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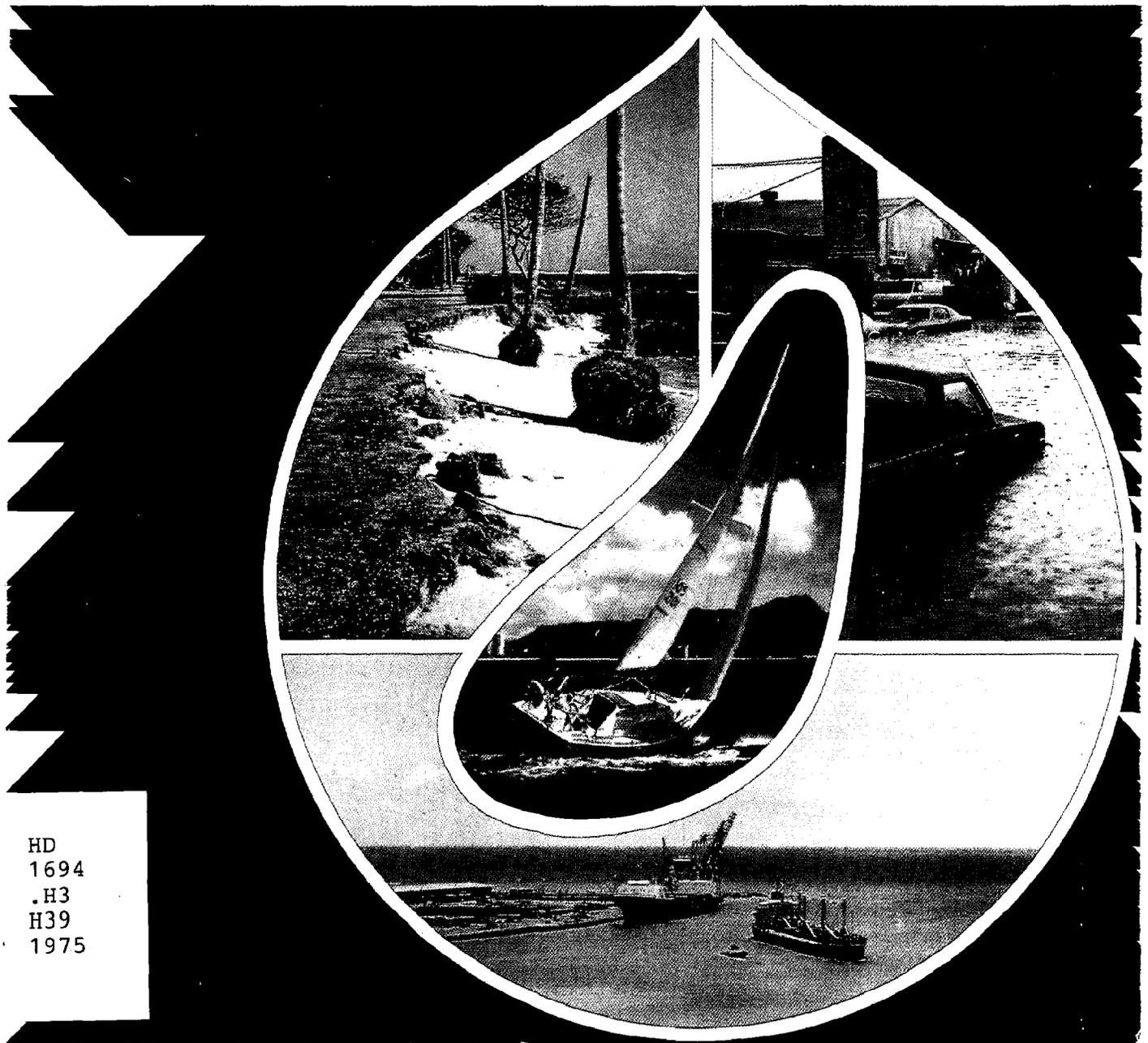
# HAWAII

## Water Resources Development

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U. S. ARMY CORPS OF ENGINEERS / PACIFIC OCEAN DIVISION / JANUARY 1975



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# HAWAII

## *Water Resources Development*

January 1975

Information on Water Resources Development Projects  
by the U.S. Army Corps of Engineers in Hawaii  
may be obtained from:

**DIVISION ENGINEER**

U.S. Army Engineer Division, Pacific Ocean  
Corps of Engineers  
Building 230, Fort Shafter  
APO 96558

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TO OUR READERS:

During June, 1975, both the United States Army and the Army Corps of Engineers commemorate their two hundredth anniversaries. And for the past century and a half, the Corps, at the direction of Congress, has planned for the wise use and proper development of America's water resources.

The Corps was born in a moment of stress and at a time of great need. The hastily formed continentals desperately needed defensive ramparts for the Battle of Bunker Hill. Our first engineers met the challenge and, since that strife-ridden genesis, the Corps has picked up the gauntlet many times and served well in each national crisis. Corps representatives, civilian and military, dedicate themselves to preserving the Nation and enhancing both our way of life and the environment which supports it.

The Army Engineers have played a vital role throughout our history—whether at peace or war. In the early decades of our Nation's development, we handled construction of the country's first interstate roads and canals, the first bridges and railroads. Numbered among our many accomplishments, the Corps built the Panama Canal and finished the Washington Monument. Since 1824 the Engineers have been charged with improving rivers and harbors, with the responsibility for both the coastal work and the intricate system of inland waterways.

We are dedicated to serving the people of the United States and responding to their needs. In this tradition, we remain sensitive to the Nation's emphasis on environmental and developmental needs of the Nation.

During this, our bicentennial year, as in years past, we urgently seek to foster public awareness of and involvement in our water resources planning efforts. To respond to your wishes, we must communicate. Therefore, I ask you to study this booklet. Learn what has been accomplished and consider what is being planned for your State. Then, provide us with your opinions and offer your counsel. We exist to serve you and all the people of the United States.



W.C. GRIBBLE, JR.  
Lieutenant General, USA  
Chief of Engineers

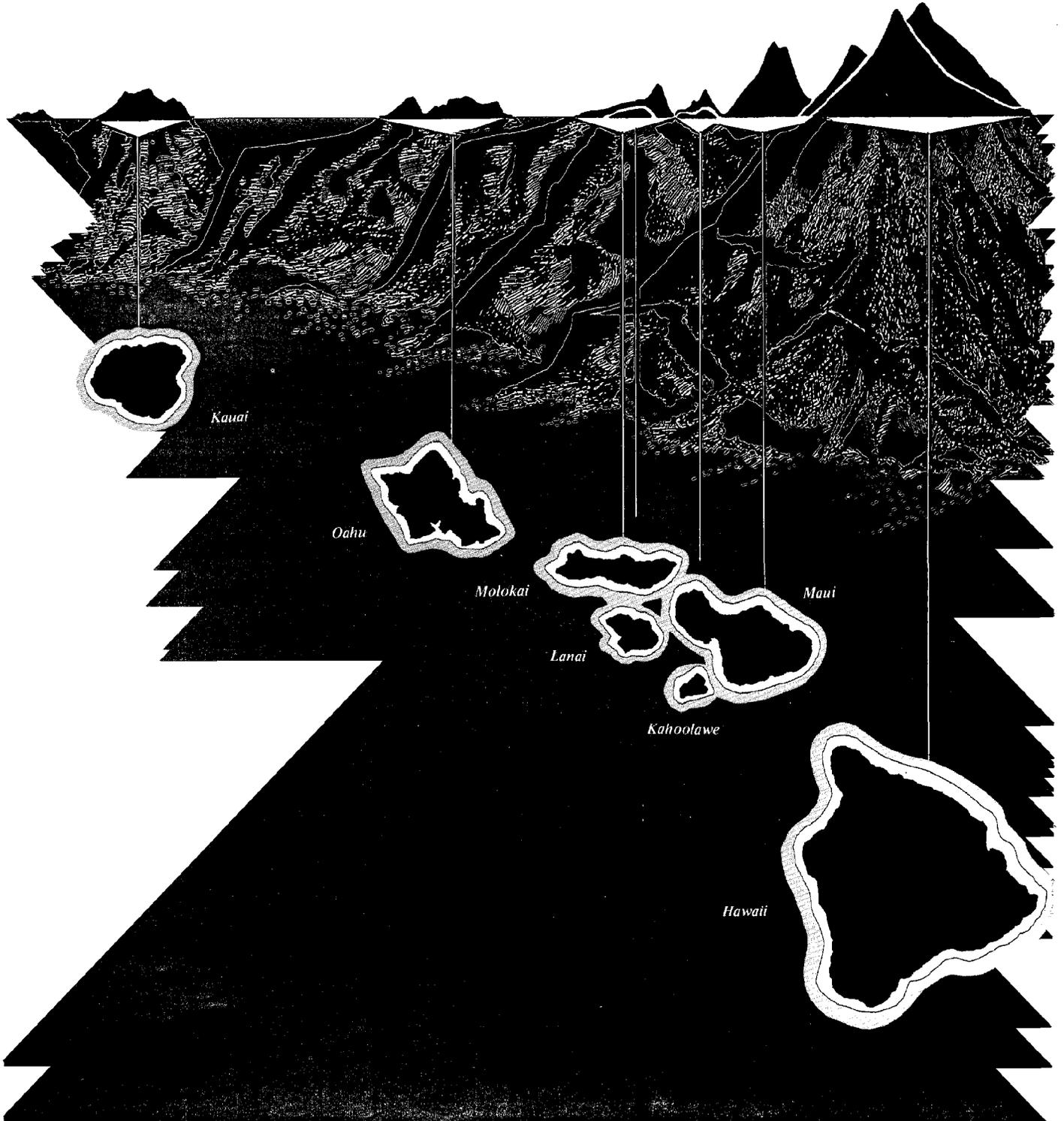
## TABLE OF CONTENTS

<p>INTRODUCTION ..... 7</p> <p>THE CORPS' ROLE IN THE DEVELOPMENT OF THE NATION'S WATER RESOURCES ..... 8</p> <p style="padding-left: 20px;">Navigation ..... 8</p> <p style="padding-left: 20px;">Flood Control ..... 8</p> <p style="padding-left: 20px;">Beach Erosion ..... 9</p> <p style="padding-left: 20px;">Water Supply ..... 10</p> <p style="padding-left: 20px;">Hydroelectric Power ..... 10</p> <p style="padding-left: 20px;">Recreation ..... 10</p> <p style="padding-left: 20px;">Fish and Wildlife Conservation ..... 10</p> <p style="padding-left: 20px;">Emergency Activities ..... 10</p> <p style="padding-left: 20px;">Other Special and Continuing   Authorities ..... 11</p> <p>HOW CORPS OF ENGINEERS' PROJECTS ARE STARTED, DEVELOPED AND BUILT ..... 13</p> <p>THE CORPS' ROLE IN THE DEVELOPMENT OF WATER RESOURCES IN THE STATE OF HAWAII ..... 18</p> <p style="padding-left: 20px;"><b>Statewide</b> ..... 18</p> <p style="padding-left: 40px;">Rivers and Harbors of Hawaii ..... 18</p> <p style="padding-left: 40px;">Hawaii Water Resources Regional Study ..... 19</p> <p style="padding-left: 20px;"><b>Island of Kauai</b> ..... 21</p> <p style="padding-left: 40px;">Nawiliwili Deep-Draft Harbor ..... 21</p> <p style="padding-left: 40px;">Nawiliwili Small Boat Harbor ..... 23</p> <p style="padding-left: 40px;">Port Allen Deep-Draft Harbor ..... 24</p> <p style="padding-left: 40px;">Hanapepe River Flood Control ..... 24</p> <p style="padding-left: 40px;">Kapaa Beach Erosion Control ..... 27</p> <p style="padding-left: 40px;">Other ..... 27</p> <p style="padding-left: 20px;"><b>Island of Oahu</b> ..... 29</p> <p style="padding-left: 40px;">Honolulu Harbor ..... 29</p> <p style="padding-left: 40px;">Haleiwa Small Boat Harbor ..... 31</p> <p style="padding-left: 40px;">Waianae Small Boat Harbor ..... 32</p> <p style="padding-left: 40px;">Ala Wai Harbor ..... 32</p> <p style="padding-left: 40px;">Waikiki Beach ..... 34</p> <p style="padding-left: 40px;">Haleiwa Beach ..... 36</p> <p style="padding-left: 40px;">Kaaawa Beach ..... 36</p>	<p style="padding-left: 20px;">Kualoa Regional Park ..... 37</p> <p style="padding-left: 20px;">Kawainui Swamp ..... 37</p> <p style="padding-left: 20px;">Kuliouou Stream ..... 38</p> <p style="padding-left: 20px;">Kaneohe Dam ..... 38</p> <p style="padding-left: 20px;">Wailupe Stream ..... 40</p> <p style="padding-left: 20px;">Kalihi Stream ..... 41</p> <p style="padding-left: 20px;">Waialua-Haleiwa Area ..... 41</p> <p style="padding-left: 20px;">Kaneohe Bay Urban Water   Resources Study ..... 42</p> <p style="padding-left: 20px;">Other ..... 43</p> <p style="padding-left: 20px;"><b>Island of Molokai</b> ..... 45</p> <p style="padding-left: 40px;">Kaunakakai Harbor ..... 45</p> <p style="padding-left: 40px;">Kalaupapa Barge Harbor ..... 45</p> <p style="padding-left: 40px;">Kaunakakai Stream ..... 45</p> <p style="padding-left: 40px;">Kapaakea Homestead Area ..... 47</p> <p style="padding-left: 20px;"><b>Island Of Lanai</b> ..... 49</p> <p style="padding-left: 40px;">Manele Harbor ..... 49</p> <p style="padding-left: 20px;"><b>Island of Maui</b> ..... 51</p> <p style="padding-left: 40px;">Kahului Harbor ..... 51</p> <p style="padding-left: 40px;">Lahaina Harbor ..... 51</p> <p style="padding-left: 40px;">Kihei Beach ..... 54</p> <p style="padding-left: 40px;">Shores of Kahului Harbor ..... 54</p> <p style="padding-left: 40px;">Iao Stream ..... 54</p> <p style="padding-left: 40px;">Kahoma Stream ..... 55</p> <p style="padding-left: 40px;">Other ..... 55</p> <p style="padding-left: 20px;"><b>Island of Hawaii</b> ..... 57</p> <p style="padding-left: 40px;">Hilo Harbor ..... 57</p> <p style="padding-left: 40px;">Kawaihae Deep-Draft Harbor ..... 58</p> <p style="padding-left: 40px;">Kawaihae Small Boat Harbor ..... 58</p> <p style="padding-left: 40px;">Honokohau Small Boat Harbor ..... 59</p> <p style="padding-left: 40px;">Kaimu Beach ..... 59</p> <p style="padding-left: 40px;">Wailoa Stream Flood Control ..... 60</p> <p style="padding-left: 40px;">Other ..... 60</p> <p>FLOOD PLAIN MANAGEMENT SERVICES ..... 61</p> <p>APPENDIX—LIST OF PROJECTS ..... 63</p>
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HAWAII . . .

*"The loveliest fleet of islands that lies  
anchored in any ocean"*

—MARK TWAIN



## INTRODUCTION



Water is probably the most important natural resource for man's survival and comfort. Not only does it sustain us, but it also determines the quality of our environment. The availability or lack of water, among other things, creates a wide range of natural surroundings for us to live in and to enjoy—from lush rain forests and verdant valleys to arid deserts. When properly developed and managed, water enhances the quality of life by not only providing for our daily needs, but by making available a wide range of recreational opportunities. On the other hand, mismanaged or uncontrolled, water can cause havoc—from soil erosion to floods and pollution which cause human misery and destroy property.

As an island state, Hawaii is heavily dependent on the water resources both within and around the islands. The ocean influences the islands' tropical climate, links the islands with each other as well as with other areas of the world, and is the highway over which Hawaii exports its agricultural and manufactured products to overseas markets and imports raw materials and other commodities for local consumption. The ocean is also a source of food, and a primary source of recreation for both residents and visitors.

The islands' surface and underground waters have also played a dominant role in the socioeconomic development of the 50th state. Early Hawaiians settled near perennial streams and springs and developed sophisticated methods for efficiently utilizing this vital resource. Water was so important to these people that formal rules governing its equitable distribution were enforced long before Captain Cook discovered Hawaii. The development of a dependable supply of water from underground sources resulting from the drilling of artesian wells in the late 1800's, opened the door to the growth and development of the islands. This growth has accelerated following admission of Hawaii to the Union in 1959. Rapid expansion and economic development have not occurred without "growing pains" and accompanying problems, however, some of which concern the islands' vital water resource.

This booklet describes the U.S. Army Corps of Engineers' role in water resources development and how the Pacific Ocean Division and Honolulu Engineer District have been assisting the State and County governments in the management and development of Hawaii's water resources.

## THE CORPS' ROLE IN THE DEVELOPMENT OF THE NATION'S WATER RESOURCES

The U.S. Army Corps of Engineers has been the Federal Government's principal water resources development agency since 1824 when the Congress directed the Corps to remove snags and sandbars from the Ohio River. Since then, the Corps has been responsible for improving the rivers and coastal waters of the United States to provide for efficient and safe transportation of the nation's waterborne commerce. The Corps of Engineers' role in the development of the nation's water resources gradually expanded to include the planning and construction of flood control, beach erosion control, hydroelectric power, water supply, and water-related recreation, all of which are accomplished in cooperation with local governments and citizens, and in response to their request and desires. The extent to which the Corps can assist the State and Counties of Hawaii under the various authorities provided by Congress are described below.

### NAVIGATION

The navigability of harbors and inland waterways is one of the most important aspects of the nation's transportation system. The Federal interest in navigation improvements stems from the commerce clause of the Constitution and from subsequent decisions of the U.S. Supreme Court which have determined that the Federal obligation to regulate navigation and commerce also includes the right to make necessary improvements. The primary objective of these improvements is to assist in the development, conduct, and safety of waterborne commerce. This objective is accomplished by deepening and widening waterways so that ships and other water craft can be accommodated safely and expeditiously, and to provide an economical means of transporting various types of cargo. Other navigation objectives include the provision of facilities for promoting the production of seafood and for recreational boating.

The methods used to improve navigation vary. Harbor entrances are protected by jetties or enlarged by dredging. Harbors are created by inclosing an area of open water within breakwaters or other structures or by dredging of estuaries and inland areas. Rivers are improved by clearing and snagging, dredging, and the construction of locks and dams. The Corps of Engineers is responsible for the maintenance as well as the construction of Federal navigation projects. The cost of constructing harbors for commercial navigation is largely Federal. For projects primarily intended for recreational boating, non-Federal interests (which is usually the local government requesting the project) are required to bear one-half of the project cost.

In addition to improving rivers and harbors for navigation, the Corps of Engineers is responsible for administering the Federal laws for the protection and preservation of the navigable waters of the United States. Under this authority, the Corps grants permits for work or structures to be constructed in or affecting these waters, regulates the discharge of dredged or fill material into navigable waters, the transportation of dredged material for dumping into ocean waters, and the construction of artificial islands and fixed structures on the outer continental shelf. The Corps also establishes and enforces regulations for the use of navigable waters, including fishing areas and harbor lines.

### FLOOD CONTROL

The Federal interest in flood control began in the alluvial valley of the Mississippi River early in the 19th Century after experience with the disastrous effects of floods on navigation. Through the Flood Control Act of 1936, Congress extended the Federal interest in flood control to include not only navigable waters but all waterways in the nation due to the impact of disastrous floods on communities as well as transportation systems.

The purpose of flood control works is to regulate flood flows and thus prevent flood damage. This objective is accomplished through the construction of dams and reservoirs (lakes), local protection works or combinations of these measures. Flood control lakes provide a place for the temporary retention of storm flows. After the storm, the stored water is released as rapidly as the downstream channel can accommodate it without causing damage, in order to provide storage space for the next storm. Local protection works include channel enlargement, realignment, removing obstructions, constructing levees and walls, providing channel paving, and stabilizing banks with stone and concrete, or combinations of these methods.

Lakes constructed for flood control often include additional storage capacity for multipurpose uses, such as for the conservation of water for municipal and industrial use, navigation, irrigation, development of hydroelectric power, conservation of fish and wildlife, and recreation.

Local protection works are turned over to non-Federal authorities for maintenance, as are small lakes of localized effect. Other lakes are operated and maintained by the Corps of Engineers. The Federal government assumes most of the cost of flood control improvements. However, non-Federal interests are responsible for providing lands, easements, and rights-of-way required for the project. Where other uses such as hydroelectric power, water supply and recreation would be served by a flood control project, the costs of providing these improvements are shared between Federal and non-Federal interests according to regulations dictated by Congress.

Until recently, floods have been controlled primarily through the construction of dams and reservoirs, channels, levees and the like. However, attention is now being focused on the prevention of floods by restricting man's use and occupation of areas vulnerable to floods. The Corps of Engineers is taking an active role in helping local governments define the flood-prone areas so that they can effectively regulate use of these areas. This work is being accomplished through the Corps' Flood Plain Management Program which is described in detail later in this booklet.

## BEACH EROSION

The Corps of Engineers' involvement in beach erosion control began in 1930 when it was directed to respond to the State of New Jersey's request for Federal assistance in solving erosion problems along its coast. This initial work led to the establishment of the Beach Erosion Board within the Corps of Engineers. Established by Congress in 1935, the Board is known today as the Coastal Engineering Research Center, and continues to lead in the investigation of physical phenomena related to coastal waters and in the development of techniques and procedures for protecting, restoring, and developing shoreline property and beaches.

The objectives of the Corps' beach erosion control program are to protect the coastal shores and the properties behind them from damages due to wave action, and to restore areas which have been severely eroded or damaged as a result of this natural force. In addition to protecting life and property, beach erosion projects are designed to preserve and enhance the nation's beaches for recreational use. Beach erosion control is achieved through remedial works such as beach replenishment and the construction of dunes, groins, and seawalls designed to prevent damages from storm tides and wave action.

The Federal contribution toward the construction of protective works for non-Federal public shores is limited to a maximum of one-half of the total project cost, except for State, county, or other publicly owned shore parks and conservation areas where the Federal share is increased to seventy percent. The Federal Government can assist in protecting private shores if there is a public benefit. Maintenance of completed beach erosion control projects is a non-Federal responsibility; however, the Federal Government can assist in periodic beach replenishment if this work is determined to be the most suitable and economical remedial measure.

## **WATER SUPPLY**

An adequate supply of water for domestic, agricultural, and industrial uses has long been recognized as being vital to the national economy and security. For this reason, water supply is included in the Corps of Engineers' planning and development of the nation's water resources. Section 6 of the Flood Control Act of 1944 authorizes the Secretary of the Army to contract with States, municipalities and private concerns or individuals for domestic and industrial uses of surplus water that may be available at Corps of Engineers projects. The Water Supply Act of 1958 further provides for the inclusion of water supply storage in Federal navigation, flood control, irrigation, or multiple-purpose projects. The Water Supply Act of 1958 requires non-Federal interests to share in the project cost related to water supply development. The extent of State and local participation and cost sharing in all new projects or modifications is specified in Section 301 of this act. In 1961, this act was amended to increase the Federal interest in water supply and water quality improvements. Additional changes are included in the Water Quality Amendments Act of 1972.

## **HYDROELECTRIC POWER**

The need for hydroelectric power has become more urgent with the continued increase in population and urban development across the nation. A series of laws and resolutions, dating back to the River and Harbor Act of 1909 and sustained by the Supreme Court, has given the Chief of Engineers the authority to include the development of hydroelectric power in multiple-purpose projects when such development can be achieved together with the primary objective of the project.

## **RECREATION**

The Federal Water Project Recreation Act of 1965 requires that all project planning give consideration to the inclusion of facilities for swimming, boating, fishing, camping, and sightseeing wherever appropriate. In developing plans for recreational facilities, the Corps of Engineers works closely with all Federal, State, and County agencies concerned with the development of recreational facilities and programs, and with interested community groups and individuals.

## **FISH AND WILDLIFE COORDINATION**

The Fish and Wildlife Coordination Act of 1958 (Public Law 85-624), as amended, states that fish and wildlife conservation shall receive equal consideration with other water development project purposes and shall be coordinated with other features of water resources development projects and programs. The act authorizes the enhancement of these resources whenever possible, and specifies the action to be taken to offset the adverse effects of water resources development projects on fish and wildlife.

## **EMERGENCY ACTIVITIES**

The Corps of Engineers is authorized to assist local governments during emergency situations. The Corps' role during flood emergencies is an advisory one until the District Engineer is notified that local agencies are unable to cope with the situation. The Corps then assumes an active role in directing the flood fight. In other emergencies such as earthquakes, tidal waves, or enemy action, the District Engineer is authorized to use all resources at his command to aid civil authorities in preventing human suffering and mitigating destruction or damage.

Several authorities have been provided by Congress which permit the Secretary of the Army and the Chief of Engineers to implement projects of limited scope for the purpose of alleviating potentially dangerous conditions resulting from emergency situations. Upon receipt of a formal request from a local government agency fully empowered under State law to provide the required local cooperation, the Corps investigates the reported problem. If the investigation clearly shows that remedial measures are required and that they are engineeringly and economically feasible, the project is adopted for construction. The various authorities for Corps participation in emergency work are described below.

### **Public Law 99, 84th Congress— Emergency Flood Activities**

Public Law 99 provides for an emergency fund to be used at the Chief of Engineers' discretion for:

- (1) Flood emergency preparations, floodfighting

and rescue operations, and the repair or restoration of any flood control work threatened or destroyed by floods; (2) emergency strengthening of Federally authorized hurricane or shore protection works being threatened, when such protection is necessary to prevent imminent and substantial loss of life and property; and (3) repair and restoration of Federally authorized hurricane and shore protection structures damaged or destroyed by wind, wave, or water action of other than ordinary nature, when such repair and restoration are necessary for adequate functioning of the structures.

**Public Law 875, 81st Congress—  
Disaster Relief**

Public Law 875 authorizes the expenditure of funds by the Office of Emergency Preparedness (OEP) for relief and recovery during and after national disasters. The Corps of Engineers furnishes engineering and construction support when requested by OEP.

**Section 14, Flood Control Act of 1946—  
Emergency Bank Protection**

Under this authority, the Corps of Engineers may spend up to \$50,000 in one locality during any one fiscal year for the construction of emergency bank protection works to prevent flood damage to highways, bridge approaches, and other public works endangered by bank erosion.

**Section 2, River and Harbor Act of 1945—  
Snagging and Clearing for Navigation**

This act authorizes the Corps of Engineers to undertake emergency work to clear or remove unreasonable obstructions from rivers, harbors, and other waterways in the interest of navigation.

**Section 208, Flood Control Act of 1954—  
Snagging and Clearing for Flood Control**

Under this act, the Corps of Engineers is authorized to spend up to \$100,000 on any single tributary during any one fiscal year for removal of snags and other accumulated debris, and for clearing and straightening stream channels, when, in the opinion of the Chief of Engineers, such work is required in the interest of flood control.

**OTHER SPECIAL AND CONTINUING  
AUTHORITIES**

Most of the work described earlier is accomplished in response to specific direction from Congress. However, Congress has also provided the Secretary of the Army and the Chief of Engineers general authorities to implement water resources projects of limited scope in response to requests from local government agencies. These projects are subject to the same principles of engineering and economic feasibility as are projects specifically authorized by Congress. They must be complete within themselves and should not commit the United States to any additional improvement to insure successful operation. The general authorities are often referred to as the "small projects or special continuing authorities" and are described below.

**Section 205, Flood Control Act of 1962—  
Small Flood Control Projects**

This legislation provides for construction of small flood control projects not specifically authorized by Congress when, in the opinion of the Chief of Engineers, such work is advisable. The Federal share in such projects may not exceed \$1,000,000 (\$2,000,000 if the area had been declared a major disaster area within the previous five years).

**Section 107, River and Harbor Act of 1960, as  
amended—Small Navigation Projects**

This legislation authorizes the Corps of Engineers to construct small river and harbor improvement projects not specifically authorized by Congress when they will result in substantial benefits to navigation. The Federal share in such projects may not exceed \$1,000,000.

**Section 103 a, River and Harbor Act of 1962, as  
amended—Small Beach Erosion Control Projects**

This legislation as amended provides for construction of small shore and beach restoration and protection projects not specifically authorized by Congress, when, in the opinion of the Chief of Engineers, such work is advisable. The Federal share in such projects may not exceed \$1,000,000.

**Section 111 of the River and Harbor Act of 1968—  
Prevention and Mitigation of Shore Damages  
Caused by Existing Federal Navigation Works**

This legislation authorizes the Corps of Engineers to investigate, study, and construct projects to prevent and mitigate shore damages attributable to Federal navigation works. The Federal Government will assume the cost of constructing, operating, and maintaining these projects, provided that the first cost is less than \$1,000,000. Specific authorization by Congress is required for projects costing more than \$1,000,000.

**Public Law 189, 55th Congress—  
Removal of Wrecks and Obstructions**

Under this law, the Corps of Engineers is authorized to investigate wrecked vessels and other obstructions to navigation, and to remove them at the owner's expense or, under certain conditions, at the expense of the Federal Government.

## HOW CORPS OF ENGINEERS' PROJECTS ARE STARTED, DEVELOPED AND BUILT

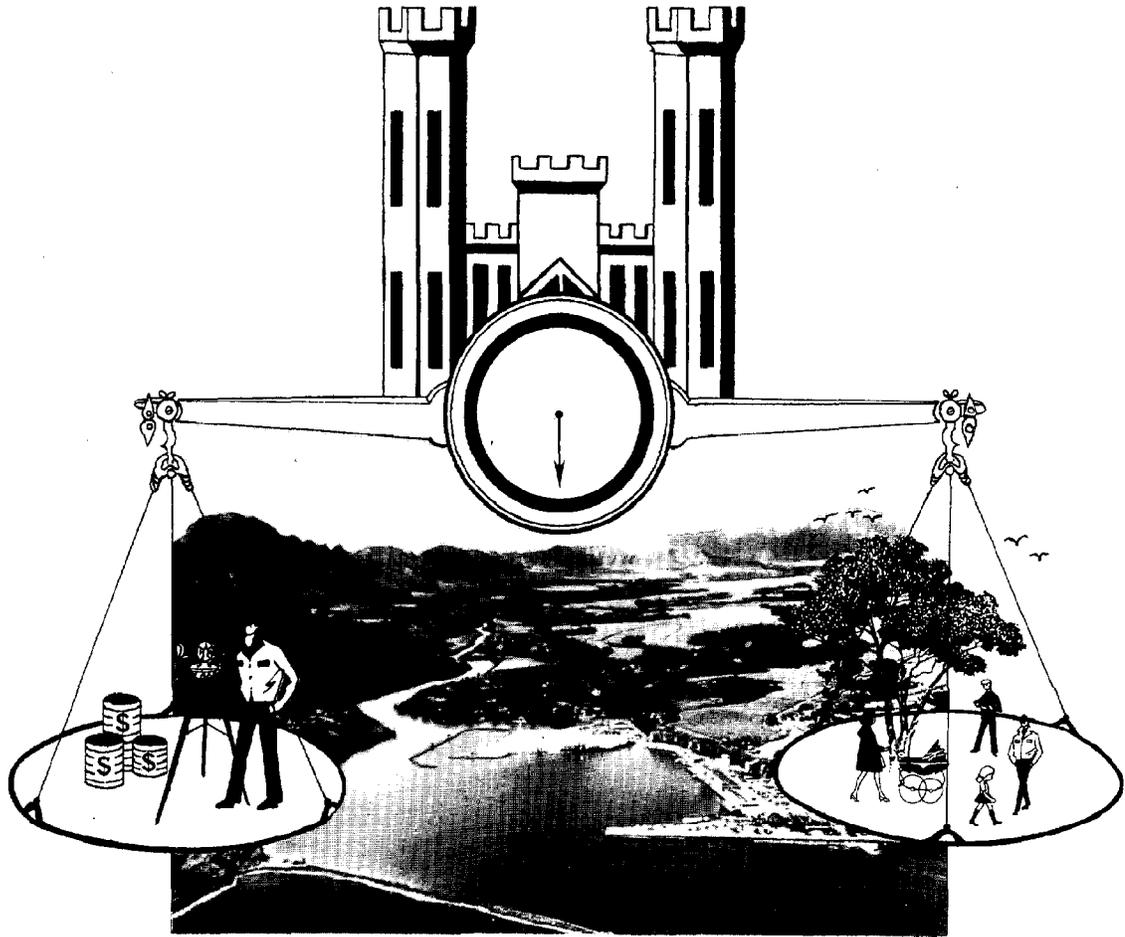
The Corps of Engineers' role in the development of the nation's water resources is primarily one of public service. The Corps serves as an engineering consultant to Congress and assists it in responding to the people's need for water resources improvements. Based on this role, the Corps of Engineers does not initiate any project. It responds to specific direction from Congress with respect to major water resources development projects or to requests from local government agencies for small projects under the special continuing authorities provided by Congress. Because the Corps is committed to serving the public, there are many tests and checks and balances involved in the planning and development of water resources projects. During the study, checks and balances are used to ensure that emphasis is not placed on one facet of the total problem at the expense of other considerations. The checks and balances are concerned not only with the engineering effectiveness and economic feasibility of the solutions considered, but also with the effects of these solutions on the natural environment and on the socio-economic well-being of the people for whom they are being developed and who will have to live with the final solution—good and bad.

In its effort to develop balanced solutions to water resources problems, the Corps of Engineers employs planners, engineers, economists, sociologists, and environmentalists. However, it is constantly aware that as a single agency, it cannot possibly understand and appreciate all of the many factors and considerations involved in developing an effective and balanced solution. For this reason, the Corps relies heavily on public participation in the planning process, and considers it to be one of the major tests in determining whether the solution considered is in the best interest of the general public.

As part of the public participation process, and because it recognizes its limitations, the Corps seeks the assistance of other agencies such as:

- State and County Planning and Public Works agencies—to provide details of the problem for which Corps assistance was requested; to furnish available engineering and technical data related to the problem; to identify related problems and needs in the problem area and their plans for this area; and to provide overall guidance and direction in the development of a solution which would not only alleviate the specific water resource problem, but which would also be compatible with and possibly enhance the overall quality of life in the community.
- The U.S. Fish and Wildlife Service, National Marine Fisheries Service, and State and County fish and wildlife agencies—to define the fish and wildlife resources in the problem area, the value and importance of these resources to the area, existing plans for developing these resources, and the impact of the solutions considered by the Corps on these resources.
- The National Parks Service and the State Historic Preservation Officer—to identify sites and artifacts of historical and/or archaeological significance which would be affected by the solutions being considered by the Corps; to determine the desired disposition of the sites and artifacts; and to advise the Corps on the actions required to achieve the desired effect.
- State and County recreation agencies—to identify the existing recreational resources, the community's recreational needs and desires, the agencies' plans for the area; and ways in which the Corps could assist in enhancing the community's recreational opportunities.
- Other Federal, State and County agencies as the need arises.

# WATER RESOURCES DEVELOPMENT ...



**A Delicate Balance**

Most importantly, the Corps relies heavily on community organizations, civic groups, and the people living in the problem area to help it understand the magnitude of the problem, how it affects their lives, and what they'd like to see done to solve the problem.

Based on the definition of the problem, planning constraints, and other information obtained from public participation during the initial phase of the study, the Corps develops alternative solutions to the problem. Public participation is again relied on in determining which solution would most effectively solve the problem and be most compatible with the community's needs and desires. Public participation mechanisms include, but are not limited to, public meetings, informal meetings with citizen groups and government officials, workshops, and citizen advisory councils. The objective of each of these mechanisms is to evaluate the alternative solutions against the following basic considerations:

- Which of the alternatives is the most effective from the engineering standpoint?
- Which alternative is the most feasible from the economic standpoint, that is, which alternative would provide the greatest benefit for the smallest outlay of our tax dollars?
- Which alternative would be most beneficial to the natural environment? Which alternative would cause the least disturbance to existing natural resources in the area? Which one would improve and enhance these resources?
- Which alternative would be most beneficial to the socio-economic well-being of the people living and working in the problem area?

Very rarely is a single alternative the best with respect to each of the four considerations. Usually the alternatives satisfy the four conditions to varying degrees. Consequently, the selection of a final solution usually involves tradeoffs, that is, the acceptance of a desired condition at the expense of some sacrifice in other conditions. For example, one solution to the flood problem on a stream where homes have been constructed along both banks would be to increase the stream capacity by widening it. This action would require acquisition of residential property along the stream and relocation of a few families. Another solution would be to increase the stream capacity by constructing high concrete walls along the banks. Although concrete walls may not be aesthetically pleasing, they would provide the desired flood protection without

having to acquire residential property and relocate families. The tradeoffs involved between the two solutions involve aesthetics and community cohesion (ugly high concrete walls vs. relocating families). Clearly, the final selection should not and is not made by the Corps, but by local government agencies and the people who would be directly affected by the decision. The Corps primarily functions as the moderator in the final selection. However, it is responsible for implementing a solution which would provide the greatest benefit to the greatest number of people. This responsibility is not an easy one to carry out. Many times, it is extremely difficult to objectively determine what action would be in the greatest public interest. Public meetings and other public participation mechanisms provide much of the input used in the decision-making process. Also heavy reliance is placed on the views and position of the local government requesting or sponsoring the study, since they will have to share in the cost of the project as well as make certain commitments to the Federal Government. Also, the local agency is considered to be sensitive to the needs of the community affected by the water resource problem and the relationship of the problem to the overall needs of the County and State.

Based on consideration of all engineering and technical data pertinent to the problem, and all comments received from government agencies and the public, the District Engineer must recommend a solution which, he feels, represents the best balancing of all factors considered, pro and con, and would serve the public interest best. The wisdom of his decision is demonstrated by the final product, that is, the extent to which the completed project satisfies or fails to satisfy the community's water resource needs.

The foregoing discussion attempted to provide insight into the principles and concepts involved in the Corps' planning of water resources development projects. The major steps involved in the initiation, planning, and construction of a water resources project specifically authorized by Congress are illustrated in the following diagram.

A LOCAL PROBLEM BECOMES SERIOUS

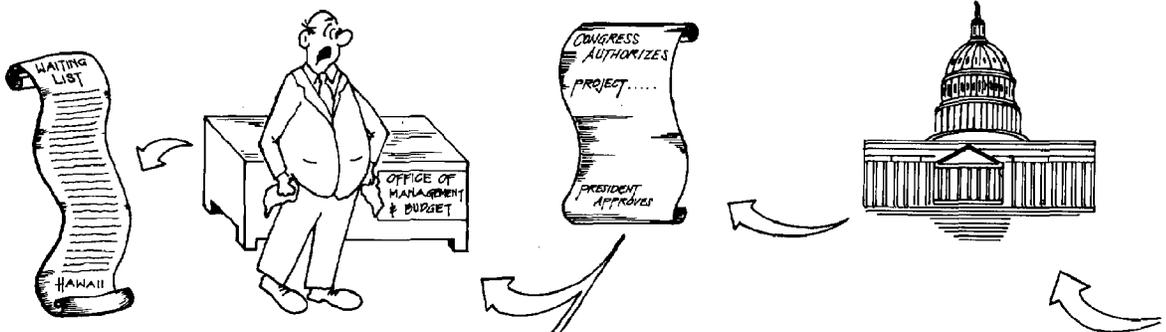


COMMUNITY ASKS FOR HELP

CONGRESS AUTHORIZES STUDY



THE STUDY BEGINS.....



SEVERAL YEARS LATER



FUNDS ARE APPROPRIATED

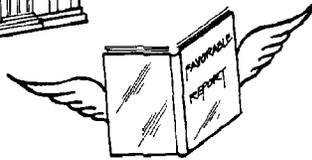
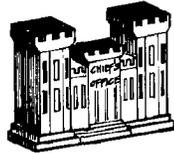
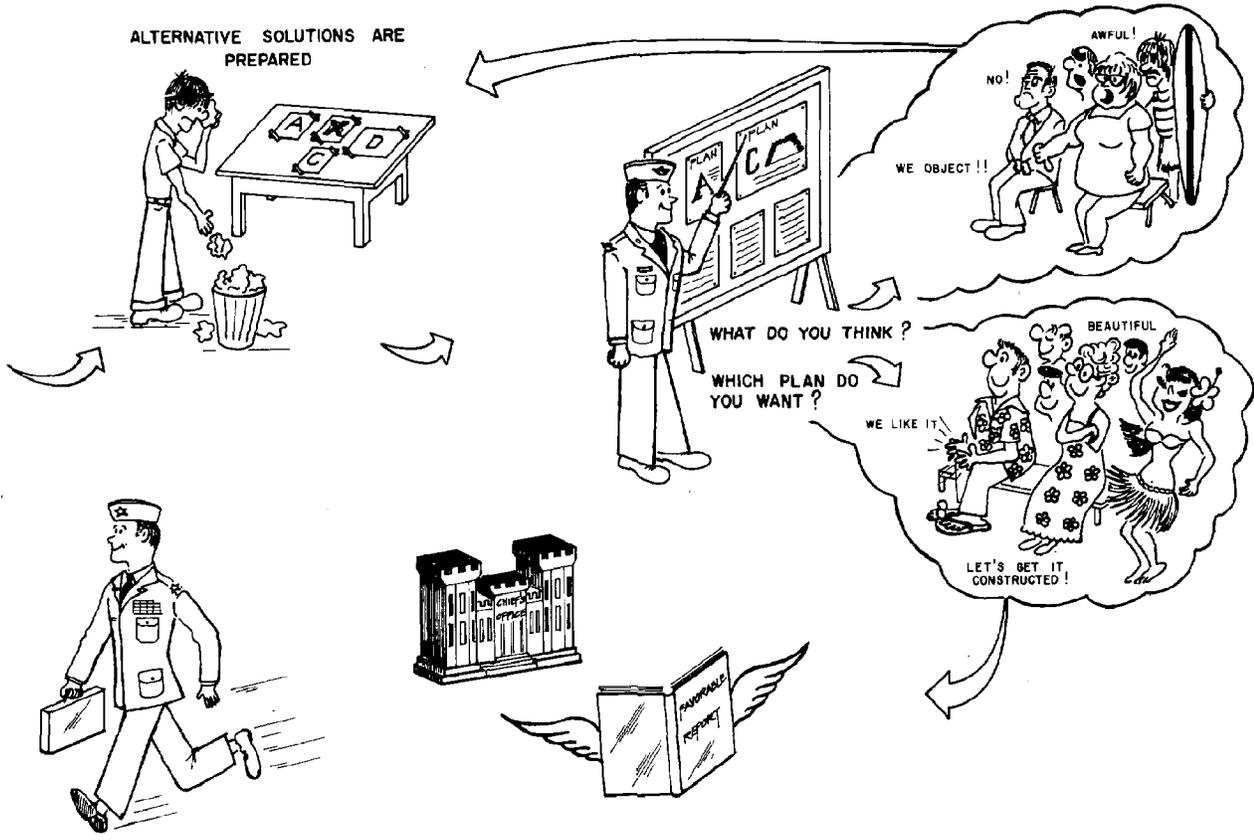


MORE MEETINGS

MODIFICATIONS AND DETAILED DESIGN



# HOW CORPS OF ENGINEERS PROJECTS



AGREEMENT



CONSTRUCTION BEGINS

ARE STARTED, DEVELOPED AND BUILT

## THE CORPS' ROLE IN THE DEVELOPMENT OF WATER RESOURCES IN THE STATE OF HAWAII

The Corps of Engineers, through its Pacific Ocean Division and Honolulu Engineer District, has been assisting in the development of Hawaii's water resources since 1905. The Corps' early efforts were concentrated on developing and improving harbors on the major islands, beginning with the dredging of Honolulu Harbor on the island of Oahu in November 1905 and expanding to Hilo Harbor on the island of Hawaii, Kahului Harbor on the island of Maui, and Nawiliwili Harbor on the island of Kauai. Through the years, the Corps has continued to play a major role in improving and maintaining Hawaii's commercial navigation system on which the State's economy is so heavily dependent. In addition, the Corps' role has expanded to include the development of improvements for controlling floods and beach erosion, as well as for expanding the State's system of small boat harbors to meet the growing demand for recreational boating. The remainder of this booklet describes the Corps' accomplishments and how it is continuing to work with State and County agencies in improving and protecting Hawaii's valuable water and related resources for the use and enjoyment of present and future generations of residents and visitors.

### STATEWIDE

#### RIVERS AND HARBORS OF HAWAII

Section 209 of the Flood Control Act of 1962 authorized the Corps of Engineers to study the water resources needs of the State of Hawaii to the year 1995. For this study, Congress defined water resources to include the traditional areas of Corps responsibility such as harbor development, flood control, beach erosion control, and water supply as well as "other beneficial water uses, and related land resources."

The idea of examining the water resources needs of the entire state of Hawaii is a departure from the usual single-problem or project-oriented approach to water resources development. Prior to this study, the Honolulu Engineer District had been directed to develop solutions to specific problems such as flooding on a stream or erosion of a beach. For this study, however, we were told to examine the total needs of the state and its counties and to provide Congress with an integrated plan for water resources development that would meet the needs and goals of the people of Hawaii.

The first phase of the study consisted of a series of public meetings and the preparation of a plan of study based on information obtained during the meetings. The public meetings began on Maui in May 1971 and spread to each of the other major islands, ending on Oahu in early 1972. During the meetings, the objectives of the Rivers and Harbors of Hawaii study were discussed together with water resources development plans for the state and the island on which the meeting was being held. The Corps then heard citizen and local government statements of water resource problems and needs, and the effects of developments planned to the year 1995 on existing and anticipated water resources.

Isolated or localized problems which were called to the Corps' attention during the meetings were investigated immediately. For example, during the meeting in Kailua on the island of Hawaii, the Corps was asked to investigate the feasibility of Federal participation in the reconstruction of a recreational beach which had fronted the town at one time. A few months later, Corps representatives returned to Kailua for a second meeting during which the results of a preliminary investigation were discussed. The results showed that Federal participation was not feasible. At a meeting on Molokai, information on a local flood problem presented by citizens has led to the development of a proposed solution under the small projects authority. The flood problem on

Wailupe Stream is also being investigated as a result of statements made during a community meeting on Oahu where Corps representatives discussed the Rivers and Harbors of Hawaii study. Details of this flood control investigation are included in the discussion of water resources projects and studies for the island of Oahu.

As the Rivers and Harbors of Hawaii study progresses, the Corps will hold more public meetings throughout the State so that residents and local government agencies can participate in the development of the study and thereby help to shape the study recommendations. The water resources development plan recommended at the conclusion of the study will identify individual water resources problems throughout the state, and the priorities for their solution as established by State and County planners and through citizen participation.

#### **HAWAII WATER RESOURCES REGIONAL STUDY**

Hawaii's geographical isolation, limited land area, and rapid growth have resulted in unparalleled demands upon her water and related land resources. These resources include the water flowing on the surface of the land, water flowing underground, and the ocean water surrounding the islands. They also include flood plains, shorelines, watersheds, and irrigated agricultural land.

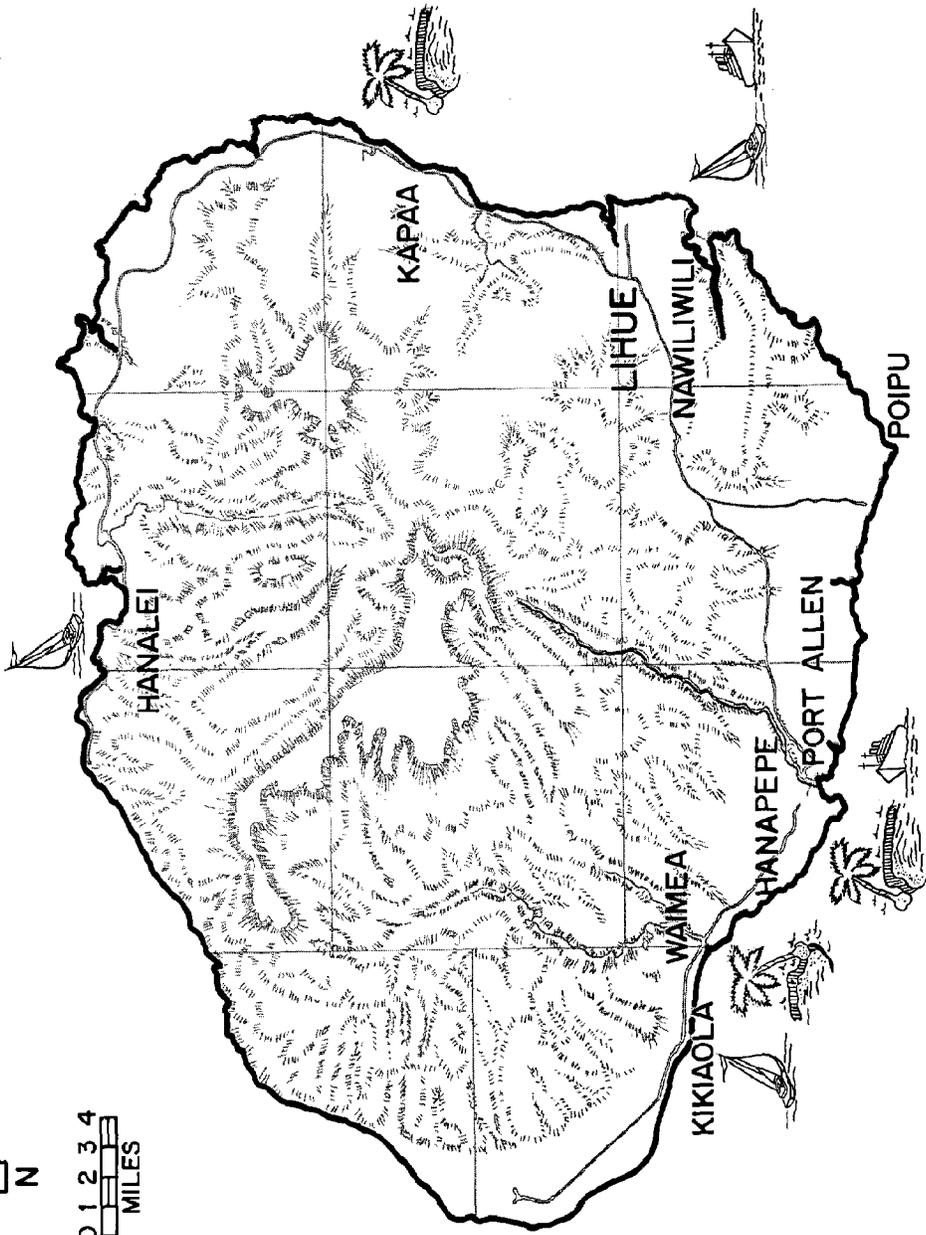
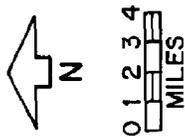
In view of the continued growth anticipated for the state, it is essential to have a complete picture of Hawaii's water and related land resources and a comprehensive plan for the future, in order to make the wisest choices for conserving, developing, and using these resources. The United States Congress and the Hawaii State Legislature have responded to this need for comprehensive water resources planning. In July 1973, the Hawaii Water Resources Study was initiated. Its purpose is to prepare a Hawaii Water Resources Regional Plan by December 1975. This plan will consider needs, problems, and

opportunities involving water and related land resources at both statewide and local levels. The decade 1990-2000 is the primary target period for the plan which will:

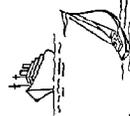
- Identify existing and emerging needs such as flood control, beach protection, and water supply development.
- Provide the means for coordinating federal, state, county and industry programs.
- Indicate priorities for public investment in water and related land resources projects.
- Recommend data collection and research programs to solve long-range problems.
- Recommend any needed changes in laws, ordinances, and regulations.
- Provide for updating and modifying the plan in light of changing conditions.

The approach to the conduct of the Regional Study is unprecedented in Hawaii in that it is a joint effort by government, industry, and the public. About 25 federal agencies, 35 state and county agencies, and citizen advisory committees consisting of citizens, community leaders, and representatives of industry, are involved. Under the supervision of a Study Manager and coordinated by full-time members of the planning staff, 16 teams of specialists and citizens are cooperating in the study. The Corps is the lead agency for four of the study teams, and has representatives serving on six other teams.

# KAUAI



## LEGEND

- DEEP-DRAFT HARBOR 
- SMALL BOAT HARBOR 
- BEACH EROSION 
- FLOOD CONTROL 
- OTHER (SEE TEXT)
- CONSTRUCTION COMPLETED 
- CONSTRUCTION AUTHORIZED 
- STUDY UNDERWAY 

## ISLAND OF KAUAI

### NAWILIWILI DEEP-DRAFT HARBOR

The Nawiliwili Deep-Draft Harbor is the principal port for the island of Kauai. Together with the airport at nearby Lihue, the harbor forms the transportation hub for this northern and westernmost of the six major islands of the state.

The Corps of Engineers first developed the harbor in 1930 by dredging the area near the mouth of the Huleia River and constructing a breakwater. In 1956, the harbor basin was enlarged and the entrance channel was deepened to 40 feet. The breakwater was rehabilitated and a section of the entrance channel was widened in 1959. Work authorized by the River and Harbor Act of 1954 was completed in 1960, and consisted of the dredging of the entrance channel near the end of the breakwater.

The existing harbor consists of a breakwater 2,150 feet long; an S-shaped entrance channel 40 feet deep with a minimum width of 600 feet and a length of about 2,400 feet; a harbor basin 35 feet deep with a maximum width of 1,540 feet and a maximum length of about 1,950 feet; and a revetted fill area on the west side of the basin. The onshore harbor facilities consist of a 1,250-foot wharf with 49,000 square feet of sheds, and 104,000 square feet of open storage; pipelines and storage for kerosene, gasoline, liquid fertilizer, and molasses; and a plant for storing, handling, and loading bulk sugar. Commerce through the harbor totalled 495,448 short tons in 1973. Sugar and molasses comprised half of the total tonnage.

The types and volume of cargo handled at Nawiliwili have not changed much during the past 20 years. However, the vessels that the cargo is carried in have changed. To keep pace with advancing technology and higher operating costs, ships are now larger. They haul more cargo more efficiently than they did 20 years ago. They also require more area to safely operate in than they did 20 years ago.

Nawiliwili Harbor was designed to accommodate ships up to about 500 feet long. Consequently, the turning area and sections of the entrance channel are not adequate to safely accommodate the 650-foot-long vessels that now call at this port. The State of Hawaii therefore requested that a study be made to determine the feasibility of enlarging the harbor and easing the sharp bend in the entrance channel. In 1966, both the U.S. House Public Works Committee and the U.S. Senate Committee on Public Works adopted resolutions requesting the Corps to investigate the navigation problem at Nawiliwili together with a similar problem at the Port Allen Deep-Draft Harbor, the second deepwater port on the island. The Corps completed the study in June 1970, and recommended that the harbor basin be expanded by about 17.3 acres and that the entrance channel be widened. The Corps' recommendation was accepted, and the project was authorized by the River and Harbor Act of 1970 with the provision that construction shall not be started until approved by the Secretary of the Army and the President.

Maintenance dredging of the harbor basin and entrance channel was last performed by the Corps of Engineers in 1972. The next maintenance dredging at Nawiliwili is scheduled for 1978. Total Federal funds expended on Nawiliwili Harbor to December 1974 were \$4,447,383.



*Aerial view of the Nawiliwili Deep-Draft Harbor (right) and the Nawiliwili Small Boat Harbor (center).*

### **NAWILIWILI SMALL BOAT HARBOR**

Safe, adequate berthing facilities for small craft in the Nawiliwili/Lihue area had not been available prior to September 1974. Small craft used to be moored in the estuary at Nawiliwili where they were often damaged during storms. To relieve this problem, a small boat harbor was authorized for construction in May 1974 under the authority of Section 107 of the River and Harbor Act of 1960, as amended. The Federal portion of the harbor was completed in September 1974, and includes a 120-foot-wide, 12-foot-deep, and 1,035-foot-long en-

trance channel; a 12-foot-deep turning basin; a 690-foot-long, 120-foot-wide, and 8- to 10-foot deep main access channel; a 1,911-foot-long revetted dike and breakwater; and a 142-foot-long stub breakwater. The Federal cost through 1974 was \$579,161.

The State of Hawaii has constructed a launching ramp and will be providing berths, comfort stations, and related shoreside facilities as funds are appropriated by the State Legislature. The harbor will ultimately accommodate about 166 small craft.

### **PORT ALLEN DEEP-DRAFT HARBOR**

This harbor is located in Hanapepe Bay on the south shore of Kauai, and is 21 nautical miles away from the principal deepwater port at Nawiliwili. The Corps of Engineers constructed the harbor in 1935 to handle the shipment of sugar and molasses from the plantations on south Kauai. The initial project was modified by the River and Harbor Act of 1945 which provided for expansion of the basin. This work was completed in 1948.

The existing Federal project consists of a breakwater 1,200 feet long, an entrance channel 500 feet wide and 35 feet deep, and a harbor basin 1,200 feet wide, 1,500 feet long, and 35 feet deep. The breakwater has required no maintenance or other work since it was constructed. Commerce through Port Allen during 1973 totalled 93,829 short tons.

The harbor is naturally sheltered from waves associated with prevailing northeast trade winds. However, it is exposed to deepwater swells from the southerly direction. Shipmasters have reported hazardous navigation conditions and objectionable surge at the pier during periods when deepwater waves approach from a southerly direction. In response to resolutions passed by the U.S. House Public Works Committee and the U.S. Senate Committee on Public Works in 1966, the Corps studied the navigation problem at Port Allen. The study, completed in June 1970, showed that Federal participation in improving the navigation conditions could not be economically justified.

Maintenance dredging of the harbor basin and entrance channel was last performed by the Corps of Engineers in 1972. The next maintenance dredging at Port Allen is scheduled for 1978. Total Federal funds expended on Port Allen Harbor to 30 June 1974 were \$1,263,861.

### **HANAPEPE RIVER FLOOD CONTROL**

The wettest spot on earth is at the top of Mt. Waialeale, Kauai, which has an average annual rainfall of 486 inches. The Hanapepe River begins in Alakai Swamp near the summit of Mt. Waialeale and flows into the sea at Hanapepe Bay. The river flows through well-defined canyons and gulches until the coastal plain where it used to seek to establish new courses. The town of Hanapepe occupies the coastal plain, including the flood plain of the Hanapepe River. Floods were a constant threat to the community and caused severe damages to residences and businesses as well as to adjacent agricultural lands.

In response to local interests' request for flood protection, the Corps of Engineers built a flood control project on the lower Hanapepe River under the authority of the Flood Control Act of 1944. The first phase of the project consisting of a levee and floodwall 2,200 feet long on the left bank of the river was completed in December 1959. The second phase consisting of a 4,465-foot-long levee on the right bank was completed in August 1963. The total Federal cost of the project was \$785,000 and the local cost was \$12,000. In 1966, the levees on both banks were raised to provide greater flood protection to the town.

It is estimated that the Hanapepe River Flood Control project has prevented an estimated \$1,056,000 of flood damages through Fiscal Year 1974. Approximately \$526,000 of these damages were prevented during the storms of 12 March, 19 April, and 22 April 1974.



*Aerial view of the Port Allen Deep-Draft Harbor with the State-constructed small boat harbor and Hanspepe River in the background.*



*In July 1974, erosion had already claimed some of the land at Kapaa Beach Park, and exposed the roots of coconut trees along the park's shoreline . . .*

*By December 1974, more park land was lost to erosion.*



*Severe winter storms during December 1974 and January 1975 claimed still more land and have left the coconut trees in an extremely precarious condition.*

### KAPAA BEACH EROSION CONTROL

The County of Kauai's Kapaa Beach Park is the only public beach park for the town of Kapaa, a rural residential community on the east coast of the island. Severe erosion along a 400-foot section of the park shoreline has not only reduced the width of the sandy beach but has also caused the loss of park land and trees.

Local residents report that the storm waves which occurred during December 1968 and January 1969 severely eroded the shore and destroyed a 20-foot section of an existing jetty on the north bank of the Moikeha Canal. The breach in the jetty causes sand that would normally be deposited on the beach by wave action to be deposited in the canal. In addition to retarding normal accretion of the beach, this condition is undesirable because the material accumulating in the canal will eventually clog the mouth and contribute to a flood problem.

In response to a request from the County of Kauai, the Corps of Engineers is investigating the feasibility of Federal participation in beach erosion control improvements for Kapaa Park. A detailed project study is being accomplished under the authority of Section 103a of the River and Harbor Act of 1962, as amended. Alternative plans for restoring the eroded section of the beach and for retarding future erosion have been developed, and the impact of each alternative on the environment has been assessed. The alternative plans and their environmental impacts were discussed at a public meeting in Kapaa on 14 November 1974. A draft report was circulated to Federal, State and County agencies for review and comment. After consideration of all comments received, a detailed project report containing the District Engineer's recommendations will be completed and forwarded to the Office of the Chief of Engineers for review and approval.

### OTHER

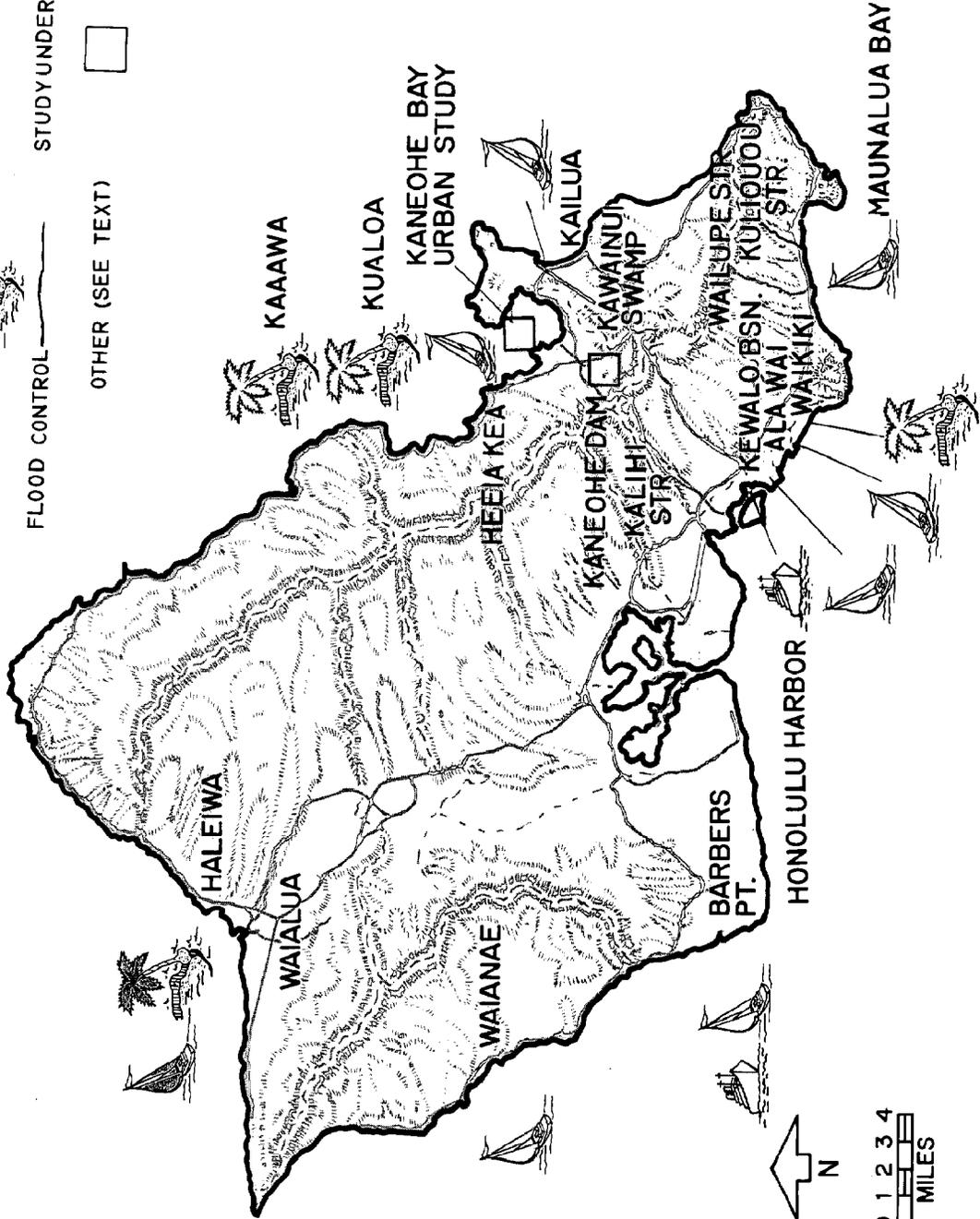
Congress included in the River and Harbor Act of 1965 authorization for constructing a small boat harbor at Hanalei on the northern coast of the island, in accordance with plans recommended by the Corps of Engineers. The River and Harbor Act of 1968 authorized the Corps of Engineers to improve the State-constructed harbor at Kikiaola on the southwest coast of Kauai. Although authorized for construction, no Federal funds have been appropriated for further work on these two projects.

The River and Harbor Act of 1958 authorized the expenditure of Federal funds for one-half of the first cost of the improvements to protect public shores along Hanapepe and Waimea Bays, as recommended by the Corps of Engineers. The Hanapepe shore protection project was advertised for bids in 1965. However, the lowest bid received exceeded the Federal and State funds available for this project. Construction of this project has therefore been deferred until additional funds are provided by both the State Legislature and the Congress.

Although the Waimea shore protection project has been authorized for construction by the State of Hawaii, no State funds have been appropriated for this project.

**L E G E N D**

- DEEP DRAFT HARBOR 
- SMALL BOAT HARBOR 
- BEACH EROSION 
- FLOOD CONTROL 
- CONSTRUCTION COMPLETED 
- CONSTRUCTION AUTHORIZED 
- COMPLETED STUDY 
- STUDY UNDERWAY 
- OTHER (SEE TEXT) 



**OAHU**

## ISLAND OF OAHU

### HONOLULU HARBOR

Honolulu Harbor on the southeast coast of the island, is the largest civil port in Hawaii and the only commercial deep-draft harbor on Oahu. The harbor was originally developed in the late 1700's in a natural protected embayment created by the flows of the Nuuanu Stream. Roughly crescent shaped, the harbor is approximately two miles long and varies in width from 600 to 2,900 feet. The existing harbor has been extensively expanded from its original configuration by the dredging of berthing areas into the natural shoreline and construction of pier and other harbor-related structures along the entire shoreline fronting the harbor complex. Sand Island, a 500-acre man-made island which protects the harbor from the open sea, was created on the shallow reef offshore of the harbor by deposition of spoil material from dredging operations over the years.

The Federal Government's involvement in the improvement and modification of Honolulu Harbor began after the harbor became an American port upon the annexation of Hawaii to the United States in 1898. On 17 June 1899, The Acting Secretary of War approved the harbor lines for Honolulu Harbor. The following year, the Acting Chief of Engineers recommended extensions and modifications to the existing harbor. His recommendations were approved on 4 May 1900, and the first of many Federal improvements for the harbor was authorized by the River and Harbor Act of 1905. The construction of these improvements also constituted the first Corps of Engineers water resources development project in Hawaii. This project, consisting of the widening and deepening of the entrance channel and basin (Kapalama Basin), was completed in 1907. Additional improvements have been constructed under the authority of the Rivers and Harbors Acts of 1917, 1930, and 1954.

The existing harbor consists of (1) an entrance channel 500 feet wide, 4,000 feet long, and 40 feet deep; (2) a main harbor basin which is about 1,520 feet wide, 3,300 feet long, and 35 feet deep; (3) a west harbor basin (Kapalama Basin) which is about 1,000 feet wide, 3,400 feet long, and 35 feet deep; (4) a 35-foot-deep connecting channel (Kapalama Channel) between the two basins which is 1,000 feet wide for the first 1,000 feet at the eastern end and 600 feet wide for the remaining 2,400 feet; (5) a 35-foot-deep second entrance channel (Kalihi Channel) extending 10,300 feet seaward of the Kapalama Basin and varying in width from 450 feet at the shoreward end to a maximum of 960 feet in the emergency turning basin in Keehi Lagoon, and to 400 feet for the remaining length seaward; and (6) a double-leaf bascule drawbridge with a clear horizontal opening of 250 feet which connects Sand Island with the main island.

Commerce through Honolulu Harbor has been generally increasing with the increasing demand for petroleum products by commercial aircraft and for general commodities to satisfy Hawaii's growing population and expanding economy. In 1973, the last year for which statistics are available, more than 8 million short tons of cargo passed through this harbor.

To safely accommodate the increasing tonnages and technological advances such as containerization and supertankers, maritime and civic interests requested that the harbor basin and entrance channels be deepened and widened. They stated at a public meeting in 1961 that the existing depths are inadequate to safely accommodate some of the vessels using the harbor, and that these shallow depths have prevented some of the newer and larger vessels engaged in transpacific commerce from calling at Honolulu. The agents and owners of some of the larger vessels using the harbor also

stressed the need for widening the entrance channel and removing a strip of land from the southeast corner of Sand Island. These improvements would reduce the hazard of grounding and ease the sharp turn which the larger vessels must make in maneuvering out the harbor through the Fort Armstrong Channel. The State of Hawaii also requested that the Kapalama Channel be widened to enable development of new berths on the Sand Island side of the channel and still retain safe clearance for vessels traveling through the channel.

In response to the needs and desires expressed by shipping interests, citizens, and the State of Hawaii, the Corps of Engineers completed a survey investigation of the navigation needs of Honolulu Harbor in August 1963. The recommendations stemming from this investigation were approved by Congress and authorized for construction by the River and Harbor Act of 1965. The authorized improvements provide for deepening the seaward 3,600 feet of the Fort Armstrong Channel to 45

feet; removing a narrow strip of the southeast corner of Sand Island; deepening the main harbor basin and the Kapalama Channel to 40 feet; widening Kapalama Channel by 60 feet along the Sand Island side for a distance of 2,500 feet; and removing a narrow strip from a 600-foot section of the Sand Island shoreline fronting Kapalama Basin.

Construction of these improvements has been deferred pending resolution of the sites for disposing the dredged spoil from deepening of the harbor. However, preconstruction planning and design are scheduled to be initiated in late 1975. At that time, the problems, needs, and desires of shipping interests and the community would be reanalyzed, and the authorized plan would be modified, if necessary, to be responsive to the prevailing needs and desires.

Maintenance dredging of the harbor was last accomplished in 1972. The next maintenance dredging is scheduled for Fiscal Year 1978. Federal funds spent for improving Honolulu Harbor through the end of calendar year 1974 total \$9,848,423.



*Honolulu Harbor, the largest commercial deep-draft harbor in Hawaii, has two entrance channels, the Fort Armstrong Channel shown in the lower left corner and the Kalihi Channel at the opposite end of Sand Island (R. M. Towill photo)*



*Aerial view of Haleiwa Small Boat Harbor and Haleiwa Beach*

### **HALEIWA SMALL BOAT HARBOR**

The Haleiwa Small Boat Harbor on the northwest coast of the island of Oahu is the first Federal-State small boat harbor on the island. Prior to construction of this harbor, small craft were moored along the banks of the Anahulu River, and pleasure craft were launched from an old ramp near the river mouth. However, boat owners experienced many difficulties under these conditions. The channel leading from the river mouth into Waialua Bay often silted, causing many vessels to run aground during storms. Flash floods on the river often tore boats from their moorings and carried debris downriver where they damaged boats and created hazards to navigation.

In response to the need for a safe berthing facility at Haleiwa, the Corps of Engineers cooperated with the State of Hawaii in the construction of a small boat harbor. Under the authority of Section 107 of the River and Harbor Act of 1960, the Corps constructed a 610-foot-long, 120-foot-wide, and 12-foot-deep entrance channel; a 1,200-foot-long revetted mole; a 520-foot-long, 80-foot-wide riprapped river diversion channel; and a 300-foot-long levee. These improvements were completed in 1966. In 1967, the State of Hawaii constructed a berthing basin along the western end of the harbor; twenty catwalks to accommodate 40 boats in the basin; a berthing basin between the interior mole and the existing shoreline; a paved parking area; a wharf next to the old launching ramp, and a comfort station. In 1972, the State added a 4-lane launching ramp, a paved trailer parking area, concrete revetment along the seaward side of the inner

mole, and a berthing basin between the interior mole and the outer revetted mole complete with two floating docks to accommodate 58 boats. The existing harbor has a total of 7.4 acres of water area and 11 acres of land.

Storms in December 1969, and January and March 1974 severely damaged the north shore of Oahu, including the Haleiwa area. The December 1969 storm damaged several boats in the harbor and the State-constructed breakwater northwest of the harbor which protects the harbor entrance. During the January 1974 storm, three boats were sunk outside the harbor. In addition, the floating docks constructed by the State in 1972 and boats berthed in the harbor, particularly along these docks, were damaged. Although damages during the March 1974 storm were not as severe as those during the January storm, the loss of one life was blamed on the unsafe berthing conditions in the harbor which forced the boat owner to take his boat out to open sea to ride out the storm.

In December 1969, the State of Hawaii asked the Corps of Engineers to provide additional protection for the boats moored in Haleiwa Harbor. The Corps completed its study of the navigation problem in June 1974, and plans and specifications for construction of the recommended improvements are currently being prepared. The improvements consist of a slight realignment of the entrance channel, and the construction of an 80- and a 110-foot-long breakwater, a 140-foot-long wave absorber, and a 500-foot-long concrete rubble masonry wall.

### WAIANAЕ SMALL BOAT HARBOR

The only small boat harbor on the west coast of the island of Oahu is at Waianae. This harbor has a capacity for 70 boats and was constructed by the State of Hawaii immediately north of Kaneilio Point, a narrow, rocky peninsula which projects seaward about 1,000 yards in front of the town and forms the southern boundary of the waters known as Pokai Bay. Sand which is carried into the bay by currents from the north are trapped within the boat basin. This condition necessitates frequent removal and redistribution of the sand. In addition to the high cost of this maintenance work, the existing harbor conflicts with the recreational uses of the adjacent swimming beach. For these reasons, the State of Hawaii wants to replace this harbor with a new facility on the south side of Kaneilio Point.

The Waianae Harbor project was authorized for construction by the River and Harbor Act of 1965. The authorized plan provides for the construction of a rectangular-shaped harbor extending south of Kaneilio Point. The harbor would have a capacity for 380 boats.

Preconstruction planning for the harbor was initiated in 1973. Because approximately 8 years had passed since the project was authorized, the first step taken was to determine whether the authorized plan was still desired by the boaters who would be using the harbor and the residents of the community who would be affected by its construction. Many meetings were held with Federal, State and County officials as well as with boating clubs and community groups. These meetings resulted in the relocation of the harbor from the site immediately south of Kaneilio Point to the south end of the proposed Waianae Regional Park about one-half mile north of the Point. Alternative plans for a 300-boat harbor at the new site are being developed in cooperation with State and County officials, boaters, and community organizations. The plans will be subjected to hydraulic model tests to determine their effectiveness from the engineering standpoint. In addition, the State of Hawaii is preparing an environmental assessment of the project area, and will prepare a master plan for the development of berthing and shoreside facilities for the harbor.

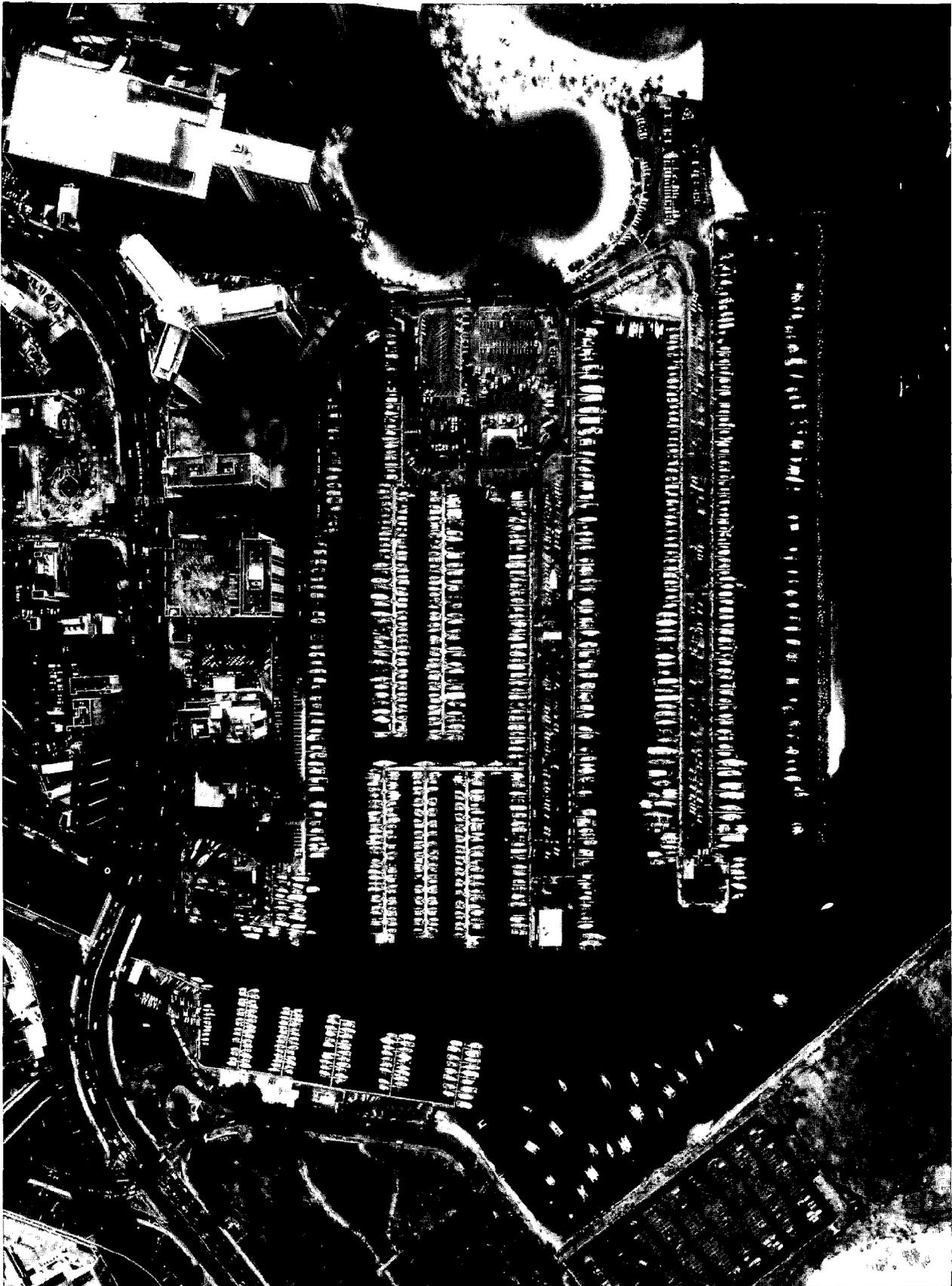
### ALA WAI HARBOR

Ala Wai Harbor lies between the metropolitan area of Honolulu and the Waikiki resort area. The harbor was constructed by the Territorial Government in 1935 through the dredging of an entrance channel and small basin in the reef at Mamala Bay. Since that time, the Territory and subsequently the State of Hawaii have made many improvements to the harbor so that it is now the largest and finest small boat facility in the state. The existing harbor has a berthing area of about 40 acres and slips for about 641 vessels. Shoreside facilities include parking areas, a fueling dock, a boat repair yard, restrooms, and utilities. The harbor is filled to capacity. As of December 1974, there was a waiting list of 967 applicants, which is more than the total number of existing berths in this harbor.

Temporary mooring along the inside of the breakwater has been provided by the State of Hawaii. However, this area is not safe during severe storms because storm waves can overtop the breakwater. Consequently, vessels are allowed to moor in this area provided that they are moved following warnings of impending storms.

The need for additional berths and for protection from storms was the basis for the Corps of Engineers' involvement in the Ala Wai Harbor project. Federal participation in the construction of navigation improvements for the harbor was authorized by the River and Harbor Act of 1968, in accordance with the plan recommended by the Corps. The original plan has been modified, however, in response to changes in recreational needs and priorities for the area, particularly the conflict between recreational boating and surfing activities.

The revised plan consisted of the construction of a seaward revetted mole to protect the area behind the existing breakwater from storm waves, thereby enabling development of additional permanent berths. This plan was discussed at a public meeting on 23 May 1974. Based on the comments received, primarily the objections to a mole with shoreside facilities on it, as would be developed in accordance with the State's master plan for the harbor, the Corps is reevaluating the project plans.



More than 900 people are waiting for a berth in the Ala Wai Harbor, the largest small boat harbor in the State (R.M. Towill photo)

## WAIKIKI BEACH

Waikiki on the southern coast of Oahu east of metropolitan Honolulu, is the primary tourist destination center of the state, and a popular recreation area for local residents. The famous beach at Waikiki and its popular offshore surfing areas are the major attractions that lure both residents and visitors to this recreation area. The approximately two-mile-long Waikiki Beach extends northwest from Diamond Head to the Ala Wai Harbor. Erosion problems along this beach began with the development of the area in the early 1900's.

As the erosion problem became more serious, it became the subject of studies by various technical and government groups. A 1926 report by the Engineering Association of Hawaii on investigations at Waikiki Beach concluded that seawalls constructed to contain landfill were the primary cause of erosion and that beach nourishment and groins could be used to rebuild the beach. Subsequent studies have been more complex and have considered the effects of currents and wave action as possible causes of erosion in addition to the seawalls, but the recommended solutions have remained the same—add sand to the beach and build groins to hold the sand in place. This solution has been applied to Waikiki Beach by various agencies over the last four decades with varying success.

The Corps of Engineers became involved in the battle to control erosion of the beach in 1947 at the request of the Territory of Hawaii. Following investigation of the problem, the Corps recommended artificial placement of sand and construction of a terrace wall in the Kuhio Beach section and two groins near the ends of the wall. The Territory of Hawaii began construction of these improvements in 1951 and completed them in 1957. The Federal Government reimbursed the Territory one-third of the construction cost which amounted to \$214,356. Two years after the project was completed, 18,700 cubic yards of sand were required to nourish eroded sections of the beach. Since then, groin construction and additional placement of sand have been accomplished to reduce erosion.

In 1959, the State again requested Federal assistance. The improvements recommended by the Corps consisted of the artificial placement of about 2 miles of beach extending from the Duke Kahanamoku Beach to the Elks Club, the addition of new groins, and the modification of three existing groins and appurtenant drainage facilities. The width of the improved beach would average 180 feet except for the Elks Club section where it would average about 75 feet. The recommended improvements were authorized for construction by the River and Harbor Act of 1965.

Congress did not provide funds for this authorized project for several years, but gave the State of Hawaii permission to construct the Kuhio Beach section and receive credit on the non-Federal cost for that portion of the project. The Army command in Hawaii also desired completion of the Ft. DeRussy section of the project. Since Congressionally authorized funds were not available, they proposed to use non-appropriated monies from their post exchange, theater, and military club operations for this work. The State asked that the Kuhio Beach sector be combined with the Ft. DeRussy sector in a single construction contract to be administered by the Corps. The Corps agreed and the combined project was advertised for bid. The bids for the Kuhio sector exceeded available State funds, therefore only the Ft. DeRussy sector was awarded for construction.

The Ft. DeRussy Beach project consisted of the placement of 1,800 lineal feet of beach with an average width of 140 feet. Two layers of selected coral were used to construct the beach. Based on cost considerations, screened coral material was used for the top layer instead of natural beach sand. Total cost of the improvements was \$886,000, and the work was completed in September 1970.

Almost from the moment the State announced its plans to construct the Kuhio Beach sector, controversy over particulars of the project developed. The Corps' earlier studies were based on traditional evaluation methods for public works projects. By 1969, however, these methods were having to be revised to include a broader range of considerations such as the natural environment and socio-economic factors. At Waikiki, these considerations focused on conflicts between recreational uses of the beach and offshore areas. Surfers protested new groins which would interfere with prime surfing breaks. Swimmers complained about plans to remove cribwalls and their impact on the sheltered waters behind them. Many people also objected to the 180-foot beach width.

As a result of the opposition to the initial plan, the Kuhio Beach project was redesigned and coordinated with government agencies, surfing and swimming groups, and the general public. Following extensive coordination, a compromise plan for the beach was developed. This plan represented sacrifice in engineering effectiveness in order to avoid interfering with surf sites and the sheltered swimming area. The Kuhio Beach improvements were constructed in 1972.

In October 1970, the Corps held a public meeting to discuss plans for the sector between Ft. DeRussy and the Royal Hawaiian Hotel. Residents and property owners attending this meeting rejected the Corps' plan and argued for more public access, narrower beach widths, and less obtrusive use of groins. Responding to the people's objections, the Corps has suspended work on this sector until the tangled problem of public access through private properties is resolved by the State of Hawaii.



*Groins jutting from the shoreline are evidence of the many attempts to control erosion along Waikiki Beach (R. M. Towill photo)*

## HALEIWA BEACH

Haleiwa Beach Park is on the north shore of Oahu immediately east of the Haleiwa Small Boat Harbor. Like the harbor, the beach is exposed to storms from the north.

Beach restoration work was completed by the State of Hawaii in 1965. Under the authority of the River and Harbor Act of 1965, the Federal Government assisted the State by paying for two-thirds of the cost of the beach restoration work. This work consisted of the construction of a 160-foot-long offshore breakwater and a 520-foot-long groin to protect the beach which was replenished with 30,000 cubic yards of foundation material, topped by 60,000 cubic yards of sand.

In December 1969, a severe storm damaged the beach. Sections of the offshore breakwater and groin were broken, and approximately 7,000 cubic yards of sand were lost to sea. The State of Hawaii asked for Federal assistance in emergency repair work under Public Law 99 (Federal Rehabilitation of Hurricane, Flood and Shore Protection Works). In 1970, the Corps repaired the damaged groin and offshore breakwater and placed 7,000 cubic yards of sand on the beach.

The January 1974 storm which severely damaged the Haleiwa Small Boat Harbor also damaged the offshore breakwater and groin at the beach park. The State of Hawaii again asked for Federal assistance under Public Law 99. In response to their request, the Corps has completed plans for the needed repairs, and expects to initiate this work in March 1975.

## KAAAWA BEACH

Kaaawa Beach is on the northeast (windward) coast of Oahu. The windward coast is noted for its scenic beauty, particularly the combination of clear blue ocean waters and lush green vegetation along the narrow coastal plain and the steep slopes of the Koolau Mountains behind it. This combination of land and sea, however, has its special problems. The Koolau Mountain Range is relatively close to the shoreline, leaving only a modest area of land suitable for residential and agricultural use. This narrow strip of land is bordered by even narrower beaches. Although the beaches are several thousand feet long, they are as little as forty feet wide and exposed to severe wave and wind action. The natural forces along the windward coast create a general pattern of winter storms eroding the shoreline and summer waves replacing lost sand.

The winter storms of 1968-1969 were particularly

severe. The beaches and park land at Hauula, Punaluu, Swanzey and Kaaawa were severely damaged by the storm-inflicted erosion. In early 1969, local government agencies asked for Federal assistance in repairing the damaged beaches and in preventing further erosion.

The Corps of Engineers was authorized to study the severely eroded areas at Hauula, Punaluu, Swanzey, and Kaaawa. Field investigations showed that the fringing reef does not adequately protect the beaches against storm waves, and that the narrow beaches do not have a large enough area to allow for the dissipation of the force of the storm waves. Therefore, these waves not only erode the beaches but also the valuable shore property behind the beaches. Based on the evaluation of the problem, Corps planners developed several plans for protecting the shoreline along the four beach parks. The plans were discussed with State and County agencies and with residents of the four communities affected by the erosion problem. The residents initially chose for their beaches either low-profile breakwaters or man-made offshore islands. The preliminary plans discussed with the residents also included beach widening, clearing and deepening of some areas for better swimming, and the replenishment of sand to convert rocky areas back to sandy beaches.

As more detailed engineering, economic, and environmental studies were completed, it became clear that Federal funds could not be justified for protecting the shoreline at Hauula, Swanzey, and Punaluu Beach Parks. Effort was therefore concentrated on finalizing a plan for Kaaawa Beach Park. More discussions were held with State agencies, the City and County of Honolulu's Department of Parks and Recreation who owns and operates the park, and residents of the Kaaawa community. During these discussions, a plan providing only for beach replenishment became more desirable than the earlier one providing for construction of a breakwater. One of the major reasons for the change was the aesthetic quality of the beach replenishment plan over the breakwater plan.

The plan recommended by the District Engineer and which has been approved for construction provides for the placement of about 9,300 cubic yards of beach sand to restore the beach to the width existing around 1949. The plan also provides for periodic nourishment at 4-year intervals over the 50-year life of the project. Based on the history of erosion at this beach, about 2,700 cubic yards of sand would be required for each nourishment.

## KUALOA REGIONAL PARK

The City and County of Honolulu is developing a 160-acre parcel of land in Kualoa on the north-east coast of the island into a major regional park for the windward area. Park facilities will include picnic and camping areas, forest preservation and open spaces, wildlife refuges, parking, and administrative and maintenance buildings. Most of the park land is on a sand spit which extends into Kaneohe Bay, and the beach frontage is an important feature of this park. However, during the first six months of 1974, a 500-foot section of the park's shoreline receded about 50 feet.

The State of Hawaii asked the Corps of Engineers to study the erosion problem at Kualoa Park under the authority of Section 103a of the River and Harbor Act of 1962, as amended. The Corps completed a reconnaissance investigation in July 1974, and concluded that Federal participation in beach erosion control improvements appears feasible. As a result, a detailed study of the erosion problem is currently being made.

## KAWAINUI SWAMP

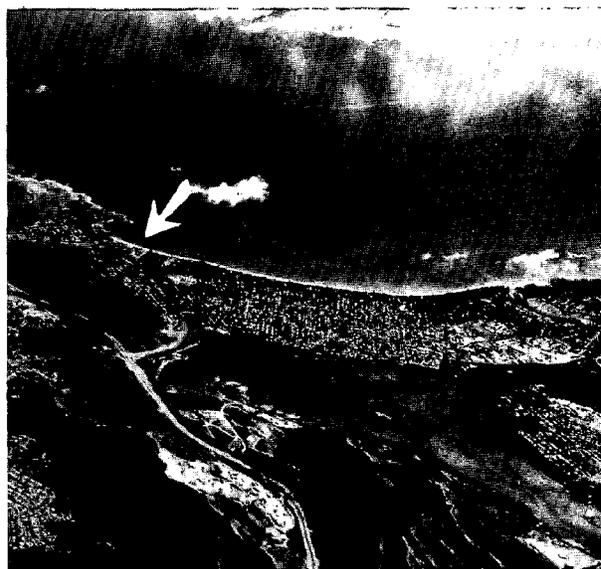
During the late 1950's and early 1960's, a large part of Oahu's residential development took place in the Kailua area on the windward coast. Growth of this area was accelerated by the construction of the Nuuanu Pali Highway which made commuting to metropolitan Honolulu more convenient. Development of Kailua was hampered, however, by an old problem. The Kawainui Swamp, covering 740 acres and draining an 11.2-square-mile area, borders the coastal area which was rapidly becoming a major suburb of Honolulu. Rain waters exceeding the storage capacity of the swamp were normally carried into the ocean through the natural channel of the Kaelepulu Stream which empties into south Kailua Bay, and through the Oneawa Channel which was constructed by the State in 1952 to carry flows into north Kailua Bay. However, this drainage system for the swamp could not accommodate the large volume of runoff from the Koolau Mountains after severe storms. Runoff from these storms often overtopped the banks of the Oneawa Channel, flooding residential areas of Kailua.

Under authority of the Flood Control Act of 1950, the Corps began construction of a flood control project for Kawainui Swamp in June 1964. Numerous rainstorms delayed the work, but the project was completed and turned over to the City and County of Honolulu for operation and maintenance in October 1966. Since that time, flood damages prevented by the project are estimated to be \$101,000.

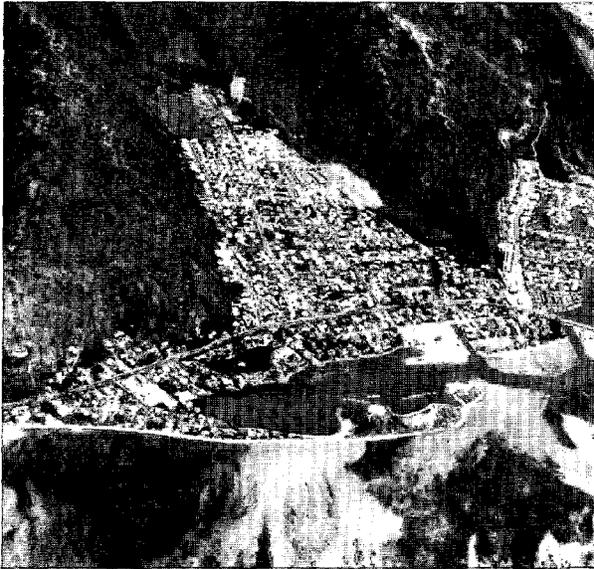
The major features of the Federal flood control project are:

- A total of 9,100 feet of channel improvement extending from the upstream end of Oneawa Channel to the ocean, and having a minimum bottom width of 80 feet and a minimum depth of 6 feet;
- A 50-foot stub groin with riprap protection at the outlet of Oneawa Channel to keep a sandbar from blocking the channel;
- A 6,800-foot-long levee with crest elevation of 9.5 feet between the swamp and the town of Kailua;
- A ponding area in the swamp for detaining flood waters; and
- Graded and grassed levees and general improvements to make the project suitable for a residential area.

The total cost of the project was \$2,533,700, of which \$1,265,100 was borne by the Federal government.



*The Corps-constructed Oneawa Channel extends from Kawainui Swamp in the foreground through Kailua town and empties into the north end of Kailua Bay (R. M. Towill photo)*



*Construction of the Kuliouou Stream flood control project by the Corps of Engineers and interior drainage improvements by the City and County of Honolulu have solved the flood problem in Kuliouou Valley (R. M. Towill photo)*

## **KULIOUOU STREAM**

Like most older developments on valley floors, the Kuliouou community on the southeast corner of Oahu used to be inundated by winter rains and periodically flooded by the overtopping of the single stream that drained the valley. The flat topography of the residential area made drainage difficult. A silty island on the reef at the mouth of Kuliouou Stream also contributed to the problem by obstructing the flow of stream waters into the ocean.

The flood problem was of serious concern to the residents of Kuliouou. However, instead of abandoning their homes in this beautiful valley, they raised their voices and asked the City and County of Honolulu for help in solving this problem. When they were heard, they joined with government agencies in solving their problems.

The first attempts to solve the drainage problem were made by the City and County of Honolulu. However, it became obvious soon after their study began that the problem was too extensive for local government to solve alone, so Federal assistance was requested. The Corps of Engineers began its investigation of the flood problem in Kuliouou in 1966 and found that Federal participation in controlling floods on Kuliouou Stream was justified. But the Corps has no authority to improve local drainage problems, and flood control without better drainage would not solve all of Kuliouou's problems.

The City and County of Honolulu therefore formed an improvement district in Kuliouou to construct storm drains, streets, and lateral drainage structures. The Corps of Engineers, in cooperation with City and County officials, integrated the flood control project with the drainage improvements to produce a complete project.

Federal monies were made available for construction of the flood control project in 1967, but before the final design of the project was completed, all Federal construction funds were frozen. Local officials made a special appeal to Washington for exemption from the cutback. The exemption was finally granted, but the difficulties were not over.

The first time the project was advertised for construction no bids were received. Then, in June 1968, the project was readvertised and a single contractor responded. His bid of \$1,595,000 was accepted and a contract was awarded on 10 September 1968.

The Federal project provided for the construction of concrete lining for a major portion of Kuliouou Stream, the addition of supplemental walls on the banks of the existing improved trapezoidal channel, the excavation of a channel from the mouth of the stream through the reef, and the construction of a 7-foot-wide rectangular reinforced-concrete-lined ditch to convey interior drainage downstream of Kalaniana'ole Highway. The project was turned over to the City and County of Honolulu for operation and maintenance on 3 February 1970, approximately six months ahead of the scheduled completion date. Total construction cost was \$1,637,670.

## **KANEOHE DAM**

The town of Kaneohe in windward Oahu is just across the Koolau Mountains from Honolulu. For years the town was a quiet rural residential community. However, with the urban pressures generated by Honolulu's rapid growth and the opening of the Wilson Tunnel through the Koolaus, residential subdivisions grew almost overnight on lands bordering Kaneohe Bay.

The rapid and often unplanned development of this community did not occur without accompanying hazards and problems. Heavy rainfall inundates low-lying residential areas and carries red silt into Kaneohe Bay. Public utilities and recreation facilities are overburdened, and the teeming undersea life of Kaneohe Bay faces extinction from sewage and silt.

These problems were recognized by local government officials in the early 1960's, and Federal assistance was asked in solving them. The River and Harbor Act of 1965 authorized the Corps of Engineers to study the flood and related water resources problems in the Kaneohe-Kailua area. The study made under this authority led to recommendations for flood control improvements on the Kamooalii-Kaneohe Stream system. Floods on this stream system have been particularly damaging. The flood of February 1965 severely damaged homes in the Keapuka subdivision. Two persons drowned during this flood. Another flood in February 1969 again severely affected the Keapuka subdivision. Damages to the entire Kamooalii-Kaneohe stream drainage basin during this flood was estimated to be \$1,093,000.

The Corps' survey investigation recommended that a dam and reservoir be constructed on Kamooalii Stream and that channel improvements be made to the mouth of Kaneohe Stream. Since the waters which would be impounded behind the dam would form a reservoir suitable for recreational purposes, the study also recommended that the land around the reservoir be developed into a park.

The study results were discussed at a public meeting on 26 February 1970. The proposed plan was well received by local government representatives and citizens at the meeting. The Corps' recommendations were subsequently approved by Congress and the Kaneohe-Kailua dam and reservoir project was authorized for construction by the Flood Control Act of 1970. In Fiscal Year 1972, Congress gave the Corps funds for detailed engineering and design work on this project. During the first phase of this work, the project plans were re-

viewed to ensure that they were still responsive to the flood problem and to the community's needs and desires. This review, which included discussions with local government agencies and the community, resulted in a few changes to the project plans. One of the changes made was to the alignment of the channel improvements at the mouth of the stream. The original plan called for realigning the stream through an old fishpond to provide a more direct route to Kaneohe Bay. However, during the review of the project, the owner of the fishpond announced plans for developing the pond for aquaculture. Also, residents along the existing stream mouth stated that they use the mouth for recreational boating and expressed the desire to be able to continue this activity. Based on the comments received, the project plans were revised to retain the existing stream alignment.

Detailed design of the flood control project is nearing completion. A master plan for the development of recreational facilities around the reservoir was completed in March 1974, in cooperation with the City and County of Honolulu Department of Parks and Recreation who will operate and maintain the park.

Construction of the project would substantially reduce flood damages to existing and future residential and public property in the Kamooalii-Kaneohe Stream flood plain. The reservoir and the recreational facilities around it would also create new opportunities for leisure-time activities. The most important point, however, is that the project would drastically reduce the threat of loss of life and limb from floods on the Kamooalii-Kaneohe Stream.



*One of the many homes in the Keapuka subdivision which was destroyed by floodwaters roaring down Lulukū Stream on 1 February 1969 (Star Bulletin photo)*



*Floods on Wailupe Stream which flows through the center of Wailupe Valley have severely damaged property in this residential community (R.M. Towill photo)*

## **WAILUPE STREAM**

Wailupe Valley is one of the valleys on the south-east coast of Oahu which was developed for urban use in conjunction with the growth of Honolulu. A moderately expensive residential community with supporting commercial and public facilities occupies almost all of the developable land in the valley and extends to the banks of Wailupe Stream which flows through the center of the valley. Residential and commercial property within the Wailupe Stream flood plain have been flooded due to the inadequate capacity of the stream. Damages from the floods of 5-6 March 1958 and 16-18 December 1967 were particularly severe and pointed to the need for flood protection.

Following the March 1958 flood, the Corps of Engineers responded to the City and County of Honolulu's request for post-flood repair and restoration work on Wailupe Stream. Under the emergency authorities available to it, the Corps removed silt and debris from the stream and restored eroded sections of the stream banks.

Under the authority of Section 205 of the Flood Control Act of 1948 and in response to a request from the City and County of Honolulu, the Corps completed a study of the flood problem on Wailupe Stream in January 1970. The study showed Federal

participation in the construction of flood control improvements to be feasible. However, the cost of the improvements developed during the study exceeded the \$1 million Federal expenditure limitation under the Section 205 authority. Because the City and County of Honolulu could not assume the remaining cost of the improvements at that time, they asked that the study under the Section 205 authority be terminated. They also asked that flood control improvements for Wailupe Stream be considered under a Congressionally authorized study which provides for greater Federal participation.

A survey report prepared under the authority of Section 209 of the Flood Control Act of 1962 was submitted to the Office of the Chief of Engineers for review in September 1974. The report recommends the construction of 8,880 feet of channel improvements on Wailupe Stream, approximately 1,000 feet of channel improvements on the Kului tributary, a debris basin at the upstream end of the channel improvements on Wailupe Stream, and increasing the capacity of the stream under the Kalaianaoale Highway bridges. The cost of these improvements is estimated at \$5,060,000. The Federal Government would assume \$4,800,000 of the total cost and the City and County of Honolulu would pay for the remaining \$260,000.

## KALIHI STREAM

The upper half of Kalihi Valley is a quiet residential community of single-family homes served by neighborhood stores and local schools. In the lower half of the valley, business and industrial firms and apartment buildings mingle with single-family dwellings to form a distinctive urban community.

Kalihi Stream flows the length of the valley from the extreme upper limits of the watershed area to the industrial development along the coastal plain. The stream periodically floods homes, public buildings and commercial structures that lie in its flood plain.

The City and County of Honolulu wanted the Corps of Engineers to study the flood problem on Kalihi Stream, and a survey study was authorized by the Flood Control Act of 1968. Corps planners worked closely with citizen groups and residents of Kalihi Valley, primarily through the Kalihi-Palama Model Cities organization, in the development of flood control plans. The possibility of including parks and "green belts" along the stream banks together with flood control improvements is being explored, and detailed engineering and economic studies are being made.

## WAIALUA-HALEIWA AREA

The Waialua-Haleiwa area is on the northwestern coast of the island of Oahu. Floods within this area are particularly severe in the Paukauila-Kiikii Stream drainage basin which is 79.8 square miles in area and the largest drainage basin on the island.

Watercourses in the basin include the Poamoho and Kaukonahua Streams which combine to form Kiikii Stream, and Opaepala and Halemano Streams which combine to form Paukauila Stream. Kiikii and Paukauila Streams, the two major streams in the drainage basin, converge before emptying into Kai-aka Bay.

The Waialua-Haleiwa area has a history of 18 floods since 1874. The last flood occurred on 19 April 1974 and caused an estimated \$1 million dollars in damage and the loss of three lives. A total of 100 homes and 10 businesses were damaged. Agricultural damages, primarily to crops and irrigation systems, were estimated at \$345,000. In view of the severe damages from this flood, the President declared Waialua-Haleiwa a major disaster area.

On 24 April 1974, the City and County of Honolulu asked the Corps of Engineers to study the flood problem on the Paukauila and Kiikii Streams. A reconnaissance investigation completed in August 1974 indicated that flood proofing by raising floors above the level expected to be inundated by severe floods may be the only solution for which Federal participation may be justified. However, the reconnaissance report concluded that a more detailed investigation is needed to determine the extent of Federal assistance that can be provided for the Waialua-Haleiwa area. A detailed study under the authority of Section 205 of the Flood Control Act of 1948 is currently being made. Informal meetings have been held with residents and additional meetings will be held as the study progresses.



Homes near the mouth of Paukauila Stream were severely damaged during the 19 April 1974 flood which caused more than \$1 million of damage to the Waialua-Haleiwa area (Honolulu Advertiser photo)

## KANEOHE BAY URBAN WATER RESOURCES STUDY

Kaneohe Bay is on the northeast coast of the island of Oahu, and is the largest estuary in the state. Rapid urbanization during the last two decades has transformed most of the watershed surrounding the bay from a rural agricultural and residential area to a suburb of the city of Honolulu. The rapid population growth and attendant development of the Kaneohe watershed have contributed to water and related resource problems, particularly the serious pollution of the bay.

The Corps of Engineers has been authorized to study the water resource problems in Kaneohe Bay and its surrounding watershed. The objectives of the Kaneohe Bay Urban Water Resources Study, as

this effort is called, is to provide a range of urban water resource plans that are compatible with comprehensive urban development goals of the Kaneohe Bay region. The plan of study completed in January 1975 addresses the following areas:

- Estuarine Protection and Restoration
- Wastewater Management
- Water-related Recreation
- Fish and Wildlife Resources
- Public Involvement and Study Management
- Flood Plain Management
- Navigation
- Water Supply

The procedures for the conduct of the study are designed to assure that the residents of the study area will guide the development of alternative



*Aerial view of Kaneohe Bay (R.M. Towill photo)*

water resource plans for their community. Throughout the study, there will be full and continuous coordination with the public which includes the community, federal, state, and county agencies. The public will be kept informed and will be actively involved in the planning process.

#### **OTHER**

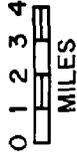
Although the River and Harbor Act of 1965 authorized the construction of a deep-draft harbor at Barbers Point and small boat harbors at Barbers Point, Maunalua Bay, Heeia-Kea, and Kailua, further work leading to construction of these projects has been deferred. Construction of the Barbers Point Deep-Draft Harbor was deferred pending receipt of the State of Hawaii's assurances that they would meet their responsibility for the project which included, among others, sharing of the construction cost and providing the required land for the project. Detailed engineering and design of the Barbers Point and Kailua Small Boat Harbors have been deferred pending receipt of Federal funds for this work. Construction of the Maunalua Bay Small Boat Harbor has been deferred pending completion of a master plan for the bay by the State of Hawaii.

Funds for detailed engineering and design of the Heeia-Kea Small Boat Harbor were made available to the Corps in 1971. The Corps planners recognized that the needs of the community and goals of government agencies may have changed since the project was authorized in 1965. Therefore, before proceeding with the preconstruction planning, the Corps held a public meeting to obtain prevailing attitudes and views on the project. The public meeting surfaced the Kaneohe community's objections to any development in Kaneohe Bay, including the Heeia-Kea Harbor, until the environmental problems of the bay are solved. Based on the community's reaction, further work on this project has been deferred, and the Corps, through its Kaneohe Bay Urban Water Resources Study, is working with the community and other government agencies in solving the water resources problems of the bay.

Construction of improvements to alleviate damaging surge conditions and hazardous cross-currents at Kewalo Harbor was deferred following objections from surfers who claimed that the improvements would adversely affect popular surf sites off the harbor entrance. Alternative plans and hydraulic model tests of these plans were made in an effort to alleviate the objections. However, because of the nature of the navigation problem, these plans were determined to be ineffective. Also, due to the increase in construction and related costs since the improvements were first developed, the economic feasibility of the plan approved for construction is questionable. The Corps is reanalyzing the economics of the project and will determine its future following discussions with the State of Hawaii and other government agencies and boating interests.

Storms in December 1967, January 1968, and November 1970 severely damaged several streams on Oahu. Existing channel linings were torn out by the force of the flood waters. The lining material, together with debris and large boulders carried down from the higher reaches, clogged lower sections of the streams, causing flood waters to back-up and flood developments on the stream banks. In response to requests from the City and County of Honolulu and under the authority of Public Law 99, the Corps made emergency repairs to Niu, Hahaione, Waialae-Iki, Waialae-Nui, Kapakahi, Moanalua and Omao Streams.

# MOLOKAI



## LEGEND

DEEP DRAFT HARBOR 

SMALL BOAT OR BARGE HARBOR 

FLOOD CONTROL 

CONSTRUCTION COMPLETED 

CONSTRUCTION AUTHORIZED 

STUDY UNDERWAY 

## ISLAND OF MOLOKAI

### KAUNAKAKAI HARBOR

The existing barge harbor at Kaunakakai on the south central coast of the island is the only port for transporting bulk goods to and from Oahu. In 1973, the harbor handled 475,246 tons of commerce, of which 382,524 tons were fresh pineapple shipped to Honolulu for canning.

Kaunakakai Harbor has a basin 600 feet wide and 1,500 feet long. The Corps assists the State in maintaining the 23-foot depth required for barge traffic through periodic dredging. The last maintenance dredging was accomplished in 1971, and the next dredging is scheduled for 1977. Federal expenditures for maintenance dredging of the harbor total \$343,849.

The River and Harbor Act of 1962 authorized the modification of the existing barge harbor into a deep-draft harbor of approximately 62 acres, and a small boat harbor of about 10 acres for fishing and recreational boating.

Construction of the deep-draft harbor, however, is contingent on the construction of a pineapple cannery proposed by private business. The postponement of this industrial plant has deferred construction of the deep-draft harbor.

In 1969 and 1970, the State of Hawaii improved the existing wharf at Kaunakakai. At that time, they also proceeded with the first portion of the small boat harbor by dredging a small mooring basin and entrance channel on the east side of the wharf.

### KALAUPAPA BARGE HARBOR

The small town of Kalaupapa is on the northern coast of the island of Molokai. This coast is exposed to severe winter storms, and is characterized by towering cliffs which make this side of the island inaccessible except by small boats and light aircraft. Interisland tugs and barges call at Kalaupapa during May through September when calm seas necessary for barge landing prevail. They seldom call during October to May because high waves generated by winds from the north and northwest often force them to anchor offshore or to return to

Honolulu. During these periods, the small community must rely on light aircraft for its supplies.

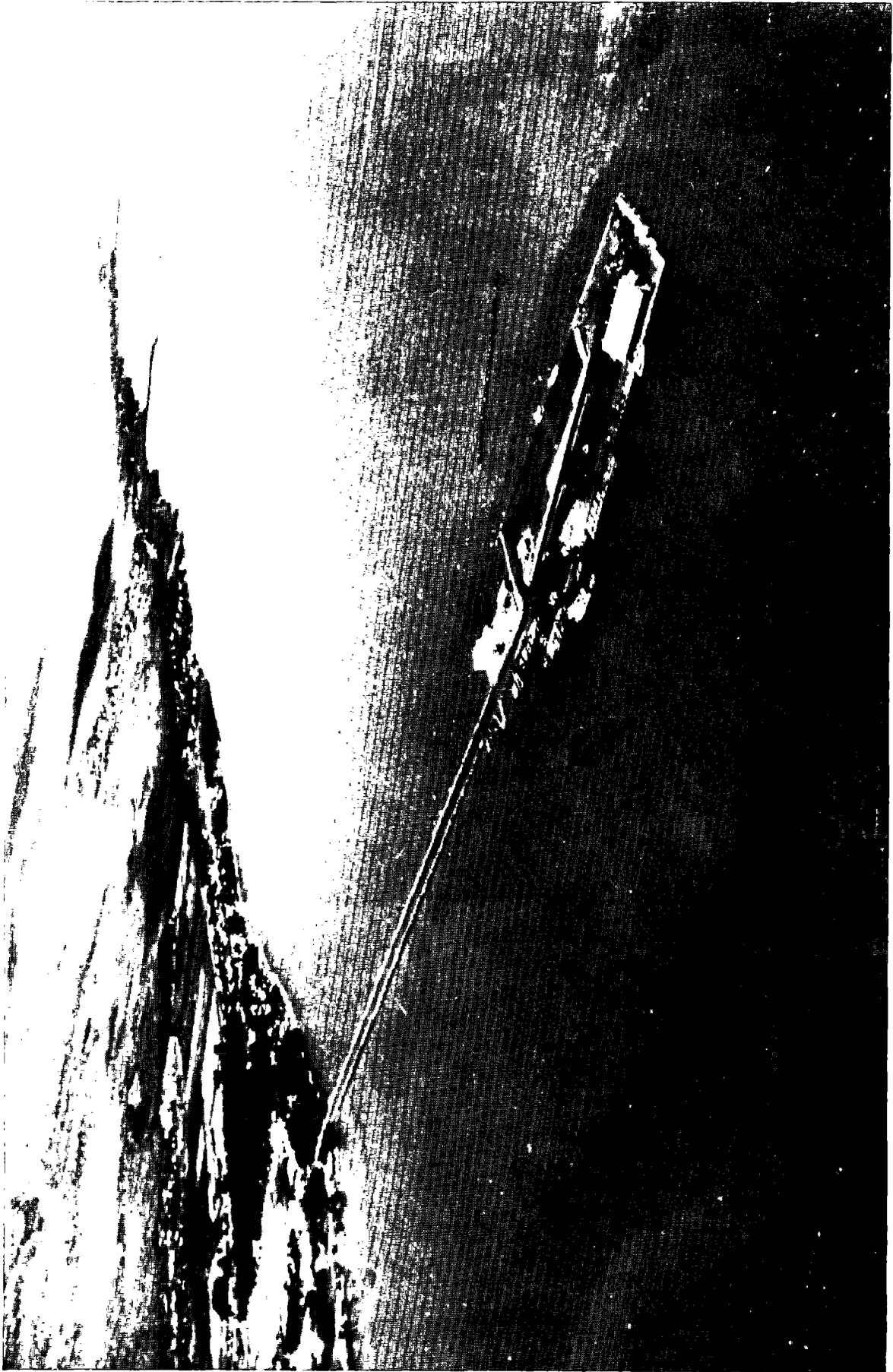
This remote community's dependence on tug-barge commerce resulted in the State of Hawaii's request for improvements to protect the harbor against the severe winter conditions. In response to this request, the Corps of Engineers improved the existing barge harbor under the authority of Section 107 of the River and Harbor Act of 1960. The improvements were completed in 1967 at a cost of \$134,543, and consisted of lengthening the breakwater to 105 feet and protecting it with armor stone. In addition, the small natural basin was reshaped and deepened.

In the spring of 1970, the State of Hawaii reported that the harbor basin was obstructed by several boulders. The Corps removed the obstructions and replaced a broken mooring buoy. Total Federal expenditures for the Kalaupapa Barge Harbor as of 31 December 1974 were \$160,912.

### KAUNAKAKAI STREAM

Kaunakakai is the urban and commercial center of the island. Although it is not exposed to severe winter storms like Kalaupapa on the north shore, it has had its own water resources problems. One of these problems was flooding during the winter months. Heavy rainfall during November through March often caused floods which cost the community from \$5,000 to \$130,000 in damages. Typical losses and damages included the disruption of communication, washed out bridges, filled in and caved in cesspools, uprooted trees, and mud and debris throughout the town. Prior to 1950, the flood plain of Kaunakakai Stream covered almost the entire business area of the town and a large part of the residential district, a total of about 125 acres.

In response to the County of Maui's request for flood protection, the Corps enlarged the capacity of Kaunakakai Stream and flanked it with earth levees lined with rock facings. This levee and channel project was completed in December 1950 under the authority of Section 205 of the Flood Control Act of 1948.



*Molokai, the only major island which is not served directly by transpacific vessels, depends on interisland barge shipments through Kaunakakai Barge Harbor.*

During the 24-year period since the project was completed, the levees and enlarged channel have completely controlled flood waters that would have otherwise damaged residential and commercial property in Kaunakakai. It is estimated that this project has prevented flood damages totalling \$1,302,000 since 1950.

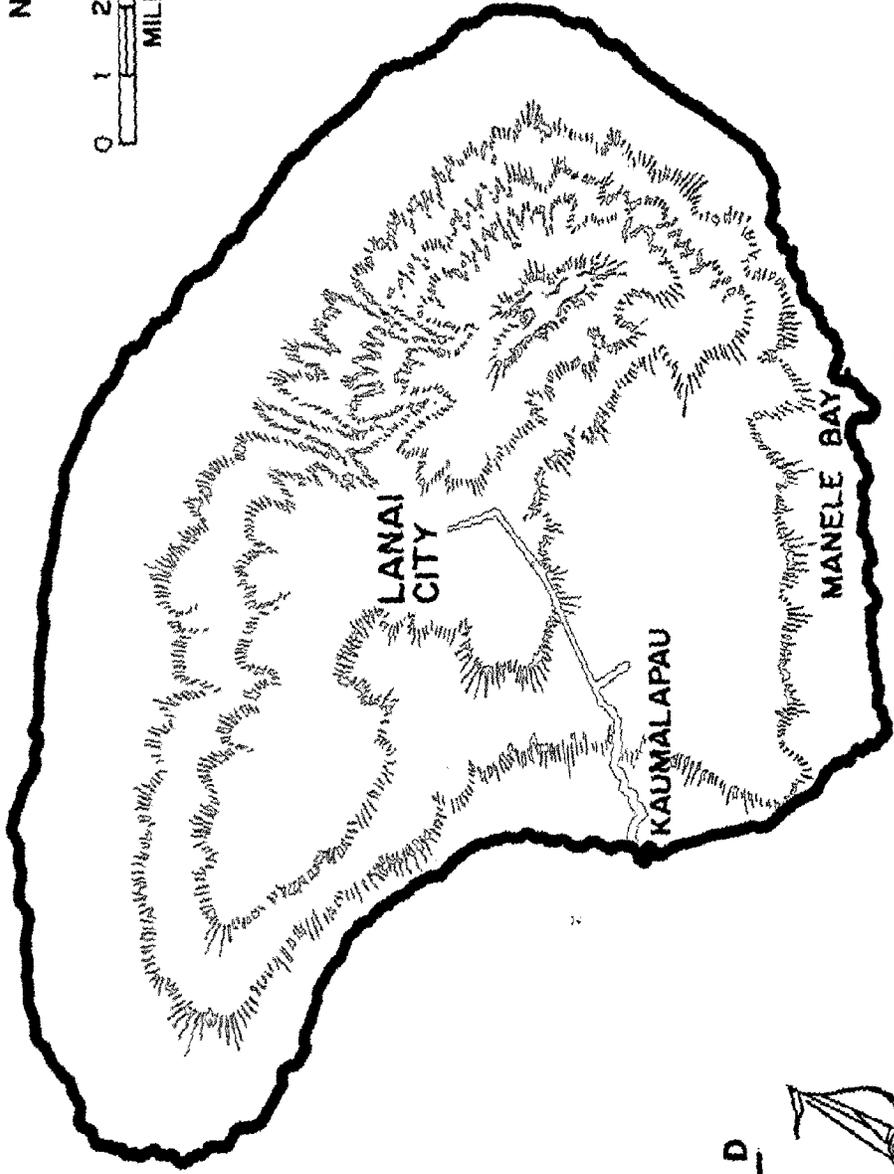
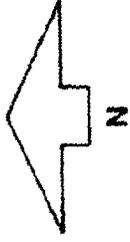
#### **KAPAAKEA HOMESTEAD AREA**

The Kapaakea Homestead is about a half-mile east of Kaunakakai. Approximately 200 people live in this 23-acre residential subdivision which has a history of floods, the most severe of which occurred during 31 October to 2 November 1961.

In 1963, the Corps studied the flood problem at Kapaakea in response to a request from the County of Maui. The study showed that the Federal Government could not participate in a flood control project for the area. The flood problem in Kapaakea as well as in other areas of Molokai persisted, and in February 1971 the Maui County Council passed a resolution requesting the Corps to help them develop a flood control program for Molokai. Also, during a public meeting held by the Corps to discuss the Rivers and Harbors of Hawaii study, residents of Kapaakea called attention to the flood problem in their community and asked for assistance in solving this problem. In response to these requests, the

Corps completed a reconnaissance study of the problem in February 1972. This study indicated that the expenditure of Federal funds for a flood control project for the Kapaakea community may be justified. Based on the results of the reconnaissance investigation, a detailed study of the flood problem was made under the authority of Section 205 of the Flood Control Act of 1948, as amended. Several solutions to the flood problem were developed. They were discussed with Federal, State, and County officials, business firms, and residents during several informal meetings and a formal public meeting on 17 January 1973. The plans were modified in response to comments made during these meetings, and the revised plans were discussed in a draft report which was circulated for additional comments. Following evaluation of all comments received, the report containing the District Engineer's recommendations was completed and forwarded to the Office of the Chief of Engineers in December 1974. The plan recommended by the District Engineer consists of the construction of diversion and protection levees on both banks upstream and downstream of Kamehameha Highway, and a debris basin at the upper end of the levee system. These improvements are designed to divert flows from the higher slopes above the subdivision into a defined waterway which would carry them into the ocean.

# LANAI



## L E G E N D



SMALL BOAT HARBOR



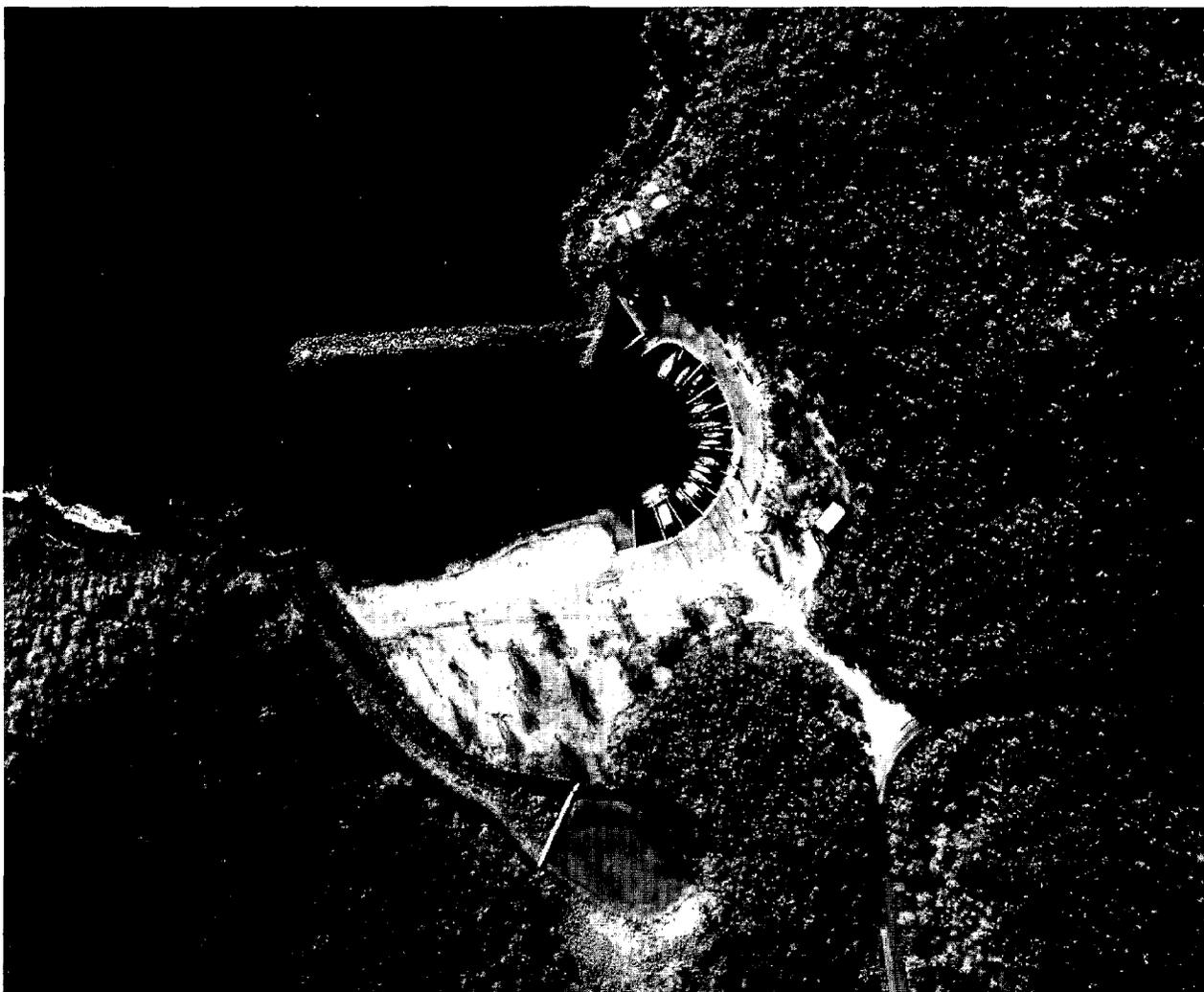
CONSTRUCTION COMPLETED

## ISLAND OF LANAI

### MANELE HARBOR

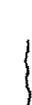
This harbor, on the southern coast of the island, was constructed by the State of Hawaii and consisted of berthing space for about 45 boats and limited protection against wave action. The State recognized that the harbor would be untenable during southerly storms, and therefore asked the Corps to improve the navigation conditions at this

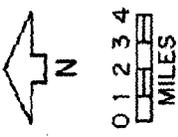
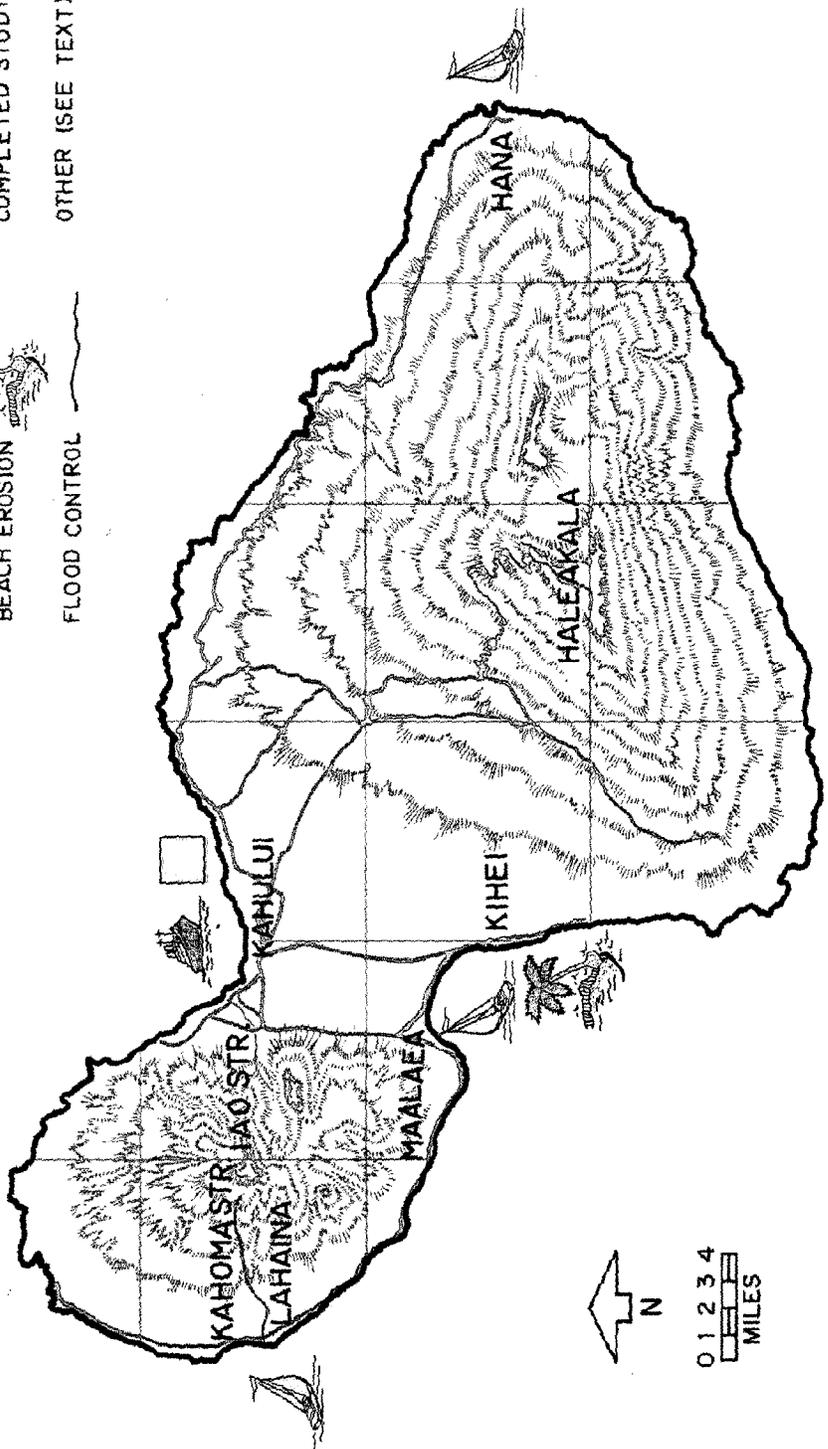
facility. Under the authority of Section 107 of the River and Harbor Act of 1960, the Corps constructed a 470-foot-long rubblemound breakwater extending from an existing 100-foot stub breakwater. In addition, the Corps dredged a 12-foot-deep entrance channel and an 8-foot-deep main access channel and maneuvering area. Construction of the project was completed in 1965.



*Aerial view of Manele Small Boat Harbor (R.M. Towill photo)*

**L E G E N D**

- DEEP DRAFT HARBOR 
- SMALL BOAT HARBOR 
- BEACH EROSION 
- FLOOD CONTROL 
- CONSTRUCTION COMPLETED 
- CONSTRUCTION AUTHORIZED 
- COMPLETED STUDY 
- OTHER (SEE TEXT) 



**MAUI**

## ISLAND OF MAUI

### KAHULUI HARBOR

Kahului Harbor on the north shore of the island, is the only deep-draft harbor on Maui. The harbor was built by the Kahului Railroad Company at the turn of the century to assist the sugar companies in shipping raw sugar to Honolulu. At that time, the principal agricultural and commercial activity on Maui was centered in the town of Wailuku. Therefore, building a harbor at Kahului adjacent to Wailuku made good economic sense. From the navigational point of view, however, Kahului was a poor choice because of its exposure to waves generated by winter storms from the north. As a result, the harbor has been repeatedly damaged by storms over the years.

The first Corps of Engineers project at Kahului was completed in December 1931. Since that time, the Corps has made additional improvements to the harbor. As a result of improvements constructed in 1962, the Federal portion of the harbor consists of:

- A 2,766-foot-long east breakwater;
- A 2,315-foot-long west breakwater;
- A 600-foot-wide, 35-foot-deep entrance channel between the breakwaters; and
- A 2,050-foot-wide, 2,400-foot-long, 35-foot-deep harbor basin.

In 1966, sections of the breakwaters were rebuilt in an attempt to strengthen these structures to withstand the pounding storm waves. Tribars (reinforced-concrete armor units) in 35-ton and 50-ton sizes were used on the seaward ends of the breakwaters instead of boulders.

A severe storm in December 1967 caused heavy damage to a 130-foot section of the west breakwater. Based on the success experienced with the "man-made stone", the Corps completed emergency repair of the damaged section using 19-ton tribars. Quarrystone was used to replace small stone washed out of the breakwater core.

The west breakwater was again damaged by a severe storm in November 1970. Repair of the damages was completed by the Corps in 1973. Total Federal funds spent on Kahului Harbor to 30 June 1974 were \$7,666,866.

Commerce through Kahului Harbor totalled 1,042,818 short tons in 1973. Sugar and molasses constituted one-third of the total tonnage.

### LAHAINA HARBOR

The town of Lahaina on the west coast of Maui was an early whaling port and the first capital of Hawaii. Based on its historical significance, the town is included in the National Register of Historic Places. Lahaina was also one of 19 sites selected during the Corps' study of the coasts of the Hawaiian Islands, the objective of which was to develop a basic statewide system of small boat harbors. Its selection was based on the inadequate capacity of the existing State-constructed harbor, the pressing need for berthing space as expressed by local boaters, and recognition of the impending growth of the Lahaina area.

Construction of a small boat harbor immediately north of the existing harbor was authorized by the River and Harbor Act of 1965. However funds for detailed engineering and design were not made available until 1968. During this period, detailed plans for the historic restoration of Lahaina were developed by local restoration groups, and the new harbor was found to conflict with the desired restoration of the Lahaina waterfront. Based on this conflict and boaters' desire for a larger harbor, the Corps reevaluated the Lahaina Harbor project. Extensive coordination was maintained with State and County agencies and the restoration groups. A public meeting was held in September 1970 to discuss the alternative plans developed by the Corps in response to prevailing needs and desires. In No-



*Aerial view of Kahului Harbor, the only deepwater port on the island of Maui*

ember 1970, the Corps completed its engineering and design report which recommended construction of a 380-boat harbor at a site about 1,000 feet north of the previous site.

Construction of this harbor has been approved. However, initiation of actual construction is pending satisfactory compliance with Section 106 of the National Historic Preservation Act of 1966. Because the harbor site is within the recently determined boundaries of the Lahaina Historic District, the impact of the harbor on the district must be determined and any adverse effect must be eliminated

or satisfactorily mitigated before construction can proceed. The Corps held a public meeting on 23 January 1975 to obtain the public's views and comments on the harbor's impact on the Lahaina Historic District. Based on the comments made during the meeting, the Corps is working with the State Historic Preservation Officer, the State Department of Transportation, and the County of Maui in mitigating the objections to the project, particularly the visual impact of the harbor on the historic district.



*A new small boat harbor at Lahaina, originally sited immediately to the left of the existing harbor, was moved to the site shown above for compatibility with local plans for restoring Lahaina town. The impact of the new site on the Lahaina Historic District is being evaluated.*

## KIHEI BEACH

Kihei Beach is the general name given to the shoreline along the west coast of East Maui. This shoreline has been eroding at a number of locations during the last 50 years, particularly during storms from the south such as those experienced during 1951, 1955, 1959, and 1963. The erosion has caused substantial loss of public lands and private beach frontage. In some instances, homes and other structures have been undermined and stretches of the coastal highway have been threatened by the erosion.

The Corps was requested to study the erosion problem in the Kihei area, and a public meeting was held in September 1963 on Maui. During the meeting, local residents pointed out that the Kihei shoreline, particularly at Kalama Park, is a major recreation area for the island, and that the park could not withstand further erosion.

The Corps' study concluded that a Federal project to stop erosion was justified. The Corps recommended construction of a 25-foot-wide berm along the entire length of Kalama Park and a rock revetment to protect the berm and park land from erosion. This plan was approved for construction under Section 103a of the River and Harbor Act of 1962, as amended. Construction began in the fall of 1968.

The Kalama Park erosion control project was completed at a cost of \$239,280 and was transferred to the County of Maui in June 1971.

## SHORES OF KAHULUI HARBOR

In February 1971, the State of Hawaii asked the Corps for assistance in solving the erosion problem along the shoreline of Kahului Harbor. A reconnaissance investigation made by the Corps indicated that the erosion problem may have resulted from the enlargement of the harbor in 1962, and recommended further study of the problem. A detailed study was initiated in 1962 under the authority of Section 111 of the River and Harbor Act of 1968 which gives the Chief of Engineers the authority to investigate, study, and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works.

The detailed study completed in 1973 recommended rehabilitation of an existing stone revetment, construction of another revetment, replenishment of two sections of the beach, and the construction of structures such as a breakwater and groins to protect the replenished sections. The plan has been approved and construction of the improvements is scheduled for mid-1975.

## IAO STREAM

Iao Stream originates on the easterly slopes of the West Maui Mountains. The stream flows in an east-northeasterly direction through Iao Valley and the town of Wailuku which occupies the coastal plain fronting the valley. During periods of heavy rainfall, Iao Stream peaks quickly because of its steep slope, and overtops as well as erodes its banks in many places. The accumulation of eroded material, debris, and boulders contributes to the flood problem by plugging the channel. Damages to public and private property are minimal in the higher reaches of the stream, but are severe within the highly developed residential and commercial areas of Wailuku and the agricultural areas above the town.

The Corps of Engineers' involvement in flood control activities on Iao Stream dates back to 1954 when it completed emergency snagging and clearing of the stream. This work was accomplished under the authority of Section 2 of the Flood Control Act of 1937, as amended, and cost \$48,932. Emergency bank protection at the County of Maui's Kepaniwai Park and at the Waiehu Beach Road near the coast was completed by the Corps in 1972 at a cost of \$96,775.

In addition to the emergency repair work, the Corps completed a survey study of the flood problem in 1966. The plan recommended by the Corps was authorized for construction by the Flood Control Act of 1968. Funds for detailed engineering and design were provided by the Congress in 1974. Because approximately seven years had elapsed since the project was authorized, the first step taken by the Corps was to reevaluate the project's responsiveness to the prevailing problems and needs on Iao Stream and the Wailuku area.

The evaluation showed that floods continue to be a problem on Iao Stream, and that flood control improvements are still desired. The Corps is finalizing detailed engineering and design of flood control improvements for this stream. These improvements consist of a debris basin 2.5 miles upstream of the stream mouth, and a combination of about 4,400 feet of concrete channel with a system of levees and floodwalls to protect lands adjacent to a 7,300-foot reach of the stream where no channel improvements are proposed. The improvements are estimated to cost \$9,950,000. The Federal Government will assume \$9,500,000 of the total cost and the County of Maui will assume the remaining \$450,000.

## **KAHOMA STREAM**

Kahoma Stream and its main tributary, Kanaha Stream, originate high on the west slopes of the West Maui Mountains. The streams are confined to narrow canyons until they reach the outwash plain above the town of Lahaina where they converge. Kahoma Stream then continues through canefields and residential and commercial developments, finally emptying into the ocean near Mala Wharf.

The stream has a history of bank erosion and overtopping. The County of Maui requested the Corps of Engineers to study the flood problem on Kahoma Stream under the authority of Section 205 of the Flood Control Act of 1948, as amended. The study was completed in 1967, and the total cost of the recommended plan of improvement was \$2.4 million. Based on the \$1 million Federal cost limitation under the Section 205 authority, \$1.4 million of the project cost would have to be paid by the County of Maui. This high cash contribution requirement led to the County of Maui's request for termination of the study under this authority, and initiation of a survey study.

A survey study was completed by the Corps in August 1973 under the authority of Section 208 of the River and Harbor Act of 1960. The survey report which has been forwarded to the Office of the Chief of Engineers for review recommends Federal participation in flood control improvements for Kahoma Stream. The recommended plan consists of realigning sections of the stream; constructing a revetted outlet at the stream mouth, about 5,280 feet of channel improvements, a diversion levee, rock sill, and debris basin; and reconstructing three bridges. The total cost of the project is estimated to be \$3,720,000. The Federal Government would pay for \$2,502,000 of this cost, and the County of Maui would assume the remaining \$1,218,000.

## **OTHER**

Construction of a small boat harbor at Hana and Maalaea was authorized by the River and Harbor Act of 1965 and 1968, respectively. However, no funds for preconstruction planning work have been received.

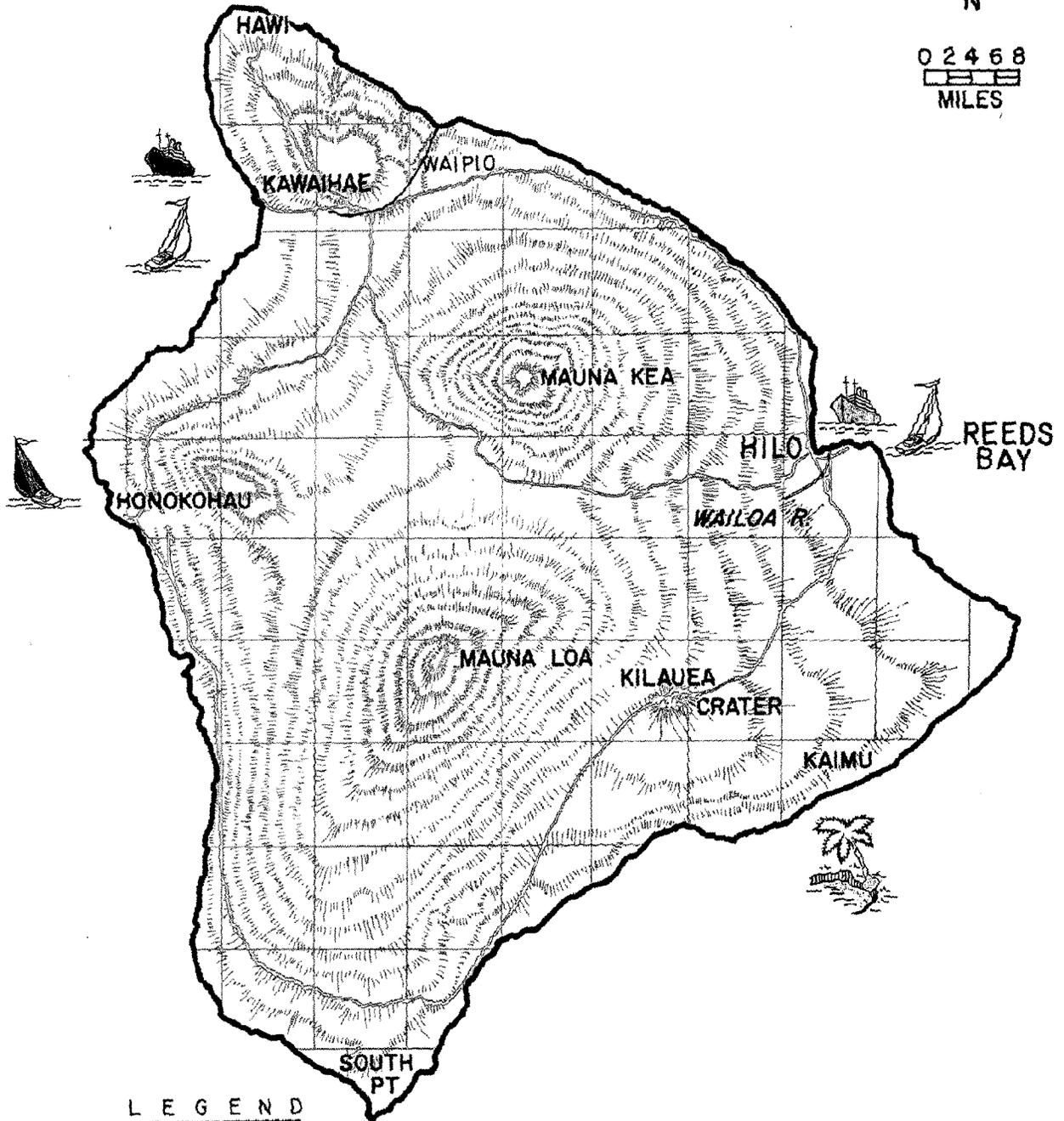


*Stranded residents swim through floodwaters along Kapunakea Street in the Kahoma Stream flood plain (State Department of Land and Natural Resources photo)*

# HAWAII



0 2 4 6 8  
MILES



## LEGEND

- |                   |  |                         |  |
|-------------------|--|-------------------------|--|
| DEEP DRAFT HARBOR |  | CONSTRUCTION COMPLETED  |  |
| SMALL BOAT HARBOR |  | CONSTRUCTION AUTHORIZED |  |
| BEACH EROSION     |  | COMPLETED STUDY         |  |
| FLOOD CONTROL     |  |                         |  |

## ISLAND OF HAWAII

### HILO HARBOR

Hilo Harbor, second largest deep-draft harbor in the state, is on the northeast coast of the island. The harbor fronts the city of Hilo, the center of economic activity on the island and the second largest city in the state. During 1973, more than 1,041,000 short tons of cargo passed through Hilo Harbor. The principal exports are sugar and molasses. The principal imports are general cargo and petroleum products.

The existing harbor was constructed in 1930, and consists of a rubblemound breakwater 10,080 feet long, an entrance channel 35 feet deep, and a harbor basin 1,400 feet wide, 2,300 feet long and 35 feet deep. Modifications to the harbor were authorized by the River and Harbor Acts of 1907, 1912, 1925, 1960, and 1962. Emergency repair of badly deteriorated sections of the breakwater was accomplished in 1968 and 1973. Repair of the entire breakwater was started in 1974 and is scheduled to be completed in the near future. Total Federal

funds spent on Hilo Harbor for work completed through calendar year 1974 were \$6,144,297.

A project to provide protection from tsunamis and to improve navigation conditions in the harbor by reducing surge was authorized by the River and Harbor Act of 1960. The Corps conducted hydraulic model tests of various structural schemes. The tests showed that conditions in the harbor could be improved by strengthening, raising, and lengthening the existing breakwater, constructing a 4,000-foot-long west breakwater and a 6,600-foot-long land dike. Further work on this project has been deferred until the State decides on the course of action desired for the problems at this harbor.

A Hilo Harbor modification study was authorized by House Resolution 739 of 9 May 1967 to determine the feasibility of harbor modifications for surge reduction. A gaging and data collection program was conducted to determine the cause of surge in the harbor. However, the results were inconclusive.



*Aerial view of Hilo Harbor with the city of Hilo in the background*

### KAWAIHAE DEEP-DRAFT HARBOR

The Island of Hawaii's second commercial harbor was constructed in 1959 at Kawaihae, about 85 nautical miles northwest of Hilo. It serves an area from Milolii on the southwest coast to Honokaa on the northeast coast of the island. This area includes all of the Kona coffee producing land on the island, the majority of the island's cattle ranches, and part of the sugar producing region of the northeast coast.

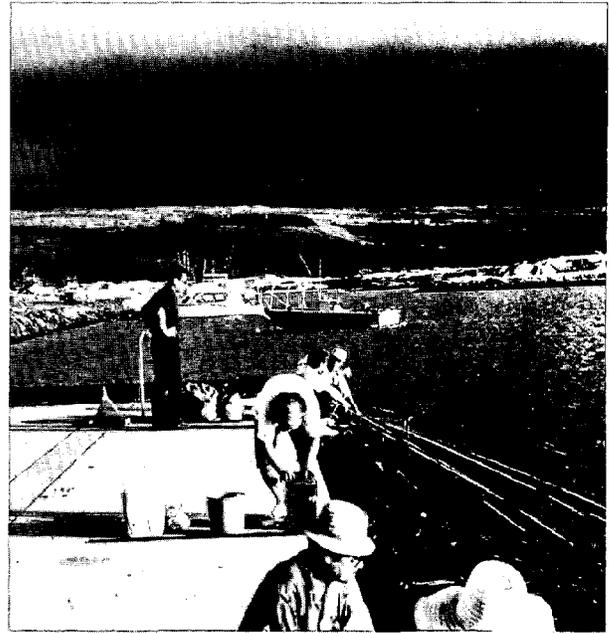
The harbor was created by dredging part of an extensive coral reef which extends 4,000 feet seaward and runs along the shore more than a mile south of Kawaihae town. Harbor modifications consisting of widening the entrance channel and enlarging the basin were completed in 1973 under the authority of the River and Harbor Act of 1965. The existing harbor has an entrance channel 500 to 520 feet wide, 3,270 feet long, and 40 feet deep. The harbor basin has an area of 71.8 acres and a depth of 35 feet. The basin is protected by a breakwater 2,650 feet long and by a fill area surrounded by 3,335 linear feet of stone revetment. Total Federal funds expended for the construction and improvement of Kawaihae Deep-Draft Harbor to 31 December 1974 were \$5,961,900.

In 1973, a total of 385,850 short tons of cargo passed through this harbor. Sugar and molasses shipments constituted about two-thirds of the total cargo.

### KAWAIHAE SMALL BOAT HARBOR

A small basin off the entrance channel of the Kawaihae Deep-Draft Harbor provides a sheltered anchorage for small craft. However, by the early 1960's the State of Hawaii recognized the growing need for a more extensive, better protected facility for small craft on the north end of the island of Hawaii. As a result, the Congress authorized the construction of the Kawaihae Small Boat Harbor in the River and Harbor Act of 1965.

The authorized plan provided for the construction of a small boat harbor at the south end of the commercial harbor. In early 1969, the State of Hawaii requested that a different site be used for the small boat harbor and that the previous site be dredged to provide additional deep-draft berths. Coincident with this request, the U.S. Army Nuclear Cratering Group (NCG) of Livermore, California, in its search for a demonstration project, selected the reef south of the deep-draft landfill as



*Local residents enjoy fishing from the pier at Kawaihae Deep-Draft Harbor (State Harbors Division photo)*

a possible site for a small boat harbor. The State of Hawaii and the Honolulu District Engineer concurred, and the construction project, code-named PROJECT TUGBOAT, was approved by the Chief of Engineers for immediate execution.

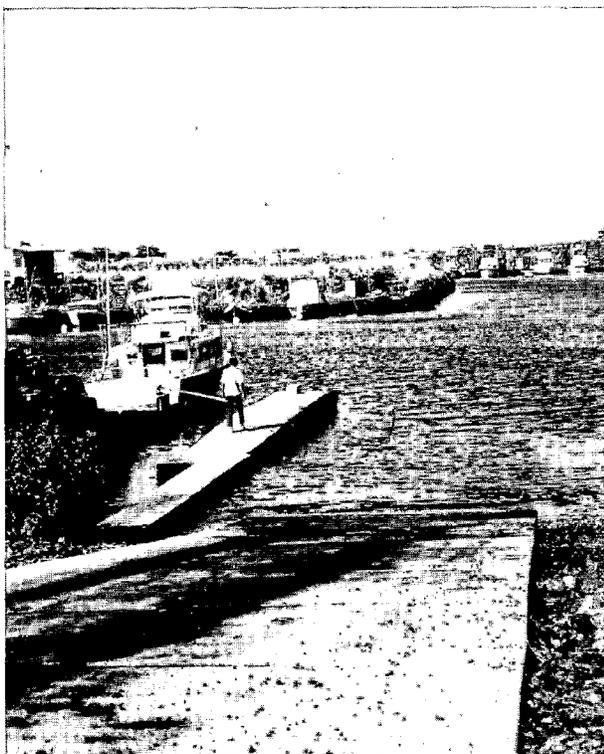
The engineering technique which was demonstrated by PROJECT TUGBOAT was "explosive excavation", an alternative to conventional methods of excavation. In explosive excavation a large charge (10 tons or more) of explosive is placed in a hole deeper than the final depth of excavation. When the charge is detonated it produces a wide shallow crater. If a series of these charges is simultaneously detonated, they produce a crater shaped in the pattern of the series. In May 1970, three patterns of four charges each were detonated to produce the entrance channel and berthing basin for the Kawaihae Small Boat Harbor.

PROJECT TUGBOAT also provided for the construction of a breakwater seaward of the craters to protect them from wave and current effects, and a launching ramp. At the completion of PROJECT TUGBOAT, the Honolulu Engineer District received authority and funds to begin detailed design of a small boat harbor at Kawaihae incorporating the structural elements produced by TUGBOAT. The design was completed in August 1971, and the project has been approved for construction.

## HONOKOHAU SMALL BOAT HARBOR

The small boat harbor at Honokohau just north of Kailua Kona is one of the 19 harbors included in the Statewide system of Federal/State recreational and commercial fishing harbors. Construction of the Honokohau Small Boat Harbor, authorized by the River and Harbor Act of 1965, began in June 1968 and was completed in March 1970. The Federal portion of the project consists of a 120-foot-wide, 840-foot-long, 15- to 20-foot-deep entrance channel; a 120-foot-wide, 660-foot-long, 12- to 15-foot-deep main access channel; two wave absorbers 650 and 150 feet long; and a wave trap. Federal funds spent on this harbor through 31 December 1974 totalled \$781,036.

The State of Hawaii has constructed berths for about 40 boats. Plans to add more berths and shore-side facilities have been delayed due to conflict with the Honokohau Settlement, a registered National Historic Landmark, on the northern boundary of the harbor.



Launching ramp and moored craft at Honokohau Harbor (State Harbors Division photo)

## KAIMU BEACH

Kaimu Beach, on the southeast shore of the island of Hawaii, is a county park little used for swimming and other beach activities but much visited for its rare beauty.

The sands at Kaimu are black, a product of volcanic glass and basalt fragments formed by rapid chilling and steam explosions which occurred when a lava flow entered the sea around the year 1750. There are other black sand beaches on the island but none are so easily accessible or so picturesque.

The black sands at Kaimu are under constant attack from waves coming from the northeast, east, southeast, and south. Sand carried from the beach by wave attack and currents is quickly lost in the deep waters immediately south of the beach. Since 1900, Kaimu Beach has eroded an average of about 275 feet along its entire length, an average annual erosion rate of about 4 feet per year. The present beach is little more than a ribbon of sand and exposed rock, and erosion is eating away at the coconut palms that fringe the beach.

The Honolulu Engineer District was asked by the County of Hawaii to study the erosion problem at Kaimu to determine whether a solution to the problem was feasible and Federal participation warranted. Several alternative solutions were studied and in September 1970 the District held a public meeting in Hilo to present these alternatives to the public. The recommended solution proposed that a breakwater with a crest elevation of 0.0 feet mean low water (MLLW) be constructed offshore across the embayment to reduce the amount of wave energy reaching the beach, and to block the currents carrying sand from the beach. In addition, the width of the beach would be restored to about 75 feet using black sand material from a nearby cinder cone, and the small amount of sand lost through normal erosion processes would be replaced periodically.

No opposition to the plan was raised at the meeting, and the plan received the support of the County Council, the business community, and Puna residents. However, a few months later it was severely attacked by surfers who claimed that Kaimu was an ancient surfing spot and still one of the finest surfing areas on the island.

Based on the surfers' objections, The Corps re-evaluated the project. More than a year was spent in developing alternative solutions and in coordinating the plans with County of Hawaii officials,

the Governor's Office of Environmental Quality Control, surfers, and interested citizens, particularly residents of the Kaimu (Puna) area. Conflict existed between government officials and the Puna residents who desired immediate construction and other government officials, surfers, and environmentalists who desired a more cautious approach to the problem. Following many meetings, both formal and informal, a compromise plan was developed. The plan provides for replenishment of a 1,600-foot reach of the beach with black sand from a nearby source, followed by a two-year monitoring program to observe the reaction of the beach to natural forces, and construction of an offshore breakwater if such a structure is determined to be necessary to protect the beach.



*Coconut trees at Kaimu Beach are continually being undermined by erosion*

### WAILOA STREAM FLOOD CONTROL

The Island of Hawaii is physically the largest and geologically the youngest of the islands. Because of its youth, the island's contours have not yet had time to age and soften. Where on other islands streams flow in well-defined channels, the island of Hawaii's streams gush through swales and troughs formed by lava flows.

Two streams, Waiakea and Kawili, originate on the eastern slopes of Mauna Loa and join into Wailoa Stream which winds its way to Hilo Bay. By the 1960's, the city of Hilo had expanded to the point where conflicts arose between natural drain-

age and urban developments. Homes, businesses, and parts of the University of Hawaii at Hilo were all endangered during rainy seasons.

A flood control project, authorized by the Flood Control Act of 1954, provided for a system of diversion channels, levees, and box culverts to protect the Waiakea (easterly) section of the city. The project diverted the Kawili Stream into Waiakea Stream and a channel in turn diverted the combined flows into a long, narrow natural swale. Further downstream, a levee diverted the flows into a new excavated channel protected by earth levees. This channel diverted the accumulated waters to drain into the fresh water spring-fed Waiakea Pond, and then to disperse naturally into Wailoa River and out into the Pacific Ocean. The project was completed in August 1965, at a cost of \$1,075,857.

The efficiency of the new drainage and diversion system was tested within a year after construction. In July 1966, heavy rains flooded the Hilo area. The flood control channel carried the runoff and prevented much damage in the area. Since the completion of the project, flood damage and losses prevented are estimated at \$154,000.

### OTHER

Construction of a small boat harbor at Reeds Bay was authorized by the River and Harbor Act of 1965. However, no funds for preconstruction planning work have been received. In 1973, the State of Hawaii provided anchor buoys in Reeds Bay as a temporary measure to accommodate small craft in the Hilo area.

In 1974, the Corps studied the feasibility of Federal participation in the construction of multiple-purpose water resources improvements for the Waipio River, Kohala-Hamakua area. The study was accomplished under the authority of Section 209 of the 1962 Flood Control Act. It focused on the problems and needs resulting from natural forces such as floods, and those concerned with the socio-economic welfare of the residents of the area in the way of better water and power service and water-oriented recreational opportunities. The study showed that, although Waipio Valley is subject to flooding, flood control improvements could not be justified because the valley is only sparsely populated and developed for agricultural purposes. Similarly, Federal participation in the construction of improvements for water supply, hydroelectric power, and water-oriented recreation could not be economically justified.

## FLOOD PLAIN MANAGEMENT SERVICES

Flood plains are areas along streams and rivers which nature has designated to receive overflows during storms. Flood plains are therefore an integral part of the stream or river and floods within these areas are natural occurrences. Flood damages are usually the result of man's occupation and use of flood plains without first providing adequate protection.

Since the dawn of civilization, man has had a magnetic attraction for streams and rivers and their flood plains. Almost all of the nation's major cities and many of the richest farms, most attractive homes, and recreation areas have been developed in flood plains. As the nation continued to grow, people began to occupy flood-vulnerable areas without concern for the flood problem and therefore without first providing protection against floods. The resulting damages from floods on the adjacent streams or rivers have often been severe, and have led to the involvement of municipal, county, state and the Federal governments in developing measures to control floods.

Up to a few years ago, floods were controlled primarily through the construction of dams, levees, channels, and similar structures. Recently, however, increasing emphasis has been placed on the basic solution which is to prevent man from occupying flood-vulnerable areas. This solution is rather drastic and often impractical due to the extent of existing developments. Therefore, although it is considered to be the ultimate solution, more practical measures such as restricting the use of flood plain areas to that compatible with the flood risk are being emphasized. To be effective, it is necessary that the flood plain regulations be based on an understanding of the flood problem, the areas subject to inundation by floods of various magnitudes, and the degree of risk involved.

Section 206 of the 1960 Flood Control Act, as amended, authorized the Corps of Engineers to assist State and local governments in developing effective flood plain management programs by providing information on floods, flood damage potentials, and general criteria and guidance on the use of flood plains. Under the flood plain management program, the Honolulu Engineer District prepared flood plain information reports for the Kaa-awa, Pupukea-Sunset Beach, and Waialua-Haleiwa

areas on the island of Oahu; the Hanalei, Anahola, and Koloa-Poipu areas on the island of Kauai; the Kihei area on the island of Maui; the Kamalo, Kawela and Waialua areas on the island of Molokai, and for the city of Hilo on the island of Hawaii.

In order to respond to the many requests for flood hazard studies of specific areas, the Honolulu Engineer District now cooperates with the State of Hawaii Department of Land and Natural Resources in publishing the basic information in a more simple and usable format centered around a map showing the areas that would be inundated by floods of various magnitudes. The following flood hazard map reports have been published in cooperation with the State Department of Land and Natural Resources:

### Island of Kauai

- Wailua River
- Opaekaa Area
- Hanamaulu Stream
- Waikaea and Moikeha Canal

### Island of Oahu

- Keaahala Stream
- Wailupe Stream
- Kahuku Area
- Kalauao Area
- Kalihi-Moanalua Area
- Makaha Area
- Waialae-Kahala Area
- Waimea Area
- Kahaluu Area
- Waialae-Iki Area
- Waikane and Waiahole Areas
- Heeia Area
- Waolani Stream
- Hauula-Punaluu Area

### Island of Molokai

- Pukoo Area
- West Molokai Area

### Island of Maui

- Kahoma Stream
- Iao Stream
- Olowalu Stream

### Island of Hawaii

- Puako to Anaehoomalu Area

The Honolulu Engineer District also participates in the Federal flood insurance program. This program has two purposes: to make flood insurance available to the public at reasonable cost, and to encourage local governments to regulate development of flood-prone lands. To achieve these purposes, the Federal government subsidizes premium rates paid by the property owner to the insurance company, reinsures the company against catastrophic loss, and requires local governments to adopt flood plain regulations in order to be eligible for flood insurance.

The Honolulu Engineer District provides technical information for this program. Corps specialists establish risk zones, determine average annual damages for structures in these zones, and convert these damage figures to actuarial premium rates. They also prepare official flood insurance maps showing rate zones, and official flood hazard

maps for flood plain regulation by local government.

The Federal, State, and County governments in Hawaii are working together to reduce the crippling damages and loss of life and property from floods. Structural measures have been used by the Corps of Engineers and local government whenever these measures were required due to the nature of the flood problem and the extent of development in the flood plain. However, more and more, Corps representatives and local government officials are leaning toward a cooperative program between all levels of government and the use of nonstructural as well as structural measures to alleviate flood problems. Flood plain management is considered the primary nonstructural measure to minimize flood damages while allowing for man's use of the flood plains.

## APPENDIX—LIST OF PROJECTS

### COMPLETED PROJECTS

#### Island of Kauai

Nawiliwili Deep-Draft Harbor  
 Nawiliwili Small Boat Harbor  
 Port Allen Deep-Draft Harbor  
 Hanapepe River Flood Control

#### Island of Oahu

Honolulu Harbor  
 Haleiwa Small Boat Harbor  
 Waikiki Beach  
 Haleiwa Beach  
 Kawainui Swamp  
 Kuliouou Stream  
 Moanalua Stream\*  
 Waialae Iki Stream\*  
 Waialae Nui Stream\*  
 Niu Stream\*  
 Hahaione Stream\*  
 Kapakahi Stream\*  
 Omao Stream\*

#### Island of Molokai

Kaunakakai Harbor  
 Kalaupapa Barge Harbor  
 Kaunakakai Flood Control

#### Island of Maui

Kahului Deep-Draft Harbor  
 Kahului Deep-Draft Harbor\*  
 Kihei Beach Erosion Control  
 Iao Stream\*

#### Island of Lanai

Manele Bay Small Boat Harbor

#### Island of Hawaii

Hilo Harbor  
 Kawaihae Deep-Draft Harbor  
 Honokohau Small Boat Harbor  
 Kawaihae Small Boat Harbor  
 (Project Tugboat)  
 Wailoa Stream Flood Control

### PROJECTS AUTHORIZED FOR CONSTRUCTION

#### Island of Kauai

Nawiliwili Deep Draft Harbor Modification  
 Kikiaola Small Boat Harbor  
 Hanapepe Beach Erosion Control  
 Waimea Beach Erosion Control

#### Island of Oahu

Honolulu Harbor Modification  
 Barbers Point Deep-Draft Harbor  
 Barbers Point Small Boat Harbor  
 Waianae Small Boat Harbor  
 Maunalua Bay Small Boat Harbor

Kailua Small Boat Harbor  
 Ala Wai Harbor Modification  
 Kewalo Harbor Modification  
 Waikiki Beach Erosion Control  
 Kaaawa Beach Erosion Control  
 Haleiwa Harbor Modification  
 Kaneohe-Kailua Area Flood Control and Related  
 Development

#### Island of Molokai

Kaunakakai Deep-Draft Harbor  
 Kaunakakai Small Boat Harbor

#### Island of Maui

Lahaina Small Boat Harbor  
 Hana Small Boat Harbor  
 Iao Stream Flood Control  
 Kahului Beach Road

#### Island of Hawaii

Kawaihae Small Boat Harbor  
 Reeds Bay Small-Boat Harbor  
 Kaimu Beach Erosion Control

\*Indicates construction performed under emergency authority.

**AUTHORIZED SURVEY STUDIES IN PROGRESS**

Comprehensive Statewide Study  
"Rivers and Harbors of Hawaii"

**Island of Oahu**

Kalihi Stream Flood Control  
Kaneohe Bay Urban Water  
Resources Study  
Wailupe Stream (under Rivers and Harbors of  
Hawaii)

**Island of Maui**

Kahoma Stream Flood Control

**Island of Hawaii**

Hilo Harbor Modification

**SMALL PROJECTS STUDIES IN PROGRESS****Island of Oahu**

Waialua-Haleiwa Flood Control  
Kualoa Beach Erosion Control

**Island of Molokai**

Kapaakea Stream Flood Control

**OPERATIONS AND MAINTENANCE PROJECTS**

Statewide maintenance dredging of all deep-draft  
harbors together with Kaunakakai Harbor,  
Kalaupapa Landing, Haleiwa Small Boat Harbor,  
and Manele Bay Small Boat Harbor

**Island of Maui**

Repair of Kahului Deep-Draft Harbor  
Breakwater

**Island of Hawaii**

Repair of Hilo Harbor Breakwater

COASTAL ZONE  
INFORMATION CENTER

