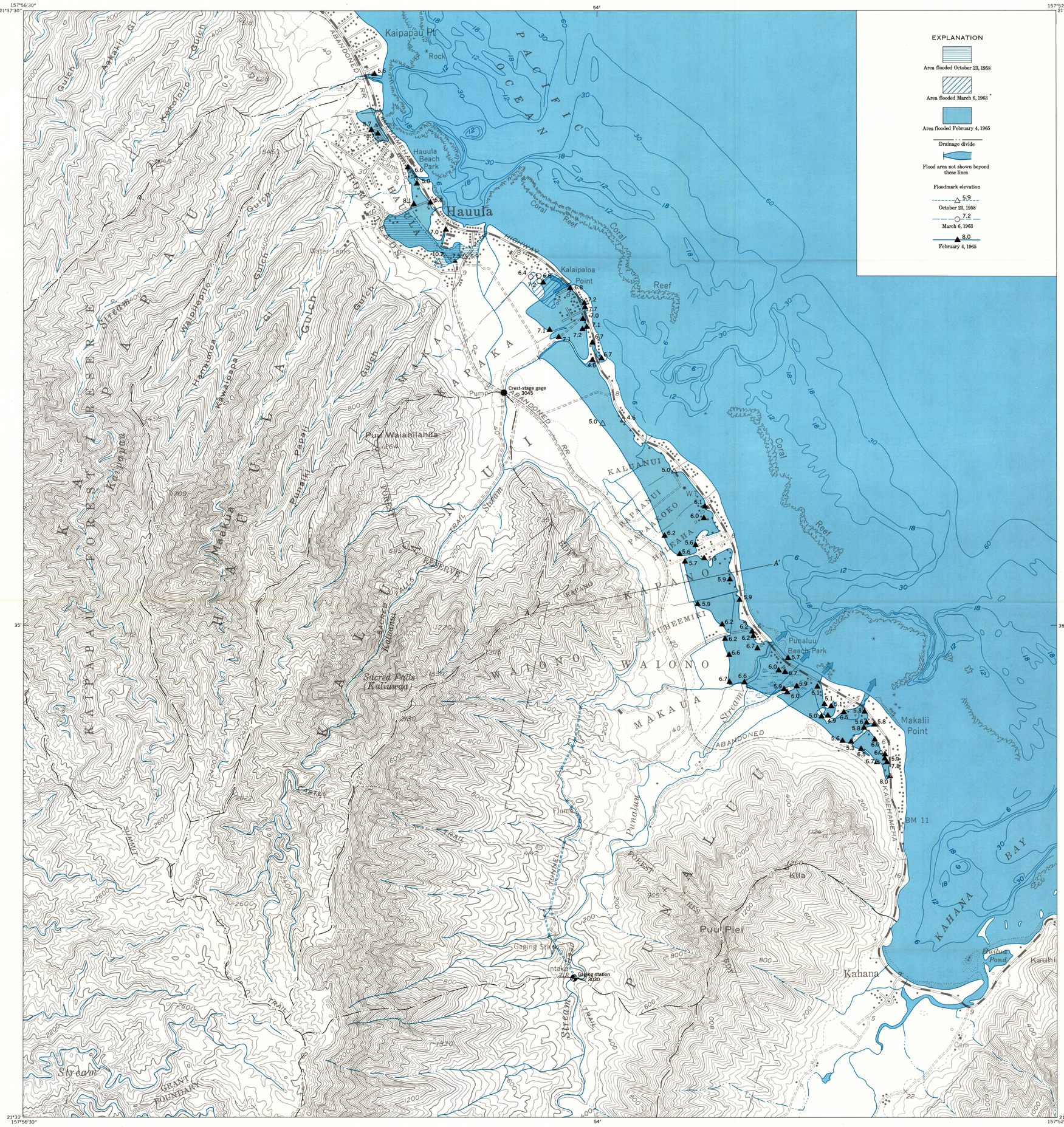
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

HYDROLOGIC INVESTIGATIONS
ATLAS HA-473



FLOODS IN PUNALUU-HAUULA AREA, OAHU, HAWAII

The part of Punaluu-Hauula area, Oahu (fig. 1) that is subject to flooding lies behind a natural beach berm that runs parallel to the coastline. This berm is from 6 to 9 feet above mean sea level. Houses and Highway 83 are located on the berm where development is at a maximum. The area west of the berm is a lowland, altitude between 1 and 7 feet, where cane growth is predominant. Several streams and ditches drain the approximately 15 square-mile project area. The flow from this area discharges to the ocean through many bridges and culverts. Shifting sand and debris clog these outlets frequently. The flood of February 4, 1965, was caused by a combination of moderately high runoff from the Koolau Range, heavy precipitation on the lowland area, and clogged outlets. Because the flood was caused by at least three factors, there is no single relation of flooding to peak stage or to total daily flow at the gaging station. A section of the area showing factors contributing to flooding in the lowland is shown on figure 2.

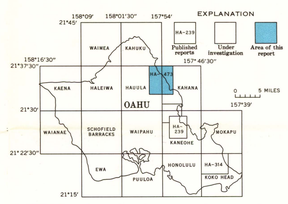


FIGURE 1. —*Index map of Oahu, Hawaii showing areas included in flood-plain mapping program and U.S. Geological Survey 7½ minute topographic quadrangles.*

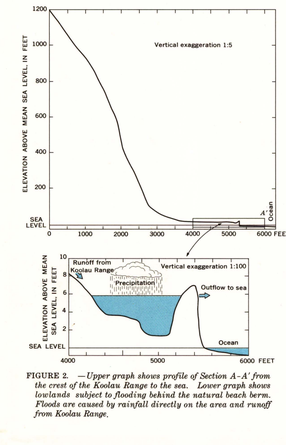


FIGURE 2. —*Upper graph shows profile of Section A-A' from the crest of the Koolau Range to the sea. Lower graph shows lowlands subject to flooding behind the natural beach berm. Floods are caused by rainfall directly on the area and runoff from Koolau Range.*

The purpose of this report is to delineate areas flooded in the past and to present hydrologic data useful in estimating the magnitude and probability of future floods. Information in the report may be used in evaluating effects of flooding in the economic development of lowlands of the Punaluu-Hauula area, in designing improvements to solve existing flood problems, and in formulating effective flood-plain regulations to minimize future flood damage.

Cooperation and acknowledgment.—This report was prepared by the U.S. Geological Survey under the direction of Mearle M. Miller, District Chief, Water Resources Division, as part of a water-resources investigation program under a cooperative agreement with the Hawaii State Department of Land and Natural Resources, Division of Water and Land Development. The cooperative program is administered, on behalf of the State, by the Board of Land and Natural Resources, Sunao Kido, Chairman and Member, and is directly coordinated by Robert T. Chuck, Manager-Chief Engineer and Chief Hydrographer, 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.

The writers gratefully acknowledge the assistance and cooperation of the Board of Water Supply, City and County of Honolulu, in supplying information on benchmark elevations from Punaluu to Hauula, and of the Department of Public Works, City and County of Honolulu, in furnishing detailed topographic maps of the Punaluu-Hauula area.

Historical information was obtained from personal interviews with local residents.

Flooded areas.—The approximate areas inundated by the floods of October 23, 1958, March 6, 1963, and February 4, 1965, are delineated on plate 1. Field investigations were not made at the time of the floods. Local residents, who recalled high-water levels and the extent of flooding, were interviewed in 1967. The extent of flooding was then determined by field surveys.

Boundaries of flooding in the caneland area were estimated on the basis of high-water marks along the berm. The surface-water gradient in the inundated areas was assumed to be negligible.

More than 100 people were interviewed. Of these, 50 percent had lived there between 1 and 10 years, 25 percent between 11 and 20 years, and the rest more than 20 years. Adequate data were obtained to define parts of areas inundated by the floods of October 23, 1958, and March 6, 1963. Residents reported that the flood of February 4, 1965, caused the most widespread flooding since 1940 and even since 1903. A resident of 37 years near Makalii Point recalled that the flood of May 1940 was about 0.4 foot higher than that of February 4, 1965, in his home. A 72-year resident of the Punaluu Beach Park area recalled a flood in 1903 that washed out the Punaluu Stream bridge. He stated that the 1903 flood was equal to or greater than the February 4, 1965, flood.

The flood boundaries shown on the map may not represent the maximum flood that occurred in the past or that may be expected in the future. These boundaries provide only a record of past floods that reflect channel width and depth and the size of the bridge and culvert openings existing at the time the floods occurred.

The inundation pattern of future floods will be influenced by new highways and bridges, relocation and improvement of stream channels, and other cultural changes.

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

Flood discharge.—The discharge of a stream is the volume of flow past a point in a given period of time. Discharge rates usually are expressed in units of cubic feet per second (cfs) or in million gallons per day (mgd). Cubic feet per second can be converted to million gallons per day by multiplying by 0.646.

Peak discharge, the maximum discharge of a flood, generally occurs at the time of maximum stage of the flood. However, if streamflow is affected by backwater, such as that caused by an outlet clogged by trees, the maximum discharge may not coincide with that of maximum stage.

Flood frequency.—Flood-frequency relations (figs. 3 and 4) for the U.S. Geological Survey gaging stations on Punaluu and Kaluanui Streams were obtained from a regionalized flood-frequency study of windward Oahu.

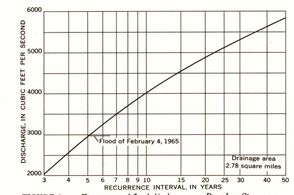


FIGURE 3. —*Frequency of flood discharges on Punaluu Stream near Punaluu.*

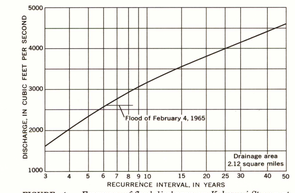


FIGURE 4. —*Frequency of flood discharges on Kaluanui Stream at Hauula.*

Figure 5 shows the relation between frequency and stage at gaging station 3045 on Kaluanui Stream at Hauula (datum of gage, 18.63 feet above mean sea level). The relation between frequency and stage depends on the relation of stage to discharge. Stream dredging, realinement, filling, and building of floodwalls in the immediate vicinity of the gage could alter stage-discharge relations, and, hence, frequency-stage relations. In addition, changes in upstream-channel conditions, such as filling or dredging the channel or building of reservoirs, may alter frequency-discharge relations. Extrapolation of curves beyond the limits shown is not recommended.

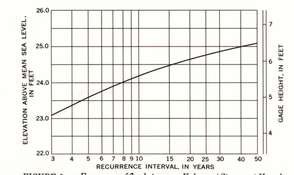


FIGURE 5. —*Frequency of flood stages on Kaluanui Stream at Hauula.*

The frequency of flood stages at gaging stations is not directly related to the extent of flooding in the lowlands. Flooding is also influenced by runoff from the Koolau Range, direct precipitation, and clogged outlets to the ocean. For example, during the flood of February 4, 1965, a large tree blocked Punaluu Stream bridge, causing water to back up into the lowland area and overflow the highway. Identical peak discharges were recorded at the gaging station for the floods of November 1, 1961, and February 4, 1965, but no flooding was reported in the lowlands for the November 1961 peak. A rain gage in the lower Punaluu area recorded rainfall of 2.33 inches on November 1, 1961, and 3.00 inches on February 4, 1965.

Recurrence intervals.—As applied to flood events, recurrence interval is the average number of years within which a given flood will be exceeded once. Frequency of floods, having recurrence intervals greater than 10 years, can be expressed in terms of their probability, which is virtually the reciprocal of the recurrence interval. For example, a flood with a recurrence interval of 50 years would have a 2-percent chance of being exceeded in any given year, or a flood with a 100-year recurrence interval would have a 1-percent chance of being exceeded in any given year.

The general relation between recurrence interval and flood height at the crest-stage gage, station 3045 on Kaluanui Stream (fig. 5), is tabulated below.

Recurrence interval (years)	*Altitude (feet)*
50	25.1
30	24.8
20	24.6
10	24.2
5	23.6
3	23.1

It is emphasized that recurrence interval is the average number of years between floods that exceed a given magnitude. A 50-year flood in any one year does not reduce the probability of a larger flood in the next year or even in the next month.

Additional data.—Other information pertaining to floods in the Punaluu-Hauula 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 Rept. 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.

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

Hoffard, S. H., and Fowler, K. H., 1968, An investigation of floods in Hawaii, Progress Report No. 10: U.S. Geol. Survey open-file report, 167 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.

U.S. Weather Bureau, 1965, Climatological data, Hawaii, v. 61, no. 2, p. 17.

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

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