

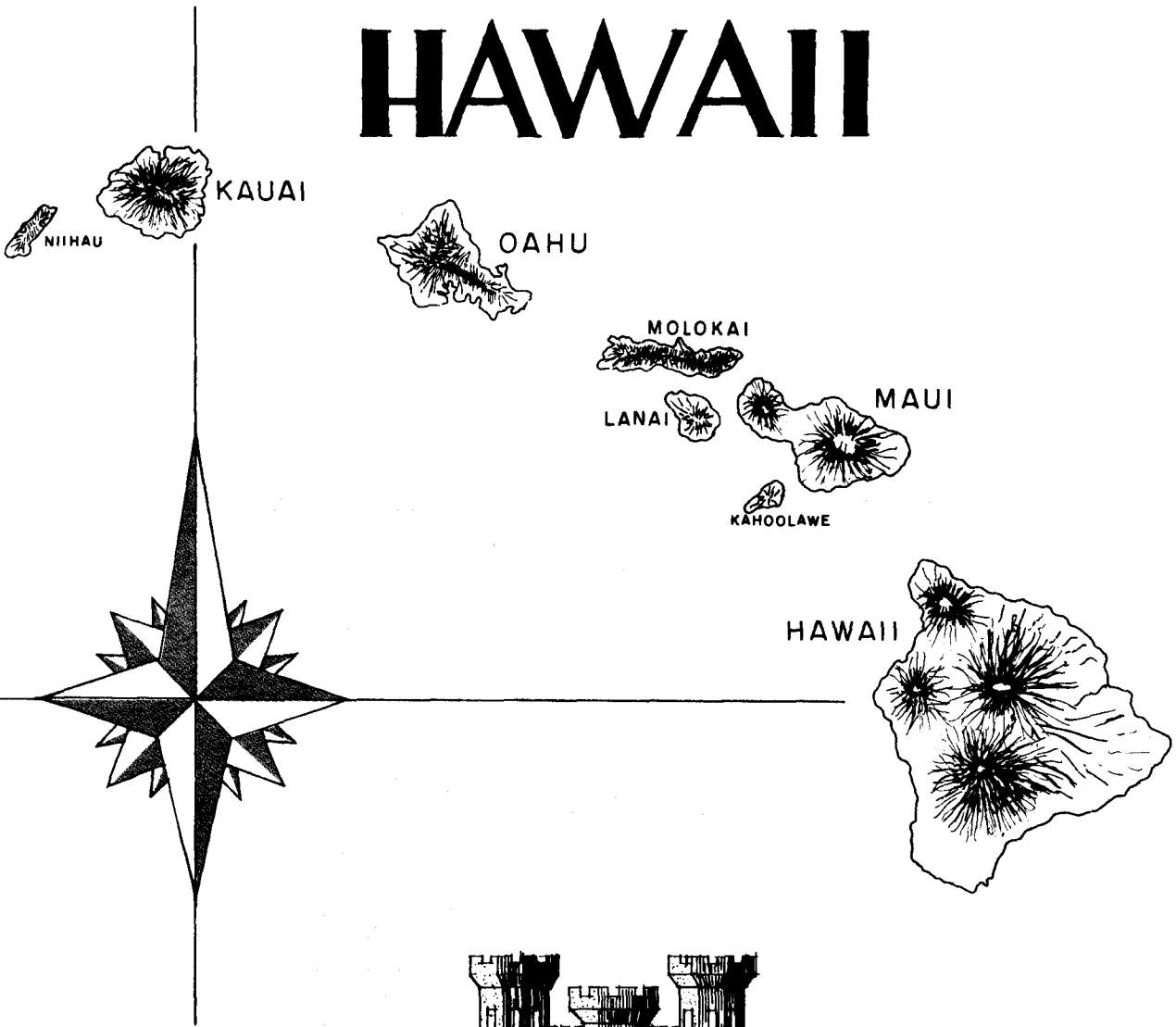
WATER RESOURCES DEVELOPMENT

BY THE

U.S. ARMY CORPS OF ENGINEERS

IN

HAWAII



U. S. ARMY ENGINEER DIVISION
PACIFIC OCEAN
HONOLULU 13, HAWAII

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WATER RESOURCES DEVELOPMENT
BY THE U. S. ARMY CORPS OF ENGINEERS
IN HAWAII

This pamphlet is published biennially, presenting accomplishments and future plans of the Corps of Engineers for the development of the water resources of the State.

Further information regarding civil works projects discussed in this pamphlet may be obtained from:

Division Engineer
U.S. Army Engineer Division, Pacific Ocean
Building 96, Fort Armstrong
Honolulu 13, Hawaii

or

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Building 96, Fort Armstrong
Honolulu 13, Hawaii

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INTRODUCTION

The purpose of this pamphlet is to familiarize you with the U. S. Army Corps of Engineers Civil Works or water resources development program in the State of Hawaii. A considerable amount of concise, easily digestible information pertaining to each individual Corps of Engineers project, whether it be completed, under construction, or in the planning or study stage, have been prepared. A table of contents and the index page will help in locating a specific project.

This pamphlet has been prepared in order that those organizations and individuals interested in the water resources development program in Hawaii may have information on the general scope and progress on that part of the program which is under the direction of the U. S. Army Corps of Engineers.

The Corps of Engineers, a regularly constituted branch of the United States Army, under assignment by Congress, is charged with the public civil works program to control, regulate, and improve river and harbor resources; to administer the laws pertaining to the preservation of navigable waters; and to plan, construct, and operate flood control works, in addition to its extensive military engineering and construction responsibilities.

The Honolulu Engineer District was established on 15 April 1905 in Honolulu, Territory of Hawaii. The District supervises and prosecutes work relating to military and civil works construction within its geographical boundaries--including the Hawaiian, Line, Gilbert, Marshall, Midway, Wake, and Johnston Islands, and such islands in the South Pacific between 159° East longitude and 180° West longitude as may be under the jurisdiction of the United States. This represents several million square miles.

One of Hawaii's first civil works projects dates back to 1905, when the River and Harbor Act provided for improvements to the harbor at Honolulu. It provided for an entrance channel 35 feet deep and 400 feet wide at mean low water from deep water at the entrance to the lighthouse point; for easing the curve at the junction of the entrance channel and the inner harbor by cutting off the lighthouse point; and for enlarging the harbor proper so that it will have a depth of 35 feet and a general width of 1,200 feet at mean low water; at an estimated cost of \$1,582,440, exclusive of a new front-range light, estimated to cost \$30,000.

In Hawaii, the authorized program of the Corps of Engineers constitutes a basic framework for the development and improvement of the Islands' harbors for both deep-draft, seagoing vessels, and small craft. A number of flood control projects on the Islands are included in the basic framework. The ultimate objectives resulting from improving or building new harbors and a system of flood control projects are the intrinsic benefits that would accrue to the people of the State and the Nation.

The State of Hawaii is unique from any other State of the Union. Many of its navigation problems are peculiar to this State alone which is so dependent on shipping. Last year, over 1,400 ocean-going vessels called at the most active port of Honolulu. The Islands have long been recognized because of their strategic importance as being of vital importance to the military. A total of seven harbors now serve the Hawaiian Islands.

The flood problems on the islands formed by volcanoes are also different from the usual river and tributary flooding on the Mainland. Flash flooding of shorter duration occurs in Hawaii.

Under the direction of Congress, the Corps of Engineers is responsible for studies of navigation, flood control, and other water resource development problems; construction of controls and improvements; operation and maintenance of such controls and improvements (local protection projects excepted); emergency flood fighting and levee or breakwater repair assistance to local and State agencies; and issuance of permits for the erection of structures in or over navigable waterways.

Close coordination of all investigation and improvement activities of the Corps of Engineers is maintained with other Federal, State, and local agencies. While Federal funds largely finance civil works projects, in some instances local interests make substantial contributions, chiefly in the matter of rights-of-way for channel and levee works.

If additional information regarding projects is desired, contact should be made directly with the District Engineer, U. S. Army Engineer District, Honolulu; Building 96, Fort Armstrong, Honolulu 13, Hawaii.



WORLD FAMOUS BEACH - WAIKIKI, HONOLULU, HAWAII

(HAWAII VISITORS BUREAU PHOTOS)

COMPLETED BEACH EROSION CONTROL PROJECT

WAIKIKI BEACH, OAHU

Waikiki Beach on the Island of Oahu, is a world-famous name for beach, recreational, and aquatic activities. Its reputation for year-round beach pleasure is, in general, of the highest.

During the past fifty years, numerous beach areas at and contiguous to Waikiki have been so depleted of sand that only parts of the original beach remain.

The beach area is on the south side of the Island of Oahu and is a shore strip three and one-half miles long, extending northwest from the eastern end of Mamala Bay. This beach is centrally located with respect to population concentration. Highly developed residential, hotel, business, and park areas are contiguous to the shore area.

The authorized Corps of Engineers project provided for the protection and improvement of the publicly-owned portion of the shores of Waikiki Beach from the War Memorial Natatorium to the southeast boundary of Fort DeRussy. These measures consisted of the artificial placement of suitable sand fill on the shore to widen the beach berm to width of 75 to 150 feet, the construction of a 1,164 feet of terrace wall, a combination storm drain and groin 315 feet long, a groin 360 feet long, and drainage facilities.

The primary benefits consist of the prevention of direct damage to beach and shore facilities from erosions; permanent loss of the remaining beach area; the prevention of indirect losses in the tourist business which would result from the direct damage; increased yield or return from land and improvements in the Waikiki business, hotel-apartment, and residential area; and the recreational welfare resulting from an adequate, protected sand beach.

Federal authorization of the project provided for the contribution of Federal funds in the amount equal to one-third of the first cost of the measures for the protection and improvement of the publicly-owned portions of the beach. Federal expenditures on this project totalled \$245,568.



2. WAIKIKI BEACH SHOWING IMPROVEMENT
RESULTING FROM BEACH NOURISHMENT AND PROTECTIVE WORKS

COMPLETED FLOOD CONTROL PROJECT

KAUNAKAKAI STREAM, MOLOKAI

The flood plain of Kaunakakai Stream, prior to the construction of flood control works in 1950, covered practically all of the business area of the town and a large portion of the residential area, totalling 125 acres. In addition to business and residential damages, losses also included such items as disruption of communications, filling and caving in of cesspools, uprooting of trees, washing out of bridges, and spreading of mud and debris through the town. Damages ranged from \$5,000 to \$130,000 for each flood. Several floods of damaging proportions, which have occurred since the completion of the project, have been completely controlled. Floods occur principally during the five-month period, November through March, as a result of severe rainfall intensities. Up to 13 inches of rain have been recorded within a 24-hour period in this community.

The existing Corps of Engineers project provided for an enlarged stream channel flanked by earth levees with rock facing on the streamside slope. The left bank levee extends for a distance of 3,520 feet from the bluff adjacent to the stream and north of the town of Kaunakakai to the Pacific Ocean. The right bank levee extends for a distance of 1,050 feet downstream from the opposite bluff past the Kaunakakai Homesteads. The project was completed in 1950.

Average annual benefits are estimated at \$6,200. Federal cost of the project was \$73,748.



3. PINEAPPLE IS THE PRINCIPAL COMMODITY SHIPPED FROM KAUNAKAKAI HARBOR, ISLAND OF MOLOKAI.

WAILUPE AND NIU STREAMS, OAHU

Wailupe Stream in the Aina Haina district and Niu Stream in Niu Valley are both in the southeastern suburbs of Honolulu.

The Wailupe Stream project consisted of excavating and clearing the mouth of the stream, between Kalaniana'ole Highway bridge and East Hind Drive bridge; constructing a rock barrier at the upstream end of the existing local improvements; and restoring portion of the right bank of the stream.

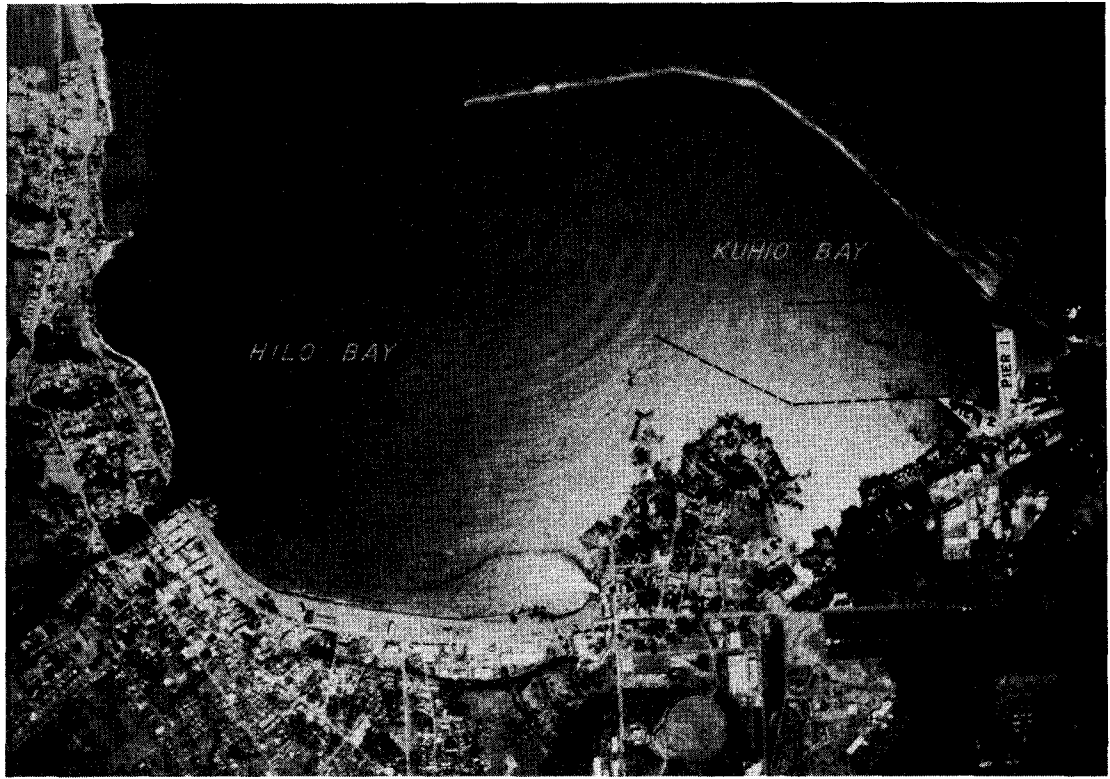
Work on the Niu Stream project consisted of excavating and clearing between the mouth of the stream and the Kalaniana'ole Highway bridge. Portions of the left bank of the stream were also restored.

The construction of the past flood repairs for Wailupe Stream and Niu Stream was started in May 1958 and completed in September of the same year. The construction of the rock barrier for Wailupe Stream was started in August 1959 and completed three months later.

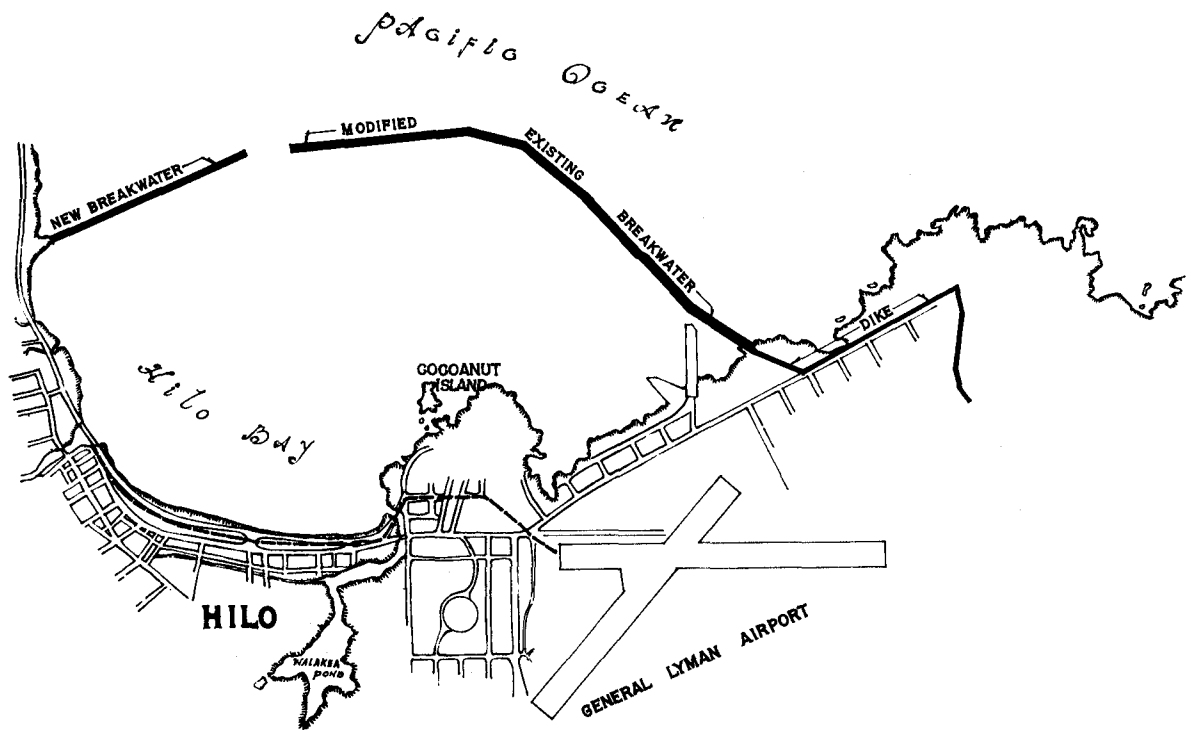
Total Federal cost of the project to date is \$61,533.



4. THE CHOKED CHANNEL OF WAILUPE STREAM WAS CLEARED OF FLOOD DEBRIS IN 1958.



5. HILO HARBOR TURNING BASIN (shown with dashed lines) IS PROTECTED BY A BREAKWATER TWO MILES LONG.



6. PROPOSED PLAN FOR TSUNAMI PROTECTION AND IMPROVEMENT FOR NAVIGATION, HILO HARBOR.

COMPLETED NAVIGATION PROJECTS

HILO HARBOR, HAWAII

Hilo is the third largest city in the State of Hawaii. It has a population of about 25,966 and is the principal city and the main supply point for the Island of Hawaii, which consists of 4,030 square miles.

The city has grown into a typical port metropolis resulting from the activity generated by the harbor. Economically, Hilo serves as the mercantile and service center of the Island, as well as being the focal point of nearly all other activity.

The island's economy is presently derived primarily from agricultural sources. A principal activity in this respect is the cultivation of sugar cane, from which raw sugar and molasses are extracted and fiberboard by-products are manufactured. Other significant agricultural endeavors are livestock, coffee, macadamia nuts, tropical fruits and flowers, lumber, and truck farming. In 1959, raw sugar and molasses production amounted to \$13.1 million. Non-agricultural enterprises of importance are the tourist, commercial, and light industries.

Commodity movement of substantial tonnage are imports of petroleum products, fertilizer, lumber, and animal feed. Principal exports consist of sugar and molasses, although significant tonnages of farm products are shipped to the other islands. Imports to Hilo in 1959 totalled 333,796 tons, and exports for the same year were 570,959 tons.

The completed Corps of Engineers project provides for a rubblemound breakwater 10,170 feet long on the north side of Kuhio Bay; an entrance to Kuhio Bay which is 35 feet deep; and a harbor basin 1,400 feet wide, 35 feet deep, and 2,300 feet long.

This project was completed in 1930 with Federal costs to date of \$5,147,604, of which \$1,738,778 has been for maintenance.



7. KAUNAKAKAI BARGE HARBOR, MOLOKAI,
AN IMPORTANT PINEAPPLE SHIPPING POINT.

KAUNAKAKAI HARBOR, MOLOKAI

Kaunakakai Harbor is centrally located on the south coast of Molokai, adjacent to the island's principal town. It is the only developed harbor of commercial consequence on Molokai, serving the entire island with the exception of the isolated Kalaupapa Settlement.

An inlet in the broad coral reef fringing the south coast of Molokai provided a natural site for the harbor. In 1899, private interests built a half-mile long mole across the reef and a wharf. These facilities were later taken over and improved by the Territorial Government but remained inadequate to satisfactorily accommodate the larger interisland vessels and barges because the entrance channel was too shallow in its inner reaches for safe navigation.

In 1953, Federal funds were allocated for the dredging of an improved entrance channel and a new barge basin beside the wharf. Controlling depths were established at 23 feet. This project was completed in 1934 and, in 1935, assigned by Congress to the Corps of Engineers for maintenance.

The existing barge harbor has proved of positive benefit to the population and economy of the island. It has been of particular value in serving the transport needs of the pineapple industry, for many years the mainstay of the island's economy. The harbor is primarily utilized by tug and barge traffic and, to a lesser degree, by fishing and recreational craft. The principal export is unprocessed pineapple, barged to the Honolulu canneries. The main imports are general commodities and petroleum products. Interisland commerce moving through Kaunakakai Harbor totalled about 229,000 tons in 1959, 183,000 tons of which were exports.

Federal cost of construction of the barge basin at Kaunakakai was \$103,200. To date, the cost of maintenance by the Corps of Engineers has been \$61,855.

The Corps of Engineers is presently finalizing a survey report on the feasibility of Federal construction of a deepwater harbor at Kaunakakai and a separate light-draft vessel basin for fishing and recreational craft. A new harbor would permit direct water shipments to and from the mainland, heretofore not possible, and greatly benefit the economic potential of Molokai.

KAWAIHAE HARBOR, HAWAII

Kawaihae Harbor is the newest deep-water harbor in the State of Hawaii. It was built at a cost of \$7 million, of which \$4,186,105 was Federal. The harbor is located on the "Big Island" of Hawaii about 15 miles south of the northernmost tip of the island and 70 highway miles northwest of Hilo, the largest town on the island. The existing harbor was completed in June 1959 and officially dedicated in October of that year.

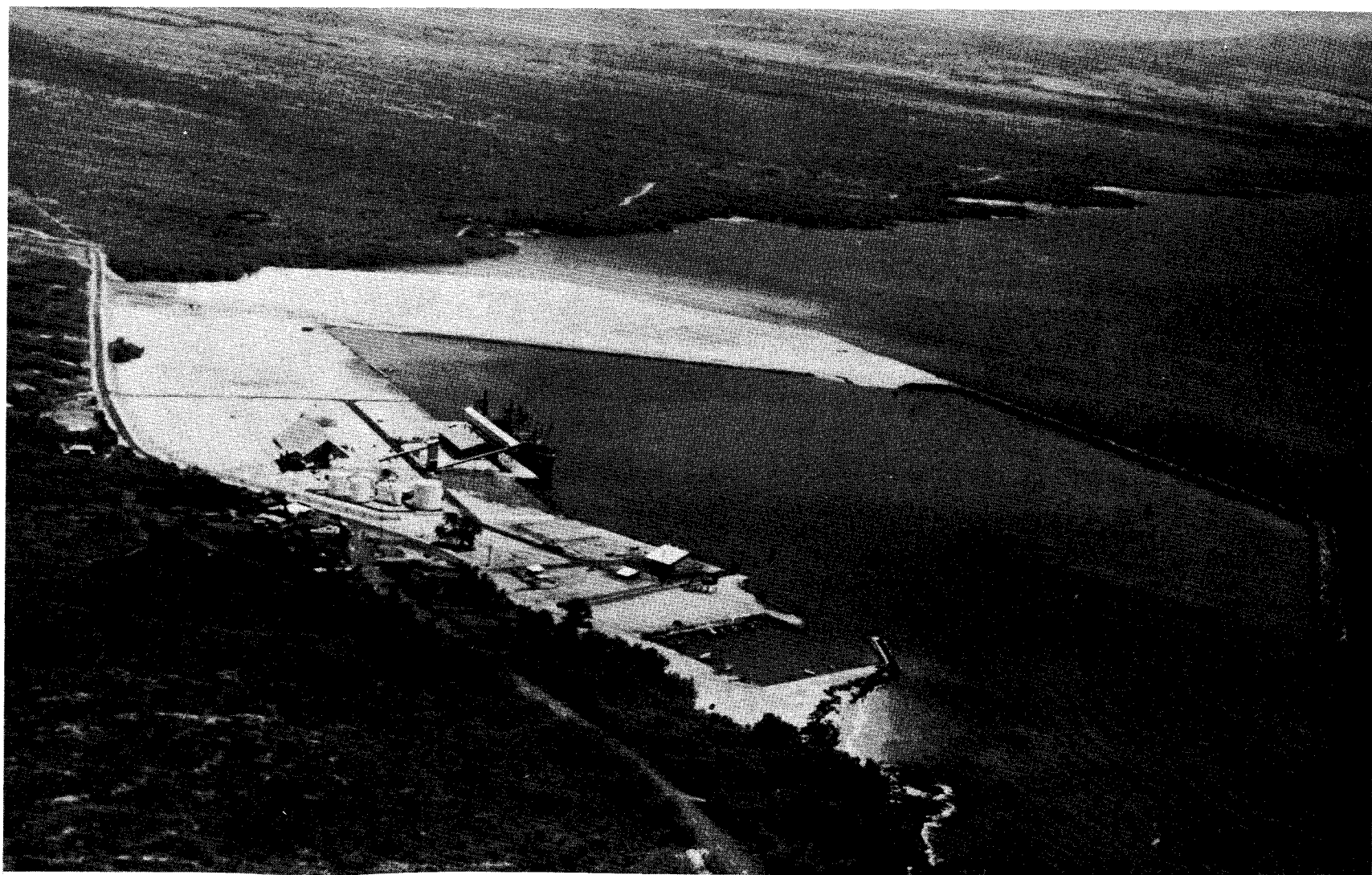
The project, as completed, has an entrance channel 400 feet wide, 2,900 feet long, and 40 feet deep. Inside the harbor is a turning basin 1,250 feet square and 35 feet deep. On the south side of the harbor is a rubblemound breakwater 2,650 feet long. During the construction of the project, about 3-1/4 million cubic yards of material was removed by dredging. The material removed was used to fill in an area of 97 acres adjacent to the harbor, making it available for beneficial industrial use. This area is also protected by stone to prevent wave erosion.

Kawaihae Harbor is the second deep-water harbor for the Island of Hawaii. It provides an alternate port to serve the island in the event Hilo Harbor is blocked during a disaster similar to the April 1946 tidal wave which struck the island.

There are several advantages in connection with the new harbor. It is centrally located with respect to the four leading industries of Western Hawaii: the coffee area of Kona, the inland cattle area, the Waimea agricultural area, and the northern coast sugar area. Shipment of sugar and molasses provide the largest tonnage. It is the most naturally protected harbor in Western Hawaii and is the best suited for harbor improvements.

Total imports to Kawaihae Harbor in 1959 were 11,855 tons while the exports for the same year totalled 22,776 tons. A labor strike, lasting ten months, reduced the tonnage during the latter part of 1959 and the first half of 1960.

The benefits derived from the Kawaihae Harbor development are attributed to the imports and exports of everyday essentials, including livestock, produce, sugar, molasses, petroleum products, coffee, nuts, and also to the local fishing industry. The economy of the island has improved as a result of the additional deep-water harbor. The cost benefit ratio was computed at 2.6 to 1.



8. KAWAIHAE HARBOR, ISLAND OF HAWAII, COMPLETED JUNE 1959.

KEEHI LAGOON, OAHU

Keehi Lagoon is located about midway between Pearl Harbor and Honolulu Harbor on the south coast of the Island of Oahu, the most populous and the third largest island of the Hawaiian Group. It is an extremely shallow bay, roughly three square miles in area, protected from the ocean by an almost continuous coral reef along its front.

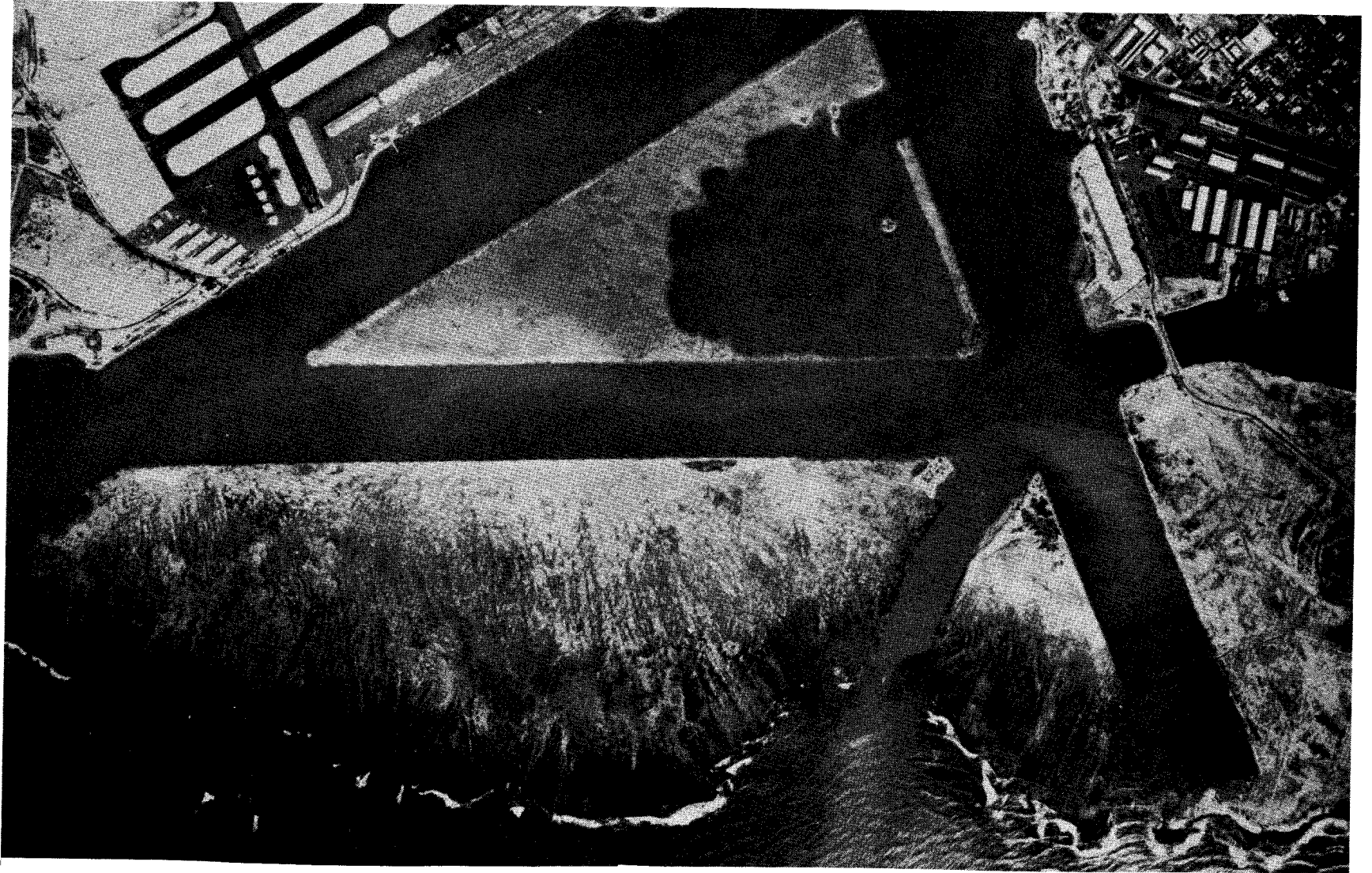
Construction of the lagoon project to provide commercial trans-Pacific seaplane operation, necessary supplies, and terminal facilities was initially authorized by the National Defense River and Harbor Act and approved 17 October 1940.

The authorized improvements provide for three intersecting seaplane runways, each 1,000 feet wide, 10 feet deep, and with individual lengths of 2.9, 3.0, and 2.25 miles, respectively; two stone breakwaters, one 2,500 feet long, the other 2,000 feet long at the seaward end of the runways; and a mooring basin 400 feet wide, 10 feet deep, and 800 feet long adjacent to the Honolulu International Airport. As a wartime measure, this basin was enlarged to 500 feet wide and 3,000 feet long.

Construction of the breakwaters was deferred, and it now appears that they will not be required because operation of the project to date has not been seriously hampered without them. (The project is considered complete without the breakwaters.)

The protected seaplane harbor, adjacent to and communicating with Honolulu Harbor and the Naval Base at Pearl Harbor, is an asset in time of war, inasmuch as Pearl Harbor would be inadequate for both the expanded naval and seaplane operations. It is also a necessary means to the safe and convenient operation of aerial navigation between the Hawaiian Islands, the Mainland, and the Orient.

The runways were completed in 1944. Total Federal cost to date is \$3,624,674 and \$41,857 for maintenance.



9. KEEHI LAGOON IS LOCATED ON SOUTH COAST OF THE ISLAND OF OAHU.

NAWILIWILI HARBOR, KAUAI

Nawiliwili Harbor, one of the two deep-water harbors on the Island of Kauai of 555 square miles, is located in Nawiliwili Bay which is defined as being within headlands, on the southeast coast of the Island of Kauai. The harbor is located about 21 nautical miles east northeast of the Federal harbor of Port Allen, Kauai, and about 93 nautical miles northwest of Honolulu Harbor on the Island of Oahu. The bay is somewhat sheltered by a high bank on the north and a low mountain ridge on the south. An inlet is formed in a sandy shore at the mouth of the Huleia River, a small stream to the west with headwaters at about elevation 3,000 feet.

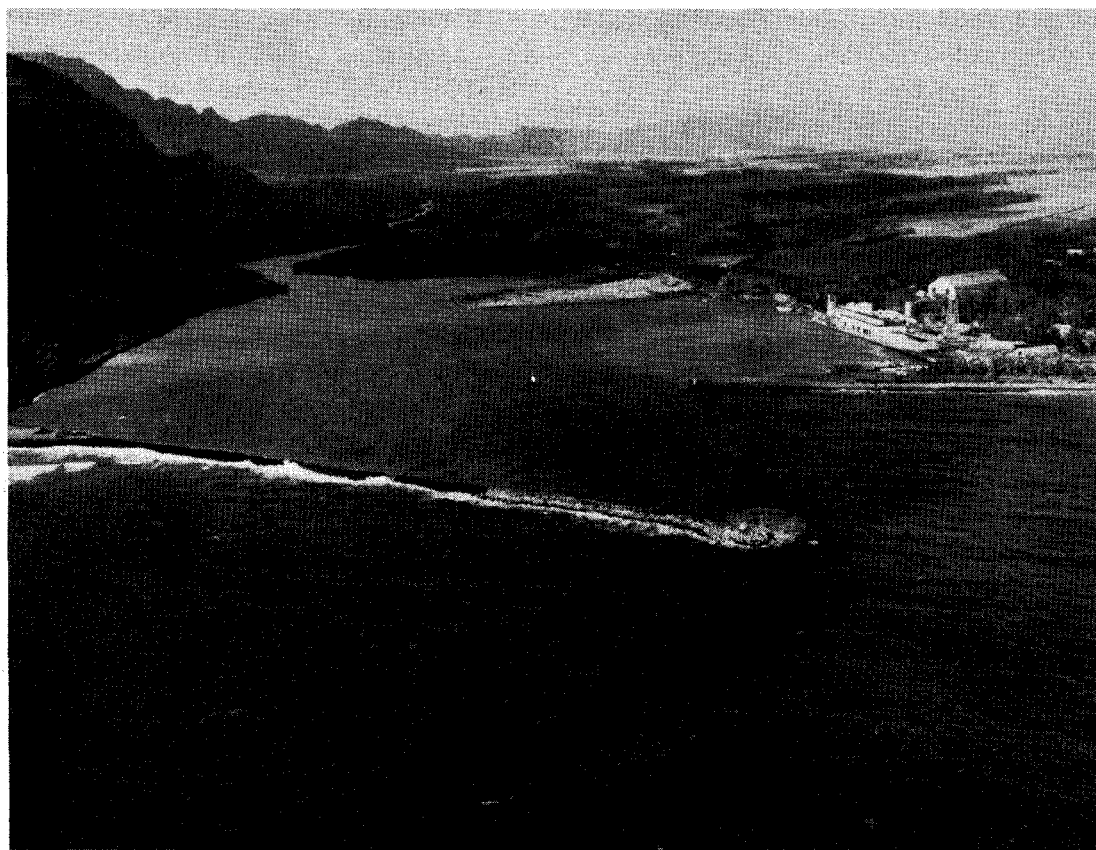
Prior to completion of the breakwater in 1926, waves entered from the open sea making the bay a difficult landing place during the greater part of the year. The site is directly exposed to the prevailing northeast tradewinds which frequently attain high velocities and cause heavy seas and swells in this locality. Mountains protect the harbor from the full force of the south and southwest "Kona" storms, or cyclonic disturbances from the south, and this fact plus the infrequency of occurrence makes such weather of lesser importance than the prevailing tradewind weather. The "Kona" storms usually do not have sufficient distance or duration to cause high waves although the winds alone, which are often high and gusty, may be hazardous to navigation. Long-period swells have their origin in tropical hurricanes in the remote South Pacific, are diffracted around the island, and enter the harbor from the southeast. Although these swells are of comparatively low height in open water, due to their long wave length, they pile up into large rollers as they enter shoal water. Such swells up to 20 feet in height have been recorded in Hawaiian waters. They may occur when the local weather is clear and calm and may continue for a day or more at a time. At Nawiliwili, such swells made navigation of the present improved channel very difficult and hazardous.

This initial Corps of Engineers project, authorized 2 March 1919, was completed in July 1930. The project was modified by the River and Harbor Act of 1954. The existing project provides for a rubblemound breakwater 2,150 feet long; an entrance channel 40 feet deep with a minimum width of 600 feet and a length of 2,400 feet; a harbor basin 35 feet deep with a maximum width of 1,540 feet and a maximum length of 1,950 feet; and a revetted fill on the west side of the harbor.

Imports to Nawiliwili in 1959 amounted to 104,783 tons which consisted of lumber, fertilizer, rice, wheat flour, animal feed, sugar, fresh vegetables, liquor, petroleum products, cement,

machinery, motor vehicles, commodities, and other miscellaneous cargo. Exports in 1959 totalled 310,896 tons which consisted of animals, fresh vegetables and fruits, sugar, molasses, machinery, motor vehicles, commodities, and miscellaneous cargo.

Total Corps of Engineers cost to 30 June 1960 is \$3,752,122, of which \$1,624,416 has been for maintenance. Local contributions totalled \$233,261.



10. NAWILIWILI BREAKWATER, ISLAND OF KAUAI.

PORT ALLEN HARBOR, KAUAI

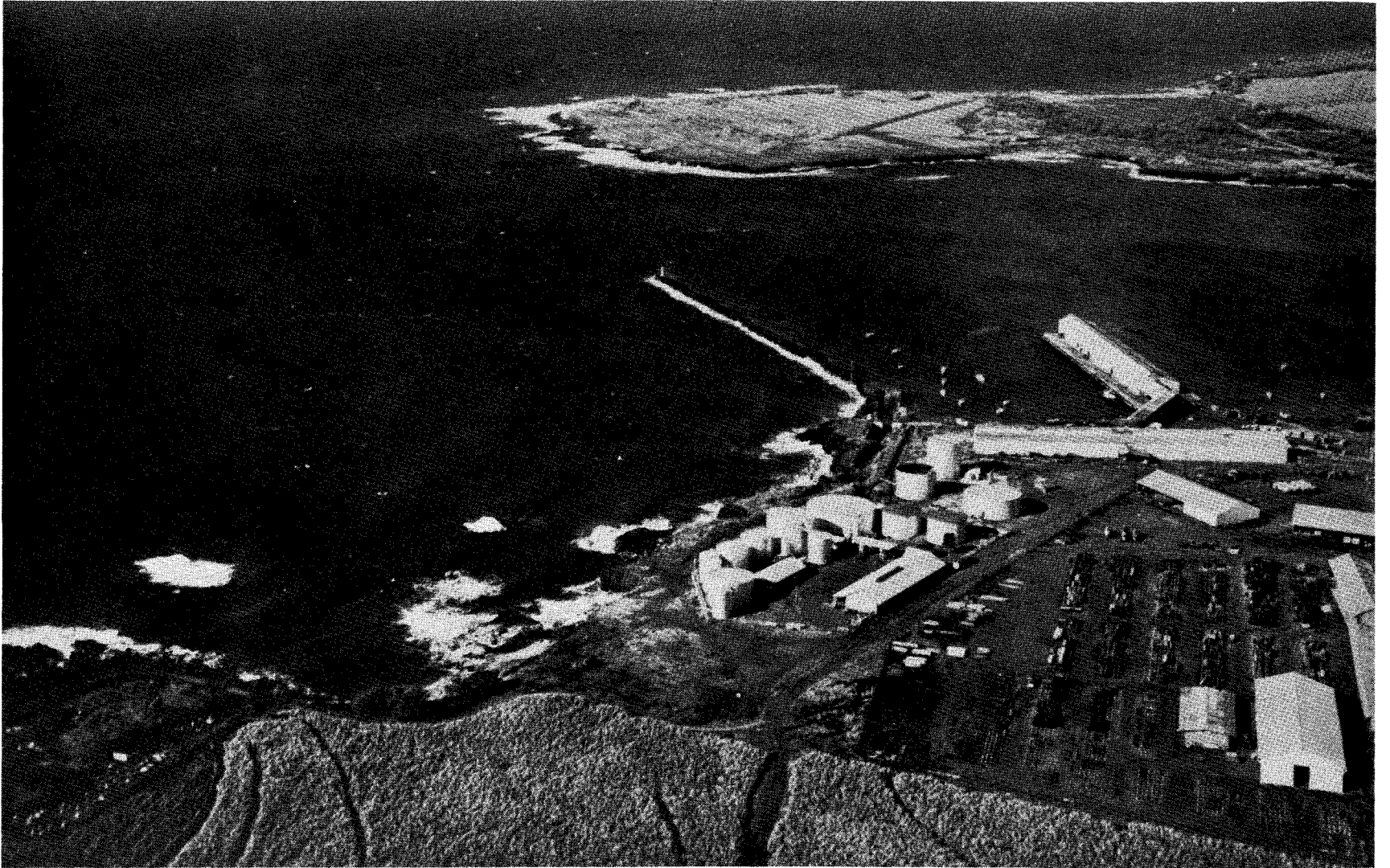
Port Allen Harbor is located in Hanapepe Bay, a small embayment on the south coast of Kauai. It is about 21 nautical miles west southwest of Nawiliwili and 103 nautical miles from Honolulu. As the shipping center serving the towns and plantations on the "west" side of Kauai, Port Allen is the secondary deep water port of the island.

During the early years of this century, Port Allen was partially developed by private interests and used as Kauai's only direct trans-Pacific shipping point. At that time, Nawiliwili Harbor, now the island's major port, was undeveloped and mainly utilized by interisland vessels. Port Allen is naturally sheltered from the tradewinds and the calmer sea conditions generally prevailing there made lightering operations easier and safer than at Nawiliwili. In those days, the inner harbor was too shallow to permit the entry of large ships to the shore and they were loaded or unloaded offport. However, Hanapepe Bay, being directly exposed to storm waves and heavy swells from the south, was too hazardous for shipping during occasional periods, usually in the winter season. This situation prompted local interests to seek Federal aid in improving the safety of the harbor and in providing an adequate deepwater channel and harbor basin to accommodate trans-Pacific shipping and facilitate in-shore cargo handling.

Improvements to date provide a 1,200-foot breakwater extending from the east side of Hanapepe Bay and a dredged harbor basin, 1,200 feet wide by 1,500 feet long with a depth of 35 feet. An entrance channel, 500 feet wide and 35 feet deep, connects the harbor with deep water. The project was completed in 1948. Project depths have been maintained by the Corps. Total Federal cost to date is \$871,483, of which \$118,838 has been for maintenance. Local interests contributed \$200,000 toward construction costs of the initial project.

Substantial benefits accrued to commerce and navigation as a result of the Federal improvement of Port Allen Harbor. The risk to life and property from storm and swell has been minimized and the extra cargo handling expense and time loss to shipping which occurred during the lightering period eliminated.

Port traffic declined after 1954, when the shipment of bagged sugar ceased in favor of the bulk method of handling via Nawiliwili Harbor. In 1959, 194 vessels called at Port Allen and cargoes totaled 146,021 tons. Imports were 77,328 tons, the chief categories being petroleum products, fertilizer, and general commodities. Exports amounted to 68,661 tons, consisting largely of bulk molasses.



11. PORT ALLEN HARBOR, ISLAND OF KAUAI.

WELLES HARBOR, MIDWAY ISLAND

The existing Corps of Engineers project was authorized by the River and Harbor Act of 26 August 1937. It provided for a flared entrance channel decreasing in width from 500 feet at the seaward end to 200 feet over a distance of 1,000 feet, then continuing at 200 feet wide for 5,500 feet with depths of 22 feet in the outer 1,500 feet of the channel and 20 feet in the remainder of the channel; a harbor basin approximately 1,200 feet square and 20 feet deep, and a seaplane basin about 1,200 feet square and 8 feet deep, with a flared entrance channel of the same depth and protected by suitable breakwater at the northeast end of Sand Island.

Cost of construction by the Corps of Engineers amounted to \$2,488,056 plus \$2,111 for maintenance. In addition to these costs, the U.S. Navy Department expended \$1,370,147 for additional blasting and dredging. The project was completed in 1941. Maintenance of the project is under the jurisdiction of the Navy Department.

Benefits derived from the south entrance channel are: reduction in cost of landing cargo; eliminate hazard to personnel engaged in unloading cargo in the open sea; enable the Pan American Airways company crash boat to quickly reach any water area as may be necessary; permit use by commercial shipping and by the Navy Department for vessels of limited classes; and provide a harbor of refuge for miscellaneous small surface craft.

Benefits derived from the seaplane harbor are: provide a protected mooring for naval and trans-Pacific commercial seaplanes; permit trans-Pacific air passengers to debark and embark safely; eliminate delays in commercial airway schedules caused by inability to service planes in rough weather; and eliminate hazard to personnel engaged in servicing planes in rough weather.

No additional work is currently planned at Midway Island by the Corps of Engineers.

COMPLETED SNAGGING AND CLEARING PROJECTS

IAO STREAM, WAILUKU, MAUI

The flash nature of flooding on the Iao Stream has in the past inflicted severe damage and caused the loss of many lives in the Wailuku area. The stream poses a threat to the people and property of the inhabitants within the flood plain.

Iao Stream, in the vicinity of Wailuku, was improved by the State Government in 1954. However, sufficient funds were not available to complete the work to provide complete protection.

The purpose of the Corps of Engineers project was to supplement flood control works completed by the County of Maui to prevent flood damages to residential and business establishments and agricultural developments within the flood plain.

The project consisted of a snagging and clearing width of 80 feet, with a channel bottom width of 60 feet, and a depth of approximately seven feet throughout, beginning at the new mouth of the stream and continuing upstream 5,800 feet.

The Federal project was initiated as an emergency measure to clear and improve the channel below the State project and was completed in 1954.



12. FLASH FLOODING OCCURS ON IAO STREAM, MAUI.

WAILOA RIVER, HILO, HAWAII

Wailoa River proper is located entirely within the bounds of the city of Hilo and extends from the north end of Waiakea Pond to Hilo Bay, a distance of about 0.6 miles.

Tsunami of 9 March 1957

As a result of the tsunami (tidal wave or seismic sea waves) of 9 March 1957, considerable wreckage and debris were deposited in the navigable channel of Wailoa Stream below Waiakea Road. Debris was from the wreckage of finger piers, submarine railways, buildings, and structures which were adjacent to the stream and consisted of concrete posts, pipe railings, tin, lumber, wires, etc.

The Corps of Engineers snagging and clearing project restored the original navigational usefulness of the river.

Tsunami of 23 May 1960

The tsunami of 23 May 1960 swept over the low-lying areas of Hilo during the early morning of the 23rd, causing damages estimated as high as \$25,000,000. A large amount of debris was deposited in the Wailoa Stream channel and pond areas. Debris included parts of automobiles, wires, pipes, concrete blocks, iron roofings, miscellaneous structural iron, rocks, and remains of several buildings. Along the stream, buildings were demolished or severely damaged. Rock walls at the lock structure and new Waiolama Canal were badly damaged. Fish market facilities, several boats that did not leave the harbor area, and the Kamehameha Avenue bridge were damaged or destroyed.

The Corps of Engineers removed debris from the mouth of the Wailoa Stream to the site of the lock structure. The channel was cleared of debris and dredged to -9.0 feet in the sampan basin and small-boat dock area. Further upstream, the channel was cleared to -5.0 feet.

The snagging and clearing work was started on 21 July 1960 and completed on 8 October 1960 at a total cost of \$78,206.



13. WAILOA RIVER ON HAWAII WAS VIRTUALLY FILLED WITH DEBRIS DURING THE 1960 TSUNAMI.

FLOOD CONTROL PROJECT UNDER WAY

HANAPEPE RIVER, KAUAI

Hanapepe River and its tributaries drain an area about 30 square miles located in the south central portion of the Island of Kauai. The drainage basin is about eleven miles long and from two to four miles wide. It extends from the Pacific Ocean on the south to about the summit of the mountains on the north. The northern end of the basin is contiguous to the basin of Waimea and Wailua Rivers. The main stream rises at about elevation 4,500 at the northernmost tip of the basin and flows generally south by southwest through a deeply eroded canyon to the confluence with Manuahi Stream, and thence, through widening valley flood plain approximately five miles to Hanapepe Bay.

Historical evidence indicates that a major flood occurred in Hanapepe Valley in 1879 of such severity that it not only spread out over the entire valley floor, but also destroyed dikes six feet in width and overgrown with trees which bordered taro and rice patches throughout the valley. In 1898, a flood inundated the town of Hanapepe to a depth of from four to five feet. This depth of water, however, is reported to have been caused partly by the blocking of the channel by drift lodging against a wooden bridge, and is, therefore, not indicative of the actual flood discharge in the river.

The most damaging flood in recent years was that of 1921, during which Hanapepe River overflowed its banks inundating portions of the town of Hanapepe to depths of from two to three feet. Other damaging floods in the past 35 years include the flood of 1927 with an estimated loss of \$15,000; 1932, \$14,000; 1924, \$10,000; 1937, \$10,000; 1935, \$8,000; and numerous lesser floods.

A completed flood control project would provide protection for the population of about 1,500 as well as for the commercial and business centers of the large surrounding agricultural areas. Previous floods in the town had a direct disrupting effect on the economy of the entire island. Serious injury and loss of life, as well as extensive damage to property, is a threat because of the flash nature of the floods.

A Corps of Engineers project provided for the construction of a 2,050-foot earth levee and a 150-foot reinforced concrete floodwall on the left bank extending upstream along the east bank of the river from the new Kauai Belt Highway bridge to the cliffs at the northeast corner of the town of Hanapepe. This portion of the project (left bank) was completed in December 1959.

Benefits secured from the completed project consist primarily of flood damages prevented and the alleviation of unsanitary conditions created during floods by overflow of septic tanks and the deposit of flood debris.

Remaining work consists of an earth levee along the right (west) bank of the Hanapepe River, from the old highway bridge upstream to Kapahili Stream, and thence along the right (south) bank of Kapahili Stream to high ground. A freeboard of two feet above the design flood water surface profile is to be provided. Four outlet structures for interior drainage are to be provided.

The total estimated Federal cost for the left and right banks is \$673,000.



14. WORK ON THE LEFT BANK OF HANAPEPE RIVER, KAUAI, WAS COMPLETED IN 1959.



15. HONOLULU HARBOR -- "CROSSROADS OF THE PACIFIC."

NAVIGATION PROJECTS UNDER WAY

HONOLULU HARBOR, OAHU

Honolulu Harbor, the largest in the Hawaiian Group and of national importance, has been termed the "Crossroads of the Pacific." It is located on the Island of Oahu, which has an area of 604 square miles. It is 2,100 miles southwesterly from San Francisco and is the only trans-Pacific commercial harbor on the island and the principal port in the Hawaiian chain. The harbor is protected by the Koolau mountains from prevailing northeasterly trade-winds and from the southerly winds by Sand Island. The present harbor entrance faces the southwest.

No other community in the United States is so dependent upon shipping, which is consummated through this harbor. Navigation interests are attempting to keep pace with the rising needs by putting more ships on the Hawaiian routes and by improving harbor facilities in the Islands.

The U. S. Army Corps of Engineers has played an important role in the development of deep-water harbors for the Hawaiian Islands, particularly, the Honolulu Harbor. The Islands have long been recognized because of the strategic importance as a vital interest to the military.

Imports to Honolulu Harbor during 1959 totalled 3,158,137 tons; exports for the same year totalled 1,137,724 tons.

The completed portion of the Corps of Engineers project consists of an entrance channel 40 feet deep, 500 feet wide, and 4,000 feet long; an outer harbor basin 35 feet deep, 1,520 feet wide, and 3,300 feet long; a channel connecting the outer harbor basin with Kapalama Basin 35 feet deep, 1,000 feet wide through the first 1,000 feet, thence 600 feet wide for the remaining 2,400 feet; an inner harbor basin (Kapalama Basin) 35 feet deep, 1,000 feet wide, and 3,400 feet long; and a slip on the easterly side of Pier 39, 35 feet deep and 1,000 feet long. This project was completed in 1945. Federal cost of the project to date is \$4,646,672, of which \$694,309 has been for maintenance.

The present Corps of Engineers project under way provides for a second entrance channel which is being constructed to permit ocean-going vessels to leave the harbor without having to make a hazardous turn and go out the way they came in. Thus, if a ship

were sunk by accident or other reason in the present harbor, entrance traffic would not be stopped.

Modification of Honolulu Harbor to provide for the construction of a second entrance channel and the installation of a double-leaf Bascule Bridge (the first of its type in the Hawaiian Islands) across the channel to Sand Island was adopted by the River and Harbor Act of 3 September 1954. This new channel extends seaward from the west end of Kapalama Basin. It will be 35 feet deep, 10,300 feet long; and the width will vary from 451 feet at Kapalama Basin to a maximum of 960 feet in the emergency turning basin in Keehi Lagoon and 400 feet for the remaining length of the channel seaward of the turning basin. The double-leaf Bascule Bridge will have a clear horizontal opening of 250 feet. This bridge, upon completion, is to be operated by the State of Hawaii. It has a width of 28 feet from curb to curb and will offer a two-way vehicular traffic with a pedestrian sidewalk.

Benefits by the construction of the second entrance channel will include a reduction of off-port and in-port waiting time caused by congestion of the existing entrance channel; reduction of ship-operating costs; elimination of harbor blocking caused by grounding of vessels in the existing entrance channel; reduction of costs to the Transportation Corps of the U. S. Army and to intercoastal shipping; reduction of harbor pollution; advantages during national emergencies; abatement of losses on shipments having a delivery time limit; and increase in conveniences to tourist trade.

The present estimated cost of the project now under way is \$3,810,000. This project is scheduled for completion during December 1961. Total Federal cost to date is \$1,932,196.



16. SECOND ENTRANCE CHANNEL FOR HONOLULU HARBOR BEING CONSTRUCTED.

KAHULUI HARBOR, MAUI

Kahului Harbor, the principal port of the island, is located on the northern shore of Maui, the second largest island in the Hawaiian Group. The population of Maui in 1960 was 35,717.

Kahului Harbor is the only deep-water port of this island of 728 square miles. The commercial tributary area to this port is virtually the entire Island of Maui. The only other commerce through a Maui port is at Hana, where limited livestock and petroleum products are barged. The principal products of the island are sugar and pineapple, the production of which is considerable and is increasing. Most of the island's commerce is handled through Kahului. Total imports there for 1959 totalled 247,972 tons and exports totalled 428,157 tons for the same year.

Located on its shore is the town of Kahului, which is the terminus of Kahului Railroad and the principal shipping port of the island. In order to ship sugar, the Kahului Railroad Company started the improvement of Kahului Harbor and constructed a stub breakwater and enlarged the bay.

The harbor is protected by an east breakwater 2,850 feet long and a west breakwater 2,390 feet long. A 600-foot wide entrance channel 40 feet deep between the breakwaters leads to a basin dredged length of 2,000 feet and a maximum width of 1,450 feet. This portion of the project was completed in 1931.

The River and Harbor Act of 1960 authorized the extension of the harbor basin by dredging an area along the westerly portion of the basin. The extension will have a maximum length of 2,400 feet and average about 600 feet wide. The depth of dredging will be 35 feet, which is the same as that of the existing project. The sand, silt, and coral material to be dredged consist of about 860,000 cubic yards, including overdepth. Construction by contract will be completed in 1961. Estimated Federal construction cost is \$962,000.

Those improvements which have been completed have increased the wealth of the island and the development of the pineapple industry. The Hawaiian Islands in general will benefit from increased production on Maui and from the addition of Kahului to the list of harbors known to be safe and convenient under all weather conditions.



17. KAHULUI HARBOR, ISLAND OF MAUI.

AUTHORIZED BEACH EROSION CONTROL PROJECTS

HANAPEPE BAY, KAUAI

Hanapepe Bay, lying on the southern coast of the Island of Kauai, includes the Federally-improved harbor of Port Allen. This bay, lying just east of Puolo Point, is roughly rectangular in shape, and is approximately one-half mile by three-quarters mile in size.

Kauai is an island of volcanic origin with rugged terrain. The steep streams bring large quantities of debris to the shore during periods of storm runoff. The problem beaches, located respectively west of Waimea and Hanapepe Rivers, are composed almost entirely of these materials.

At Hanapepe, the breakwater on the east side of the bay shelters the bay head beach from waves from the southeast. Diffracted waves and southerly swells cause eastward movement of beach material and progressive erosion on the western half of the shore at the head of the bay.

The authorized project provides for protecting the shore of Hanapepe Bay by constructing rubblemound seawalls along the affected portions of both the publicly and privately owned shores and is the most practicable of all the methods studied because of its low initial and annual costs. Existing emergency riprap could be readily incorporated into the plan for complete protection. The construction contemplated would not contribute to the recreational aspects of the beaches, except that it would assist in preserving the areas behind the beaches reserved and used for parks. Protection and preservation of roads paralleling the beaches and of the cemetery of Hanapepe Bay would serve a public need of considerable merit. The improvements would protect both public and private properties.

The project would afford prevention of direct damage to the public shore, roads, and structures to private property.

Federal participation by contribution of one-third the first cost of construction is applicable to the portion of the seawall fronting public property only. Total approved Federal cost to date is \$28,000.

Construction has not started as yet.

WAIMEA BEACH, KAUAI

Waimea Beach extends about one mile westward from the Waimea River along the entire ocean front of the town of Waimea. The beach lies along the eastern part of Waimea Bay, which is a shallow bight in the shore line extending from Laauokala Point to Oomano Point.

A steady recession of the shore over a period of years became critical in 1948 and 1949 when heavy swells from the south eroded the beach and necessitated the closing of a public street. In addition to the purpose of determining the most suitable method of preventing erosion and of increasing the usable recreational beach areas at Waimea Beach, local interests have indicated a desire for a more permanent form of protection, with lower maintenance costs, than the present emergency riprap protection. The Board of Harbor Commissioners also requested that consideration be given to constructing a breakwater at Waimea parallel to the shore to form a harbor, thereby providing adequate protection to the shore at Waimea and a safe anchorage for small boats in the area.

The Waimea Beach protection plan would include a beach fill by the initial placement of approximately 65,000 cubic yards of sand and thereafter maintained by placement of a volume of 5,000 to 20,000 cubic yards of sand annually, depending upon the volume of material supplied by river floods; a seawall which would protect the local road behind the critical area, either of riprap or concrete. The Federal Government would participate only in the cost of erecting a seawall.

The Federal Government would participate by contributing Federal funds in the amount of one-third the cost applicable to protection of publicly-owned portions of the shore areas. It is believed that the improvements would prevent further loss of land, permit restoration of beach road, and eliminate damage to the shore end of the pier.

Federal cost at the end of December 1960 was \$3,000 for pre-authorization studies.

AUTHORIZED FLOOD CONTROL PROJECT

KAWAINUI SWAMP, OAHU

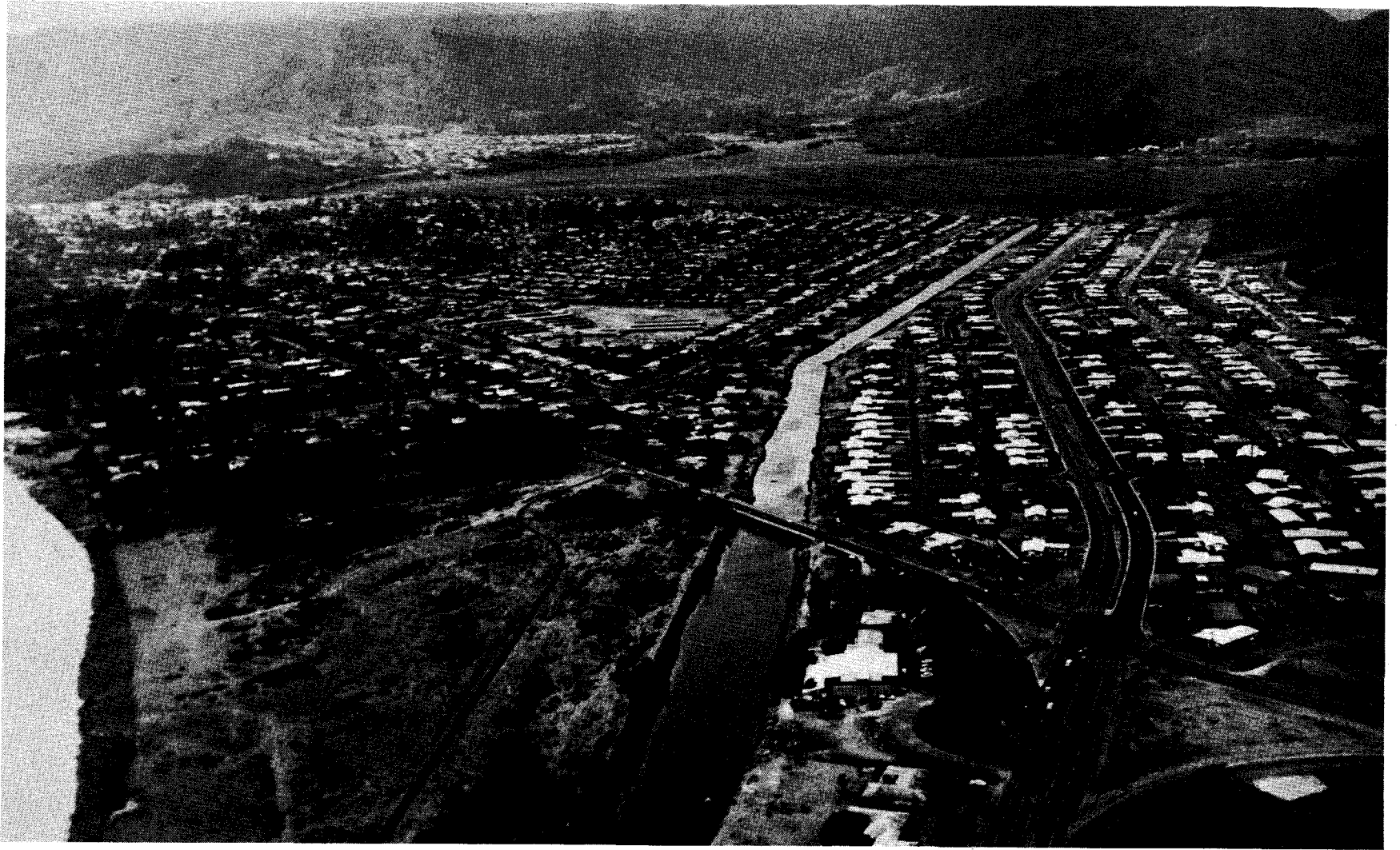
The Kawainui flood control channel is located on the windward side of the Island of Oahu in a rapidly developing residential community. The developed area contains 540 acres up to an elevation of nine feet above the mean sea level. The area takes in a major portion of the downtown area of Kailua, the second largest town on the Island of Oahu.

A major portion of the area is subject to flooding. The worst flood of record occurred in March 1951 which caused damages estimated at \$190,000. Shortly thereafter, the State constructed the Oneawa Channel which partially alleviates flood threats; however, a flood of the 1951 magnitude would do considerable damage.

An authorized flood control project has been approved for the area. However, a restudy is being made in order to determine if the plan proposed by local interests, with a view to developing the area, is compatible to the Corps of Engineers plan and is economically feasible.

The flood control plan, as approved by the Flood Control Act of May 1950, provided for an underlined tidewater flood channel 9,465 feet long, 80 to 110 feet wide at the bottom, and 10 to 14 feet deep with a reinforced concrete control structure 262 feet long at the inlet of the channel. A levee was included along the existing drainage canal west of the town of Kailua.

The average annual flood control benefits, under this authorized plan, is estimated to be \$236,300. Currently, the estimated Federal cost of the project, under the approved plan, is \$1,030,000.



18. KAWAINUI FLOOD CONTROL CHANNEL, ISLAND OF OAHU.

WAILOA STREAM AND TRIBUTARIES, HAWAII

Wailoa Stream, known locally as Wailoa River, is entirely within the bounds of the city of Hilo on the northeastern side of the Island of Hawaii. It extends northeasterly about 0.6 mile from the north end of Waiakea Pond to Hilo Bay. Waiakea Pond is an artificial lake about 2,000 feet long formed by the construction of a barge lock across the river bed. The tributary drainage basin of approximately 160 square miles lies on the northeastern slope of Mauna Loa, a volcanic cone rising 13,659 feet above sea level. The basin consists of three main tributary areas: the Waiakea-Kawili Stream area, the Alemaio Stream area, and the Palai Creek and Four-Mile Creek area.

Floods in the upper Waiakea section, in general, rise very quickly and last from a few hours to several days. One person has lost his life in attempting to reach higher ground.

The existing channel of the Wailoa Stream through Hilo is adequate to handle the flow from only relatively minor rainstorms. Consequently, flood damages are frequent in the areas adjacent to the stream.

The authorized project provides for the construction of a diversion dike 335 feet long, 12 feet high, with a top width of 10 feet, and an unlined channel 230 feet long with a bottom width of 40 feet, to combine the flows of Kawili and Waiakea Streams above the city to Hilo; improvements of the present Waiakea Channel to contain the combined flows within the channel at low points between the point of diversion and the residential area; and construction of a new channel 20 feet wide and 2,600 feet long, for Waiakea Stream from the sink holes just above Kinoole Street to Waiakea Pond with necessary flanking levees along the lower portion of its length.

Average annual flood control benefits are estimated to be \$27,700. The estimated Federal cost of the improvement is \$477,000.



19. WAILOA STREAM LOCATED IN HILO, HAWAII.



20. SMALL-BOAT OWNERS UTILIZE WAILOA STREAM
AS SMALL-BOAT HARBOR.

AUTHORIZED NAVIGATION PROJECT

WAKE ISLAND HARBOR, WAKE ISLAND

Wake Island is an atoll in the Pacific Ocean approximately 2,000 nautical miles west of Honolulu and 2,700 miles east of Manila. It is formed generally in the shape of a V, with Wake Island proper, the largest island in the group, forming the apex of the V.

The two legs of Wake Island proper are about 2-1/2 miles long, and the area of the island is 2.20 square miles. A lagoon in the V area is approximately 2-1/2 miles long and 1 mile wide.

The existing Corps of Engineers project was authorized by the River and Harbor Act of 26 August 1937. The project provides for an entrance channel 200 feet wide, 18 feet deep, from deep water in the Pacific Ocean to a turning basin 1,000 feet square, 18 feet deep just south of Peale Island; the channel dimensions to be suitably increased at the entrance as may be found advisable by the Chief of Engineers.

In addition to monetary savings from increases in shipments of cargo to Wake Island, the improvement would result in other intangible benefits such as eliminating the hazard to personnel that now exists in unloading cargo in the open sea, providing a safe anchorage for the company's crash boat so that it always would be available in case of necessity, and providing a harbor of refuge for small surface craft.

Imports and exports for 1959 totalled 144,996 tons. No work has been done on this project yet.



21. POTENTIAL SMALL-BOAT HARBOR, ISLAND OF MOLOKAI.

SURVEY INVESTIGATIONS UNDER WAY

<u>Name of Survey</u>	<u>Purpose</u>	<u>Approximate Completion Date</u>
<u>NAVIGATION</u>		
Barbers Point and Honolulu Harbor, Oahu	To determine the advisability of constructing a deep-water harbor at Barbers Point, and increasing the project depth of Honolulu Harbor to at least 40 feet in the harbor basin, 45 feet in the present channel, and 40 feet in the second entrance channel.	Indefinite
Coasts of Hawaiian Islands and Keauhou Bay, Hawaii	To determine the advisability of establishing harbors along the coasts of the Hawaiian Islands for light-draft vessels for refuge and other purposes.	Indefinite
Hilo Harbor, Hawaii	To determine the advisability of providing improvement to protect against tidal waves and excessive high tides, and of modifying the existing project for navigation purposes.	
	a. Improvements recommended to protect Hilo against tidal waves and high tides and to reduce surge action in the harbor provide for construction of a west breakwater; raising, strengthening, and extending the existing breakwater; and constructing a dike from the shoreward end of the existing breakwater to high ground. A 600-foot entrance would be provided between the two breakwaters.	December 1960
	b. Proposal for enlargement of the harbor basin is under consideration.	June 1962

Kaunakakai Harbor, Molokai	To determine the advisability of modifying the existing harbor to accommodate deep-water vessels. A tentative plan under consideration would provide a new deep-water harbor and a harbor basin for light-draft vessels, and utilize the present harbor basin as a barge basin.	June 1961
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FLOOD CONTROL

Iao Stream, Maui	To determine the advisability of constructing flood control works on Iao Stream. Tentative improvements under consideration comprise an upstream debris basin and downstream channel improvements augmented by concrete flood walls and earth levees.	1962
Palolo and Manoa Valleys, Oahu	To determine the advisability of constructing flood control works on Palolo and Manoa Streams.	Indefinite
Waimea River, Kauai	To determine the advisability of providing flood control works on the Waimea River. Proposed project is being considered under provisions of Section 205 of the 1948 Flood Control Act, Public Law 858, 80th Congress, as amended by Public Law 685, 84th Congress.	Fall of 1961
Wailua River, Kauai	To determine the advisability of providing flood control works on the Waialua River. Proposed project is being considered under provisions of Section 205 of the 1948 Flood Control Act, Public Law 858, 80th Congress, as amended by Public Law 685, 84th Congress.	June 1961



22. ALA WAI YACHT BASIN, HONOLULU. This harbor, built by the State, shows full utilization of existing facilities.



23. BEACH EROSION IS A PROBLEM AT HALEIWA BEACH, OAHU.

BEACH EROSION CONTROL

Haleiwa Beach, Oahu	To determine the advisability of providing improvements to preserve and maintain the beach and to counteract the eroding effects of waves.	March 1962
Waikiki Beach, Oahu	To evaluate the effectiveness of the existing beach erosion control works and to determine the advisability and feasibility of modifications thereto.	January 1962

SURVEY INVESTIGATIONS AUTHORIZED

<u>Name of Survey</u>	<u>Purpose</u>
<u>NAVIGATION</u>	
Honolulu Harbor, Oahu, and Coastal Waters of the State of Hawaii	To determine the advisability of providing anchorage areas for the handling of explosives. Areas of investigation are to be designated by the State Governor's Advisory Committee on Explosives.
Kahaluu, Oahu	To determine the advisability of constructing a deep-water harbor at Kahaluu.
Kalaupapa Landing, Molokai	To determine the advisability of providing improvements for navigation purposes.
Kawaihae Harbor, Hawaii	To determine the advisability of modifying the existing Kawaihae Harbor project to provide a second breakwater and a wider entrance channel and to ease the turn at the entrance to the harbor basin.
Kewalo Basin and Ala Wai Yacht Harbor, Oahu	To determine the advisability of providing improvements for navigation purposes.

Lahaina Harbor,
Kalepolepo, and
Maalaea Bay, Maui

To determine the advisability of constructing a second deep-water harbor for the Island of Maui.

Port Allen Harbor,
Kauai

To determine the advisability of modifying the existing harbor to provide a second breakwater and such pertinent improvements for navigation purposes.

FLOOD CONTROL

Hilo Harbor and Island
of Hawaii

To determine the advisability of constructing dikes, barriers, or walls to protect lives and property from lava flows resulting from volcanic eruptions.

Kahoma Stream, Maui

To determine the advisability of providing flood control works on Kahoma Stream.

Kihei District, Maui

To determine the advisability of providing flood control works in the Kihei District.

SPECIAL CONTINUING AUTHORITIES

FLOOD PLAIN INFORMATION

Section 206, Flood Control Act of 14 July 1960, authorizes the Chief of Engineers to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance.

SMALL NAVIGATION PROJECTS

Section 107, River and Harbor Act of 14 July 1960, authorized the Secretary of the Army to allot, not to exceed \$2,000,000 for any one fiscal year, for construction of small river and harbor improvement projects not specifically authorized by Congress; not more than \$200,000 shall be allotted for the construction of a project at any single locality and the amount allotted shall be sufficient to complete the Federal participation in the project.

Local interests requested consideration of the following sites:

Haleiwa, Oahu

Nawiliwili, Kauai

Kikiaola, Kauai

Kukuiula, Kauai

Maalaea, Maui

Mala, Maui

Manele Bay, Lanai

Nawiliwili Harbor is the only preliminary investigation authorized to date.

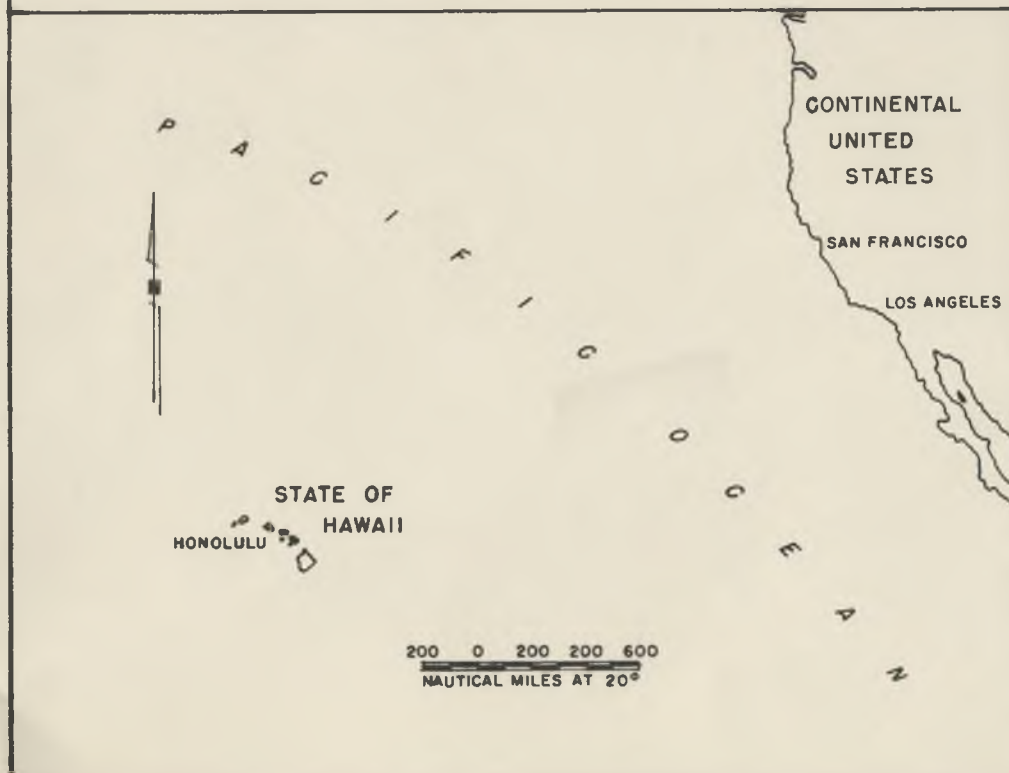
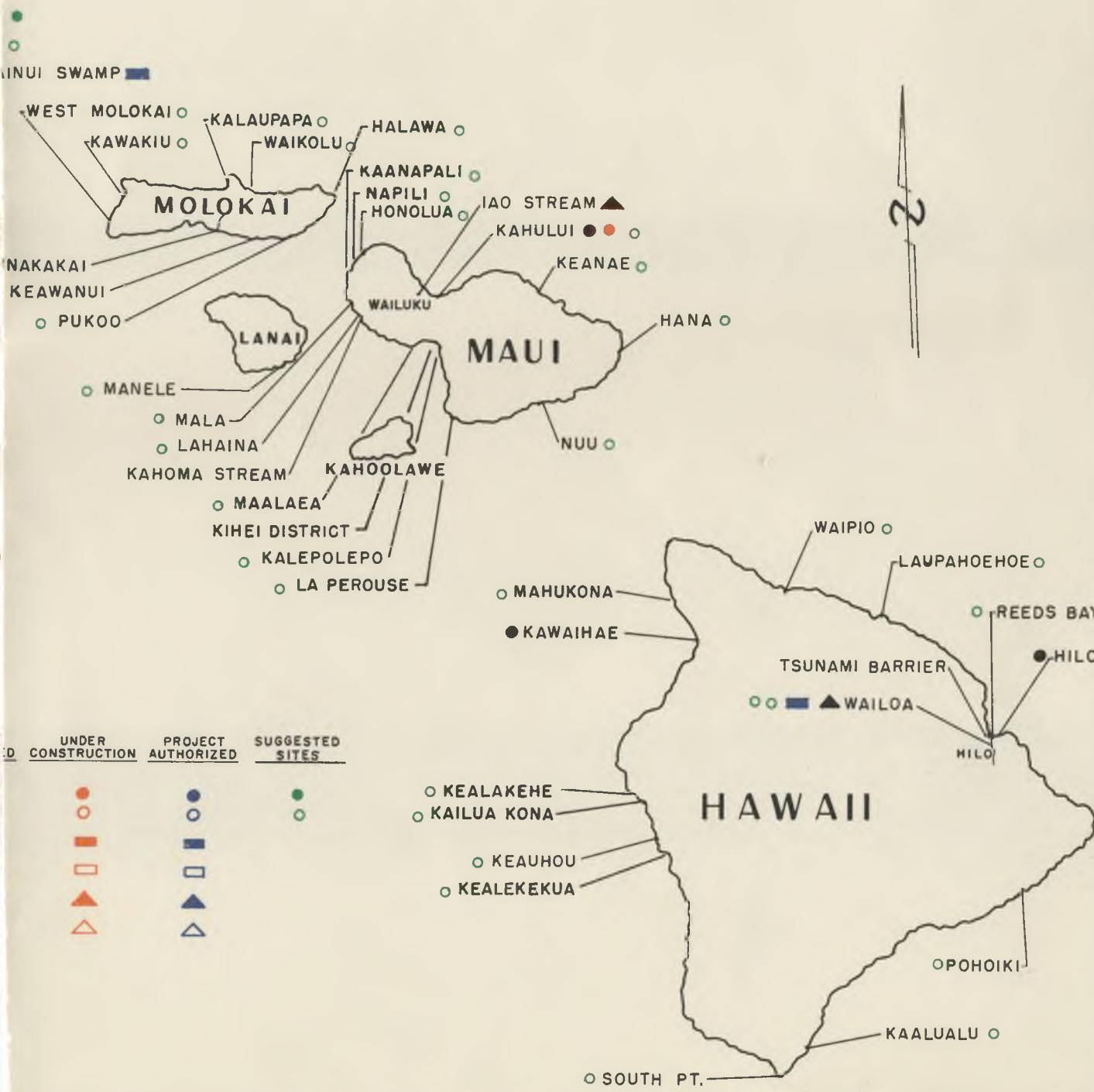
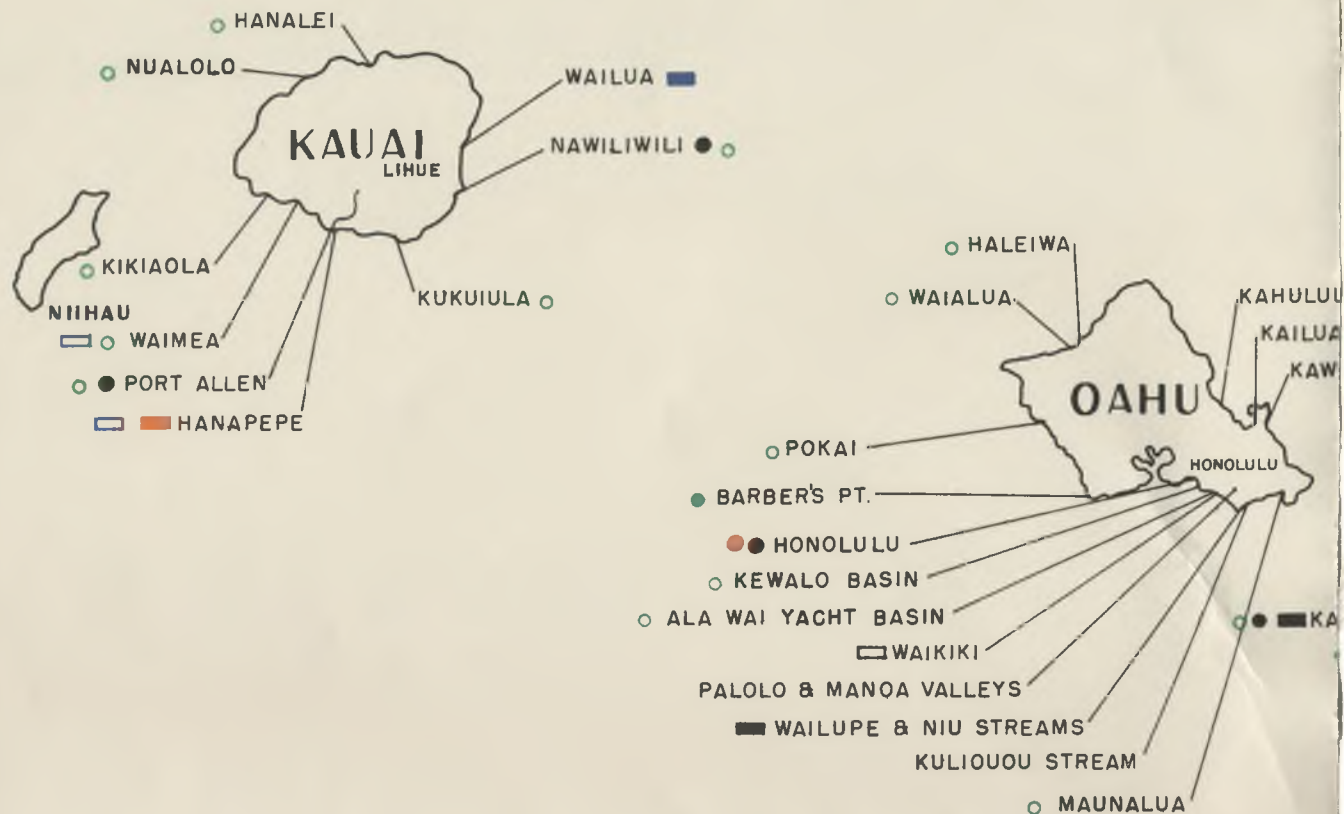
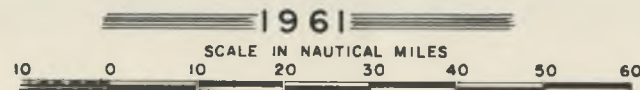
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CORPS OF ENGINEERS CIVIL WORKS PROJECTS IN HAWAII



PROJECT	COMPLETED	UNDER CONSTRUCTION	PROJECT AUTHORIZED	SUGGESTED SITES
NAVIGATION	●	○	○	○
DEEP WATER	●	○	○	○
LIGHT DRAFT	○	○	○	○
FLOOD CONTROL	■	■	■	■
BEACH EROSION	□	□	□	□
STREAM CLEARING	▲	▲	▲	▲
TSUNAMI BARRIER	△	△	△	△