *k. Prevent dumping of accumulated snow into surface waters.*

- *l. Maintain retaining walls and pavements to minimize cracks and leakage.*

- *m. Repair potholes.*

- *n. Encourage litter and debris control management.*

o. *Develop an inspection program to ensure that general maintenance is performed on urban runoff and NPS pollution control facilities.*

To be effective, erosion and sediment control devices and practices must receive thorough and periodic inspection checks. The following is a suggested checklist for the inspection of erosion and sediment controls (AASHTO Operating Subcommittee on Design, 1990):

- Clean out sediment basins and traps; ensure that structures are stable.
- Inspect silt fences and replace deteriorated fabrics and wire connections; properly dispose of deteriorated materials.
- Renew riprapped areas and reapply supplemental rock as necessary.
- Repair/replace check dams and brush barriers; replace or stabilize straw bales as needed.
- Regrade and shape berms and drainage ditches to ensure that runoff is properly channeled.
- Apply seed and mulch where bare spots appear, and replace matting material if deteriorated.
- Ensure that culverts and inlets are protected from siltation.
- Inspect all permanent erosion and sediment controls on a scheduled, programmed basis.

p. *Ensure that energy dissipators and velocity controls to minimize runoff velocity and erosion are maintained.*

q. *Dispose of accumulated sediment collected from urban runoff management and pollution control facilities, and any wastes generated during maintenance operations, in accordance with appropriate local, State, and Federal regulations.*

r. *Use techniques such as suspended tarps, vacuums, or booms to reduce, to the extent practicable, the delivery to surface waters of pollutants used or generated during bridge maintenance (e.g., paint, solvents, scrapings).*

s. *Develop education programs to promote the practices listed above.*

5. Effectiveness Information and Cost Information

Preventive maintenance is a time-proven, cost-effective management approach. Operation schedules and maintenance procedures to restore vegetation, proper management of salt and fertilizer application, regular cleaning of urban runoff structures, and frequent sweeping and vacuuming of urban streets have effective results in pollution control. Litter control, clean-up, and fix-up practices are a low-cost means for eliminating causes of pollution, as is the proper handling of fertilizers, pesticides, and other toxic materials including deicing salts and abrasives. Table 4-30 presents summary information on the cost and effectiveness of operation and maintenance practices for roads, highways, and bridges. Many States and communities are already implementing several of these practices within their budget limitations. As shown in Table 4-30, the use of road salt alternatives such as calcium magnesium acetate (CMA) can be very costly. Some researchers have indicated, however, that reductions in corrosion of infrastructure, damage to roadside vegetation, and the quantity of material that needs to be applied may offset the higher cost of CMA. Use of road salt minimization practices such as salt storage protection and special salt spreading equipment reduces the amount of salt that a State or community must purchase. Consequently, implementation of these practices can pay for itself through savings in salt purchasing costs. Similar programs such as nutrient and pesticide management can also lead to decreased expenditures for materials.

CMA Eligible for Matching Funds

Calcium magnesium acetate (CMA) is now eligible for Federal matching funds under the Bridge Program of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The Act provides 80 percent funding for use of CMA on salt-sensitive bridges in order to protect against corrosion and to extend their useful life. CMA can also be used to protect vegetation from salt damage in environmentally sensitive areas.

Table 4-30. Effectiveness and Cost Summary for Roads, Highways, and Bridges Operation and Maintenance Management Practices

Management Practice	% Removal TSS	TP	TN	COD	Pb	Zn	Cost
MAINTAIN VEGETATION							
For Sediment Control							
Average:	90	NA	NA	NA	NA	NA	Natural succession allowed to occur - Avg: $100/ac/year
Reported Range:	50-100	NA	NA	NA	NA	NA	Reported Range: $50-$200/ac/year
Probable Range:	80-100	-	-	-	-	-	
For Pollutant Removal							
Average:	60	40	40	50	50	50	Natural succession not allowed to occur - Avg: $800/ac/year
Reported Range	0-100	0-100	0-70	20-80	0-100	50-60	Reported Range: $700-$900/ac/year
Probable Range:	0-100	0-100	0-100	0-100	0-100	0-100	
PESTICIDE/HERBICIDE USE MANAGEMENT							Generally accepted as an economical program to control excessive use
Average:	NA						
Reported Range:	NA						
Probable Range:							
STREET SWEEPING							
Smooth Street, Frequent Cleaning (One or More Passes Per Week)							Avg: $20/curb mile Reported Range: $10-$30/curb mile
Average:	20	NA	NA	5	25	NA	
Reported Range:	20	NA	NA	0-10	5-35	NA	
Probable Range:	20-50	-	-	0-10	20-50	10-30	
Infrequent Cleaning (One Pass Per Month or Less)							
Average:	NA	NA	NA	NA	5	NA	
Reported Range:	NA	NA	NA	NA	0-10	NA	
Probable Range:	0-20	-	-	-	0-20	0-10	
LITTER CONTROL							Generally accepted as an economical approach to control excessive use
Average:	NA						
Reported Range:	NA						
Probable Range:							

Table 4-30. (Continued)

Management Practice	% Removal TSS	TP	TN	COD	Pb	Zn	Cost
GENERAL MAINTENANCE (e.g., pothole and roadside repairs)							Generally accepted as an economical preventive maintenance program by local and State agencies
Average:	NA						
Reported Range:	NA						
Probable Range:							
PROTECTION OF SALT PILES							For salt storage building -
Average:	NA						Ave: $30/ton salt
Reported Range:	NA						Reported Range: $10-$70/ton salt
Probable Range:	90-100[a]						
MINIMIZATION OF APPLICATION OF DEICING SALTS							Generally accepted as an economical preventive maintenance program by local and State agencies
Average:	NA						
Reported Range:	NA						
Probable Range:	Deicing salts that are not applied to roads will not enter runoff.						
SPECIALLY EQUIPPED SALT APPLICATION TRUCKS							For spread rate control on truck -
Average:	NA						Ave: $6,000/truck
Reported Range:	NA						Reported Range: $6,000/truck
Probable Range:	Deicing salts that are not applied to roads will not enter runoff.						
USE OF ALTERNATIVE DEICING MATERIALS							CMA -
Average:	NA						Ave: $650/ton
Reported Range:	NA						Reported Range: $650/ton
Probable Range:	Deicing salts that are not applied to roads will not enter runoff.						(note: cost of salt $30/ton)
CONTAIN POLLUTANTS GENERATED DURING BRIDGE MAINTENANCE							Varies with method of containment use
Average:	NA						
Reported Range:	NA						
Probable Range:	50-100[b]						

NA = Not applicable.
[a]Measured as reduction in salt.
[b]Measured as reduction of all pollutants.

F. Management Measure for Road, Highway, and Bridge Runoff Systems

Develop and implement runoff management systems for existing roads, highways, and bridges to reduce runoff pollutant concentrations and volumes entering surface waters.

(1) Identify priority and watershed pollutant reduction opportunities (e.g., improvements to existing urban runoff control structures; and

(2) Establish schedules for implementing appropriate controls.

1. Applicability

This management measure is intended to be applied by States to existing, resurfaced, restored, and rehabilitated roads, highways, and bridges that contribute to adverse effects in surface waters. Under the Coastal Zone Act Reauthorization Amendments of 1990, States are subject to a number of requirements as they develop coastal NPS programs in conformity with this management measure and will have some flexibility in doing so. The application of management measures by States is described more fully in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*, published jointly by the U.S. Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce.

2. Description

This measure requires that operation and maintenance systems include the development of retrofit projects, where needed, to collect NPS pollutant loadings from existing, reconstructed, and rehabilitated roads, highways, and bridges. Poorly designed or maintained roads and bridges can generate significant erosion and pollution loads containing heavy metals, hydrocarbons, sediment, and debris that run off into and threaten the quality of surface waters and their tributaries. In areas where such adverse impacts to surface waters can be attributed to adjacent roads or bridges, retrofit management projects to protect these waters may be needed (e.g., installation of structural or nonstructural pollution controls). Retrofit projects can be located in existing rights-of-way, within interchange loops, or on adjacent land areas. Areas with severe erosion and pollution runoff problems may require relocation or reconstruction to mitigate these impacts.

Runoff management systems are a combination of nonstructural and structural practices selected to reduce nonpoint source loadings from roads, highways, and bridges. These systems are expected to include structural improvements to existing runoff control structures for water quality purposes; construction of new runoff control devices, where necessary to protect water quality; and scheduled operation and maintenance activities for these runoff control practices. Typical runoff controls for roads, highways, and bridges include vegetated filter strips, grassed swales, detention basins, constructed wetlands, and infiltration trenches.

3. Management Measure Selection

This management measure was selected because of the demonstrated effectiveness of retrofit systems for existing roads and highways that were constructed with inadequate nonpoint source pollution controls or without such controls. Structural practices for mitigating polluted runoff from existing highways are described in the literature (Silverman, 1988).

4. Practices

As discussed more fully at the beginning of this chapter and in Chapter 1, the following practices are described for illustrative purposes only. State programs need not require implementation of these practices. However, as a practical matter, EPA anticipates that the management measure set forth above generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. The practices set forth below have been found by EPA to be representative of the types of practices that can be applied successfully to achieve the management measure described above.

- *a. Locate runoff treatment facilities within existing rights-of-way or in medians and interchange loops.*
- *b. Develop multiple-use treatment facilities on adjacent lands (e.g., parks and golf courses).*
- *c. Acquire additional land for locating treatment facilities.*
- *d. Use underground storage where no alternative is available.*
- *e. Maximize the length and width of vegetated filter strips to slow the travel time of sheet flow and increase the infiltration rate of urban runoff.*

5. Effectiveness Information and Cost Information

Cost and effectiveness data for structural urban runoff management and pollution control facilities are outlined in Tables 4-15 and 4-16 in Section III and discussed in Section IV of this chapter and are applicable to determine the cost and effectiveness of retrofit projects. Retrofit projects can often be more costly to construct because of the need to locate the required structures within existing space or the need to locate the structures within adjacent property that requires purchase. However, the use of multiple-use facilities on adjacent lands, such as diverting runoff waters to parkland or golf courses, can offset this cost. Nonstructural practices described in the urban section also can be effective in achieving source control. As with other sections of this document, the costs of loss of habitat, fisheries, and recreational areas must be weighed against the cost of retrofitting control structures within existing rights-of-way.

6. Pollutants of Concern

Table 4-31 lists the pollutants commonly found in urban runoff from roads, highways, and bridges and their sources. The disposition and subsequent magnitude of pollutants found in highway runoff are site-specific and are affected by traffic volume, road or highway design, surrounding land use, climate, and accidental spills.

The FHWA conducted an extensive field monitoring and laboratory analysis program to determine the pollutant concentration in highway runoff from 31 sites in 11 States (Driscoll et al., 1990). The event mean concentrations (EMCs) developed in the study for a number of pollutants are presented in Table 4-32. The study also indicated that for highways discharging into lakes, the pollutants of major concern are phosphorus and heavy metals. For highways discharging into streams, the pollutants of major concern are heavy metals—cadmium, copper, lead, and zinc.

Table 4-31. Highway Runoff Constituents and Their Primary Sources

Constituents	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material, lubricating oil and grease, bearing wear)
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails, bridges, etc.), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, break lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticake compound (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

In colder regions where deicing agents are used, deicing chemicals and abrasives are the largest source of pollutants during winter months. Deicing salt (primarily sodium chloride, NaCl) is the most commonly used deicing agent. Potential pollutants from deicing salt include sodium chloride, ferric ferrocyanide (used to keep the salt in granular form), and sulfates such as gypsum. Table 4-33 summarizes potential environmental impacts caused by road salt. Other chemicals used as a salt substitute include calcium magnesium acetate (CMA) and, less frequently, urea and glycol compounds. Researchers have differing opinions on the environmental impacts of CMA compared to those of road salt (Chevron Chemical Company, 1991; Salt Institute, undated; Transportation Research Board, 1991).

Table 4-32. Pollutant Concentrations in Highway Runoff (Driscoll et al., 1990)

Pollutant	Event Mean Concentration for Highways With Fewer Than 30,000 Vehicles/Day[a] (mg/L)	Event Mean Concentration for Highways With More Than 30,000 Vehicles/Day[a] (mg/L)
Total Suspended Solids	41	142
Volatile Suspended Solids	12	39
Total Organic Carbon	8	25
Chemical Oxygen Demand	49	114
Nitrite and Nitrate	0.46	0.76
Total Kjeldahl Nitrogen	0.87	1.83
Phosphate Phosphorus	0.16	0.40
Copper	0.022	0.054
Lead	0.080	0.400
Zinc	0.080	0.329

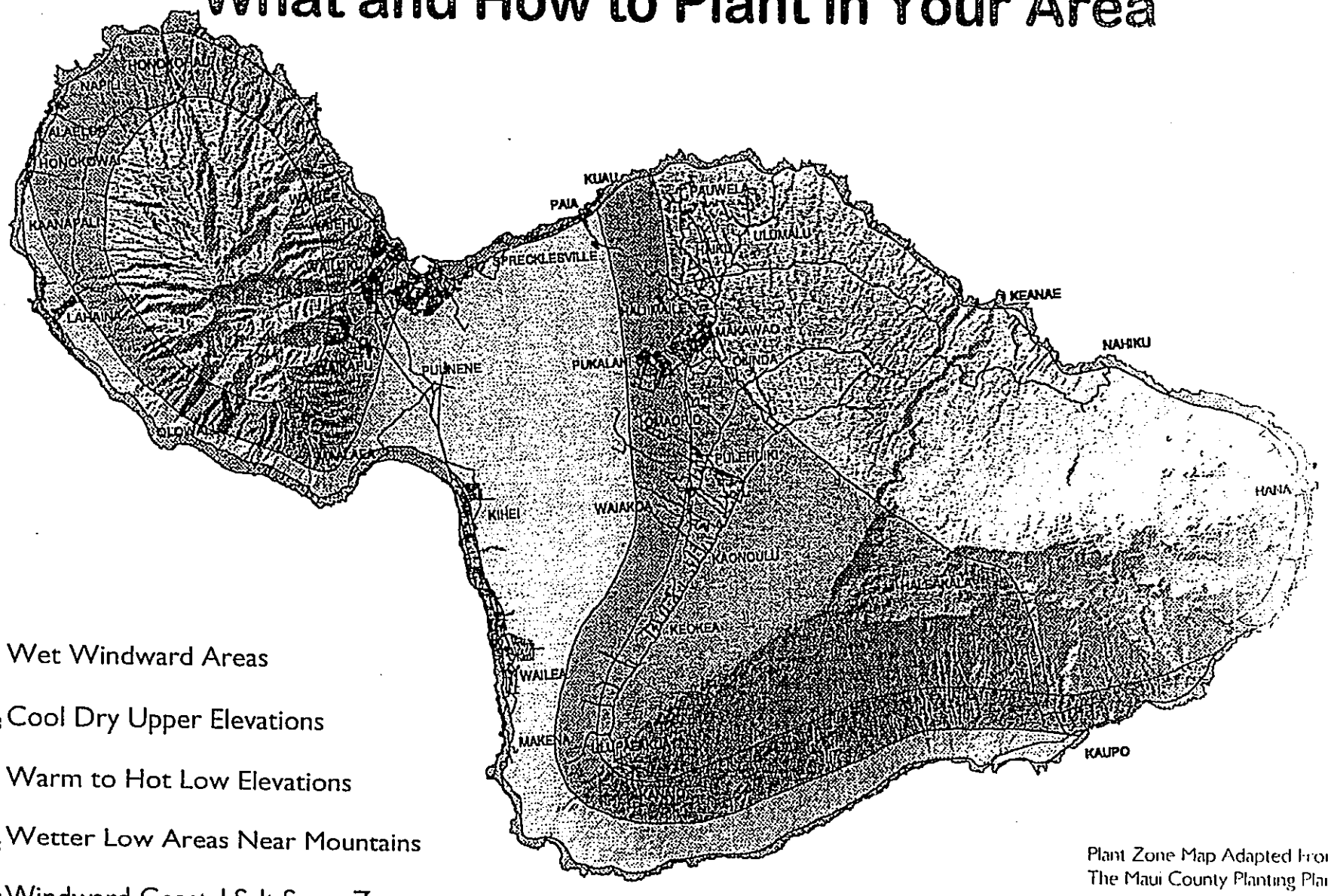
[a]Event mean concentrations are for the 50% median site.

Table 4-33. Potential Environmental Impacts of Road Salts

Environmental Resource	Potential Environmental Impact of Road Salt (NaCl)
Soils	May accumulate in soil. Breaks down soil structure, increases erosion. Causes soil compaction that results in decreased permeability.
Vegetation	Osmotic stress and soil compaction harm root systems. Spray causes foliage dehydration damage. Many plant species are salt-sensitive.
Ground Water	Mobile Na and Cl ions readily reach ground water. Increases NaCl concentration in well water, as well as alkalinity and hardness.
Surface Water	Causes density stratification in ponds and lakes that can prevent reoxygenation. Increases runoff of heavy metals and nutrients through increased erosion.
Aquatic Life	Monovalent Na and Cl ions stress osmotic balances. Toxic levels: Na - 500 ppm for stickleback; Cl - 400 ppm for trout.
Human/Mammalian	Sodium is linked to heart disease and hypertension. Chlorine causes unpleasant taste in drinking water. Mild skin and eye irritant. Acute oral LD_{50} in rats is approximately 3,000 mg/kg (slightly toxic).

Saving Water in The Yard

What and How to Plant in Your Area



1 Wet Windward Areas

2 Cool Dry Upper Elevations

3 Warm to Hot Low Elevations

4 Wetter Low Areas Near Mountains

5 Windward Coastal Salt Spray Zones

Plant Zone Map Adapted From
The Maui County Planting Plan

Tips From The Maui County Department of Water Supply

By Water All Things Find Life

Zone-specific Native and Polynesian plants for Maui County

Zone 2

TYPE: **F** Fern **G** Grass **Gr** Ground Cover **Sh** Shrub **P** Palm **S** Sedge **Tr** Tree **V** Vine

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
F	Psilotum nudum	moa, moa kula	1'	1'	sea to 3,000'	Dry to Wet
F	Sadleria cyatheoides	'ama'u, ama'uma'u				
G	Eragrostis monticola	kalamalo	1'	2'	sea to 3,000'	Dry to Medium
Gr	Ipomoea tuboides	Hawaiian moon flower, 'uala	1'	10'	sea to 3,000'	Dry to Medium
Gr	Peperomia leptostachya	'ala'ala-wai-nui	1'	1'	sea to 3,000'	Dry to Medium
Gr	Plumbago zeylanica	'ilie'e	1'			
Gr - Sh	Hibiscus calyphyllus	ma'o hau hele, Rock's hibiscus	3'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lipochaeta rockii	nehe	2'	2'	sea to 3,000'	Dry to Medium
Sh	Argemone glauca var. decipiens	pua kala	3'	2'	sea to 3,000'	Dry to Medium
Sh	Artemisia mauiensis var. diffusa	Maui wormwood, 'ahinahina	2'	3'	1,000' to higher	Dry to Medium
Sh	Chenopodium oahuense	'aheahea, 'aweoweo	6'		sea to higher	Dry to Medium
Sh	Dianella sandwicensis	'uki	2'	2'	1,000' to higher	Dry to Medium
Sh	Lipochaeta lavarum	nehe	3'	3'	sea to 3,000'	Dry to Medium
Sh	Osteomeles anthyllidifolia	'ulei, eluehe	4'	6'	sea to 3,000'	Dry to Medium
Sh	Senna gaudichaudii	kolomana	5'	5'	sea to 3,000'	Dry to Medium
Sh	Styphelia tamelamelae	pukiawe	6'	6'	1,000' to higher	Dry to Medium
Sh	Vitex rotundifolia	pohinahina	3'	4'	sea to 1,000'	Dry to Medium
Sh - Tr	Myoporum sandwicense	naio, false sandalwood	10'	10'	sea to higher	Dry to Medium
Sh - Tr	Nototrichium sandwicense	kulu'i	8'	8'	sea to 3,000'	Dry to Medium
Sh-Tr	Dodonaea viscosa	'a'ali'i	6'	8'	sea to higher	Dry to Medium
Tr	Acacia koa	koa	50' - 100'	40' - 80'	1,500' to 4,000'	Dry to Medium
Tr	Charpentiera obovata		15'			
Tr	Erythrina sandwicensis	wiliwili	20'	20'	sea to 1,000'	Dry
Tr	Metrosideros polymorpha var. macrophylla	ohi'a lehua	25'	25'	sea to 1,000'	Dry to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 2

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Tr	Nestegis sandwicensis	olopua	15'	15'	1,000' to 3,000'	Dry to Medium
Tr	Pleomele auwahiensis	halapepe	20'			
Tr	Rauvolfia sandwicensis	hao	20'	15'	sea to 3,000'	Dry to Medium
Tr	Santalum ellipticum	coastal sandalwood, 'ili-ahi	8'	8'	sea to 3,000'	Dry to Medium
Tr	Sophora chrysophylla	mamane	15'	15'	1,000' to 3,000'	Medium
V	Alyxia oliviformis	maile	Vine		sea to 6,000'	Medium to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 3

TYPE: **F** Fern **G** Grass **Gr** Ground Cover **Sh** Shrub **P** Palm **S** Sedge **Tr** Tree **V** Vine

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
F	Psilotum nudum	moa, moa kula	1'	1'	sea to 3,000'	Dry to Wet
G	Colubrina asiatica	'anapanapa	3'	10'	sea to 1,000'	Dry to Wet
G	Eragrostis monticola	kalamalo	1'	2'	sea to 3,000'	Dry to Medium
G	Eragrostis variabilis	'emo-loa	1'	2'	sea to 3,000'	Dry to Medium
G	Fimbristylis cymosa ssp. spathacea	mau'u'aki'aki fimbristylis	0.5'	1'	sea to 1,000'	Dry to Medium
Gr	Boerhavia repens	alena	0.5'	4'	sea to 1,000'	Dry to Medium
Gr	Chamaesyce celastroides var. laehiensis	'akoko	2'	3'	sea to 1,000'	Dry to Medium
Gr	Cressa truxillensis	cressa	0.5'	1'	sea to 1,000'	Dry to Medium
Gr	Heliotropium anomalum var. argenteum	hinahina ku kahakai	1'	2'	sea to 1,000'	Dry to Medium
Gr	Ipomoea tuboides	Hawaiian moon flower, 'uala	1'	10'	sea to 3,000'	Dry to Medium
Gr	Jacquemontia ovalifolia ssp. sandwicensis	pa'u o hi'iaka	0.5'	6'	sea to 1,000'	Dry to Medium
Gr	Lipochaeta integrifolia	nehe	1'	5'	sea to 1,00'	Dry to Medium
Gr	Peperomia leptostachya	'ala'ala-wai-nui	1'	1'	sea to 3,000'	Dry to Medium
Gr	Plumbago zeylanica	'ilie'e	1'			
Gr	Sesuvium portulacastrum	'akulikuli, sea-purslane	0.5'	2'	sea to 1,000'	Dry to Wet
Gr	Sida fallax	'ilima	0.5'	3'	sea to 1,000'	Dry to Medium
Gr	Tephrosia purpurea var. purpurea	'auhuhu	2'	2'	sea to 1,000'	Dry to Medium
Gr - Sh	Hibiscus calyphyllus	ma'o hau hele, Rock's hibiscus	3'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lipochaeta rockii	nehe	2'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lipochaeta succulenta	nehe	2'	5'	sea to 1,000'	Dry to Wet
Gr - Sh	Lycium sandwicense	'ohelo-kai, 'ae'ae	2'	2'	sea to 1,000'	Dry to Medium
P	Cocos nucifera	coconut, niu	100'	30'	sea to 1,000'	Dry to Wet
P	Pritchardia hillebrandii	lo'ulu, fan palm	25'	15'	sea to 1,000'	Dry to Wet
S	Mariscus javanicus	marsh cypress, 'ahu'awa	0.5'	0.5'	sea to 1,000'	Dry to Medium

Zone-specific Native and Polynesian plants for Maui County

Zone 3

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Sh	Argemone glauca var. deciplens	pua kala	3'	2'	sea to 3,000'	Dry to Medium
Sh	Bidens mauiensis	ko'oko'olau	1'	3'	sea to 1,000'	Dry to Medium
Sh	Bidens menziesii ssp. menziesii	ko'oko'olau	1'	3'		
Sh	Bidens micrantha ssp. micrantha	ko'oko'olau	1'	3'		
Sh	Chenopodium oahuense	'aheahea, 'aweoweo	6'		sea to higher	Dry to Medium
Sh	Dianella sandwicensis	'uki	2'	2'	1,000' to higher	Dry to Medium
Sh	Gossypium tomentosum	mao, Hawaiian cotton	5'	8'	sea to 1,000'	Dry to Medium
Sh	Hedyotis spp.	au, pilo	3'	2'	1,000' to 3,000'	Dry to Wet
Sh	Lipochaeta lavarum	nehe	3'	3'	sea to 3,000'	Dry to Medium
Sh	Osteomeles anthyllidifolia	'ulei, eluehe	4'	6'	sea to 3,000'	Dry to Medium
Sh	Scaevola sericea	naupaka, naupaka-kahakai	6'	8'	sea to 1,000'	Dry to Medium
Sh	Senna gaudichaudii	kolomana	5'	5'	sea to 3,000'	Dry to Medium
Sh	Solanum nelsonii	'akia, beach solanum	3'	3'	sea to 1,00'	Dry to Medium
Sh	Styphelia tameiameiae	pukiawe	6'	6'	1,000' to higher	Dry to Medium
Sh	Vitex rotundifolia	pohinahina	3'	4'	sea to 1,000'	Dry to Medium
Sh	Wikstroemia uva-ursi kaualensis kaualensis	'akia, Molokai osmanthus				
Sh - Tr	Broussonetia papyrifera	wauke, paper mulberry	8'	6'	sea to 1,000'	Dry to Medium
Sh - Tr	Myoporum sandwicense	naio, false sandalwood	10'	10'	sea to higher	Dry to Medium
Sh - Tr	Nototrichium sandwicense	kulu'i	8'	8'	sea to 3,000'	Dry to Medium
Sh-Tr	Dodonaea viscosa	'a'ali'i	6'	8'	sea to higher	Dry to Medium
Tr	Aleurites moluccana	candlenut, kukui	50'	50'	sea to 3,000'	Medium to Wet
Tr	Calophyllum inophyllum	kamani, alexandrian laurel	60'	40'	sea to 3,000'	Medium to Wet
Tr	Canthium odoratum	Alahe'e, 'ohe'e, walahe'e	12'	8'	sea to 3,000'	Dry to Medium
Tr	Cordia subcordata	kou	30'	25'	sea to 1,000'	Dry to Wet
Tr	Diospyros sandwicensis	lama	12'	15'	sea to 3,000'	Dry to Medium
Tr	Erythrina sandwicensis	wiliwili	20'	20'	sea to 1,000'	Dry
Tr	Metrosideros polymorpha var. macrophylla	ohi'a lehua	25'	25'	sea to 1,000'	Dry to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 3

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Tr	Morinda citrifolia	indian mulberry, noni	20'	15'	sea to 1,000'	Dry to Wet
Tr	Nesoluma polynesicum	keahi	15'	15'	sea to 3,00'	Dry
Tr	Nestegis sandwicensis	olopua	15'	15'	1,000' to 3,000'	Dry to Medium
Tr	Pandanus tectorius	hala, puhala (HALELIST)	35'	25'	sea to 1,000'	Dry to Wet
Tr	Pleomele auwahiensis	halapepe	20'			
Tr	Rauvolfia sandwicensis	hao	20'	15'	sea to 3,000'	Dry to Medium
Tr	Reynoldsia sandwicensis	'ohe makai	20'	20'	1,000' to 3,000'	Dry
Tr	Santalum ellipticum	coastal sandalwood, 'ili-ahi	8'	8'	sea to 3,000'	Dry to Medium
Tr	Thespesia populnea	milo	30'	30'	sea to 3,000'	Dry to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 4

TYPE: F Fern G Grass Gr Ground Cover Sh Shrub P Palm S Sedge Tr Tree V Vine

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
F	Psilotum nudum	moa, moa kula	1'	1'	sea to 3,000'	Dry to Wet
F	Sadleria cyatheoides	'ama'u, ama'uma'u				
G	Colubrina asiatica	'anapanapa	3'	10'	sea to 1,000'	Dry to Wet
G	Eragrostis monticola	kalamalo	1'	2'	sea to 3,000'	Dry to Medium
G	Eragrostis variabilis	'emo-loa	1'	2'	sea to 3,000'	Dry to Medium
G	Fimbristylis cymosa ssp. spathacea	mau'u'aki'aki fimbristylis	0.5'	1'	sea to 1,000'	Dry to Medium
Gr	Chamaesyce celastroides var. laehiensis	'akoko	2'	3'	sea to 1,000'	Dry to Medium
Gr	Ipomoea tuboides	Hawaiian moon flower, 'uala	1'	10'	sea to 3,000'	Dry to Medium
Gr	Jacquemontia ovalifolia ssp. sandwicensis	pa'u o hi'iaka	0.5'	6'	sea to 1,000'	Dry to Medium
Gr	Lipochaeta integrifolia	nehe	1'	5'	sea to 1,00'	Dry to Medium
Gr	Peperomia leptostachya	'ala'ala-wai-nui	1'	1'	sea to 3,000'	Dry to Medium
Gr	Plumbago zeylanica	'ilie'e	1'			
Gr	Sida fallax	'ilima	0.5'	3'	sea to 1,000'	Dry to Medium
Gr	Tephrosia purpurea var. purpurea	'auhuhu	2'	2'	sea to 1,000'	Dry to Medium
Gr - Sh	Hibiscus calyphyllus	ma'o hau hele, Rock's hibiscus	3'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lipochaeta rockii	nehe	2'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lipochaeta succulenta	nehe	2'	5'	sea to 1,000'	Dry to Wet
P	Cocos nucifera	coconut, niu	100'	30'	sea to 1,000'	Dry to Wet
P	Pritchardia arecina	lo'ulu, hawane	40'	10'	1,000' to 3,000'	Dry to Wet
P	Pritchardia forbesiana	lo'ulu	15'			
P	Pritchardia hillebrandii	lo'ulu, fan palm	25'	15'	sea to 1,000'	Dry to Wet
S	Mariscus javanicus	marsh cypress, 'ahu'awa	0.5'	0.5'	sea to 1,000'	Dry to Medium
Sh	Argemone glauca var. decipiens	pua kala	3'	2'	sea to 3,000'	Dry to Medium
Sh	Artemisia australis	'ahinahina	2'	3'	sea to 3,000'	Dry to Medium

Zone-specific Native and Polynesian plants for Maui County

Zone 4

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Sh	Artemisia mauiensis var. diffusa	Maui wormwood, 'ahinahina	2'	3'	1,000' to higher	Dry to Medium
Sh	Bidens hillebrandiana ssp. hillebrandiana	ko'oko'olau	1'	2'	sea to 1,000'	Dry to Wet
Sh	Bidens menziesii ssp. menziesii	ko'oko'olau	1'	3'		
Sh	Bidens micrantha ssp. micrantha	ko'oko'olau	1'	3'		
Sh	Cordyline fruticosa	ti, ki	6			
Sh	Dianella sandwicensis	'uki	2'	2'	1,000' to higher	Dry to Medium
Sh	Lipochaeta lavarum	nehe	3'	3'	sea to 3,000'	Dry to Medium
Sh	Osteomeles anthyllidifolia	'ulei, eluehe	4'	6'	sea to 3,000'	Dry to Medium
Sh	Scaevola sericea	naupaka, naupaka-kahakai	6'	8'	sea to 1,000'	Dry to Medium
Sh	Solanum nelsonii	'akia, beach solanum	3'	3'	sea to 1,00'	Dry to Medium
Sh	Styphelia tameiameiae	pukiawe	6'	6'	1,000' to higher	Dry to Medium
Sh	Vitex rotundifolia	pohinahina	3'	4'	sea to 1,000'	Dry to Medium
Sh	Wikstroemia uva-ursi kauaiensis kauaiensis	'akia, Molokai osmanthus				
Sh - Tr	Broussonetia papyrifera	wauke, paper mulberry	8'	6'	sea to 1,000'	Dry to Medium
Sh - Tr	Myoporum sandwicense	naio, false sandalwood	10'	10'	sea to higher	Dry to Medium
Sh - Tr	Nototrichium sandwicense	kulu'i	8'	8'	sea to 3,000'	Dry to Medium
Sh-Tr	Dodonaea viscosa	'a'ali'i	6'	8'	sea to higher	Dry to Medium
Tr	Acacia koa	koa	50' - 100'	40' - 80'	1,500' to 4,000'	Dry to Medium
Tr	Aleurites moluccana	candlenut, kukui	50'	50'	sea to 3,000'	Medium to Wet
Tr	Calophyllum inophyllum	kamani, alexandrian laurel	60'	40'	sea to 3,000'	Medium to Wet
Tr	Canthium odoratum	Alahe'e, 'ohe'e, walahe'e	12'	8'	sea to 3,000'	Dry to Medium
Tr	Charpentiera obovata		15'			
Tr	Cordia subcordata	kou	30'	25'	sea to 1,000'	Dry to Wet
Tr	Diospyros sandwicensis	lama	12'	15'	sea to 3,000'	Dry to Medium
Tr	Hibiscus furcellatus	'akiohala, hau-hele	8'			
Tr	Metrosideros polymorpha var. macrophylla	ohi'a lehua	25'	25'	sea to 1,000'	Dry to Wet
Tr	Morinda citrifolia	Indian mulberry, noni	20'	15'	sea to 1,000'	Dry to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 4

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Tr	Nestegis sandwicensis	olopua	15'	15'	1,000' to 3,000'	Dry to Medium
Tr	Pandanus tectorius	hala, puhala (HALELIST)	35'	25'	sea to 1,000'	Dry to Wet
Tr	Pleomele auwahiensis	halapepe	20'			
Tr	Rauvolfia sandwicensis	hao	20'	15'	sea to 3,000'	Dry to Medium
Tr	Santalum ellipticum	coastal sandalwood, 'ili-ahi	8'	8'	sea to 3,000'	Dry to Medium
Tr	Sophora chrysophylla	mamane	15'	15'	1,000' to 3,000'	Medium
Tr	Thespesia populnea	milo	30'	30'	sea to 3,000'	Dry to Wet
V	Alyxia oliviformis	maile	Vine		sea to 6,000'	Medium to Wet

Zone-specific Native and Polynesian plants for Maui County

Zone 5

TYPE: **F** Fern **G** Grass **Gr** Ground Cover **Sh** Shrub **P** Palm **S** Sedge **Tr** Tree **V** Vine

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
G	Colubrina asiatica	'anapanapa	3'	10'	sea to 1,000'	Dry to Wet
G	Eragrostis variabilis	'emo-loa	1'	2'	sea to 3,000'	Dry to Medium
G	Fimbristylis cymosa ssp. spathacea	mau'u'aki'aki fimbristylis	0.5'	1'	sea to 1,000'	Dry to Medium
Gr	Boerhavia repens	alena	0.5'	4'	sea to 1,000'	Dry to Medium
Gr	Chamaesyce celastroides var. laehlensis	'akoko	2'	3'	sea to 1,000'	Dry to Medium
Gr	Cressa truxillensis	cressa	0.5'	1'	sea to 1,000'	Dry to Medium
Gr	Heliotropium anomalum var. argenteum	hinahina ku kahakai	1'	2'	sea to 1,000'	Dry to Medium
Gr	Jacquemontia ovalifolia ssp. sandwicensis	pa'u o hi'iaka	0.5'	6'	sea to 1,000'	Dry to Medium
Gr	Lipochaeta integrifolia	nehe	1'	5'	sea to 1,00'	Dry to Medium
Gr	Sesuvium portulacastrum	'akulikuli, sea-purslane	0.5'	2'	sea to 1,000'	Dry to Wet
Gr	Sida fallax	'ilima	0.5'	3'	sea to 1,000'	Dry to Medium
Gr	Tephrosia purpurea var. purpurea	'auhuhu	2'	2'	sea to 1,000'	Dry to Medium
Gr - Sh	Hibiscus calyphyllus	ma'o hau hele, Rock's hibiscus	3'	2'	sea to 3,000'	Dry to Medium
Gr - Sh	Lycium sandwicense	'ohelo-kai, 'ae'ae	2'	2'	sea to 1,000'	Dry to Medium
P	Cocos nucifera	coconut, niu	100'	30'	sea to 1,000'	Dry to Wet
P	Pritchardia hillebrandii	lo'ulu, fan palm	25'	15'	sea to 1,000'	Dry to Wet
S	Mariscus javanicus	marsh cypress, 'ahu'awa	0.5'	0.5'	sea to 1,000'	Dry to Medium
Sh	Argemone glauca var. decipiens	pua kala	3'	2'	sea to 3,000'	Dry to Medium
Sh	Artemisia australis	'ahinahina	2'	3'	sea to 3,000'	Dry to Medium
Sh	Bidens hillebrandiana ssp. hillebrandiana	ko'oko'olau	1'	2'	sea to 1,000'	Dry to Wet
Sh	Bidens mauiensis	ko'oko'olau	1'	3'	sea to 1,000'	Dry to Medium
Sh	Chenopodium oahuense	'aheahea, 'aweoweo	6'		sea to higher	Dry to Medium
Sh	Dianella sandwicensis	'uki	2'	2'	1,000' to higher	Dry to Medium
Sh	Gossypium tomentosum	mao, Hawaiian cotton	5'	8'	sea to 1,000'	Dry to Medium

Zone-specific Native and Polynesian plants for Maui County

Zone 5

Type	Scientific Name	Common Name	Height	Spread	Elevation	Water req.
Sh	Hedyotis spp.	au, pilo	3'	2'	1,000' to 3,000'	Dry to Wet
Sh	Lipochaeta lavarum	nehe	3'	3'	sea to 3,000'	Dry to Medium
Sh	Osteomeles anthyllidifolia	'ulei, eluehe	4'	6'	sea to 3,000'	Dry to Medium
Sh	Scaevola sericea	naupaka, naupaka-kahakai	6'	8'	sea to 1,000'	Dry to Medium
Sh	Senna gaudichaudii	kolomana	5'	5'	sea to 3,000'	Dry to Medium
Sh	Solanum nelsonii	'akia, beach solanum	3'	3'	sea to 1,00'	Dry to Medium
Sh	Vitex rotundifolia	pohinahina	3'	4'	sea to 1,000'	Dry to Medium
Sh	Wikstroemia uva-ursi kauaiensis kauaiensis	'akia, Molokai osmanthus				
Sh - Tr	Myoporum sandwicense	naio, false sandalwood	10'	10'	sea to higher	Dry to Medium
Sh-Tr	Dodonaea viscosa	'a'ali'i	6'	8'	sea to higher	Dry to Medium
Tr	Aleurites moluccana	candlenut, kukui	50'	50'	sea to 3,000'	Medium to Wet
Tr	Calophyllum inophyllum	kamani, alexandrian laurel	60'	40'	sea to 3,000'	Medium to Wet
Tr	Cordia subcordata	kou	30'	25'	sea to 1,000'	Dry to Wet
Tr	Hibiscus furcellatus	'akiohala, hau-hele	8'			
Tr	Morinda citrifolia	indian mulberry, noni	20'	15'	sea to 1,000'	Dry to Wet
Tr	Pandanus tectorius	hala, puhala (HALELIST)	35'	25'	sea to 1,000'	Dry to Wet
Tr	Thespesia populnea	milo	30'	30'	sea to 3,000'	Dry to Wet
V	Ipomoea pes-caprae	beach morning glory, pohuehue	1			

DO NOT PLANT THESE PLANTS !!!

Common name	Scientific name	Plant family
black wattle	Acacia mearnsii	Mimosaceae
blackberry	Rubus argutus	Rosaceae
blue gum	Eucalyptus globulus	Myrtaceae
bocconia	Bocconia frutescens	Papaveraceae
broad-leaved cordia	Cordia glabra	Boraginaceae
broomsedge, yellow bluestem	Andropogon virginicus	Poaceae
buffelgrass	Cenchrus ciliaris	Poaceae
butterfly bush, smoke bush	Buddleja madagascariensis	Buddlejaceae
cats claw, Mysore thorn, wait-a-bit	Caesalpinia decapetala	Caesalpiniaceae
common ironwood	Casuarina equisetifolia	Casuarinaceae
common velvet grass, Yorkshire fog	Holcus lanatus	Poaceae
fiddlewood	Citharexylum spinosum	Verbenaceae
fire tree, faya tree	Myrica faya	Myricaceae
glorybower	Clerodendrum laponicum	Verbenaceae
hairy cat's ear, gosmore	Hypochoeris radicata	Asteraceae
haole koa	Leucaena leucocephala	Fabaceae
ivy gourd, scarlet-fruited gourd	Coccinia grandis	Cucurbitaceae
juniper berry	Citharexylum caudatum	Verbenaceae
kahili flower	Grevillea banksii	Proteaceae
klu, popinac	Acacia farnesiana	Mimosaceae
logwood, bloodwood tree	Haematoxylon campechianum	Caesalpiniaceae
loquat	Eriobotrya japonica	Rosaceae
meadow ricegrass	Ehrharta stipoides	Poaceae
melaleuca	Melaleuca quinquenervia	Myrtaceae
miconia, velvet leaf	Miconia calvescens	Melastomataceae
narrow-leaved carpetgrass	Axonopus fissifolius	Poaceae
oleaster	Elaeagnus umbellata	Elaeagnaceae
oriental mangrove	Bruguiera gymnorrhiza	Rhizophoraceae
padang cassia	Cinnamomum burmanii	Lauraceae
palmgrass	Setaria palmifolia	Poaceae
pearl flower	Heterocentron subtriplinervium	Melastomataceae
quinine tree	Cinchona pubesens	Rubiaceae
satin leaf, caimitillo	Chrysophyllum oliviforme	Sapotaceae
silkwood, Queensland maple	Flindersia brayleyana	Rutaceae
silky oak, silver oak	Grevillea robusta	Proteaceae
strawberry guava	Psidium cattleianum	Myrtaceae
swamp oak, saltmarsh, longleaf ironwood	Casuarina glauca	Casuarinaceae
sweet vernalgrass	Anthoxanthum odoratum	Poaceae
tree of heaven	Ailanthus altissima	Simaroubaceae
trumpet tree, guarumo	Cecropia obtusifolia	Cecropiaceae
white ginger	Hedychium coronarium	Zingiberaceae
white moho	Heliocarpus popayanensis	Tiliaceae
yellow ginger	Hedychium flavescens	Zingiberaceae

DO NOT PLANT THESE PLANTS !!!

Common name	Scientific name	Plant family
	Jasminum fluminense	Oleaceae
	Arthrostema ciliatum	Melastomataceae
	Dissotis rotundifolia	Melastomataceae
	Erigeron karvinskianus	Asteraceae
	Eucalyptus robusta	Myrtaceae
	Hedychium gardnerianum	Zingiberaceae
	Juncus planifolius	Juncaceae
	Lophostemon confertus	Myrtaceae
	Medinilla cumingii	Melastomataceae
	Medinilla magnifica	Melastomataceae
	Medinilla venosa	Melastomataceae
	Melastoma candidum	Melastomataceae
	Melinis minutiflora	Poaceae
	Olea europaea	
	Oxyspora paniculata	Melastomataceae
	Panicum maximum	Poaceae
	Paspalum urvillei	Poaceae
	Passiflora edulis	Passifloraceae
	Phormium tenax	Agavaceae
	Pinus taeda	Pinaceae
	Prosopis pallida	Fabaceae
	Pterolepis glomerata	Melastomataceae
	Rhodomyrtus tomentosa	Myrtaceae
	Schefflera actinophylla	Araliaceae
	Syzygium jambos	Myrtaceae
Australian blackwood	Acacia melanoxylon	Mimosaceae
Australian tree fern	Cyathea cooperi	Cyatheaceae
Australian tree fern	Sphaeropteris cooperi	Cyatheaceae
Beggar's tick, Spanish needle	Bidens pilosa	Asteraceae
California grass	Brachiaria mutica	Poaceae
Chinese banyon, Maylayan banyon	Ficus mirocarpa	Moraceae
Chinese violet	Asystasia gangetica	Acanthaceae
Christmasberry, Brazilian pepper	Schinus terebinthifolius	Anacardiaceae
Formosan koa	Acacia confusa	Mimosaceae
German ivy	Senecio mikanioides	Asteraceae
Japanese honeysuckle	Lonicera japonica	Caprifoliaceae
Koster's curse	Clidemia hirta	Melastomataceae
Lantana	Lantana camara	Verbenaceae
Mauritius hemp	Furcraea foetida	Agavaceae
Mexican ash, tropical ash	Fraxinus uhdei	Oleaceae
Mexican tulip poppy	Hunnemannia fumariifolia	Papaveraceae
Mules foot, Madagascar tree fern	Angiopteris evecta	Maratiaceae
New Zealand laurel, karakaranut	Corynocarpus laevigatus	Corynocarpaceae
New Zealand tea	Leptospermum scoparium	Myrtaceae
Pampas grass	Cortaderia jubata	Poaceae
Panama rubber tree, Mexican rubber tree	Castilloa elastica	Moraceae
Shoebutton ardisia	Ardisia elliptica	Myrsinaceae
banana poka	Passiflora mollissima	Passifloraceae

Selection

As a general rule, it is best to select the largest and healthiest specimens. However, be sure to note that they are not pot-bound. Smaller, younger plants may result in a low rate of plant survival.[1] When selecting native species, consider the site they are to be planted in, and the space that you have to plant. For example: Mountain species such as koa and maile will not grow well in hot coastal areas exposed to strong ocean breezes. Lowland and coastal species such as wiliwili and Kou require abundant sunshine and porus soil. They will not grow well with frequent cloud cover, high rainfall and heavy soil.

Consider too, the size that the species will grow to be. It is not wise to plant trees that will grow too large.[2] Overplanting tends to be a big problem in the landscape due to the underestimation of a species' height, width or spread.

A large, dense canopied tree such as the kukui is a good shade tree for a lawn. However, it's canopy size and density of shade will limit what can be planted in the surrounding area. Shade cast by a koa and ohia lehua is relatively light and will not inhibit growth beneath it.

Keep seasons in mind when you are selecting your plants. Not all plants look good year round, some plants such as ilima will look scraggly after they have flowered and formed seeds. Avoid planting large areas with only one native plant. Mixing plants which naturally grow together will ensure the garden will look good all year round.[3] Looking at natural habitats helps to show how plants grow naturally in the landscape.

When planting an area with a mixed-ecosystem, keep in mind the size and ecological requirements of each plant. Start with the hardiest and most easily grown species, but allow space for fragile ones in subsequent plantings.

Acquiring natives

Plants in their wild habitat must be protected and maintained. It is best and easiest to get your plants from nurseries (see list), or friend's gardens. Obtain proper permits from landowners and make sure you follow a few common sense rules:

- collect sparingly from each plant or area.
- some plants are on the state or Federal Endangered Species list. Make sure you get permits (see app. A,B)

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[1] K. Nagata, P.6

[2] K. Nagata, P.9

[3] Nagata, P.9

Soil

Once you have selected your site and the plants you wish to establish there, you must look at the soil conditions on the site. Proper soil is necessary for the successful growth of most native plants, which preform poorly in hard pan, clay or adobe soils. If natives are to be planted in these types of soil, it would be wise to dig planting holes several times the size of the rootball and backfill with 50-75% compost.[4] A large planting hole ensures the development of a strong root system. The plant will have a headstart before the roots penetrate the surrounding poor soil.[5]

It is recommended that native plants not be planted in ground that is more dense than potting soil. If there is no alternative, dig a hole in a mound of soil mixed with volcanic cinder which encourages maximum root development. Fill the hole with water, if the water tends to puddle or drain too slowly, dig a deeper hole until the water does not puddle longer than 1 or 2 minutes.[6] Well-drained soil is one of the most important things when planting natives as you will see in the next section.

Irrigation

Most natives do very poorly in waterlogged conditions. Do not water if the soil is damp. Water when the soil is dry and the plants are wilting. Once established, a good soaking twice a week should suffice. Deep soaking encourages the development of stronger, and deeper root systems. This is better than frequent and shallow watering which encourage weaker, more shallow root systems.

The following is a watering schedule from Kenneth Nagata's Booklet, *How To Plant A Native Hawaiian Garden*:

WATER REQUIREMENT	WATERING FREQUENCY
Heavy	3x / week
Moderate	2x / week
Light	1x / week

Red clay soils hold more water for a longer period of time than sandy soils do. If your area is very sunny or near a beach, things will dry out faster. Even in the area of one garden, there are parts that will need more or less water. Soils can vary and amount of shade and wind differ. After plants are established (a month or two for most plants, up to a year for some trees), you can back off watering.

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[4] Nagata, p. 6

[5] Nagata, p. 8

[6] Nagata, p. 8

Automatic sprinkler systems are expensive to install and must be checked and adjusted regularly. Above-ground systems allow you to monitor how much water is being put out, but you lose a lot due to malfunctioning of sprinkler heads and wind. The most efficient way to save water and make sure your plants get enough water, is to hand-water. This way you are getting our precious water to the right places in the right amounts.[7]

Fertilizer

An all-purpose fertilizer 10-10-10 is adequate for most species. They should be applied at planting time, 3 months later, and 6 months thereafter. Use half the dosage recommended for ornamentals and pay special attention to native ferns which are sensitive to strong fertilizers. Use of organic composts and aged animal manures is suggested instead of chemical fertilizers. In addition, use of cinders for providing trace minerals is strongly recommended.[8]

Natives are plants which were here hundreds of years before the polynesians inhabited the Hawaiian Islands. They were brought here by birds, or survived the harsh ocean conditions to float here. They are well-adapted to Hawaii's varying soil and environmental conditions. This is why they make prime specimens for a xeriscape garden. However, natives will not thrive on their own, especially under harsh conditions. On the other hand, like any other plant, if you over-water and over-fertilize them, they will die. Follow the instructions given to you by the nursery you buy the plant from, or from this booklet. Better yet, buy a book (suggested readings can be found in the bibliography in the back of this pamphlet), read it, and learn more about native plants. I guarantee that you will be pleased with the results.

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[7] Bornhorst, p. 19-20

[8] Nagata, p. 6

Propagation

There are many ways to propagate and plant-out native Hawaiian species. One of the most thourough and helpful book is Heidi Bornhorst's book, *Growing Native Hawaiian Plants.* The easiest, and best way to obtain natives for the novice gardener is to get them from a reputable nursery (see appendix c). That way all you will have to do is know how to transplant (if necessary) and plant-out when you are ready. These are the two methods I have listed here.

Transplanting

1. Use pots that are one size bigger than the potted plant is in
2. Get your potting medium ready

Good potting medium is a ½, ½ mixture of peat moss and perlite. If the plant is from a dry or coastal area, add chunks of cinder or extra perlite. If it is a wet forest species, add more peat moss or compost. Be aware that peat moss is very acidic and certain plants react severely to acidity.

If the plant is to eventually be planted into the ground, make a mix of equal parts peat moss, perlite, and soil from the area in which the plant is to be planted. Slow-release fertilizer can be mixed into the potting medium.

3. Once pots, potting medium, fertilizer and water are ready, you can begin re-potting. Keep the plant stem at the same depth it was in the original pot. Avoid putting the plant in too large a pot, as the plant may not be able to soak up all the water in the soil and the roots may drown and rot.

Mix potting medium and add slow-release fertilizer at this time. Pre-wet the medium to keep dust down and lessen shock to the plant. Put medium in bottom of pot. Measure for the correct depth in the new pot. Make sure there is from ½ to 2 inches from the top of the pot so the plant can get adequate water. Try to stand the plant upright and center the stem in the middle of the pot.

Water the plant thoroughly after transplanting. A vitamin B-1 transplanting solution can help to lessen the transplant shock. Keep the plant in the same type of environment as it was before, sun or shade. If roots were broken, trimm off some of the leaves to compensate for the loss.[9]

Planting out

1. Plant most native Hawaiian plants in a sunny location in soil that is well-drained.
2. Make the planting hole twice as wide as the root ball or present pot, and just as deep.

If the soil is clay-like, and drains slowly, mix in some coarse red or bland cinder, coarse perlite or

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[9] Bornhorst, p.20-21

coarse compost. Place some slow-release fertilizer at the bottom of the hole.

3. Carefully remove the plant from the container and place it in the hole. The top of the soil should be at the same level as the top of the hole, if it is too high or too low, adjust the soil level so that the plant is at the right depth.

4. Water thoroughly after you transplant.

Mulch

Most natives cannot compete with weeds, and therefore must be weeded around constantly in order to thrive. Mulch is a practical alternative, which discourages and prevents weeds from growing.

Hawaii's hot, humid climate leads to the breaking down of organic mulches. Thick organic mulches such as wood chips and leaves, may also be hiding places for pests.

Stone mulches are attractive, permanent and can help to improve soil quality. Red or black cinder, blue rock chips, smooth river rocks and coral chips are some natural choices.[10] Macadamia nut hulls are also easy to find and can make a nice mulch.[11]

Never pile up mulch right next to the stem or trunk of a plant, keep it a few inches away.

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[10] Bornhorst, p. 24

[11] Nagata, p. 7

PLACES TO SEE NATIVES ON:

The following places propagate native Hawaiian plants from seeds and/or cuttings. Their purpose is to protect and preserve these native plants. Please contact them before going to view the sites, they can provide valuable information and referral to other sources.

Maui:

1. Hoolawa Farms, P.O. Box 731, Haiku, Hawaii, 96708	572-4835
2. The Hawaiian Collection, 1127 Manu St., Kula, Hawaii, 96790	878-1701
3. Kula Botanical Gardens, RR 4, Box 228, Kula, Hawaii, 96790	878-1715
4. Maui Botanical Gardens, Kanaloa Avenue across from stadium	243-7337
5. Kula Forest Reserve, access road at the end of Waipouli Rd. Call the Maui District Forester	984-8100
6. Wailea Point, Private Condominium residence, 4000 Wailea Alanui, public access points at Four Seasons Resort or Polo Beach	875-9557
7. Kahanu Gardens, National Tropical Botanical Garden, Alau Pl, Hana, Hawaii, 96713	248-8912
9. Kahului Library Courtyard, 20 School Street, Kahului, Hawaii	873-3097

ZONES

The Maui County Planting Plan has compiled a system of 5 zones of plant growth for Maui County. The descriptions of zones and maps for these zones are as follows:

Zone 1:
Wet areas on the windward side of the island. More than 40 inches of rain per year. Higher than 3,000 feet.

Zone 2:
Cool, dry areas in higher elevations (above 1,000 feet). 20 to 40 inches of rain per year.

Zone 3:
Low, drier areas, warm to hot. Less than 20 inches of rain per year. Sea level to 1,000 feet.

Zone 4:
Lower elevations which are wetter due to proximity of mountains. 1,000 to 3,000 feet.

Zone 5:
Salt spray zones in coastal areas on the windward side.

These zones are to be used as a general guide to planting for Maui County. In addition to looking at the maps, read the descriptions of the zones and decide which zone best fits your area. Plants can be listed in more than one zone and can be planted in a variety of conditions. For best results, take notes on the rainfall, wind, sun and salt conditions of your site. Use the zones as a general guide for selection and read about the plants to decide which best fits your needs as far as care and or function.

PLACES TO BUY NATIVES ON:

Maui:

1. **Hoolawa Farms** — 575-5099
   P O Box 731
   Haiku HI 96708
   The largest and best collection of natives in the state. They will deliver, but it's worth the drive to go and see!
   Will propagate upon request

2. **Kula True Value Nursery** — 878-2551
   Many natives in stock
   Get most of their plants from Hoolawa Farms
   They take special requests

3. **Kihei Garden and Landscape** — 244-3804

4. **Kihana Nursery, Kihei** — 879-1165

5. **The Hawaiian Collection** — 878-1701
   Specialize in Sandalwood propagation
   Will propagate special requests

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

Mr. George Tengan
Director
County of Maui Department of Water Supply
PO Box 1109
Wailuku, HI 96793

NOV 12 2003

Re: Natural Resources Conservation Project, Kanaio Natural Area Reserve

Dear Mr. Tengan:

Thank you and your staff for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. We appreciate your suggestion to incorporate Best Management Practices (BMPs) to minimize infiltration and run off from construction and vehicle operations, as well as the inclusion of sample BMPs. We intend to incorporate the Division of Forestry and Wildlife's Best Management Practices (BMPs) for Maintaining Water Quality in Hawaii (1996) during construction, including the following specific BMPs:

- Locating roads to fit topography and minimize alterations to the natural features;
- Provision of culverts, dips, water bars and cross drainage to minimize road bed erosion;
- Avoidance of diverting water from natural drainage ways;
- Keeping road grades at less than 10%, except where terrain unavoidably requires a short, steep grade;
- Incorporation of a stabilized construction entrance;
- Dust control measures as appropriate;
- Silt control as need to prevent silt runoff onto Highway 31;
- Sediment barriers as needed;
- Slope protection as needed;
- Inlet protection as needed;
- Temporary and permanent stabilization as needed; and
- Maintenance of roadway to maintain a stable surface and minimize any erosion.

We also appreciate the suggestion of appropriate native plants for the project zone. In accordance with the Management Policies of the Natural Area Reserve System, outplanting of native plants not currently found in the Natural Area Reserve will be limited to those species whose historic range includes the Natural Area Reserve.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

KAHEA
The Hawaiian-Environmental Alliance

Protecting
Native Hawaiian
traditional and
customary rights
and our
fragile environment

September 8, 2003

Christen Mitchell
Division of Forestry and Wildlife
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawai`i 96813

Re: Draft Environmental Assessment Natural Resources Conservation Project Kanaio Natural Area Reserve August 2003

Dear Christen:

Aloha. Mahalo nui loa for providing KAHEA the opportunity to comment on the Draft Environmental Assessment of the Natural Resources Conservation Project in the Kanaio Natural Area Reserve, dated August 2003.

KAHEA supports the proposed action to protect native dry forest and habitat for rare and endangered Hawaiian species in the Kanaio Natural Area Reserve. Approximately 90% of the native Hawaiian dry forest in the islands has been destroyed. The dry forest is essential to the Native Hawaiian culture and must be perpetuated. Fencing and controlling non-native species will enhance the likelihood that this special area will be preserved for the enjoyment and benefit of future generations. The proposed action will have a positive impact on the land and its resources, which support the people of Hawai`i, Native Hawaiian culture, and economy. The benefits of the proposed action far outweigh any short-term minor impacts that might result from the proposed fencing project.

If we can be of any assistance in implementing the project in a timely manner, please do not hesitate to contact us.

Sincerely,

Marjorie Ziegler
Program Associate

PO Box 27112 • Honolulu HI 96827
tel: (808) 524-8220 • fax: (808) 524-8221
www.kahea.org • kahea-alliance@hawaii.rr.com

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DAN DAVIDSON
DEPUTY DIRECTOR FOR LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR FOR
THE COMMISSION ON
WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND MANAGEMENT
STATE PARKS

Ms. Marjorie Ziegler
Program Associate
Kahea – the Hawaiian-Environmental Alliance
PO Box 27112
Honolulu HI 96827

NOV 12 2003

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Ms. Ziegler:

Thank you for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project in the Kanaio Natural Area Reserve.

We appreciate your comments in support of the project. We agree that the proposal will enhance the likelihood that this special area will be preserved for the enjoyment and benefit of future generations and that it will have a positive impact on the land and its resources.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

Chuck Chimera
PO Box 664
Kula, HI 96790

October 15, 2003

Division of Forestry and Wildlife
Maui Branch Natural Area Reserve Program
54 S. High Street
Wailuku, HI 96793

Dear Bill Evanson:

I just wanted to submit some brief comments regarding the draft EA for the fencing of the Kanaio Natural Area Reserve. First of all, as an author on the 1993 management plan, and as a graduate student currently working within the preserve, I have witnessed first hand the impacts of introduced ungulates on the flora of this rare dryland ecosystem and fully support both phases of the fencing project as described under the project description. I also appreciate the time you and your staff have spent in preparing the EA and in informing the public of your intentions. The following are a few brief comments on the project as put forth in the EA:

1. Use of bulldozers. I understand that using a bulldozer to clear the fence line makes a greater impact on the biological and cultural resources, but I believe, as you have indicated, that this is the only way to be both cost-effective in the construction of the fence as well as in future maintenance. Driving along the fence line will greatly facilitate the efficiency of fence inspections as well as allow for the transportation of materials needed for upkeep and repairs. In addition, the bulldozer roads will serve as both fire breaks and as access routes for firefighters, not only to protect the NAR from wildland fires, but also to provide additional protection to the residential structures in the Kanaio Homesteads area to the west. As the number of fires on Maui has been on the rise over the past year, I believe that the key to quickly and safely extinguishing fires in the area will heavily depend on access for fire crews.

2. Mitigation measures for native vegetation: Page 22 of the EA indicates that no native plants over 6 inches in diameter will be removed along the fence line, and that the line will pass through weedy areas when possible. During the clearing of the fence line, you may want to either avoid bulldozing the non-native shrub *Nicotiana glauca* or conduct visual surveys of the foliage for the presence of eggs or larvae of the endangered native moth, *Manduca blackburni*. It may be possible to remove the larvae and place them on plants away from the cleared area.

3. Public Access: I understand that you want to allow for the public to freely access the NAR, but I think that fewer gates in combination with ladders or climb-over structures would be preferable to gates every ½ mile. I realize that climbing over an 8-foot fence will be difficult, but I also believe that hiking over the lava of the reserve is difficult. I feel that if an individual cannot climb over an 8-foot fence, then they will probably not be able to hike very far within the reserve itself. I think that fewer gates, placed where people can easily access them, and where they can be checked to make sure they are closed, would be sufficient for entry by the general public. For those that are accustomed to hiking over the rough terrain found within the NAR, climb-overs spaced at regular intervals should be more than adequate to allow for entry and exit. If I'm not mistaken, that would also reduce the cost of the exclosure.

4. *Spermolepis hawaiiensis* has been found in the reserve within the past few years (Hank Oppenheimer and Fern Duvall, pers. comm). This is an endangered species that comes up after heavy winter rains and could possibly be located in the former `Uweko`olani parcel.

Thank you for receiving my belated comments and good luck with the completion of this very worthwhile project.

Sincerely,

Chuck Chimera
Department of Botany
University of Hawaii

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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LAND MANAGEMENT
STATE PARKS

NOV 12 2003

Mr. Chuck Chimera
PO Box 664
Kula, HI 96790

Re: Natural Resources Conservation Project, Kanaio Natural Area Reserve

Dear Mr. Chimera:

Thank you for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve.

We appreciate your comment that bull-dozing may be the only cost-effective method of construction and maintenance of this fencing. In addition, we will incorporate your observation that the bull-dozer roads may serve both as fire breaks and as access routes for firefighters, thus protecting the existing NAR as well as residential structures in the Kanaio Homesteads area from fire, into the Final EA.

We acknowledge your comment that the non-native shrub *Nicotiana glauca* (tree tobacco) serves as habitat for the endangered native moth, *Manduca blackburni*. We plan to incorporate your recommendation to avoid bull-dozing this plant where possible, and where not, to conduct visual surveys of the foliage for the presence of eggs or larvae to prevent disturbance to the moth.

We also acknowledge your recommendation to incorporate ladders or climb-overs rather than gates as the main method to provide public access into the NAR and will consider your comments as we make the final decision on the method and location of public accessways.

Finally, we appreciate the information that *Spermolepis hawaiiensis* has been found in the NAR and may be located in the former 'Uweko'olani parcel. We will incorporate this information into the Final EA.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

FROM :Maui HI Realty FAX NO. :808 575 5305 Oct. 31 2003 02:01PM P2

To: "Bruce R. Faulkner" <brf@maui.net>
Subject: Re: Kanaio NARS Conservation Restoration Project - Comments
cc: "Paul Conry" <Paul_Conry@exec.state.hi.us>, "Jeffrey DeBuse" <jmhunter@aol.com>, "Jon Sakai" <JonSakai@hawaii.rr.com>

In my opinion it is wrong to fence in the Kanaio NARS with 8' high fencing. More research is necessary to better determine the over all negative impact of doing so! The most obvious negative impact of the proposed 8' high fencing will be an aesthetically and visually disturbing barrier. Traditionally this area has always been "open range" land. It should remain that way with limited fencing at best to protect the scenic views. This stature enhances the over all appeal of the ruggedness of the terrain. The fencing project will contribute to the destruction of some of Maui's greater expanses of open space. As such this will support further division of an area that remains one of Maui's last great open spaces. To make the drive around that part of the island in the early morning hours as the sun rises in the East is a rejuvenating experience. The idea of 8' fencing either Mauka or Makai of the road is really quite disturbing for anyone frequenting the area.

The article in the Maui News said the fencing was needed to keep out game animals and cattle. Any one familiar with this are knows that there are very few of these animals in this area. Certainly not enough to justify the expense and unsightly-ness of such a project. For the most part these animals are somewhat self regulating to the point that this area would be one of the least desirable for them to inhabit on a regular bases! If the animals present were such a threat than why hasn't the public been allowed to participate in management hunts? Has the State let it get to a point that this serious threat really exist? It says right in the Kanaio NARS "Purpose" that the State should work with local hunters to help manage any present game animals but to date that hasn't happened and now you want to fence the area! Personally I have asked on numerous occasions if I could hunt in this area and have always been denied the opportunity to do so. The excuses I've heard are "the area is not clearly defined, if you are allowed to go what about the general public?, it's to close to the road, and how do we regulate it?" My suggestion was to make the area Archery Only hunting and have a check-in mail box down by the road with a general map of the area. It would not take to much effort to post the boundaries for this area. In fact, I'll bet some of the local hunting clubs would be willing to help post the area with T pins and signs. Hand held GPS units could be used effectively to accomplish this.

How often have we seen large tracts of land fenced off and our game animals slaughtered or snared to death. Very little is done in these areas after the fencing and killing. Where is the follow up by the organizations that purport these activities as being sound management. Why isn't there any cat, rat, insect, and alien plant control after the fencing/slaughter? What we do see as a result of fencing in large areas is a very real threat by fire and aggressive alien plants once the animals are gone. The sad fact of the matter is that in most cases fencing will not take care of the basic problem due to major changes in our environment and land management practices. We need to work toward more acceptable solutions rather than constantly proposing fencing with limited follow up! Lets work towards remedying the problem and realize the limitations as to what can be done effectively!

In conclusion, I feel that the lands that I love are being threatened by these practices! We need to work towards a more balanced approach in our future land management practices!

At 12:02 PM 10/17/03 -1000, you wrote:

> Aloha Bruce:
>
> Sorry you couldn't find the meeting the other night. No hunters showed up or made comments.
>
> As I just mentioned to you on the phone, we are still accepting comments but need to set a deadline for them in order to keep the project moving. We will accept any comments you submit by October 30 and include them in the Final Environmental Assessment.
>
> Thanks for calling to share your concerns about this project. Call me at 873-3506 or 264-9325 (cell) if you have questions or need more information.

FROM :Maui HI Realty FAX NO. :808 575 5305 Oct. 31 2003 02:01PM P3

It was good talking to you on the phone and I look forward to working more with you on various hunter related issues like Axis Deer.

Mahalo

Aloha,

Bruce R. Faulkner

PH #'s 808-575-5300 (O), 808-575-3505 (F), 808-280-4445 (C), 808-572-7926 (H)

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

Mr. Bruce Faulkner
810 Kokomo Road, Ste. 209
Haiku, HI 96708

NOV 12 2003

Re: Natural Resources Conservation Project; Kanaio Natural Area Reserve

Dear Mr. Faulkner:

Thank you for taking the time to review the Draft Environmental Assessment (Draft EA) for the Natural Resources Conservation Project in Kanaio Natural Area Reserve.

We understand that you object to the use of eight-foot high fencing and that you believe the fencing will be "aesthetically and visually disturbing." The Draft EA recognizes that the visual character, and public perception, of the Kanaio NAR is likely to change as a result of this project and that a fence visible from the highway may detract from the "wilderness" character of Kanaio. While it may not be possible to completely avoid these impacts, DOFAW will attempt to lessen these impacts by placing the segment of fence along the highway farther upslope from the road, and possibly by painting sections of fence a dark color to make it less visible.

We also acknowledge your suggestion that DOFAW utilize public hunting to address the feral animal threat. Conservation efforts elsewhere in Hawai'i have repeatedly shown that removing feral animal is an important first step towards protecting and restoring Hawaiian ecosystems. Public hunting alone, in this remote area, is not likely to remove sufficient animals to provide effective protection to the rare plants and animals of Kanaio NAR. Fourteen plant species found in the NAR have or are proposed for legal protection under the Endangered Species Act. Just one feral animal could seriously damage these plants and decrease the likelihood of long-term recovery for these plants. DOFAW believes that fencing is the best option to prevent continued decline of the unique natural resources found in Kanaio NAR.

We note that you asked about follow-up management actions planned after the fencing is complete, specifically about cat, rate, insect and alien plant control. DOFAW intends to incorporate practices to minimize the possibility of establishment of alien plants during construction. After construction, ongoing maintenance of the fence will include regular visits to repair damage, to check for animal incursion, and to control non-native weeds that may colonize the disturbed area along the fence corridor. Long-term management of the area inside the fence will include such actions as outplanting of appropriate native species (both rare and common), control of non-native weeds, and control of other non-native organisms such as insects, rodents, plant disease, etc. that may be adversely affecting forest health and the regeneration process.

Finally, we acknowledge your suggestion to "work towards a more balanced approach in our future land management practices." The Natural Area Reserve system was established to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawai'i." (HRS, Chapter 195). DOFAW believes that the planned fencing is the most appropriate method to provide long-term protection to the unique and threatened dryland forest ecosystem contained within Kanaio Natural Area Reserve.

If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

Mr. Randy Awo
Department of Land and Natural Resources
Division of Conservation and Resources Enforcement
1151 Punchbowl Street
Honolulu, HI 96813

NOV 12 2003

Re: Natural Resources Conservation Project, Kanaio Natural Area Reserve

Dear Mr. Awo:

Thank you for taking the time to review the Draft Environmental Assessment for the Natural Resources Conservation Project, Kanaio Natural Area Reserve. Based on the telephone conversation of August 18, 2003, we understand that you have no comment at this time. If you have any future questions or concerns about this project, please feel free to contact me at (808) 873-3506.

Sincerely,

William Evanson
Maui Natural Area Reserves Specialist

Summary of Public Informational Meeting
Mayor Hannibal Tavares Community Center, Pukalani, Maui
October 14, 2003 6:30 p.m.

In attendance:

DLNR Staff	William Evanson, DLNR NARS Specialist, Maui Bryon Stevens, DLNR NARS Specialist, Maui Fern Duvall, DLNR Wildlife Biologist, Maui Christen Mitchell, DLNR NARS Project Coordinator, Oahu
Public:	David Johnston Dot Buck Rene Sylva Anna Palomino Charles Maxwell Edward Uwekoolani Art Medeiros Mr. & Mrs. David Dutro Mary Evanson Valerie Munson K. Mahea Kaiaokamalie Diana Dahl Curt Gallop Chuck Chimera Mrs. Hahn Chris Grasa

William Evanson, DLNR NARS Specialist, Maui, welcomed those attending, noting that the public meeting was scheduled to ensure that Maui residents have the opportunity to comment and learn about the proposed Kānaio Fencing Project before construction begins. After introducing DLNR staff present, he then gave a powerpoint presentation. Comments received during and after the presentation included the following (with responses given during the meeting in italics):

- Will areas inside the fencing be formally added to the Natural Area Reserve (NAR)? Does the State intend to purchase the Ulupalakua Ranch land within the fencing? *DLNR does intend to formally add the State land inside the fencing to the existing NAR, but does not intend to add the private land owned by Ulupalakua Ranch to the NAR. Ulupalakua Ranch has offered to participate in this project as a partner with the State to protect the unique ecosystem within the NAR, and there are currently no plans for the State to formally acquire this land.*

- What about the Native Hawaiians who once lived on the land now part of the NAR? Specifically, what about Lot 17 that was taken away from Edward Uwekoolani by Executive Order, and that does not host any threatened or endangered plants? *Previous DLNR investigation into this claim concluded that the Uwekoolani claim to Lot 17 was never perfected. Mr. Uwekoolani is encouraged to investigate the issue and file*

claims with DLNR, raising the issue with DLNR again as he sees fit. But as long as the land is under the administration of NARS, NARS staff is mandated to take action to protect the natural resources. This fencing project is not intended to exclude people, but to exclude feral animals that harm the unique ecosystem protected by the NAR. The fencing is designed to protect this land for future generations. While the majority of Parcel 17 has been disturbed by grazing, there are still pockets of native forest remaining, particularly in lava channels that were not accessible to cattle and where some threatened and/or endangered species can be found. Finally, this area contains some soil, and as a result, provides opportunities for future outplanting and regeneration.

- Bulldozing the land and crushing the rock is a cultural impact, because it symbolizes harm to Pele. Bulldozing is not necessary to construct fencing.
  Due to the terrain along much of the fence alignment, construction of fencing by hand would be very expensive. In addition, construction by hand would not create an accessway (as bulldozing would), which would increase the difficulty of long-term maintenance of the 8-foot high fence. Bulldozing will be done only where necessary for effective and efficient construction and maintenance of the fenceline. No archaeological sites were observed along the area planned for bulldozing. Bulldozing on bare lava in and of itself is not known to constitute a significant cultural impact.

- What are the timeframes for this project? Are there any other required public meetings?
  This meeting was not required but was scheduled to ensure continued community input and discussion. The Draft Environmental Assessment for the project was released for comment on August 8, 2003 and a Final Environmental Assessment that incorporates public comments received is being drafted. If things proceed as scheduled, construction may begin within the next 3 months.