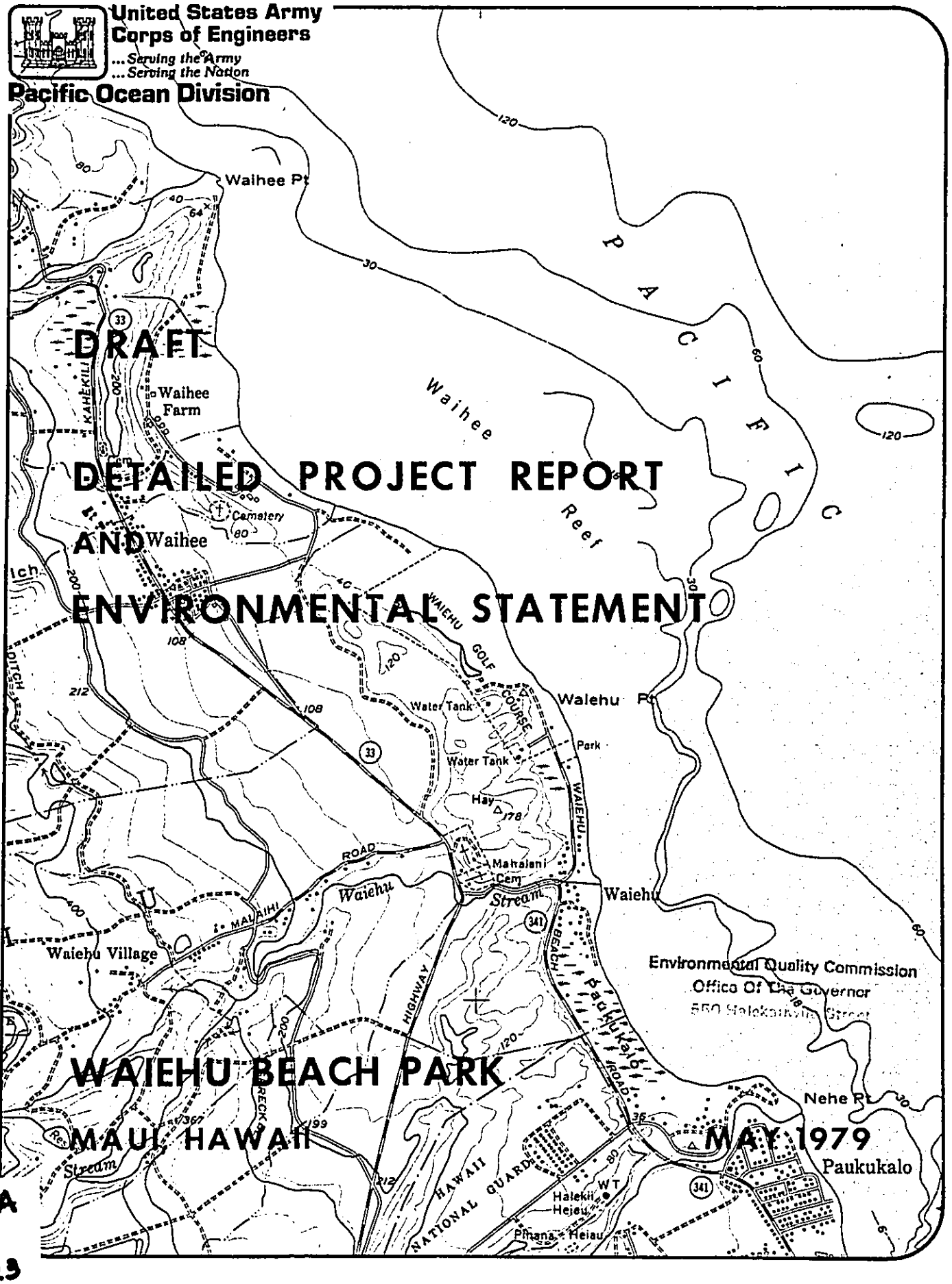
United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

Pacific Ocean Division



DRAFT

DETAILED PROJECT REPORT AND ENVIRONMENTAL STATEMENT

WAIEHU BEACH PARK

MAUI, HAWAII

MAY 1979

DRAFT

DETAILED PROJECT REPORT

AND

ENVIRONMENTAL STATEMENT

WAIEHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

U.S. ARMY ENGINEER DISTRICT
HONOLULU
BLDG 230
FORT SHAFTER, HAWAII 96858

MAY 1979

WAIEHU BEACH PARK
DETAILED PROJECT REPORT
AND
ENVIRONMENTAL STATEMENT
MAUI, HAWAII

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LIST OF ABBREVIATIONS AND SYMBOLS

Symbol	Definition
CERC	US Army Coastal Engineering Research Center
CRM	Concrete Rubble Mound
cy	Cubic Yard(s)
d_s	Design Water Depth (ft)
DEIS	Draft Environmental Impact Statement
DPR	Detailed Project Report
EIS	Environmental Impact Statement
EQ	Environmental Quality
ft	Foot or Feet
H	Wave Height (ft)
H_b	Design Breaker Height (ft)
K_D	Stability Coefficient
lbs	Pounds
LS	Lump Sum
MHHW	Mean Higher High Water (ft)
MHW	Mean High Water (ft)
MLLW	Mean Lower Low Water (ft)
MLW	Mean Low Water (ft)
MPN	Most Probable Number
MSL	Mean Sea Level (Ft)
NED	National Economic Development
pcf	Pounds Per Cubic Foot

Symbol	Definition
P&S	Principles & Standards
RD	Regional Development
S_a	Astronomical Tide (ft)
S_r	Specific Gravity with Respect to Seawater
S_s	Rise Due to Storm Surge (ft)
S_w	Rise Due to Wave Setup (ft)
S_{ap}	Rise Due to Atmospheric Pressure Drop (ft)
SWB	Social Well Being
SWL	Sea Water Level (ft)
W	Weight of Armor Stone (lbs)
Wr	Unit Weight of Stone (pcf)
WRC	Water Resources Council
α (Alpha)	Angle of the Revetment Face with Respect to the Horizontal
$^{o}/_{oo}$	Parts Per Thousand

WAIEHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

MAIN REPORT

I. INTRODUCTION

1. Purpose.

The purposes of this study were to identify the cause and extent of shore erosion in Waiehu Beach Park, Maui, Hawaii and to develop an efficient, practical, and environmentally acceptable plan to protect the project area from erosion.

2. Study Authority.

a. The Waiehu Beach Park shore protection study was initiated following a request from the Department of Public Works, County of Maui (State of Hawaii), dated 19 September 1977. Based upon this request, a reconnaissance report was completed on 3 July 1978 and approved for detailed project studies by the Chief of Engineers on 13 July 1978.

b. This study and report were accomplished under the authority provided by Section 103 of the River and Harbor Act of 1962, as amended, which states:

> "The Secretary of the Army is hereby authorized to undertake construction of small shore and beach restoration and protection projects not specifically authorized by Congress, which otherwise comply with Section 1 of this Act, when he finds that such work is advisable, and he is further authorized to allot from any appropriations hereafter made for civil works, not to exceed $25,000,000 for any one fiscal year for the Federal share of the costs of construction of such projects: Provided, That not more than $1,000,000 shall be allotted for this purpose for any single project and the total amount allotted shall be sufficient to complete the Federal participation in the project under this section including periodic nourishment as provided for under Section 1(c) of this Act: Provided further, That the provisions of local cooperation specified in Section 1 of this Act shall apply: And provided further, That the work shall be complete in itself and shall not commit the United States to any additional improvement to insure its successful operation, except for participation in periodic beach nourishment in accordance with Section 1 (c) of this Act, and as may result from the normal procedure applying to projects authorized after submission of survey reports."

3. Study Area.

Waiehu Beach Park is located on the northeast coast of the island of Maui (State of Hawaii), approximately three miles north of the town of Wailuku (see Figure 1). The park shoreline is approximately 560 feet, and the project study area (see Figure 2) is approximately 350 feet of

shoreline, extending from the Waiehu Municipal Golf Course to the pavilion park area.

4. Scope of the Study.

a. This study identifies and evaluates the problems and needs of providing shore protection at Waiehu Beach Park and the impacts upon the overall environmental, cultural, and recreational resources of the area. The development of alternative solutions for protecting the shoreline from further erosion and the determination of costs, benefits, and environmental impacts associated with implementing these measures are considered.

b. Studies conducted included site investigations, archaeological surveys, topographic surveys, geologic and material investigations, fish and wildlife studies, oceanographic and meteorological studies, engineering designs, economic evaluations and environmental assessments.

5. Study Participants and Coordination.

a. The U.S. Army Corps of Engineers, Honolulu District, was responsible for conducting and coordinating the study and preparing the study report. Studies and investigations were performed with the assistance of the Maui County Department of Public Works who initially requested the study and who serves as the local sponsor of the project.

b. Governmental agencies, community groups, and private interests were contacted during the course of the study in an effort to identify study concerns, obtain pertinent study information, and to develop alternative plans. A list of agencies and organizations that were contacted can be found in Appendix A (Public Involvement).

6. Study Constraints and Concerns.

The Waiehu Beach Park area is being leased by the County of Maui from the Wailuku Sugar Company. If Federal participation in shore protection is warranted, local cooperation agreements must insure that the lease agreement would be in effect for the expected 50 year life of the project.

7. Report Preparation.

a. This report consists of a main report and a series of supporting appendices. The main report is a self-contained document which describes the planning process and includes the environmental statement.

b. In accordance with the Fish and Wildlife Coordination Act, a section 2(b) report was prepared by the U.S. Fish and Wildlife Service and is included in the Environmental Statement and Appendix E.

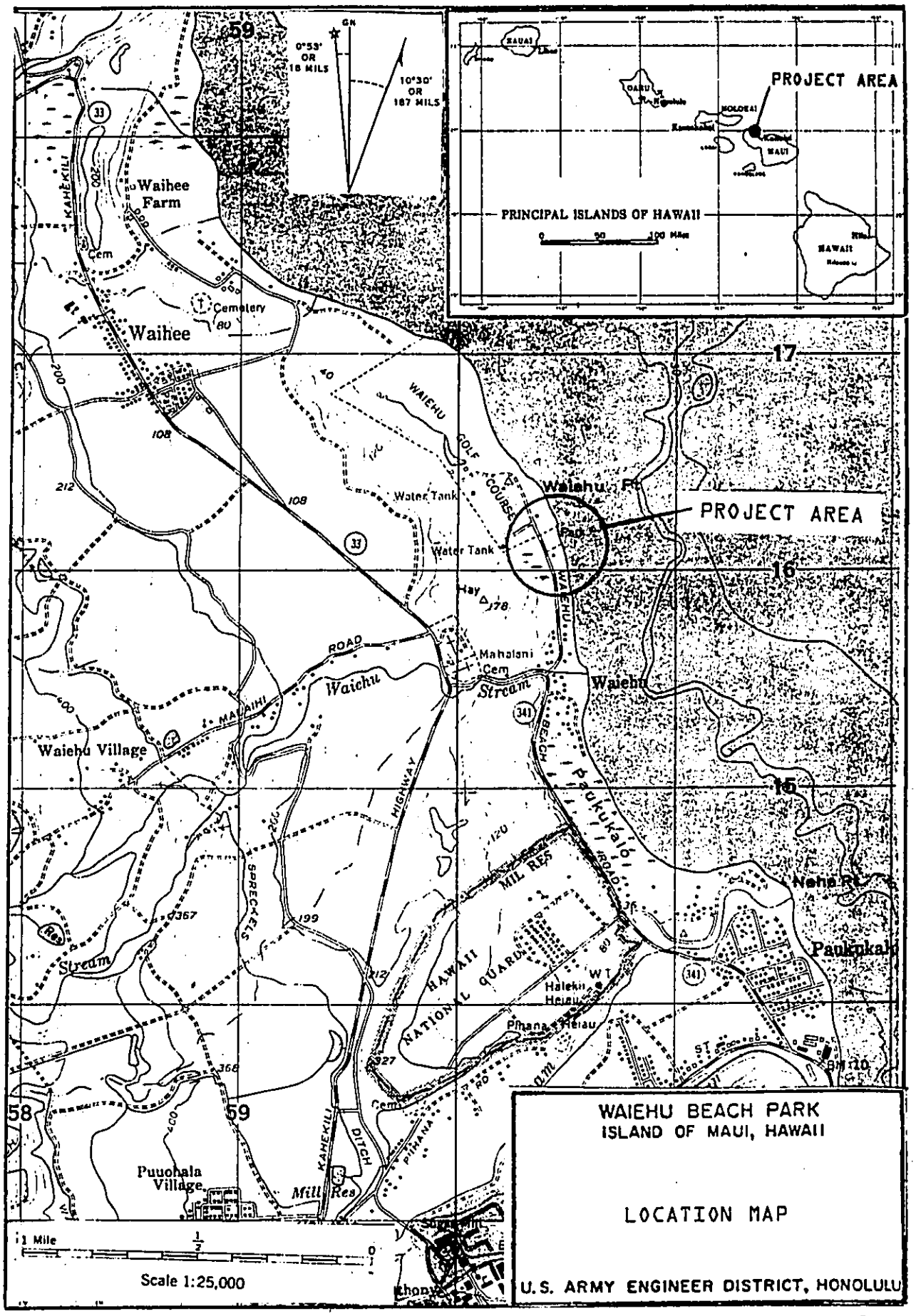
PROJECT AREA
PRINCIPAL ISLANDS OF HAWAII
KAUAI
OAHU
MOLOKAI
MAUI
HAWAII
PROJECT AREA
Waihee Farm
Cem
Cemetery
Waihee
WAIEHU GOLF COURSE
Waiehu Pt
Water Tank
Water Tank
Hay
Mahalani Cem
Waiehu
Stream
Waiehu Village
Waiehu Pt
Nohe Pt
Paukukalo
Stream
Mill Res
Halekii Heiau
Phana Heiau
Puuohala Village
Mill Res
Cem
Scale 1:25,000
WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII
LOCATION MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1

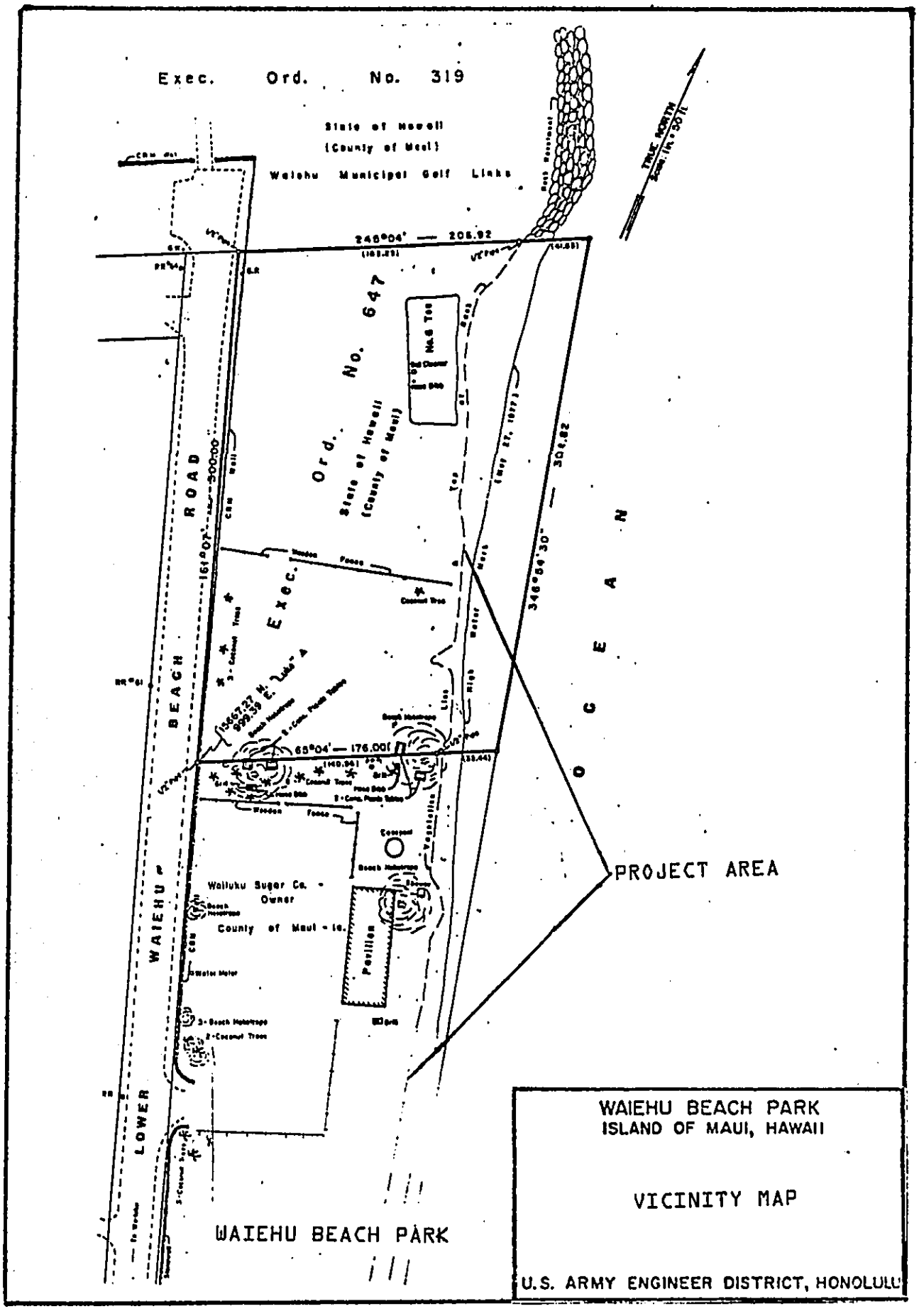
Exec. Ord. No. 319
State of Hawaii
(County of Maui)
Waiehu Municipal Golf Links
248°04' — 205.92
Ord. No. 647
State of Hawaii
(County of Maui)
ROAD
BEACH
Exec.
348°56'30" — 306.82
OCEAN
65°04' — 176.00'
Wailuku Sugar Co. -
Owner
County of Maui - Lo.
Pavilion
WAIEHU
LOWER
WAIEHU BEACH PARK
PROJECT AREA
WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII
VICINITY MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2

c. The appendices contain technically detailed information and background data to support the information contained in the main report.

Appendix A, Public Involvement, contains the public involvement program of this study and any pertinent correspondence and public comments recorded during the progress of the study.

Appendix B, Design, contains pertinent engineering data and analysis to support the plan formulation process and alternative solutions.

Appendix C, Recreation and Natural Resources, contains information on the various recreational activities within the study area and natural resources pertinent to the study area. The Social and Cultural Resources portion contains the social components and the cultural resources of the study area.

Appendix D, Economic Evaluation, contains the economic environment of the area and the benefits and costs which would be accrued from the proposed project.

Appendix E, Fish and Wildlife Information, contains data provided by the U.S. Fish and Wildlife Service in support of their section 2(b) report.

8. Prior Studies.

a. A reconnaissance report on shore protection at Waiehu Beach Park was completed by the Honolulu District, Corps of Engineers on 3 July 1978. This report established Federal interest in providing possible shore protection for the study area.

b. Technical assistance under Section 55 for shoreline protection of the Waiehu Municipal Golf Course, Island of Maui, Hawaii, was completed on 16 May 1978 for the Maui Department of Public Works. This report suggested constructing a stone revetment along the golf course to protect it from further erosion.

II. PROBLEM IDENTIFICATION

1. Purpose.

The purpose of problem identification is to develop planning objectives which will guide the formulation of alternative plans. Public concerns which relate to water and related land resource problems are identified and then refined based on national and local policies and the study authority. National planning policies are dictated by the Water Resources Council Principles and Standards (38 FR 24778-24 869), the National Environmental Policy Act of 1969 (PL 91-190), Section 122 of the River and Harbor and Flood Control Act of 1970 (PL 91-611), Clean Water Act of 1977 (PL 95-217), the Water Resources Development Act of 1974 (PL 93-251), and the Corps of Engineers' Policy Guidelines (ER's). To understand the resource management 1/ problems the base condition of the study area is first defined. The base condition is the existing economic, social, and environmental characteristics of the area. Future conditions are then projected and analyzed to determine the "most probable future" 2/ which would prevail over the area without any changes to existing resource management plans. This analysis is described as the "without condition" criterion. Planning objectives 3/ are then based on the problems and needs of the area as related to the "without condition" criterion and national and local planning policies.

2. National Objectives.

The Principles and Standards (P&S) for Planning Water and Land Resources define the national objectives of national economic development and environmental quality. The national objectives provide the basis for formulation and analysis of alternative plans. The national economic development (NED) objective is achieved by increasing the value of the nation's output of goods and services and improving national economic efficiency. The environment quality (EQ) objective provides for the

---

1/ "Resource management" involves the development, conservation, enhancement, preservation, or maintenance of water and related land resources to achieve the goals of society expressed nationally and locally.

2/ "Most probable future" is the projection of basic demographic, economic, social, and environmental parameters, which is used as the basis for defining the "without condition" and the planning objectives for a particular study.

3/ "Planning objectives" are the national, state, and local water and related land resource management needs (opportunities and problems) specific to a given study area that can be addressed to enhance National Economic Development or Environmental Quality.

management, conservation, preservation or improvement of the quality of certain natural and cultural resources and ecological systems in the study area. During the formulation of alternative plans the NED and EQ contributions are evaluated on an equal basis; however, for any plan to be recommended, the benefits accruing from the project must exceed the economic cost of the project. P&S also requires that the impacts of a proposed action be measured in terms of Regional Development (RD) and Social Well Being (SWB). Contributions to the RD account are determined by establishing a proposal's effects on a region's income, employment, population, economic base, environment, and social development. Contributions to the SWB account are determined by establishing a proposal's effects on real income, security of life, health and safety, education, cultural and recreational opportunities, and emergency preparedness.

3. Existing Base Conditions

a. Physical Setting. Waiehu Beach Park is located on the northern coastline of West Maui, about 3 miles north of the town of Wailuku and 4 miles from Kahului. The West Maui Mountains form a steeply incised backdrop for the area. The surrounding area is composed of State and private land holdings. The Waiehu Municipal Golf Course is directly adjacent to the Park. The beach fronting the golf course to the north consists of a grass covered berm with a near vertical drop of about 6 feet to the water's edge. Approximately 200 feet from the park area, the front of the berm is protected by a line of basalt armor stone. Constructed in 1969, the stones were randomly placed and have diameters of about 3 to 4 feet. Some scouring has occurred in this section where the fronting beach has partially eroded up to the armor stones. The areas to the south of the park consist of residential housing, many with low level shore protection seawalls (approximately 2-3 feet in height) and fences with vegetative barriers. The fronting beaches in these areas are covered with a thick layer of debris and basaltic cobbles.

The park has approximately 560 feet of coastline and consists of about 3 acres 1/ of land. Physical features within the park include a wooden pavilion, a parking area, miscellaneous picnic tables and grills. The park's fronting beach is about 35 to 45 feet wide where a 2- to 3-foot escarpment has developed. The backshore areas are grassy flat areas approximately 200 feet wide. An offshore reef extends offshore to approximately 500 feet.

b. Natural Forces.

(1) Astronomical tides. Tidal data referenced to mean lower low water from Kahului Harbor, approximately 2 miles from the study area were obtained from the National Oceanic and Atmospheric Administration, National Ocean Survey.

1/ Approximately 1.2 acres of improved park area and 1.8 acres of unimproved lands.

Reference	Feet
Highest Observed (12 Nov 58, 20 Jun 59)	3.60
Mean Higher High Water	2.30
Mean High Water	1.90
Mean Tide Level	1.15
Mean Low Water	0.40
Mean Lower Low Water	0.00
Lowest Observed (19-20 Jun 55)	-1.20

(2) Winds. Tradewinds prevail more than 75 percent of the time from the north and northeast. Sustained wind velocities ranging between 25 and 35 miles per hour have been recorded for about one-third of the day at the Kahului airport approximately 4 miles from the study area. There is no indication that the winds play a direct role in causing erosion at the project area.

(3) Waves. The Hawaiian Islands are affected by waves generated in all parts of the Pacific. Five types of waves affect the study area: north Pacific swells, northeast trade waves, Kona storm waves, hurricane generated waves, and tsunamis.

North Pacific swells are waves produced by storms in the Aleutian and mid-latitude areas, and may arrive in the Hawaiian area any time throughout the year. They are largest and occur most frequently from October through May. They may approach from the north, northwest, or northeast and typically have periods of about 10 to 15 seconds and heights from 8 to 19 feet.

Northeast trade waves generated by the prevailing tradewinds are present throughout the year and are most intense from April through November. These waves usually have periods ranging from 6 to 12 seconds and heights ranging from 4 to 12 feet approaching most frequently from the northeast and east.

"Kona" storm waves are generated by intense winds associated with local fronts or Hawaiian lows. The Kona waves have periods ranging from 6 to 10 seconds and heights from 10 to 15 feet.

Hurricanes are uncommon in Hawaii. Tropical storms are more frequent and pass close to the Hawaiian Islands. From 1950 to 1979, 14 hurricanes or near hurricanes occured in the vicinity of the Hawaiian islands. The predominant path of hurricanes is from the southeast to the northeast passing either south or north of the island chain.

Tsunamis (seismic seawaves) are impulse generated waves. Their long period gravity waves are generated by a sudden large displacement of the sea bottom associated with earthquakes. In recent years, Hawaii has been affected by 5 tsunamis that have caused appreciable runup or vertical rise above stillwater levels on the island of Maui. Tsunami wave runup in the order of 9 to 12 feet has been recorded in the study area. The Waiehu Beach Park lies within the tsunami inundation area designated by the Maui Civil Defense maps. Based on preliminary flood insurance maps prepared by the Federal Insurance Administration, the runup of a 1 percent frequency tsunami would extend about 500 feet inland from the shore at the beach park site.

c. Natural Resources.

(1) Climate. Hawaii's climate reflects the interplay of its latitude, the moderating effect of the surrounding ocean, location relative to storm tracks, and the terrain. A major factor in the attractiveness of the Hawaiian Islands is the moderate climate. The islands' climate is characterized by a two season year: a 5-month summer and a 7-month winter period with small variations in temperature. During the summer, the weather is warmer and drier and the northeasterly tradewinds are predominant. During the winter, storm conditions in the Pacific play a major role in influencing the islands' weather conditions. The average annual temperature is 74.6°F. The mean annual precipitation of Maui varies from about 25 inches along the coast to about 400 inches at the summit of Puu Kuhui.

(2) Geology. The park is founded on weakly consolidated dune sands which were blown onto the site during the late Pleistocene period. These dunes are composed of bedded and cross-bedded fine grained cream or tan colored calcareous sand. The beach sand is well sorted and very coarse in grain size. A thin mantle of recent medium grained beach sand and a line of coarse basaltic gravel and cobbles cover the dunes and form the water's edge. Vegetated grassy sand dunes are found between the beach and its marshy hinterlands. Waiehu reef extends offshore with its edge approaching the shore at a boulder beach to the north. Boulders, cobbles, and sand pockets cover the reef's surface.

Although the northernmost part of this coast is low, no beaches exist along this part of the coastline. To the south, Kahului Harbor has beaches of varying widths. Waihee reef is the most prominent offshore feature along this coast. North of Waihee Point, there is no reef, and south of Waihee Point into Kahului Harbor, the reef narrows to half its width off Waihee. The eastern part of Kahului Harbor has been dredged and most of the inshore areas are sediment-covered.

(3) Terrestrial biota. Flora consists of either intentionally cultivated or unintentionally introduced exotic species. Vegetation within the coastal lowlands is characterized by cultivated sugarcane or

thicket forests. Fauna consist of birds and mammals. Rats, mice, mongoose and feral cats and dogs are probably present within and near the project area where they probably feed on food scraps from the picnic areas of the park. No known endangered or threatened species habitat exists within the project area. A detailed biological description of the area can be found in the environmental statement.

(4) Marine. The water quality off Waiehu Point is classified as "A" by the State of Hawaii Water Quality Standards, and these waters are to be protected for recreation. aesthetic enjoyment and the support of propagation of aquatic life. The offshore area is rich in the assemblage of flora and fauna. In accordance with the Fish and Wildlife Act, a section 2(b) report was prepared by the U.S. Fish and Wildlife Service which details the marine environment. This report is included in the environmental statement.

d. Cultural.

The surrounding area is culturally significant to the native Hawaiians. A Hawaiian fishing pond, ancient cave dwellings, a former battleground, and skeletal remains within the general area indicate that the area was formerly occuped by the ancient Hawaiians. It is believed, but not documented, that the project area may contain archaeologically significant deposits. An archaeological survey is being conducted to determine if significant artifacts exist within the project area. The conclusion of this report will be available in the final Detailed Project Report.

e. Social/Recreational.

The park is a primary source of social and recreational activities in the local surrounding communities. The physical facilities (pavilion, tables, grills) serve as a social gathering point providing restrooms, dressing areas, tables, and water facilities. The park is the only one of its kind available to the local residents along the northeast coast of West Maui and is frequently used for fishing, snorkeling, limu (seaweed) gathering, and social and special party events. Many senior citizens spend their leisure time fishing at the park. The offshore area is considered one of the choicest sites for fishing on northeast Maui. There are no good swimming beach areas within the park and camping is not allowed. The park plays a significant social and recreational role for the local communities giving them an area with access close to their residences. An estimated 35,000 annual visits were made in 1978.

f. Future Conditions Without Federal Action.

(1) Population. The State of Hawaii's resident population has grown from 154,000 in the year 1900, to 633,000 in 1960, 770,000 in 1970, and to an estimated 896,700 in 1978. This population is

relatively young and diversified. Migration has been a major factor in rapid growth. Between 1960 and 1970, about 193,000 migrants moved to Hawaii with only approximately 140,000 people moving away. The resident population of the island of Maui in 1978 was 53,900. Population projections prepared by State Department of Planning and Economic Development (Series II F) point to continued growth and are summarized in the following table.

TABLE 1

SUMMARY OF POPULATION PROJECTIONS
TOTAL POPULATION PROJECTIONS BY COUNTY

Year	State	Oahu	Kauai	Maui 1/	Hawaii
1970	769,913	630,529	29,761	46,156	63,468
1978 (EST)	896,700	722,400	34,000	61,400	78,900
1980	942,300	753,000	36,500	67,400	84,700
1985	1,020,900	803,800	40,600	81,400	95,200
1990	1,091,500	845,000	46,500	94,900	105,100
1995	1,163,800	885,800	53,100	109,900	115,000
2000	1,225,900	917,400	60,400	124,700	123,300

1/ Maui County is made up of four islands: Maui, Lanai, Molokai, and Kahoolawe.

Source: Hawaii State Department of Planning and Economic Development Revised Population and Economic Projections 1975-2000 (1 March 1978) p. 4.

The population of the island of Maui is geographically distributed into four distinct centers; Wailuku-Kahului, Makawao-Kula, Hana, and Lahaina. Waiehu Beach Park is located in the Wailuku-Kahului area that has over half of the island's population. This area has developed into the commercial and industrial hub of the island and is expected to continue to dominate the island's population. The current projected population for the island of Maui to the year 2000 (Series II F) is shown in Table 2. Included with the island's projections is the historical population by district for the years 1960 and 1970.

TABLE 2

ISLAND OF MAUI POPULATION PROJECTION WITH HISTORICAL POPULATION BY DISTRICT

Year	Island of Maui	Wailuku-Kahului	Makawao-Kula	Hana	Lahaina
1960	35,757	19,391	10,409	1,073	4,884
1970	38,691	22,219	9,979	969	5,524
1978	53,900 (EST)	-	-	-	-
1980	59,900	-	-	-	-
1990	87,400	-	-	-	-
2000	117,200	-	-	-	-

(2) Economy and land use. Hawaii is a prosperous state with a growing population and economy. Between 1950 and 1976, the total resident population increased over 77 percent from 498,000 to 883,500. During the same period, the gross state product quadrupled; from $900 million to over $7.4 billion. The three largest contributors to the state economy are tourism, defense expenditures, and agriculture; the bulk of the last activity being in the production of sugar and pineapple. The most rapid growth during the last several years has been in the tourist industry which in 1970 became the state's leading export industry. Tourist arrivals totaled 687,000 in 1965 and 3,220,151 in 1976. Tourist expenditures were $225 million in 1965 and $1.64 billion in 1976; an increase of 630 percent. This is compared to an increase of slightly over 125 percent for defense spending during this same period. Growth of the tourist industry, together with the state economy in general, is expected to continue. The island of Maui witnessed a more vigorous economic growth since the 1960's than any of Oahu's other neighbor islands. Tourism has accounted for its major growth although sugar and pineapple continue to be major industries. Maui is the center of trade of Maui County which is made up of four islands (Maui, Lanai, Molokai, and Kahoolawe). Maui County accounts for approximately 23 percent of the beef, 19 percent of the pork, 38 percent of the vegetable and melons, 23 percent of the sugar, and 61 percent of the pineapples marketed in the State of Hawaii.

The economy of Maui and the State of Hawaii is heavily dependent on waterborne commerce because of the geographic isolation. In 1961 the state port handled 4,263,000 tons of waterborne commerce.

The State of Hawaii Land Use District classifications designates Waiehu Beach Park as urban. Hawaii's Land Use Law, Act 187, defines urban districts as "areas characterized by city-like concentrations of people, structures, and streets and other related land use." The County of Maui interim zoning code designates the area for park use and the surrounding lands for urban development.

(4) Recreation Facilities. A study 1/ by the State of Hawaii on recreational needs show only approximately 1.2 acres of available improved beach park lands in the Wailuku-Kahului tributary area, indicating that the Waiehu beach park is the only facility of its kind in northwest Maui. The study concluded that the number of existing recreation facilities/ areas in the Wailuku-Kahului planning area are at or near capacity. Deficiencies in supply are reflected for the three most popular district pursuits: attending outdoor events, walking/jogging, and swimming/sunbathing, which represents 60 percent of the total activities occurring within the district.

4. Problems.

a. Shore History and Erosion Analysis.

Portions of the northern shoreline of the island of Maui have experienced chronic erosion in recent years. A 900-foot-long rock revetment was constructed by the County of Maui in 1969 along the shoreline fronting the golf course north of Waiehu beach park to protect that area against erosion. This existing revetment stops approximately 200 feet north of the park's northern boundary. The sandy shoreline between the revetment end and the park has eroded approximately 40 feet in recent years. The County of Maui plans to extend the existing revetment an additional 200 feet to protect the shoreline and to regain use of the No. 6 tee of the municipal golf course.

The erosion along the beach park shoreline, immediately south of the golf course shoreline, has not been as severe. Aerial photographs indicate that approximately 20 feet of shoreline has been lost in the 27 year period ending in 1977, averaging about 0.8 feet per year. Surveys indicate that approximately 2.5 feet of shoreline eroded during calendar year 1978. At this rate, the backshore recreational area is losing about 0.014 acre per year. A reconnaissance inspection in June 1978 noted a 2- to 4-foot-high scarp along the shoreline fronting the park.

During the last 29 years about 3,200 cubic yards of sand have been lost from the 350-foot-long beach park frontage, averaging 110 cubic yards per year, which is equivalent to an average of 0.316 cubic yards per lineal foot per year. In calendar year 1978, however, about 360 cubic yards of sand were lost, which is equivalent to about 1 cubic yard per lineal foot of beach front per year.

1/ Hawaii State Comprehensive Outdoor Recreation Plan, Department of Planning and Economic Development, 1975.

RIP-RAP PLACED ALONG THE MUNICIPAL GOLF COURSE IN 1969

NORTH VIEW FROM PARK LOOKING TOWARDS WAIEHU MUNICIPAL GOLF COURSE

PHOTOGRAPHS TAKEN FEB 1979

WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII

PHOTOGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PHOTO 1

SOUTH VIEW
ALONG
SHORELINE
OF PARK

NORTH VIEW OF
PARK AT SOUTH
END

PHOTOGRAPHS TAKEN FEB 1979

WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII

PHOTOGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PHOTO 2

SHOWER PAD
ALONG SHORELINE
BEING UNDERMINED

SOUTH VIEW
OF PARK

PHOTOGRAPHS TAKEN FEB 1979

WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII

PHOTOGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

SOUTH VIEW
ALONG
SHORELINE

SHORELINE IN
FRONT OF
PAVILION

PHOTOGRAPHS TAKEN JUN 1978

WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII

PHOTOGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PHOTO 4

NORTH VIEW AT SOUTH END OF PARK

SOUTH VIEW
ALONG SHORELINE
FROM PARK

PHOTOGRAPHS TAKEN FEB 1979

WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII

PHOTOGRAPHS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PHOTO 5

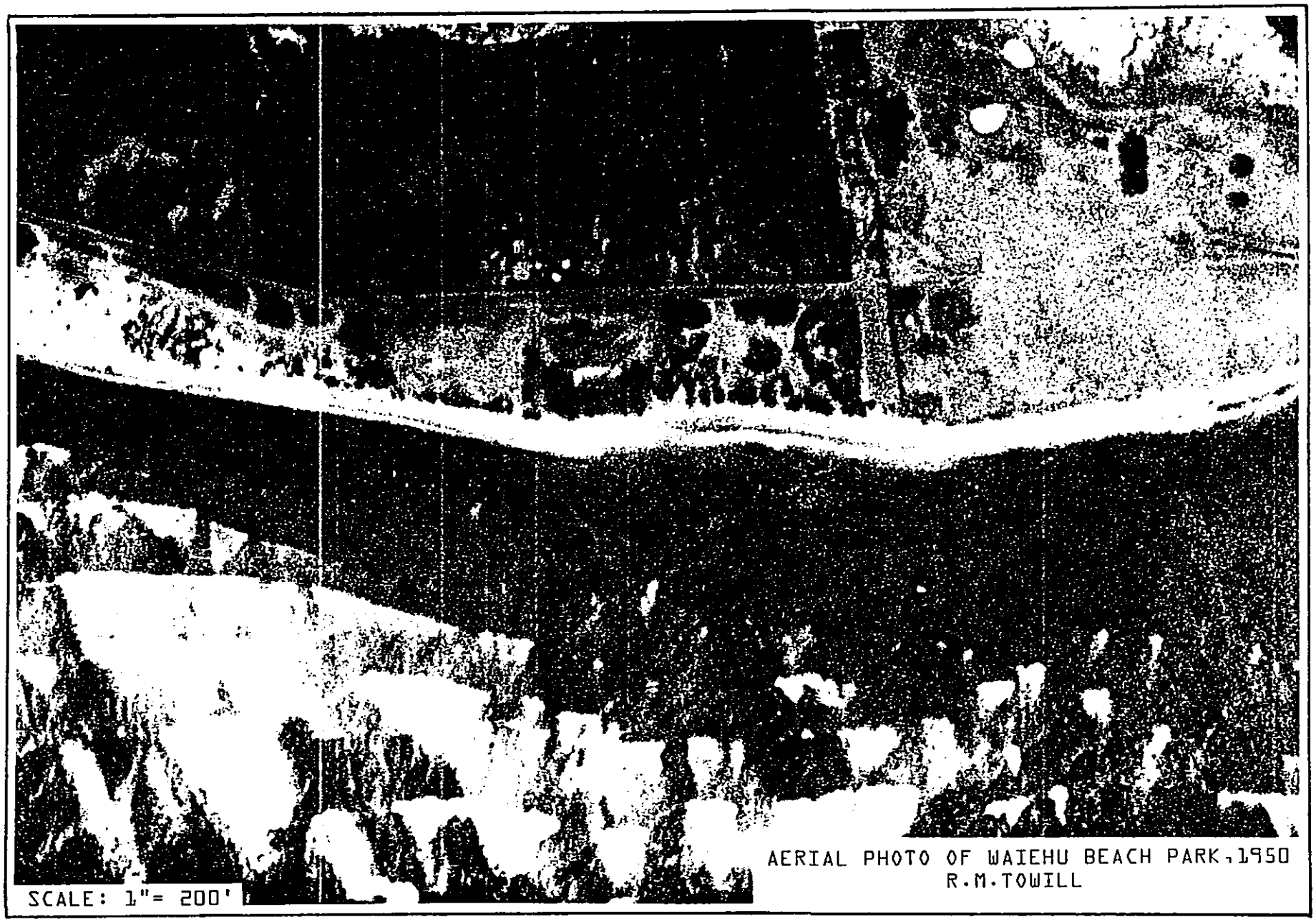

PHOTO 6

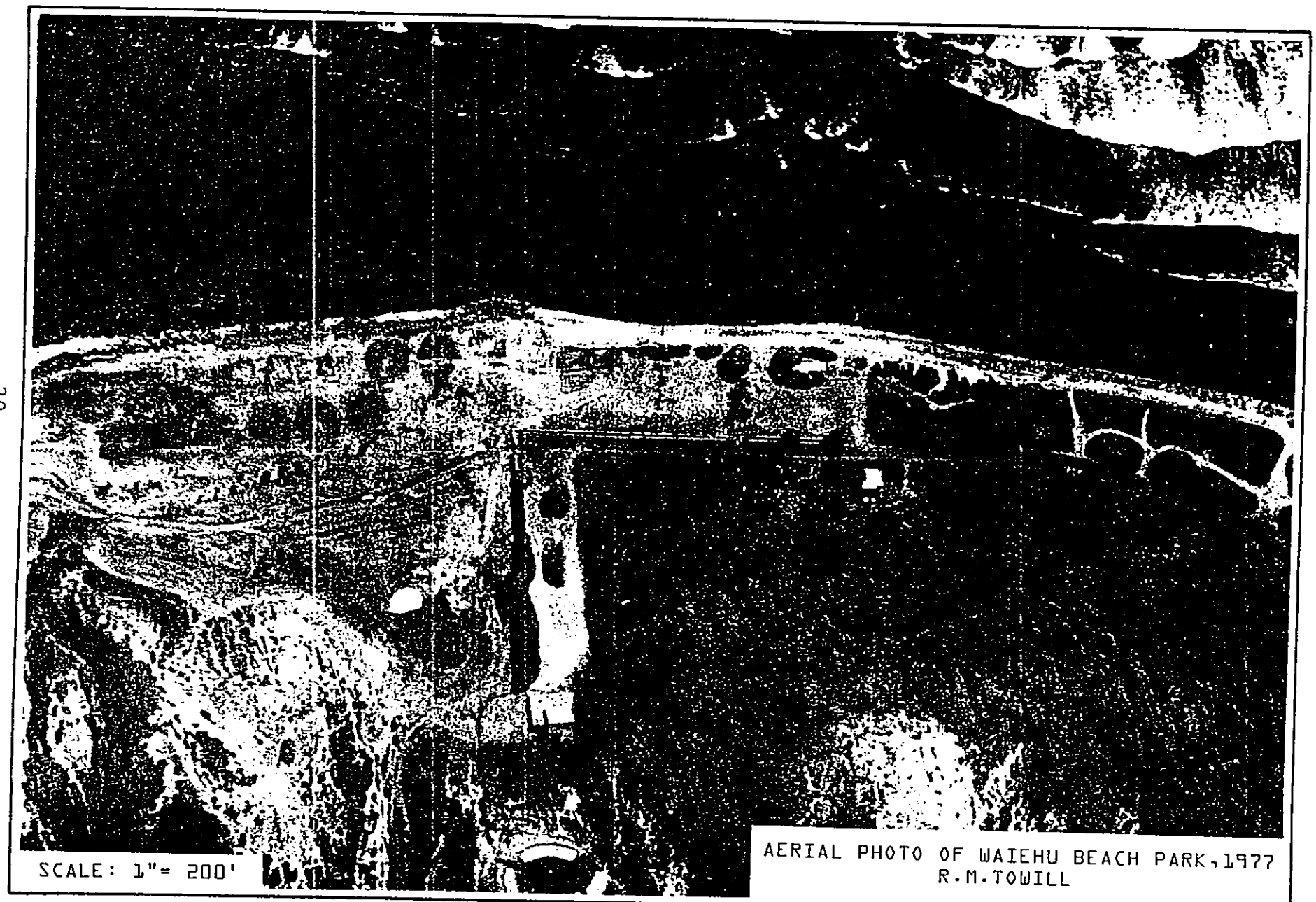

PHOTO 7

SCALE: 1"= 200'

AERIAL PHOTO OF WAIEHU BEACH PARK, 1977
R.M.TOWILL

Seasonal fluctuations in the beach volume are correlated with the amount and type of wave energy that reaches the beach. Seasonal accretion and erosion rates of 0 to 1.3 cubic yards per lineal foot of beach per month have been reported for this area. Under normal tradewind conditions, waves reaching the shore are small and contribute little to the erosion process.

b. Shore Processes.

(1) The normal offshore currents outside the fringing reef set in a northerly direction. From aerial photographs it appears that wind-driven onshore waves produce two opposite setting longshore currents at the beach, possibly due to the offshore topographic configuration of the fringing reef near the project area. One current sets toward the south along the shoreline fronting the golf course, and the other sets towards the north along the shoreline fronting the beach park. These currents converge forming a rip current just south of the existing revetment as evidenced by localized turbidity extending offshore in this area. Sand may be lost from the littoral system as a result of the convergence and rip current.

(2) Storm winds and waves from the north and northeasterly quadrants are the principal erosion factors. Strong winds and large waves breaking on the reef result in a rise in water level, or setup. This increased water elevation allows a greater amount of wave energy to reach the shore, resulting in erosion of the beach. When onshore littoral transport between storms fails to supply as much sand as is lost, net erosion occurs.

c. Land Loss.

If the erosion rate continues, possible physical property damage to the pavilion and losses in recreational opportunities may occur. Costs associated with the loss of the pavilion would include the replacement value and its utility loss to the users. The eroding shoreline would diminish potential recreational land areas and degrade the aesthetic quality of the park, devaluing the general recreational value.

d. Archaeological/Cultural Significance.

It is believed but not documented that the project area may contain archaeologically or socially significant resources. If it is found that the inner park land area contains such vestiges, continued erosion along the beach may expose and destroy these resources.

5. Needs.

During field interviews in February and a public workshop held on 14 February 1979, the general consensus indicated that an erosion problem does exist and that the park plays an important role in their social and

recreational activities. Although a general agreement was not made on the solution to this problem, it was the consensus that any proposed shore protection measure should not jeopardize the present recreational and aesthetic attributes of the park and surrounding lands, nor detrimentally affect the regional coastal processes.

6. Planning Objectives.

Based on the analysis of social, economic and environmental aspects of the study area, and the identification of problems and needs, the following planning objectives have been developed to guide the formulation and evaluation of alternative plans of improvement for shore erosion problems within the study area.

a. Eliminate or substantially reduce shoreline erosion within the study area.

b. Preserve or enhance recreational activities along the shoreline.

c. Preserve or enhance the aesthetic qualities of the park and shoreline.

d. Protect or enhance the water quality, and fish and wildlife resources of the study area.

e. Eliminate or minimize unfavorable impacts on archaeological and historical resources in the area.

f. Eliminate or minimize detrimental effects of any shore protection project along the shoreline.

III. FORMULATION OF PRELIMINARY PLANS

1. Rationale.

a. This section of the report is directed toward the development and evaluation of alternative measures to resolve the problems and needs of the study area and to fulfill the planning objectives defined in the previous section. The initial step in the formulation process is the identification of a broad range of institutional and technical measures available to resolve problems and needs.

b. Following a preliminary screening of these measures for their applicability to the problems and the extent to which they meet the planning objectives, the range of applicable management measures is reduced. The remaining measures to be pursued further are then developed

singly or in combination with other measures to create management plans, each of which satisfy some or all of the planning objectives to varying degrees. The formulation of alternative plans of improvement is guided by the following technical, economic, and environmental criteria.

2. Technical Criteria.

a. Plans of improvement should provide sound engineering shore protection practices as established by the state of the art technology, and

b. Design guidelines recommended by the U.S. Army Coastal Engineering Research Center (CERC) and other authoritative institutions.

3. Economic Criteria.

a. Quantifiable benefits should exceed project economic costs.

b. The plan of improvement should maximize net benefits.

c. The cost for alternative plans of improvement should be based on preliminary layouts and estimates of quantities, and current unit price levels. The benefits and costs should be expressed in comparable quantitative economic terms to the fullest extent possible. Annual costs should be based on a 50 year amortization period and a 6-7/8 percent interest rate. The annual charges should include annual maintenance cost.

4. Environmental and Social Criteria.

a. Avoid or minimize the physical destruction of cultural, marine, fish and terrestrial resources in the project area.

b. Avoid or minimize long-term disturbances to the physical environment (i.e., water circulation, water quality, and sediment transport) which may have secondary impacts on the living resources that inhabit the project area.

5. General Criteria.

The following general criteria and concepts were also used to guide the formulation, assessment, and evaluation of alternative shore protection plans.

a. The desires of local interests should be given full consideration in the planning process.

b. The adverse and beneficial impacts of alternative plans should be identified, measured, and evaluated.

c. The plans should be evaluated with respect to their acceptability, certainty, completeness, effectiveness, efficiency, equity, benefit-to-cost comparison and reversibility.

6. Possible Solutions.

Possible alternative solutions to meet the planning objectives, including both nonstructural and structural measures were investigated. From a full array of possible solutions, a preliminary evaluation eliminated solutions that were technically not applicable, obviously too expensive, socially and environmentally unacceptable, or obviously nonworkable alternatives. Nonstructural measures considered were no-action, shoreline management, and vegetative stabilization. Structural measures considered included construction of a protective beach, groins, an offshore breakwater, a seawall, a bulkhead, and a stone revetment.

7. Nonstructural Measures.

a. No Action.

(1) Although "no action" is not truly a management measure, it has been discussed under the nonstructural category as a management option. "No action" is interpreted for the purposes of this report as no action by anyone, leaving the existing situation unchanged.

(2) A "no action" alternative is not considered an acceptable or viable solution to the problems and needs of the study area since it does not solve any problems nor fulfill identified needs of the study area. Under this measure, land loss, damage to physical properties, and losses to recreational opportunities would continue. With very limited available data regarding the erosion processes, it is not possible to accurately predict the maximum extent of erosion or the stabilized configuration of the shoreline. It is doubtful if the shoreline would maintain the existing condition if left to natural forces. The area would be subject to further erosion until the shoreline reaches a stabilized configuration. However, before it reaches this configuration, unacceptable losses and damages to property may occur.

b. Shoreline Management.

(1) Under shoreline management, a setback zone may be established inland from the shoreline in which no damageable structure would be allowed to be constructed. All future development would be confined to interior areas where shore erosion would not threaten them, and all existing endangered facilities within the erosion area would be relocated. Shoreline management would not abate the erosion problem but would prevent the loss of physical property by controlling the types of development within the setback zone area. Shoreline management would be implemented by local agencies and could be implemented in conjunction with any other nonstructural or structural measure.

(2) Since existing damageable physical properties within the fluctuating shoreline area consist only of a wooden pavilion and other miscellaneous park facilities, it may be economically prudent to relocate these existing facilities at a lower cost than to construct a shoreline protection system. This would not mitigate the loss of lands and recreational opportunities. However, if the fluctuating nature of erosion and accretion can be accepted as normal coastal processes, then recreational activities and acceptance of potential land loss values should also adjust to the fluctuating shoreline. Shoreline policy compatible with the fluctuating cycle of the coastal shoreline may be more environmentally and economically beneficial. Consequently, shoreline management will be further considered as a possible measure.

c. Vegetative Stabilization.

(1) This measure provides for the planting of vegetation along the eroding shoreline to reduce the rate of erosion within the study area. The creation of vegetation zones resilient to wave and salt exposure would be incorporated to aid in stabilizing and anchoring the alluvial material along the shore. Ordinances restricting vehicular and pedestrian access to the beach area would be instituted to maintain the integrity and effectiveness of this vegetation zone.

(2) The use of a vegetative stabilization measure would be a very economical system compatible to the surrounding environment. However, this method cannot be relied upon for erosion control, particularly against storm conditions, the primary cause of erosion at Waiehu. This system can retard daily erosion and partially mitigate some losses in land. However, vegetative stabilization can only be considered a partial solution or measure as its stability is usually uncertain. This measure may be effective in conjunction with other structural or nonstructural measures.

8. Structural Measures.

a. Protective Beach.

(1) A protective beach is created by placing beach sand along the shore to dissipate wave energy impinging on the shoreline and to protect the backshore area from erosion. The beach fill would function as a shore protection structure as well as a recreation area. Since it extends beyond the existing shoreline, it would be subject to continuing erosion. Consequently, periodic sand replenishment would be required to replace sand losses and to maintain an acceptable beach width.

(2) A protective beach is one structural measure which is the most natural and effective method of protecting a shoreline. However, an important consideration in a protective beach alternative is the

availability and cost of suitable clean sand. Since the project area is comparatively small at 350 feet, further consideration of this measure will be made to better identify possible cost relative to the initial sand requirements and periodic maintenance.

b. Groins/Groin System.

(1) A groin is a shore protection structure designed to build a protective beach to retard erosion of an existing or restored beach by trapping material in the nearshore zone. Groins are usually perpendicular to the shore and extend from a point landward of predicted shoreline recession into the water far enough to accomplish their purpose. Groins are narrow and vary in length depending on their purpose. Groins can be fixed or adjustable, permeable or impermeable, high or low, and long or short. These factors determine the areal pattern of sand accumulation. In Hawaii, groins have been constructed of rock materials, but other materials such as concrete, steel, or timber may be used.

(2) Sand accumulation by groins would occur at the expense of downdrift areas, as it traps these materials and prevents them from naturally transporting down current. Groin placement also does not guarantee sand accumulation as the movement of sand along a shore is often difficult to assess. The lack of an extensive sandy beach in the project area indicates that no significant quantity of sand is being naturally transported into the area. Consequently, the groin fields may have to be artificially nourished by placing sandfill between them. If groins were used to stabilize the beach at the park, detrimental effects may occur at the downdrift areas, possibly affecting privately owned lands and homes. These groins may affect the stable configuration of these areas as they would naturally adjust to the placement of the groins. This would contradict the established objective of minimizing or eliminating possible detrimental effects of any proposed measure. Consequently, no further evaluation of this plan was made in favor of other possible effective alternatives with less detrimental effects.

c. Offshore Breakwater.

(1) An offshore breakwater is a structure designed to protect an area from wave action. This structure is usually constructed to intercept the movement of littoral material by dissipating the wave force that would normally move it. In the same manner, an offshore breakwater can provide shoreline protection by dissipating wave energy that would normally strike the shore and cause erosion. Offshore breakwaters may be built as low profile structures, or to a height sufficient to prevent overtopping under design wave conditions, depending on the degree of protection desired. They can be continuous for long distances or

segmented with passages between them to allow for exchange of water. They are generally of rubblemound construction.

(2) A breakwater at Waiehu would be designed to dissipate the wave energy that would normally cause the erosion problem. The breakwater would be of a low profile sufficient to break the orbital path of the oncoming wave and to minimize the aesthetic impact of the structure. This barrier need not extend above high water, and is less costly than a high non-overtopping breakwater. It is believed that the effects of trapping the littoral transport should be minimal as the condition of the existing short width coarse beach does not indicate significant sand being transported along the shore. However, the offshore breakwater alternative is likely to result in aggravated erosion of the beach inshore from each end of the structure, expecially at the north end. This alternative will be considered for further analysis.

d. Bulkhead.

(1) A bulkhead is a structure which retains or prevents sliding of land and protects land against erosion damages. Precasted concrete sheet pile, steel sheet pile, or timber pile can be installed in an upright position along the shoreline and held in that position by tie-rods anchored to concrete blocks buried in the inland area.

(2) The construction of a bulkhead would require extensive excavation to backshore land areas for installing the deadman anchoring system. The cost of a bulkhead is very high compared to a gravity seawall or a stone revetment, primarily due to the extensive concrete deadman anchoring system which requires a massive excavation system. Consequently, this measure would be undesirable as compared to either a seawall or stone revetment.

e. Seawall.

(1) A seawall is a structure separating land and water areas, primarily designed to prevent erosion and other damages caused by wave action. Seawalls are similar to that of gravity retaining walls used on interior lands. The stability of a seawall against wave and earth forces depends on its massive weight. The facing is generally vertical or on a steep slope.

(2) The seawall would basically function as a bulkhead. Undesirable erosion or scouring may result along the fronting beach. The seawall has a poor wave energy dissipation or absorption capability due to an impermeable vertical face which would reflect the wave energy causing scouring and possible hazards to park users along the beach. A stone revetment may be more suitable as a sloping profile has a better capacity for dampening wave energy. Consequently, this alternative would be less desirable than a possible stone revetment.

f. Stone Revetment.

(1) A stone revetment is comprised of riprap stone placed adjacent and parallel to the eroding shore. It is constructed at a sloping angle to the shore to dissipate the wave energy causing erosion on the beach.

(2) A rubble-mound revetment would be the most suitable method to stabilize the shoreline by dissipating wave energy. The rock comprising the revetment would be able to readjust and settle without causing structural failure. However, some scouring at the fronting beach may occur, but should be less than from a seawall or bulkhead. Since the beach is not considered a primary sandy recreational beach, some scouring may be acceptable. If the project area is a supply source (feeder beach) to downdrift beach areas, the revetment may cutoff this sand source and detrimentally affect these downdrift areas. The immediate downdrift area at the south end of the path is comprised of a unimproved beach front covered with a thick layer of basaltic gravel and cobbles. This area may be able to act as an effective buffer zone between the park and downdrift areas, minimizing any possible detrimental downdrift eroding effects, as the thick layers of gravel and cobble would aid in stabilizing the beach front.

9. Development of Alternative Plans.

An evaluation matrix (see Table 3) was prepared to summarize the relationship of each alternative measure to the established planning objectives. Based on the preliminary screening and analysis, the following plans were further developed to provide a feasible solution to shore protection.

10. Shoreline Management.

a. During the erosion phase of the erosion-accretion cycle park lands would be reduced by losses in recreational areas. Since the limits of erosion cannot be accurately predicted, the implementation of a shoreline setback area as the sole plan alternative may not be acceptable to agencies or persons most concerned about protecting existing recreational facilities. However, if we can accept the fluctuating nature of erosion and accretion as normal coastal processes and the idea that recreational activities should adjust to these normal coastal processes, this measure may be a more viable alternative than implementing a structural measure. Consequently, it remains a potentially viable nonstructural plan to be considered by the public. Since this plan does not fulfill the primary project planning objective of maintaining the sand, quantitative costs and benefits were not developed.

b. Some measures that can be instituted include:

(1) Establishing setback lines for damageable physical property subject to erosion lines or tsunami inundation lines.

TABLE 3 SUMMARY OF ALTERNATIVE MEASURES IN RELATION TO PLANNING OBJECTIVES

○ DOES NOT MEET PLANNING OBJECTIVES
◒ PARTIALLY MEETS PLANNING OBJECTIVES
● MEETS PLANNING OBJECTIVES

PLANNING OBJECTIVES		ALTERNATIVES								
		NON-STRUCTURAL			STRUCTURAL					
		NO ACTION	SHORELINE MANAGEMENT	VEGETATIVE stabilization	OFFSHORE BREAKWATER	PROTECTIVE BEACH	GROINS	BULKHEAD	SEAWALL	STONE REVETMENT
A	ELIMINATE OR SUBSTANTIALLY REDUCE SHORELINE EROSION WITHIN THE STUDY AREA	○	○	◒	●	●	●	●	●	●
B	PROTECT OR ENHANCE RECREATIONAL ACTIVITIES ALONG THE SHORE	○	○	◒	●	●	●	◒	◒	◒
C	PRESERVE OR ENHANCE THE AESTHETIC QUALITY OF THE PARK AND SHORELINE	○	◒	◒	◒	●	◒	◒	◒	◒
D	PROTECT OR ENHANCE THE WATER QUALITY AND FISH AND WILDLIFE RESOURCES IN THE STUDY AREA	○	○	◒	●	◒	◒	◒	◒	◒
E	AVOID OR MINIMIZE UNFAVORABLE IMPACTS ON THE ARCHAEOLOGICAL AND HISTORICAL RESOURCES OF THE AREA	◒	◒	◒	●	●	◒	◒	◒	◒
F	AVOID OR MINIMIZE DETRIMENTAL AFFECTS OF ANY SHORE PROTECTION PROJECT	●	●	●	◒	●	○	◒	◒	◒

(2) Implementing complimentary nonstructural measures such as a vegetative barrier to retard the erosion processes.

(3) Establishing ordinances restricting vehicular and pedestrian access points to preserve existing and built-up dune and vegetative lines along the shoreline.

(4) Instituting a regional coastal plan establishing a shoreline management policy, monitoring coastal processes for future evaluation and assessment on the erosion problem, and to regulate the building of structural shore protection systems along the region.

11. Shoreline Stone Revetment.

a. Design. This plan provides for the construction of approximately 350 feet of shoreline stone revetment (see Figure 3). The revetment would be armored with 500 to 1,000 lb. stone placed on a 1 vertical to 1.5 horizontal slope. This slope would be flat enough and have enough voids to reduce wave reflection, thereby encouraging beach material accretion when the seasonal cycle of sand movement is favorable. The crest elevation would be +10.0 feet MLLW to prevent overtopping. Bedding and intermediate layers of smaller stone are included in the revetment design as shown on the conceptual plan.

b. Benefit to Cost Comparison. Table 4 presents a summary of the cost and benefit associated with the shoreline stone revetment plan. A detailed benefit and cost analysis can be found in Appendix D.

TABLE 4

COST AND BENEFIT SUMMARY
SHORELINE STONE REVETMENT
(Dollars)

Total Estimated Cost	$191,800
Average Annual Cost	14,400
Average Annual Benefit	20,800
Benefit to Cost Ratio	1.4

12. Offshore Breakwater

a. Design. This plan provides for the placement of a 450-foot long breakwater approximately 200 feet offshore (see Figure 4). The breakwater would be armored with 800 to 1,200 lb. stone, at the trunk and 1,000 to 1,500 lb. stone at the head, with a crest elevation of +2.5' MLLW. The side slopes would be 1 horizontal to 1.5 vertical with a crest width of 6.0 feet.

b. Benefit to Cost Comparison. Table 5 presents a summary of the cost and benefit associated with the offshore breakwater plan.

TABLE 5

COST AND BENEFIT SUMMARY
OFFSHORE BREAKWATER
(DOLLARS)

Total Estimated Cost	$224,400
Average Annual Cost	18,800
Average Annual Benefit	20,800
Benefit to Cost Ratio	1.1

13. Protective Beach.

a. Design. This plan provides for the construction of a protective beach along a 350-foot reach of park shoreline (see Figure 5). It would require approximately 3,500 cy of clean sand with a periodic nourishment of approximately 2,000 cy every 10 years. The beach elevation would match the existing top of the scarp with a berm of approximately 25 feet. The beach front would be sloped on 7 horizontal to 1 vertical onto the existing beach elevation.

b. Benefit to Cost Comparison. Table 6 presents a summary of the associated cost and benefit.

TABLE 6

COST AND BENEFIT SUMMARY
PROTECTIVE BEACH
(DOLLARS)

Total Estimated First Cost	$176,000
Average Annual Cost	16,000
Average Annual Benefit	20,800
Benefit to Cost Ratio	1.3

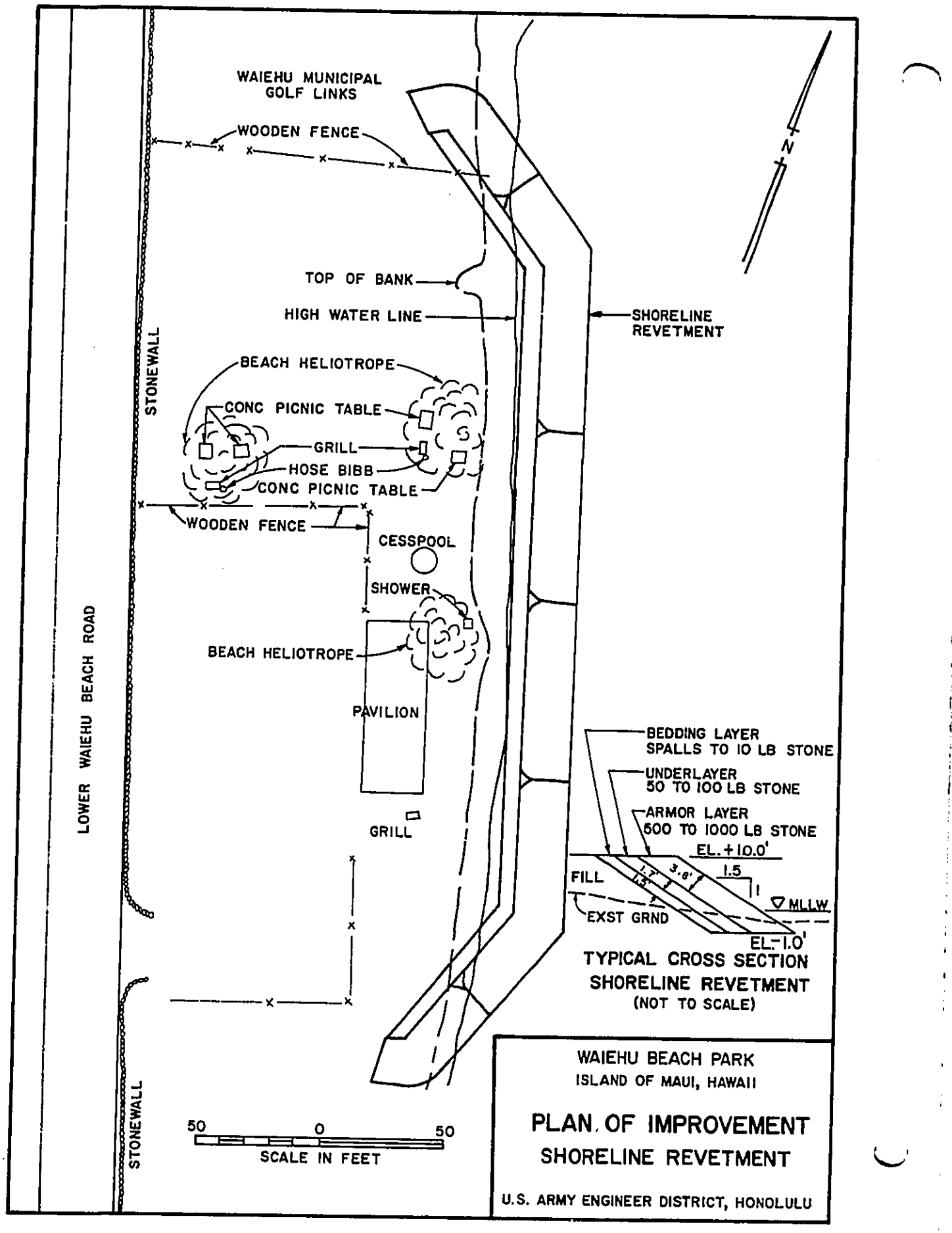
WAIEHU MUNICIPAL GOLF LINKS
WOODEN FENCE
TOP OF BANK
HIGH WATER LINE
SHORELINE REVETMENT
N
STONEWALL
BEACH HELIOTROPE
CONC PICNIC TABLE
GRILL
HOSE BIBB
CONC PICNIC TABLE
WOODEN FENCE
CESSPOOL
SHOWER
BEACH HELIOTROPE
PAVILION
GRILL
LOWER WAIEHU BEACH ROAD
STONEWALL
50 0 50
SCALE IN FEET
BEDDING LAYER
SPALLS TO 10 LB STONE
UNDERLAYER
50 TO 100 LB STONE
ARMOR LAYER
500 TO 1000 LB STONE
EL. +10.0'
FILL
1.5
1
MLLW
EXST GRND
EL.-1.0'
TYPICAL CROSS SECTION
SHORELINE REVETMENT
(NOT TO SCALE)
WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII
PLAN OF IMPROVEMENT
SHORELINE REVETMENT
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3

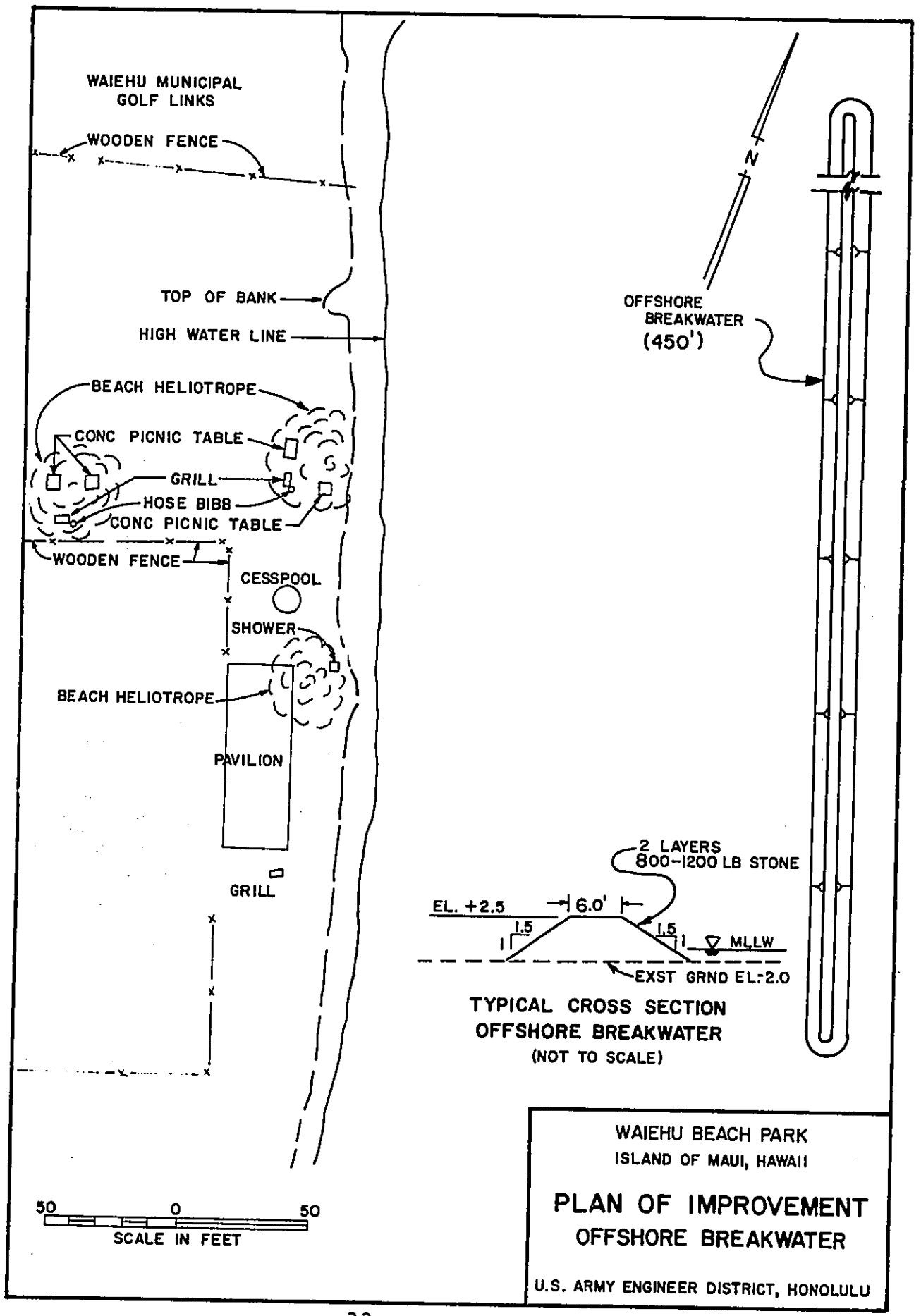
WAIEHU MUNICIPAL
GOLF LINKS
WOODEN FENCE
TOP OF BANK
HIGH WATER LINE
BEACH HELIOTROPE
CONC PICNIC TABLE
GRILL
HOSE BIBB
CONC PICNIC TABLE
WOODEN FENCE
CESSPOOL
SHOWER
BEACH HELIOTROPE
PAVILION
GRILL
N
OFFSHORE
BREAKWATER
(450')
2 LAYERS
800-1200 LB STONE
EL. +2.5
6.0'
1.5
1
1.5
1
MLLW
EXST GRND EL:-2.0
TYPICAL CROSS SECTION
OFFSHORE BREAKWATER
(NOT TO SCALE)
50
0
50
SCALE IN FEET
WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII
PLAN OF IMPROVEMENT
OFFSHORE BREAKWATER
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4

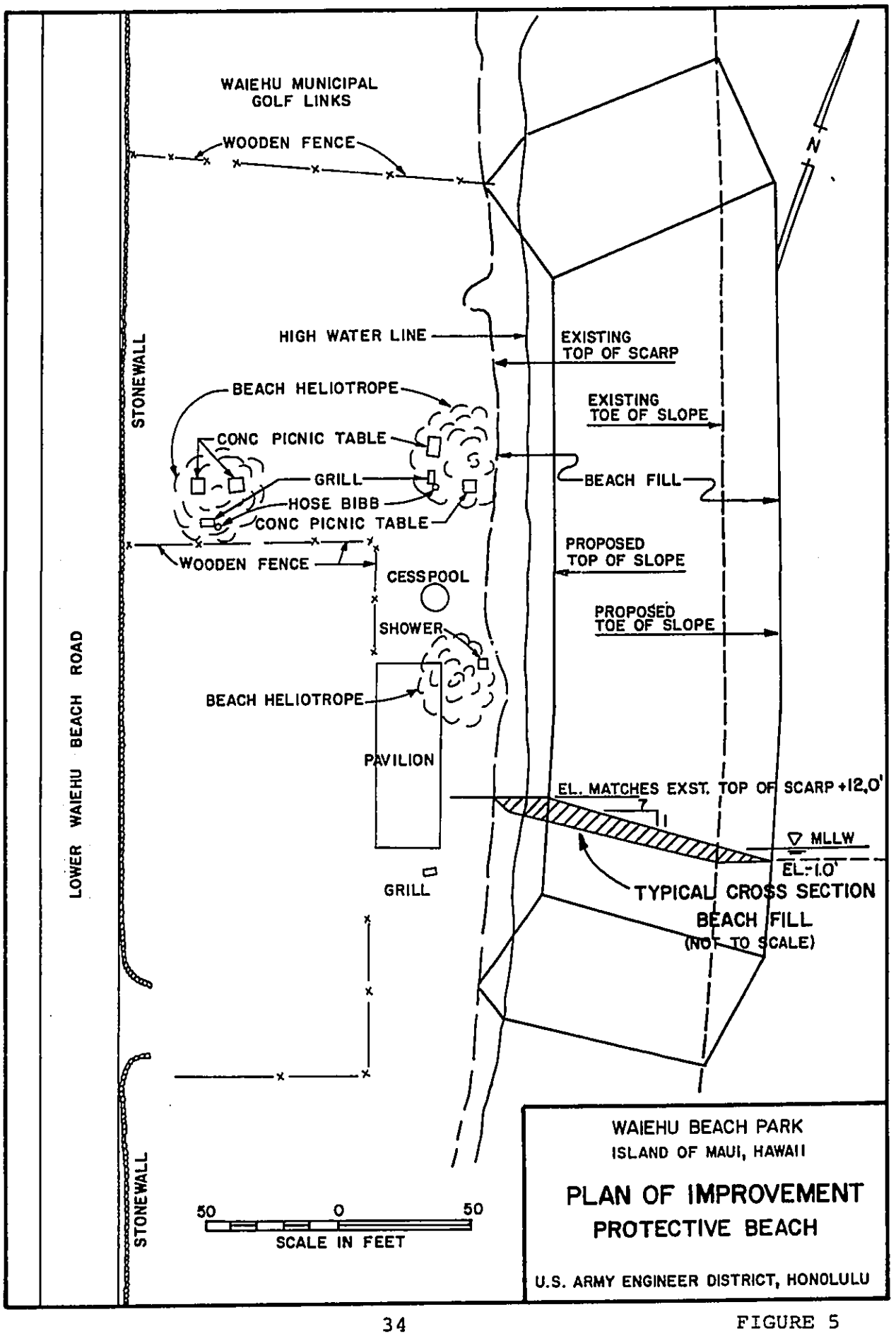
WAIEHU MUNICIPAL GOLF LINKS
WOODEN FENCE
N
HIGH WATER LINE
EXISTING TOP OF SCARP
STONEWALL
BEACH HELIOTROPE
EXISTING TOE OF SLOPE
CONC PICNIC TABLE
GRILL
BEACH FILL
HOSE BIBB
CONC PICNIC TABLE
WOODEN FENCE
PROPOSED TOP OF SLOPE
CESSPOOL
PROPOSED TOE OF SLOPE
SHOWER
BEACH HELIOTROPE
PAVILION
EL. MATCHES EXST. TOP OF SCARP +12.0'
MLLW
EL.-1.0'
GRILL
TYPICAL CROSS SECTION
BEACH FILL
(NOT TO SCALE)
LOWER WAIEHU BEACH ROAD
STONEWALL
50 0 50
SCALE IN FEET
WAIEHU BEACH PARK
ISLAND OF MAUI, HAWAII
PLAN OF IMPROVEMENT
PROTECTIVE BEACH
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 5

14. Apportionment of Cost.

a. The apportionment of costs between Federal and non-Federal interests is in accordance with Section 103 of Public Law 98-874 which prescribes the cost of restoration and protection of Federal, non-Federal, public and private shores. In accordance with the above prescribed law, Federal participation would be 70 percent of the total cost of the project. Tabl 7 summarizes the non-Federal and Federal share of each proposed plan.

TABLE 7

APPORTIONMENT OF COST

Plan	Total Estimated Cost	Federal Share	Non-Federal Share
Shoreline Stone Revetment	$191,800	$134,300	$57,500
Offshore Breakwater	224,400	157,000	67,400
Protective Beach	176,000	123,200	52,800
Shoreline Management 1/	-	-	-

1/ To be implemented by local agencies.

15. Assessment and Evaluation.

a. The economic, social, and environmental effects of the four alternative plans have been assessed and evaluated, and a summarization of these evaluations is presented in Tables 8 and 9, Summary of Comparison of Alternative Plans, and System of Accounts. These tables display the significant contributions, the beneficial and adverse effects, and the extent to which various planning objectives and evaluation criteria are met by each plan. The tables will be revised and refined when comments on the plans are received during the review of the project documents and during the public meeting.

b. Implementation of any of the structural plans will be subject to compliance with the requirements of Section 404 of the Clean Water Act of 1977. Sand and stone placement along and off the shore is included within the definition of "discharge of fill material" within the navigable waters of the United States. The public meeting will provide the public with the opportunity to comment on Section 404 evaluation matters as well as project formulation aspects.

c. Executive Order 11988 (Flood Plain Management) signed on 24 May 1977, requires federal agencies to avoid adverse impacts associated with the use of floodplains and to avoid inducing development in the one percent chance floodplain as a result of their proposed actions. The final plan selection process will address the impacts of Executive Order 11988 on Waiehu Beach Park.

IV. THE SELECTED PLAN

A final plan selection will follow the review of this draft project report and environmental statement. Following a formal public meeting all public input will be considered in the plan selection and will be documented in the final project report. Additional sections of this report to be completed after the public meeting and incorporated into the final report are:

1. CONCLUSIONS
2. RECOMMENDED PLAN
3. RECOMMENDATIONS

TABLE 8

SUMMARY OF COMPARISON OF ALTERNATIVE PLANS

DESCRIPTION	PLAN 1 SHORELINE MANAGEMENT	PLAN 2 SHORELINE STONE REVETMENT	PLAN 3 OFFSHORE BREAKWATER	PLAN 4 PROTECTIVE BEACH
A. PLAN	ESTABLISHMENT OF A SETBACK LINE BASED ON THE ESTIMATED LIMIT OF SHORELINE RECESSION. EXISTING AND FUTURE FACILITIES WOULD BE LANDWARD OF THIS SETBACK LINE.	CONSTRUCTION OF A 350-FOOT STONE REVETMENT ALONG THE SHORELINE.	CONSTRUCTION OF A 450-FT-RUBBLE MOUND OFFSHORE BREAKWATER APPROXIMATELY 200 FEET OFFSHORE.	CONSTRUCTION OF A 350-FT PROTECTIVE BEACH ALONG THE SHORELINE.
B. SIGNIFICANT IMPACTS				
1. ECONOMIC	BEACH AREA WOULD CONTINUE TO FLUCTUATE, POSSIBLE RELOCATION OR REPLACEMENT COST FOR EXISTING FACILITIES.	STABILIZES SHORELINE WITHIN THE STUDY AREA, ELIMINATES APPROXIMATELY 0.4 ACRES OF LAND LOSSES (50-YR), PREVENTS PHYSICAL DAMAGES TO EXISTING FACILITIES AND MAINTAINS RECREATIONAL AREAS.	SAME AS PLAN 2	SAME AS PLAN 2
2. ENVIRONMENTAL				
a. MARINE	NO CHANGE FROM EXISTING CONDITIONS.	MINOR CHANGES TO SHORELINE ENVIRONMENT FROM THE PARTIAL REPLACEMENT OF SOFT SUBSTRATE DEPENDENT ORGANISMS WITH HARD SUBSTRATE DEPENDENT ORGANISMS WHICH WOULD ENCOURAGE DIVERSITY OF NEARSHORE MARINE FLORA & FAUNA. DISRUPTION AND DESTRUCTION OF SOME SESSILE ORGANISMS MAY OCCUR DURING CONSTRUCTION.	INTERTIDAL ORGANISMS WILL REPLACE SHALLOW WATER ORGANISMS IN REEF AREAS COVERED BY THE BREAKWATER. MINOR CHANGES IN WATER CIRCULATION WILL OCCUR. DISRUPTION AND DESTRUCTION OF SOME SESSILE ORGANISMS MAY OCCUR DURING CONSTRUCTION. INCREASED SPECIES DIVERSITY AND BIOMASS MAY ENHANCE RECREATIONAL FISHING RESOURCES.	DISRUPTION AND DESTRUCTION OF SOME SESSILE ORGANISMS MAY OCCUR DURING CONSTRUCTION.
b. TERRESTRIAL	CONTINUED NATURAL FLUCTUATIONS OF SHORELINE IN PARK, NO SIGNIFICANT AFFECTS ON EXISTING HABITATS.	MAINTAINS EXISTING HABITATS, NO CHANGE FROM EXISTING CONDITIONS.	SAME AS PLAN 2	SAME AS PLAN 2
c. WATER QUALITY	NO CHANGE FROM EXISTING CONDITIONS.	TEMPORARY TURBIDITY DURING CONSTRUCTION.	SAME AS PLAN 2	SAME AS PLAN 2
d. COMMITMENT OF NATURAL RESOURCES	NONE	COMMITS APPROXIMATELY 3480 TONS OF STONE.	COMMITS APPROXIMATELY 3570 TONS OF STONE.	COMMITS APPROXIMATELY 3500 CY OF SAND AND 2000 CY EVERY 10 YEARS FOR PERIODIC NOURISHMENTS.
e. HISTORICAL/CULTURAL RESOURCES	EROSION MAY UNCOVER & DESTROY POSSIBLE ARCHAEOLOGICAL VESTIGES IN THE PARK AREA.	MAY PROTECT POSSIBLE ARCHAEOLOGICAL VESTIGES IN THE PARK AREA.	SAME AS PLAN 2. THE CONSTRUCTION OF A TEMPORARY CAUSEWAY COULD DISTURB POSSIBLE ARCHEOLOGICAL/HISTORICAL RESOURCES AT THE EROSIONAL SCARP.	SAME AS PLAN 2

f. FISH & WILDLIFE	NO CHANGE FROM EXISTING CONDITIONS.	NO IMPACT ON ENDANGERED OR THREATENED SPECIES OR THEIR HABITATS. NO SIGNIFICANT IMPACTS TO FISH & WILDLIFE.	SAME AS PLAN 2	SAME AS PLAN 2
g. SCENIC	NO CHANGE FROM EXISTING CONDITIONS, ERODED APPEARANCE WOULD CONTINUE INTERMITTENTLY.	REVETMENT INTRODUCES NEW VISUAL ELEMENT IN THE COASTAL ZONE, REVETMENT HEIGHT OF +10 FT MLLW WILL NOT INTERFERE WITH ANY VIEWING CORRIDOR.	BREAKWATER INTRODUCES NEW VISUAL ELEMENT IN THE COASTAL ZONE, BREAKWATER HEIGHT OF+2.5 FT MLLW WILL NOT INTERFERE WITH ANY VIEWING CORRIDOR.	NATURALLY INCREASES BEACH FRONT AREA BY .7 ACRES.
3. SOCIAL				
a. HEALTH, SAFETY, COMMUNITY WELL-BEING	MAY DIMINISH COMMUNITY WELL BEING BY LOSS OF PARK LAND.	PROMOTES WELL-BEING BY MAINTAINING RECREATIONAL OPPORTUNITIES AND COMMUNITY COHESION BY MAINTAINING SOCIAL INTERACTION.	SAME AS PLAN 2	SAME AS PLAN 2
b. RECREATIONAL OPPORTUNITIES	WILL ADJUST TO NATURAL FLUCTUATIONS OF SHORELINE. MAY REDUCE PASSIVE USE AND CAPACITY OF PARKLAND.	MAINTAINS BACKSHORE RECREATIONAL AREAS, REVETMENT MAY SCOUR FRONTING BEACH AND MAY BE A SAFETY HAZARD TO PARK USERS UNLESS ACCESS POINTS ARE PROVIDED.	MAINTAINS RECREATIONAL AREAS. BREAKWATER WOULD ATTRACT & ENHANCE FISHING OPPORTUNITIES.	NEW BEACH AREA INCREASES RECREATIONAL AREAS AND OPPORTUNITIES.
C. PLAN EVALUATION				
1. CONTRIBUTIONS TO PLANNING OBJECTIVES				
a. ELIMINATE OR SUBSTANTIALLY REDUCE SHORELINE EROSION WITHIN THE STUDY AREA	NO CHANGE TO EXISTING CYCLICAL EROSION/ ACCRETION.	ELIMINATES EROSION WITHIN THE PROJECT AREA, PROVIDES PROTECTION FOR A 50-YEAR LIFE.	SAME AS PLAN 2.	SAME AS PLAN 2
b. PROTECT AND ENHANCE RECREATIONAL ACTIVITIES ALONG THE SHORELINE	NO CHANGE TO EXISTING CONDITIONS, RECREATIONAL OPPORTUNITIES WILL ADJUST TO NATURAL FLUCUATIONS OF SHORELINE.	MAINTAINS BACKSHORE RECREATIONAL AREAS, REVETMENT MAY SCOUR FRONTING BEACH AND MAY BE A SAFETY HAZARD TO PARK USERS UNLESS ACCESS POINTS ARE PROVIDED.	MAINTAINS RECREATIONAL AREAS.	NEW BEACH AREA INCREASES RECREATIONAL AREAS AND OPPORTUNITIES.
c. PRESERVE AND ENHANCE THE AESTHETIC QUALITIES OF THE PARK AND SHORELINE	NO CHANGE TO EXISTING CONDITIONS, ERODED APPEARANCES WILL CONTINUE INTERMITTENTLY AND REFLECT NATURAL COASTAL PROCESSES.	REVETMENT INTRODUCES NEW VISUAL ELEMENT IN THE COASTAL ZONE, BUT WILL NOT INTERFERE WITH ANY VIEWING CORRIDOR.	BREAKWATER INTRODUCES NEW VISUAL ELEMENT IN THE COASTAL ZONE, BUT WILL NOT INTERFERE WITH ANY VIEWING CORRIDOR.	A WIDER BEACH FRONT WILL BE INTRODUCED.
d. PROTECT AND ENHANCE THE WATER QUALITY AND FISH & WILDLIFE RESOURCES OF THE STUDY AREA	NO CHANGE TO EXISTING CONDITIONS.	TEMPORARY TURBIDITY WILL OCCUR DURING CONSTRUCTION & CHANGES IN NEARSHORE MARINE FLORA AND FAUNA DIVERSITY.	SAME AS PLAN 2	SAME AS PLAN 2

e. ELIMINATE OR MINIMIZE UNFAVORABLE IMPACTS ON ARCHAEOLOGICAL AND HISTORICAL RESOURCES	EROSION MAY UNCOVER AND DESTROY POSSIBLE ARCHAEOLOGICAL VESTIGES.	MAY PROTECT POSSIBLE ARCHAEOLOGICAL VESTIGES WITHIN PARK AREA.	SAME AS PLAN 2	SAME AS PLAN 2
f. ELIMINATE OR MINIMIZE DETRIMENTAL AFFECTS OF ANY SHORE PROTECTION PROJECTS ALONG THE COAST	NO INDUCED CHANGE TO EXISTING COASTLINE.	MAY ACCELERATE EROSION TO THE IMMEDIATE DOWN DRIFT AREAS OF THE PROJECT, HOWEVER A BUFFER ZONE MAY LESSEN THE EFFECTS ON THESE AREAS.	MAY INTERCEPT THE MOVEMENT OF LITTORAL MATERIAL ALONG THE SHORE, BUT MAY BE CONSIDERED MINOR AS EVIDENCE OF LITTLE LITTORAL MATERIAL BEING TRANSPORTED AND THE DESIGN OF A LOW, LESS EFFECTIVE BREAKWATER.	NO SIGNIFICANT DETRIMENTAL AFFECTS WILL OCCUR.
2. RELATIONSHIP TO NATIONAL ACCOUNTS				
a. NATIONAL ECONOMIC DEV (NED)				
AVG ANNUAL BENEFITS	NOT APPLICABLE	20,800	20,800	20,900
AVG ANNUAL COSTS	NOT APPLICABLE	14,400	18,800	16,000
BENEFIT TO COST RATIO	NOT APPLICABLE	1.4	1.1	1.3
b. ENVIRONMENTAL QUALITY (EQ)	SEE SECTION B.2	SEE SECTION B.2	SEE SECTION B. 2	SEE SECTION B.2
c. SOCIAL WELL BEING (SWB)	SEE SECTION B.3	SEE SECTION B.3	SEE SECTION B.3	SEE SECTION B.3
d. REGIONAL DEVELOPMENT (RD)	DETAILED REGIONAL ANALYSIS NOT PERFORMED, STUDY AREA AND REGIONAL AREA NOT SEPARABLE.			
3. RESPONSE TO ASSOCIATED EVALUATION CRITERIA				
a. ACCEPTABILITY	TO BE COMPLETED FOLLOWING COORDINATION & REVIEW OF DRAFT REPORT AND PUBLIC MEETING			
b. COMPLETENESS	COMPLETE	*COMPLETE AS DESCRIBED	*COMPLETE AS DESCRIBED	*COMPLETE AS DESCRIBED WITH PERIODIC NOURISHMENT EVERY 10 YEARS.
c. EFFECTIVENESS	MODERATE	HIGH	HIGH	HIGH
d. EFFICIENCY	HIGH	HIGH	HIGH	MODERATE
e. CERTAINTY	LOW	HIGH	HIGH	MODERATE
f. REVERSIBILITY	HIGH	MODERATE	MODERATE	HIGH
g. STABILITY	LOW	HIGH	HIGH	MODERATE
*FEDERAL RESPONSIBILITY				
4. IMPLEMENTATION RESPONSIBILITY	COUNTY OF MAUI (STATE OF HAWAII)	CORPS OF ENGINEERS COUNTY OF MAUI (STATE OF HAWAII)	CORPS OF ENGINEERS COUNTY OF MAUI (STATE OF HAWAII)	CORPS OF ENGINEERS COUNTY OF MAUI (STATE OF HAWAII)

TABLE 9

SYSTEM OF ACCOUNTS

ACCOUNTS	PLAN 1 SHORELINE MANAGEMENT	PLAN 2 SHORELINE STONE REVETMENT	PLAN 3 OFFSHORE BREAKWATER	PLAN 4 PROTECTIVE BEACH
1. NATIONAL ECONOMIC DEV (NED)				
a. BENEFICIAL IMPACTS				
INCREASED OUTPUT				
STUDY AREA	0	20,800	20,800	20,800
REST OF ISLAND	0	0	0	0
REST OF NATION	0	0	0	0
TOTAL NED BENEFITS	0	20,800	20,800	20,800
b. ADVERSE IMPACTS				
VALUE OF RESOURCES FOR CONSTRUCTION				
STUDY AREA	0	191,800	224,400	176,000
REST OF ISLAND	0	NOT SEPARABLE	NOT SEPARABLE	NOT SEPARABLE
REST OF NATION	0	0	0	0
TOTAL NED COST	0	191,800	224,400	176,000
c. NET NED BENEFITS				
STUDY AREA	0	20,800	20,800	20,800
REST OF ISLAND	0	0	0	0
REST OF NATION	0	0	0	0
TOTAL NED BENEFITS	0	20,800	20,800	20,800
2. ENVIRONMENTAL QUALITY (EQ)				
a. EQ ENHANCED				
*(1) MARINE ENVIRONMENT	NONE	WOULD PROVIDE HABITATS TO SOME MARINE LIFE. IMPROVEMENT TO WATER QUALITY BY PREVENTING FURTHER EROSION. (2,6,9)	SAME AS PLAN 2	SAME AS PLAN 2

(2) SCENIC/AESTHETIC RESOURCES	NONE	MAINTAIN STABILIZED SHORELINE WITHIN PROJECT AREA (1,6,9)	ERODED AND DEGRADED SHORELINE WITHIN PROJECT AREA RESTORED. (2,5,9)	ERODED AND DEGRADED SHORELINE WITHIN PROJECT AREA RESTORES. (1,6,9)
(3) TERRESTRIAL ENVIRONMENT	PARK LAND WILL FLUCTUATE.	PARK LAND WILL BE STABLE. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
b. EQ DEGRADED				
*(1) MARINE ENVIRONMENT	NONE	MINIMAL CHANGE IN EXISTING ENVIRONMENT. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
(2) MATERIAL SOURCES	NONE	3480 TONS OF STONE WOULD BE COMMITTED FOR CONSTRUCTION. (1,6,9)	1570 TONS OF STONE WOULD BE COMMITTED FOR CONSTRUCTION. (1,6,9)	3500 CY OF SAND AND 2000 CY OF PERIODIC NOURISHMENT EVERY 10 YEARS. (1,6,9)
*(3) WATER QUALITY	NONE	SHORT-TERM TURBIDITY DURING CONSTRUCTION. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
c. EQ DESTROYED				
*MARINE LIFE	NONE	SESSILE ORGANISMS MAY BE DESTROYED DURING CONSTRUCTION. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
3. SOCIAL WELL BEING				
a. BENEFICIAL IMPACTS				
*(1) HEALTH, SAFETY, COMMUNITY WELL-BEING.	REMOVES DAMAGEABLE PHYSICAL PROPERTY WITHIN EROSION AND TSUNAMI INUNDATION AREAS. (1,6,9)	MAINTAINS HEALTH, SAFETY, COMMUNITY WELL-BEING THROUGH STABILIZED SHORELINE WITHIN PROJECT AREA. (1,6,9)	RESTORED SHORELINE WITHIN PROJECT AREA WOULD ENHANCE HEALTH, SAFETY, COMMUNITY WELL-BEING. (2,6,9)	SAME AS PLAN 3
*(2) EDUCATIONAL, CULTURAL, AND RECREATIONAL OPPORTUNITIES	NONE	MAINTAINS OPPORTUNITIES (2,6,9)	MAINTAINS OPPORTUNITIES (2,6,9)	INCREASES RECREATIONAL OPPORTUNITIES. (1,6,9)
*(3) ENHANCEMENT OF AESTHETIC VALUES	NONE	MAINTAINS APPEARANCE OF THE SHORELINE WITHIN PROJECT AREA. (1,6,9)	RESTORES APPEARANCE OF THE SHORE WITHIN THE PROJECT AREA. (2,5,9)	RESTORES APPEARANCE OF THE SHORE WITHIN THE PROJECT AREA. (1,6,9)
*(4) COMMUNITY GROWTH COHESION	NONE	SUPPORTS GROWTH & COHESION THROUGH INCREASED RECREATIONAL OPPORTUNITIES AND SOCIAL INTERACTION. (7,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
(5) HISTORIC RESOURCES	NONE	BURIED FEATURES OF POSSIBLE HISTORIC VALUE WILL BE PROTECTED. (1,5,9)	SAME AS PLAN 2	SAME AS PLAN 2

b. ADVERSE IMPACTS					
*(1) DEGRADATION TO AESTHETIC VALUES	INTERMITTEN APPEARANCE OF EROSION. (1,6,9)	INTRODUCES NEW VISUAL ELEMENT IN COASTAL ZONE. (1,6,9)	INTRODUCES NEW VISUAL ELEMENT OFFSHORE. (1,6,9)	INTRODUCES APPROXIMATELY .7 ACRES OF BEACH. (1,6,9)	
*(2) DETERIORATION IN QUALITY OF LIFE, HEALTH, AND SAFETY	NONE	REVETMENT MAY BE AN OBSTACLE TO BEACH FOR THE VERY YOUNG AND OLD.	NONE	NONE	
*(3) DEGRADED EDUCATIONAL, CULTURAL, AND RECREATIONAL OPPORTUNITIES	MINOR - OPPORTUNITIES WILL ADJUST TO FLUCTUATING SHORELINES. (2,5,9)	NONE	NONE	NONE	
*(4) INJURIOUS DISPLACEMENT OF PEOPLE AND COMMUNITY DISRUPTION	NONE	NONE	NONE	NONE	
*(5) NOISE	NONE	SHORT-TERM IMPACT DURING CONSTRUCTION. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2	
4. REGIONAL DEVELOPMENT					
a. BENEFICIAL IMPACTS	COMPLIES WITH EO 11988; FLOODPLAIN MANAGEMENT.	DETAILED REGIONAL INCOME, POPULATION DISTRIBUTION & EMPLOYMENT ANALYSES NOT PERFORMED. STUDY AREA & REGIONAL AREA EVALUATIONS NOT SEPARABLE. NED ACCOUNTS APPLIES TO REGION.	SAME AS PLAN 2	SAME AS PLAN 2	
b. ADVERSE IMPACTS	NONE	NO ADVERSE IMPACTS TO EMPLOYMENT, BUSINESS, OR INDUSTRIAL ACTIVITY.	SAME AS PLAN 2	SAME AS PLAN 2	

INDEX OF FOOTNOTES:

TIMING

1. IMPACT IS EXPECTED TO OCCUR PRIOR TO OR DURING IMPLEMENTATION OF THE PLAN.
2. IMPACT IS EXPECTED WITHIN 15 YEARS FOLLOWING PLAN IMPLEMENTATION.
3. IMPACT IS EXPECTED IN A LONGER TIME FRAME (15 OR MORE YEARS FOLLOWING IMPLEMENTATION).

UNCERTAINTY

4. THE UNCERTAINTY ASSOCIATED WITH IMPACT IS 50% OR MORE.
5. THE UNCERTAINTY IS BETWEEN 10% AND 50%.
6. THE UNCERTAINTY IS LESS THAN 10%.

EXCLUSIVITY

7. OVERLAPPING ENTRY: FULLY MONETIZED IN NED ACCOUNT.
8. OVERLAPPING ENTRY: NOT FULLY MONETIZED IN NED ACCOUNT.

ACTUALITY

9. IMPACT WILL OCCUR WITH IMPLEMENTATION.
10. IMPACT WILL OCCUR ONLY WHEN SPECIFIC ADDITIONAL ACTIONS ARE CARRIED OUT DURING IMPLEMENTATION.
11. IMPACT WILL NOT OCCUR BECAUSE NECESSARY ADDITIONAL ACTIONS ARE LACKING.

* ITEM SPECIFICALLY REQUIRED IN SECTION 122, PUBLIC LAW 91-611 AND ER 1105-2-240.

b. ADVERSE IMPACTS				
*(1) DEGRADATION TO AESTHETIC VALUES	INTERMITTEN APPEARANCE OF EROSION. (1,6,9)	INTRODUCES NEW VISUAL ELEMENT IN COASTAL ZONE. (1,6,9)	INTRODUCES NEW VISUAL ELEMENT OFFSHORE. (1,6,9)	INTRODUCES APPROXIMATELY .7 ACRES OF BEACH. (1,6,9)
*(2) DETERIORATION IN QUALITY OF LIFE, HEALTH, AND SAFETY	NONE	REVETMENT MAY BE AN OBSTACLE TO BEACH FOR THE VERY YOUNG AND OLD.	NONE	NONE
*(3) DEGRADED EDUCATIONAL, CULTURAL, AND RECREATIONAL OPPORTUNITIES	MINOR - OPPORTUNITIES WILL ADJUST TO FLUCTUATING SHORELINES. (2,5,9)	NONE	NONE	NONE
*(4) INJURIOUS DISPLACEMENT OF PEOPLE AND COMMUNITY DISRUPTION	NONE	NONE	NONE	NONE
*(5) NOISE	NONE	SHORT-TERM IMPACT DURING CONSTRUCTION. (1,6,9)	SAME AS PLAN 2	SAME AS PLAN 2
4. REGIONAL DEVELOPMENT				
a. BENEFICIAL IMPACTS	COMPLIES WITH EO 11988; FLOODPLAIN MANAGEMENT.	DETAILED REGIONAL INCOME, POPULATION DISTRIBUTION & EMPLOYMENT ANALYSES NOT PERFORMED. STUDY AREA & REGIONAL AREA EVALUATIONS NOT SEPARABLE. NED ACCOUNTS APPLIES TO REGION.	SAME AS PLAN 2	SAME AS PLAN 2
b. ADVERSE IMPACTS	NONE	NO ADVERSE IMPACTS TO EMPLOYMENT, BUSINESS, OR INDUSTRIAL ACTIVITY.	SAME AS PLAN 2	SAME AS PLAN 2

INDEX OF FOOTNOTES:

TIMING

1. IMPACT IS EXPECTED TO OCCUR PRIOR TO OR DURING IMPLEMENTATION OF THE PLAN.
2. IMPACT IS EXPECTED WITHIN 15 YEARS FOLLOWING PLAN IMPLEMENTATION.
3. IMPACT IS EXPECTED IN A LONGER TIME FRAME (15 OR MORE YEARS FOLLOWING IMPLEMENTATION).

UNCERTAINTY

4. THE UNCERTAINTY ASSOCIATED WITH IMPACT IS 50% OR MORE.
5. THE UNCERTAINTY IS BETWEEN 10% AND 50%.
6. THE UNCERTAINTY IS LESS THAN 10%.

EXCLUSIVITY

7. OVERLAPPING ENTRY: FULLY MONETIZED IN NED ACCOUNT.
8. OVERLAPPING ENTRY: NOT FULLY MONETIZED IN NED ACCOUNT.

ACTUALITY

9. IMPACT WILL OCCUR WITH IMPLEMENTATION.
10. IMPACT WILL OCCUR ONLY WHEN SPECIFIC ADDITIONAL ACTIONS ARE CARRIED OUT DURING IMPLEMENTATION.
11. IMPACT WILL NOT OCCUR BECAUSE NECESSARY ADDITIONAL ACTIONS ARE LACKING.

* ITEM SPECIFICALLY REQUIRED IN SECTION 122, PUBLIC LAW 91-611 AND ER 1105-2-240.

V. ENVIRONMENTAL STATEMENT

WAIEHU BEACH PARK SHORE PROTECTION STUDY
WAIEHU, ISLAND OF MAUI, HAWAII

i. (X) Draft Environmental Statement ( ) Final Environmental Statement

ii. Responsible Office: U.S. Army Engineer District, Honolulu, Hawaii
Building 230, Fort Shafter, Hawaii 96858

iii. Point of Contact: Dr. James Maragos
Chief, Environmental Resources Section
(808) 438-2263

iv. Name of Action: (X) Administrative ( ) Legislative

v. Abstract: In September 1978, the County of Maui requested the U.S. Army Corps of Engineers to study the feasibility of protecting Waiehu Beach Park from continued loss of fastland and destruction of park facilities caused by wave erosion. Both structural and nonstructural alternative measures were evaluated. A shoreline management nonstructural plan and a shoreline stone revetment, an offshore breakwater and a protective beach plan were considered. Under the shoreline management measures, natural erosion/accretion could destroy park facilities, cultural and historic resources, the aesthetic setting of park, and adversely affect the sociocultural well-being and growth characteristics of the local community. Construction of structural measures could have temporary, short-term adverse effects on local water, air and noise quality. A shoreline revetment would be a man-made intrusive element eliminating some of the sandy beach and impeding safe passage to the sea for reef-flat net fishing. All potential archaeological, other cultural sites and park facilities could be preserved and a net enhancement of biological productivity should occur. An offshore breakwater would also provide a net increase of marine habitat and with proper placement could enhance existing offshore reef-flat fishing opportunities. An offshore breakwater would be an intrusive element in the seascape but should preserve cultural and park resources. However, the construction of a temporary causeway could destroy archaeological features believed to be embedded in other beach deposits at the erosional scarp. If an offshore breakwater were to allow natural accretion of a beach or if a protective beach were provided, recreational opportunities would be enhanced, cultural sites and park facilities would be protected, and new habitats would be created for sand-dwelling and feeding organisms. Preservation of the existing park under the three structural alternatives could serve as one incentive to attract new residents to the Waiehu community.

vi. Date Comments are Due: July 9, 1979.

1. SUMMARY

a. Environmental Impacts:

(1) Shoreline Management. This alternative would allow the shoreline to continue to erode and possibly destroy an estimated 35% (based only on existing historical data) of the park over a 50-year period. The marine environment may expand at the expense of the terrestrial environment with resultant changes in habitats and species. Existing water, noise and air quality will not be affected. Some recreational opportunities within the park may be lost. This alternative would permit the destruction of possible cultural resources within the improved area of the park. Continued erosion may also destroy the aesthetic setting of the existing park.

(2) Shoreline Stone Revetment. This alternative would add a new visual element to the park area by covering part of the existing sandy beach with the stone revetment. Most or all of the existing sandy beach would be removed from public recreational use by the new revetment. A small portion of the nearshore benthos would be covered and the benthic biota and habitat destroyed. The rocks and interstices of the revetment would provide a new habitat for possible colonization by intertidal motile and sessile biota. The revetment will provide protection for potentially significant cultural resources in the park area. There will be minor and temporary changes in water, noise, and air quality in park use during construction activities.

(3) Offshore Breakwater. The breakwater would be a new visual element affecting the seascape as viewed from the park. The breakwater would destroy about 1.2 acres of the existing bottom biota and preclude the area from future habitation by certain bottom species. However, new habitats offered by the completed breakwater may attract fish species of recreational value. The offshore breakwater could act as an obstacle to fishermen net fishing seaward of the breakwater. Alternatively, proper placement of breakwaters may possibly even enhance net fishing opportunities. Archaeological, historic and cultural resources in the park area should be preserved and if a beach accretes, passive recreational opportunities would be enhanced. There will be minor and temporary changes in water, noise, and air quality and park use during construction activities.

(4) Protective Beach. Construction of a 3,500 cubic yard (.7 acres) beach, fronting Waiehu Beach Park would be a natural seaward extension of the existing beach and would offer short-term (5 years or more) protection to existing park facilities and potential cultural resources. The new beach would require periodic nourishment approximately every 10 years to adjust for continued erosion. Additional beach area should enhance passive recreational opportunities and the use-capacity

of the park. About 0.5 acres of existing foreshore beach and 0.2 acres of nearshore beach habitat would be replaced by 0.7 acres of foreshore beach habitat for recolonization by epibiota and infauna. There would be minor and temporary changes in water, noise and air quality and in park use during construction.

b. Areas of Controversy and Issues to be Resolved:

(1) Neither public agencies nor the general public have yet been given an opportunity to review and comment on the four final array of alternatives. Preliminary comments at a public workshop held on 14 February 1979 in Wailuku, Maui on the plan proposed in the initial reconnaissance report revealed some opposition to a shoreline revetment. Concerns were voided about the effect of the revetment on access to the sea for fishermen and potential loss of sandy beach for passive recreation. When this draft EIS and DPR are published and distributed, governmental agencies and the general public will be given an opportunity to review the alternatives. A public meeting is also scheduled to present the alternatives to the public.

(2) Archaeological, historic, and other sociocultural resources of possible great significance may be present in the park area and could be affected by some of the alternatives. Additional studies are planned to resolve the issue of further identification and evaluation of the significance of these potential cultural resources.

2. PURPOSE AND NEED FOR ACTION

a. In September 1978, the County of Maui requested the U.S. Army Engineer District, Honolulu to study the feasibility of alternative measures to protect the County's 3-acre Waiehu Beach Park from erosion caused by wave attack. The shoreline eroded landward approximately 20 feet in the 27 years from 1950 to 1977 and lost 2.5 feet in 1978. Portions of a shower facility was recently damaged and there is concern that a potentially historic pavilion may have to be relocated or reconstructed. The park is very popular for active activitities such as reef net-fishing and for passive activities such as picnics and parties, especially among native Hawaiians.

b. The Draft Environmental Impact Statement (DEIS) is integrated with the Draft Detailed Project Report (DPR), both of which use common sets of plates and figures and use a common list of references. Treatment of general State and County-wide descriptive data, engineering-related oceanography, and detailed description of all the alternatives are primarily provided in the DPR. A detailed cost-benefit analysis is provided in Appendix D.

3. ALTERNATIVES CONSIDERED

Alternatives considered for shoreline protection at Waiehu Beach Park included non-structural measures such as no-action, shoreline management, and vegetative stabilization. Structural measures considered were groins, a seawall, a bulkhead, an offshore breakwater, a shoreline stone revetment, and a protective beach. Detailed descriptions of these alternatives and reasons some were eliminated from further consideration are presented in Section III of the Detailed Project Report (DPR).

Based on the preliminary screening, analysis, and intial public coordination efforts, feasible alternative plans have been developed to provide a long-term method of protecting recreational, natural, and cultural resources at Waiehu Beach Park from wave erosion. A nonstructural shoreline management measure was selected for detailed analysis as were three structural alternatives shown in Figures 3 through 5: a shoreline revetment, an offshore breakwater and a protective beach. The environmental impact of all alternative measures are briefly summarized in Table 3 and in the final array of alternatives in Tables 8 and 9.

4. AFFECTED ENVIRONMENT

a. Physical Setting: The geologic setting of Maui has been described in the DPR (Ref. 20). The Waiehu area is essentially a rural suburb adjacent to Wailuku, as many residents commute daily to places of employment in the Wailuku/Kahului area. The project is located along the northeastern shoreline of West Maui at Waiehu Beach Park and fronts Waihee Reef and Kahului Bay. About 500 feet landward of the park, sand dunes rise to an average elevation of 150 feet above sea level. The project is situated approximately 3 miles north of the town of Wailuku, the seat of Maui County government. The village of Waiehu is located approximately 1/2 mile south of the study area and the village of Waihee is located approximately 1 mile northwest of the study area. The Waiehu Municipal Golf Course is located north of and adjacent to Waiehu Beach Park. Waiehu Beach Park is one of two beach parks located along this stretch of the coastline fronting Waihee Reef.

b. Oceanography.

(1) Tides. Based on the highest and lowest tides observed (from MLLW) the extreme tidal range is 4.8 feet.

(2) Waves. Tradewind generated seas are the predominant wave climate. These waves have periods from 6 to 12 seconds and heights between 4 to 12 feet. The area is also exposed to large swells generated by storms in the North Pacific Ocean. These swells typically have periods of 10 to 15 seconds and heights from 8 to 14 feet. An offshore reef protects the shore from waves approaching from the north and northeast. These waves are refracted, broken, and reformed, losing much of their energy before reaching the shoreline.

(3) Currents. An alongshore current setting to the north prevails during tradewind conditions. This current converges with a southerly setting alongshore current approximately at the park's northern boundary. This convergence is marked by a sand channel which extends through the offshore reef.

c. Geology/Bathmetry. The coast from Waihee (north of the project site) through Kahului Harbor (south of the project site) is a depositional coast dominated by Waihee Reef and Iao Stream. The beach fronting the Waiehu Beach Park is narrow averaging 50 feet at MLLW. The forebeach consists predominantly of 4" to 6" basaltic cobbles and the back beach consist of sand. The sand is a mixture of basaltic and coralline grains. A wave erosion scarp between 1 to 3 feet high is the landward beach boundary. The fringing reef is widest (1,000 feet) off Waihee and tapers to approximately 500 feet off Waiehu Beach Park. The improved portion of the park is founded on weakly consolidated dune sands which were blown onto the site during the late Pleistocene Epoch. Erosion as a result of wave action has progressed to the point that park facilities have been destroyed and others are threatened with destruction. The nearest rock source is Iao Stream located about 2 miles to the south.

d. Biological: The study area is not located within or adjacent to any designated wildlife refuge, marine sanctuary, or natural area reserve. No threatened or endangered species or their habitats are present within or adjacent to the proposed project area.

(1) Terrestrial - Flora at Waiehu Beach Park consist of either intentionally cultivated (e.g., beach heliotrope, Messerschmidia argentea; coconut palm, Cocos nucifera; naupaka, Scaevola taccada, and grasses) or unintentionally introduced exotic species. Two heliotrope trees are located close to the shoreward edge of the park and could be destroyed by further beach erosion. Fauna in the area consists of birds and mammals. Rats, mice, mongoose, and feral cats and dogs are probably present within and near the study area and probably feed on food scraps from the picnic areas of the park. An ornithological survey of Hawaiian wetlands was performed by Shallenberger in 1977 (Ref. 11). The nearest wetland is located less than 250 feet southwest of the park at the base of the sand dunes. In its present state, the study site is of no value to waterbirds. Bird species probably present in the project area and vicinity are shown on Table 10.

TABLE 10.

Probable Bird Species[1/]
Within the Study Area

URBAN BIRDS	SHORE BIRDS
Common Mynah (Acridotheres tristus)	Golden plover (Pluvalius dominica fulva)
House sparrow (Passer domesticus)	Wandering tattler (Heteroscelus incanus)
House finch (Carpodacus mexicanus)	Ruddy turnstone (Arenaria interpres)
Cardinal (Cardinalis cardinalis)	Sanderling (Calidris alba)
White-eye (Zosterops japonica)	
Spotted munia (Lonchura punctulata)	
Barred dove (Geopelia striata)	
Spotted dove (Streptopelia chinensis)	
Rock dove (pigeon) (Columba livia)	

1/ Ref: Shallenberger, personal communication, 1979.

(2) Marine - The marine environment of the study area has been surveyed and evaluated in a preliminary draft report prepared by the U.S. Fish and Wildlife Service (USFWS)(Ref 28).

(a) The seaward portion of the project vicinity gradually decreases in depth from the high tide line (+1.6 feet above MLLW) located at the existing terrestrial vegetative line to a depth of about 5.5 feet (MLLW), approximately 500 feet from shore on the near reef edge. The reef appears to provide a protective barrier minimizing the amount of substrate movement in the nearshore area. During the (USFWS) survey period (18 March 1979), air and water temperature of 25°C and salinity of 32°/oo were recorded about 30 feet from shore.

(b) The nearshore area is primarily composed of coralline sand (above MLLW). At the low tide line (MLLW), cobbles of terrigeneous origin are interspersed with sand. Approximately 25 feet beyond this sand/cobble edge, the substrate is comprised of coral rubble covering a consolidated reef platform. The coral rubble occasionally is interspersed with pockets of sand. Red coralline algae encrusts this substrate and many of the sessile organisms that inhabit this zone. In some areas the platform reef rises above the coral rubble to form small pockets or caves inhabited by a variety of larger marine organisms. Near the reef edge, about 500 feet from shore, the coral rubble diminishes and extended sand deposits become the dominant substrate type.

(c) Although little coral and few fish were observed between shore and the inner reef edge, the area had a rich assemblage of flora and fauna. Sixteen types of marine algae and one marine angiosperm were found in the proposed project vicinity (see Appendix E). They covered

about 75 percent on the nearshore substrate but thinned to about a 30-percent coverage with increasing depth. Ulva fasciata and U. reticulata were the most abundant species observed. Although many algal are considered edible, only one, Laurencia sp. was observed being harvested. Limu pickers interviewed indicated that this had been a bad year for the edible varieties because of turbulence caused by winter storms and increased freshwater seepage.

(d) Numerous invertebrates were recorded during random observations within the project vicinity and collected in benthic samples (see Appendix E). They include a variety of mollusks, primarily gastropods and nudibranchs, echinoderms, anemones, polychaetes, amphipods, crabs, holothurians and urochordates. Only one species of live coral, Porites evermanni, was recorded. Although not observed, octopus are taken frequently within the nearshore area.

(e) Only four species of fish were encountered in the study area and at most 5 of each was observed: one tang (Acanthurus triostegus sandvicensis), two wrasse (Thalassoma duperreyi and Stethojulis batteata), and the maka'a (Malacanthus hoedtii). Although these nearshore species provide limited nearshore fishery resources, the beach marine area is utilized as access to those species inhabiting the offshore reef. Fishermen net primarily kala (Naso unicornis) in the reef area although other species may be taken incidentally.

e. Water Quality. The waters of Kahului Bay are classified "A" by the State of Hawaii (Ref. 13) to be protected for recreation, aesthetic enjoyment, and the support of aquatic (marine) life. Waiehu Point is located in an Effluent Limitation II Segment (EL II) of the Hawaii Water Resources Regional Study (Ref. 6). The EL II Segment includes those water areas where water quality is meeting or will be higher than the period 1973-1978 (Ref. 12). The range of total coliform was 2 to 16,000 MPN/100 ml. with the annual mean for the same period ranging between 5.53061 and 67.7385 MPN/100 ml. Another monitoring station is located approximately 1 mile to the north at the Waihee Farm shoreline. During the same period as above, the range of total coliform count was 2 to 920.000 MPN/100 ml, with the annual mean ranging between 3 to 13.4761 MPN/100 ml (Ref. 12).

f. Noise Quality. The natural noise level in the study area is generated by wind, waves, and wildlife. Superimposed upon the natural noise level are man-induced intermittent noises generated primarily by park users and their vehicles and overflights of commercial and private aircraft utilizing the Kahului Airport tradewind landing pattern.

g. Air Quality. The nearest State air quality monitoring station is located in the town of Kahului, approximately 3-3/4 miles to the south of the study area. Data recorded at this station reflects some

industrial pollutants from the Kahului area. The air quality of the park site, however, may be described as excellent due to the clean sea air transported into the area by the predominant northeast tradewinds. In addition, there are no industrial pollutant sources near the study area.

h. Recreation.

(1) Waiehu Beach Park is one of six County beach parks in the Wailuku-Kahului tributary region, three of which are currently improved. The improved portion of Waiehu Beach Park consists of a 1.2 acre grassed area with a forty to fifty-year old pavilion/shelter, four picnic tables, two cooking grills, restrooms, a drinking fountain and parking space for thirty cars (Ref. 2). Waiehu Beach Park is the only beach park northwest of Wailuku-Kahului with a pavilion. The park is in daily use, mainly by local residents for such activities as picnicking, swimming, skin diving, fishing, limu (seaweed) picking, boating and surfing. There was an estimated 35,000 visits to the park in 1978 (see Appendix D). According to local informants, Waiehu Beach Park is the main gathering place on this stretch of coastline for fishing and socializing by the local residents from Waihee to Wailuku, especialiy native Hawaiians (Ref. 7). The reef area off the 1.8 acre beach is considered to be an excellent fishing ground. Fishermen walk and swim over the shallow reef flat fronting the park, pulling gill-nets in a "surrounding" procedure. Portions of the catch may then be shared among the waiting families on shore in the traditional manner.

(2) Good winter surfing on three to four-foot waves is conducted in the waters off the park. One surfing site is directly seaward of the park at the edge of the reef about 250 feet offshore and a second site to the south of the park is located only about 50 feet offshore. According to observations made in 1968, from 10 to 15 people normally use these areas about 10 percent and fifty percent of the year, respectively (Ref. 15). Located immediately adjacent and north of the park is the Waiehu Municipal Golf Links, a 124-acre 18-hole course which is one of five other golf courses on the island of Maui.

i. Cultural Resources.

(1) The National Register of Historic Places lists no historic sites within the boundaries nor in the vicinity of the Waiehu Beach Park (Ref. 27). There are no sites listed on the State Register of Historic Places within the park, but there are seven State Register prehistoric archaeological sites and site areas within a one-mile radius of the park, including three within 500 feet (Ref. 18)(see Appendix C). A local native Hawaiian resident often used by historians as an informant has indicated that older Hawaiians tell of the area around the beach park as being an old Hawaiian fishing ground, a dwelling area, a pre-contact (1790's) battleground and the location of an inland fishpond

(Ref. 7). Partly because of the battles, many burial sites have been found in the surrounding sand dunes. Within 500 feet to the west and north of the park are a small burial cave, a concentration of 33 human burials in association with prehistoric artifacts, and an extensive, 190-acre midden deposit containing various cultural materials of probably prehistoric origin (Ref. 4). Within the last year, over seventy historic era burials (in coffins) were also uncovered in the sand dunes of nearby Waiehu Heights residential subdivision currently under construction. The local informant also reported that construction of the beach pavilion had destroyed an archaeological site within the park boundary. An archaeological walk-through reconnaissance was conducted in the study area in January 1979 (Ref. 4). No archaeological deposits were found after exposing and facing fresh sections of the eroding beach deposit. Because of the archaeological richness of the surrounding vicinity, the archaeologist felt that there was a strong probability of finding cultural materials *in situ* within older beach deposits now covered by the present beach deposits.

(2) Analysis of an aerial photograph dating from 1942 reveals a structure at the present location of the pavilion (Ref. 29) and even an early U.S.G.S. map, based on surveys conducted in 1925, locates several structures in the vicinity of the park pavilion (Ref. 30). The style of the pavilion (see photographs in Appendix C) and its history of use as a traditional gathering place for socializing and fishing by local residents, especially native Hawaiians, suggest that the pavilion and park site may be considered as cultural resources by the local people. The pavilion structure may also be an historically and architecturally significant resource. Intensive archaeological and historical studies should be conducted to determine the significance of these cultural resources for possible inclusion on the National Register of Historic Places, and whether the pavilion in particular, can be relocated to safer ground, if warranted.

j. Scenic Resources. Waiehu Beach Park lies along an attractive natural coastline where the multiple wave breaks on the fringing reef provide a spectacular seascape, especially during storm periods or periods of high waves. The adjacent golf course north of the project area provides an pleasing uncluttered, well manicured appearance. The area 1000 feet to the south of the project consists of a pleasing coastline with natural vegetation. The area immediately west of the project area consists of low sand dunes with the West Maui Mountains in the background. The scenic values of Waiehu Beach Park and its surroundings may be considered to be relatively high.

k. Socioeconomic and Land-Use Characteristics.

(1) A detailed description of the social characteristics of the residents of Maui Island and especially the people living in the Waihee to Wailuku-Kahului tributary region is found in Appendix C. In

1978, the estimated resident population of Maui Island was 52,900, an increase of an average annual rate of 4 percent since the 1970 Census level of 38,691 (Ref. 16). The Island's population is anticipated to rise to projected levels between approximately 58,000 to 60,000 in 1980, 83,000 to 96,000 in 1990, and 110,000 to 91,000 in 2000 (Refs. 14 & 5). About 50 percent of Maui Island's resident population lives in the study tributary region, but a lack of comparable statistical regions precludes an accurate estimation of the current population. Wailuku is the governmental and cultural center of Maui and in recent years Kahului has developed into the commercial and industrial hub of the island, containing both the island's major airport and only commercial deep-draft harbor. The district's population is expected to increase at a moderate pace, and the area's dominant civic and economic position in the County is not expected to diminish in the foreseeable future (Ref. 2). The communities of Waihee and Waiehu are the remnants of several old plantation camps and experienced a 42 percent loss in population from 1960 to 1970 (Ref. 17). These older communities in the immediate vicinity of the Waiehu Beach Park are relatively stable communities with generally older people than the communities and town to the east. People of Japanese, Filipino and Hawaiian origin predominate with distinctly higher percentages of Caucasians and Japanese living in Wailuku and Kahului. In comparison to the Wailuku-Kahului region in 1970, the people of Waihee and Waiehu had considerably lower educational levels, had less white-collar workers and had almost twice the island average of families below poverty levels. In 1970 the median family income was $10,235, slightly higher than the island-wide average (Ref. 17). In 1977, the household income for the whole island was estimated to be about $13,630 (in 1976 dollars)(Ref. 5).

(2) Pineapple and sugar growing and processing have been traditionally the major industries of Maui and lead in both total employment and employee earnings (Ref. 5). Both are in a stable position and are not expected to grow as compared to diversified agriculture which is growing substantially. The tourist industry is the largest industry in terms of export income and is the fastest growing industry. Tourism is anticipated to surpass both sugar, pineapple, and diversified agriculture in employment and employee earning by 1985.

(3) The plains stretching out westward toward the mountains from Waiehu Beach Park behind the coastal sand dunes are currently in sugarcane and are anticipated to remain so. Interspersed among the sugarcane fields are diversified agricultural plots primarily belonging to old plantation workers and their descendants, many of which according to an analysis of lists of property owner's names appear to be of Hawaiian origin. About 1000 feet south of Waiehu Beach Park is an old beach-front subdivision of lots on the northern bank of Waiehu Stream. On the other side of the stream are several residences and churches. Two thousand feet southwest of the park are 7.5 acres of old cemeteries.

(4) Immediately westward and running south of Waiehu Beach Park is about 280 acres of land which is classified "Urban" by the State of Hawaii. This land is zoned as Project District I by the County of Maui. Two hundred twenty five acres of this district are planned for residential uses. Within the district, the Waiehu Heights development currently has houses constructed or under construction on about 115 lots of a total of 156 lots of their first unit, with an estimated population of 400 people (Ref. 1). By the early 1980's, a total of 400 lots are anticipated to be developed in addition to 65 low-cost housing units currently under construction by the County of Maui (see maps in Appendix C)(Refs. 1 & 21). By about 1985, an additional 230 house lots may be developed immediately to the southwest and across Waiehu Beach Road from Waiehu Beach Park (Ref. 1). The total estimated population that may be living in the Waiehu area by 1885 could reach about 2,500 in addition to the approximately 500 people living there in 1970 (Ref. 26). Based on an analysis of family names of those currently living in houses in Waiehu Heights, it is anticipated that there will be a relative decline in the predominance of Hawaiian families currently residing in the area and a community social profile similar to that found in Wailuku and Kahului will emerge. With this change from traditional plantation life style to suburban life style will come demands for expanded services and facilities. A new school is planned for development along Waiehu Beach Road. The improved Waiehu Beach Park is already utilized to its capacity and unimproved beach parks such as Waihee Beach Park located within the municipal golf links need to be developed.

(5) The only traffic directly related to the project area is that utilizing the parking lot of the park and the golf course. Traffic within the nearby region is normally light because the area is not heavily populated and the main road deteriorates to a secondary road north of Waihee. Traffic may be expected to increase as adjacent areas are developed for residential uses.

5. ENVIRONMENTAL CONSEQUENCES

a. Physical Setting.

(1) Shoreline Management. This alternative would allow the shoreline to fluctuate at its natural erosion/accretion cycle. The appearance and shape of the shoreline would be altered over a period of time by wave erosion. The erosion may result in the destruction of existing park improvements such as vegetation, the pavilion, and picnic facilities. Continued erosion may require relocation of the pavilion further landward or the construction of a new pavilion thereby altering the present appearance of the park. The potentially historical, architectural, and social significance of the present pavilion should be taken into consideration when planning for its future status. Relocation of the pavilion could also be a specific component of a shoreline management plan.

(2) Shoreline Stone Revetment. The stone revetment would add a man-made visual element to the park area that did not previously exist. The naturally curving shoreline would be altered to a straightened, rock-lined, man-made shoreline. The revetment would not alter the panoramic views of the landscape or the seascape as viewed from the park area due to the existing elevation of the park area.

(3) Offshore Breakwater. The present design indicates a low profile breakwater with a crest elevation of approximately +2.5 feet about MLLW. The breakwater would be a new visual element that did not previously exist in the area and may affect the seascape when viewed from the park. The appearance of the existing beach and park areas would remain in their present condition.

(4) Protective Beach. The appearance of the park and its facilities would remain as at present. The appearance of the beach would be initially altered by widening with imported sand. The appearance of the nourished beach will be subsequently altered by the continued wave action until such time as it is periodically renourished with sand. A protective beach would probably maintain the existing natural setting more than any of the other alternative plans.

b. Biological. None of the alternatives would affect any designated wildlife refuge, marine sanctuary, wetland or natural area reserve nor will any threatened or endangered wildlife or their habitats be affected.

(1) Shoreline Management. Common terrestrial and marine biota would gradually adjust and adapt to the changes in the shoreline caused by continuing wave erosion. The marine environment would increase at the expense of the terrestrial environment with the resultant changes in habitat and species.

(2) Shoreline Revetment. This alternative would cover a total of 0.1 acre of beach and nearshore benthos. Approximately 0.08 acre of the beach would be covered, resulting in minor biological impacts. Approximately 0.02 acre of nearshore benthic habitat would be destroyed and permently lost. Motile species would probably temporarily evacuate the area during construction and probably return after completion of the revetment. The rocks and interstices of the revetment would provide a new habitat for possible colonization by intertidal motile and sessile biota.

(3) Offshore Breakwater. The breakwater would destroy an area of 0.2 acre of benthic habitat and preclude the area from future habitation by bottom species. Motile species would temporarily evacuate the area during construction and probably return after completion of the breakwater. The rocks and interstices of the breakwater sould provide a new habitat for possible colonization by intertidal and subtidal motile and sessile species and may improve recreational fishing and trapping in the reef area.

(4) Protective Beach. This alternative will cover with imported sand a total of 0.7 acres consisting of 0.5 acres of the existing sandy beach and 0.2 acres of the nearshore benthic habitat. The protective beach will destroy existing epibiota and may destroy or smother the infauna depending upon the thickness of the new sand layer. Upon completion of the protective beach, infauna and epibiota will probably be recruited to the new nearshore benthic area from the surrounding reef flat. Benthic species would probably adjust to their habitat over a period of time in relation to beach erosion between periodic beach nourishment.

c. Water Quality. The evaluation of the selected plan will include the application of the US Environmental Protection Guidelines under the authority of Section 404(b) of the Federal Water Pollution Control Act (40 CFR Part 230).

(1) Shoreline Management. Shoreline management excluding relocation of the pavilion essentially does nothing physical to the existing shoreline; therefore, no adverse water quality effects are anticipated to occur from implementation of this alternative. Relocation of the pavilion, while modifying the appearance of the shoreline, can probably be accomplished without affecting water quality.

(2) Shoreline Revetment. Some temporary and minor water turbidity would occur during construction of the revetment; however, it is anticipated that the water will clear rapidly after disturbance because the sediment particles are larger than silt. Mitigation of the problem, if necessary, could include the use of silt curtains.

(3) Offshore Breakwater. The same comments provided under "Shoreline Revetment" apply to the offshore breakwater alternative. However, a temporary causeway out to the breakwater site would be constructed with coarse fill material which would provide an additional source of temporary water turbidity during construction and removal. Silt curtains may be used for mitigation, if necessary.

(4) Protective Beach. Some minor and temporary water turbidity can be expected during the placement of imported beach sand during beach nourishment activity. Mitigation, if necessary, could include the placement of silt curtains during placement.

d. Noise Quality.

(1) Shoreline Management. Except for possible relocation of the pavilion this alternative does not include the use of any equipment; therefore, no construction noise would be generated by this plan. The existing noise levels of the area will remain unaltered. Some noise of a temporary and minor nature is anticipated if relocation of the pavilion is included in the plan.

(2) Shoreline Revetment, Offshore Breakwater, and Protective Beach. Construction activities for the above alternatives would generate temporary noise that will be superimposed upon the natural noise level of the area. The area is sparsely populated; and no residential areas are located nearby, therefore, noise impacts would be minimal and would affect only construction workers and those utilizing the park area. Noise may be mitigated by the use of mufflers on motorized construction equipment and by scheduling of work to occur during normal weekday work hours.

e. Air Quality.

(1) Shoreline Management. This alternative would have no effect upon the air quality of the project area, since little or no construction is involved.

(2) Shoreline Revetment, Offshore Breakwater, and Protective Beach. The above alternatives would utilize motorized construction equipment that will generate hydrocarbon emissions in the project area. These emissions would usually be dispersed and transported over uninhabited land areas outside of the project area by the predominant northeast tradewinds. Mitigation may include the use of emission control devices on all motorized construction equipment.

f. Recreation.

(1) Shoreline Management. Under this alternative, it is estimated that over a 50-year period, a total of approximately 35 percent of the park's fastland may be lost to erosion. Even assuming that all the facilities will be relocated or rebuilt within other areas of the existing park, the loss of open space could depress the average annual intended level of open space usage. However, current usage of the park is estimated to be only 30 to 50 percent of potential capacity (using State of Hawaii SCORP activity participation rates)(Ref. 2) and the population of the immediate tributary area of the Waiehu Community is anticipated to rise in 1985 by 500 percent over 1970 levels. Thus, it is more likely that all types of park usage would increase whether or not a nonstructural or structural management measure is implemented. Offshore and shoreline activities such as surfing, fishing and shell collecting should, moreover, be unaffected by the shoreline management alternative.

(2) Shoreline Revetment. The shoreline revetment would cover the existing sandy beach escarpment and preclude its use by the public as a play area. The stony portion of the beach should remain unaffected, thus permitting a continuation of its use for the collection of shells and limu (seaweed). The completed revetment could act as an obstacle for access to the sea, especially for children and fishermen, unless safe passageways are provided. Even with intermittent passageways, the

rocky surface of the revetment could tear the nets of fishermen going to and from the offshore fishing grounds. On the other hand, beachcombers may find the revetment a new resource for collecting shells and intertidal organisms.

(3) Offshore Breakwater(s). This alternative would preclude part of the offshore reef for fishing and collecting, but these same recreational/semi-subsistence opportunities may be enhanced by the potential intertidal and subtidal habitats offered by offshore breakwaters. A single breakwater could act as an obstacle to existing patterns of net-fishing operations, but optional placement of a series of breakwaters may also improve fishing conditions by directing fish toward well-placed nets. Current recreational activities focused on the beach escarpment and the fronting beach would remain unchanged as would recreational and social activities on fastland. The accretion of a sandy beach could enhance opportunities for playing in the sand.

(4) Protective Beach. This plan would widen the existing sand beach and provide additional areas for sandy beach users. Recreational opportunities provided by the new beach would diminish in response to the erosion regime of this stretch of the coastline. During construction of this alternative and the shoreline revetment and offshore breakwater, certain portions of the park would be temporarily restricted from public use for safety reasons.

g. Cultural, Archaeological and Historic Resources.

(1) None of the management alternatives will affect any site or object currently listed on or determined to be eligible for either the State or National Register of Historic Places. Evidence collected to date suggests, however, that prehistoric or historic cultural materials lie embedded within older beach deposits beneath the beach escarpment. The beach pavilion may also be a structure of historic or architectural value, and the beach park as a whole may be of significant sociocultural value to the Maui residents, especially native Hawaiians. In accordance with the National Historic Preservation Act (PL 89-665) and applicable regulations, the Corps of Engineers intends to conduct archaeological/historical surveys to determine if eligible resources exist within the affected area and to undertake the necessary coordination with the State Historic Preservation Officer and/or the Secretary of the Interior.

(2) Shoreline Management. Continued wave erosion permitted by this alternative would destroy cultural materials and artifacts that lie embedded beneath the beach escarpment and may cause the beach pavilion to be relocated or rebuilt. If the pavilion is shown to have historic or architectural value, even if not of National Register significance, should this alternative be implemented, consideration should be given to preserving the structure by the relocation or reconstruction. Eventual loss of possibly 35 percent of the beach park over a fifty-year period would probably not adversely affect the park's potential value as a sociocultural resource.

(3) Shoreline Revetment. Construction of a shoreline revetment could destroy shoreline cultural materials. To avoid adversely affecting these presumed materials, excavation for a revetment should be restricted to areas seaward of the present erosional escarpment. The landward portion between the revetment and the erosional escarpment could be backfilled to preserve the cultural materials. If the erosional escarpment had to be excavated, salvage excavation of the cultural materials could be required should the cultural deposits be determined to be eligible for the National Register. In any case, a shoreline revetment would protect any additional archaeological, historic or cultural resources that may be determined to be present in landward portions of the park.

(4) Offshore Breakwater. Potential shoreline cultural materials could be affected by construction and subsequent removal of a causeway, which would be required to construct the offshore breakwater or breakwaters. To avoid this possible adverse effect, a part of the erosional escarpment should be identifed either from which a construction causeway could be safely built or over which construction equipment could safely pass to build a causeway starting from the fronting beach. The completed offshore breakwater would absorb wave energy thus halting continued wave erosion of the shoreline and affording protection to the potential cultural resources within the park area.

(5) Protective Beach. Construction activities requiring access to the fronting beach and construction of a protective beach within the fronting beach area could possibly disturb potential cultural resources beneath the erosional escarpment. A completed protective beach would preserve the potential cultural resources within the park area, but cultural materials in the erosional escarpment could be destroyed by future wave erosion before beach nourishment could be implemented.

h. Socioeconomic and Land-Use Effects.

(1) The principal role for the Waiehu Beach Park in the socioeconomic and land-use milieu of the Waihee to Wailuku-Kahului tributary region is its value as a recreational and sociocultural amenity. Management measures such as a shoreline revetment, an offshore breakwater, and a protective beach would maintain this amenity at its present level of use or even enhance its attractiveness in the case of the latter two measures which could add fastland (beach) to the park area. The maintenance or enhancement of current value for the beach park could serve to play a role in attracting new residents to the Waiehu community and specifically to the expanding Waiehu Heights subdivision and the low-cost Ho'o Hui Ana County of Maui housing project. The attraction of new residents in turn will probably continue the current trend that is changing the character of a relaxed plantation village to a suburban extension of Wailuku-Kahului.

(2) Shoreline Management. This alternative would probably result in the natural destruction of some unknown area of the existing improved portion of Waiehu Beach Park, thus reducing the part of the park which is currently intensively used for a traditional gathering place for parties, anniversaries and traditional Hawaiian luau (feasts). The value of the park as a recreational amenity could be diminished, thus possibly discouraging people considering a move to the Waiehu community area. The community should grow nevertheless and the possible reduction in recreational opportunities at Waiehu Beach Park could encourage the County to program funds for construction of park facilities at Waihee Beach Park and other unimproved County parks in the Wailuku-Kahului region.

(3) Whether or not any of the management plans are implemented, they are not expected to have a significant effect on the socioeconomic and land-use characteristics of the study area. Nor are any of the alternatives in conflict with any existing or future land-use plans or zoning for the study area.

6. LIST OF PREPARERS

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7. ENVIRONMENTAL IMPACT STATEMENT SENT TO THE FOLLOWING AGENCIES:

For mailing list, see Appendix A (Public Involvement).

8. INDEX

To be completed in the Final Environmental Impact Statement.

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ER 1105-2-200	Planning Process: Multi-Objective Planning Framework	13 Jul 78
ER 1105-2-210	Planning Process: Plan Development Stages	13 Jul 78
ER 1105-2-220	Planning Process: Problem Identification	13 Jul 78
ER 1105-2-230	Planning Process: Formulation of Alternatives	13 Jul 78

Number	Title	Date
ER 1105-2-240	Planning Process: Impact Assessment	13 Jul 78
ER 1105-2-250	Planning Process: Evaluation	13 Jul 78
ER 1105-2-460	Identification and Administration of Cultural Resources	3 Apr 78
ER 1105-2-502	Public Meetings	4 Dec 72
ER 1105-2-800	Public Involvement: General Policies	2 Apr 76
ER 1105-2-921	Feasibility Reports: System of Accounts	13 Jul 78
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31. Water Resources Council, Principles and Standards for Planning Water and Related Land Resources (P&S) 38 FR 24 778-24869, 10 September 1973.

32. Woodhouse, W.W., Dune Building and Stabilization with Vegetation, Special Report No. 3, U.S. Army Corps of Engineers, September 1978.

WAIEHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

PUBLIC INVOLVEMENT

APPENDIX A

APPENDIX A

PUBLIC INVOLVEMENT

1. The U.S. Army Corps of Engineers, Honolulu District is responsible for conducting and coordinating the overall study. The study was coordinated with the Maui's Department of Public Works, the local sponsoring agency.

2. Federal, State of Hawaii, County of Maui agencies and officials were notified in January 1979 of the initiation of detailed studies for possible shore protection in Waiehu Beach Park, Maui, Hawaii.

3. An informal workshop was held on 14 February 1979 at Kahului, Maui to obtain public input on the desires and needs of providing possible shore protection measures.

TABLE 1

ATTENDANCE AT PUBLIC WORKSHOP
14 FEBRUARY 1979

FEDERAL, CORPS OF ENGINEERS

Mr. James Ligh, Project Manager
Mr. David Dang, Engineer Technician

STATE OF HAWAII

Mr. Alvin Haaile, Dept. of Land and Natural Resources

COUNTY OF MAUI

Mr. Fred Araki, Dept. of Public Works

INDIVIDUALS

Messrs: Herman Adalist
Allen Barr (Maui County Councilman)
James Brock
Cordrill Chang
D. Hein
Cranston Kapoi
Charles Keau
Joseph Kia
Glenn Shepard
Leslie Skillings, Jr.
C. G. Street, Jr.

The general opinion of the workshop fell into two main areas. One group felt that nothing should be done until a comprehensive study is completed detailing and defining the erosion problem for the entire regional coastline. In addition, improvements should be mainly non-structural (planting of vegetation, control of vehicular and pedestrian access to beach, set-back line, etc.) and utilizing "let nature take her course" concepts. The other group felt that something structural must be done to save the park. They cited the rapid erosion rate and felt a structural concept could best protect the park. The workshop concluded that any shore protection measure should be compatible with the recreational purposes of the park.

4. After this draft report is circulated to Federal, State, and local agencies and interested citizens, a public meeting will be held to obtain the public's view on the alternative plans of improvements. Public views and concerns expressed at that meeting will be incorporated into the final report, and a final public meeting, if necessary, will be held to present the final selected plan.

MAILING LIST

WAIEHU BEACH PARK, SHORE PROTECTION
MAUI, HAWAII

MEMBERS OF CONGRESS

Honorable Spark M. Matsunaga
United States Senate
Washington, D. C. 20510

Honorable Spark Matsunaga
United States Senator
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Honolulu, Hawaii 96850

Honorable Daniel K. Inouye
United States Senate
Washington D. C. 20510

Honorable Daniel K. Inouye
United States Senator
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Water Resources Division
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Postmaster
Wailuku, Maui, Hawaii 96793

Postmaster
Lahaina, Maui, Hawaii 96761

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Governor of Hawaii
Honolulu, Hawaii 96813

Honorable Henry Takitani
Hawaii Senate, Room 202
Honolulu, Hawaii 96813

Honorable Mamoru Yamasaki
Hawaii Senate, Room 232
Honolulu, Hawaii 96813

Honorable Herbert J. Honda
Hawaii House of Representatives
Honolulu, Hawaii 96813

Honorable Anthony Takitani
Hawaii House of Representatives
Honolulu, Hawaii 96813

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Environmental Center
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Look Laboratory of Oceano-
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Office of Marine Affairs
State of Hawaii
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Mayor of the County of Maui
Wailuku, Maui, Hawaii 96793

Mr. Robert Nakasone
Chairman, Maui County Council
Wailuku, Maui, Hawaii 96793

Councilman Toshio Ansai
Maui County Council
Wailuku, Maui, Hawaii 96793

Councilman Rick Medina
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Office of the Economic Development
Coordinator
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Director
Department of Water Supply
County of Maui
Wailuku, Maui, Hawaii 96793

Maui Public Library
Regional Library
Wailuku, Maui, Hawaii 96793

Maui Public Library
Kahului Branch
Kahului, Maui, Hawaii 96732

Maui Public Library
Lahaina Branch
Lahaina, Maui, Hawaii 96761

Maui Public Library
Makawao Branch
Makawao, Maui, Hawaii

STATE DISTRICT OFFICES

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Wailuku, Hawaii 96793

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Maui District Office
DLNR, Division of Land Management
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District Manager
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Facilities Division
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District Engineer
Maui District Office
DOT, Land Transportation
Facilities Division
650 Palapala Drive
Kahului, Hawaii 96732

WAIEHU BEACH
SHORE PROTECTION STUDY

WEDNESDAY, FEBRUARY 14, 1979

AT 7:30 PM

KAHULUI LIBRARY

KAHULUI, MAUI, HAWAII

LOCAL, COUNTY, AND CONGRESSIONAL INTERESTS HAVE EXPRESSED THE NEED FOR POSSIBLE SHORE PROTECTION IMPROVEMENTS AT WAIEHU BEACH PARK. THE US ARMY CORPS OF ENGINEERS HAS INITIATED A DETAILED STUDY OF THE EROSION PROBLEM.

A WORKSHOP IS BEING HELD TO OBTAIN INFORMATION ON THE PROBLEM AND TO HELP US IDENTIFY THE ECONOMIC, SOCIAL, AND ENVIRONMENTAL ASPECTS OF THE WAIEHU BEACH PARK AREA.

YOUR ATTENDANCE AND PARTICIPATION AT THE WORKSHOP WILL HELP US UNDERSTAND THE PROBLEMS AT WAIEHU BEACH PARK. IF YOU HAVE ANY QUESTIONS CONCERNING THE WORKSHOP OR WOULD LIKE ADDITIONAL INFORMATION, PLEASE CONTACT MR. JAMES K. LIGH AT 438-9526, OR WRITE TO THE ADDRESS BELOW.

PLEASE BRING THIS NOTICE TO THE ATTENTION OF ANY INTERESTED INDIVIDUAL OR ORGANIZATION .

U.S. ARMY ENGINEER DISTRICT, HONOLULU BUILDING 230 FORT SHAFTER, HAWAII 96858

Public Workshop

WAIEHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

DESIGN

APPENDIX B

APPENDIX B

DESIGN ANALYSIS

1. The design analysis for stone structures is based on procedures contained in the Shore Protection Manual (U.S. Army Coastal Engineering Research Center), and available physical data for the project area.

2. Design Water Depth. The design water depth is equal to the mean lower low water depth at the structure toe plus the still water level (SWL) above MLLW depth due to tides and other oceanographic factors. The MLLW depth is about 1.0 feet at the toe of the revetment and 2.0 feet at the toe of the breakwater. The SWL is the sum of the mean higher high water level (2.3 feet) and the estimated storm surge level (1.2 feet) for a total of 3.5'. The design water depth would then be (d_s = 1.0' + 2.3' + 1.2') 4.5 feet for the stone revetment. The design water depth of the offshore breakwater would be (d_s = 2.0 + 2.3 + 1.2) 5.5 feet

3. Design Wave Height. The design wave height, H_b, is based on the controlling depth criteria. The Shore Protection Manual (Figure 7.4) states that with a reef flat slope equal to zero, the ratio of the breaking wave height to water depth, regardless of the wave period is 0.78 or H_b = .78 d_s = 3.6' (stone revetment) and 4.3' (breakwater).

4. Armor Weight Stability. Armor stone size was calculated for the two alternatives (shoreline stone revetment and offshore breakwater) using the U.S. Army Waterways Experiment Station formula:

$$W = \frac{W_r H_b^3}{K_D (S_r 1)^3 \cot \alpha}$$

Where

W_r = Unit weight of stone = 165 lb/cu. ft.

H_b = Design wave height = 3.6 ft.(stone revetment)
4.3 ft.(breakwater)

K_D = Empirical stability coefficient = 3.5 (TRUNK), 2.9 (HEAD)

S_r = Specific gravity of stone relative to sea water = 165▲ 64

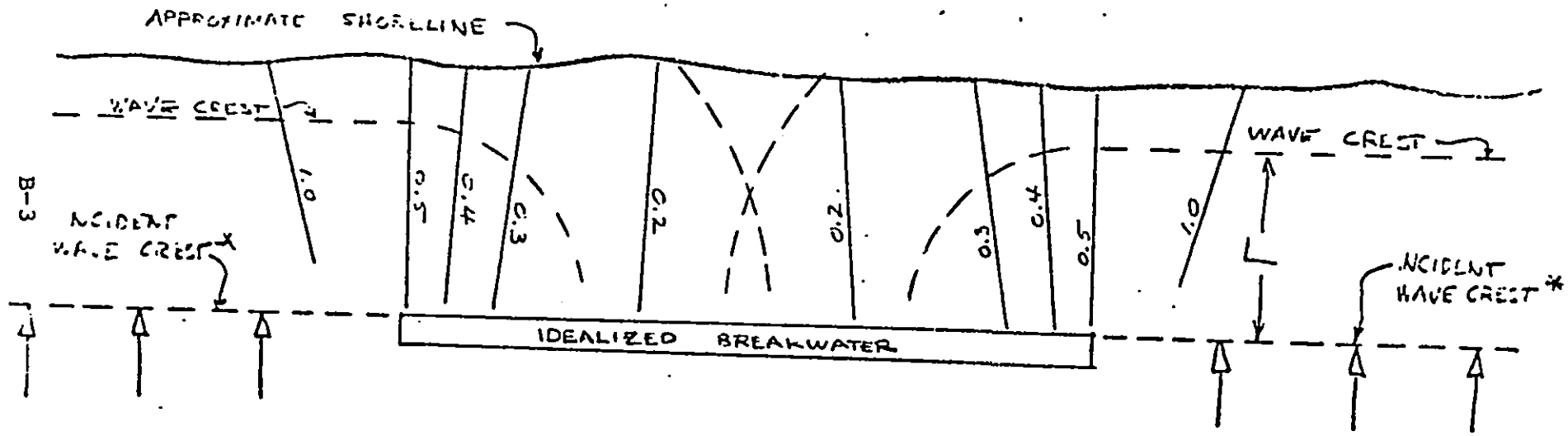
cot α = Cotangent of the angle between the structure slope and horizontal = 1.5

The armor layer for a non-overtopping structure (shoreline stone revetment) would be utilizing 500- to 1,000-pound stones having an average dimension of 1.9 feet, resulting in a 2-stone thick layer of 3.8 feet. The underlayer would consist of a 1.7-foot thick layer of 50- to 100-pound stone.

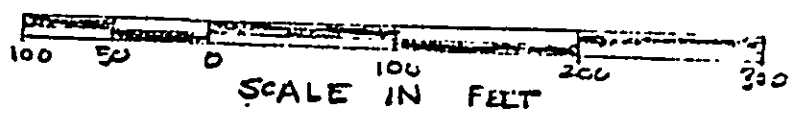
The armor stone size for a low profile overtopping structure (offshore breakwater) would be 800- to 1200-pound stone on the trunk, and 1000-to 1500-pound stone at the structure heads, having an average dimension of 2.1 feet (2.3 feet at the heads) resulting in a 2-stone thick layer of 4.2 feet. The underlayer, if required, would consist of a 1.7-foot thick layer of 50- to 100-pound stone.

5. A non-overtopping crest elevation was calculated for the design conditions for the shoreline stone revetment. A maximum wave runup of about 5.5 feet above the stillwater level can be expected for an overtopping crest elevation of about 9.0 feet. Since the top of the existing bank is at about 12.0 feet, a stone revetment would tie in at that elevation, which is above the maximum predicted runup elevation.

WAIEHU BEACH PARK



DIFFRACTION ANALYSIS
FOR 10 second wave



* INCIDENT WAVE APPROACH DIRECTION FROM AERIAL PHOTOGRAPHS.

WAEIHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

SOCIAL AND CULTURAL RESOURCES

RECREATION AND NATURAL RESOURCES

APPENDIX C

NOTE: APPENDIX C WILL BE COMPLETED DURING THE FINAL DETAILED PROJECT REPORT PHASE

WAIEHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

ECONOMIC ANALYSIS

APPENDIX D

APPENDIX D

ECONOMIC ANALYSIS

1. METHODOLOGY

a. The economic justification of the proposed improvements was determined by comparing the equivalent average annual charges (i.e., interest, amortization, and maintenance costs) to an estimate of the equivalent average annual benefits accruing over the project life. The average annual benefits should equal or exceed the annual costs for Federal Government participation.

b. The benefits derived at the time of accrual and total costs are then amortized over the project life using the Federal interest rate established by the US Water Resources Council. This discount rate of 6-7/8 percent is based on the established rate for fiscal year 1979. The computed average annual benefits and costs are then compared as a basis for economic justification.

c. A number of economic and physical forces, such as physical depreciation, obsolescence, changing requirements for project services, and inaccuracies in making overly long projections, limit the economic life of the project. Based on these factors, an economic life of 50 years was used for project analysis.

d. The development of project costs and benefits follows standard Corps of Engineers practice. The value of all goods and services used in the project is estimated on the cost side. Benefits which would accrue from erosion control improvements at Waiehu Beach Park consist of reduction in land and physical property losses, and the continued quality of recreational opportunities.

2. COST ANALYSIS

a. The estimated cost for the construction of shore protection improvements at Waiehu is based on the following assumptions:

(1) A construction period of the following:

Protective Beach:	2 months
Offshore Breakwater:	4 month
Shoreline Stone Revetment:	6 months

(2) April 1979 price levels for the project area.

(3) Mobilization and demobilization costs.

(4) A 20 percent contingency cost allowance.

(5) Engineering and design costs (excluding preauthorization study cost).

(6) Supervision and administration cost.

(7) Labor from Maui, no overtime.

(8) Estimated maintenance costs for the project life (50 years).

(9) The construction of a causeway made from quarry material to build the offshore breakwater.

3. ESTIMATE OF COST

a. Shoreline stone revetment:

Item	Quantity	Unit Cost	Total (Dollars)
Mobilization and Demobilization	L.S.	-	$ 16,200
Armor Stone	1,830 Tons	$39.00/Ton	71,400
Underlayer	820 Tons	$31.00/Ton	25,400
Bedding	830 Tons	$28.00/Ton	23,200
Excavation and Backfill	1,100 cy	$ 6.40/cy	7,000
Contingency (20%)	-	-	28,600
SUBTOTAL			$171,800
Engineering and Design			8,600
Supervision and Administration			11,400
TOTAL			$191,800
Average Annual Cost (Includes interest & amortization)			13,700
Annual Maintenance Cost (Based on 1% of the first cost of armor stone)			700
TOTAL AVERAGE ANNUAL COST			$ 14,400

b. Offshore breakwater:

Item	Quantity	Unit Cost	Total (Dollars)
Mobilization and Demobilization	L.S.	-	$ 18,700
Stone	1,570 Tons	$90.00/Ton	141,300
Contingency (20%)	-	-	32,000
SUBTOTAL			$192,000
Engineering and Design			9,600
Supervision and Administration			12,800
TOTAL			$224,400
Average Annual Cost (includes interest and amortization)			16,000
Average Maintenance Cost (based on 2% of the first cost of armor stone)			2,800
TOTAL AVERAGE ANNUAL COST			$ 18,800

c. Protective beach:

Item	Quantity	Unit Cost	Total (Dollars)
Sand	3,500 cy	$37.00/cy 1/	$129,500
Contingency (20%)	-	-	25,900
SUBTOTAL			$155,400
Engineering and Design			9,300
Supervison and Administration			11,300
TOTAL FIRST COST			$176,000

1/ Includes cost of mobilization and demobilization.

	Total (Dollars)
Average Annual Cost (includes interest and amortization)	12,600
Annual Maintenance Cost (based on 2,000 cy/10 years)	3,400
TOTAL AVERAGE ANNUAL COST	$ 16,000

4. APPORTIONMENT OF COSTS

a. The apportionment of costs between Federal and non-Federal interest is in accordance with Section 103 of Public Law 87-874 which prescribes the cost of restoration and protection of Federal, non-Federal, public, and private shores. The maximum level of Federal aid for protection on publicly owned non-Federal shores for parks and conservation areas is 70 percent of the total cost of construction. The maximum level of financial aid for construction of publicly owned non-Federal shore other than parks and conservation areas is 50 percent of the total first cost. However, the statutory Federal share for any beach erosion control improvement under Section 103a is $1,000,000.

b. To qualify for the maximum 70 percent Federal paritication applied to parks and conservation areas, all of the criteria specified by Public Law 826, 84th Congress and its amendment by the River and Harbor Act of 1962 (PL 87-874) must be met. In accordance with Section 103 of Public Law 87-874, Federal participation would be 70 percent of the total first cost of the project. The following apportionment of cost would be applicable to this project.

Plan	Total Estimated First Cost	Federal Share	Non-Federal Share
Shoreline Stone Revetment	$191,800	$134,300	$57,500
Protective Beach	176,000	123,200	52,800
Offshore Breakwater	224,400	157,000	67,400

5. BENEFITS

a. General. Benefits accrued from shoreline protection at Waiehu Beach Park result from the continued use of the beach park grounds, the existing pavilion, and picnic facilities for recreation, leisure, and social activities by preventing land loss and structure damages due to erosion. Intangible benefits accrued include improved morale of the community, reduction of loss in social and recreational activities, and the elimination of possible dangerous conditions that would be created from a constricted beach park. Benefits were determined by measuring the difference between conditions with and without shoreline protection in equivalent average annual value, using a discount rate of 6-7/8 percent and an economic life of 50 years.

b. Recreation. Waiehu Beach Park is the most popular of three [1/] beach parks within the Wailuku-Kahului tributary area. It is the only beach park in that tributary with a pavilion that can accommodate approximately 100 people. Data obtained from interviews indicate that the beach park is well used but information on recorded daily attendance is not available. "Old timers," park attendants, and public officials interviewed supplied all of the data used to derive the annual usage of the park. The total annual visits under ideal conditions was estimated to be 37,950. This figure was adjusted by 92 percent to account for bad weather days based on climatological data by the Weather Bureau by assuming bad weather days had 0.1 inches of rain or more. The adjusted annual visits was determined to be 35,000 for 1978 and is tabulated in Table D-1. This estimate of annual visits was compared with 45,000 annual visits that was computed using data from the State Comprehensive Outdoor Recreation Plan (SCORP) as shown in Table D-2. Since SCORP involves broad planning for the entire island of Maui and is not site oriented, the interviewed figures of 35,000 visits at Waiehu was accepted as reasonable. When asked of their intended use of Waiehu Beach Park, the consolidated opinions indicated that 15 percent use the beach and offshore areas, 27 percent use the open park area, and 58 percent use the pavilion (as summarized in Table D-3). Based on the above figures, in 1978, of the total estimated 35,000 annual visits, there were 5,400 visits to use the beach areas, 9,400 visits to use the open park and 20,200 visits to use the pavilion.

c. Prevention of Loss of Recreational Opportunities from the Loss of the Pavilion. The pavilion at Waiehu is popular because of its capacity and location. There are no other beach park pavilions in the Wailuku-Kahului tributary conducive to events such as a luau (Hawaiian

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1/ Waiehu is the only improved beach park within the Wailuku-Kahului area, the other two are within traveling distance in the Makawao-Kula planning area.

type party), recreational, or organizational events. Table D-3 indicates that an estimated 20,200 visits made annually were intended for pavilion usage. To estimate the lower end of the recreation benefit, no growth in visits was considered in this report even though there would be increases as the population is expected to double in the next 50 years. Based on $1.75 1/ per visitor day using guidelines by the Water Resources Council Principles and Standard for Planning Water and Related Land Resources established pursuant to Section 103 of the Water Resources Planning Act (PL 89-80), the benefit for recreational use of the pavilion is $35,400. The utility of the pavilion is expected to be lost in about 10 years from the base year. The average annual recreational benefit from prevention of damage to the pavilion would be $17,600.

d. Prevention of Loss in Recreational Opportunities from the Open Park. Besides the pavilion, the open park has picnic tables, barbecue facilities, and grassy areas for family gatherings, lunch groups, or people just spending their leisure time. Participation is usually by the local people who consider it too inconvenienet to travel elsewhere and most have considered it to be a pleasant meeting area. From the interviewed opinion of park uses, about 9,400 visits were made annually for open park use. However, at the probable rate of erosion, based on limited historical data, approximately 35 percent of the improved park will be lost in a 50-year period. The park will become unattractive and about 50 percent of the annual visits will be lost. This estimate is based on loss of land and the loss of one of two picinic areas which include tables, grills, and shade trees. The annual loss would be 4,700 (9,400 x .50) visitor days within a 50 year period. With the loss of pavilion and park areas, the visitor-day value for the remaining users would be the minimum based on a judgement factor for a public beach with no facilities with a generally unattractive appearance. The visitor-day value for those who continue to use the park would then be $0.75. Consequently, the average annual loss is $3,200 and is summarized below.

1/ Recreation unit day values range from $0.75 to $2.25 for general recreation associated with civil works projects. Using criteria from the Pacific Southwest Inter-Agency Committee (Methodology for Determining General Recreational Values Under Senate Document No. 17, July 1969) which are also recomended in the proposed Corps of Engineers' Engineering Regulations entitled, Recreation and Natural Resources Investigation and Reporting, a judgment factor for the recreation value of the pavilion is estimated to be $1.75.

Loss of visitors	(4,700 x $1.75)	$ 8,200
Loss of visitor-day value	(4,700 x $0.75)	3,500
	Total	$11,700
Equivalent annual loss	($11,700 x 0.27357)	$ 3,200

e. Reduction of Loss of Shoreline Use. There will be no change in shoreline usage.

f. Summary of Benefits. In summary the average annual benefits are as follows:

Type	Average Annual Benefits
Prevent Recreational Opportunity Losses from Pavilion	$17,600
Prevent Recreational Opportunity Losses from Open Park Area	3,200
TOTAL	$ 20,800

TABLE D-1

ESTIMATED ANNUAL VISITS TO WAIEHU BEACH PARK (1978)
FROM INTERVIEWS

Usage Category	Average Number of Visits: Week Day	Week-Ends	Week	Month	Year	Estimated Annual Visits
Fishing, Leisure, Gathering Limu (seaweed)	30					7,800
Clubs, Retirees		45				4,680
Organizational Events					500	500
Family Picnics		20				2,080
Lunch Groups	20					5,220
Regular Weekend Events		120				12,200
Parties (Luau)				75		900
Snorkeling, Gathering Shells & Surfing		20				2,080
Holiday Events					1,260	1,260
Summer Events			100			1,200
TOTAL ANNUAL VISITS - IDEAL CONDITION						37,950
ADJUSTED TOTAL ANNUAL VISITS BASED ON 92 PERCENT GOOD WEATHER DAYS						35,000

TABLE D-2

ESTIMATED ANNUAL VISITS TO WAIEHU BEACH PARK
USING SCORP ACTIVITY PARTICIPATION RATES

Activity	Activity/1,000 Pop Weekend Day	Week Day
Picnicking	112.0	27.7
Surfing	15.0	7.2
Fishing	42.0	16.7
Attending Outdoor Events	115.0	20.5
TOTAL	274.2	72.1
Adjustments to Activity/1,000 Population		
Activity Participation in Improved Area 38%	104.1	27.4
Activity Participation in Shore Area 40%	41.6	11.0
Activity Within District: Weekend 65%, Weekday 81%	27.0	8.9
Activities		
Estimates Based on 28,900 Population 1/	780.3	257.2
Estimated Activities per Year (Ideal Condition) Using 104 Weekend Days and 260 Weekdays	148,000 Visits	
Adjusted Estimated Activities per Year Using 90% Good Weather Days	136,200 "	
Estimated Annual Waiehu Beach Park Activity Based on 1/3 of 3 Improved Beach Parks	45,000 "	

1/ Wailuku-Kahului Trubutary Hawaii State Census Statistical Committee Report CTC-40 3October 1978, 1977 population.

TABLE D-3

INTERVIEWED OPINIONS OF INTENDED PARK USAGE AT WAIEHU BEACH

Usage Category	Percent			
	Shoreline	Open Park	Pavilion	Total
Fishing Leisure, Gathering Limu	33		67	100
Clubs, Retirees			100	100
Organizational Events		30	70	100
Family Picnics		70	30	100
Regular Weekend Events	10	50	40	100
Lunch Groups		50	50	100
Parties (Luau)		10	90	100
Snorkeling, Surfing, Gathering Shells	100			100
Holiday Events	10	50	40	100
Summer Events	___	10	90	100
TOTALS	153	270	577	1,000
Percent of Total Intended Park Use	15%	27%	58%	100%
Estimated Annual Visits to Waiehu Based on 35,000 Visits	5,400	9,400	20,200	35,000

6. SUMMARY OF COSTS AND BENEFITS AND BENEFIT TO COST RATIOS

	Shoreline Stone Revetment	Offshore Breakwater	Protective Beach
Total Estimated Cost	$191,800	$224,400	$176,000
Average Annual Cost	14,400	18,800	16,000
Average Annual Benefits	20,800	20,800	20,800
Benefit to Cost Ratio	1.4	1.1	1.3

WAEIHU BEACH PARK

SHORE PROTECTION PROJECT

MAUI, HAWAII

FISH AND WILDLIFE INFORMATION

APPENDIX E

DRAFT

Table 1. Marine plants collected in the Waiehu Beach study area, Waiehu, Maui, Hawaii 18 March 1979.

Angiosperm

Halophora hawaiiensis

Marine Algae

Ulva reticulata

U. fasciata

Halimedia discoidea

Colpomenia sinuosa

Scinaia hormoides

Laurencia nidifica

L. obtusa

Polyopes clarionensis

Sargassum echinocarpum

Hypnea sp. (2 sp.)

Acanthophora spicifera

Gracelaria sp. (2 sp.)

Jania sp.

Ralfsia occidentalis

Porolithon onkodes

DRAFT

Table 2. Macroinvertebrates observed in the proposed Waichu Beach Erosion Protection project vicinity, Waichu, Maui, Hawaii on 18 March 1979.

Phylum Cnidaria

Class Anthozoa

Order Actiniaria (species observed but not collected)
Order Zoanthiniaria

Isaurus elongatus
Zoanthus sp.
Palythoa tuberculosa

Order Scleractinia

Porites evermanni

Phylum Mollusca

Class Amphineura

Ischnochiton petaloides

Class Gastropoda

Conus abbreviatus
Conus lividus
Conus ebraeus
Pyrene zebra
Peristernia chlorostoma
Strombus maculatus
nudibranchs - 2 species

Class Pelecypoda

Ostrea sandwichensis

Class Cephalopoda

Octopus

Phylum Ectoprocta (Bryozoa collected)

Phylum Arthopoda

Class Crustacea

Order Decopoda

1 Brachyuran crab

Table 2. Cont'd

Simocarcinum simplex

Order Amphipoda

1 species

Order Isopoda

1 species

Phylum Annelida

Polycheata (1 sp.)

Phylum Echinodermata

Class Echinoidea

Echinometra mathaei
Echinothrix deadema
Echinothrix calamaria

Class Ophiuroidea

Ophiocoma sp.

Class Holothuroidea

Holothuria sp.

Phylum Chorodata

Class Ascidiacea

Ascidia sp.

000667 MAUI WAIHEE
20 55 23.0 156 29 42.0 2
WAIEHU STREAM MOUTH
15009 HAWAII
MAUI
WAIHEE
21HI 04001001
0001 FEET DEPTH CLASS 00

Lat/Long Location ID

/TYPA/AMBNT/OCEAN

DATE FROM TO	TIME OF DAY	DEPTH FEET	31503 TOT COLI MFDLENDO /100ML LOG	31505 TOT COLI MPN CONF /100ML LOG	31615 FEC COLI MPNECMED /100ML LOG	31678 FECSTREP MPN TUBECODE LOG
73/01/01						
YEAR	NUMBER			19.0000	19.0000	
	MAXIMUM			2400.00	2400.00	
	MINIMUM			3.00000	3.00000	
	MEAN			29.7645	8.51636	
74/01/00						
74/01/01						
YEAR	NUMBER			8.00000	8.00000	
	MAXIMUM			4600.00	1100.00	
	MINIMUM			2.00000	2.00000	
	MEAN			67.7385	15.8759	
75/01/00						
75/01/01						
YEAR	NUMBER			19.0000	19.0000	
	MAXIMUM			9200.00	1300.00	
	MINIMUM			2.00000	2.00000	
	MEAN			12.6705	5.07689	
76/01/00						
76/01/01						
YEAR	NUMBER			40.0000	40.0000	8.00000
	MAXIMUM			16000.0	1600.00	221.000
	MINIMUM			2.00000	2.00000	2.00000
	MEAN			12.0992	4.87135	7.65307
77/01/00						
77/01/01						
YEAR	NUMBER			14.0000	14.0000	
	MAXIMUM			790.000	790.000	
	MINIMUM			2.00000	2.00000	
	MEAN			5.53061	3.74510	
78/01/00						
00/00/00						
STATION	NUMBER			100.000	100.000	8.00000
	MAXIMUM			16000.0	2400.00	221.000
	MINIMUM			2.00000	2.00000	2.00000
	MEAN			14.8967	5.78382	7.65307
[illegible]/99/99						

RETRIEVAL DATE 77/11/29

000668 MAUI WAIHEE
20 56 16.0 156 30 28.0 2
WAIHEE FARM SHORELINE
15009 HAWAII
MAUI
WAIHEE
21HI 04001001
0001 FEET DEPTH CLASS 00

/TYPA/AMBNT/OCEAN

DATE FROM TO	TIME OF DAY	DEPTH FEET	31503 TOT COLI MFDLENDO /100ML LOG	31505 TOT COLI MPN CONF /100ML LOG	31615 FEC COLI MPNECMED /100ML LOG	31678 FECSTREP MPN TUBECODE LOG
73/01/01						
YEAR	NUMBER			18.0000	18.0000	
	MAXIMUM			460.000	460.000	
	MINIMUM			3.00000	3.00000	
	MEAN			13.4761	6.73636	
74/01/00						
74/01/01						
YEAR	NUMBER			10.0000	10.0000	
	MAXIMUM			170.000	33.0000	
	MINIMUM			3.00000	2.00000	
	MEAN			12.9699	4.67526	
75/01/00						
75/01/01						
YEAR	NUMBER			20.0000	20.0000	
	MAXIMUM			79.0000	23.0000	
	MINIMUM			2.00000	2.00000	
	MEAN			6.18001	2.79756	
76/01/00						
76/01/01						
YEAR	NUMBER			11.0000	11.0000	9.00000
	MAXIMUM			33.0000	33.0000	33.0000
	MINIMUM			2.00000	2.00000	2.00000
	MEAN			3.24660	3.04833	6.04215
77/01/00						
77/01/01						
YEAR	NUMBER			9.00000	9.00000	
	MAXIMUM			920.000	920.000	
	MINIMUM			2.00000	2.00000	
	MEAN			4.61091	3.95267	
78/01/00						
00/00/00						
STATION	NUMBER			68.0000	68.0000	9.00000
	MAXIMUM			920.000	920.000	33.0000
	MINIMUM			2.00000	2.00000	2.00000
	MEAN			7.14342	4.04110	6.04215

SHEET RETRIEVAL DATE 75/05/23

/TYPA/AMBNT/OCEAN

000660 MAU
20 55 16.0 155 30 28
WAIMEE FARM SHORELINE
15009 HAWAII
MAUI
WAIMEE
21HI
0001 FEET DEPTH C

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00300 DO MG/L	00400 PH SU	00480 SALINITY PPTH	00530 RESIDUE TOT VFLT MG/L	005 TOTAL N MG/
73/02/05	13	10	25.0	21.0		8.15	30.0		0.
73/05/01	12	40	25.3K	21.0	7.3K	8.15	25.5		0.
73/08/07	10	30	25.1K	0.3L	6.9L		28.2		0.
73/11/05	10	25	25.5	6.0	6.9	8.23	29.5		0.
74/02/11	14	10	25.4K	1.9	9.0K	8.50	25.3		0.
74/05/07	14	15		9.9					0.
74/09/04	06	00	24.6	6.9	6.3	7.85			0.
75/03/04	10	25		33.0					0.
75/05/12	15	15	25.5	15.0	3.4>	8.30	11.5		0.
75/08/12	15	00	25.0	0.3	6.9	8.30	28.2		0.
75/11/10	14	50	26.5		5.0	5.90	35.0		
76/02/09	08	30		15.0					0.
76/05/11	08	05	23.5	1.5	7.8	7.80	33.0		0.
76/08/17	09	30	25.0	5.2	6.8	6.90 -	32.5		0.
76/12/13	11	55	24.0	0.1K	6.6	7.40	(5.2)	omit data	
75/12/14	09	00	22.0	5.8	8.2	6.80	29.0		0.
77/05/09	15	00	24.0	2.1	7.8		33.0		0.
77/08/08	10	45	21.5	3.9	9.1	8.60 -	33.0		0.
77/11/07	09	15	24.2	8.4			33.7		0.

COE -6