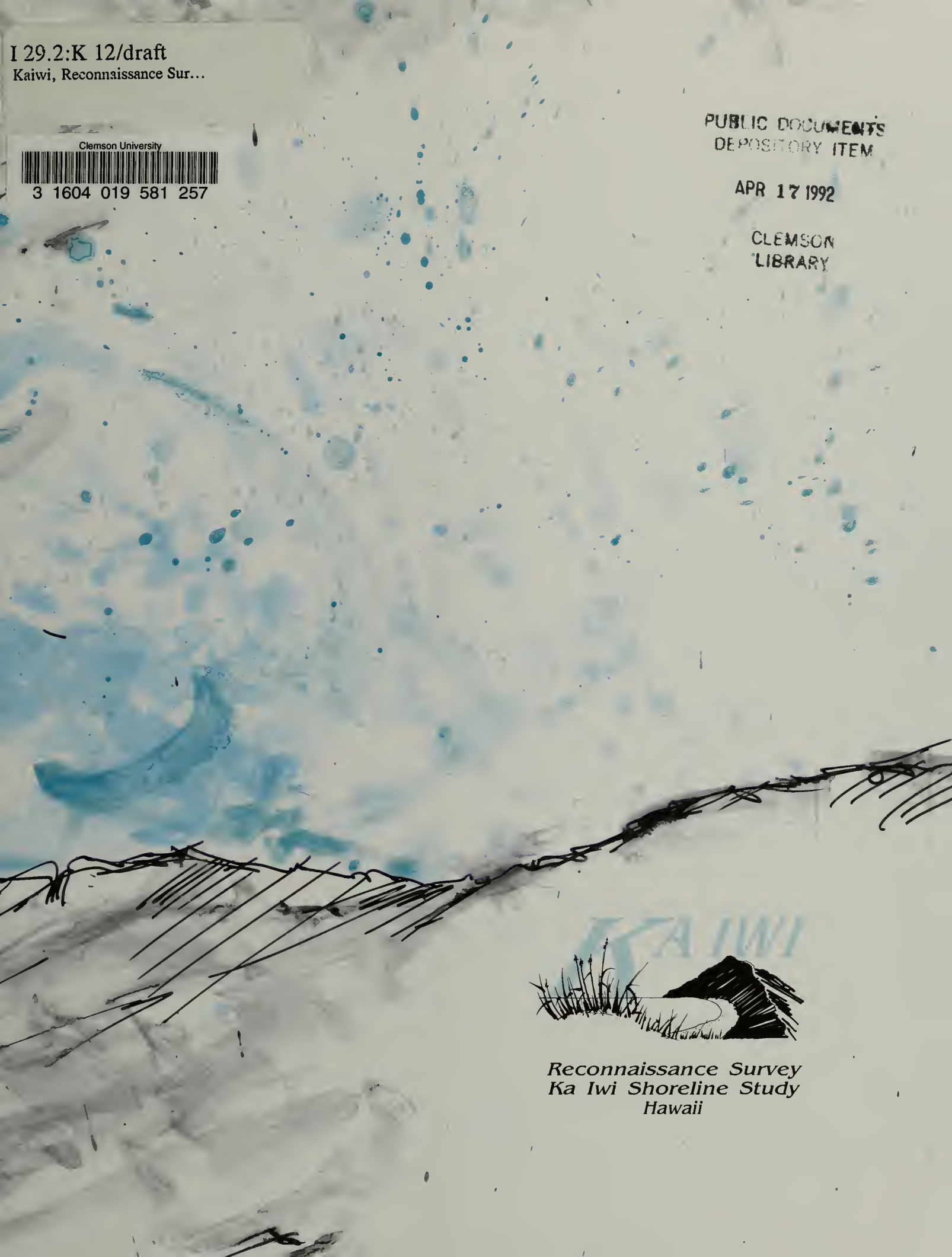

Reconnaissance Survey
Ka Iwi Shoreline Study
Hawaii

Publication of this document should not be construed as representing either approval or disapproval by the secretary of the interior. The purpose of this document is to provide information for further consideration of the area as a submission to the Congress in compliance with Public Law 101-512.

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Reconnaissance Survey
Ka Iwi Shoreline Study

Draft

January 1992

Oahu, Hawaii

United States Department of the Interior
National Park Service
Denver Service Center

SUMMARY

The National Park Service (NPS) has been directed to undertake a study of the Ka Iwi shoreline and offshore islands of east Oahu and other nearby lands on the windward side of the island of Oahu for consideration as a possible addition to the national park system. Authorization for this study is in Public Law 101-512, conference report 101-971. In accord with the NPS planning process, a ***reconnaissance survey*** is the first step in evaluating a proposed addition to the national park system. The survey is a fact-finding effort based on readily available information, and it is used primarily to determine the significance of the area's resources, the degree of existing protection, and the suitability/feasibility of including the area in the national park system.

The NPS publication *Criteria for Parklands* sets the criteria for determining significance, suitability, and feasibility. To qualify as an addition to the national park system, an area must meet all criteria for national significance, suitability, and feasibility.

For purposes of this reconnaissance survey, the NPS team divided the area being considered for inclusion in the national park system, the study area, into three sections – the Koko Rift unit, the Waimanalo Bay unit, and the Maunawili Valley unit. Each unit has its own distinctive characteristics, and each is evaluated separately for significance, suitability, and feasibility; however, consideration also is given to various combinations.

The Koko Rift unit includes public and private lands from Koko Head to Makapuu Point and two offshore islands. The Waimanalo Bay unit includes public lands along Waimanalo Bay and Bellows Air Force Station. The Maunawili Valley unit has a less defined boundary, generally encompassing Olomana Peak and Kawainui Marsh and its watershed in Maunawili Valley.

Because this survey is based on readily available information, there may be conflicting (differing professional opinions) and outdated information in the various resource descriptions. The survey process does not permit extensive research to verify the significance of various features; the NPS study team has relied on the opinions in various studies and reports obtained from numerous sources (see the "Selected References" section.)

In some instances an area is known by several names or has several spellings; the study team has tried to use what appears to be the one most consistently used. Should any of the study units be proposed for addition to the national park system, additional studies would be needed to refine the boundaries.

The conclusion of the survey is that none of the three units meets all of the criteria for significance, suitability, and feasibility. The following table summarizes the findings for each unit.

SUMMARY – CRITERIA FOR PARKLANDS			
	KOKO RIFT UNIT	**WAIMANALO BAY UNIT**	**MAUNAWILI VALLEY UNIT**
NATIONAL SIGNIFICANCE	Nationally significant combination of natural and recreational resources (Hanauma Bay and Koko Rift); state significant cultural resources.	Local and state significant recreational beaches and archeological resources.	Local and state significant cultural and natural resources; Hawaiian heritage sites lack integrity. Wetlands of Kawainui Marsh provide critical waterfowl habitat.
SUITABILITY	Resource themes are adequately represented in NPS system# although specific features unique to area are not represented. Combination of natural and recreational features is such that unit is suitable for inclusion in the system. Does not meet criteria for suitability because significant resources are protected and managed for public enjoyment by other agencies.	Does not meet criteria for suitability. Significant resources are protected and managed for public enjoyment by other agencies. Resources are well represented in NPS system.	Does not meet criteria for suitability. Significant cultural resources are adequately represented in NPS system; they are protected and will be managed for public enjoyment by other agencies. Significant natural resource themes are represented in NPS system; specific features unique to Oahu are not.
FEASIBILITY	Meets criteria for feasibility if private lands are included and management authority for lands and waters is granted to Park Service.	Does not meet criteria for feasibility as a **separate** unit due to inadequate size and configuration, but qualifies if combined with Koko Rift unit. Expanded public recreational use of Bellows beach is encouraged.	Does not meet criteria for feasibility – inadequate size and configuration to permit national visitor enjoyment.
CONCLUSION	**Unit fails to meet all three criteria.**	**Unit fails to meet all three criteria.**	**Unit fails to meet all three criteria.**
OTHER EVALUATION FACTORS			
EXISTING PROTECTION	Public lands adequately protected under existing management. Private land use controls appear less than adequate to protect resources.	Adequately protected under existing management.	Private land use controls appear less than adequate to protect resources. Lands under city-county and state management are adequately protected.
THREATS TO RESOURCES	Potential development of private lands could alter the area's scenic quality and limit public recreational use. Sewage treatment plant is a threat to marine resources. Overuse and inappropriate use of some areas has resulted in resource damage; the city and county of Honolulu is addressing these problems.	Some damage to archeological sites due to military and public use of area. Flooding and stream pollution are concerns. Air Force Station might contain hazardous wastes.	Continuing development has potential to destroy natural and cultural resources and significantly alter water quality. Unknown impacts on water quality from landfill.

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Introduction

THE RECONNAISSANCE SURVEY – PURPOSE

The National Park Service (NPS) has been directed to undertake a study of the Ka Iwi shoreline and offshore islands of east Oahu and other nearby lands on the windward side of the island of Oahu for consideration as a possible addition to the national park system. Authorization for this study is in Public Law 101-512, conference report 101-971. In accord with the NPS planning process, a ***reconnaissance survey*** is the first step in evaluating a proposed addition to the national park system. The survey is a fact-finding effort based on readily available information, and it is used primarily to determine if the area resources have national significance, the degree of existing protection, and the suitability/feasibility of including the area in the national park system.

SIGNIFICANCE, SUITABILITY, AND FEASIBILITY

To qualify for addition to the national park system, an area must meet all criteria for national significance, suitability, and feasibility. The NPS publication *Criteria for Parklands* sets the criteria for determining significance, suitability, and feasibility.

As stated in *Criteria for Parklands,* **to qualify as nationally significant, an area must** meet all of the following criteria:

> It is an outstanding example of a particular type of resource.

It possesses exceptional value or quality in illustrating or interpreting the natural or cultural themes of our nation's heritage.

It offers superlative opportunities for recreation, public use and enjoyment, or scientific study.

It retains a high degree of integrity as a true, accurate, and relatively unspoiled example of a resource.

Also according to *Criteria for Parklands,* an area that is nationally significant also must meet criteria for suitability and feasibility to qualify as a potential addition to the national park system. **To be suitable for addition to the national park system an area must**

represent a natural/cultural theme or type of recreational resource that is not already adequately represented in the national park system, unless such an area is comparably protected and presented for public enjoyment by another land-managing entity.

Adequacy of representation will be determined on a case-by-case basis by comparing the proposed addition to other units in the national park system, considering differences and similarities in the character, quality, quantity, or combination of resources and opportunities for public enjoyment.

To be feasible as a new unit of the national park system, an area must

be of sufficient size and appropriate configuration, considering natural systems and/or historic settings, to ensure long-term protection of resources and to accommodate public use, and it must have potential for efficient administration at a reasonable cost.

Important feasibility factors include landownership, acquisition costs, access, threats to the resource, and staff or development requirements. Although some of these factors can be evaluated from existing data, others must be based on broad concepts. For example, acquisition costs can be estimated with reasonable accuracy, but long-range development and staffing costs must be based on past experience until a comprehensive general management plan has been prepared.

New additions to the national park system will not usually be recommended if other arrangements can provide adequate protection for the resources and opportunities for public enjoyment.

STUDY PROCESS

The process leading to a recommendation for inclusion in the national park system has several stages.

Reconnaissance survey – determines national significance, suitability, and feasibility.

Study of management alternatives – includes alternative boundaries, development scenarios, and management strategies.

Legislative proposal – a detailed legislative support package with estimates of costs for land protection/acquisition, development, operations, etc. Draft legislation is usually submitted with this package.

Congressional action – the legislative process can be lengthy, possibly involving hearings in the study area. The legislation is often a compromise in response to the concerns of those for and against the proposal to include certain areas in the park system.

The reconnaissance survey is a study by a team of NPS professionals to apply the criteria for parklands to the areas authorized for study. The team visits the areas and consults with other interested federal, state, and local agencies, and individuals. Basically, the survey is a review of existing information from various sources, and it is rare that original research is undertaken at this stage. The findings are the professional opinions of

Island of Oahu

Cultural site

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Feet

Study Area

Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service

DSC/Dec '91/20,000A

Wailea Point

Waimanalo Bay

Waimanalo Beach Park

Kaiona Beach Park

Bellows Air Force Station

Kawainui Marsh

Ulu Po Heiau

Kalanianaole Highway

Waimanalo Bay State Recreation Area

Bellows Field Archeological Area

Pahukini Heiau

Waimanalo Bay Unit

Olomana Peak

Undefined Boundary

Maunawili Valley

Waimanalo Forest Reserve

Pali Highway

Maunawili Valley Unit

Makapuu Point

Makapuu Point Lighthouse

Manana Island

Makapuu State Park

Kaohikaipu Island

Kaupo Beach Park

Makapuu Beach Park

Queens Beach

Sandy Beach

Halona Point

Koko Crater

Ka Iwi Channel

Koko Head District Park

Job Corps Center

Hanauma Bay

Koko Head

Koko Rift Unit

Island of Oahu

Cultural site

N

0 2000 4000 8000
Feet

Study Area

Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service

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the team, provided to management for their consideration.

If an area meets all the criteria for parklands, a study of management alternatives may be authorized. These additional studies can be costly and take several years to accomplish if they are to produce a comprehensive management plan for an area. An environmental assessment or environmental impact statement might be required when specific federal actions are proposed.

Should Congress decide to consider addition of all or parts of the study area to the national park system, additional studies might be required to refine boundaries and determine costs for the development and management of the proposed area. These are presented as a legislative support package, usually with draft legislation for addition to the national park system.

KA IWI – A SLIGHTLY DIFFERENT APPROACH

The Ka Iwi study area is a mixture of federal, state, local, and private ownerships. There are no single, comprehensive sources for information about either the natural or cultural resources of the study units. The Nature Conservancy currently has the most complete inventory of natural resources for the area, although some of the information is out of date. A contract with the conservancy permitted them to field check portions of the study area and to provide the team with vegetation mapping. The changing conditions in Maunawili Valley would have required an extensive inventory beyond the scope of this project.

There is no single source for cultural resource information. Generally, archeological surveys and historic sites or structures reports tend to be done in relation to development proposals. Records of the State Historic Preservation Office were searched for relevant information. The Bishop Museum was able to supply some information on archeological sites, and the Kawai Nui Heritage Foundation provided considerable information about sites related to Hawaiian heritage. The Air Force provided information on archeological studies at Bellows.

Various theme studies by the National Park Service and other agencies were also reviewed. Listing on the National Register of Historic Places or designation as a natural or cultural landmark does not automatically imply that the site/feature meets the criteria for inclusion in the national park system. During the reconnaissance survey, sites or features might be identified that appear to meet the criteria for landmark designation or for listing on the national register, but it is not within the scope of the survey to evaluate and prepare nomination forms for them.

In the case of Ka Iwi, a decision was made to study some possible management alternatives regardless of the findings in the reconnaissance survey. The management alternatives will be conceptual and will not present specific boundary or development proposals. A park boundary is often a compromise between the ideal and what is practical, and it is usually worked out in congressional committees. The future management alternatives document will include an environmental assessment that will be based on the conceptual management strategies.

This reconnaissance survey does not and the study of management alternatives will not contain recommendations. These two documents will be combined in a single document and presented to the NPS regional director who will then make his recommendation and forward the document to the director of the National Park Service. Following review by Department of the Interior staff, the document will be forwarded to Congress and cleared for public distribution.

The Study Area

ACCESS/CIRCULATION

Access

The study area is about 11 miles east and 10 miles north (by highway) from downtown Honolulu and is well served by public transit and the highway system. The primary road, Highway 72 (Kalanianaole Highway), passes through the Koko Rift unit and parallels the Waimanalo Bay unit as far as the entrance to Bellows Air Force Station (AFS). The road is quite narrow as it winds along the cliffs east of Hanauma Bay, and parking spaces at overlooks are limited. Traffic becomes quite congested at the entrance to Hanauma Bay and the blowhole overlook when these parking areas are full. The remainder of the road from Sandy Beach to Bellows AFS is a reasonably good two-lane highway. The few pullouts are small, turn lanes are lacking at many of the turnoffs, and in some areas the shoulders are inadequate for parking. Trucks carrying hazardous materials and oversize trucks that cannot go through the tunnels on the main cross-island routes must use this highway.

There have been proposals to widen the narrow parts of the highway, and alternatives to bypass the Hanauma Bay to Sandy Beach section are being debated. If a bypass were created, under some alternative, the Hanauma Bay/Sandy Beach section could become a one-way park road. The issue of a bypass has yet to be resolved. Both the county and the state are in the process of preparing master plans for all or part of the Koko Rift unit. The state is considering a Ka' Iwi State Park that would incorporate Makapuu State Park

and some of the intervening private lands in the area, permitting public access to the Makapuu area.

Highway 72 (Kalanianaole Highway) and Highway 61 (the Kailua Road part of the scenic Pali Highway that goes between Honolulu and Kailua) crosses the southern end of the Kawainui Marsh, separating it from the Maunawili Valley. The marsh is accessible from roads along the west and south sides and through subdivision roads on the north and east sides. Access is generally undeveloped, but users can walk along the levee at the north edge of the marsh and a parking area on the west side provides some access (although this area is used primarily for model airplane flying).

The two *heiau* (places of worship) in the Maunawili Valley unit are difficult to reach. One is on the edge of a major sanitary landfill, and visitors must pass through the control gates to reach it. The landfill is nearly full and eventually this site may become more accessible. The other heiau, on the east side of the marsh, must be reached through a subdivision. Located behind a YMCA and a residence, this heiau is reached by an access path between the two structures.

Access to public lands in the Maunawili Valley is severely limited by private lands. The roads throughout the valley vary from wide subdivision streets to narrow primitive roads and tracks. Access to many traditional trails and use areas has been closed off as the area developed.

Parking

Although existing access and public transportation are reasonably good, parking is a problem in many parts of the study area. At Hanauma Bay, parking is used as a means to limit the number of visitors, but those waiting to get in create traffic jams along the highway. The 325-space parking area is generally filled by 10 a.m., and cars are let in only after several cars have left.

Between Hanauma Bay and Sandy Beach there are two main overlooks plus some small turnouts. The parking area at the Halona Point blowhole is quite large; the one at the Lanai viewpoint is small and usually filled.

There are paved parking areas at most of the beach parks; parking for other beaches is along the highway shoulders or, east of Sandy Beach, along the strip between the road and the ocean. Sandy Beach is considered to be used to capacity, and the parking areas are frequently full. The draft master plan for the area considers options to extend the parking areas into the unimproved sections of Wawamalu Beach Park, the eastward extension of Sandy Beach. East of Sandy Beach, parking on private land is uncontrolled and causing extensive resource damage.

There is currently no parking available for Makapuu State Park (also called Makapuu Point State Wayside), and the only feasible locations are on private lands. A small pullout where Highway 72 crosses the ridge from leeward to windward side is used by some who climb up to Makapuu Head. Others park along the road shoulder and hike up along the narrow service road, which passes through private lands, and some get into the area in four-wheel drive vehicles. The no-trespassing and closure signs are generally ignored.

There is no parking area at Kaupo Beach Park and only a small parking area at Kaiona Beach Park; parking on highway shoulders is common. Waimanalo Beach Park has more than 100 parking spaces, and Waimanalo Bay State Recreation Area has extensive parking.

Parking at the weekend public use area in Bellows AFS is ample, but vehicles are allowed to pull in anywhere under the trees and, as a result, there is little remaining vegetation on the ground. The end of an abandoned airstrip provides a very large parking area but tends to concentrate visitors in one stretch of the beach.

Trails

A comprehensive trail system is lacking throughout the study area, although there are numerous opportunities to hike on public lands. An old tramway route goes straight to

the top of Koko Crater, and it is often used as a trail. Users have somewhat defined a route to Makapuu Head. Access to some traditional trails, such as the one to Maunawili Falls, is blocked by development. A number of formal and informal trails exist in the Koolau Mountains, and several trails exist in the Maunawili Valley, including trails up Olomana Peak.

Routes for some future trails in the Maunawili Valley have been identified. According to Victoria Creede (see "Selected References" section), there are approximately 8 miles of trail between the 800-1,000 foot elevations of Maunawili Valley, with a possibility of over 15 miles of trail curving around the entire valley and connecting with a Maunawili Falls trail, the Mt. Olomana trail, and eventual connections to other areas. A trail following one of the streams out of Bellows AFS might connect with trails on Olomana Peak. Another trail could conceivably follow the base of the Pali connecting Maunawili Valley with Makapuu Point and on to Koko Crater and Hanauma Bay (the steep Pali makes cross-island trails nearly impossible). Trails around Kawainui Marsh could connect to Olomana Peak and other trails in Maunawili Valley. Private lands, subdivisions, golf courses, and roads are obstacles in the way of a coordinated trail system.

A trail system linking the three units with trails in the Koolau Mountains would greatly expand recreational opportunities. This system would require a concerted effort by the county or state to obtain rights-of-way for some trails, but others could be developed entirely on public lands.

The Na Ala Hele trail system project will develop and improve mountain and shoreline trails and accesses throughout the island, presumably accomplishing the desired linkage of the study units.

INTERPRETATION

Perhaps the major deficiency in the current management of the state and county parks in the study area (all three units) is the lack of interpretive programs. Admittedly, this is a strong NPS bias. The National Park Service generally excels at placing a site or resource in context with its geological and anthropological history. At Hanauma Bay there are some wayside exhibits, and Friends of Hanauma Bay conducts tours and staffs an education desk on the edge of the beach. This educational effort, sponsored by the University of Hawaii's Sea Grant program, is primarily designed to reduce resource damage through visitor education. One unique aspect is the fish food exchange program; the staff trades approved fish food for the bread and peas brought in by visitors.

Other than efforts at Hanauma Bay and some efforts by the Kawai Nui Heritage Foundation and other interest groups, there is virtually no interpretation of the natural and cultural resources of the study area. The Makapuu area is rich in cultural history, and the entire Koko Rift unit is dominated by volcanic features begging to be interpreted.

The Waimanalo Bay unit is primarily for recreation, with limited interpretive opportunities. The history of early settlement, the Hawaiian homelands, and the military history of Bellows AFS are potential themes. Bellows AFS might also offer some potential for nature programs.

SCENIC AND VISUAL QUALITY

Koko Rift Unit

The roughly 5-mile stretch of shoreline in this unit is unusual–the coastline does not have any commercial or private development. Over 3½ miles of the coastline consist of steep cliffs, offshore rocks, and pocket beaches. The remaining 1½-mile, low-lying stretch offers several beaches, tide pools, and offshore rocks. The prominent volcanic features define the study unit and visually isolate it from extensive development to the north and west.

The study unit is not without some intrusions from development. Residential subdivisions, a golf course, and a wastewater treatment plant occupy a portion of the area inland (*mauka*) from the highway. Fortunately these are all low-rise developments and are not major scenic intrusions. However, some 300 acres of private lands in the unit are potentially

developable. Specific proposals for development across the highway from Sandy Beach led to a public outcry, rezoning, and court challenges by the owners and developers.

On the leeward side of the island, the unit is almost desert-like in character–not what most tourists expect to find in Hawaii. But the ocean-land interface is quite scenic, and areas such as Hanauma Bay, the Halona Point blowhole, Sandy Beach, and the views to other islands are important tourist attractions. Those who hike to Koko Head or Koko Crater are rewarded with spectacular views toward Diamond Head and Honolulu as well as views of the Ka Iwi shoreline. The opening of Makapuu Head State Park as a visitor destination, when adequate access can be provided, will add to enjoyment of this scenic area.

Waimanalo Bay Unit

The gentle curve of the bay, the white sand beaches, the sparkling blue water, and the backdrop of the Koolau Mountains combine to make this unit one of the more attractive stretches on the island. Although there is extensive development adjacent to the unit, including some beachfront homes, it is mostly rural, low-rise, and often hidden by the lush vegetation of the windward side of the island. The view is best appreciated from the small turnout above Makapuu Beach or from many points along the beach.

There are almost continuous views of the shoreline from much of the roadway from Makapuu Point to Waimanalo Beach Park. Also, good views of the dramatic Koolau Pali exist throughout most of this area.

The larger beach parks, including the weekend use area at Bellows AFS, contain extensive vegetation, which offers shade, pleasant picnic sites, and a screen of nearby development.

Maunawili Valley Unit

Maunawili Valley is deceptive. The lush vegetation conceals the extensive development of residences and a golf course. Dramatic Olomana Peak (1,600 feet) is visible from many places throughout the area. The Pali, rising over 2,600 feet, forms a spectacular backdrop for the valley and Kawainui Marsh. Driving through the valley, one becomes aware of the extensive residential development and the remains of old farms. There are no parking areas at trailheads or vista points (except for an overlook along the Pali Highway).

Kawainui Marsh is a very scenic area, but access is limited by the subdivisions on two sides and the current lack of a trail system and viewpoints. The view from the Pahukini heiau towards the marsh and Kailua is spectacular, although the intervening landfill detracts from it. This landfill and an adjacent quarry are quite visible from many points around the marsh. Ulu Po heiau is difficult to find; once on site, the setting is quite scenic with a view across the marsh (one must mentally block out the adjoining residence).

Because of the extensive development all around, the unit lacks the scenic and visual quality normally associated with a unit of the national park system. However, if interpretive facilities and/or sites are developed adjacent to the marsh area and capture the visitors' attention, many of the visual intrusions could seem less intrusive.

EXISTING PROTECTION

Resources in the study area are currently protected under various local ordinances, state legislation, and federal laws, executive orders, and regulations (see table C2 appendix C for existing zoning). There is considerable local concern that these are inadequate to protect significant resources from undesirable development as evidenced by the proposals for Sandy and Queens beaches and the controversial golf course development in Maunawili Valley.

City and County of Honolulu

Preservation Districts. The *Land Use Ordinance*, as adopted by the city-county Department of Land Utilization in December

1990, provides for the designation and establishment of preservation districts. The purpose of the districts is "to preserve and manage major open space and recreation land and lands of scenic and other natural resource values." The ordinance provides for three types of preservation districts and defines their intent, as follows:

P-1 Restricted Preservation District – to incorporate all lands within a state-designated conservation district. (P-1 zones are governed by the state Department of Land and Natural Resources regulations for conservation district lands.)

F-1 Military and Federal Preservation District – to identify areas under military or federal government jurisdiction and permit the full range of military and federal government activities.

P-2 General Preservation District – to incorporate all lands removed from either the state-designated conservation districts or federal jurisdictions; to incorporate lands designated urban by the state but well suited to the functions of providing visual relief and contrast to the city and county's built environment or serving as outdoor space for the public's use and enjoyment; to incorporate areas unsuitable for other uses because of topographical considerations related to public health, safety, and welfare; and to incorporate all county-designated preservation lands not located within a state-designated conservation district.

Appropriate uses, structures, and development standards for the three preservation district types are delineated in the ordinance. Within the P-1 district they are regulated by the appropriate state agencies. All military and federal uses and structures are permitted in a F-1 district. In a P-2 district the following uses and structures are permitted, some being subject to various conditions: (1) aquaculture, (2) cemeteries and columbaria, (3) crop production, (4) forestry, (5) golf courses, (6) game preserves, (7) livestock grazing, (8) public uses and structures, (9) recreational facilities, outdoor, (10) telecommunications antennas, and (11) utility installations. Development standards in a P-2 district include a (1) minimum lot area of 5 acres, (2) minimum lot width and depth of 200 feet, (3) maximum building area amounting to 5 percent of lot, and (4) maximum building height of 15 feet (25 feet is permitted if lot setbacks are provided).

Golf courses are permitted in the P-2 district only when they are consistent with the city and county's development plans. The golf courses on P-2 zoned land are deemed consistent with the development plans only when they are situated on lands designated for preservation as parks and recreation or they are on the development plan land use maps.

Coastal Zone Management. As part of the state's coastal zone management, city and counties administer designated special management areas to "avoid permanent losses of valuable resources and the foreclosure of management options, and to assure (public) access to. . . . beaches, recreation areas, and natural preserves. . . ." Lands within special management area boundaries are subject to various specified rules and regulations. Proposed improvements would first be evaluated by the Department of Land Utilization. Depending on the type and the value of the proposed changes, a major, minor, or no special management area permit may be required before work could proceed. Among the activities or improvements exempted from such regulations are (1) agriculture or aquaculture, so long as the accumulated impact does not have a significant environmental or ecological impact; (2) construction of a single family residence; (3) road repair and maintenance; (4) routine maintenance dredging of streams, channels, and drainage ways; and (5) repair and maintenance of underground utility lines.

State of Hawaii

The Hawaii State Land Use Commission regulates land use statewide by designating lands for one of four broad use categories. One of the categories is that of conservation district. Lands under this classification

generally are unsuitable or undesirable for development because they have significant features or resources, unique scenic or historic qualities, or value as recreational resources. Uses permitted in conservation districts require a conservation district use permit that is issued by the State Department of Land and Natural Resources. Under provisions of the Hawaiian Homes Commission Act, the Department of Hawaiian Home Lands is exempt from zoning when it develops land for homestead purposes.

Chapter 6, "Memorials," of the *Hawaii Revised Statutes* provides a division within the Department of Land and Natural Resources to administer a comprehensive historic preservation program of historical, architectural, and archeological research, regulation, management, and development of cultural resources and properties. Among other responsibilities, the division prepares information for the Hawaii Register of Historic Places and for listing on the National Register of Historic Places in consultation with the Hawaii Historic Places Review Board (appointed by the governor). The division's mandate also involves preparing a statewide historic preservation plan, coordinating evaluation and management of burial sites, and designating or serving as the depository for all materials generated or recovered through historic preservation projects supported in whole or in part by the state or taking place on state lands. The governor appoints a state historic preservation officer who is responsible for the comprehensive historic preservation program and is the state liaison officer with the federal government and other states with regard to historic preservation concerns.

U.S. Government

Cultural resource protection concerns in the study area are subject to various federal laws, executive orders, and regulations. These include the National Environmental Policy Act of 1969; the National Historic Preservation Act of 1966, sections 106 and 110; Executive Order 11953 "Protection and Enhancement of the Cultural Environment"; the Archeological Resources Protection Act of 1979; and the American Indian Religious Freedom Act of 1979.

Natural resource protection concerns are also subject to various federal laws, executive orders, and regulations, including the National Environmental Policy Act of 1969; Endangered Species Act of 1973, as amended; Executive Orders 11987 "Exotic Organisms," 11988 "Floodplain Management," and 11990 "Protection of Wetlands"; and the Coastal Zone Management Act of 1972.

KOKO RIFT UNIT

Natural Resources

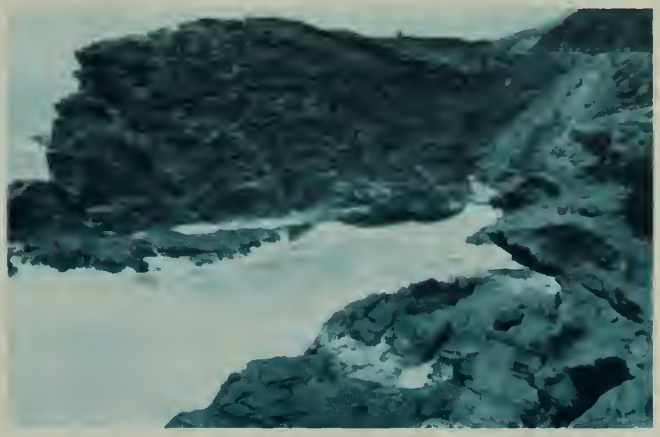
In the following section, text on geology and landforms relies heavily on Abbott et al. 1981, pg. 140. Most of the information about biotic resources relies heavily on the Hawaii Heritage Program report (1991a).

Geology/Landforms. Eastern Oahu was formed by two major volcanic events. About 2.5 million years ago, the Koolau volcanic series formed the bulk of the Koolau Mountain Range. This shield volcano was then heavily eroded during a 2-million-year lull in volcanic activity, creating the dramatic Koolau Pali (cliffs) on the northeast (windward) side of the island, and a series of roughly parallel ridges dissecting the southwestern (leeward) slopes. About a half million years ago, the Honolulu volcanic series formed a series of cinder cones and other volcanic formations on top of part of the eroded Koolau series. This series of volcanic formations and vents, known as the Koko Rift, includes Koko Head, Hanauma Bay, Koko Crater, Makapuu Head, and Manana Island.

In its entirety, the Koko Rift contains examples of virtually all types of Honolulu volcanic series activity, including lava flows, tuff and ash cones, and cinder cones. Sea caves and at least two blowholes occur in the Koko Rift. There is a significant lava flow in Kalama Valley, and the Kaupo lava flow forms the northeastern boundary of the unit.

According to Abbott et al., the eastern flank of Koko Crater contains the only base surge

Koko Rift Unit



deposits known on the islands, and the Koko Head-Hanauma Bay-Koko Crater complex contains one of the best examples of tuff cones in the islands. Large fragments of old coral reef and country rock are incorporated in the tuff, illustrating especially well the effects of volcanic explosion through old coral reef. Hanauma Bay occupies the former principal craterof Koko Head and, according to Abbott et al., provides a unique example of an old tuff cone that has been breached by wave erosion. Koko Crater is the largest, highest (at 1,208 feet elevation), and best preserved cone in the Koko Rift, providing an example of youthful stream erosion into the soft tuff. The Kalama and Kaupo lava flows represent the youngest volcanic activity on Oahu (although the island of Hawaii has current volcanic activity).

In a letter from the Office of Council Services for the city and county of Honolulu dated April 18, 1889, a statement attributed to Dr. George Walker, Professor of Geology and Geophysics at the University of Hawaii states that a lava tube near Makapuu Point may be the best documented example on earth of a geological feature akin to one found on the moon known as a sinuous rill.

Climate. The climate discussion for the Maunawili Valley unit provides a more complete description of the overall climate. In contrast to the Maunawili Valley unit, which is on the windward (wet) side of Oahu, the Koko Rift unit is on the leeward (dry) side of the island. The differences are dramatic, with the Koko Rift unit receiving less than 30 inches of precipitation annually (in contrast to 40 to 80+ inches in the Maunawili Valley unit). Daytime temperatures average 70°-90°.

Vegetation. Native plant taxa were those typically found in dry coastal and lowland settings on Oahu (see appendix A and the Vegetation, Koko Rift Unit map for more information).

Natural communities in the unit include the rare *Marsilea villosa* lowland dry herbland (see discussion below). Other native communities, not considered rare, include wiliwili lowland dry forest in a portion of the floor of Koko Crater, kawelu coastal dry grassland on wind-swept faces of the slopes of Koko Crater and Koko Head, a'ali'i lowland dry shrubland on some of the moderate slopes of Koko Crater, and a mixed, variable native strand community on sandy beaches and coastal cliffs.

Within Koko Crater is the partially developed Koko Crater Botanical Garden. The floor of the crater is covered with dryland plants, including introduced kiawe and a large grove of native wiliwili. A number of indigenous shrubs, herbs, and grasses persist on the steep, exposed crater slopes. Plant collections in the inner crater include climbing cacti, aloes, euphorbias, sansevierias, and palms. Bougainvillea and plumeria cultivars decorate the outer crater. Plans for the garden are primarily to demonstrate xeriscape techniques as part of the Honolulu Botanical Gardens system.

Wildlife. Animal taxa were also typical of dry coastal and lowland settings on Oahu (see appendix B for a list of animal species in this unit).

Several common indigenous seabirds have been observed in the Koko Rift unit, including red-tailed tropic birds (*Phaethon rubicauda rothschildi*), red-footed boobies (*Sula sula rubripes*), and frigate birds (*Fregata minor palmerstoni*). Manana and Kaohikaipu islands are state bird sanctuaries.

Threatened, Endangered, and Sensitive Species.

> ***Rare Plants*** – Two plant species in the Koko Rift unit are officially proposed for federal listing as endangered, *Marsilea villosa* and *Centaurium sebaeoides*. Four others are candidates for federal listing as threatened or endangered–*Spermolepis hawaiiensis*, *Sesbania tomentosa*, *Portulaca villosa*, and *Cyperus trachysanthos*, but these are known from historical records only (1937 or earlier). Four additional plant species are considered rare by the Hawaii Heritage Program–*Lipochaeta lobata*, *Lepidium bidentatum* var. *o-waihiense*, *Schiedea globosa*, and *Kokia lanceolata*. (See appendix A for a list of the species.)

- Koa haole shrubland/grassland
- Kiawe forest/grassland
- Ironwood forest
- Native coastal vegetation on beach and cliff*
- Mangrove/batis wetland
- Maintained lawns and bare ground
- A'ali'i lowland dry shrubland*
- Other alien vegetation types and plantings
- Rare *marsilea villosa* lowland dry herbland*
- Wiliwili dry forest*

* Native vegetation

N

0 2000 4000
Feet

Vegetation
Koko Rift Unit
Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
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Vegetation

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Rare Animals – Two animals on the federal list of endangered species have been reported in the Koko Rift unit–the Hawaiian hoary bat and Hawaiian monk seal. The Green sea turtle, a federally listed threatened species has also been reported. Another species, the Hawaiian owl, is formally listed as endangered by the state of Hawaii on Oahu only. No additional animal species are considered rare by the Hawaii Heritage Program in the Koko Rift unit.

Rare Natural Communities – One rare native natural community, the *Marsilea villosa* lowland dry herbland, was observed in the Koko Rift unit. This community occupies an ephemeral pool that floods infrequently. This pool is the best remaining habitat for this species. The Koko Rift unit also contains examples of four other natural communities that, although not considered rare, are dwindling resources.

Marine Resources. The inshore waters of Hanauma Bay, a world-renowned marine resource, are a Marine Life Conservation District (MLCD) and a state underwater park administered by the state Department of Land and Natural Resources (DLNR). This MLCD has been heavily impacted by humans in the past decade. Protected from wave action, these waters provide an extensive coral reef that is easily accessible to novice swimmers and divers. Hanauma Bay is internationally known as a prime place to view marine life associated with a coral reef. Few places in the world offer such an easily accessible, protected opportunity for viewing marine resources on a coral reef. The other waters off the Koko Rift are also very popular for fishing and tidepooling.

Air Quality. There appear to be no issues related to air quality. The area would be class II under the Clean Air Act if it was added to the national park system. This may affect new pollution sources (such as powerplants) that might be proposed in the vicinity because they would not be able to violate applicable class II increments.

Water Resources. There is virtually no fresh water, except for ephemeral pools, in this unit. Most of the low-lying areas of the unit are in floodplains. The only stream channel is an artificial one in the Queens Beach area, which was built for storm and sewage outflow drainage. The study team has no information on the level of water quality or treatment for the outflow in this drainage. However, there was a sewage leak of 400,000 gallons in 1991.

Cultural Resources

Legendary and documentary history, as well as an array of archeological and historical sites, indicate long-term occupation of the area from Koko Head to Makapuu Point by Hawaiians in both pre- and post-contact times.

The Makapuu Point area, for instance, was once the site of sacred stones, such as the Makapuu and Malai stones, that are significant to the legendary history of Oahu. These sites, as well as fishing shrines, various piles of stones, the Kealakipapa Valley road, and the legendary Pele's canoe stone in the Queens Beach area, retain significance for contemporary members of traditionally associated groups.

In 1930 J. Gilbert McAllister found more than 30 archeological sites on the easternmost portion of Oahu, known historically as the Maunalua ahupua'a (a traditional Hawaiian land division encompassing an area from the mountains to the sea). As noted by McAllister and subsequent archeologists, remnants of heiaus, shrines, house sites and platforms, rock walls, enclosures and shelters, midden areas and rockshelter dwelling sites, burial mounds or cultivation mounds, a stone-paved road, a habitation cave said to be used for refuge in times of war, a canoe house, and petroglyphs indicated permanent habitation of small fishing hamlets scattered along the coastline with crop cultivation inland.

Many of the surface sites, particularly along the coastline and in low-lying areas such as Sandy and Queens beaches, were destroyed by a tsunami in 1946. Other sites were destroyed or buried in the Sandy and Queens beach areas during the 1960s and 1970s by resort and commercial development related activities. Wave actions along the coastline, relic hunting, modern highway development,

and unregulated recreational use of the area have resulted in major adverse impacts to many of the cultural sites and their contextual significance.

There is no historical record of Hawaiian settlements during the early 19th century, although fishing families probably lived along the coast. A native sandalwood tree (*naio*) and perhaps beach sandalwood may have been harvested in the area during the 1820s. Throughout the 1840s and early 1850s, portions of the Wawamalu coastal plain between Koko Crater and Makapuu Head were used at least seasonally for cultivating sweet potatoes to supply whaling ship crews. During the late 1850s and 1860s much of the Wawamalu area was leased for raising cattle and pigs, and cattle ranching became the primary use of the land for nearly a century until after World War II. Because ranching operations were frequently unprofitable, significant portions of Maunalua land were subleased by the 1950s for truck, flower, and chicken farms to serve the expanding population of the Honolulu area.

Several large ranches, using lands leased from the Bishop Estate, dominated the agriculturally based economy of the area in the Koko Rift unit from the 1900s to the early post-World War II era. The extensive Maunalua Ranch, which included a significant portion of the Koko Rift unit, was operated during the 1900-26 period, and the most recent and best-known ranch (Wawamalu Ranch) was established in 1932 by Alan Sanford Davis. Most ranch facilities and buildings, including the remnants of a self-filling saltwater swimming pool on the north side of Kaloko inlet and a wall at the southernmost boundary of the ranch, were devastated by the 1946 tsunami.

Although ranching was the primary use of the land along the easternmost portion of Oahu for nearly a century, other commercial activities were conducted in the area that formed the basic landholdings of the Bernice Pauahi Bishop Estate founded in 1884. One of these business ventures was an apiary near Koko Crater, operated during the early 1920s. Another business was making charcoal from the wood of the kiawe tree that grew plentifully in the area. Beginning in the 1880s the coastal lands from Koko Head to Makapuu Point were leased to fishing entrepreneurs to exploit the area's sea fishery resources.

Just offshore from Makapuu Beach Park are two islets, the larger of the two being known as Rabbit Island. Before 1880 the island, which has some significant archeological sites, was called Manana. During the late 1880s John Cummins, the first owner of the Waimanalo Sugar Plantation in Waimanalo Valley, decided to raise rabbits as a hobby. Not wanting his hares to ruin Waimanalo's crops, he released them on Manana Island, thus giving the island its modern appellation.

The Makapuu lighthouse, listed on the National Register of Historic Places in 1977, was constructed above Makapuu Point in 1909 by the U.S. Light House Service after the liner *Manchuria* ran aground at Waimanalo the previous year. The lighthouse lens, known as a hyper-radiant, was then and still remains the largest lens in the United States–a light that can be seen for more than 20 miles out at sea. The lighthouse was on a strategic promontory overlooking the Kaiwi Channel, which served as the most heavily used shipping lane for Honolulu harbor trans-Pacific traffic. Thus, the light became the most important navigational aid for shipping into and out of Honolulu. In 1927 a radio beacon was installed at the lighthouse, the first such light in Hawaii to be so equipped. Until the lighthouse was automated in 1974, lighthouse keepers lived with their families in three stone houses, since demolished, on Makapuu Head above the light. Makapuu lighthouse continues to be a significant navigational aid for both aircraft and ships.

During World War II, Makapuu Point and Koko Head served as vital links in the defense system for Oahu. Following the Japanese attack on Pearl Harbor on December 7, 1941, early warning radar and fire control stations were established at those locations. The station at Makapuu Point was established to control the battery at Kaneohe Marine Base and the gun derricks retrieved from the battleship *Arizona* that were on the ridge to the west of the study area. A railroad tramway track, now abandoned, was also installed by

the military to serve a radar facility at Koko Crater summit.

Since World War II, Koko Head has been a prime location for telecommunications facilities. The summit has become the site of an aircraft navigational facility, radio receivers, antennas and radio relay stations, and most recently microwave receiver sites and cellular telephone facilities. With its line-of-sight to Diamond Head, the Waianae mountain range, Molokai and Lanai, and Makapuu Point, this area has become an important link in an islandwide and multi- island communications network.

Between 1957 and 1962 the University of Hawaii operated a solar observatory, housed in an abandoned telephone relay station building on the southern end of Makapuu Head. It included an optical telescope, sub-atomic particle detectors, and a radio telescope.

The oldest known road (the Kealakipapa Valley Road) in the Koko Rift unit was a stone-paved road for horse-drawn carts, probably constructed during the reign of Kamehameha III sometime after 1825. Originally extending from the eastern edge of Kalama Valley to Makapuu Point, the road was likely preceded by an ancient foot trail that had been used by the pre-contact inhabitants of the Waimanalo area as a path to the great fishpond of Maunalua (once the largest of its kind on Oahu) that served as an important source of mullet. The lighthouse road right-of-way across the Bishop Estate property in Kealakipapa Valley was granted in 1916. The first paved highway (Kalanianaole Highway) between Koko Head and Makapuu Head and along the scenic eastern coast of Oahu was built during the early 1930s. The section of this highway between the Queens Beach area and Makapuu Head was completed in 1932. Thus, for the first time the area was opened to tourists, sightseers, fishermen, bathers, and surfers on a grand scale. Hanauma Bay, once a favorite resort for Hawaiian royalty because of its beauty, isolation, and excellent fishing, became a popular area for divers, thrownetters, and shore casters.

As part of the Kalanianaole Highway project, the Wawamalu Ranch boundary wall was rebuilt to mark the ranch's southern boundary. The 1946 tsunami destroyed low-lying portions of the highway in the Sandy and Queens beach area but left intact the 1931 Wawamalu Bridge over the stream flowing into the Kaloko inlet. Portions of the highway were realigned inland during 1947-48, and a new bridge was built mauka (inland) of the old Wawamalu Bridge.

In 1928 the Bishop Estate trustees sold the city and county of Honolulu some 1,300 acres in five parcels for the sum of $1.00, the conveyed land to be restricted to "public parks and/or rights of way." This land, which became Koko Head Park, was transferred with the assurance that the city and county would extend and maintain the city water system through Maunalua. By this time the Kalanianaole Highway along the eastern coast of Oahu was in the planning stages, providing highway access to estate lands in the Sandy and Queens beach areas. A potable water supply and adjacent open park space would enhance the prospects for future development of the estate's retained land in that vicinity.

In 1959 the Hawaii Kai Development Corporation, a subsidiary of Kaiser Industries, obtained the development rights for the Bishop Estate property in the Queens Beach vicinity and during the next five years made a number of alterations to the coastal strip in preparation for resort and commercial development. During the early 1970s the Kaiser-Aetna Corporation, a successor to the Hawaii Kai Development Corporation, stockpiled large boulders and dirt from nearby subdivision sites on much of the coastal plain of the Sandy and Queens beach area, and a dirt drainage channel was dredged across the strip to carry storm runoff from the recently completed Hawaii Kai Golf Course and adjacent residential development to the Kaloko inlet.

As the Hawaii Kai development expanded into adjacent areas, additional sources of water and sewage treatment were needed. In 1965 a sewage treatment plant mauka of Sandy Beach was placed in operation. A tunnel for a pipeline through the ridge between Makapuu Point and Sea Life Park was completed in

1973. Nine large water storage tanks (including two at Koko Head) for the Hawaii Kai community are kept full with water from this pipeline as water is used.

Recreational Resources

The Koko Rift unit contains a diversity of recreational resources–some developed and some potential. Hanauma Bay is an outstanding resource with approximately 2.5 million visitors annually. The capacity of the area to handle use without unacceptable levels of resource deterioration has been exceeded in the past. Measures are being implemented to reduce these impacts.

The inner reef protects the sandy beach and provides a safe area for snorkeling and swimming. It is the only area along this stretch of coast that is safe for visitors who are inexperienced at snorkeling, swimming, and surfing. Outside the protective reef, but still within the bay, these and other activities can be quite dangerous. A natural ledge (marine terrace) around the bay forms a walkway and provides access for fishing, but visitors have been swept off the ledge by unexpected waves. Still, if care is taken, the bay provides an outstanding recreational resource.

Sandy Beach is the only other beach currently developed for recreation in this unit. However, swimming, diving, and surfing is only for the experienced due to the exceptionally hazardous rip currents and shore break. Beachcombing, lying on the beach, or playing on the lawns (kite flying appeared quite popular) are the primary activities for the inexperienced; diving, board surfing, bodysurfing, paipo board surfing, and swimming are activities for the experienced. Sandy Beach has a reputation as the most dangerous beach in Hawaii based on the number of deaths that occur primarily due to the shorebreak. There are other equally dangerous beaches; the high visitation at Sandy Beach makes it the most dangerous in shear numbers of accidents. The county considers use of this beach to be near capacity.

Between the developed portion of Sandy Beach and Makapuu Point, the shoreline is undeveloped and mostly in private ownership. (Beaches are public up to the vegetation line.) The area is actively used by island residents and has potential for a variety of recreational uses if placed in public ownership. Net casting, pole fishing, beachcombing, and hiking would be even more popular with improved access and parking and amenities such as comfort stations. Uncontrolled off-road vehicle use in this area is particularly damaging to the natural shoreline vegetation. A campground might be possible, although additional study would be needed to determine if it would be safe during storms because the area is quite low. Camping opportunities are currently lacking but are being considered in the state and county planning efforts.

The state park on Makapuu Head has not been developed (except for some safety rails at two viewpoints). The area contains a number of possibly hazardous military fortifications. In addition to the spectacular views, visitors could learn about the military and lighthouse history, and it is an ideal place to interpret the geology of the Koko Rift. Other interpretive themes might include the biological resources of the area and the human history, including use by native Hawaiians and more recently by the Davis family. Currently there is no public access to the state park because of intervening private lands.

Other recreational resources include extensive playing fields in Koko Head District Park and the Kahauloa Crater rifle range. These serve local residents and would have little benefit for national visitors. Koko Crater also is considered underused, primarily because of problems with access to the interior and exterior portions of the crater, lack of funding for the botanical garden, and conflicting adjacent uses such as the rifle range, golf course, and possibly the stables. The potential for hiking trails and development of the botanical gardens for public use could add to the attractions of the unit.

The Hawaii Job Corps center within the park is considered an inconsistent, nonrecreational

use that is unrelated to the natural character of the park.

On the windward side, Sea Life Park is a tourist attraction and an educational experience (although technically not included in the study unit). Makapuu Beach Park is famous for bodysurfing; board surfing is prohibited. The beach can be extremely hazardous during the winter months, but is generally calm during the summer and suitable for recreational swimming. Parking is limited, and the area is frequently at capacity during the right surf conditions.

Existing Protection

Nearly 80% of this unit is in public ownership and is managed for preservation of open space and recreational values. The remaining lands, mostly in private ownership, are subject to development that could significantly alter the visual quality of the area and eliminate some existing recreational uses. Although the county has the authority, zoning does not appear to offer adequate protection from incompatible development.

More coordinated management than the existing multiple state and county jurisdictions might help address resource management problems. Traffic problems remain unresolved, but options are being explored. Both the state and county are working on master plans to address and hopefully resolve problems in the area.

Threats to Unit Resources

Resource management problems, primarily due to overuse of Hanauma Bay, are being addressed, and actions are being taken to reduce resource impacts to an acceptable level. It will take some time to see if these actions can bring Hanauma Bay's coral reef back to life, restore the algae, and lead to the return of the diverse species that inhabited the bay. Erosion of the hillsides and subsequent sedimentation of Hanauma Bay are a significant concern. A system of lift stations is being installed to take comfort station sewage out of the bay, reducing the chance of pollution from this source. The number of visitors has been reduced through strict controls on parking and tour bus use. The program to provide appropriate fish food will hopefully lead to the return of more species.

Existing residential, commercial, and commercial recreational development (golf courses) is an intrusion in this otherwise natural area. Currently, this development is low rise and is set back from the shoreline, and does not significantly alter the integrity of the unit. High-rise development on the private lands or even low-rise development towards the ocean (*makai*) from the highway would significantly alter the visual and scenic quality of the unit.

It is the Park Service's understanding that the state would consider a land exchange with the private landowner as a means of acquiring additional park land and blocking incompatible development. Unless some means of ensuring compatible development is realized, the integrity of the unit as a scenic resource will be compromised. Purchase of the private lands would be extremely expensive and probably beyond the means of any government agency. Exchange for other state lands appears to be the most feasible means to protect these resources.

Threats to Natural Resources. Alien plants dominate the landscape in most of the unit. Native plant communities are restricted to the harshest locations where their particular characteristics have allowed them so far to outcompete alien species. However, many of these sites are near roads and vulnerable to human disturbance, making it likely that if native plants were damaged or removed, alien species would recover in their place. Without significant efforts at preserving the remaining native communities, alien plants could completely replace native vegetation in the area. According to the Hawaii Heritage Program report (1991a), alien plants have already displaced over 80% of the native landscape in the study unit, and new, aggressive alien taxa are already escaping from the dryland arboretum in Koko Crater. Efforts are reportedly underway to control some of the worst of these.

Plans for development in the area could severely threaten much of the remaining natural communities, especially in the Wawamalu area. Plans for visitor facilities and access at Hanauma Bay, Koko Head, and Makapuu Head should be carefully evaluated for potential to impact native species.

The threat of fire is high in this unit, especially during the dry summer months when dead grasses dominate the landscape. The Hawaiian Heritage Program report suggests that fire has played an important role in the displacement of native vegetation from the area.

Heavy visitor use has already impacted Hanauma Bay's marine resources. The number of fish species commonly observed in Hanauma Bay has decreased dramatically, from 22 species to five species in the last 10 years, according to the site manager for Koko Head Park. There has also been a very marked elimination of algae and live coral in the easily accessible parts of the reef over the past 10 years. The site manager said that the dominant fish in the bay now does not even appear on an interpretive exhibit of the fish in the reef installed about 10 years ago, presumably because it was a very minor species in the bay at that time.

Predators such as mongoose, rats, and feral dogs and cats limit the use of the unit by native animal species.

The low-lying portions of the unit, especially Hanauma Bay, all beach areas, and inland from Sandy and Queens beaches, are susceptible to tsunamis.

At Hanauma Bay, there are the following water quality concerns:

- sedimentation originating from dirt areas around the parking lots and highway
- runoff from the paved parking lot and roads, carrying petroleum residues, rat, mongoose, and domestic animal waste
- runoff from showers at the beach
- leaching of sunscreens and oils from swimmers
- drainage of wastewater from the concessions area
- fecal coliform caused by sewage system failure
- extensive feeding of fish
- trash from beach visitors

Sewage outflow from the Hawaii Kai plant near Sandy Beach is the subject of considerable controversy due to a problem resulting in the release of 400,000 gallons of sewage in 1991.

Although no survey for hazardous materials was conducted for this reconnaissance survey, such a survey would have to be carried out before lands were considered for acquisition of any type (including exchange, donation, etc.) for inclusion in the national park system (*Interior Departmental Manual 602 DM 2*). Areas within the unit with the greatest potential for hazardous materials include Makapuu Point (old military bunkers, etc.), the area between the highway and Makapuu Point (junk cars and dumping), Wawamalu (Queens Beach) area (junk cars and dumping), areas of sewage outflow, the Koko Crater area, the shooting range area, and the Hawaii Kai area.

Trucks carrying hazardous substances are not allowed through the tunnels on the highways going through the Koolau Range, so they must use the Kalanianaole Highway through the study unit to get between Honolulu and Waimanalo, Kailua, and the rest of the windward side of the island. Hazardous substances most likely to be encountered include petroleum products, chemicals, pesticides, herbicides, paints, and solvents.

Currently, the Makapuu and Wawamalu areas are heavily traveled by off-road vehicles, creating significant soil erosion and vegetation impacts. Erosion from new developments upslope from the study unit and runoff from the golf course are also threats to natural resources in the stream and its confluence with the coast.

Threats to Cultural Resources. Cultural resource sites in the Koko Rift Unit have been and are continuing to be adversely impacted by a variety of threats. Many of the surface prehistoric and historic sites in the unit, particularly along the coastline and in low areas such as Sandy and Queens beaches,

were destroyed by a tsunami in 1946. Some of the sites that survived have been destroyed or buried by preparations for resort and commercial development activities in the Sandy and Queens beach areas during the 1960s and 1970s. In the early 1960s the Hawaii Kai Development Corporation conducted bulldozing operations, constructed breakwater and revetment walls, dredged portions of the coastline, and stockpiled the dredge-spoil on land.

During the early 1970s the Kaiser-Aetna Corporation, a successor to the Hawaii Kai Development Corporation, stockpiled large boulders and dirt from nearby subdivision sites on much of the coastal plain in the Queens Beach area. A dirt drainage channel was dredged across the coastal plain to carry storm runoff from the Hawaii Kai Golf Course to the bay bordering Queens Beach. Since then, apart from boulders and junked cars placed to block public vehicular access to the coastal plain, there has been little alteration of the Queens Beach area.

Other threats have resulted in adverse impacts to some of the cultural resources in the Koko Rift unit and their contextual significance. These include wave action along the coastline, relic hunting and looting, unregulated recreational use of the area, lack of adequate site protection by the land management agencies, and highway, park, and beachfront development. Wind and wave action have eroded some cultural sites, such as burial mounds and grounds on Manana Island. Wave action and looters have damaged other sites, such as the Koko Head petroglyphs.

WAIMANALO BAY UNIT

Natural Resources

In the following section, text on geology and landforms relies heavily on Abbott et al. 1981, pg. 140. Most of the information about biotic resources relies on heavily on the Hawaii Heritage Program report (1991a).

Geology/Landforms. Most of this unit is narrow coastal strand consisting of sandy beaches giving way inland to stabilized sand dunes and alluvium covering eroded basalt. Recent calcareous beach deposits exist locally.

The dramatic Pali (cliffs) of the Koolau Mountains forms a backdrop for the unit, but none of the Pali is in this study unit.

Climate. Precipitation at Bellows AFS (which is typical of the entire unit) averages about 40 inches annually. The average daily maximum temperature for the warmest month at Bellows AFS is 84.6$ F., and the temperature almost never dips below 50$ F.

Waimanalo Bay is on the windward side of Oahu, receiving the full force of the common northeast trade winds. (See the climate discussion for the Maunawili Valley unit for a more complete description.)

Vegetation. Native vegetation consists largely of common strand and lowland species. Alien plants, particularly koa haole, kiawe, and ironwood, dominate the unit's landscape. (See appendix A and the Vegetation, Waimanalo Bay Unit map for more information.)

Native natural communities were restricted to the narrow coastal strand, where common, hardy native taxa form a variable set of local dominants along the sandy coastline. This mixed coastal strand is typical of more highly disturbed sandy beaches on Oahu.

Wildlife. Animal species are generally those common to coastal strand and lowland areas on Oahu. A small area of wetland habitat at Bellows AFS is important for water birds. (See appendix B for a list of animal species known to occur in the unit.)

Threatened, Endangered, and Sensitive Species.

> ***Rare Plants*** – There were no rare plants reported in this unit.
>
> ***Rare Animals*** – The small wetland at Bellows AFS provides habitat for four federally listed endangered native waterbirds: the Hawaiian stilt, Hawaiian coot, Hawaiian gallinule, and Hawaiian duck (see appendix B, table B1). The endangered Hawaiian monk seal has

Waimanalo Bay Unit

- Koa haole shrubland/grassland
- Kiawe forest/grassland
- Ironwood forest
- Native coastal vegetation on beach and cliff*
- Mangrove/batis wetland
- Maintained lawns and bare ground

* Native vegetation

N

0 2000 4000
Feet

Vegetation

Waimanalo Bay Unit

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been seen on the beaches near Makapuu. Also, the Hawaiian owl, listed as endangered by the state only on Oahu, has been observed at Bellows AFS.

Rare Natural Communities – There are no rare natural communities reported in the Waimanalo Bay unit.

Marine Resources. The Waimanalo coast is considered a very important fishing and recreation asset on Oahu. Activities related to marine resources include net-throwing, spear fishing, diving, fishing, swimming, surfing, and canoeing; picnicking, camping, and field sports also occur. An extensive coral reef system occurs offshore.

At the southeastern end of the study unit is a research facility of the Oceanic Institute. It is affiliated with Sea Life Park (just outside the unit boundary), which has marine animal exhibits, shows, shops, and a restaurant.

Portuguese Man-o-war are said to be commonly washed ashore when strong onshore winds occur along this coast. They can cause painful stings similar to bee stings, and some people may experience allergic reactions and require medical attention.

Air Quality. There appear to be no issues related to air quality. The area would be class II under the Clean Air Act if it became part of the national park system. This may affect new pollution sources (such as power plants) that might be proposed in the vicinity because they would not be able to violate class II increments applicable to the area.

Water Resources. Most of the unit is susceptible to tsunamis. These low-lying coastal areas have drainage and flooding concerns, and most are in 100-year floodplains.

The only wetland appears to be a 30- to 60-acre area at Bellows AFS. The only perennial stream channel is Waimanalo Stream, which flows from Mt. Olympus through Bellows AFS.

Potable water in the area is from wells and diversions. Groundwater tends to surface at about the 400-foot contour near Waimanalo, rising in elevation as one moves to the northwest along the Koolau Pali.

Cultural Resources

From its earliest period of occupation, the Waimanalo Bay region was an extensive agricultural area, featuring taro farms that used the traditional Hawaiian pondfield cultivation system. Taro was grown in the lowlands, irrigated with water from Waimanalo Stream, as well as on terraced sections that were watered by the small streams and springs flowing out of the Koolau Range. These terraced sections extended for nearly 2 miles in a semicircle at the foot of the mountains around the broad base of the Waimanalo valley. By the 1850s the area's fertile soil provided not only taro but also breadfruit, mountain apple, kukui and coconut trees, sweet potatoes, and sugar cane.

In addition to the agrarian-based economy, several fishing villages dotted the bay's shoreline. Two of the best-known villages in the area were Kaupo and Kukui. On a small peninsula opposite Manana Island and just northwest of Makapuu Beach Park, Kaupo has various archeological sites, including remnants of fishing shrines, a heiau, house platforms, and an old royal road. The village may have been depopulated during the early 1800s and probably was repopulated during the early 1850s when a disastrous smallpox epidemic struck Honolulu and Hawaiians settled temporarily in the Waimanalo Bay region to escape its ravages. The small fishing village of Kukui was further northwest, along the bay in the Kaiona Beach vicinity near Pahonu Pond–a prehistoric walled enclosure where it is said that turtles were kept for the use of Hawaiian chieftains.

The three most significant archeological sites in the Waimanalo Bay unit, however, are in the Bellows Field Archeological Area, which was listed on the National Register of Historic Places in 1973. The Bellows area is one of the earliest archeological sites in the Hawaiian Islands. Because of problems with both the radiocarbon and volcanic glass dates for the area, however, the question of how early it

might be has been left open by field researchers. This area's principal site is on a sand dune at the mouth of Waimanalo Stream on the north bank. The site is an extensive stratified dune deposit containing subsurface early prehistoric cultural deposits. Archeological investigations have revealed significant cultural materials, including midden areas, burials, habitation features, and artifacts.

According to scholars in Hawaiian archeological research, pre-contact sites such as the aforementioned Bellows site, which may date to 600 A.D. or possibly earlier, are extremely rare and provide considerable insight into the lifeways and customs of the earliest Polynesian migrants to the Hawaiian Islands, their adaptation to a pristine island environment, and ecological factors that may have influenced change and/or stability in Hawaiian social organization, subsistence strategies, religious behavior, and variation with other Polynesian societies. Thus, the site is representative of an incipient stage in the development of Hawaiian culture as distinctive from proto-Eastern Polynesian culture.

In addition, some rare artifacts have been documented in the Bellows area that are suggestive of affinities with other early East Polynesian sites outside of Hawaii. These include a coconut grater made from a Conus shell, one- and two-piece fishhooks, a reverse triangular adze, a plano-convex adze, and an imitation porpoise tooth pendant. A curved lei niho palaoa shell, regarded as a chiefly symbol in Hawaiian society, may indicate that some form of hierarchical social organization had developed by the end of the first millennium.

The Bellows archeological area extends over a broad expanse of the shoreward section of Bellows AFS, as well as the entire Waimanalo Bay State Recreation Area. A portion of the archeological area also extends westward across the Kalanianaole Highway and includes lands outside the study area. Other sites besides the aforementioned site have been recognized within the Bellows archeological area, including two stratified sand dune sites in Waimanalo Bay State Recreation Area. One of these sites is a small stratified deposit containing middens and artifacts with evidence of at least two periods of occupation. The other site consists of several shallow human burials associated with a dark-stained deposit. Many isolated burials have been found eroding along the sand beach in the Air Force Station and state recreation areas.

Despite the impacts of wind and sea erosion, recreational and military use, and development associated with Bellows AFS, the known archeological resources of the Bellows archeological area retain fair integrity. Sand borrowing in the area has caused damage to some of the resources.

During the 1850s the Waimanalo area was converted to cattle ranching by *haole* (white person or foreigner) entrepreneurs. In 1876 Chinese farmers were the first to cultivate sugar cane in the Waimanalo Valley, and within two years sugar cane plantations had supplanted ranching operations. The largest sugar cane plantation in the area was the estate of John M. Cummins, a wealthy half-Hawaiian nobleman who organized the Waimanalo Sugar Plantation in 1878. The plantation would dominate the area's agrarian-based economy until its liquidation in 1947. The sugar cane was grown on the lower slopes of the Koolau Range and in the valley lowlands, irrigated with water from the Waimanalo Stream and from Maunawili Valley via an extensive ditch, tunnel, and flume system.

Waimanalo Beach Park area was the site of Waimanalo Landing, which extended into Waimanalo Bay during the late 19th and early 20th centuries. The landing, currently in ruins, was used by interisland steamers and other vessels that visited the different sugar plantations and towns along Oahu's coasts. This landing served both the Waimanalo Sugar Plantation and the seaside community that grew up around it.

In addition to sugar cane other crops such as pineapple were grown in the Waimanalo Valley. As the population of windward Oahu increased, especially during and after World War II as a result of expanding military installations in the vicinity, Japanese truck

farming became an integral part of the local economy.

In 1917 a 1,531.71-acre parcel of land in the Waimanalo Valley was acquired and established as the Waimanalo Military Reservation. This installation was renamed Bellows Field in 1933 after 2d Lieutenant Franklin B. Bellows, who was killed in action during World War I while on a reconnaissance flight near St. Mihiel, France. Bellows Field was a subpost of Wheeler Field until 1941 when it became a separate military post. In 1947 Bellows Field was redesignated Bellows Air Force Base, and in 1958 it became Bellows Air Force Station when its runways were closed, terminating its status as a flying field.

During the 1930s Bellows Field was used as a bombing and gunnery range by aircraft from Luke, Wheeler, and Hickam fields. On August 7, 1941, a training camp was established to provide basic training for newly arrived recruits. During the Japanese attack on December 7, 1941, Bellows Field suffered damage to some 20 planes and facilities.

Bellows Field remained active throughout World War II, then served as home of Hawaii Air National Guard's 199th fighter squadron during 1946-47. The U.S. Marines began using the Bellows runway for air-to-ground training in 1951, and since 1958 personnel from nearby Kaneohe Marine Corps Air Station have used Bellows as a key amphibious, ground, and helicopter training area. In 1960 the U.S. Army built two Nike-Hercules antiaircraft missile sites at Bellows, which were operated by the Hawaii Army National Guard for aerial defense of Hawaii until deactivated in 1970. The communications command transmitter facility, constructed by the U.S. Air Force in 1956-58, is the principal ground-to-air link with aircraft flying to and from Hawaii, and it provides communications for presidential flights and other flights that carry high-level government officials. Since 1947 a portion of Bellows has been developed as a recreation center for active-duty and retired military personnel and civilian employees of the Department of Defense.

Recreational Resources

Waimanalo Beach is the longest white sand beach on the island. The extensive, and generally safe, beaches, picnic areas, and campgrounds make this one of the best beach-oriented recreation areas on the island. Camping is available year-round in several of the parks and on weekends and holidays at Bellows AFS. Some sections of the beach lack adequate access and parking, but most of the facilities are adequate for current use levels. A large stretch of beach in Bellows AFS is open to the public only on weekends and holidays, significantly limiting its public recreation capacity. The military maintains an extensive recreational complex with cabins, tennis, a golf driving range, a clubhouse, a campground, etc. exclusively for military use. The section of beach where public use is permitted is used for military training exercises during the week. Should Bellows become excess to military needs, there is a potential to significantly expand public recreational opportunities such as camping, hiking, water sports, nature study, and other activities on the lands now occupied by military facilities or used for military training and recreation.

Existing Protection

The lands being considered in this unit are in some form of public ownership. (Hawaiian homelands are considered publicly owned for the purposes of this report, although it is recognized that their management is somewhat unique.) State and county lands are managed for recreational use and preservation and appear to be adequately protected from adverse uses. Bellows AFS is managed to protect natural, cultural, and recreational resources to the extent possible considering the training and communication missions of the station.

Adjacent lands are zoned for various uses, and these uses could change over time. The development adjoining the narrow strip of beaches and parks is not a major intrusion. Beachfront homes block access to the beach in two areas, although beach access is available at the ends of residential area streets in Waimanalo Beach.

The state and county, in theory, have adequate powers to ensure compatible development of adjacent lands.

Threats to Unit Resources

Lands adjoining this study unit are primarily agricultural and residential, with small clusters of commercial development. A significant change in the type of development on adjacent lands could alter the visual quality of the area and have a significant impact on traffic and possibly on the use of the beach resources.

If Bellows AFS were to be declared surplus, it is difficult to predict what uses might occur on these lands. The beach frontage would likely remain a recreation area, regardless of the type of development that could occur behind the beach zone. Because Bellows AFS is not on the base closure list, it does not seem likely that there would be any significant change in present land management policies in the near future. However, both the government of Hawaii and the military are reportedly seeking to use some portions of Bellows AFS for housing. Such an action might adversely impact the recreational resources, but it is difficult to analyze without specific proposals.

Threats to Natural Resources. Similar to the Koko Rift unit, alien plants dominate the landscape in the unit and contribute to fire risk. Fire risk seems especially high in the Bellows AFS area, where large expanses of koa haole and dead grasses are present in the summer. However, the firefighting facilities at Bellows AFS probably have kept fire risk at a reasonable level due to early detection and ready access.

New developments at Makapuu Beach Park and Sea Life Park have impacted the native natural setting, as has past development adjacent to most of the study unit.

Waterbirds have probably been significantly limited in their use of the wetland at Bellows due to predators such as mongoose (which were commonly seen during field studies in the unit), rats, and feral dogs and cats.

All of the beaches in this unit are heavily used by visitors. Foot traffic and vehicles (especially at Bellows AFS) on easily erodible cliffs and loosely consolidated soils have impacted vegetation and soils.

Upstream of the study unit is the extensive agricultural area of Waimanalo, fueling concerns of pollution into the drainages by fertilizers and pesticides. Sewage outflow may also impact the unit.

Most of the unit is susceptible to tsunamis, although portions are protected from all but the worst waves. This low-lying coastal area has drainage and flooding concerns, and most of the unit is in the 100-year floodplain.

Although no survey for hazardous materials was conducted for this reconnaissance survey, such a survey would have to be carried out before lands were considered for acquisition of any type for inclusion in the national park system. The entire unit has potential for hazardous materials along roads, adjacent to roads terminating at the ocean, and near storm and sewer outflow sites. Bellows AFS would be especially important to survey for hazardous materials. Hazardous substances most likely to be encountered include petroleum products, chemicals, pesticides, herbicides, paints, and solvents.

Threats to Cultural Resources. Cultural resources in the Waimanalo Bay unit have been impacted adversely both by natural forces and modern development. Sand dunes along the coastline, which have been found to contain extensive archeological sites, are subject to erosion from wind and sea action. The public beachfront areas are subject to heavy recreational use, resulting in the possibility of relic hunting and looting. Road and park development projects throughout the unit have impacted cultural sites and their contextual significance. Archeological sites within the boundaries of Bellows AFS have been adversely impacted by bulldozing activities, sand removal operations, and military and recreational facility construction. The portion of Bellows AFS that is open to the public for beach recreation is subject to numerous impacts resulting from generally unregulated parking and driving activities. Use of portions of the Bellows AFS beach area for

U.S. Marine amphibious training continues to pose hazards to archeological sites.

MAUNAWILI VALLEY UNIT

Natural Resources

The section on geology/landforms relies heavily on Abbott et al. 1981, page 191. For biotic resources in the this unit, this text also borrows heavily from the Hawaii Heritage Program report (1991b), the Corps of Engineers (1980 and 1991), the State of Hawaii Department of Planning and Economic Development (1983), and Drigot and Seto (1982).

Geology/Landforms. The 1,643-foot Olomana Peak is a prominent feature, consisting of remnants of lava flows and breccia that once filled the Koolau caldera. The lava flows comprising the peak are unusually thick, indicating they were probably formed by lava ponding within the Koolau caldera walls. There is free quartz at the base of Olomana, a rare mineral in Hawaii. Also, Abbott et al. considered Olomana Peak unique because of its height, isolation, and sharp peak.

The Oneawa Hills (just outside the study unit) between Kaneohe Bay and Kawainui Marsh are the only remnants of the original Koolau caldera wall left standing (throat breccia marking the site of the main vent of Koolau volcano). Kawainui Marsh is at the center of what once was the great Koolau shield volcano.

The Koolau Range Pali, outside the study unit, has been recognized as nationally significant through designation as a national natural landmark under the following themes: "Mountain Systems", "Works of Volcanism", and "Sculpture of the Land" (NPS 1990). The continuation of the Pali within the study unit is an equally spectacular feature.

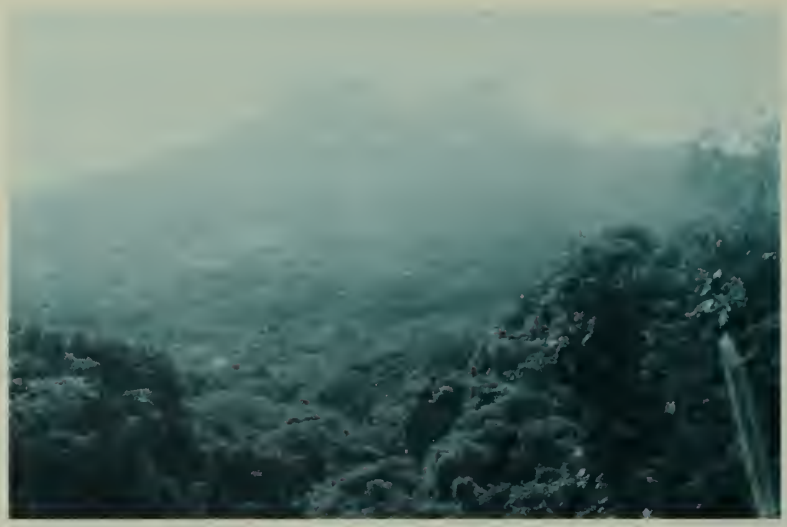
Maunawili Valley is a watershed of about 18 square miles in area, which drains into Kawainui Marsh and Kailua Bay. Kawainui Marsh occupies about 1,000 acres between the 1-foot and the 40-foot elevation contours. It is a lagoonal marsh, formed by a barrier beach that isolated the mouths of two large valleys from Kailua Bay. The town of Kailua is now built on the barrier beach.

Kawainui Marsh is overlain by a thick blanket of roots and peat underneath a floating mat of vegetation. The geologic formation underlying the marsh is unconsolidated calcareous marine sediments, consisting of a very permeable beach sand of grains of worn coral, coralline algae, and shells with appreciable amounts of foraminifera and other marine organisms. An impermeable basaltic plug is deep under the surface.

The ridges surrounding the unit are composed primarily of the Kailua and Koolau volcanic series. Pyroclastic flows of the Honolulu series are scattered throughout Maunawili Valley and make up a significant portion of exposed volcanic rocks. Older alluvium forms an apron at the base of the cliffs and extends far into the valley. Younger alluvium (composed of peat, clay, and silt) is found at the lower part of the stream valleys.

Climate. The climate is dominated by northeast trade winds. Rainfall increases sharply with elevation due to the orographic effect of the Koolau crest (i.e., cooling of warm, moist air as the trade winds push the air up and over the Koolau range). The wet season is usually from October to April. Median annual precipitation varies from about 40 inches along the coast to over 150 inches in the Koolau Mountains. August and September are the warmest months, and January and February are the coolest. Mean annual rainfall over the Maunawili Valley is estimated at 86 inches.

Major storms in Hawaii are caused by cold fronts, low pressure passages, and true tropical storms or hurricanes. Cold fronts occur one to eight times during the winter and cause scattered rainfall and gusty winds. Low pressure storms, called "kona" storms, also occur during the winter months and are characterized by strong and persistent southerly and southwesterly winds and intense rainfall. Hurricanes are infrequent, but tropical storms with winds below hurricane force pass close to the Hawaiian Islands an average of once every three years, generating very strong winds and intense rainfall.



Maunawili Valley Unit

Vegetation. It was discovered very early in the planning process for this report that most of the vegetation in the Maunawili Valley unit was primarily nonnative and heavily influenced by extensive development and agriculture in the unit (Hawaii Heritage Program 1991a and 1991b). Native vegetation is prevalent only above 1,000 feet elevation along the Koolau Pali. The time and cost to update biotic data in this unit was determined to be prohibitive and nonproductive due to the extremely complex mixture of predominately nonnative vegetation, and due to the extensive development of the golf course in the unit that was occurring during the study period. Also, the Hawaii Heritage Program had recently completed a field survey of part of the area above 1,000 feet elevation where native communities dominate (Hawaii Heritage Program 1991b). Therefore, no field survey was conducted in the Maunawili Valley unit, and no vegetation map was produced for this unit. Existing information was used to describe species and communities (see appendix A, table A3).

Most of the wetland plant species in the Kawainui Marsh are not native, although some areas of native sedgeland are present. A marsh, in contrast to a swamp which is characterized by trees and shrubs, is dominated by herbaceous, nonwoody vegetation, in the form of grasses, sedges, and rushes. The vegetation surrounding the marsh is composed almost entirely of alien species (see appendix A for species composition).

The area above 400 feet elevation along the Koolau Pali is part of the Waimanalo Forest Reserve. A stand of about 50 "exceptional trees" as defined by city and county of Honolulu ordinance no. 78-91 exists in the northwest part of Maunawili Valley.

Three major types of vegetation comprise the Kawainui Marsh. The floating mats of vegetation and peat that predominate in the northern part of the marsh are primarily bulrush and sawgrass, interspersed with taro patch fern and cattails. The floating mats also host a variety of nonwetland plants that root in the substrate. The California grass bog meadow is in the southeastern and southwestern portions of the marsh. No peat occurs in this community, so it grows on mineral soil and detritus. California grass is interspersed with honohono grass. In open water areas within the marsh and its periphery, water hyacinth and water lettuce dominate (herbicides and mechanical clearing have been used to control these weeds). A shrub and tree community occurs along the slopes above the marsh and on the outer edges of the grass and bulrush community, consisting primarily of koa haole, guava, Chinese banyan, and monkey pod (see appendix A for list of plant species).

Wildlife. Animal species in this unit are listed in appendix B. Kawainui Marsh is important habitat for waterbirds. The quality of the habitat is related to water quality and the openness of vegetation in the marsh. Several of the waterbirds in the area require a combination of open water and vegetated areas.

The open waterways of the marsh are dominated by alien warm water species such as tilapia and mosquitofish. The lower Maunawili and Kahanaiki streams are dominated by alien fish species: Chinese catfish, Cuban limia, swordtails, smallmouth bass, and koi. Louisiana crayfish, as well as frogs, toads, and snails are also found. Native diadromous species such as shrimp and goby have been recorded in Oneawa Channel, along with species such as mullet, milkfish, silversides, and barracuda, which are indicative of brackish conditions.

Threatened, Endangered, and Sensitive Species.

> ***Rare Plants*** – Eighteen rare plants have been reported along the Koolau summit ridge high above Maunawili Valley. However, no rare plant taxa have been reported for other locations in the study unit, including the lower Maunawili Valley and Kawainui Marsh. Ten of the 18 rare species are candidates for federal listing, but none have been officially listed or proposed for listing (see appendix A, table A1).
>
> ***Rare Animals*** – Eighteen rare animals have been reported in this unit. Fourteen of those are federally listed

endangered species, including the Hawksbill sea turtle, Hawaiian duck, Hawaiian coot, Hawaiian gallinule, Hawaiian stilt, Oahu creeper, Hawaiian hoary bat, Hawaiian monk seal, and six different species of Oahu tree snail. Of the other four rare species in the unit, the Hawaiian owl is listed as endangered by the state on Oahu only, and the 'I'iwi is listed as endangered by the state on Oahu, Molokai, and Lanai only; the Oahu megalagrion damselfly is a candidate for federal listing, and a moth (*Hedylepta monogramma*) is considered critically imperilled globally by the Hawaii Heritage Program (see appendix B, table B1).

Five of the 14 federally listed endangered animals are waterbirds, which are clustered mainly in and around the Kawainui Marsh area. Because Kawainui Marsh is the largest remaining freshwater wetland in the state, even in its impacted condition it must be considered a very important resource for the recovery of these endangered species.

The Hawksbill sea turtle and Hawaiian monk seal have been reported only in the lower marsh area of the unit. The other rare animals are found along the Koolau summit ridge above Maunawili Valley, with the exception of historic reports of endangered land snails in Maunawili Valley. Only two of the six species of endangered Oahu tree snail have been reported in this unit since 1953, but the Hawaii Heritage Program believes that there is hope that some or all of them may still be extant.

Rare Natural Communities – Although there are several native natural communities in the unit, only the Hawaiian continuous perennial stream community is considered rare by the Hawaii Heritage Program. This community runs through the Maunawili Valley and Kawainui Marsh, and on to the sea through the Oneawa Channel. The Hawaii Heritage Program report states that the quality of this community in the unit is compromised by channel modification, eutrophication from adjacent sewage treatment and agricultural effluent, and development within the Maunawili Valley watershed. Even in its impacted condition, it is an example of a stream community restricted to the Hawaiian Islands, and it is one of less than 400 examples of such stream communities worldwide.

Marine Resources. There are no marine resources in this unit.

Air Quality. There appear to be no issues related to air quality. The area would be class II under the Clean Air Act if it were included in the national park system. This may affect new pollution sources (such as power plants) that might be proposed in the vicinity because they would not be able to violate class II increments applicable to the area.

Water Resources. Stream channels feed almost 7 million gallons of water per day into Kawainui Marsh, making it the largest remaining freshwater wetland in the Hawaiian Islands. Several springs and tributaries in the unit empty into two main perennial streams–Maunawili and Kahanaiki.

The Oneawa Channel (also called the Kawainui Canal) discharges into the northern end of Kailua Bay. Tidal influence extends 9,000 feet up the 9,470-foot-long Oneawa Channel, which means that salt water and tidal influence does not normally extend into Kawainui Marsh. In the 1950s, the normal drainage of the marsh along Kaelepulu Stream to Kaelepulu Pond and then into south Kailua Bay was cut off, and the direction of the outflow was established to the north through the Oneawa Channel as it is today.

Water quality in Kawainui Marsh is dependent on factors including stormwater runoff, nutrient inputs, growth and decay of vegetation, solar heating, water percolation from springs, and rainfall. According to the Corps of Engineers environmental impact statement (1980, p.6), water quality analyses show little change where the two major streams–Maunawili and Kahanaiki–enter the marsh. As the water moves through the vegetation, pH tends to become more acidic, becoming basic again as the water comes in

contact with the brackish water of Oneawa Channel. In the southern end of the emergency ditch (the ditch on the upstream side of the levee separating Kailua from the marsh), elevated levels of ammonia, orthophosphate, and organic forms of nitrogen and phosphorus have been measured. Grazing by cattle and horses appears to contribute to elevated fecal coliform counts.

Water has been diverted from the Maunawili Valley and Kawainui Marsh for irrigation in Waimanalo and Kailua since the late 1800s. Five water development tunnels were driven in the upper Maunawili Valley between 1900 and 1924 to supplement flow into the irrigation ditch system.

Cultural Resources

Both Kawainui Marsh and Maunawili Valley are important as prehistoric and historic sites of Hawaiian occupation as evidenced by legends, historic documentation, archeological studies, and extant remains of extensive wetland and terraced hillslope dryland agricultural systems, ceremonial and burial sites, and habitation areas. The marsh and valley contain a variety of sites that are important to the legendary history of Oahu and continue to retain significance for contemporary members of traditionally associated groups. The Kawainui fishpond, for instance, was the site of the famous mythological fish-attracting tree *makalei*, the home of *Hau-wahine*, and a *mo'o* or guardian spirit ensuring the area's continued prosperity, and the location of *lepo 'ai 'ia*, an edible mud guaranteeing the region's agricultural productivity. Other sites in the marsh and valley having significance for the legendary and traditional history of Oahu include Olomana Peak, fertility sites, sacred stones, heiaus, and native trails such as the Nu'uanu, Olomana, Na Ala Hele, Maunawili, and Kiolea. In 1979 the marsh was determined to be eligible for listing on the National Register of Historic Places–based on the early occupation of the marsh vicinity (possibly as early as the 6th century A.D.), its association with important traditional/prehistoric/historic events and personalities (such as Kamehameha I), and its role as a major subsistence component of a larger cultural socioeconomic unit or traditional Hawaiian land division (known as the Kailua ahupua'a).

Geological and archeological studies indicate that the Kawainui Marsh was once open to the sea. Thus, when voyagers first came to the Kailua region of Oahu (possibly as early as the 6th century A.D.) the slopes of Maunawili, Kapa'a, Pokakupu, and Olomana were the shoreline areas where these peoples would have settled. By the mid 7th century the Kawainui Marsh basin had evolved into a lagoon. Between that date and 1300 a floating and fringing vegetation mat composed of salt-tolerant vegetal species began to build within the present marsh basin. The slopes adjacent to the marsh were occupied, and indigenous Hawaiian economic endeavors included broad-spectrum collecting, arboriculture, and swidden and/or permanent dryfield cultivation. Wet taro patches were cultivated along upper valley lands adjacent to permanent streams such as Maunawili and Kahanaiki.

From the early 14th century to the mid 19th century, taro cultivation was the principal agricultural activity in the marsh wetland and adjacent valleys. The pre-contact agricultural system probably was a subsistence terraced pondfield taro cultivation type, having an accompanying drainage system with a fishpond at the makai (toward the sea) end to receive the nutrient-rich surplus waters from the pondfields. The taro fields within the marsh appear to be one of the few, if not the only, lowland taro field complex on Oahu that may have used a drainage technology in contrast to an irrigation technology. The Kailua region had one of the most extensive terraced pondfield agricultural complexes on Oahu, and together the elements of the system made an overall energy-efficient system for exploiting the natural resources of the Hawaiian valley environment.

The freshwater Kawainui fishpond, separated from the Kaelepulu fishpond by a low stone wall, may have been in use as early as the late 17th century. By the late 1820s, however, the main section of the wetland was dominated by emergent bulrushes, resulting

from a decline of fishpond use and lack of periodic maintenance.

In addition to taro agriculture, dryland crops in the vicinity of the marsh basin by the 1850s included sweet potatoes, gourds, wauke, ʻawa, bananas, arrowroot, sugarcane, and tobacco. Trees included coconut, hala, kukui, orange, and lemon. Dryland agriculture and small clusters of houses occupied the rise between the Maunawili and Kahanaiki streams where they entered the marsh as well as on the surrounding slopes. Native upland forests of Maunawili may have been used as fuel for the early steamships that plied Oahu's coastal waters and stopped at Waimanalo Bay.

From the time of Kamehameha I, the Kawainui Marsh and Maunawili Valley were favorite resorts of Hawaiian royalty. In 1795 Kamehameha conquered the Oahu warriors at Nuuanu Pali overlooking the Maunawili Valley. This victory marked the traditional ascension of Kamehameha to rule over the Hawaiian Island kingdom. After consolidating his power and establishing the Hawaiian monarchy, he helped the residents of the Maunawili and Waimanalo valleys clear the Kawainui Marsh. Hawaiian royalty continued to visit the marsh and valley until the late 19th century. Maunawili Valley was a favorite retreat of Hawaii's last reigning monarch, Queen Liliokalani, and the source of her inspiration when she composed the well-known Hawaiian song "Aloha Oe."

Historical records indicate that the population of the Kailua ahupuaʻa was approximately 610 persons in 1850, a decrease from an 1835-36 missionary census of 762 persons. Nearly 180 persons lived in the Maunawili region, one of four population clusters in the ahupuaʻa.

After the mid 19th century, commercial agriculture took over Hawaiian subsistence activities in the Kawainui Marsh and Maunawili Valley areas. By 1860 rice cultivation became a major agricultural activity in the marsh with the application of Chinese rice-growing methods to former taro fields in the wet lowlands. Rice-growing remained primarily in the hands of the Chinese as long as it remained profitable. After rice profits peaked in 1875 they decreased rapidly, largely because of the preference by local consumers for Japanese-grown rice. Thereafter, rice cultivation became a Japanese enterprise, with the Chinese retaining control of the mills and marketing.

During the 1870s, sugarcane and pineapples became the principal crops in the Maunawili and Waimanalo valleys. The Waimanalo Sugar Plantation was established in 1878, and the need for irrigation water increased rapidly. Thus, water resources were removed from the Kailua ahupuaʻa to irrigate the Waimanalo plantation fields via the Maunawili ditch system, the first section of which was completed in 1878. Springs in the upper Maunawili Valley were tapped, and the Maunawili Stream was diverted into the ditch system. By the 1920s the ditch system consisted of more than 16,000 feet of lined and unlined ditches, tunnels, and elevated wooden flumes, remnants of which still remain. Water was also pumped out of the marsh for Waimanalo irrigation purposes.

By the late 19th century the Kawainui Marsh and Maunawili Valley were used as extensive cattle ranching operations. The Maunawili Ranch extended from the Maunawili Valley to the coastal area now known as Lanikai. In 1890 the Kaneohe Ranch began grazing activities in the marsh. Rice cultivation declined steadily until the mid 1940s when the fields were abandoned, and the Waimanalo Sugar Plantation was liquidated in 1947. Cattle grazing was expanded in Kawainui Marsh until 1965 when 600 acres of grazing land were purchased by the city and county of Honolulu as floodwater storage for the Kawainui flood control project to handle the periodic flooding. The Kapaʻa quarry was established at the west edge of the marsh in 1951, and after rock quarrying activities declined, the city and county of Honolulu began sanitary landfill operations at the site. In 1976 a private corporation installed a sand manufacturing plant in the quarry vicinity.

The town of Kailua, adjacent to the marsh, was a post-World War II community, having grown from a semirural area of 7,740 residents in 1950 to a suburban community of 25,622 residents in 1960 (an increase of 231 percent). Growth slowed in the next decade to 32 percent, with a 1970 census population of 33,783. Outside downtown

Kailua itself, residential growth since the mid 1960s has focused at Enchanted Lake (or Kaelepulu fishpond), Pohakupu on the southeastern edge of the marsh, and the Maunawili Park and Maunawili Estates subdivisions in Maunawili Valley. In 1987 nearly 1,200 acres of the former Maunawili Ranch, which had been sold to the Castle Estate in 1943 and leased to the military during World War II for use as a training area and prisoner-of-war camp, were obtained by Ham Kuk Chun, a Korean living in Japan who is developing two world-class golf courses on the slopes of Olomana Peak.

Two substantial Hawaiian heiau, Ulu Po and Pahukini, are adjacent to Kawainui Marsh. Both heiau were listed on the National Register of Historic Places in 1972, and the former has been designated a state historical monument. The heiau are monumental examples of the engineering knowledge, fine stone craftsmanship, and religious dedication of pre-contact Hawaiians in constructing their temples of worship and ceremony. The Pahukini heiau commands a sweeping view of the marsh from its location on the slopes of the Kapa'a quarry and is considered to be of the sacrificial class. Archeological studies have concluded that the agricultural site cluster below the Ulu Po heiau on the southeast edge of the marsh contains some of the earliest known cultural deposits on the Hawaiian Islands.

The national register boundary shown for Kawainui Marsh was arbitrarily established in 1979, using aerial photographs rather than thorough standard scientific pedestrian surveys and testing. As a result, the extent of modern disturbance as well as the extent of archeological sites in the marsh remains unknown. The sites that have been identified within the marsh and on its adjacent slopes include (1) remnants of retaining walls, springs, and house platforms; (2) remains of an old road bed; (3) several agricultural complexes within rectangular walled fields in which excavations have revealed large taro root stains and taro pollen, dryland agricultural terraces, mounds, small c-shaped structures, earthen platforms, and stone-lined channels; (4) several occupation sites consisting of cultural layers with shell middens, basalt flakes and adzes and flake tools, and surface artifacts; (5) remnants of agricultural or fishpond walls; (6) adze preform fragments, and (7) ruins of several historic structures.

The Maunawili Valley, like the Kawainui Marsh, has a number of important archeological sites that indicate early and at least periodic occupation and agricultural use of the area during prehistoric times. Along the base of cliffs in the Maunawili and Omao stream drainages and their tributaries are numerous prehistoric agricultural complexes consisting of terraces (that may be habitation sites), mounds (that may be burial sites), rock concentrations, spring construction, irrigated taro terrace and pondfield wall remnants, house sites, and basalt and cobble-lined earthen terraces. On the slopes of the Olomana Stream drainage where the golf course development is underway, the principal archeological sites consist of large taro agricultural complexes, a heiau, charcoal pit sites, and some post-European-contact house sites. Other sites in the valley include the ruins of at least one other prehistoric heiau near Nuuanu Pali, a stone-lined canal, historic house sites and terraces, a historic agricultural complex probably related to modern truck farming, and various remains of the tunnels, ditch, and flume associated with the Maunawili ditch system.

Recreational Resources

Recreational opportunities are limited in this unit. Maunawili Neighborhood Park, with tennis and basketball courts, soccer fields, and a park area, serves local residents. Walking along the levee at the north end of the marsh and flying model airplanes in an area on the west side of the marsh are the most common activities around the marsh. Hiking trails in Maunawili Valley are available, although access is limited. A trail system is developing that could potentially link several trails within the valley with trails to areas outside the valley. The Olomana Peak trail starts near the Olomana subdivision on one side, and the pump house on the Maunawili Valley side. Both climb to the Pines (a stand of ironwood trees on Olomana Ridge) where they join to ascend to the peaks. According to Victoria Creed, the hike takes about

one and one-half to three hours each way and is medium to difficult with two rope-assisted climbs. Some have stated that the trail is unsafe for general public use and that the lack of trailhead parking is a problem. Occasionally, support groups like the Kawai Nui Heritage Foundation are permitted access across private lands to some of the unit's cultural and natural features where they conduct special programs.

Existing Protection

This unit and adjacent lands are zoned for a wide variety of uses, including residential, industrial, commercial, and preservation. Maunawili Valley presents many problems for the protection of natural and cultural resources, with so much of the land in private ownership. The controversial golf course development has led some to believe that neither the county nor the state can adequately protect lands from adverse development. Golf courses are permitted in preservation zones, even though the landforms might be drastically altered.

Numerous cultural sites have been severely altered or destroyed due to changing land uses and development. A large, two-terrace heiau was destroyed with the development of Maunawili Estates.

The 1991 state legislature voted to acquire lands on the northeast flanks of Olomana Peak to preserve this area as open space. Doubt has been expressed that the funds will prove adequate to acquire sufficient land.

Although existing protection of resources in Maunawili Valley appears inadequate, there is little the National Park Service could do short of a massive, expensive, land acquisition program.

The county and the state have acquired lands in and around Kawainui Marsh, and these eventually will be managed by the state to preserve the resources of the marsh. The state Kawainui Marsh resource management plan recognizes, to a limited extent, the effect development in the valley has on the water quality of the marsh, but the plan does not address cultural resources outside of the marsh study area.

Currently, the natural and cultural resources of this unit are protected to varying degrees. As the state acquires additional properties and implements the resource management plan, the level of protection will be significantly increased for the marsh and adjoining areas. It must be left to speculation that the state and county can adequately protect resources in Maunawili Valley through their existing authorities.

Threats to Unit Resources

The limited recreational resources of this unit are threatened by continuing development in the Maunawili Valley, which has reduced or eliminated access to trails and cultural sites.

Threats to Natural Resources. According to the Hawaii Heritage Program report (1991a), much of the lower Maunawili Valley and Kawainui Marsh is dominated by alien vegetation. The vegetation surrounding the marsh is composed almost entirely of alien taxa. The report suggests that it is probably too late to attempt to control alien plants in this unit, except in core native-dominated areas. Native vegetation does begin to dominate at 1,000 feet elevation and is extensive in the higher elevations of this unit.

Impacts from development on the lower elevations in this unit have been extensive. Junk cars, landfills, sewage effluent, channel modification, erosion, agricultural uses, and the new golf course are the major developments that have shaped the unit. The Kawainui Marsh was an extensive complex of fishponds and taro fields, then rice fields. The Maunawili Valley has supported plantations of rubber trees, coffee, and bananas, with Kailua supporting coconut groves and ironwood. Development influences are pervasive and extensive when one considers the natural environment of all but the higher elevations in this unit.

The risk of fire is relatively low in this unit (compared to the other units) due to moist habitat, increased rainfall, and streams and marsh.

An important limiting factor for waterbirds is the presence of predators such as mongoose,

rats, and feral cats and dogs, which are common in the unit. Horses and cattle graze in the upper parts of Kawainui Marsh.

The waterbird habitat in the Kawainui Marsh is related to water quality and the openness of vegetation in the marsh. Several waterbirds in the area require a combination of open water and vegetated areas. Most of the marsh is now filled with vegetation and sediments, which must be physically removed to maintain the waterbird habitat.

A carnivorous snail (*Euglandina rosea*) introduced to the island has been found in Maunawili Valley moving up toward the Koolau summit ridge, where it is considered to be heavily impacting the endangered land snails in the area.

Accelerated plant growth in the marsh is due to input of nitrogen and phosphorus from sewage treatment plants that began discharging into Maunawili Stream in recent decades. Two other sewage plants have indirectly discharged into the marsh. Both Maunawili and Kahanaiki streams have brought increased sediments into the marsh due to upstream development, especially on slopes. The middle reaches of the two streams have been channelized.

Loss of water through evaporation and transpiration during dry weather nearly balances the volume of water flowing into the marsh from principal contributing sources (streams and sewage treatment plants). This condition results in low flow through the marsh, contributes to high retention rates of inorganic nutrients, and is the cause of occasional saltwater intrusion into the lower end of the marsh during high tide. More than 95% of the nitrogen and phosphorus that flows into the marsh is retained during dry weather; the percentage is lower during wet weather.

Although no survey for hazardous materials was conducted for this reconnaissance survey, such a survey would have to be carried out before lands were considered for acquisition of any type for inclusion in the national park system. The lower elevations in the unit along roads and watercourses have the greatest potential for hazardous substances, including petroleum products, chemicals, pesticides, herbicides, paints, and solvents.

Threats to Cultural Resources. Cultural sites in the Kawainui Marsh and Maunawili Valley face various threats that have and are continuing to diminish the integrity and contextual significance of the sites. Many of the prehistoric sites within and on the adjacent slopes of the marsh have been adversely impacted by grading and bulldozing associated with flood control projects; periodic flooding of the area; use of the vicinity for farming, ranching, drainage, sewage disposal, and wetlands during the past century; and highway, residential, landfill, and quarry development.

Many of the cultural sites in the Maunawili Valley, particularly in the lowlands and on the lower and more accessible slopes and stream drainages, have been adversely impacted by residential and road development; modern recreational activities such as hunting, hiking, camping, and marijuana growing; and erosion from overflows of the Maunawili ditch system. Some sites on the higher and less accessible slopes of the valley have retained their integrity and hence cultural significance; these merit further protection by state and local agencies. Many of the sites on the slopes of Olomana Peak, where the golf course is being constructed, have been impacted to a high degree, although a few representative cultural sites and features apparently will be preserved.

SOCIOECONOMIC ENVIRONMENT

Existing Landownership and Use

The study area boundaries are not precise, and data supplied by the city and county of Honolulu differs in some instances from the data obtained by the NPS Division of Lands. There are several instances where the city and county indicates ownership of lands shown as state-owned on the tax records. In most instances the tax records indicate these lands are leased to the city-county. Similarly some additional lands along Waimanalo Bay are said to be Hawaiian homelands but are not indicated as such on the tax records. It was beyond the scope of this survey to resolve these differences.

Information for the following table was supplied by the NPS Division of Land Resources from tax maps and records.

TABLE 1: LANDOWNERSHIP

LANDOWNERSHIP Based on Tax Maps and Records	APPROXIMATE ACREAGE KA IWI SHORELINE	WAIMANALO BAY BELLOWS AFS	MAUNAWILI VALLEY KAWAINUI MARSH[1]	TOTAL	PERCENT
Federal Government	0.11	1,493.17		1,493.28	29.70
State of Hawaii[2]	240.12	126.43	369.90	736.45	14
City and County of Honolulu	1,259.95	0.12	750.71	2,010.78	40
Utility/Communication	0.98			0.98	< 1
Hawaiian Homelands		20.80		20.80	< 1
Private	441.22	0.00	324.59	765.81	15
TOTAL	1,942.38	1,640.52	1,445.20	5,028.10	100

[1] Improved lands (4,000 acres) and Forest Reserve included in the study area are not indicated in this table.
[2] Includes beach parks owned by state and operated by city and county.

Koko Rift Unit. Most of the land in this unit is owned by the city and county of Honolulu; the state and federal government hold small interests. Private lands account for about 23% of the study unit. Nearly 75% of the land is zoned for preservation and used for recreation (see Landownership, Koko Rift Unit map).

Development of the remaining private lands is uncertain. Residential development is continuing, mostly in the valleys on the edges of the study unit. Long-term prospects are for resort development in the Queens Beach area. Recent development plans for lands across the highway from Sandy Beach have been opposed and led to court challenges. High rise structures, in particular, are opposed by those desiring to retain the scenic quality of the area. All of the undeveloped private lands are under one ownership. High-rise development anywhere on the private lands or even low-rise development makai (toward the sea) from the highway would significantly alter the visual and scenic quality of the unit.

Waimanalo Bay Unit. All of the lands in this unit are in public ownership (see Landownership, Waimanalo Bay Unit map). It is our understanding that some additional beaches are Hawaiian homelands and are leased to the city and county of Honolulu for public use and are, therefore, included as a part of the study unit. The largest tract of land, Bellows AFS, has various uses classified primarily as "services" and "unused land" by the county. However, according to the military, very little of the land is unused, and a significant portion is primarily recreational use.

The major facility at Bellows AFS is a large antenna "farm" occupying the central area of the base. This is a controlled area with limited access. A former Nike site and adjacent beaches are used as a Marine training area, as are the steep hills on the edge of the property. A portion of the same

N

0 2000 4000
Feet

Landownership

Koko Rift Unit

Reconnaissance Survey

Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service

DSC/Dec '91/20,005A

State

State

Federal

State

Private

Private

City & County
of Honolulu

State

State

N

0 2000 4000
Feet

Landownership

Koko Rift Unit

Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service
DSC/Dec '91/20,005A

N

0 2000 4000
Feet

Landownership

Waimanalo Bay Unit

Reconnaissance Survey

Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service
DSC/Dec '91/20,004A

United States
Air Force

State

State
(with portions leased to the
City and County of Honolulu)

State

Hawaiian Homelands

N

0 2000 4000
Feet

Landownership
Waimanalo Bay Unit
Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service
DSC/Dec '91/20,004A

beach used as a Marine training area is open for public use on weekends and holidays and is managed for recreation by the city and county of Honolulu. Other portions of the property are used by the Hawaii National Guard and Civil Air Patrol. The military recreation complex and administrative facilities actually occupy a relatively small percentage of the property.

Waimanalo Bay State Recreation Area (74.76 acres), formerly a part of Bellows AFS, was transferred to the state in 1966. The park provides camping and various beach activities. In 1991 the legislature directed the state to transfer the property to the city and county of Honolulu, apparently without funds for maintenance and operation.

The remaining lands within this study unit are a mixture of Hawaiian homelands and some county beach property (indicated in tax records as owned by the state and leased to the county). Adjoining the study unit are several residential and agricultural communities and the small towns of Waimanalo and Waimanalo Beach. A short stretch of residences interrupts the public shoreline between Kaiona and Kaupo beaches.

Maunawili Valley Unit. The limits of this study unit are somewhat arbitrary. Basically, the unit includes the watershed for Kawainui Marsh plus some lands on the flanks of Olomana Peak. Additional study would be required to refine the lands that might be included in a park proposal. Acreages supplied by the NPS Lands Division include undeveloped private lands in addition to public lands; developed private lands are not included. NPS acreages for private lands include the lands needed to complete protection of the marsh and some of the lands on the slopes of Olomana Peak above the 400-foot elevation. Additional lands might be needed for administrative and visitor use sites if the unit were to be administered by the National Park Service.

Maunawili Valley is extensively developed, with approximately 97% of the land (other than forest reserve) in private ownership (see Landownership, Maunawili Valley Unit map). Some of this land is undeveloped, but future development appears inevitable. Most of the land is either residential or golf course; the few remaining farms are disappearing as development continues. The state and county lands in the valley are isolated and difficult to reach. The 1991 legislature authorized funds to acquire lands on the slopes of Olomana Peak. At the time of this survey, specific parcels had not been selected. Presumably these acquisitions would be adjacent to existing state or county lands.

Kawainui Marsh is mostly in public ownership, depending on where the line around the marsh is drawn. The county is responsible for management of the area, with the major emphasis on levee maintenance for flood control. Recreational use is limited. A portion of the marsh area is leased for grazing, and the Kawai Nui Heritage Foundation has leased an area of the marsh adjacent to the Pali Highway for development as an education center.

Solutions to the flood control problem are being studied and, when resolved, the county lands are to be turned over to the state for management as a natural area. The state has been acquiring some lands for use in future implementation of plans to protect the wetland.

Adjoining the marsh on the north and east are extensive residential developments. The south side is bordered by the Pali Highway and the Maunawili development. The west side, bounded by Quarry Road, has been used extensively as a trash dump (particularly for abandoned cars); a major cleanup has vastly improved the appearance of the area. A drive-in theater at the intersection of the Pali Highway and Quarry Road is visible for long distances. This property is slated to become a golf driving range, but it has also been identified as a possible site for a visitor center because of the panoramic views of the marsh and valley. A large quarry and sanitary landfill are quite prominent in one of the drainages leading into the marsh. These properties were not included in the study area, but could be critical to preserving the wetland.

Socioeconomic Concerns

Of the three units in the study area, the Koko Rift unit has the most direct impact on the island economy. Hanauma Bay is a significant tourist attraction and supports over 20 operators with permits for underwater tours plus others providing package tours and/or transportation. There is also a thriving taxi business ferrying tourists from a nearby shopping center to the park as a means of getting around the recently implemented parking and tour bus restrictions.

Sightseeing on tour buses and trips to Sea Life Park are less directly related to the study area resources, although the blowhole and Sandy Beach are promoted as features of these island tours.

The beaches along Waimanalo Bay are primarily used by locals. Makapuu Beach would be an exception when the waves are good for body surfing. There is little direct economic benefit to the local communities from this unit except for Sea Life Park.

The resources of Maunawili Valley and Kawainui Marsh currently offer no direct economic benefit. (The golf course under development in Maunawili Valley will bring in revenues, but it is not considered an economic benefit in terms of this survey.)

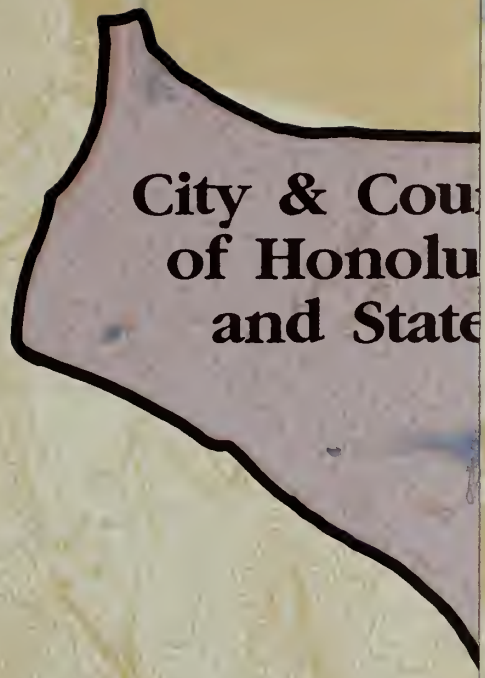
Local residents have expressed a number of concerns about this NPS survey and other studies by the state and county. A public meeting in March 1991 permitted a sampling of feelings, but those are not being considered as representing a consensus. Some see the National Park Service as a possible savior of the resources, while others see only negative aspects if the area were to be designated nationally significant.

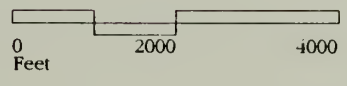
The Koko Head Regional Park is an important recreational resource for island residents. However, some feel they are already being denied access to portions of the area due to the invasion of tourists. This is particularly true of Hanauma Bay and the stretch of highway between Hanauma Bay and Sandy Beach. Some local residents feel that Sandy Beach is becoming overrun with tourists.

Residents of Hawaii Kai have objected to alternatives to solve traffic problems along the highway by routing traffic through the Hawaii Kai neighborhood and turning the coastal highway into a one-way road between Hanauma Bay and Sandy Beach or some point beyond.

Concern was also expressed that any form of national park designation would draw more tourists and deprive locals of their traditional recreation areas. This feeling seemed particularly strong regarding Sandy Beach and the beaches and parks along Waimanalo Bay.

In contrast, some people felt that the National Park Service could stop development in some areas, that the parks would be better managed and maintained, and interpretation would be significantly improved.





Landownership

Maunawili Valley Unit

Reconnaissance Survey

Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service
DSC/Dec '91/20,003A

City & County of Honolulu and State

Private

Private

State

State

Private

State Forest Reserve

Undefined Boundary

N

0 2000 4000
Feet

Landownership
Maunawili Valley Unit
Reconnaissance Survey
Ka Iwi Shoreline Study

United States Department of the Interior
National Park Service
DSC/Dec '91/20,003A

Significance

Before an area can be proposed for inclusion in the national park system it is evaluated for its significance. Significance of a proposed area relates to established themes for natural history, prehistory, and history that should be represented in the national park system. (This thematic classification is in the *History and Prehistory in the National Park System and the National Historic Landmarks Program* (NPS 1987) and in the *Natural History in the National Park System and on the National Register of Natural Landmarks* (NPS 1990). These themes are not applicable to recreational resources, which are evaluated individually.

A natural, cultural, or recreational resource will be considered nationally significant only if it meets ALL of the following criteria:

It is an outstanding example of a particular type of resource.

It possesses exceptional value or quality in illustrating or interpreting the natural or cultural themes of our nation's heritage.

It offers superlative opportunities for recreation, public use and enjoyment or for scientific study.

It retains a high degree of integrity as a true, accurate, and relatively unspoiled example of a resource.

The criteria are somewhat different for recreational resources because there are no applicable themes. The following evaluation

considers and summarizes the natural, cultural, and recreation values of each study unit separately.

KOKO RIFT UNIT

Natural Resource Significance

The description of geologic features below relies heavily on Abbott et al. (1981, pg. 140) and a letter from the Office of Council Services dated April 18, 1989. The description of rare plants and animals and the rare natural communities below relies heavily on the Hawaii Heritage Program report (1991a).

Geology/Landforms. Koko Rift is a prominent row of volcanic vents of the Honolulu volcanic series. According to Abbott et al., the study unit contains excellent examples of virtually all types of Honolulu volcanic series activity (e.g., lava flows, tuff and ash cones, and cinder cones) and the only base surge deposits known to exist on the islands. Also, the Koko Head-Hanauma Bay-Koko Crater complex contains one of the best examples of tuff cones in the islands. Large fragments of old coral reef and country rock are incorporated in the tuff, illustrating the effects of volcanic explosion through old coral reef.

According to Abbott et al., Hanauma Bay occupies the former principal crater of Koko Head, and provides a unique example of an old tuff cone that has been breached by wave erosion. Koko Crater, the largest and best preserved cone in the Koko Rift, provides an example of youthful stream erosion into the soft tuff. The Kalama and Kaupo lava flows in the study unit represent the youngest volcanic activity on Oahu, although there are active lava flows on the island of Hawaii. The April 1989 letter states that a lava tube near Makapuu Point may be the best documented example on earth of a geological feature akin to one found on the moon known as a sinuous rill.

Rare Plants. Two plant species in the Koko Rift unit are officially proposed for federal listing as endangered; four others are candidates for federal listing as threatened or endangered. All four of the candidate species are from historical records only (1937 or earlier). Four additional plant species are considered rare by the Hawaii Heritage Program. (See appendix A for a list of the species.)

Rare Animals. Two federally listed endangered animal species have been reported in the Koko Rift unit (Hawaiian hoary bat and Hawaiian monk seal), and one species federally listed as threatened has been reported (Green sea turtle). Another species in the unit, the Hawaiian owl, is listed as endangered by the state of Hawaii on Oahu only.

Rare Natural Communities. One rare native natural community, the *Marsilea villosa* lowland dry herbland, was observed in the Koko Rift unit. This community occupies an ephemeral pool that floods infrequently. This pool is the best remaining habitat for this species. The Koko Rift unit also contains examples of four other natural communities that, although not considered rare, are dwindling resources.

Marine Resources. The inshore waters of Hanauma Bay, a world-renowned marine resource, are a Marine Life Conservation District (MLCD) and a state underwater park administered by the state Department of Land and Natural Resources. This MLCD has been heavily impacted by humans during the past decade. Few places in the world offer such an easily accessible, protected opportunity for viewing marine resources of a coral reef. In addition to its superlative recreation values, the area may have important scientific value in monitoring human impacts and the effectiveness of mitigation measures.

Other Resources of Significance. Manana and Kaohikaipu islands, in the study unit, are state seabird sanctuaries.

National Significance. The Koko Rift unit as a whole provides examples of the following NPS natural history themes: "Works of Volcanism", "Sculpture of the Land", "Oligocene-Recent Epochs," and "Seashores, Lakeshores, and Islands." In addition, Hanauma Bay is an example of the "Marine Environments" theme, and the Koko Head and Makapuu Head areas provide several

relatively intact examples of the "Woodland and Scrub Formation" subtheme under the "Tropical Ecosystem" theme.

Of the themes represented in the unit, it is the opinion of the study team, based on the above information, that the unit provides nationally significant examples of the "Works of Volcanism", "Seashores, Lakeshores, and Islands", and "Marine Environments" themes.

The Koko Rift unit is of national significance because (1) it is an outstanding example of particular types of geologic, coastal, and marine resources and has a rare natural plant community, (2) it possesses exceptional value and quality in illustrating and interpreting the natural themes of our nation's heritage, including volcanism, erosional forces, coastal features, offshore islands, and marine environments, (3) it offers superlative opportunities for public use, interpretation, and scientific study, and (4) it retains a high degree of integrity as a true, accurate, and relatively unspoiled example of such natural resources.

Cultural Resource Significance

The most important cultural resource in the Koko Rift unit is the Makapuu lighthouse, which was listed on the National Register of Historic Places in 1977. Makapuu lighthouse is a cultural resource of state significance.

Many cultural sites in the unit retain significance for contemporary members of traditionally associated groups although the physical evidence of many of the sites was destroyed in the 1946 tsunami. These sites, along with the remnants of military installations and the lighthouse, offer excellent interpretive possibilities but do not meet the other criteria for national significance. Except for the lighthouse, these resources are not outstanding examples of their types and lack a high degree of integrity.

Recreational Significance

The Koko Rift unit is an outstanding recreational resource and has potential to become even more significant if some of the problems can be resolved. The unit offers diverse recreational opportunities, including water sports and swimming (although these are somewhat limited for national and international visitors due to the hazardous conditions along most of the beaches), hiking, nature study, fishing, and organized sports. It retains a high degree of integrity at this time, although there are some intrusions of development. Overall, the unit offers superlative opportunities for recreation and public enjoyment. The combination of the natural resources and, to a lesser extent, the cultural resources, with diverse recreational opportunities makes the Koko Rift unit a nationally significant recreational resource.

WAIMANALO BAY UNIT

Natural Resource Significance

The description of rare plants and animals and the rare natural communities below relies heavily on the Hawaii Heritage Program report (1991a).

Geology/Landforms. No specially significant geologic features are found in this unit.

Rare Plants. There were no rare plants reported in this unit.

Rare Animals. The wetland at Bellows AFS provides habitat for four federally listed endangered native waterbirds: the Hawaiian stilt, Hawaiian coot, Hawaiian gallinule, and Hawaiian duck. The Hawaiian owl, listed by the state as endangered on Oahu only, has also been observed at Bellows AFS.

Rare Natural Communities. There are no rare natural communities reported in the Waimanalo Bay unit. Native natural communities along the coastal strand are typical of disturbed sandy beaches on Oahu.

Marine Resources. The Waimanalo coast is considered a very important local/regional fishing and recreational asset of the island of Oahu. An extensive reef system occurs offshore.

National Significance. No portion of this unit meets all four requirements for national

significance for natural resources, as set out in *Criteria for Parklands*. The wetland at Bellows AFS comes the closest to meeting the requirements, but it only marginally meets two of the four requirements (i.e., it has value in illustrating the natural themes of our nation's heritage, and it has opportunities for scientific study, recreation, and enjoyment).

Cultural Resource Significance

According to scholars in Hawaiian archeological research, pre-contact sites such as the Bellows site, which may date to 600 A.D. or possibly earlier, are extremely rare and provide considerable insight into the lifeways and customs of the earliest Polynesian migrants to the Hawaiian Islands, their adaptation to a pristine island environment, and ecological factors that may have influenced change and/or stability in Hawaiian social organization, subsistence strategies, religious behavior, and variation with other Polynesian societies. Thus, the site is representative of an incipient stage in the development of Hawaiian culture as distinctive from proto-Eastern Polynesian culture.

In addition, some rare artifacts have been documented in the Bellows area that are suggestive of affinities with other early Eastern Polynesian sites outside of Hawaii. These include a coconut grater made from a Conus shell, one- and two-piece fishhooks, a reverse triangular adze, a plano-convex adze, and an imitation porpoise tooth pendant. A curved lei niho palaoa shell, regarded as a chiefly symbol in Hawaiian society, may indicate that some form of hierarchical social organization had developed by the end of the first millennium.

The Bellows archeological area extends over a broad expanse of the shoreward section of Bellows AFS, as well as the entire Waimanalo Bay State Recreation Area. A portion of the archeological area also extends westward across the Kalanianaole Highway and includes lands outside the study area. Other sites besides the aforementioned site have been recognized within the Bellows archeological area, including two stratified sand dune sites in Waimanalo Bay State Recreation Area. One of these sites is a small stratified deposit containing middens and artifacts with evidence of at least two periods of occupation. The other site consists of several shallow human burials associated with a dark-stained deposit. Many isolated burials have been found eroding along the sand beach in Bellows AFS and the state recreation areas.

Despite of the impacts of wind and sea erosion, recreational and military use, and development associated with Bellows AFS, the known archeological resources of the Bellows archeological area retain fair integrity. Sand borrowing in the area has caused damage to some of the resources. The Bellows archeological area is a cultural resource of state significance, and it does not meet all the criteria for national significance. Although it is an excellent example of Hawaiian cultural resources and is important for research, it lacks value in illustrating and interpreting the cultural themes of our nation's heritage to the visiting public.

Recreational Resource Significance

Waimanalo Beach is the longest white sand beach on the island and one of the safest. The recreational resources of this unit are primarily beach/ocean oriented. Camping is available year-round in several of the parks and on weekends and holidays at Bellows AFS. Some sections of the beach lack adequate access and parking, but most of the facilities are adequate for current use levels.

The national park system contains many superlative beaches, including some in Hawaii. Many of the beaches in the system have extensive land with varied resources, including dune systems, estuaries, and wetlands. Waimanalo Beach is a narrow strip except in the Bellows AFS area, and it lacks resource diversity when compared to other units in the national park system, such as Padre Island, Cape Cod, Cape Hatteras, and Golden Gate. The Waimanalo beaches' lack of diversity limits the recreational opportunities, and adjacent development reduces the integrity of the resources; the beaches do not offer national visitors superlative opportunities for recreation, but are

outstanding regionally significant recreational resources. The beaches would be considered a more significant resource, although not necessarily of national significance, if the Bellows AFS beach sections were not limited to weekend and holiday use.

Although there are no indications that the military will discontinue their use of Bellows, there is a potential to significantly expand public recreational opportunities such as camping, hiking, water sports, nature study, and other activities on these lands if military use were discontinued. These potential opportunities would not increase the national significance but would add significantly to local/regional recreational resources.

MAUNAWILI VALLEY UNIT

Natural Resource Significance

The section on geology/landforms relies heavily on Abbott et al. 1981, page 191. For biotic resources in the this unit, this text also borrows heavily from the Hawaii Heritage Program report (1991b), the Corps of Engineers (1980 and 1991), the state of Hawaii Department of Planning and Economic Development (1983), and Drigot and Seto (1982).

Geologic Features. Olomana Peak is a remnant of lava flows and breccia that once filled the Koolau caldera. According to Abbott et al., the lava flows comprising the peak are unusually thick, indicating they were probably formed by the ponding of lava within the Koolau caldera walls, and there is free quartz at the base of Olomana Peak, a rare mineral in the Hawaiian Islands. Also, Olomana Peak is considered unique because of its height, isolation, and sharp peak.

The Koolau Range Pali, outside the study unit, has been recognized as nationally significant through designation as a national natural landmark under the following themes: "Mountain Systems", "Works of Volcanism", and "Sculpture of the Land" (NPS 1990). The continuation of the Pali within the study unit is an equally spectacular feature.

Rare Plants. Eighteen rare plants have been reported along the Koolau summit ridge, high above Maunawili Valley. Ten of the 18 rare species are candidates for federal listing, but none have been proposed for listing. No rare plant taxa have been reported for other locations in the study unit, including the lower Maunawili Valley and Kawainui Marsh. Most of the wetland plant species in the Kawainui Marsh are not native, although some areas of native sedgeland are present. The vegetation surrounding the marsh is almost entirely alien species. (See appendix A for a list of rare species.)

A stand of about 50 "exceptional trees" (as defined by city and county of Honolulu ordinance no. 78-91) exists in the northwest part of Maunawili Valley.

Rare Animals. Eighteen rare animals have been reported in this unit. Fourteen of those are federally listed as endangered species. The Hawaiian owl is listed as endangered on Oahu only by the state. The ʻIʻiwi is listed as endangered by the state on Oahu, Molokai, and Lanai only. The Oahu megalagrion damselfly is a candidate for federal listing, and a moth (*Hedylepta monogramma*) is considered critically imperiled globally by the Hawaii Heritage Program. (See appendix B for a list of rare species.)

Five of the 14 federally listed endangered animals are waterbirds that are clustered mainly in and around the Kawainui Marsh area. Because Kawainui Marsh is the largest remaining freshwater wetland in the state, even in its impacted condition it must be considered a very important resource for the recovery of these endangered species.

The hawksbill sea turtle and Hawaiian monk seal would also occur only in the lower marsh area of the unit. With the exception of historic reports of endangered land snails in Maunawili Valley, the other rare animals would be found along the Koolau summit ridge above Maunawili Valley. Only two of the six species of endangered Oahu tree snail have been reported in this unit since 1953, but the Hawaii Heritage Program believes that there is hope that some or all of them may still be extant.

Rare Natural Communities. Although there are several native natural communities in the unit, only the Hawaiian continuous perennial stream community is considered rare by the Hawaii Heritage Program. This community runs through the Maunawili Valley and Kawainui Marsh, and on to the sea through the Oneawa Channel. The Hawaii Heritage Program report states that the quality of this community in the unit is compromised by channel modification, eutrophication from adjacent sewage treatment and agricultural effluent, and development within the Maunawili Valley watershed. Even in its impacted condition, it is an example of a stream community restricted to the Hawaiian Islands, and it is one of less than 400 examples of such stream communities worldwide.

National Significance. Koolau Pali, when combined with Olomana Peak, provides an outstanding example of the NPS themes "Works of Volcanism", "Sculpture of the Land", and "Oligocene-Recent Epochs" of geologic history. The upper portions of Maunawili Valley and the Pali are also outstanding examples of the "Lowland Rain Forest" subtheme of the "Tropical Ecosystems" theme.

Portions of the unit meet three of the four criteria for national significance because (1) they are outstanding examples of particular types of geologic resources and natural communities, (2) they possess exceptional value and quality in illustrating and interpreting the natural themes of our nation's heritage, including volcanism, erosional forces, and tropical ecosystems, and (3) they retain a high degree of integrity as true, accurate, and relatively unspoiled examples of such natural resources (although development at the base of Olomana Peak is beginning to impact this criterion). However, they do not offer superlative opportunities for public use, interpretation, and scientific study, primarily due to access problems associated with development in Maunawili Valley. Even if they met this fourth criterion, the Pali and Olomana Peak would not in and of themselves make the entire unit nationally significant.

Although other parts of the unit, especially Kawainui Marsh and the perennial stream community, contain significant natural resources and opportunities for interpretation and scientific study, they lack the integrity as true, accurate, and relatively unspoiled examples of the resource, and thus are not nationally significant under the NPS criteria. Even though they do not meet the criteria for national significance in terms of additions to the national park system, the rarity of the perennial stream community and the fact that Kawainui Marsh is the largest remaining freshwater wetland in the Hawaiian Islands make these extremely important regional resources that should be protected.

In summary, the unit does not meet the requirements for national significance for natural resources according to the *Criteria for Parklands*.

Cultural Resource Significance

Both Kawainui Marsh and Maunawili Valley are important as prehistoric and historic sites of Hawaiian occupation as evidenced by legends, historic documentation, archeological studies, and extant remains of extensive wetland and terraced hillslope dryland agricultural systems, ceremonial and burial sites, and habitation areas. The marsh and valley contain various sites that are important to Oahu legends and retain significance for contemporary members of traditionally associated groups.

In 1979 the marsh was determined to be eligible for listing on the National Register of Historic Places – based on the early occupation of the marsh vicinity (possibly as early as the 6th century A.D.), its association with important traditional/prehistoric/historic events and personalities (such as Kamehameha I), and its role as a major subsistence component of a larger cultural socioeconomic unit or traditional Hawaiian land division (known as the Kailua ahupua'a).

The national register boundary shown for Kawainui Marsh was arbitrarily established in 1979, using aerial photographs rather than thorough standard scientific pedestrian surveys and testing. As a result, the extent of modern disturbance as well as the extent of

archeological sites in the marsh remains unknown.

Two substantial Hawaiian heiau, Ulu Po and Pahukini, are adjacent to Kawainui Marsh. Both heiau were listed on the National Register of Historic Places in 1972, and the former has been designated a state historical monument. The heiau are monumental examples of the engineering knowledge, fine stone craftsmanship, and religious dedication of pre-contact Hawaiians in constructing their temples.

Despite the presence of numerous prehistoric and historic sites in Kawainui Marsh and its adjacent slopes and in the Maunawili Valley, the significance of these sites is diminished considerably by their lack of integrity. Many sites in and near the marsh wetlands have been adversely impacted by grading and bulldozing associated with flood control work; highway, residential, landfill, and quarry development adjacent to the marsh; periodic flooding of the area; and use of the area during the past century for farming, ranching, drainage, sewage disposal, and wetlands. The integrity of the Pahukini heiau is fair, although it was somewhat damaged by bulldozing in 1976, and modern quarrying operations have carved away major portions of the hill upon which it is located. The Ulu Po heiau, although in generally good condition, has been disturbed by relic hunters, and the provision of walkways over the top has altered its original appearance. The southern walls of Ulu Po were obliterated during the construction of a cattle pen (when the area was used for a pasture), and residential development presently abuts the heiau.

Many of the cultural sites in the Maunawili Valley, particularly on the lower and more accessible slopes and along the stream drainages, have lost integrity as a result of residential development, modern recreational uses (such as hunting, hiking, and camping), and erosion from overflows of the Maunawili ditch system. Some sites on the higher and less accessible slopes of the valley have retained their integrity and merit further study, evaluation, and protection. The sites on the slopes of Olomana Peak, where one golf course is being constructed, have been impacted to a high degree, although portions of the taro agricultural site complexes, a heiau, some charcoal pits, and several pre-contact and post-contact house sites apparently will be preserved. The overall cultural milieu of the sites and their surroundings will be disturbed, however, thus negating their integrity and potential contextual significance.

Although many of the sites in this unit offer opportunities for interpretation and scientific study and are representative examples of their particular type of resource, the lack of integrity precludes them from being determined nationally significant.

Recreational Resource Significance

This unit is primarily a natural and cultural resource, and it has limited recreational opportunities at this time. Passive recreational opportunities are included in both state and private plans for the marsh area, including picnic sites, overlooks, wildlife viewing, interpretive centers, trails, campsites, open fields, and possibly boating. Emphasis in the state plan is on a "natural heritage area" with special emphasis on maintaining and improving waterbird habitat for endangered wildlife; cultural and recreational aspects are secondary to the ecological concerns. A trail system within Maunawili Valley will eventually enhance hiking opportunities around the extensively developed areas. The valley and marsh are not a nationally significant recreational resource; if long-range concepts for management of the marsh are realized, the area could become a significant local recreational resource.

BRIEF SUMMARY OF SIGNIFICANCE

Koko Rift Unit

The volcanic features of the Koko Rift are outstanding examples of a landform that still has many features that are the best examples of particular works of volcanism in the Hawaiian Islands. Hanauma Bay is a unique example of a volcanic cone that has been breached by wave action, as well as a significant marine resource. These features

possess exceptional value in illustrating our nation's natural heritage under the NPS themes "Works of Volcanism," "Seashores, Lakeshores, and Islands," and "Marine Environments." The features retain a high degree of integrity even though Hanauma Bay has recently been adversely impacted.

The unit provides a special setting for various recreational activities that are different than those at the local or regional level. The surfing opportunities from Sandy Beach to Makapuu Beach (although not available to the average tourist) are among the best in the islands, and Hanauma Bay is an internationally known recreational resource. As a whole, the unit offers opportunities for public use and enjoyment of natural and recreational resources and has potential for interpretation of historic resources as well as additional recreational activities such as camping, hiking, and horseback riding. The NPS study team's opinion is that the existing combination of natural and recreational resources make the unit nationally significant. The unit's significance should be enhanced with implementation of the state and county plans.

Waimanalo Bay Unit

The beaches in this unit are outstanding examples of the white sand beaches of Hawaii, and they offer excellent opportunities for recreation, public use, and enjoyment. They lack exceptional value in illustrating the natural or cultural themes of our nation's heritage due to the encroaching development and military use, which have reduced their integrity as true, accurate, and relatively unspoiled examples of a resource. The Bellows archeological area, while significant for scientific study of Hawaii's cultural heritage, lacks (and is threatened by) opportunities for public use and enjoyment. The NPS study team feels that the Waimanalo Bay unit is a very significant local and regional recreational resource, but it is not nationally significant.

Maunawili Valley Unit

Due primarily to the extensive residential development and alteration of landforms, the unit lacks a high degree of integrity as a relatively unspoiled example of natural or cultural resources. Opportunities for recreation, public use and enjoyment and scientific study are limited by lack of access due to this extensive development. If it was not so extensively developed, the unit might provide outstanding examples of the "Tropical Ecosystem" and "Works of Volcanism" themes. Also, if the entire unit were not so impacted, the Kawainui Marsh and its associated perennial stream system would provide nationally significant examples of natural resources under several themes.

The potential for interpretation of this ecosystem and its significance in Hawaiian heritage will be enhanced as the state and county implement plans for protecting some of these resources. However, even if the various plans for protecting the marsh and valley are realized, many of the features would be a re-creation of Hawaiian heritage and would lack the integrity desired for a unit of the national park system. Overall, the Maunawili Valley unit is a significant local or regional resource; however, the study team does not feel that it meets the criteria for a nationally significant resource.

Suitability

An area that is nationally significant must also meet criteria for suitability to qualify as a potential addition to the national park system. **To be suitable for addition to the national park system an area must**

> represent a natural/cultural theme or type of recreational resource that is not already adequately represented in the national park system, unless such an area is comparably protected and presented for public enjoyment by another land-managing entity.

Adequacy of representation will be determined on a case-by-case basis by comparing the proposed addition to other units in the national park system for differences or similarities in the character, quality, quantity, or combination of resources and opportunities for public enjoyment.

KOKO RIFT UNIT

All of the natural history themes ("Works of Volcanism," "Sculpture of the Land", "Oligocene-Recent Epochs," "Seashores, Lakeshores, and Islands," "Marine Environments," and the "Woodland and Scrub Formation" subtheme of the "Tropical Ecosystem" theme) represented in the Koko Rift unit are represented in other NPS units in the Hawaiian Islands natural region (NPS 1990). However, no NPS units on Oahu encompass significant natural resources (the USS *Arizona* Memorial is the only NPS unit on Oahu). With respect to differences between islands, the NPS natural history

thematic framework recognizes that "Endemism is very high though less among marine species than terrestrial species. On land there are great differences in biota from island to island" (NPS 1990, p.13). The natural communities and geologic features in this unit, then, would probably not be well represented within the other NPS Hawaiian parks. However, it is not likely that the resources in the Koko Rift unit would significantly add to representation of each theme in the national park system if this unit were added to the system.

Hanauma Bay is a unique combination of several themes ("Works of Volcanism," "Sculpture of the Land," and "Marine Environments"), which, when combined with the outstanding recreational resources, is not represented in the national park system. Several parks in the national park system offer a similar interface between visitors and the marine life – Virgin Islands National Park, Buck Island Reef National Monument, and Biscayne National Park. Also, several NPS Hawaiian parks offer examples of the same themes. However, none of these offer quite the same character as Hanauma Bay.

The Makapuu Point lighthouse is on the national register; the national park system contains numerous lighthouses and many are considered to have unique features. The military installations related to World War II are well represented in the national park system, particularly in Golden Gate National Recreation Area, but not in Hawaii.

All of the significant resources of the Koko Rift unit are protected under state and city-county management, with the exception of the Wawamalu (Queens Beach) area. With the exception of Makapuu State Park, which is in the development stage, and Wawamalu, these resources are adequately presented for public enjoyment. Although development on private lands in the unit would alter the visual quality of the unit, such development does not present a direct threat to significant resources.

Under the *Criteria for Parklands* (NPS 1990), the themes represented by the natural and cultural resources of the Koko Rift unit are well represented in the national park system. However, it is the combination of several themes in one geographic area plus some aspects unique to the island of Oahu which, in the judgement of the study team, meet part of the criteria for suitability, and would make the unit a suitable addition to the national park system if it were not for the fact that it is for the most part adequately protected and managed by the Hawaii State Parks and the city-county Parks and Recreation Department. The unit, therefore, does not meet all of the criteria for suitability.

WAIMANALO BAY UNIT

The long, fine, white sand beaches of Waimanalo Bay and the state significant archeological resources are adequately protected and managed by the Hawaii State Parks, the city and county of Honolulu, and the U.S. Air Force. With the exception of the beaches in Bellows AFS where public use is limited to weekends and holidays, the recreational resources are adequately presented for public enjoyment. The archeological resources in the unit are adequately protected for scientific research. An NPS presence would not necessarily alter public use at Bellows AFS; additional public use could occur through negotiations between the Air Force and the city and county of Honolulu.

Should Bellows become excess to military needs, the beaches and adjacent lands, including the significant archeological sites, should be added to Waimanalo Bay State Recreation Area.

Under the *Criteria for Parklands* the Waimanalo Bay unit is not a suitable addition to the national park system because the resources are of a type already well represented in the system and they are adequately protected and presented for public enjoyment by the existing managing agencies.

MAUNAWILI VALLEY UNIT

The regionally and locally significant natural and cultural resources of the Maunawili Valley and Kawainui Marsh were not considered nationally significant, primarily due to the

lack of integrity of these resources. In theory, these resources are adequately protected under state and city-county management. The continuing development in the unit leads many Hawaiians to question the adequacy of this protection. The resources are not adequately presented for public enjoyment at this time; as management plans for the Kawainui Marsh area are implemented, both the protection and presentation should improve. However, in Maunawili Valley many cultural sites of importance to native Hawaiians could remain inaccessible.

All of the NPS themes ("Mountain Systems," "Works of Volcanism," "Sculpture of the Land", "Oligocene-Recent Epochs," and the "Lowland Rain Forest" subtheme of the "Tropical Ecosystems" theme) represented in the Maunawili Valley unit are represented in other NPS units in the Hawaiian Islands natural region (NPS 1990).

At least in theory, the section of the Pali that has already been designated as a national natural landmark has adequate protection by the state. Although the landmark portions of the Pali are not in the study area, similar features occur at the head of Maunawili Valley and they are adequately protected by the state. This is especially true when considering the Pali's steepness, its forest reserve designation, and its general unsuitability for development on most of its upper slopes on the windward side of Oahu. The same is true of Olomana Peak although development on the lower slopes has significantly altered the scenic quality and appears to have had an adverse effect on cultural resources and streams.

The cultural resources related to Hawaiian heritage are generally well represented in the national park system, particularly in the parks on the island of Hawaii, although not on the island of Oahu. These resources generally fall under the theme of "Ethnohistory of Indigenous American Populations" but several other themes are applicable to some extent. Many of these resources have been severely impacted by development and lack the integrity needed to provide a meaningful experience for national visitors.

Under the *Criteria for Parklands* the Maunawili Valley unit is not a suitable addition to the national park system. The resources are of a type already well represented in the national park system and they are, in theory, adequately protected by the existing managing agencies – although many cultural sites have been destroyed or severely altered by development. Currently the cultural sites and marshlands are not adequately presented for public enjoyment.

Feasibility

As well as meeting criteria for suitability, an area that is nationally significant must also meet criteria for feasibility to qualify as a potential addition to the national park system. **To be feasible as a new unit of the national park system, an area must**

> be of sufficient size and appropriate configuration, considering natural systems and/or historic settings, to ensure long-term protection of resources and to accommodate public use, and it must have potential for efficient administration at a reasonable cost.

Important feasibility factors include landownership, acquisition costs, access, threats to the resource, and staff or development requirements. Although some of these factors can be evaluated from existing data, others must be based on broad concepts. For example, acquisition costs can be estimated with reasonable accuracy, and long-range development and staff costs must be based on past experience until a comprehensive general management plan has been prepared.

KOKO RIFT UNIT

Public ownership of the lands in this unit does not necessarily ensure long-term protection of the scenic resources. Acquisition of the private lands needed to ensure such protection could be accomplished through a land exchange, scenic easement, or other means of protection. Fee acquisition of these

lands could be prohibitively expensive. The National Park Service does not have lands to offer for exchange, and there is no known surplus federal property on the island to use in exchange. If the state could exchange lands for private properties in the study area before transferring management to the Park Service, this problem would be resolved.

The existing recreation field complex in Koko Head District Park and the rifle range are more appropriately managed by the county. It would be best if the rifle range were relocated out of the park due to its proximity to Hanauma Bay and the limitations it places on other activities such as hiking trails around Koko Crater.

Development and staff costs are difficult to determine without a comprehensive plan for the area. Existing county staff levels cannot be used as a basis for determining NPS staff; the Park Service would have to establish a maintenance division, and there would be more emphasis on interpretation. Some administrative positions might be combined with the USS *Arizona* Memorial to minimize duplication. Staffing would be comparable to similar NPS units with an emphasis on recreation.

Development costs would be significant if some of the problems are to be resolved and opportunities addressed. Major development projects could include a visitor center, campgrounds, additional parking, an administrative complex, trail systems, and interpretive wayside exhibits. It might be possible to use some of the Job Corps Center facilities for an administrative complex and possibly a visitor center, thus reducing development costs. It is assumed that the Kalanianaole Highway and other major roads would continue to be maintained by the state and/or county. The issue of a bypass through Hawaii Kai would need to be resolved; depending on the route selected, this could be a very expensive project regardless of who funds it.

NPS jurisdiction would also be needed along the shoreline and within the waters of Hanauma Bay to ensure adequate, coordinated management of the marine resources.

NPS management of this unit might be feasible if all of the state and county lands (with the possible exception of the athletic fields) and a major portion of the existing private lands were transferred to or in other ways placed under NPS administration. This would provide a unit of sufficient size and configuration to ensure long-term protection of the natural, cultural, and scenic resources and accommodate public use and enjoyment. Although initial costs for development and administration would be high, the unit could be administered in an efficient manner and at costs similar to comparable areas in the system.

WAIMANALO BAY UNIT

The feasibility of NPS management of this unit depends on several factors, the most important being the inclusion of Bellows AFS as a part of the unit.

The unit would be expensive to operate as a separate entity, with high costs for administration and maintenance for a relatively small area. The only suitable location for management facilities would be within Bellows AFS. Although adequate room might exist within Waimanalo Beach State Recreation Area, it seems an inappropriate use for what is now a fairly natural area.

Staff costs would be comparable with other, similar parks. Development costs, other than for administrative and maintenance facilities, would be minimal, with generally adequate facilities in place. However, the condition of the facilities and utility systems might be worse than they appear, requiring some major rehabilitation. The Park Service would conceivably make some major changes in the beach area of Bellows AFS to organize camping and parking in accord with NPS standards. These changes might not be compatible with military training exercises.

There would be no acquisition costs for lands within this unit. Management of the beaches on Hawaiian homelands would require an agreement, possibly a long-term, renewable lease, with the agencies responsible for these lands.

NPS management of this unit would be feasible if (1) lands in the Koko Rift unit (described above) are also included, (2) all state and county lands in this unit and some or all of the lands in Bellows AFS were transferred to or in other ways placed under NPS administration and (3) significantly expanded public use of the beaches in Bellows AFS was permitted. This combination would provide a unit of sufficient size and configuration to ensure long-term protection of the natural, cultural, and scenic resources and to accommodate public use and enjoyment. Although initial costs for development and administration of the two units as a single park would be high, they could be administered in an efficient manner and at costs similar to comparable areas in the system. The additional cost to administer the Waimanalo Bay Unit would be relatively small in comparison to the relatively high costs as a separate unit. Should this unit be added to the national park system, the legislation should include all of Bellow AFS with provisions for automatic transfer to the Park Service if it becomes excess to military needs.

MAUNAWILI VALLEY UNIT

The Maunawili Valley would not be feasible for NPS management; the area is extensively developed and access is severely restricted. Development of adequate trailheads and interpretive facilities to accommodate large numbers of national and international visitors would be difficult.

The feasibility of NPS management of the Kawainui Marsh is a better possibility. Acquisition costs for land – to accommodate numerous visitors and NPS management facilities – could be very high, even with the assumption that the county and state will have acquired all of the lands needed for protection of the marsh and these lands would be transferred to NPS management.

The state and the Kawai Nui Heritage Foundation have developed plans for the area. The state would manage the marsh primarily for the wetland value whereas the foundation has plans that require extensive rehabilitation, reconstruction, and restoration of the natural and cultural features. Cost estimates for this work and development of educational, interpretive, and recreational facilities range up to $250 million.

Generally, the Park Service is opposed to re-creation of cultural sites. The Park Service would need to develop a management plan for the area in compliance with NPS management policies, which might be significantly different than state or private plans. NPS development costs would likely be considerably less than the costs projected by the foundation. However, there would be costs for administrative and maintenance facilities if this became a separate NPS unit.

Staffing could prove costly, with the needs for expertise in management of the stream, estuarine, and waterbird habitat. Hazardous materials might be located within the area or its drainages, which might require specific staff expertise.

The limited land base does not provide sufficient size and appropriate configuration to ensure long-term protection of the resources while providing for relatively high levels of use. High development and staff costs, potentially high land acquisition costs, and insufficient size and appropriate configuration preclude this as a feasible unit of the national park system.

Conclusions

Of the three study units, only the Koko Rift unit meets the criteria for national significance. The area contains significant examples of the works of volcanism and the effects of wind and water on the forms of the land. The marine environment in Hanauma Bay is a unique combination of the above with an unusual marine habitat within a volcanic crater. Although Hanauma Bay and Sandy Beach are used to (or beyond) capacity, the full recreational potential of this unit is as yet unrealized. The city and county has plans underway to address resource management problems, particularly at Hanauma Bay, and to tap the underused resources.

None of the units meet the criteria for suitability for addition to the national park system, primarily because they are, for the most part, protected and managed for public use by other entities. The private lands within the study area are theoretically protected from inappropriate uses under existing zoning ordinances, although the golf course development in Maunawili Valley is an example of a permitted use that does not adequately protect natural and cultural resources, and one can only speculate on what development might ultimately be allowed in the Queens Beach-Sandy Beach areas.

The Koko Rift unit would be a feasible addition only if management authority over public lands and waters is transferred to the Park Service and adequate private lands can be acquired at reasonable cost or through other means such as exchange, easements, or long-term, renewable leases. This would

provide a size and configuration necessary to retain the scenic quality of the unit and provide access for public use and enjoyment of the area. Acquisition of private lands might also provide opportunities for camping, an interpretive/environmental education center, and enhanced access to the shoreline.

The Waimanalo Bay unit would be a feasible addition only if combined with the Koko Rift unit and with (1) NPS management responsibilities granted for expanded public use of Bellows AFS, and (2) management authority over state and county lands transferred to the Park Service. The Park Service also might need sufficient space in Bellows AFS to develop some management facilities. Without expanded user days of the Bellows AFS beach areas, the beaches of this unit are probably best left to city-county management.

The Maunawili Valley unit does not meet the criteria for significance, suitability, or feasibility for addition to the national park system. However, the importance of these resources to Hawaiian heritage and the significance of the natural resources of the marsh and remaining undeveloped reaches of the valley should not be ignored. Although addition to the national park system is not appropriate, the area can provide a valuable educational and low-key recreational resource for the island of Oahu.

The conclusion of this survey is that none of the three units meets all of the criteria for significance, suitability, and feasibility.

The Next Step-Management Alternatives

The second step in the NPS planning process would be a ***study of management alternatives***, which will evaluate reasonable alternatives for the management, protection, and use of the area and analyze the perceptual, economic, social, cultural, and environmental consequences of implementing the various alternatives. Normally this step is taken only if an area is determined to be of national significance and meets the criteria for suitability and feasibility. However, the NPS Denver Service Center has been directed to prepare a study of alternatives regardless of the results of this *Reconnaissance Survey*. The study of alternatives uses and elaborates upon the information contained in the *Reconnaissance Survey* and often requires extensive field work. At this stage possible boundaries and alternatives to fee acquisition and federal management are explored.

This *Reconnaissance Survey* is the first section of a two-part document. Each part will be released in draft for public comment and then combined in a final report for submittal to Congress. The final report normally does not recommend a preferred course of action. However, it may be submitted to Congress with a recommendation by the secretary of the interior.

APPENDIX A: PLANT SPECIES LISTS

Appendix A is composed of four tables, as follows:

Table A1, Rare Plants Reported in the Study Area, is taken completely from the Hawaii Heritage Program report (1991a). Nomenclature references are found in that document. According to Hawaii Heritage Program policy, the following statement must accompany all information distributed from their reports:

> The Nature Conservancy's Hawaii Heritage Program database is dependent on the research of many scientists and individuals. In most cases this information is not the result of comprehensive, site-specific field surveys, and is not confirmed by the Heritage staff. Many areas in Hawaii have never been thoroughly surveyed, and new plants and animals are still being discovered. Database information should never be regarded as final statements or substituted for on-site surveys required for environmental assessments. Data provided by the Hawaii Heritage Program do not represent a position taken by The Nature Conservancy of Hawaii.

Table A2, Vascular Plants Observed During June 1991 Field Surveys, Koko Rift and Waimanalo Bay Units, is taken completely from the Hawaii Heritage Program report (1991a). It is based on field surveys they conducted under contract to the National Park Service during late June 1991 for the Koko Rift and Waimanalo Bay study area units.

The field surveys dealt with terrestrial taxa and communities only. No assessment of nearshore or marine resources was undertaken, and Manana and Kaohikaipu islands were not surveyed. The surveys took place on six consecutive working days during the dry season in late June. The taxa recorded reflect the seasonal and environmental conditions at the time of the survey. Annual plants in particular may have been in a senescent or cryptic state, and much of the vegetation was wilted or dead above ground. The data from the field surveys may not provide a complete account of rare and native natural communities in the study area. Small pockets of native vegetation may have been overlooked in the complex terrain of this large study area.

Table A3, Vascular Plants Reported or Observed in the Maunawili Valley Unit, is the third table in this appendix. It was discovered very early in the planning process for this report that vegetation in the Maunawili Valley unit was primarily nonnative and heavily influenced by extensive development and agriculture in the unit (Hawaii Heritage Program 1991a and 1991b). Native vegetation is prevalent only above 1,000 feet elevation along the Koolau Pali. The time and cost to update biotic data in this unit was determined to be prohibitive and nonproductive due to the extremely complex mixture of predominately nonnative vegetation and the extensive development of golf course complexes in the unit that was occurring during the study period. Also, the Hawaii Heritage Program had just recently completed a field survey of part of the area above 1,000 feet elevation where native communities dominate (Hawaii Heritage Program 1991b). Therefore, no field survey was conducted in the Maunawili Valley unit; existing information was used to describe species and communities.

The major sources of plant and animal information used in table A3 for the Maunawili Valley unit are Hawaii Heritage Program 1991a and 1991b, Corps of Engineers 1991, and Drigot and Seto 1982.

Table A4, Natural Communities in the Study Area, was derived from the references listed above for Table A3.

TABLE A1: RARE PLANTS REPORTED IN THE STUDY AREA

SPECIES NAME[a]	COMMON NAME	STATUS[b]	UNIT & YEAR(c)
FERNS AND FERN ALLIES			
Grammitaceae			
Adenophorus periens L. E. Bishop		C1, G1	M(1913)
Lindsaeaceae			
Lindsaea repens (Bory) Thwaites ssp. *macraeana* (Hook. & Arnott), C. H. Lamoureux, comb. nov. inedit		N, G1T1	M(18??)
Lycopodiaceae			
Huperzia nutans Brack.	Wawae'iole	C1, GH	M(ND)
Marsileaceae			
Marsilea villosa Kaulf.		PE, G1	K(1991)
FLOWERING PLANTS: DICOTS			
Apiaceae (Parsley family)			
Spermolepis hawaiiensis Wolff		C1, G1	K(18??)
Araliaceae (Ginseng family)			
Tetraplasandra gymnocarpa (Hillebr.) Sherff	'Ohe'ohe	C1, G1 *	M(1987)
Asteraceae (Sunflower family)			
Hesperomannia arborescens A. Gray		C1, G1	M(1973)
Lipochaeta lobata (Gaud.) DC var. *lobata*	Nehe	3C, G2T2	K(1987)
Brassicaceae (Mustard family)			
Lepidium bidentatum Montin var. *o-waihiense* (Cham. & Schlechtend.) Fosb.	'Anaunau, naunau, kunana	N, G2T2	K(1991)
Campanulaceae (Bellflower family)			
Lobelia hypoleuca Hillebr.	'Opelu, mo'owahie	N, G1	M(1918)
Lobelia oahuensis Rock	'Oha, haha, 'ohawai	C1, G1 *	M(1986)
Rollandia crispa Gaud.	'Oha, haha, 'ohawai	C1, G1 *	M(1920)
Rollandia lanceolata Gaud. ssp. *calycina* (Cham.) Lammers	'Oha, haha, 'ohawai	3C, G3?T1 *	M(1985)
Trematolobelia singularis St. John	Koli'i	C2, G1 *	M(1985)
Caryophyllaceae (Pink family)			
Schiedea globosa H. Mann		3B, G2	K(1991)
Fabaceae (Pea family)			
Sesbania tomentosa Hook. & Arnott	'Ohai	C1, G2	K(1937)
Gentianaceae (Gentian family)			
Centaurium sebaeoides (Griseb.) Druce	'Awiwi	PE, G1	K(19??)
Gesneriaceae (African violet family)			
Cyrtandra gracilis Hillebr. ex C. B. Clarke	Ha'iwale, kanawao ke'oke'o	3A, GH *	M(18??)
Cyrtandra waiolani Wawra	Ha'iwale, kanawao ke'oke'o	3A, GH *	M(18??)
Lamiaceae (Mint family)			
Phyllostegia hirsuta Benth.		3C, G1 *	M(186?)
Phyllostegia parviflora (Gaud.) Benth. var. *parviflora*		N, G2TH	M(1911)
Malvaceae (Mallow family)			
Kokia lanceolata Lewton	Koki'o	3A, GH *	K(19??)

SPECIES NAME[a]	COMMON NAME	STATUS[b]	UNIT & YEAR(c)
FLOWERING PLANTS: DICOTS (cont.)			
Portulacaceae (Purslane family)			
Portulaca villosa Cham.		C2, G1	K(1937)
Rutaceae (Rue family)			
Platydesma cornuta Hillebr. var. *cornuta*		C2, G2TH *	M(1909)
Zanthoxylum oahuense Hillebr.	Hea'e, a'e	N, G2 *	M(1985)
Santalaceae (Sandalwood family)			
Exocarpos gaudichaudii A. DC	Heau	C2, G1	M(1909)
Theaceae (Tea family)			
Eurya sandwicensis A. Gray	Anini	C2, G2	M(1983)
FLOWERING PLANTS: MONOCOTS			
Cyperaceae			
Cyperus trachysanthos		C2, G1	K(18??)

Key:

(a) References for nomenclature are provided in Hawaii Heritage Program 1991a.
(b) Key to status:

* = Endemic to Oahu

FEDERAL RANKING (USFWS 1990):

PE = Proposed to be federally listed within the next year as endangered.
C1 = Candidate taxa for which USFWS has substantial information on biological vulnerability and threats to support the proposal to list as them as endangered or threatened species.
C2 = Candidate taxa for which USFWS has information which indicates that proposing to list them as endangered or threatened taxa is possibly appropriate. More data on biological vulnerability and threats are needed before they can be proposed for listing as endangered or threatened.
3A = Taxa that are no longer being considered for listing as threatened or endangered because they are thought to be extinct.
3B = Taxa that are no longer being considered for listing as threatened or endangered on the basis of current taxonomic understanding.
3C = Taxa that are no longer being considered for listing as threatened or endangered.
N = No federal status.

HAWAII HERITAGE PROGRAM RANKING:

G1 = Species critically imperilled globally (typically 1-5 current viable occurrences).
G2 = Species imperilled globally (typically 6-20 current viable occurrences).
G3 = Species vulnerable throughout range.
GH = Species known only from historical occurrences (last observed prior to 1976).
T1 = Subspecies or variety critically imperilled globally.
T2 = Subspecies or variety imperilled globally.
TH = Subspecies or variety known only from historical occurrences (last observed prior to 1976).

(c) Key to study unit and year last reported in study unit:

K = Koko Rift unit
W = Waimanalo Bay unit
M = Maunawili Valley unit
(####) = Year of most recent occurrence reported for each unit of the study area.
(ND) = Observed but no date given.

TABLE A2: VASCULAR PLANTS OBSERVED DURING JUNE 1991 FIELD SURVEYS, KOKO RIFT AND WAIMANALO BAY UNITS

STATUS	TAXON	COMMON NAME
FERNS AND FERN ALLIES		
	Marsileaceae	
+ E	*Marsilea villosa* Kaulf.	
	Nephrolepidaceae	
N	*Nephrolepis multiflora* (Roxb.) Jarrett ex Morton	Kupukupu, ni'ani'au
	Psilotaceae	
I	*Psilotum nudum* (L.) Beauv.	Moa
	Pteridaceae	
N	*Pteris vittata* L.	
	Sinopteridaceae	
E	*Doryopteris decipiens* (Hook.) J. Sm.	Kumuniu
FLOWERING PLANTS: DICOTS		
	Acanthaceae (Acanthacea family)	
N	*Asystasia gangetica* (L.)T.Anderson	Chinese violet
	Aizoaceae (Fig-marigold family)	
I	*Sesuvium portulacastrum* (L.) L.	'Akulikuli, sea purslane
	Amaranthaceae (Amaranth family)	
N	*Alternanthera pungens* Kunth	Khaki weed
N	*Amaranthus spinosus* L.	Spiny amaranth, pakai kuku
N	*Amaranthus viridis* L.	Slender amaranth, pakai
	Anacardiaceae (Mango family)	
N	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki
	Araliaceae (Ginseng family)	
N	*Schefflera actinophylla* (Endl.) Harms	Octopus tree
	Asclepiadaceae (Milkweed family)	
N	*Stapelia gigantea* N. E. Brown	Zulu-giant, giant toad plant
	Asteraceae (Sunflower family)	
N	*Bidens cynapiifolia* Kunth	Spanish needle, beggartick
N	*Bidens pilosa* L.	Spanish needle, beggartick
N	*Conyza bonariensis* (L.) Cronq.	Hairy horseweed, ilioha
N	*Eclipta alba* (L.) Hassk.	False daisy
N	*Emilia fosbergii* Nicolson	Flora's paintbrush
N	*Emilia sonchifolia* (L.) DC	Flora's paintbrush
N	*Gaillardia pulchella* Foug.	Melekule wai kahuli
N	*Lactuca serriola* L.	Prickly lettuce
E	*Lipochaeta integrifolia* (Nutt.) A.Gray	Nehe
N	*Pluchea indica* (L.) Less.	Indian fleabane
N	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush
N	*Reichardia tingitana* (L.) Roth	
N	*Sonchus oleraceus* L.	Sow thistle, pualele
N	*Tridax procumbens* L.	Coat buttons
N	*Verbesina encelioides* (Cav.) Benth. & Hook.	Golden crown-beard
N	*Vernonia cinerea* (L.) Less. var. *parviflora* (Reinw.) DC	Little ironweed
N	*Wedelia trilobata* (L.) Hitchc.	
N	*Xanthium strumarium* L. var. *canadense* (Mill.)Torr. & A.Gray	Cocklebur, kikania
	Bataceae (Saltwort family)	
N	*Batis maritima* L.	Pickleweed, 'akulikuli kai

STATUS	TAXON	COMMON NAME
FLOWERING PLANTS: DICOTS (cont.)		
	Boraginaceae (Borage family)	
E	*Heliotropium anomalum* Hook. & Arnott var. *argenteum* A. Gray	Hinahina, hinahina ku kahakai
I	*Heliotropium curassavicum* L.	Nena, seaside heliotrope
N	*Heliotropium procumbens* Mill. var. *depressum* (Cham.) Fosb.	
N	*Tournefortia argentea* L. fil.	Tree heliotrope
	Brassicaceae (Mustard family)	
+ E	*Lepidium bidentatum* Montin var. *o-waihiense* (Cham. & Schlechtend.) Fosb.	'Anaunau, naunau, kunana
	Cactaceae (Cactus family)	
N	*Cereus uruguayanus* Ritter ex R. Kiesling	Hedge cactus
N	*Hylocereus undatus* (Haw.) Britton & Rose	Night blooming cereus
N	*Opuntia ficus-indica* (L.) Mill.	Prickly pear, panini
N	*Cactaceae* spp. indet.	
	Capparaceae (Caper family)	
N	*Cleome gynandra* L.	Wild spider flower
	Caryophyllaceae (Pink family)	
+ E	*Schiedea globosa* H. Mann	
+ E	*Schiedea nuttallii* Hook.	
N	*Spergularia marina* (L.) Griseb.	Saltmarsh sand spurry
	Casuarinaceae (She-oak family)	
N	*Casuarina equisetifolia* L.	Common ironwood, paina
	Chenopodiaceae (Goosefoot family)	
N	*Atriplex semibaccata* R. Br.	Australian saltbush
N	*Chenopodium murale* L.	Goosefoot, pigweed
	Clusiaceae (Mangosteen family)	
N	*Clusia rosea* Jacq.	Autograph tree
	Combretaceae (Indian almond family)	
N	*Terminalia catappa* L.	Tropical almond, false kamani
	Convolvulaceae (Morning glory family)	
N?	*Ipomoea cairica* (L.) Sweet	Ivy-leaved morning glory, koali 'ai
I	*Ipomoea indica* (J. Burm.) Merr.	Koali 'awa, koali 'awahia
I	*Ipomoea pes-caprae* (L.) R. Br. ssp. *brasiliensis* (L.) Ooststr.	Pohuehue, beach morning glory
N	*Ipomoea* sp.	
E	*Jacquemontia ovalifolia* (Choisy) H. Hallier ssp. *sandwicensis* (A. Gray) K. Robertson	Pa'u-o-Hi'iaka
N?	*Merremia aegyptia* (L.) Urb.	Hairy merremia
	Crassulaceae (Orpine family)	
N	*Kalanchoe pinnata* (Lam.) Pers.	Air plant, 'oliwa ku kahakai
	Cucurbitaceae (Gourd family)	
N	*Coccinia grandis* (L.) Voigt	Scarlet-fruited gourd
N	*Cucumis dipsaceus* Ehrenb. ex Spach	Hedgehog gourd, teasel gourd
N	*Momordica charantia* L.	Balsam pear
	Cuscutaceae (Dodder family)	
E	*Cuscuta sandwichiana* Choisy	Kauna'oa, kauna'oa lei, dodder
	Euphorbiaceae (Spurge family)	
N	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui
E	*Chamaesyce degeneri* (Sherff) Croizat & Degener	'Akoko, koko, kokomalei
N	*Chamaesyce hirta* (L.) Millsp.	Hairy spurge, garden spurge, koko kahiki
N	*Chamaesyce hypericifolia* (L.) Millsp.	Graceful spurge

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: DICOTS (cont.)	
	Euphorbiaceae (Spurge family) (cont.)	
N	*Chamaesyce prostrata* (Aiton) Small	Prostrate spurge
N	*Euphorbia lactea* Haw.	
N	*Euphorbia tirucalli* L.	Pencil tree
N	*Phyllanthus debilis* Klein ex Willd.	Niruri
N	*Ricinus communis* L.	Castor bean, pa'aila, koli
	Fabaceae (Pea family)	
N	*Acacia farnesiana* (L.) Willd.	Klu, kolu
N	*Alysicarpus vaginalis* (L.) DC	Alyce clover
N	*Canavalia sericea* A. Gray	Silky jackbean
N	*Chamaecrista nictitans* (L.) Moench ssp. *patellaria* (DC ex Collad.) H. Irwin & Barneby var. *glabrata* (Vogel) H. Irwin & Barneby	Partridge pea, lauki
N	*Crotalaria incana* L.	Rattlepod
N	*Delonix regia* (Bojer ex Hook.) Raf.	Royal poinciana
N	*Desmodium triflorum* (L.) DC	Three-flowered beggarweed
E	*Erythrina sandwicensis* Degener	Wiliwili
N	*Indigofera spicata* Forssk.	Creeping indigo
N	*Indigofera suffruticosa* Mill.	Indigo
N	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa
N	*Macroptilium lathyroides* (L.) Urb.	Wild bean, cow pea
N	*Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth	Algaroba, mesquite, kiawe
I	*Vigna marina* (J. Burm.) Merr.	Nanea, mohihihi, beach pea
	Gentianaceae (Gentian family)	
N	*Centaurium erythraea* Raf. ssp. *erythraea*	Bitter herb, European centaury
	Goodeniaceae (Goodenia family)	
I	*Scaevola sericea* Vahl	Naupaka kahakai
	Hydrophyllaceae (Waterleaf family)	
E	*Nama sandwicensis* A. Gray	Hinahina kahakai
	Lamiaceae (Mint family)	
N	*Hyptis pectinata* (L.) Poit.	Comb hyptis
N	*Leonurus sibiricus* L.	Lion's tail
N	*Ocimum gratissimum* L.	Basil
I	*Plectranthus parviflorus* Willd.	'Ala'ala wai nui
N	*Stachys arvensis* L.	Staggerweed
	Malvaceae (Mallow family)	
N	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, ma'o
E	*Gossypium tomentosum* Nutt. ex Seem.	Ma'o
I?	*Hibiscus tiliaceus* L.	Hau
N	*Malva parviflora* L.	Cheese weed
N	*Malvastrum coromandelianum* (L.) Garcke ssp. *coromandelianum*	False mallow
I	*Sida fallax* Walp.	'Ilima
N	*Sida spinosa* L.	Prickly sida
I?	*Thespesia populnea* (L.) Sol. ex Correa	Milo
	Menispermaceae (Moonseed family)	
I	*Cocculus trilobus* (Thunb.) DC	Huehue
	Moraceae (Mulberry family)	
N	*Ficus microcarpa* L. fil.	Chinese banyan, Malayan banyan

STATUS	TAXON	COMMON NAME
FLOWERING PLANTS: DICOTS (cont.)		
	Myoporaceae (Myoporum family)	
I	*Myoporum sandwicense* A. Gray	Naio, bastard sandalwood
	Myrtaceae (Myrtle family)	
N	*Eucalyptus* sp.	Eucalyptus
	Nyctaginaceae (Four-o'clock family)	
N	*Boerhavia coccinea* Mill.	
I	*Boerhavia glabrata* Blume	Alena
E	*Boerhavia herbstii* Fosb.	Alena
I	*Boerhavia repens* L.	Alena
N	*Bougainvillea* sp.	Bougainvillea
	Oxalidaceae (Wood sorrel family)	
N?	*Oxalis corniculata* L.	Yellow wood sorrel, 'ihi makole
	Papaveraceae (Poppy family)	
E	*Argemone glauca* (Nutt. ex Prain) Pope	Pua kala
	Passifloraceae (Passion flower family)	
N	*Passiflora foetida* L.	Love-in-a-mist, pohapoha
N	*Passiflora suberosa* L.	Huehue haole
N	*Passiflora* sp.	Passion flower
	Phytolaccaceae (Pokeweed family)	
N	*Rivina humilis* L.	Coral berry
	Polygonaceae (Buckwheat family)	
N	*Coccoloba uvifera* (L.) L.	Sea grape
	Portulacaceae (Purslane family)	
N	*Portulaca oleracea* L.	Pigweed, 'ihi
N	*Portulaca pilosa* L.	Pigweed, 'ihi
	Primulaceae (Primrose family)	
N	*Anagallis arvensis* L.	Scarlet pimpernel mangrove
	Rhizophoraceae (Mangrove family)	
N	*Rhizophora mangle* L.	American mangrove, red
	Santalaceae (Sandalwood family)	
E	*Santalum ellipticum* Gaud.	'Iliahi, sandalwood
	Sapindaceae (Soapberry family)	
E	*Dodonaea viscosa* Jacq.	'A'ali'i
	Solanaceae (Nightshade family)	
I	*Lycium sandwicense* A. Gray	'Ohelo kai, 'ae'ae
N	*Lycopersicon pimpinellifolium* (Jusl.) Mill.	Currant tomato
N	*Nicandra physalodes* (L.) Gaertn.	Apple of Peru
N	*Nicotiana glauca* R. C. Graham	Tree tobacco
I?	*Solanum americanum* Mill.	Glossy nightshade, Popolo
+ E	*Solanum sandwicense* Hook. & Arnott	Popolo-'ai-a-ke-akua
	Sterculiaceae (Cacao family)	
I?	*Waltheria indica* L.	'Uhaloa
	Verbenaceae (Verbena family)	
N	*Lantana camara* L.	Lantana
N	*Stachytarpheta jamaicensis* (L.) Vahl	Jamaica vervain, oi
I	*Vitex rotundifolia* L. fil.	Kolokolo kahakai, pohinahina, beach vitex
	Vitaceae (Grape family)	
N	*Cissus quadrangula* L.	

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: MONOCOTS	
	Agavaceae (Agave family)	
N	*Agave sisalana* Perrine	Sisal, malina
	Arecaceae (Palm family)	
N	*Cocos nucifera* L.	Coconut, niu
N	*Phoenix* sp.	Date palm
	Bromeliaceae (Bromeliad family)	
N	Bromeliaceae indet.	
	Commelinaceae (Spiderwort family)	
N	*Commelina benghalensis* L.	Hairy honohono
N	*Commelina diffusa* N. L. Burm.	Honohono
	Cyperaceae (Sedge family)	
?	*Cyperus* spp.	
I	*Fimbristylis cymosa* R. Br.	
E	*Mariscus hillebrandii* (Boeck.) T. Koyama	
	Liliaceae (Lily family)	
N	*Aloe* sp.	Aloe
N	*Crinum asiaticum*	
N	*Sansevieria* sp.	Bowstring hemp
	Pandanaceae (Screw pine family)	
I?	*Pandanus tectorius* S. Parkinson ex Z.	Hala, screw pine
	Poaceae (Grass family)	
N	*Bothriochloa pertusa* (L.) A. Camus	Pitted beardgrass
N	*Brachiaria mutica* (Forssk.) Stapf	California grass, para grass
N	*Cenchrus ciliaris* L.	Buffelgrass
N	*Cenchrus echinatus* L.	Common sandbur, 'ume'alu
N	*Chloris barbata* (L.) Sw.	Swollen fingergrass, mau'u lei
N	*Cynodon dactylon* (L.) Pers.	Bermuda grass, manienie
N	*Dactyloctenium aegyptium* (L.) Willd.	Beach wiregrass
N	*Digitaria ciliaris* (Retz.) Koeler	Henry's crabgrass, kukaepua'a
N	*Digitaria insularis* (L.) Mez ex Ekman	Sourgrass
N	*Echinochloa crus-galli* (L.) P. Beauv.	Barnyard grass
N	*Eleusine indica* (L.) Gaertn.	Wiregrass
N	*Eragrostis tenella* (L.) P. Beauv ex Roem. & Schult.	Japanese lovegrass
E	*Eragrostis variabilis* (Gaud.) Steud.	Kawelu, 'emoloa
I?	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Pili, twisted beardgrass
E	*Panicum fauriei* Hitchc. var. *latius* (St. John) Davidse	
N	*Panicum maximum* Jacq.	Guinea grass
N	*Rhynchelytrum repens* (Willd.) Hubb.	Natal redtop
N	*Setaria gracilis* Kunth	Yellow foxtail
N	*Setaria verticillata* (L.) P. Beauv.	Bristly foxtail
N	*Sporobolus pyramidatus* (Lam.) Hitchc.	
I	*Sporobolus virginicus* (L.) Kunth	'Aki'aki
N	*Stenotaphrum secundatum* (Walter) Kuntze	St. Augustine grass

Status Codes:
+ = Rare
N = Nonnative
I = Indigenous (found naturally in Hawaii and elsewhere)
E = Endemic (restricted to Hawaii)

TABLE A3: VASCULAR PLANTS REPORTED OR OBSERVED IN THE MAUNAWILI VALLEY UNIT

STATUS	TAXON	COMMON NAME
FERNS AND FERN ALLIES		
	Adiantaceae	
N	*Adiantum raddianum* Presl	Maidenhair fern
	Angiopteridaceae	
N	*Angiopteris evecta* (Forst.) Hoffm.	
	Aspidiaceae	
E	*Ctenitis latifrons* (Brack.) Copel.	
E	*Tectaria gaudichaudii* (Mett.) Maxon	'Iwa'iwa lau nui
	Aspleniaceae	
I	*Asplenium nidus* L.	'Ekaha, bird's-nest fern
	Athyriaceae	
N	*Athyrium japonicum* (Thunb.) Copel.	
E	*Deparia prolifera* (Kaulf.) Hook. & Grev. var. *marginale* (Hillebr.)	
E	*Diplazium sandwichianum* (Presl) Diels	Ho'i'o, pohole
	Blechnaceae	
N	*Blechnum occidentale* L.	
E	*Sadleria cyatheoides* Kaulf.	'Ama'u, ma'u
	Dennstaedtiaceae	
I	*Microlepia strigosa* (Thunb.) Presl	Palapalai
	Dicksoniaceae	
E	*Cibotium splendens* (Gaud.) Krajina ex Skottsb.	Hapu'u pulu, treefern
	Elaphoglossaceae	
E	*Elaphoglossum crassifolium* (Gaud.) Anders. & Crosby	
	Gleicheniaceae	
I	*Dicranopteris linearis* (Burm.) Underw.	Uluhe
	Hemionitidaceae	
N	*Pityrogramma calomelanos* (L.) Link	Goldfern
	Hymenophyllaceae	
I	*Gonocormus minutus* (Blume) v. d. Bosch	
E	*Vandenboschia cyrtotheca* (Hillebr.) Copel.	
E	*Vandenboschia davallioides* (Gaud.) Copel.	
	Hypolepidaceae	
E	*Pteridium aquilinum* (L.) Kuhn ssp. *decompositum* (Gaud.)	
	Lindsaeaceae	
I	*Sphenomeris chinensis* (L.) Maxon	Pala'a
	Lycopodiaceae	
I	*Lycopodium cernuum* L.	Wawae'iole
	Nephrolepidaceae	
I	*Nephrolepis exaltata* (L.) Schott	Kupukupu, ni'ani'au
N	*Nephrolepis multiflora* (Roxb.) Jarrett ex Morton	Kupukupu, ni'ani'au
	Ophioglossaceae	
E	*Ophioglossum pendulum* L. ssp. *falcatum* Clausen	Puapuamoa
	Parkeriaceae	
?	*Ceratopteris siliquosa*	Swamp fern
	Polypodiaceae	
?	*Cyclosorus gongylodes*	Swamp cyclosorus
?	*Cyclosorus interruptus*	Taro patch fern
N	*Phlebodium aureum* (L.) J. Sm.	Hare's-foot fern, laua'e haole
N	*Phymatosorus scolopendria* (Burm.) Pic.-Ser.	Laua'e
I	*Pleopeltis thunbergiana* Kaulf.	Pakahakaha, 'ekaha 'akolea

STATUS	TAXON	COMMON NAME
FERNS AND FERN ALLIES (cont.)		
	Psilotaceae	
I	*Psilotum nudum* (L.) Beauv.	Moa
	Selaginellaceae	
E	*Selaginella arbuscula* (Kaulf.) Spring	Lepelepe-a-moa
	Thelypteridaceae	
E	*Christella cyatheoides* (Kaulf.) Holtt.	Kikawaio
N	*Christella dentata* (Forsk.) Brownsey & Jermy	
N	*Christella parasitica* (L.) Levl.	
N	*Macrothelypteris torresiana* (Gaud.) Ching	
E	*Pneumatopteris hudsoniana* (Brack.) Holtt.	
	Vittariaceae	
I	*Vittaria elongata* Sw.	
FLOWERING PLANTS: DICOTS		
	Acanthaceae (Acanthacea family)	
N	*Thunbergia laurifolia* Lindl.	Purple allamanda
	Amaranthaceae (Amaranth family)	
?	*Amaranthus spinosus*	Spiny amaranth
E	*Charpentiera obovata* Gaud.	Papala
	Anacardiaceae (Mango family)	
N	*Mangifera indica* L.	Mango
N	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki
	Apiaceae (Parsley family)	
N	*Centella asiatica* (L.) Urb.	Asiatic pennywort, pohekula
	Apocynaceae (Dogbane family)	
E	*Alyxia oliviformis* Gaud.	Maile
	Aquifoliaceae (Holly family)	
E	*Ilex anomala* Hook. & Arnott	Kawa'u
	Araliaceae (Ginseng family)	
N	*Schefflera actinophylla* (Endl.) Harms	Octopus tree
	Asteraceae (Sunflower family)	
I	*Adenostemma lavenia* (L.) Kuntze	Kamanamana
N	*Ageratina adenophora* (Spreng.) R. King & H. Robinson	Maui pamakani
N	*Ageratina riparia* (Regel) R. King & H. Robinson	Hamakua pamakani
N	*Ageratum conyzoides* L.	Maile hohono
E	*Artemisia australis* Less.	Hinahina, hinahina kuahiwi
E	*Bidens sandvicensis* Less. ssp. *sandvicensis*	Ko'oko'olau, koko'olau
N	*Conyza bonariensis* (L.) Cronq.	Hairy horseweed, ilioha
N	*Crassocephalum crepidioides* (Benth.) S. Moore	
?	*Eclipta alba*	False daisy
?	*Elephantopus mollis*	Elephant's foot
N	*Emilia sonchifolia* (L.) DC	Flora's paintbrush
N	*Erechtites valerianifolia* (Wolf) DC	Fireweed
N	*Erigeron karvinskianus* DC	Daisy fleabane
N	*Pluchea indica* (L.) Less.	Indian fleabane
?	*Pluchea odorata*	Pluchea
N	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush
N	*Sonchus oleraceus* L.	Sow thistle, pualele
N	*Vernonia cinerea* (L.) Less. var. *parviflora* (Reinw.) DC	Little ironweed
N	*Youngia japonica* (L.) DC	Oriental hawksbeard
	Begoniaceae (Begonia family)	
N	*Begonia hirtella* Link	Begonia

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: DICOTS (cont.)	
	Bignoniaceae (Bignonia family)	
N	*Jacaranda mimosifolia* D. Don	Jacaranda
N	*Spathodea campanulata* P. Beauv.	African tulip tree
	Buddlejaceae (Butterfly bush family)	
N	*Buddleia asiatica* Lour.	Dogtail
	Campanulaceae (Bellflower family)	
E	*Clermontia kakeana* Meyen	ʻOha, ʻohawai
E	*Cyanea angustifolia* (Cham.) Hillebr.	ʻOha, haha, ʻohawai
	Caryophyllaceae (Pink family)	
N	*Drymaria cordata* (L.) Willd. ex Roem. & Schult. var. *pacifica* Mizush.	Pipili, pilipili
	Casuarinaceae (She-oak family)	
N	*Casuarina equisetifolia* L.	Common ironwood, paina
	Cecropiaceae (Cecropia family)	
N	*Cecropia obtusifolia* Bertol.	Guarumo, trumpet tree
	Combretaceae (Indian almond family)	
N	*Terminalia myriocarpa* Van Heurck & Mull. Arg.	Jhalna
	Convolvulaceae (Morning glory family)	
N	*Ipomoea alba* L.	Moon flower, koali pehu
I	*Ipomoea indica* (J. Burm.) Merr.	Koali ʻawa, koali ʻawahia
	Cucurbitaceae (Gourd family)	
N	*Momordica charantia* L.	Balsam pear
	Ebenaceae (Ebony family)	
E	*Diospyros hillebrandii* (Seem.) Fosb.	Lama, elama
E	*Diospyros sandwicensis* (A. DC) Fosb.	Lama, elama
	Elaeocarpaceae (Elaeocarpus family)	
E	*Elaeocarpus bifidus* Hook. & Arnott	Kalia
	Epacridaceae (Epacris family)	
I	*Styphelia tameiameiae* (Cham. & Schlechtend.) F. v. Muell.	Pukiawe
	Euphorbiaceae (Spurge family)	
N	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui
E	*Antidesma platyphyllum* H. Mann var. *platyphyllum*	Hame, mehame
E	*Chamaesyce multiformis* (Hook. & Arnott) Croizat & Degener var. *microphylla*	
	Fabaceae (Pea family)	
N	*Acacia confusa* Merr.	Formosan koa
E	*Acacia koa* A. Gray	Koa
N	*Caesalpinia decapetala* (Roth) Alston	Wait-a-bit, mysore thorn
?	*Canavalia cathartica*	Mauna-loa
N	*Chamaecrista nictitans* (L.) Moench ssp. *patellaria* (DC ex Collad.)	
?	*Desmanthus virgatus*	Virgate mimosa
N	*Desmodium incanum* DC	Spanish clover, kaʻimi
N	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa
?	*Mimosa pudica*	Sensitive plant
N	*Paraserianthus falcataria* (L.) I. Nielsen	
N	*Senna septemtrionalis* (Viv.) H. Irwin & Barneby	Kolomona
	Gesneriaceae (African violet family)	
E	*Cyrtandra grandiflora* Gaud.	Haʻiwale, kanawao keʻokeʻo
E	*Cyrtandra laxiflora* H. Mann	Haʻiwale, kanawao keʻokeʻo
E	*Cyrtandra paludosa* Gaud. var. *paludosa*	Haʻiwale, kanawao keʻokeʻo
	Goodeniaceae (Goodenia family)	
E	*Scaevola gaudichaudiana* Cham.	Naupaka

STATUS	TAXON	COMMON NAME
FLOWERING PLANTS: DICOTS (cont.)		
	Loganiaceae (Logania family)	
E	*Labordia tinifolia* A. Gray var. *tinifolia*	Kamakahala
	Malvaceae (Mallow family)	
I?	*Hibiscus tiliaceus* L.	Hau
I	*Sida fallax* Walp.	'Ilima
	Melastomataceae (Melastoma family)	
N	*Arthrostema ciliatum* Pav. ex D. Don	
N	*Clidemia hirta* (L.) D. Don var. *hirta*	Koster's curse
N	*Oxyspora paniculata* (D. Don) DC	
	Meliaceae (Mahogany family)	
N	*Toona ciliata* M. Roem. var. *australis* (F. v. Muell.) C. DC	Austrailian red cedar
	Menispermaceae (Moonseed family)	
I	*Cocculus trilobus* (Thunb.) DC	Huehue
	Moraceae (Mulberry family)	
N	*Ficus* sp.	
N	*Ficus microcarpa* L. fil.	Chinese banyan, Malayan banyan
	Myrsinaceae (Myrsine family)	
E	*Myrsine lessertiana* A. DC	Kolea
	Myrtaceae (Myrtle family)	
I	*Eugenia reinwardtiana* (Blume) DC	Nioi
?	*Melaleuca leucadendra*	Paperbark
N	*Melaleuca quinquenervia* (Cav.) S. T. Blake	Paperbark
E	*Metrosideros macropus* Hook. & Arnott	'Ohi'a, 'ohi'a lehua, lehua
E	*Metrosideros polymorpha* Gaud.	'Ohi'a, 'ohi'a lehua, lehua
E	*Metrosideros tremuloides* (A. Heller) Lehua 'ahihi P. Knuth	
N	*Psidium cattleianum* Sabine	Strawberry guava, waiawi
N	*Psidium guajava* L.	Guava, kuawa
N	*Syzygium cuminii* (L.) Skeels	Java plum
N	*Syzygium jambos* (L.) Alston	Rose apple
N	*Syzygium malaccense* (L.) Merr. & Perry	Mountain apple, 'ohi'a 'ai
	Nyctaginaceae (Four-o'clock family)	
E	*Pisonia umbellifera* (G. Forster) Seem.	Papala kepau
	Oleaceae (Olive family)	
E	*Nestegis sandwicensis* (A. Gray) Degener, I. Degener & L. Johnson	Olopua, pua
	Onagraceae (Evening primrose family)	
N?	*Ludwigia octovalvis* (Jacq.) Raven	Primrose willow, kamole
?	*Ludwigia palustris*	Water purslane
	Passifloraceae (Passion flower family)	
?	*Passiflora foetida*	Scarlet-flowered passion flower
N	*Passiflora laurifolia* L.	Yellow granadilla, yellow water lemon
N	*Passiflora suberosa* L.	Huehue haole
	Piperaceae (Pepper family)	
I	*Peperomia leptostachya* Hook. & Arnott	'Ala'ala wai nui
E	*Peperomia membranacea* Hook. & Arnott	'Ala'ala wai nui
E	*Peperomia sandwicensis* Miq.	'Ala'ala wai nui
I	*Peperomia tetraphylla* (G. Forster) Hook. & Arnott	'Ala'ala wai nui
N	*Piper methysticum* G. Forster	Kava, 'awa
	Pittosporaceae (Pittosporum family)	
E	*Pittosporum flocculosum* (Hillebr.) Sherff	Ho'awa

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: DICOTS (cont.)	
	Proteaceae (Protea family)	
N	*Grevillea robusta* A. Cunn. ex R. Br.	Silk oak
	Rosaceae (Rose family)	
I	*Osteomeles anthyllidifolia* (Sm.) Lindl.	'Ulei
N	*Rubus rosifolius* Sm.	Thimbleberry
	Rubiaceae (Coffee family)	
E	*Bobea elatior* Gaud.	'Ahakea
I	*Canthium odoratum* (G. Forster) Seem.	Alahe'e
N	*Coffea arabica* L.	Arabian coffee
E	*Hedyotis acuminata* (Cham. & Schlechtend.) Steud.	Au
E	*Hedyotis terminalis* (Hook. & Arnott) W. L. Wagner & Herbst	Manono
N	*Morinda citrifolia* L.	Noni
N	*Paederia scandens* (Lour.) Merr.	Maile pilau
E	*Psychotria kaduana* (Cham. & Schlechtend.) Fosb.	Kopiko, 'opiko
E	*Psychotria mariniana* (Cham. & Schlechtend.) Fosb.	Kopiko, 'opiko
	Scrophulariaceae	
?	*Bacopa monnieria*	Water hyssop
	Solanaceae (Nightshade family)	
I?	*Solanum americanum* Mill.	Glossy nightshade, Popolo
	Thymelaeaceae ('Akia family)	
E	*Wikstroemia oahuensis* (A. Gray) Rock	'Akia
	Tiliaceae (Linden family)	
N	*Triumfetta semitriloba* Jacq.	Sacramento bur
N	*Heliocarpus popayanensis* Kunth	Moho, white moho
	Urticaceae (Nettle family)	
E	*Boehmeria grandis* (Hook. & Arnott) A. Heller	
N	*Pilea microphylla* (L.) Liebm.	Artillery plant, rockweed
I	*Pilea peploides* (Gaud.) Hook. & Arnott	
E	*Pipturus albidus* (Hook. & Arnott) A. Gray	Mamaki
E	*Touchardia latifolia* Gaud.	Olona
E	*Urera glabra* (Hook. & Arnott) Wedd.	Opuhe
	Verbenaceae (Verbena family)	
N	*Citharexylum caudatum* L.	Fiddlewood
N	*Lantana camara* L.	Lantana
N	*Stachytarpheta dichotoma* (Ruiz & Pav.) Vahl	Oi
N	*Stachytarpheta urticifolia* (Salisb.) Sims	
	FLOWERING PLANTS: MONOCOTS	
	Agavaceae (Agave family)	
N	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki
E	*Pleomele halapepe* St. John	Halapepe
	Alismataceae	
?	*Sagittaria sagittaefolia*	Arrowhead
	Araceae (Philodendron family)	
N	*Alocasia macrorrhiza* (L.) Schott	'Ape
N	*Colocasia esculenta* (L.) Schott	Taro, kalo
N?	*Pistia stratiotes*	Water lettuce
	Arecaceae (Palm family)	
N	*Livistonia chinensis* (Jacq.) R. Br. ex Mart.	Chinese fan palm
N	*Phoenix* sp.	Date palm
N	*Roystonea* sp.	Royal palm

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: MONOCOTS (cont.)	
	Commelinaceae (Spiderwort family)	
N	*Commelina diffusa* N. L. Burm.	Honohono
	Cyperaceae (Sedge family)	
I	*Carex meyenii* Nees	
E	*Carex wahuensis* C. A. Mey.	
I	*Cladium jamaicensis* Crantz	Sawgrass, ʻUki
?	*Cyperus alternifolius*	Umbrella sedge
?	*Cyperus brevifolius*	Kyllinga
?	*Cyperus difformis*	
?	*Eleocharis acicularis*	
N	*Eleocharis geniculata* (L.) Roem. & Schult.	Spikerush
?	*Eleocharis obtusa*	Pipi wai
I	*Fimbristylis dichotoma* (L.) Vahl	
N	*Kyllinga nemoralis* (J. R. Forster & G. Forster) Dandy ex Hutchinson & Dalziel	Kiliʻoʻopu
E	*Machaerina mariscoides* (Gaud.) J. Kern ssp. *meyenii* (Kunth) T. Koyama	
I?	*Schoenoplectus californicus*	Bulrush, kaluha
	Dioscoreaceae (Yam family)	
N	*Dioscorea alata*	Yam
N	*Dioscorea bulbifera* L.	Bitter yam, hoi
N	*Dioscorea pentaphylla* L.	Piʻa
	Heliconiaceae (Heliconia family)	
N	*Heliconia* sp.	Heliconia
	Lemnaceae	
N?	*Lemna minor*	Duckweed
N?	*Spirodela polyrrhiza*	Greater duckweed
	Musaceae (Banana family)	
N	*Musa x paradisiaca* L.	Banana, maiʻa
	Orchidaceae (Orchid family)	
N	*Epidendrum x obrienianum* Rolfe	Scarlet orchid, butterfly orchid
N	*Spathoglottis plicata* Blume	Malayan ground orchid
	Pandanaceae (Screw pine family)	
I	*Freycinetia arborea* Gaud.	ʻIeʻie
I?	*Pandanus tectorius* S. Parkinson ex Z.	Hala, screw pine
	Poaceae (Grass family)	
N	*Andropogon virginicus* L.	Broomsedge, yellow bluestem
N	*Brachiaria mutica* (Forssk.) Stapf	California grass
I?	*Chrysopogon aciculatus* (Retz.) Trin.	Golden beardgrass, manienie ʻula, pilipili
N	*Coix lachryma-jobi* L.	Job's tears, puʻohe'ohe
N?	*Cynodon dactylon*	Bermuda grass
N	*Digitaria ciliaris* (Retz.) Koeler	Henry's crabgrass, kukaepuaʻa
N	*Digitaria pentzii* Stent	Pangola grass
E	*Eragrostis variabilis* (Gaud.) Steud.	Kawelu, ʻemoloa
I?	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Pili, twisted beardgrass
N	*Oplismenus hirtellus* (L.) P. Beauv.	Basketgrass, honohono kukui
N	*Paspalum conjugatum* Bergius	Hilo grass
I?	*Paspalum scrobiculatum* L.	Ricegrass
?	*Paspalum vaginatum*	Seashore paspalum
?	*Pennisetum clandestinum*	Kikuyu grass
N	*Pennisetum purpureum* Schumach.	Elephant grass, Napier grass
N	*Sacciolepis indica* (L.) Chase	Glenwood grass
N?	*Schizostachyum glaucifolium* (Rupr.) Munro	Bamboo, ʻohe

STATUS	TAXON	COMMON NAME
	FLOWERING PLANTS: MONOCOTS (cont.)	
	Poaceae (Grass family) (cont.)	
N	*Setaria gracilis* Kunth	Yellow foxtail
N	*Setaria palmifolia* (J. Konig) Stapf	Palmgrass
N?	*Sporobolus virginicus*	Beach dropseed
	Pontederiaceae	
N	*Eichornia crassipes*	Water hyacinth
N	*Monochoria vaginalis*	Cordate monochoria
	Smilacaceae (Catbrier family)	
E	*Smilax melastomifolia* Sm.	Hoi kuahiwi
	Typhaceae	
N?	*Typhus angustata*	Cattail
	Zingiberaceae (Ginger family)	
N	*Hedychium gardnerianum* Ker-Gawl.	Kahili ginger
N	*Zingiber zerumbet* (L.) Sm.	Shampoo ginger, 'awapuhi kuahiwi

Status Codes:
N = Nonnative
I = Indigenous (found naturally in Hawaii and elsewhere)
E = Endemic (restricted to Hawaii)
? = None of the references used in this table provided information regarding status for this taxa

TABLE A4: NATURAL COMMUNITIES IN THE STUDY AREA

This list of natural communities is grouped within each study unit first by rare communities, then alphabetically by primarily native communities, followed by primarily nonnative communities. These lists attempt to include all the major communities, but do not necessarily include all natural communities that may be encountered in the units. Complex patterns of nonnative vegetation affected by development make classification of vegetation into distinct natural communities very difficult in some areas, especially in parts of the Maunawili Valley unit.

KOKO RIFT UNIT

Natural Community	Status	Dominant Species
Marsilea villosa Lowland Dry Herbland	Rare, native	*Marsilea villosa*
'A'ali'i Lowland Dry Shrubland	Native	'A'ali'i (*Dodonaea viscosa*)
Kawelu Coastal Dry Grassland (incorporated on vegetation maps in this report as part of "Native Coastal Vegetation on Beach and Cliff")	Native	Kawelu (*Eragrostis variabilis*)
Wiliwili Lowland Dry Forest (shown as Wiliwili Dry Forest on vegetation maps in this document)	Native	Wiliwili (*Erythrina sandwichensis*)
Variable native strand community (incorporated on vegetation maps in this report as part of "Native Coastal Vegetation on Beach and Cliff")	Native	Naupaka (*Scaevola sericea*), 'Ilima (*Sida fallax*, Pa'u-o-Hi'iaka (*Jacquemontia ovalifolia*)
Ironwood Forest	Nonnative	Ironwood (*Casuarina equisetifolia*)
Kiawe Forest/Grassland	Nonnative	Kiawe (*Prosopis pallida*)
Koa Haole Shrubland/Grassland	Nonnative	Koa Haole (*Leucaena leucocephala*)
Mangrove/Batis Wetland	Nonnative	Mangrove (*Rhizophora mangle*), Pickleweed (*Batis maritima*)

WAIMANALO BAY UNIT

Natural Community	Status	Dominant Species
Variable native strand community (incorporated on vegetation maps in this report as "Native Coastal Vegetation on Beach and Cliff")	Native	Naupaka (*Scaevola sericea*), 'Aki'aki (*Sporobolus virginicus*), Pohuehue (*Ipomoea pes-caprae*), 'Ilima (*Sida fallax*), Pa'u-o-Hi'iaka (*Jacquemontia ovalifolia*)
Ironwood Forest	Nonnative	Ironwood (*Casuarina equisetifolia*)
Kiawe Forest/Grassland	Nonnative	Kiawe (*Prosopis pallida*)
Koa Haole Shrubland/Grassland	Nonnative	Koa Haole (*Leucaena leucocephala*)
Mangrove/Batis Wetland	Nonnative	Mangrove (*Rhizophora mangle*), Pickleweed (*Batis maritima*)

Natural Community	Status	Dominant Species
Hawaiian Continuous Perennial Stream	Rare, native	'O'opu (various species of native gobies), 'opae kala'ole shrimp (*Atyoida bisulcata*)
Koa Lowland Mesic Forest	Native	Koa (*Acacia koa*), 'Ohi'a (*Metrosideros polymorpha*), 'Ahakea (*Bobea elatior*), Uluhe (*Dicranopteris linearis*), Hapu'u pulu tree ferns (*Cibotium splendens*), 'Ie'ie (*Freycinetia arborea*)
Mamaki Lowland Wet Shrubland	Native	Mamaki (*Pipturus albidus*) and other native nettles including Olona (*Touchardia latifolia*), Opuhe (*Urera glabra*), and *Boehmeria grandis*.
'Ohi'a/Uluhe Lowland Wet Forest	Native	'O'hia (*Metrosideros polymorpha*), Uluhe (*Dicranopteris linearis*), 'Ahakea (*Bobea elatior*).
Uluhe Lowland Wet Shrubland	Native	Uluhe (*Dicranopteris linearis*)
Bulrush/Sawgrass Coastal Wet Grassland	Possibly native	Kaluha (Bulrush) (*Schoenoplectus californicus*), 'Uki (Sawgrass) (*Cladium jamaicensis*), Taro patch fern (*Cyclosorus interruptus*), Cattail (*Typhus angustata*)
California Grass Lowland Wet Grassland	Nonnative	California grass (*Brachiaria mutica*), Honohono grass (*Commelina diffusa*), Arrowhead (*Sagittaria sagittaefolia*)
Mixed tree and shrub community surrounding Kawainui Marsh	Nonnative	Koa haole (*Leucaena leucocephala*), Guava (*Psidium guajava*), Chinese banyan (*Ficus microcarpa*), Monkey pod (*Samanea saman*)
Mixed tree and shrub community in lower Maunawili Valley	Nonnative	Kukui (*Aleurites moluccana*), Rose apple (*Syzygium jambos*), Java plum (*Syzygium cuminii*), Guava (*Psidium guajava*), Christmas berry (*Schinus terebinthifolius*, Hau (*Hibiscus tiliaceus*), Octopus tree (*Schefflera actinophylla*)

APPENDIX B: ANIMAL SPECIES LISTS

Appendix B is composed of three tables as follows:

Table B1, Rare Animals Reported in the Study Area, is taken completely from the Hawaii Heritage Program report (1991a). Nomenclature references are found in that document. According to the policy of the Hawaii Heritage Program, the following statement must accompany all information distributed from their reports:

> The Nature Conservancy's Hawaii Heritage Program database is dependent on the research of many scientists and individuals. In most cases this information is not the result of comprehensive site-specific field surveys and is not confirmed by the Heritage staff. Many areas in Hawaii have never been thoroughly surveyed, and new plants and animals are still being discovered. Database information should never be regarded as final statements or substituted for on-site surveys required for environmental assessments. Data provided by the Hawaii Heritage Program do not represent a position taken by The Nature Conservancy of Hawaii.

Table B2, Animals Observed During June 1991 Field Surveys, Koko Rift and Waimanalo Bay Units, is taken completely from the Hawaii Heritage Program report (1991a). It is based on field surveys they conducted under contract to the National Park Service during late June 1991 for the Koko Rift and Waimanalo Bay Units of the study area.

The field surveys dealt with terrestrial taxa and communities only. No assessment of nearshore or marine resources was undertaken, and Manana and Kaohikaipu islands were not surveyed. Censusing of birds during the field survey included both sight and vocalization identification. A special effort was made to census birds in early morning and evening, to take advantage of peak bird activity at those times. The presence of mammalian species was determined by sight, spoor, or scat. No effort was made to identify invertebrate species, except land snails (which were not found).

The surveys took place on six consecutive working days during the dry season in late June. The taxa recorded reflect the seasonal and environmental conditions at the time of the survey. Animals that are more abundant or active during the wet season (e.g., native land snails) could have been overlooked. Some species may have been overlooked in the complex terrain of this large study area.

Table B3, Animals Reported or Observed in the Maunawili Valley Unit is the third table in this appendix. It was discovered very early in the planning process for this report that plants and animals in the Maunawili Valley unit were primarily nonnative and heavily influenced by extensive development and agriculture in the unit (Hawaii Heritage Program 1991a and 1991b). Native plants are prevalent only above 1,000 feet elevation along the Koolau Pali. The time and cost to update biotic data in this unit was determined to be prohibitive and nonproductive due to the extremely complex mixture of predominately nonnative natural communities and the extensive development of golf course complexes in the unit occurring during the study period. Also, the Hawaii Heritage Program had just recently completed a field survey of part of the area above 1,000 feet elevation where native communities dominate (Hawaii Heritage Program 1991b). Therefore, no field survey was conducted in the Maunawili Valley unit; existing information was used to describe species and communities.

The major sources of plant and animal information used in Table B3 for the Maunawili Valley unit are Hawaii Heritage Program 1991a and 1991b, Corps of Engineers 1991, and Drigot and Seto 1982. Although Table B3 does not claim to provide a complete list of all animals that may occur in the study unit, it uses existing references to list the most common animals as well as those animals that are most significant from a planning perspective.

TABLE B1: RARE ANIMALS REPORTED IN THE STUDY AREA

SPECIES NAME (a)	COMMON NAME	STATUS (b)	UNIT & YEAR (c)
VERTEBRATES			
REPTILES			
Chelonidae			
Chelonia mydas	Honu, green turtle	LT, G3	K(1991**)
Eretmochelys imbricata	'Ea, hawksbill sea turtle	LE, G3	M(197?)
BIRDS			
Anatidae			
Anas wyvilliana	Koloa, Hawaiian duck	LE, G1	W(1986), M(1988)
Rallidae			
Fulica americana alai	'Alae-ke'oke'o, Hawaiian coot	LE, G5	W(1988), M(1988)
Gallinula chloropus sandvicensis	'Alae-'ula, Hawaiian gallinule	LE, G5	W(1980), M(1987)
Recurvirostridae			
Himantopus mexicanus knudseni	Ae'o, Hawaiian stilt	LE, G5	W(1980), M(1988)
Strigidae			
Asio flammeus sandwichensis	Pueo, Hawaiian owl	*, G3	K(1986), W(1986), M(1969)
Fringillidae			
Paroreomyza maculata	'Alauahio, Oahu creeper	LE, G1	M(1970)
Vestiaria coccinea	'I'iwi	*, G4	M(ND)
MAMMALS			
Vespertilionidae			
Lasiurus cinereus semotus	'Ope'ape'a, Hawaiian hoary bat	LE, G5	K(1963), M(1963)
Phocidae			
Monachus schauinslandi	Hawaiian monk seal	LE, G2	K(1990), W(1990), M(1990)
INVERTEBRATES			
INSECTS			
Coenagrionidae			
Megalagrion oahuense	Oahu megalagrion damselfly	C2, G?	M(1955)
Pyralidae			
Hedylepta monogramma	(moth)	G1	M(ND)
MOLLUSKS			
Achatinellidae			
Achatinella bellula	Pupu kuahiwi, Oahu tree snail	LE, G1	M(1953)
Achatinella fulgens	Pupu kuahiwi, Oahu tree snail	LE, G1	M(1966)
Achatinella fuscobasis	Pupu kuahiwi, Oahu tree snail	LE, G1	M(1989)
Achatinella taeniolata	Pupu kuahiwi, Oahu tree snail	LE, GH	M(1953)
Achatinella vittata	Pupu kuahiwi, Oahu tree snail	LE, GH	M(1953)
Achatinella vulpina	Pupu kuahiwi, Oahu tree snail	LE, GH	M(1953)

Key:

(a) References for nomenclature are provided in Hawaii Heritage Program report (1991a).

(b) Key to status:

FEDERAL RANKING (USFWS 1989):

LE = Taxa formally listed as endangered
LT = Taxa formally listed as threatened
C1 = Candidate for endangered or threatened status
C2 = Same as C1, more information needed to complete listing package

HAWAII HERITAGE PROGRAM RANKING:

G1 = Species critically imperilled globally (typically 1-5 current viable populations).
G2 = Species imperilled globally (typically 6-20 current viable populations).
G3 = Very rare with restricted range (typically 21-100 occurrences).
G4 = Apparently secure globally, although possibly rare locally (less than 100 occurrences).
G5 = Demonstrated secure globally, although possibly rare locally (e.g., at periphery of range).
GH = Species known only from historical populations (not observed since 1975).

(c) Key to study unit and year last reported in study unit:

K = Koko Rift unit
W = Waimanalo Bay unit
M = Maunawili Valley unit
(####) = Year of most recent occurrence reported for each unit of the study area.
(ND) = Observed but no date given.

* = *Asio flammeus sandwichensis* is formally listed as endangered by the state on Oahu only; *Vestiaria coccinea* is formally listed as endangered by the state on Oahu, Molokai, and Lanai only.

** = *Chelonia mydas* was observed offshore during the survey, but only occurrences onshore are included in the Hawaii Heritage Program's database.

TABLE B2: ANIMALS OBSERVED DURING JUNE 1991 FIELD SURVEYS, KOKO RIFT AND WAIMANALO BAY UNITS

STATUS	TAXON	COMMON NAME
VERTEBRATES		
REPTILES		
	Chelonidae	
+I	*Chelonia mydas*	Honu, green turtle
BIRDS		
	Procellariidae	
I	*Puffinus pacificus chlororhynchus*	ʻUaʻu kani, wedge-tailed shearwater
	Phaethontidae	
V	*Phaethon rubricauda rothschildi*	Koaʻeʻula, red-tailed tropicbird
	Sulidae	
I	*Sula sula rubripes*	Red-footed booby
	Fregatidae	
I	*Fregata minor palmerstoni*	ʻIwa, great frigatebird
	Ardeidae	
N	*Bubulcus ibis*	Cattle egret
I	*Nycticorax nycticorax hoactli*	ʻAukuʻu, black-crowned night-heron
	Phasianidae	
N	*Pavo cristatus*	Common peafowl
	Charadriidae	
V	*Pluvialis dominica*	Kolea, lesser golden-plover
	Scolopacidae	
V	*Arenaria arenaria*	ʻAkekeke, ruddy turnstone
V	*Heteroscelus incanus*	ʻUlili, wandering tattler
	Laridae	
I	*Anous stolidus pileatus*	Noio koha, brown noddy
I	*Gygis alba rothschildi*	Manu-o-ku, white tern
I	*Sterna fuscata oahuensis*	ʻEwaʻewa, sooty tern
	Columbidae	
N	*Columba livia*	Rock dove
N	*Geopelia striata*	Zebra dove
N	*Streptopelia chinensis*	Spotted dove
	Tytonidae	
N	*Tyto alba*	Common barn-owl
	Pycnonotidae	
N	*Pycnonotus cafer*	Red-vented bulbul
	Muscicapidae	
N	*Cettia diphone*	Japanese bush-warbler
N	*Copsychus malabaricus*	White-rumped shama
	Sturnidae	
N	*Acridotheres tristis*	Common myna
	Zosteropidae	
N	*Zosterops japonicus*	Japanese white-eye
	Emberizidae	
N	*Cardinalis cardinalis*	Northern cardinal
N	*Paroaria coronata*	Red-crested cardinal
	Fringillidae	
N	*Carpodacus mexicanus*	House finch
	Passeridae	
N	*Passer domesticus*	House sparrow

STATUS	TAXON	COMMON NAME
BIRDS (cont.)		
	Estrildidae	
N	*Estrilda astrild*	Common waxbill
N	*Lonchura punctulata*	Nutmeg mannikin
N	*Padda oryzivora*	Java sparrow
MAMMALS		
	Viverridae	
N	*Herpestes auropunctatus auropunctatus*	Small Indian mongoose
	Felidae	
N	*Felis catus*	Feral cat

+ = Rare
E = Endemic, native only to the Hawaiian Islands
I = Indigenous, native to the Hawaiian Islands and elsewhere
N = Non-native, not native to the Hawaiian Islands
V = Visitor

TABLE B3: ANIMALS REPORTED OR OBSERVED IN THE MAUNAWILI VALLEY UNIT

STATUS	SCIENTIFIC NAME	COMMON NAME
VERTEBRATES		
	REPTILES	
*	*Eretmochelys imbricata*	ʻEa, hawksbill sea turtle
	BIRDS	
N	*Acridotheres tristis*	Common myna
?	*Anas acuta*	Koloa-mapu, Northern Pintail
?	*Anas clypeata*	Koloa-moha, Northern shoveler
?	*Anas platyrhynchos*	Mallard
*	*Anas wyvilliana*	Koloa-maoli, Hawaiian duck
?	*Arenaria arenaria*	Akekeke, Ruddy turnstone
*	*Asio flammeus sandwichensis*	Pueo, Hawaiian owl
N	*Bubulcus ibis*	Cattle egret
?	*Caladris alba*	Huna-kai, Sanderling
N	*Cardinalis cardinalis*	Northern cardinal
N	*Carpodacus mexicanus*	House finch
N	*Cettia diphone*	Japanese bush-warbler
E	*Chasiempis sandwichensis gayi*	Oahu ʻelepaio
N	*Columbia livia*	Rock dove
N	*Copsychus malabaricus*	White-rumped shama
E	*Fregata minor palmerstoni*	ʻIwa, Great Frigatebird
*	*Fulica americana alai*	ʻAlae-keʻokeʻo, Hawaiian coot
*	*Gallinula chloropus sandvicensis*	ʻAlae-ʻula, Hawaiian gallinule
N	*Garrulax canorus*	Melodious laughing-thrush, Hwamei
N	*Geopelia striata*	Zebra dove
?	*Heteroscelus incanus*	ʻUlili, Wandering tattler
*	*Himantopus mexicanus knudseni*	Aeʻo, Hawaiian stilt
N	*Leiothrix lutea*	Red-billed leiothrix
N	*Lonchura punctulata*	Nutmeg mannikin
E	*Nycticorax nycticorax hoactli*	Aukuʻu, Black-crowned night heron
N	*Paroaria coronata*	Red-crested cardinal
*	*Paroreomyza maculata*	ʻAlauahio, Oahu creeper
N	*Passer domesticus*	House sparrow
I	*Phaethon lepturus dorotheae*	Koaʻe kea, white-tailed tropicbird
I	*Pluvialis dominica*	Kolea, lesser golden-plover
N	*Pycnonotus cafer*	Red-vented bulbul
N	*Streptopelia chinensis*	Spotted dove
*	*Vestiaria coccinea*	ʻIʻiwi
N	*Zosterops japonicus*	Japanese white-eye
	MAMMALS	
N	*Bos taurus*	Domestic cattle
N	*Canis familiaris*	Feral dog
N	*Felis catus*	Feral cat
N	*Herpestes auropunctatus auropunctatus*	Small Indian mongoose
*	*Lasiurus cinereus semotus*	ʻOpeʻapeʻa, Hawaiian hoary bat
*	*Monachus schauinslandi*	Hawaiian monk seal
N	*Rattus rattus*	Rat
	FISH	
E?	*Awaous stamineus*	ʻOʻopu nakea, goby
N?	*Chanos chanos*	Awa, milkfish
N	*Clarias fuscus*	Chinese catfish
I?	*Caranx* sp.	Papio, ulva
E?	*Eleotris sandwichensis*	ʻOʻopu okuhe, akupa, goby
N?	*Fluta alba*	Oriental rice eel
N	*Gambusia affinis*	Mosquitofish
E?	*Kuhlia sandvicensis*	Aholehole

STATUS	SCIENTIFIC NAME	COMMON NAME
	FISH (cont.)	
N	*Micropterus* sp.	Small-mouth bass
I?	*Mugil cephalus*	Mullet
I?	*Oxyurichthys lonchotus*	Pointed tail goby
N	*Poecilia reticulata*	Wild guppy
I?	*Saurida gracilis*	Lizard fish
I?	*Sphyraena barracuda*	Kaku
N	*Tilapia mossambica*	Tilapia
I?	*Stenogobius genivittatus*	ʻOʻopu naniha, Goby
N	*Xiphophorus helleri*	Swordtail
	AMPHIBIANS	
N	*Bufo marinus*	Toad
N	*Rana* sp.	Frog
INVERTEBRATES		
	INSECTS	
*	*Hedylepta monogramma*	(moth)
*	*Megalagrion oahuense*	Oahu megalagrion damselfly
	MOLLUSKS	
N	*Achatina fulica*	Giant Africal snail
*	*Achatinella bellula*	Pupu kuahiwi, Oahu tree snail
*	*Achatinella fulgens*	Pupu kuahiwi, Oahu tree snail
*	*Achatinella fuscobasis*	Pupu kuahiwi, Oahu tree snail
*	*Achatinella taeniolata*	Pupu kuahiwi, Oahu tree snail
*	*Achatinella vittata*	Pupu kuahiwi, Oahu tree snail
*	*Achatinella vulpina*	Pupu kuahiwi, Oahu tree snail
N	*Euglandia rosea*	Carnivorous snail
I?	*Melanoides* sp.	Carnivorous snail
?	*Physa* sp.	Pond snail
	CRUSTACEANS	
E	*Atyoida bisculata*	ʻOpae kalaʻole, Mountain shrimp
E?	*Macrobrachium grandimanus*	ʻOpae ʻoehaʻa, Hawaiian prawn
N	*Macrobrachium lar*	Tahitian prawn
I?	*Palaemon debilis*	ʻOpae huna
I?	*Podophthalmus vigil*	Long eyed swimming crab
N	*Portunus sanguinolentus*	Haole, blue-spot crab
N	*Procambarus clarkii*	Louisiana crayfish
N	*Scylla serrata*	Samoan crab
I?	*Thalamita crenata*	Hapa crab

Key to status:
* = Rare, threatened, or endangered (see table B1)
N = Nonnative
E = Endemic
I = Indigenous
? = None of the references used in this table provided information on status for this taxa

APPENDIX C: LAND USE AND ZONING DATA

The Office of Council Services, city and county of Honolulu, provided information for the following tables. Figures for Waimanalo Bay do not include all of the beach parks in the study area. Figures for Maunawili Valley might not reflect recent changes or include all private lands since the study area boundary is somewhat indefinite. The totals in the following tables will not agree with table 1 due to different boundaries and methods used by the two agencies.

TABLE C-1: EXISTING LAND USE

EXISTING LAND USE	APPROXIMATE ACREAGE			TOTAL	PERCENT
	KA IWI SHORELINE	WAIMANALO BAY BELLOWS AFS	MAUNAWILI VALLEY KAWAINUI MARSH		
Residential	–	–	328.74	328.74	3.90
Industrial	3.61	0.29	13.09	16.99	0.20
Commercial	0.03	–	–	0.03	0.00
Services	35.13	909.09[1]	14.32	958.54	11.40
Social/Cultural	–	–	37.59	37.59	0.45
Recreation	1,231.46	74.76	127.01	1,433.23	17.04
Extraction	–	–	922.38	922.38	10.97
Unused Land	382.82	583.80[1]	3,747.74	4,714.36	56.04
TOTAL	1,653.05	1,567.94	5,190.87	8,411.86	100.00

[1] Bellows AFS – Services includes lands used for military and public recreation; unused lands are military training areas.

TABLE C-2: ZONING DISTRICTS

ZONING DISTRICTS		APPROXIMATE ACREAGE			TOTAL	PERCENT
		KA IWI SHORELINE	WAIMANALO BAY BELLOWS AFS	MAUNAWILI VALLEY KAWAINUI MARSH		
Residential	R-20[1]	–	–	69.63	69.63	0.83
	R-7.5[1]	–	–	71.63	71.63	0.85
	R-5[1]	31.75	–	60.24	91.99	1.09
Subtotal – Residential		31.75	0.00	201.50	233.25	2.77
Agriculture – AG-2		–	–	1,109.48	1,109.48	13.19
Country[2]		–	–	38.22	38.22	0.45
Preservation	P-1[3]	1,392.47	–	3,728.54	5,121.01	60.87
	P-2[3]	229.02	74.76	112.95	416.73	4.95
Subtotal – Preservation		1,621.49	74.76	3,841.49	5,537.74	65.84
Military Preservation	F-1[3]	–	1,493.17	–	1,493.17	17.75
TOTAL		1,653.24	1,567.93	5,190.69	8,411.86	100.00

[1] R-20, R-5, and R-7.5 refer to minimum lot size for one-family detached dwellings

R-20 – Single family, schools, utilities, meeting facilities, day care facilities

R-5 & R-7.5 – Detached one- and two-family dwellings, duplexes, schools, utilities, meeting facilities, day care facilities

[2] Country rural quality – limited agriculture, residential, and supporting services.

[3] P-1 State preservation lands – uses as permitted by managing agency.

P-2 General preservation district – permits a variety of uses such as grazing, aquaculture, golf courses, crop production, and recreational facilities.

F-1 Military preservation – identifies military and other federal lands regardless of use. If these become surplus they revert to P-2 zoning.

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PLANNING TEAM

National Park Service, Denver Service Center

Douglas Cornell, Architect/Planner - Team Captain
Rick Ernenwein, Natural Resource Specialist
Christy Fischer, Writer/Editor
Harlan Unrau, Cultural Resource Specialist

The Nature Conservancy, Hawaii Heritage Program

CONSULTANTS

National Park Service

Western Regional Office
Jack McDonald, Division of Land Resources
Ray Murray, Chief Planning, Grants and Environmental Compliance Division

Pacific Area Office
Gary Barbano, Park Planner
Bryan Harry, Area Director
Buddy Neller, Cultural Resource Specialist

State of Hawaii
Department of Hawaiian Home Lands
Department of Land and Natural Resources staff
Tom Dye, Archeologist, State Historic Preservation Division
Bill Gorst, State Parks Division and his staff
William W. Paty, State Historic Preservation Officer, State of Hawaii
Ron Walker, State Forestry and Wildlife Division
Office of Hawaiian Affairs

City and County of Honolulu
Councilmember John Henry Felix, and Tom Rack and Ron Boyer of his staff
Walter Ozawa, City & County Parks Department and his staff

Other Agencies, Organizations, and Individuals
Russ Apple, Retired, NPS Historian
Bishop Museum
Jane Allen, Archeologist
Aki Sinoto, Public Archeology Contract Manager, Applied Research Group
James Delgado, Director, Vancouver Maritime Museum
Hawaii's Thousand Friends
Muriel B. Seto, Cultural Chair
Donna Wong
Kawai Nui Heritage Foundation
Dr. Diane C. Drigot
Mr. Robert Herlinger

Colonel Don A. Lyon, Commander 15th Air Base Wing and his staff, Hickam Air Force Base
Maunawili Community Association
Victoria S. Creed
University of Hawaii
Dr. Marion Kelly, Cultural Anthropologist

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