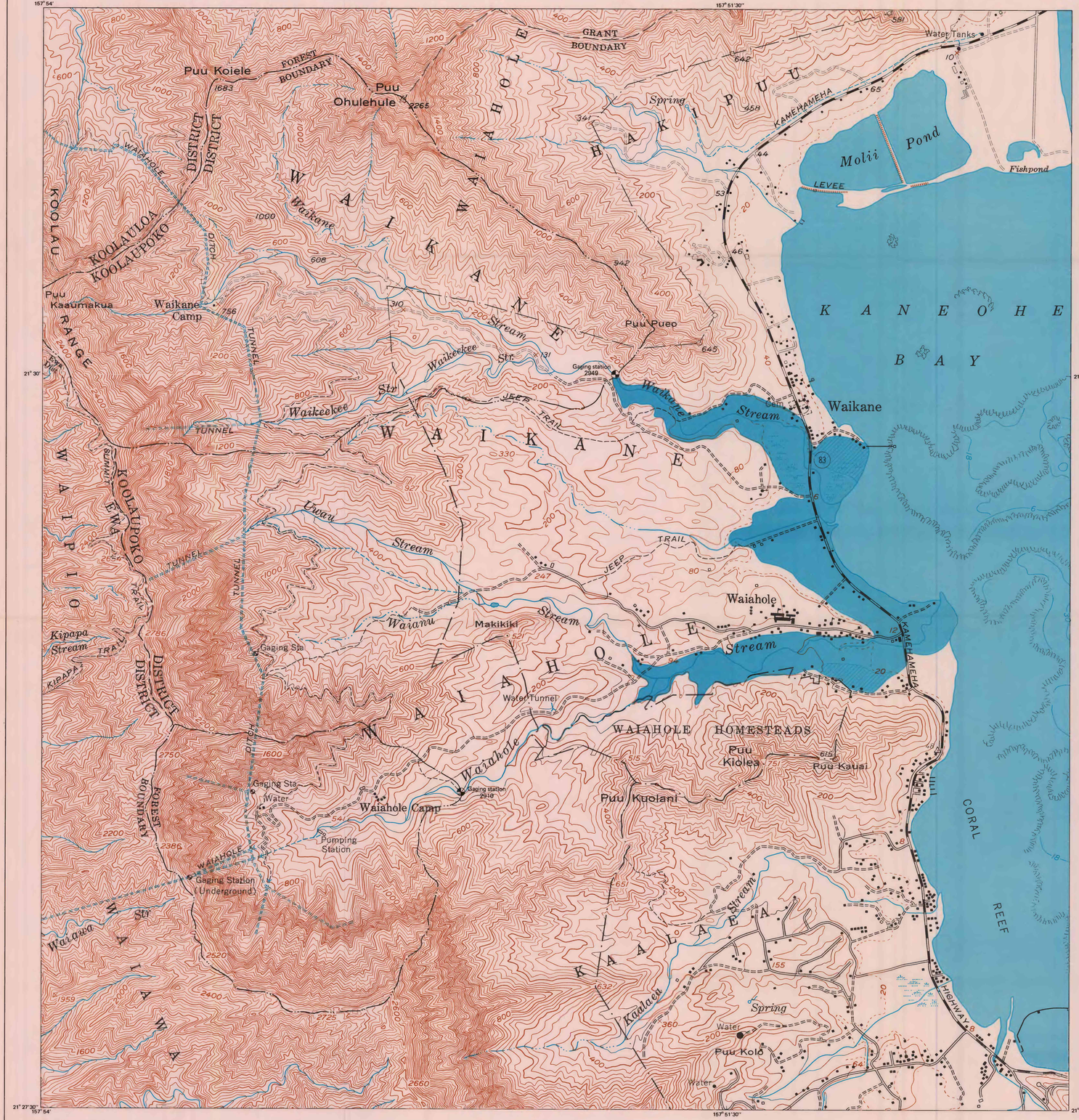
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

HYDROLOGIC INVESTIGATIONS
ATLAS HA-531



FLOODS IN WAIAHOLE-WAIKANE AREA, OAHU, HAWAII

This report presents hydrologic data concerning the extent and frequency of flooding in the Waiahole-Waikane area of windward Oahu (fig. 1). The data provide a technical basis for the formulation of flood-plain regulations, building and zoning ordinances, the design and location of flood-control projects, and modification or improvement of the existing drainage system.

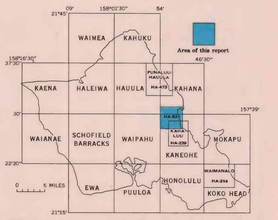


FIGURE 1.—*Index map of Oahu, Hawaii, showing areas included in flood-plain mapping program and U.S. Geological Survey 7½-minute quadrangles.*

The approximate area subject to inundation by a flood having an estimated recurrence interval of 50 years is outlined on the topographic map. The area inundated by the floods of May 2 and November 12-14, 1965, is shown in figure 7. The actual flood boundaries along the lower reaches of Waiahole and Waikane Streams and the central-ponded area were surveyed during the period December 15, 1965, through January 6, 1966. The inundation limits and flood profiles for the estimated 50-year flood were developed from field data collected during April 1972. Areas of localized ponding are caused by storage of local rainfall and runoff from adjacent slopes.

The three main streams in the study area are Waiahole, Waikane, and a smaller unnamed stream, which is located between these two. Waiahole and Waikane Streams head near the crest of the Koolau Range and are perennial; the unnamed stream heads at about the 700-foot elevation and is intermittent. The stream gradients are steep in the upper reaches and fairly flat on the coastal flood plain.

The major part of the inundated area is the lowland between Waiahole and Waikane Streams (flood map). The lowland is drained by a ditch which parallels Kamehameha Highway, and the runoff is conveyed through several culverts to Kaneohe Bay. If the culverts are clogged by debris or are inadequate to handle floodflows, the water backs up and overflows Kamehameha Highway. In addition to direct rainfall, the lowland area receives a part of the overbank flows of the three main streams.

The areal extent of inundation caused by the May 2, 1965, floodwaters was approximately 0.76 square mile or about 10 percent of the combined watershed area of the three streams. The drainage areas and the available peak discharges for the storms of May 2, 1965, and November 12-14, 1965, are listed in the following table.

Gaging station		Drainage area		Peak discharge (cfs)	
				At station	
No.	Name	At station	At Kamehameha Highway	May 1965	Nov. 1965
2910	Waiahole Stream at altitude 250 feet, near Waiahole[1]	0.99	3.82	2,230	916
2949	Waikane Stream at altitude 75 feet, at Waikane[2]	2.22	2.51	3,300	3,230
—	Unnamed stream between Waiahole and Waikane	—	1.10	(3)	(3)

[1] Recording station established July 1955.
[2] Recording station established December 1959.
[3] Not determined.

The areas inundated during the May 2 and the November 12-14 floods reflect channel and cultural conditions existing at the times flooding occurred. Inundation boundaries and water-surface profiles for the 50-year flood were estimated by backwater analyses and represent current channel conditions. The inundation pattern of future floods can be modified, and the frequency and severity of flooding can be reduced by stream-channel improvements, addition of drainage elements, improved bridge and culvert structures, or the construction of protective works.

Flooding in coastal areas that may occur because of tsunamis is described by Cox and Mink (1963) and Macdonald, Shepard, and Cox, (1947). Potential tsunami-inundation areas in Hawaii, including the area discussed in this report, are delineated by Cox (1960).

Cooperation and acknowledgment.—This report was prepared by the Hawaii District, U.S. Geological Survey, as part of a continuing cooperative water-resources investigation program with the Hawaii State Department of Land and Natural Resources, Division of Water and Land Development. Streamflow records at the gaging stations have been collected in cooperation with the State of Hawaii and the City and County of Honolulu.

Personal interviews with local residents provided helpful information concerning the flood boundaries shown in this report, as well as information on past flooding.

Flood occurrence.—The irregular occurrence of floods is illustrated by the histogram of annual-peak discharges at the gaging station on Haiku Stream near Heeia (2750) during 1914-19, 1940-72 (fig. 2). Station 2750 is located about 5 miles southeast of the Waiahole-Waikane area, and its flood record is considered to be representative of the area.

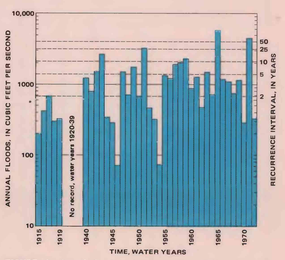


FIGURE 2.—*Annual floods and recurrence intervals, water years 1915-19, 1940-72, for Haiku Stream near Heeia (2750).*

Flood discharge.—The discharge of a stream is the volume of water which passes a particular site within a specified period of time. Discharge is usually expressed in cubic feet per second (cfs). A conversion to million gallons per day (mgd) may be made by multiplying the discharge in cubic feet per second by 0.646.

Peak discharge is the maximum discharge attained by a flood. The maximum discharge and the maximum height (stage) of a flood generally coincide. However, if the streamflow is affected by variable backwater conditions, such as when a culvert or bridge opening is clogged by debris, the maximum stage may occur at a time other than that of maximum discharge.

The extent of the overflow in the lowland parts of the flood plain may not be directly related to the peak rate of discharge determined in the upper reaches of the streams. The volume and duration of surface runoff, the amount of rainfall on the lowland areas, the time at which the runoff occurs with respect to the tidal cycle, and the condition of the stream channel, bridge openings, and culverts will influence the extent of inundation. For example, the flood of May 2, 1965, collapsed the center section of the Waiahole Stream bridge at Kamehameha Highway. This collapsed section served as a dam to back up the water and increased the extent of inundation in the lowland area. Also the peak discharge, recorded at the gaging station on Waiahole Stream (2910) for the storm of November 12-14, 1965, was about 40 percent that of the May 2, 1965, flood, but the extent of the inundation was nearly the same for both storms, primarily because of a longer storm period and a greater volume of rainfall. Debris-clogged drainage facilities probably also helped increase the extent of the inundation.

Flood profiles.—The water-surface elevations along Waiahole and Waikane Streams for the 50-year flood were estimated by backwater computations (figs. 3 and 4). The profiles for the May 2, 1965, flood

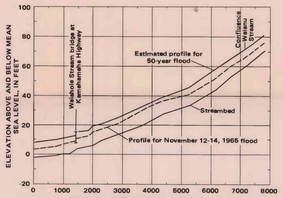


FIGURE 3.—*Flood profiles for Waiahole Stream.*

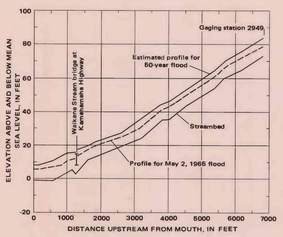


FIGURE 4.—*Flood profiles for Waikane Stream.*

(Waikane Stream) and the November 12-14, 1965, flood (Waiahole Stream) were determined by interpolation between actual high-water marks. The profiles represent the channel conditions existing in May and November 1965 and April 1972. The approximate flood boundaries for the 50-year flood are shown on the map.

Recurrence intervals.—With respect to flood events, the recurrence interval can be defined as the average interval of time (years) within which a flood of a given magnitude will be exceeded once. Due to the irregular distribution of flood events with respect to time, recurrence intervals cannot be used to predict when future floods will occur, but they can be used to estimate the probability of a given magnitude of a future flood. The recurrence interval is inversely related to the probability or percent chance of a given flood being exceeded in any year for floods greater than the 10-year flood. For example, a 25-year flood would have a 4-percent chance of being exceeded in any one year. The fact that a 25-year flood may occur in any given year does not reduce the probability of the occurrence of another flood of greater magnitude within the same year.

Flood-frequency relations.—A flood-frequency relation is usually defined from a gaging-station record. However, a flood-frequency relation based on the combined records from a group of gaging stations in a hydrologically homogeneous region is considered more reliable than one defined from the records of a single gaging station. A regionalized flood-frequency relation has the advantage of being applicable at any point within the region. Streamflow records for Waiahole Stream (2910) and Waikane Stream (2949) were combined with the records of several gaging stations located in windward Oahu to develop a general flood-frequency relation for a part of windward Oahu. The flood-frequency relations for Waiahole Stream (2910) and Waikane Stream (2949) were defined from this regional relationship and are shown in figures 5 and 6. The recurrence interval of the May 2, 1965, flood is 12 years for

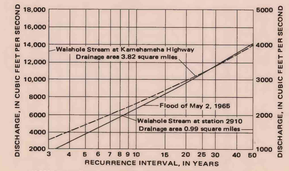


FIGURE 5.—*Frequency of flood discharges on Waiahole Stream.*

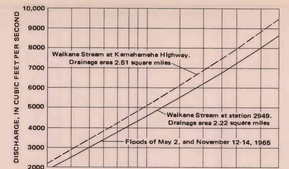


FIGURE 6.—*Frequency of flood discharges on Waikane Stream.*

Waiahole Stream at station 2910. The floods of May 2 and November 12-14, 1965, are estimated to have a recurrence interval of about 6 years for Waikane Stream at station 2949. Floods exceeding these in magnitude may be expected in the future.

A longer period of streamflow records at gaging stations within the region may define a somewhat different flood-frequency relation. Extrapolation of the frequency curves beyond the limits shown is not recommended.

Flood elevations.—The elevations shown in figure 7 are representative of the water surface for the indicated floods. Elevations given were obtained from high-water marks on trees, fences, streambanks, and other surfaces.

The depth of flooding in the inundated area may not be the same for future floods because of variations in magnitude and duration of stream discharges and the condition of the stream channels and drainage elements. The area subject to flooding would be approximately the same as that shown on the map and in figure 7 for floods of similar magnitudes under the same cultural conditions.

Additional data.—Other information pertaining to floods in the Waiahole-Waikane area can be obtained at the office of the U.S. Geological Survey, Honolulu, Hawaii, and from the following reports:

Cox, D. C., 1960, Potential tsunami inundation areas in Hawaii: Hawaii Institute of Geophysics Report 14, 26 p.

Cox, D. C., and Mink, J. F., 1963, The tsunami of 23 May 1960 in the Hawaiian Islands: Seismol. Soc. America Bull., v. 53, no. 6, p. 1191-1209.

Hawaii Division of Water and Land Development, 1970, Flood frequencies for selected streams in Hawaii: Rept. R36, 120 p.

Hoffard, S. H., 1965, Floods of December 1964-February 1965 in Hawaii: Hawaii Div. Water and Land Devel. Rept. R26, 68 p.

Macdonald, G. A., Shepard, F. P., and Cox, D. C., 1947, The tsunami of April 1, 1946, in the Hawaiian Islands: Pacific Sci., v. 1, no. 1, p. 21-37.

Nakahara, R. H., and Ewart, C. J., 1972, An investigation of floods in Hawaii through September 30, 1971, Progress Report No. 14: U.S. Geol. Survey open-file report, 161 p.

U.S. Weather Bureau, 1965, Climatological data, Hawaii: v. 61, no. 2, p. 52, 131.

Vaudrey, W. C., 1963, Floods of March-May 1963 in Hawaii: U.S. Geol. Survey open-file report, 65 p.

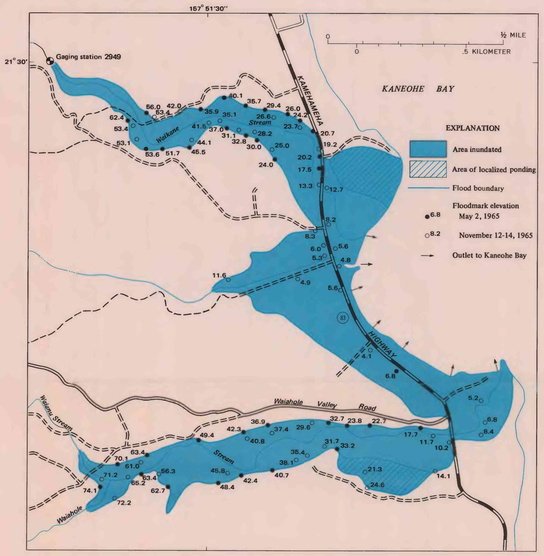


FIGURE 7.—*Outline of Waiahole-Waikane flood area showing floodmark elevations above mean sea level, in feet.*

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