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FIRST-ORDER LEVELING
IN HAWAII

BY

HOWARD S. RAPPLEYE

Associate Mathematician

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CONTENTS

	Page
General statement.....	1
Field work.....	1
Field methods.....	2
Bench marks.....	2
Computation and adjustment.....	3
Closures of circuits.....	3
Corrections distributed in the various lines.....	4
Datum planes.....	5
Elevations.....	5
Descriptions.....	5
Descriptions and elevations of bench marks.....	6
Line 1, Hilo to the summit of Mauna Loa.....	6
Lines 2, 3, and 4, in Honolulu.....	8
Line 5, Honolulu to a point northeast of Nuuanu Pali, via the coast.....	9
Line 6, from a point northeast of Nuuanu Pali to Haleiwa.....	10
Line 7, Haleiwa to a point near Waipahu.....	11
Line 8, from a point near Waipahu to Honolulu.....	13
Line 9, from a point near Waipahu to Haleiwa, via Schofield Barracks.....	13
Line 10, from Honolulu to a point northeast of Nuuanu Pali, via Nuuanu Valley.....	14
Line 11, spur line up Wilhelmina Rise, Honolulu.....	14
Line 12, along the water front in Honolulu.....	15
Line 13, the Pauoa spur line, Honolulu.....	16
Lines 14 and 15, the spurs in the Kapalama district, Honolulu.....	16
Index to bench-mark locations.....	21

ILLUSTRATIONS

Figure	
1.—Standard marks of the United States Coast and Geodetic Survey.....	2
2.—Leveling on the island of Hawaii.....	18
3.—Leveling on the island of Oahu.....	19

FIRST-ORDER LEVELING IN HAWAII

By HOWARD S. RAPPEYE, *Associate Mathematician, United States Coast and Geodetic Survey*

GENERAL STATEMENT

In this publication will be found the descriptions and elevations of all the first-order leveling bench marks established or tied in by the field parties of the Coast and Geodetic Survey on the islands of Hawaii and Oahu in the Territory of Hawaii. The publication is intended primarily as a field book for the use of engineers and others who may have occasion to make use of the bench marks as starting points for leveling run in connection with their engineering or construction projects. Little attention is paid in this publication to the details of computation and adjustment beyond that necessary for a clear understanding of the general scope and quality of the work.

Such details regarding the field and office work as may be necessary will be found in the following pages. The descriptions and elevations will be found on pages 6 to 17. Index maps showing the routes over which the level lines were run will be found at the end of the publication.

FIELD WORK

The field work was begun at Hilo, on the island of Hawaii, in October, 1926. The leveling extended from the bench marks at the tidal station at Hilo, to which the datum plane of mean sea level is referred, to the summit of Mauna Loa, via Volcano House. The work above Volcano House was done at the request of Dr. T. A. Jaggar, volcanologist of the United States Geological Survey, in charge of the Hawaiian Volcano Observatory, for use in connection with earthquake investigations. It is proposed to rerun this line at intervals in order to detect possible vertical displacements of the mountain mass, which will be indicated by discrepancies between the present and future runnings not attributable to errors in the leveling itself.

For the work on the island of Hawaii, two Ford trucks, furnished by the United States Geological Survey, were used as far as Volcano House. Above Volcano House pack animals were used as far as possible, but on the work near the summit of the mountain all travel had to be on foot.

The line from Hilo to the summit of Mauna Loa was completed by December 18, 1926, and the party was then transferred to the island of Oahu.

On January 4, 1927, the leveling on the island of Oahu was begun. This work was done in cooperation with the United States Army and the United States Geological Survey. The United States Army furnished transportation and all personnel except the chief of party. The United States Geological Survey furnished all materials for the construction of the bench marks except the standard metal disks, which were furnished by the United States Coast and Geodetic Survey.

The leveling on the island of Oahu consisted of a circuit around the island, a small circuit within the city of Honolulu and two cross-lines; one via Schofield Barracks and the other via the Nuuanu Valley. The crosslines served to break the principal circuit around the island into three smaller circuits. Later, in March 1928, additional work was done within the city of Honolulu which included another small circuit along the water front and four short spur lines leading back to the higher portions of the city.

The observing was all done by Lieut. Lansing G. Simmons, junior hydrographic and geodetic engineer, the chief of party.

FIELD METHODS

The leveling was done in accordance with the specifications and instructions for first-order leveling set forth in detail in United States Coast and Geodetic Survey Special Publication No. 140, *Manual of First-Order Leveling*.

The instrument used was the United States Coast and Geodetic Survey type of first-order level. The rods were the usual type used on this class of work. They have an invar strip down the center of the rod on which the centimeter graduations are marked. The instrument and rods are described in United States Coast and Geodetic Survey Special Publication No. 129, *Geodetic Level and Rod*.

BENCH MARKS

Bench marks of other organizations were tied into the first-order leveling whenever possible without too great an amount of extra field work. Credit for the establishment of these marks of other organizations is given immediately following the designation of the mark in the lists of descriptions and elevations.

The standard mark of the United States Coast and Geodetic Survey is shown in Figure 1. It consists of a bronze disk, appropriately lettered, with a tennon extending from the back of the disk by means of which it is fastened in place. Some marks were leaded or cemented into holes drilled in existing structures, but in the majority of cases the tablets were set in the top of concrete posts. The concrete posts were constructed in place and as a rule projected only a few inches above the surface of the ground.

The character of each mark is stated in the description of the mark, but in the case of the permanent marks of the city of Honolulu an additional word of explanation is needed. These marks are of a very permanent nature. They consist of a concrete post, set below the surface of the ground, in the top of which is fastened a brass rod. The point on which the leveling rods are held is the top of the brass rod. Above the top of the post is an iron cover, supported inde-

pendently of the post, which serves to protect it from traffic disturbances, most of the marks being in the paved areas at street intersections.

Bench marks of the United States Coast and Geodetic Survey are stamped with a letter and number beginning with A or A 1 in each State or Territory. When the alphabet has been exhausted a new alphabet is started with the number following the letters increased by one. The year the mark was established is also stamped on the disk.

COMPUTATION AND ADJUSTMENT

The office computation and adjustment of the observations were made in accordance with the instructions contained in United States Coast and Geodetic Survey Special Publication No. 140, Manual of First-Order Leveling.

The orthometric correction was applied to the leveling. This correction is an allowance for the effect of the convergence of level surfaces on the earth. The earth being an oblate spheroid, level surfaces at different elevations are not strictly parallel but converge slightly toward the poles of the earth. A detailed treatment of the subject of the orthometric correction is contained in Special Publication No. 140.

The leveling on the Island of Hawaii required no adjustment, since there was no circuit closure. The Oahu leveling was adjusted to eliminate the circuit closures from the one small circuit and the three large circuits of leveling. The circuits are numbered as shown on the sketch at the end of this publication and the circuit closures were as shown in the following table.

Closures of circuits

Circuit No.	Length	Closure
	<i>Kilometers</i>	<i>Millimeters</i>
I	5.1	-1.5
II	56.7	-2.8
III	136.1	+9.9
IV	102.3	+11.6

The adjustment was made by the method of least squares and the resulting elevations are the most probable values derivable from the observations.

Later, when the additional work was done in the city of Honolulu, the extra circuit which developed was adjusted by fitting the new line in between the adjusted elevations of the terminal marks. The amount of the correction distributed in this additional line was only 0.2 mm. The spur lines in the city of Honolulu were made consistent with the adjusted elevations from which they were started.

The following table shows the various lines or sections into which the leveling in the Hawaiian Islands has been broken for convenience in computation, adjustment, and publication. The corrections distributed through each particular line and the length of the line are shown as an indication of the accuracy of the leveling.

Corrections distributed in the various lines

Line No.	From—	B. M.	To—	B. M.	Correc- tion dis- tributed	Length of line	Remarks
1	Hilo.....	F 2.....	Summit of Mauna Loa.....	A 1.....	<i>mm.</i>	<i>km.</i>	
2	Honolulu.....	Tidal 18.....	Honolulu.....	B. M. 4.....	-0.6	101.2	Spur line.
3	do.....	B. M. 4.....	do.....	B. M. 3.....	-0.3	2.0	
4	do.....	B. M. 3.....	do.....	Tidal 18.....	-0.6	1.2	
5	do.....	B. M. 4.....	Northeast of Nuuanu Pali.....	V 2.....	-1.4	1.9	Via the coast.
6	Northeast of Nuuanu Pali.....	V 2.....	Haleiwa.....	C 3.....	+7.4	43.5	
7	Haleiwa.....	C 3.....	Near Waipahu.....	T. B. M. 486.....	+10.2	70.2	Do.
8	Near Waipahu.....	T. B. M. 486.....	Honolulu.....	B. M. 3.....	+2.2	69.8	
9	do.....	do.....	Haleiwa.....	C 3.....	+1.4	21.4	Via Schofield Barracks.
10	Honolulu.....	B. M. 3.....	Northeast of Nuuanu Pali.....	V 2.....	+1.7	32.5	Via Nuuanu Valley.
11	do.....	B. M. 8.....	Up Wilhelmina Rise.....			12.0	
12	do.....	Tidal 18.....	Honolulu.....	J 2.....	-0.2	2.8	Spur line.
13	do.....	B. M. 200.....	Along Pauoa Valley.....			8.8	Fitted to adjusted elevations.
14	do.....	do.....	Honolulu.....	U. S. G. S. 120.....		3.5	Spur line in Pauoa district.
15	do.....	U 4.....	do.....	Y 4.....		3.1	Spur line in Kapalama district.
						3.0	Do.

DATUM PLANES

The datum plane of mean sea level at Honolulu was derived from 25 years of observations made with an automatic, self-registering tide gage. The gage was operated by the Hawaiian Government and the records forwarded to the United States Coast and Geodetic Survey for reduction. The datum plane at Honolulu was defined by the division of tides and currents, as being 16.54 feet below tidal bench mark No. 2. This tidal plane is well determined and will not, in all probability, be changed by any appreciable amount as a result of additional observations made at that place.

At Hilo, two years of observations with an automatic, self-registering tide gage are available. The gage was operated by the personnel of the United States Geological Survey Volcano Observatory and the records sent to the United States Coast and Geodetic Survey for reduction. The mean sea level datum plane derived from these observations by the division of tides and currents is given as 7.98 feet below bench mark F 2. This datum plane, being based on such a short series of continuous observations, can not be said to be extremely well determined and may be subject to some change when additional observations are available. However, any change in the value of this datum plane will require only the addition of a constant correction to the elevations of the bench marks between Hilo and the summit of Mauna Loa. The plane derived from a long series of observations should differ only a small fraction of a foot from the one used as the datum for the elevations published in this report, unless there should be a rise or fall of the land at Hilo due to volcanic or seismic activity.

ELEVATIONS

The elevations are given in both meters and feet above the adopted datum planes of mean sea level. The leveling was done with metric rods and the resulting elevations are given to three decimal places. At considerable distances from the tidal stations these elevations may not be accurate to the nearest millimeter and even the centimeters may be in doubt, but the differences in elevation between adjacent bench marks, against which engineers are likely to check level lines of their own, are accurate enough to warrant carrying the published elevations to millimeters.

In the normal case the elevation to the nearest millimeter is adopted and then converted to feet, using the conversion factor 1 meter=3.2808333 feet. Two exceptions to this rule are bench marks Tidal 2 and F 2, to which the mean sea level datum at Honolulu and Hilo are referred. The elevations of these marks were furnished by the division of tides and currents to the nearest hundredth of a foot, and these values were then converted to meters by the use of the factor 1 foot=0.3048006 meter.

DESCRIPTIONS

The descriptions of the marks are standardized as much as possible. They begin with the designation of the mark. Then, in the case of bench marks of other organizations, credit is given in paren-

theses for the establishment of the mark. The descriptions then proceed from the general to the detailed location of the bench mark and finally to the character of the mark itself. The elevation of the mark is then given in parentheses.

An index to the bench marks is given on page 21. It will be found to be of considerable assistance in locating marks in any particular locality.

DESCRIPTIONS AND ELEVATIONS OF BENCH MARKS

LINE 1, HILO TO THE SUMMIT OF MAUNA LOA

F 2.—About 2 miles east of **Hilo**, at Pier No. 1, in the concrete floor, just inside the north end of the most northerly door on the west side of the pier. A standard disk, stamped "F 2 1926." (2.432 meters or 7.98 feet.)

E 2.—About 2 miles east of **Hilo**, at Pier No. 1, in the concrete floor and 12 feet north of the southwest corner. A standard disk, stamped "E 2 1926." (2.419 meters or 7.936 feet.)

6.89 (U. S. G. S.).—At **Hilo**, at the shore end of the breakwater, 50 feet east of the tracks of the Hilo Railroad, on top of the breakwater, in rock and cement. A United States Geological Survey standard disk, stamped "6.89." (2.099 meters or 6.886 feet.)

D 2.—About 2 miles east of **Hilo**, at Pier No. 2 (the Interisland Pier), at the extreme northeast corner of the pier, in the concrete floor. A standard disk, stamped "D 2 1926." (2.566 meters or 8.419 feet.)

5.79 (U. S. G. S.).—About 1 mile east of **Hilo**, on the north side of the land end of Hilo Wharf, in a cement-covered masonry pier about 3.5 feet in diameter. A United States Geological Survey standard disk, stamped "5.79 1910" and set in the center of the top of the pier. (1.792 meters or 5.879 feet.)

5.83 (U. S. G. S.).—About 1 mile east of **Hilo**, 100 yards west of the land end of Hilo Wharf, and in the top of the sea wall extending out from the old Government wharf. A United States Geological Survey standard disk, stamped "5.83 1910." (1.804 meters or 5.919 feet.)

8.82 (U. S. G. S.).—At **Hilo**, at the foot of Walanuenue Street, 100 yards east of the United States lighthouse and in the concrete foundation of a tower. A United States Geological Survey standard disk, stamped "8.82 1910." (2.705 meters or 8.875 feet.)

Sun-dial plug.—At **Hilo**, in the City Park, at the sun dial, in the concrete base. A metal plug. (12.522 meters or 41.083 feet.)

Sun dial (city of Hilo).—At **Hilo**, in the City Park, on the sun dial. The top of the sun dial. (13.486 meters or 44.245 feet.) *NOTE.*—This mark defines the level datum for the city of Hilo.

C 2.—At **Hilo**, at the Crescent City Cracker Co. building, in the foundation at the northeast corner of the building, to the left of the entrance when facing the building, and about 4 inches above the sidewalk. A standard disk, stamped "C 2 1926" and set vertically. (2.294 meters or 7.526 feet.)

B 2.—About 3.9 miles south of **Hilo**, on the Hilo-Volcano Road, at the bridge known as "4-mile bridge," just above the upper end of the double-parkway road south of Hilo, and in the south end of the west rail of the bridge. A standard disk, stamped "B 2 1926." (60.390 meters or 198.130 feet.)

A 2.—About 6.2 miles south of **Hilo**, on the Hilo-Volcano Road, on the west side of the road, about 3 feet from the edge of the road, about 1 foot higher than the road, in black lava rock. A standard disk, stamped "A 2 1926." (84.682 meters, or 277.828 feet.)

Z 1.—At **Olaa**, about 7.8 miles south of **Hilo**, on the Hilo-Volcano Road, at the north edge of the town, in front of the Japanese Buddhist Church, to the right of the road when facing up the hill, and in a large stone monument. A standard disk, stamped "Z 1 1926." (100.011 meters, or 328.119 feet.)

359.3 (U. S. G. S.).—At **Keaau**, 770 feet north of the station, in the yard of the Japanese Christian Church, 50 feet west of the road, in a rock outcrop. A United States Geological Survey standard disk, stamped "359.3." (109.522 meters, or 359.323 feet.)

Y 1.—About 3 miles above **Olaa**, on the Hilo-Volcano Road, one-third mile above Kurtistown post office, at the south edge of the yard where a black tank

stands in front of the house, 25 feet to the left of the road when facing up the hill, at a sharp curve in the road, and in an outcrop of black rock. A standard disk, stamped "Y 1 1926." (210,424 meters, or 690,366 feet.)

764 (U. S. G. S.).—About 3.2 miles southwest of **Keaau**, at 12-mile school-house, in the bottom step at the entrance. A United States Geological Survey standard disk, stamped "764." (233,047 meters, or 764,588 feet.)

X 1.—About one-half mile southeast of **Kukui**, about 150 feet downhill from Olau plantation store on the Hilo-Volcano Road, 12 feet to the right of the center of the road when facing up the hill, in lava rock. A standard disk, stamped "X 1 1926." (349,530 meters, or 1,146,750 feet.)

1266 (U. S. G. S.).—About 6.2 miles southwest of **Keaau**, on the Hilo-Volcano Road, about 0.6 mile above Olau plantation store, about 0.4 mile southwest of a Japanese joss house, on the mountainward side of the road, and about 2 feet higher than the road, in a rock ledge. A United States Geological Survey standard disk, stamped "1266." (386,023 meters, or 1,266,477 feet.)

W 1.—At **Mountain View**, on the Hilo-Volcano Road, about 160 feet downhill from the point where a sugar flume crosses the road just above Mountain View, in a deep rock cut, 19 feet to the right of the center of the road when facing uphill, in lava rock. A standard disk, stamped "W 1 1926." (466,492 meters, or 1,530,482 feet.)

2002 (U. S. G. S.).—About 2 miles southwest of **Mountain View**, on the Hilo-Volcano Road, at the house of Norman Lyman, in the rock base of the front steps. A United States Geological Survey standard disk, stamped "2002." (610,400 meters, or 2,002,621 feet.)

V 1.—About 3 miles above **Mountain View**, 30 feet uphill from the 18-mile sign on the Hilo-Volcano Road, on the bank about 2 feet higher than the road. A standard disk, stamped "V 1 1926," and set in the top of a concrete post. (646,199 meters, or 2,120,071 feet.)

U 1.—About one telephone pole downhill from the 21-mile sign on the Hilo-Volcano Road, and 20 feet to the right of the center of the road when facing uphill. A standard disk, stamped "U 1 1926" and set in the top of a concrete post. (715,571 meters or 2,347,609 feet.)

T 1.—About 15 telephone poles uphill from milepost 23 on the Hilo-Volcano Road, about 23 telephone poles downhill from milepost 24, in an outcrop of lava rock which is flush with the ground. A standard disk, stamped "T 1 1926." (850,661 meters or 2,790,877 feet.)

S 1.—About 3 miles downhill from **Volcano House**, on the Hilo-Volcano Road, 35 feet to the left of the center of the road when facing uphill, and 10 feet outside of a wire fence, in lava rock. A standard disk, stamped "S 1 1926." (1,073,548 meters or 3,522,132 feet.)

R 1.—Opposite milepost 28 on the Hilo-Volcano Road, 200 feet downhill from the entrance to the new (1926) golf course, and 13 feet to the right of the center of the road when facing uphill, in an outcrop of lava rock which is flush with the ground. A standard disk, stamped "R 1 1926." (1,153,110 meters or 3,783,162 feet.)

3821 (U. S. G. S.).—At the **Crater Hotel**, at the front entrance and in the concrete base of the steps. A United States Geological Survey standard disk, stamped "3821." (1,164,568 meters or 3,820,753 feet.)

3973 (U. S. G. S.).—At **Volcano House**, at secondary triangulation station known as "Volcano House Flag," in front of the hotel, and 15 feet west of the road, in a concrete pier. A United States Geological Survey standard disk, stamped "3973." (1,210,833 meters or 3,972,541 feet.)

Q 1.—At **Brown's ranch**, 180 feet south of the gate to the ranch house and 60 feet east of the edge of the golf green, in an outcrop of lava rock which is flush with the ground. A standard disk, stamped "Q 1 1926." (1,223,962 meters or 4,015,615 feet.)

P 1.—About 1.5 miles above **Brown's ranch**, at the end of the traveled road, 180 feet southeast of the entrance to the bird park, 30 feet east of the Mauna Loa trail sign, 25 feet south of the road, and near a rock cairn. A standard disk, stamped "P 1 1926" and set in lava rock. (1,204,155 meters or 3,950,632 feet.)

N 1.—About 3.4 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, near a large rock cairn, at the edge of the 1823 lava flow, 20 feet to the right of the trail when facing uphill, and 12 feet south of a giant koa tree, in lava rock. A standard disk, stamped "N 1 1926." (1,349,516 meters or 4,427,537 feet.)

M 1.—About 5.6 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, near a large rock cairn, opposite a group of trees and a camp site, about 100 yards above a water hole on the trail, and about 65 feet south of the trail, in lava rock. A standard disk, stamped "M 1 1926." (1,538.204 meters or 5,046.591 feet.)

L 1.—About 9.1 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, 27 yards south of the corner of a stone wall in a depression in the trail, between the trail and the stone wall, and 2 feet higher than the trail, in a large lava boulder. A standard disk, stamped "L 1 1926." (2,009.980 meters or 6,594.409 feet.)

K 1.—About 11.1 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, near a large rock cairn, 10 feet to the right of the trail when facing uphill, and in lava rock. A standard disk, stamped "K 1 1926." (2,312.342 meters or 7,586.409 feet.)

J 1.—About 12.2 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, near a large rock cairn, and 18 feet to the right of the trail when facing uphill, in brown lava rock. A standard disk, stamped "J 1 1926." (2,494.192 meters or 8,183.028 feet.)

I 1.—About 14.7 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, near a large rock cairn, about 30 feet to the left of the trail when facing uphill, and in brown lava rock. A standard disk, stamped "I 1 1926." (2,842.503 meters or 9,325.778 feet.)

H 1.—About 16.4 miles above **Brown's ranch**, on the Mauna Loa-Volcano House trail, about 40 feet north of Red Hill House, and 4 feet southeast of the corner of an old stable which has now been torn down, in lava rock. A standard disk, stamped "H 1 1926." (3,058.925 meters or 10,035.823 feet.)

G 1.—About 0.5 mile above **Red Hill**, on the Mauna Loa-Volcano House trail, near a large rock cairn, 8 feet to the left of the trail when facing uphill, and in lava rock. A standard disk, stamped "G 1 1926." (3,095.538 meters or 10,155.944 feet.)

F 1.—About 3 miles above **Red Hill**, on the Mauna Loa-Volcano House trail, near a large rock cairn, in a depression in the trail, and 25 feet to the right of the trail when facing uphill, in black lava rock. A standard disk, stamped "F 1 1926." (3,299.480 meters or 10,825.044 feet.)

E 1.—About 4.7 miles above **Red Hill**, on the Mauna Loa-Volcano House trail, about 50 yards southwest of a small red lava hill, and 12 feet to the left of the trail when facing uphill, in lava rock. A standard disk, stamped "E 1 1926." (3,475.407 meters or 11,402.231 feet.)

D 1.—About 6.6 miles above **Red Hill**, on the Mauna Loa-Volcano House trail, near a large rock cairn, and 10 feet to the left of the trail when facing uphill, in black lava rock. A standard disk, stamped "D 1 1926." (3,660.717 meters or 12,010.202 feet.)

C 1.—About 9.3 miles above **Red Hill**, on the Mauna Loa-Volcano House trail, about 50 feet west of a large stone cairn marking the end of the trail, near a small stone cairn, at a crack just south of Jaggar's Cave, in lava rock. A standard disk, stamped "C 1 1926." (3,968.111 meters or 13,018.711 feet.)

AA.—About 9.4 miles above **Red Hill**, about 40 yards west of the edge of the crater, at the end of the Mauna Loa-Volcano House trail, near a large stone cairn, on the floor of the crater, in lava rock. A nail set head up in cement in a drill hole in the rock. (3,953.787 meters or 12,971.716 feet.)

B 1.—About 11.5 miles above **Red Hill**, about one-fourth mile downhill from the United States Geological Survey triangulation station, 110 feet west of a stone cairn of the United States Geological Survey, and 130 feet northwest of the edge of the crater, in lava rock flush with the ground. A standard disk, stamped "B 1 1926." (4,161.792 meters or 13,654.146 feet.)

A 1.—About 11.8 miles above **Red Hill**, a few hundred feet from the summit of Mauna Loa, 30 feet southeast of the United States Geological Survey triangulation station, 30 feet from the edge of the crater, near a rock cairn, in lava rock. A standard disk, stamped "A 1 1926." (4,160.097 meters or 13,648.585 feet.)

LINES 2, 3, AND 4, IN HONOLULU

Tidal 18.—At **Honolulu**, at Pier No. 2, near the tide-gage house of the United States Engineer Corps, in the edge of the concrete pier. A standard disk. (1.921 meters or 6.302 feet.)

Tidal 12.—At **Honolulu**, at the Federal Building on King Street, directly across the court in front of the main entrance, in the floor of the peristyle. A standard disk. (3.846 meters or 12.618 feet.)

Tidal 2.—At **Honolulu**, at the large Government Building (Aliioli Hale), later called the "Judiciary Building," at the left of the main entrance when entering the building, on top of the pediment of a pilaster. The top of the pediment. (5.041 meters or 16.54 feet.) **NOTE.**—This mark was established by the Hawaiian Government and is known as "Standard City Bench Mark."

B. M. 3 (city of Honolulu).—In **Honolulu**, at the intersection of Nuuanu Avenue and Beretania Street, the northerly of two marks. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (6.511 meters or 21.362 feet.)

B. M. 4.—In **Honolulu**, at the northeast corner of the intersection of Beretania and Alapai Streets. The top of a water plug. (7.260 meters or 23.819 feet.)

Tidal 17.—At **Honolulu**, at the corner of Fort and Halekauwila Streets, in the southeast steps of the American Factor Building. A standard disk, stamped "17." (2.056 meters or 6.745 feet.)

Tidal 11.—At **Honolulu**, at the corner of Allen and Alakoa Streets, at the corner of the Hawaiian Electric Co.'s plant, in the concrete foundation. A standard disk, stamped "11." (1.687 meters or 5.535 feet.)

LINE 5, HONOLULU TO A POINT NORTHEAST OF NUUANU PALI, VIA THE COAST

B. M. 4.—(See above.)

B. M. 5 (city of Honolulu).—In **Honolulu**, at the intersection of Beretania and Piikoi Streets. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (5.730 meters or 18.799 feet.)

H 2.—About 2.4 miles east of **Honolulu**, at the Central Union Church on Beretania Street, in the extreme southwest corner of the churchyard. A standard disk, stamped "H 2 1927" and set in the top of a concrete post. (9.611 meters or 31.532 feet.)

B. M. 6 (city of Honolulu).—In **Honolulu**, on Beretania Street at Isenberg Street, opposite the old Mollilili Ball Park, and just north of the curbing. The top of a brass rod set vertically in the top of a concrete post. (3.050 meters or 10.007 feet.)

B. M. 7 (city of Honolulu).—In **Honolulu**, at the Kuhio School on Beretania Street, on the west end of the steps leading to the entrance. A small brass plug set in the concrete steps. (8.750 meters or 28.707 feet.)

J 2.—About 4.2 miles east of **Honolulu**, about 50 yards north of Waiālae Road at Third Avenue, at a concrete bridge, in the south end of the west rail. A standard disk, stamped "J 2 1927." (24.562 meters or 80.584 feet.)

B. M. 8 (city of Honolulu).—In **Honolulu**, at the Liliuokalani School in Kaimuki, on the west end of the steps leading to the main entrance. A small brass plug set in the concrete steps. (54.615 meters or 179.183 feet.)

B. M. 9 (city of Honolulu).—In **Honolulu**, on the north side of Waiālae Road, near the intersection of Twentieth Avenue, on the east end of the steps leading to the porch of the only house in the near vicinity. A chiseled square. (33.587 meters or 110.193 feet.)

K 2.—About 5.9 miles east of **Honolulu**, southeast of the intersection of Waiālae Road and Isenberg Road, and just inside the fence corner at the golf course. A standard disk, stamped "K 2 1927" and set in the top of a concrete post. (11.465 meters or 37.615 feet.)

L 2.—About 7.5 miles east of **Honolulu**, at the Waialue Naval Wireless Station, about 25 feet south of the center of the main road, directly in front of the pier, and in the northeast corner of a concrete manhole. A standard disk, stamped "L 2 1927." (1.907 meters or 6.257 feet.)

M 2.—About 11.3 miles east of **Honolulu**, at a fork in the road where the Koko Head Road turns north from the entrance to the Bishop estate, and 4 feet inside the fence corner at the gate. A standard disk, stamped "M 2 1927" and set in the top of a concrete post. (0.775 meter or 2.543 feet.)

N 2.—About 11.6 miles east of **Honolulu**, about 600 yards north of the entrance to the Bishop estate, 8 feet west of the Koko Head Park Road, 12 feet south of a small plank bridge, in the concrete block which anchored an old wireless guy. A standard disk, stamped "N 2 1927." (3.565 meters or 11.696 feet.)

P 2.—About one-half mile north of **Koko Crater**, on the **Makapuu Lighthouse Road**, about 250 yards west of the divide opposite Koko Crater, at the most westerly of two sharp bends in the road, 10 feet south of the road, and 2½ feet higher than the road, in lava rock. A standard disk, stamped "P 2 1927." (58.688 meters or 192.546 feet.)

Q 2.—About one-half mile southwest of **Makapuu Head**, on the **Makapuu Lighthouse Road** as it begins to rise to Makapuu Head, at the first sharp right-hand bend, and 20 feet to the left of the center of the road when facing up the hill. A standard disk, stamped "Q 2 1927" and set in the top of a concrete post. (22.001 meters or 72.182 feet.)

R 2.—About one-half mile west of **Makapuu Head**, at the end of the old road from Makapuu Lighthouse to the north side of the island, at the edge of the cliff, 60 feet east of a trail, in lava rock. A standard disk, stamped "R 2 1927." (43.815 meters or 143.750 feet.)

S 2.—At **Waimanalo Landing**, on a small rise of ground on the beach about 40 feet back from the shore end of the pier. A standard disk, stamped "S 2 1927" and set in the top of a concrete post. (3.269 meters or 10.725 feet.)
NOTE.—This mark has been reported destroyed.

T 2.—At **Waimanalo**, across the tracks from the mill building, in a large yard, in the concrete base of a flag pole. A standard disk, stamped "T 2 1927." (9.068 meters or 29.751 feet.)

U 2.—About 3.9 miles toward **Nuuanu Pali** from **Waimanalo**, on the **Waimanalo-Honolulu Road** at its junction with the **Kailua Beach Road**, 12 feet north of the **Waimanalo Road**, in a concrete culvert. A standard disk, stamped "U 2 1927." (38.153 meters or 125.174 feet.)

V 2.—Northeast of **Nuuanu Pali**, near where the road forks to **Waimanalo** and **Haleiwa**, about 100 feet toward **Waimanalo** from the fork, on the north side of the road, in the top of the end of a concrete wall. A standard disk, stamped "V 2 1927." (197.830 meters or 649.047 feet.)

LINE 6, FROM A POINT NORTHEAST OF NUUANU PALI TO HALEIWA

V 2.—(See end of line 5.)

A 4.—About 0.9 mile toward **Nuuanu Pali** from **Heeia**, at the junction of the main road around the island with the branch road to **Kaneohe**, about 60 feet north of the main road, and 15 feet west of the branch road. A standard disk, stamped "A 4 1927" and set in the top of a concrete post. (38.531 meters or 126.414 feet.)

B 4.—About 1.3 miles toward **Kahana** from **Heeia**, about one-half mile toward **Kahana** from the wireless towers at **Heeia**, one-fourth mile toward **Heeia** from a long concrete highway bridge, at the first road turning south past **Heeia** into the plantation of **Sun Hop Chong Co.**, 20 feet south of the main road, and just inside a fence corner. A standard disk, stamped "B 4 1927" and set in the top of a concrete post. (12.550 meters or 41.174 feet.)

C 4.—At **Libbyville**, 30 feet west of the intersection of the main road around the island and the branch road to **Libbyville**, 15 feet north of the main road, and 20 feet south of the branch road. A standard disk, stamped "C 4 1927" and set in the top of a concrete post. (12.065 meters or 39.583 feet.)

D 4.—About one-fourth mile north of the post office at **Waikane**, just north of a small graveyard, across the road from a church, in the corner of a school yard, and 15 feet seaward from the main road. A standard disk, stamped "D 4 1927" and set in the top of a concrete post. (13.775 meters or 45.193 feet.)

E 4.—About 2.6 miles toward **Kahana** from **Waikane**, about one-fourth mile toward **Waikane** from an old abandoned sugar mill, at the **Kahana** end of a curve where the road from **Waikane** reaches the beach, about 65 feet toward **Waikane** from a culvert, 25 feet seaward from the main road around the island, and 3 feet seaward from a stone wall. A standard disk, stamped "E 4 1927" and set in the top of a concrete post. (1.628 meters or 5.341 feet.)

F 4.—About 4.3 miles toward **Kahana** from **Waikane**, at **Kaaawa Gulch**, across the road from the small cottages owned in 1927 by **Edward Williams**, 20 feet seaward from the main road around the island, and 3 feet toward the road from a stone wall. A standard disk, stamped "F 4 1927" and set in the top of a concrete post. (3.172 meters or 10.407 feet.)

G 4.—At **Kahana Bay**, on the west side of the bay, 80 yards toward **Hauula** from the end of the **Koolua Railroad**, in the southwest corner of the grounds of the **Kainehe** cottage, 18 feet seaward from the main road around the island,

and 2 feet seaward from a fence line. A standard disk, stamped "G 4 1927" and set in the top of a concrete post. (3.487 meters or 11.440 feet.)

H 4.—About 1.8 miles toward Kahana from Hauula, at Haleaha station on the Koolua Railroad, 18 feet seaward from the main track, and 12 feet west of the station platform. A standard disk, stamped "H 4 1927" and set in the top of a concrete post. (7.029 meters or 23.061 feet.)

J 4.—At Hauula, on the Koolua Railroad, 18 feet north of the north track, and 5 feet south of the concrete platform at the station. A standard disk, stamped "J 4 1927" and set in the top of a concrete post. (2.712 meters or 8.898 feet.)

K 4.—At Laie, on the Koolua Railroad, about 30 feet south of the road crossing at Laie general store, 15 feet south of the track, 8 feet north of a water tank, and just inside a fence corner. A standard disk, stamped "K 4 1927" and set in the top of a concrete post. (1.756 meters or 5.761 feet.)

L 4.—At Kahuku, on the Koolua Railroad, opposite the mill, and in the southwest corner of the stone base of a water tank near the station. A standard disk, stamped "L 4 1927." (2.242 meters or 7.356 feet.)

M 4.—About 2.2 miles toward Haleiwa from Kahuku, at Marconi waiting station (Kahuku Wireless Station) of the Oahu Railroad & Land Co., 25 feet north of the track, 7 feet toward Kahuku from the station platform, and 2 feet outside of the right-of-way fence. A standard disk, stamped "M 4 1927" and set in the top of a concrete post. (2.693 meters or 8.835 feet.)

N 4.—Near Waialea, 1.250 yards toward Kahuku from Waialea station of the Oahu Railroad & Land Co., 360 feet toward Kahuku from the Kahuku end of Bridge No. 92, 150 feet west of a house north of the track, and 15 feet north of the track. A standard disk, stamped "N 4 1927" and set in the top of a concrete post. (3.765 meters or 12.352 feet.)

A 3.—About 7.8 miles toward Kahuku from Haleiwa, about 130 yards toward Kahuku from the Paumalu station of the Oahu Railroad & Land Co., 95 feet south of the track, 13 feet south of the main road, 12 feet east of a branch road, and just inside a fence corner. A standard disk, stamped "A 3 1927" and set in the top of a concrete post. (7.193 meters or 23.599 feet.)

B 3.—About 4.1 miles toward Kahuku from Haleiwa, at Waimea Bay, 60 feet north of the north end of Bridge No. 84 of the Oahu Railroad & Land Co., 100 yards south of a switch stand, and about 20 feet west of the tracks, in a large lava boulder. A standard disk, stamped "B 3 1927." (6.437 meters or 21.119 feet.)

C 3.—At Haleiwa, along the track of the Oahu Railroad & Land Co., 200 yards from Sea View Inn, about 18 feet south of the track, and about 10 feet north of the Army E. & R. Building, on the lawn. A standard disk, stamped "C 3 1927" and set in the top of a concrete post. (2.713 meters or 8.901 feet.)

Tidal 3.—At Haleiwa, about one-fourth mile from the railroad station, about 30 feet from the end of a point extending into the sea to the northward of Haleiwa. A standard disk, stamped "3" and set in lava rock. (2.536 meters or 8.320 feet.)

Tidal 2.—At Haleiwa, about one-fourth mile from the railroad station, about 330 feet from the end of a point extending into the sea to the northward of Haleiwa, and 10 feet from the edge of the cliff, in lava rock. A standard disk, stamped "2." (3.081 meters or 10.108 feet.)

LINE 7. HALEIWA TO A POINT NEAR WAIPAHAU

C 3.—(See line 6.)

D 3.—At Puuiki Station of the Oahu Railroad & Land Co., about 3 miles toward Kaena Point from Haleiwa, south of the tracks, and 2 feet from and behind the freight station. A standard disk, stamped "D 3 1927" and set in the top of a concrete post. (2.117 meters or 6.946 feet.)

E 3.—At Makuleia Station of the Oahu Railroad & Land Co., about 4.3 miles toward Kaena Point from Haleiwa, 30 feet west of a point opposite the waiting station, 17 feet north of the track, 2 feet north of the right-of-way fence, and 10 feet west of a gatepost. A standard disk, stamped "E 3 1927" and set in the top of a concrete post. (3.096 meters or 10.157 feet.)

F 3.—At Kawaihapai Station of the Oahu Railroad & Land Co., about 6.4 miles toward Kaena Point from Haleiwa, 160 feet west of the station, 35 feet north of a road, 18 feet south of the track, and just inside a fence corner. A standard disk, stamped "F 3 1927" and set in the top of a concrete post. (4.201 meters or 13.783 feet.)

G 3.—About 2 miles west of **Kawaihapai Station** of the Oahu Railroad & Land Co., about 8.2 miles toward Kaena Point from Haleiwa, at Kaena Section No. 7, 25 feet south of the track, 12 feet west of a water tank, and 8 feet outside of the right-of-way fence. A standard disk, stamped "G 3 1927" and set in the top of a concrete post. (5.907 meters or 19.380 feet.)

H 3.—At **Kaena Point**, about 700 feet southwest of the extreme point of the Oahu Railroad & Land Co.'s track around Kaena Point, opposite the last hill before reaching Kaena Point from Waianae, opposite a whistle post, and 33 feet west of the track, in a rock outcrop. A standard disk, stamped "H 3 1927." (9.601 meters or 31.499 feet.)

J 3.—At **Makua**, at Wood's platform of the Oahu Railroad & Land Co., about 7.2 miles toward Kaena Point from Waianae, in the yard of Mr. Wood's house, in the concrete surrounding a well. A standard disk, stamped "J 3 1927." (3.243 meters or 10.640 feet.)

K 3.—At **Keaau Siding** of the Oahu Railroad & Land Co., about 5.3 miles toward Kaena Point from Waianae, 15 feet east of the track, 15 feet south of the waiting platform, and just outside of the right-of-way fence. A standard disk, stamped "K 3 1927" and set in the top of a concrete post. (5.247 meters or 17.215 feet.)

L 3.—At **Makaha**, 3.5 miles toward Kaena Point from Waianae, along the track of the Oahu Railroad & Land Co., in a yard belonging in 1927 to J. R. Holt, 70 feet south of a road crossing, 35 feet east of the track, 10 feet east of a road, and 3 feet inside of the fence. A standard disk, stamped "L 3 1927," and set in the top of a concrete post. (3.219 meters or 10.561 feet.)

M 3.—About 1.6 miles toward Kaena Point from **Waianae**, along the track of the Oahu Railroad & Land Co., 220 yards north of a cattle crossing, 200 feet north of culvert No. 49, 45 feet north of a hand car bay, 17 feet west of the track, and 2 feet outside of the right-of-way fence, in lava rock. A standard disk, stamped "M 3 1927." (1.732 meters or 5.682 feet.)

Tidal 3.—At **Waianae**, at the station of the Oahu Railroad & Land Co., in the foundation of the water tank, in the corner stone at the southeast corner. A standard disk, stamped "3." (3.506 meters or 11.503 feet.)

Tidal 2.—At **Waianae**, opposite the water tank at the station of the Oahu Railroad & Land Co., on the shore, in a rock outcrop. A standard disk, stamped "2." (2.474 meters or 8.117 feet.)

Tidal 1.—At **Waianae**, opposite the station of the Oahu Railroad & Land Co., at the site of an old tide gage, in a rock outcrop. A standard disk, stamped "1." (2.230 meters or 7.316 feet.)

N 3A.—At **Maili Siding** of the Oahu Railroad & Land Co., about 2.2 miles toward Barbers Point from Waianae, 75 yards north of the freight shed, 90 feet east of the track, southeast of the intersection of the main road, and the road to the Maili tract, and just inside a fence corner. A standard disk, stamped "N 3A 1927," and set in the top of a concrete post. (3.271 meters or 10.732 feet.) *NOTE.*—This mark has been destroyed.

N 3.—At **Maili Siding** of the Oahu Railroad & Land Co., about 2.2 miles toward Barbers Point from Waianae, about 80 yards north of the freight shed, between the track and the main road, and 20 feet north of a branch road, in a fence line. A standard disk, stamped "N 3 1927," and set in the top of a concrete post. (3.555 meters or 11.663 feet.)

P 3.—At **Nanakuli Siding** of the Oahu Railroad & Land Co., about 5.5 miles toward Barbers Point from Waianae, 40 feet southwest of a road crossing, 35 feet west of the track, about 15 feet south of a water tank, and just inside a fence corner. A standard disk, stamped "P 3 1927," and set in the top of a concrete post. (5.099 meters or 16.729 feet.)

Q 3.—At **Brown's Camp** of the Oahu Railroad & Land Co., about 8.2 miles toward Barbers Point from Waianae, 22 feet west of the track, 3 feet west of the fence, and 3 feet south of a gatepost at the gate leading to the yard of the house at Brown's Camp. A standard disk, stamped "Q 3 1927," and set in the top of a concrete post. (6.566 meters or 21.542 feet.)

Gilbert (U. S. E.).—At **Gilbert Siding** of the Oahu Railroad & Land Co., 60 feet toward Ewa from a switch stand, 35 feet south of the main track, and just inside of a fence line, in a 4-inch soil pipe. A rectangular bronze plate, stamped "Gilbert." (20.160 meters or 66.142 feet.)

R 3.—At **Sisal Siding** of the Oahu Railroad & Land Co., about 1.9 miles toward Waianae from Ewa, 25 feet east of a road crossing, and 15 feet south of the track. A standard disk, stamped "R 3 1927" and set in the top of a concrete post. (15.496 meters or 50.840 feet.)

S 3.—At **Ewa**, in the face of the concrete loading platform at Ewa Mill, in the southwest face of the south corner, 8 inches above the ground. A standard disk, stamped "S 3 1927" and set vertically. (14.291 meters or 46.886 feet.)

T 3.—At **Hoaeae Station** of the Oahu Railroad & Land Co., about 3.2 miles toward Honolulu from Ewa, 75 yards east of the station, just across the track from the place where the wagon road comes to the track, and 20 feet south of the track. A standard disk, stamped "T 3 1927" and set in the top of a concrete post. (1.669 meters or 5.476 feet.)

LINE 8, FROM A POINT NEAR WAIPAHAU TO HONOLULU

V 3.—At **Pearl City**, 12.1 miles toward Ewa from Honolulu, 75 yards west of the station of the Oahu Railroad & Land Co., 45 feet east of the first road crossing to the west of the station, and 13 feet south of the track. A standard disk, stamped "V 3 1927" and set in the top of a concrete post. (6.652 meters or 21.824 feet.)

W 3.—At **Aiea**, about 9.1 miles west of Honolulu, about 40 yards toward Honolulu from the station of the Oahu Railroad & Land Co., 10 feet north of the track, and 3 feet south of a sidewalk. A standard disk, stamped "W 3 1927" and set in the top of a concrete post. (1.863 meters or 6.112 feet.)

X 3.—At **Puuloa**, about 6.8 miles west of Honolulu, about 70 yards west of the station of the Oahu Railroad & Land Co., on the south side of the track, in the concrete base of a semaphore. A standard disk, stamped "X 3 1927." (9.659 meters or 31.690 feet.)

Y 3.—About 4.5 miles west of **Honolulu**, at the place where the highway from Honolulu to Pearl Harbor crosses the main track of the Oahu Railroad & Land Co. and then parallels the track to Pearl Harbor, 30 feet south of the track, 6 feet south of the edge of the highway, and just inside a fence corner. A standard disk, stamped "Y 3 1927" and set in the top of a concrete post. (5.669 meters or 18.599 feet.)

Z 3.—About 2.8 miles west of **Honolulu**, at the Mokaeua Street crossing of the main line of the Oahu Railroad & Land Co., 22 feet north of the center of the railroad, and northwest of the crossing. A standard disk, stamped "Z 3 1927" and set in the top of a concrete post. (4.946 meters or 16.227 feet.)

G 2.—At **Honolulu**, at the southeast corner of the station of the Oahu Railroad & Land Co., in the face of the foundation. A standard disk, stamped "G 2 1927" and set vertically in the concrete foundation. (1.615 meters or 5.299 feet.)

B. M. 3.—(See p. 9.)

LINE 9, FROM A POINT NEAR WAIPAHAU TO HALEIWA, VIA SCHOFIELD BARRACKS

U 3.—About 1 mile toward Honolulu from **Waipahu Junction**, 75 yards toward Ewa from the junction of the main line of the Oahu Railroad & Land Co. and a sugar road running out on the Waipio Peninsula, and 12 feet south of the main track. A standard disk, stamped "U 3 1927" and set in the top of a concrete post. (2.440 meters or 8.005 feet.)

P 4.—About 6.9 miles toward Honolulu from **Schofield Barracks**, on the Honolulu-Schofield Road, about 1½ miles south of the bottom of Kipapa Gulch, at the place where the road branches to the Pearl City fruit cannery, in the **V** of the fork, 20 feet from the center of the main road, and 12 feet from the center of the road to the cannery. A standard disk, stamped "P 4 1927" and set in the top of a concrete post. (137.367 meters or 450.678 feet.)

Q 4.—About 5.6 miles toward Honolulu from **Schofield Barracks**, at the bottom of Kipapa Gulch, on the Honolulu-Schofield Road, in the north abutment of the west end of the bridge. A standard disk, stamped "Q 4 1927" and set in the concrete abutment. (107.295 meters or 352.017 feet.)

R 4.—About 2.4 miles toward Honolulu from **Schofield Barracks**, at the crossing of the main road to Schofield and the Schofield Branch of the Oahu Railroad & Land Co., a few feet east of the road. A standard disk, stamped "R 4 1927" and set in the top of a concrete post. (208.525 meters or 684.136 feet.)

Base Line No. 2 (U. S. E).—About three-fourths mile toward Honolulu from **Schofield Barracks** on the main Honolulu-Schofield Road, 15 feet south of the railroad crossing near Wheeler Field, 6 feet west of the edge of the road, and

3 feet north of a crossing sign. A square bronze plate set in the top of a concrete post. (251.574 meters or 825.372 feet.)

U. S. M. R. No. 39 (U. S. A.).—At **Schofield**, on the main Honolulu-Schofield Road, opposite Carter Gate, 80 feet east of the center of the main road, about 24 feet north of Wahiawa Road, and just inside a fence corner. A bronze plate set in the top of a concrete post. (270.087 meters or 886.110 feet.)

U. S. M. R. No. 35 (U. S. A.).—At **Schofield**, about 40 feet east of the main Schofield-Haleiwa Road, 100 feet north of a point opposite Macomb Gate, at Kemoo farm store, and 10 feet east of a line of telephone poles. A bronze plate set in the top of a concrete post. (264.192 meters or 866.770 feet.)

U. S. M. R. No. 31 (U. S. A.).—About 1 mile toward Haleiwa from **Schofield**, on the main Schofield-Haleiwa Road, at the bottom of Kaukonahua Gulch, 15 feet south of the main road, on the edge of the bank about 10 feet west of the west end of a bridge. A bronze plate set in the top of a concrete post. (233.502 meters or 766.081 feet.)

S 4.—About 3.2 miles toward Haleiwa from **Schofield Barracks**, on the Schofield-Haleiwa Road, about one-fourth mile toward Haleiwa from the summit, 26 feet west of the road at a place where the road to Kemoo farm turns westward, 16 feet south of the Kemoo farm road, and 25 feet from a water tank. A standard disk, stamped "S 4 1927" and set in the top of a concrete post. (284.588 meters or 933.686 feet.)

T 4.—About 2.5 miles toward Schofield from **Haleiwa**, on the Schofield-Haleiwa Road, at the junction of the road to Waiialua Mill, 40 feet southeast of the intersection of the roads, between the road and the ditch. A standard disk, stamped "T 4 1927" and set in the top of a concrete post. (22.080 meters or 72.441 feet.)

C 3.—(See p. 11.)

LINE 10, FROM HONOLULU TO A POINT NORTHEAST OF NUUANU PALI, VIA NUUANU VALLEY

B. M. 3.—(See p. 9.)

B. M. 200 (city of Honolulu).—In **Honolulu**, on Kuakini Street, about 8 feet east of the east end of the bridge over Nuuanu Stream, and about 75 yards west of Nuuanu Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (19.224 meters or 63.071 feet.)

B. M. 203 (city of Honolulu).—In **Honolulu**, on Nuuanu Avenue, opposite the Queen Emma Museum, just below Puiwa Street, between the tracks of the short stretch of double tracking at the upper end of the Nuuanu Valley trolley line. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (92.137 meters or 302.236 feet.)

Z 2.—About 2.4 miles up Nuuanu Valley from **Honolulu**, at the end of the Nuuanu Valley trolley line, at the corner of Nuuanu and Puiwa Roads, at the northwest corner of the Queen Emma Museum grounds and about 7 feet higher than the road. A standard disk, stamped "Z 2 1927" and set in the top of a concrete post. (113.177 meters or 371.315 feet.)

Y 2.—About 3.2 miles up Nuuanu Valley from **Honolulu**, about 0.8 mile above the end of the Nuuanu Valley trolley line, just above a fork in the road where the main road goes to the left in ascending the valley, and about 10 feet from the edge of the road to the east, in a rock outcrop. A standard disk, stamped "Y 2 1927." (170.411 meters or 559.090 feet.)

X 2.—At **Nuuanu Pali**, about 6.3 miles up Nuuanu Valley from Honolulu, at the summit of the Pali Road, on the concrete wall along the road, on top of the last concrete post. A standard disk, stamped "X 2 1927." (361.566 meters or 1,186.238 feet.)

W 2.—At **Nuuanu Pali**, about 6.3 miles up Nuuanu Valley from Honolulu, at the summit of the Pali Road, and just north of the Historical Memorial Tablet, in rock. A standard disk, stamped "W 2 1927." (360.683 meters or 1,183.341 feet.)

V 2.—(See p. 10.)

LINE 11, SPUR LINE UP WILHELMINA RISE, HONOLULU

B. M. 3.—(See p. 9.)

G (city of Honolulu).—In **Honolulu**, at the intersection of Wilhelmina Rise Avenue and Thirteenth Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (58.561 meters or 192.129 feet.)

F (city of Honolulu).—In Honolulu, at the intersection of Wilhelmina Rise Avenue and Likelike Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (85.248 meters or 279.684 feet.)

Z 4.—In Honolulu, at the northwest corner of the intersection of Wilhelmina Rise Avenue and the lowest crossing of Lurline Avenue, one intersection above the intersection of Sierra Avenue and Wilhelmina Rise Avenue. A standard disk, stamped "Z 4 1928" and set in the concrete of a sewer structure. (125.852 meters or 412.899 feet.)

E (city of Honolulu).—In Honolulu, at the intersection of Wilhelmina Rise Avenue and the second intersection of Lurline Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (186.692 meters or 612.505 feet.)

D (city of Honolulu).—In Honolulu, at the intersection of Wilhelmina Rise Avenue and the third crossing of Lurline Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (234.250 meters or 768.535 feet.)

C (city of Honolulu).—In Honolulu, at the highest point on Wilhelmina Rise Avenue itself. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (263.698 meters or 865.149 feet.)

B (city of Honolulu).—In Honolulu, at the intersection of Lurline Avenue and Lurline Circle. The easterly of two marks. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (290.860 meters or 954.263 feet.)

A (city of Honolulu).—In Honolulu, on the northeast side of Lurline Circle at the intersection of the street leading eastward from the circle. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (318.090 meters or 1,043.600 feet.)

Triangulation station Kalipeamoa.—In Honolulu, at the highest point of Wilhelmina Rise above Kaimuki. A standard triangulation station disk, set in the top of a concrete post. (340.268 meters or 1,116.363 feet.)

LINE 12, ALONG THE WATER FRONT IN HONOLULU

Tidal 18.—(See p. 8.)

H (city of Honolulu).—In Honolulu, at the intersection of Ala Moana and Keawe Street. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (0.989 meters or 3.245 feet.)

B 5.—In Honolulu, just east of the intersection of Ala Moana and Ward Avenue, on the Kewalo Basin Pier, at the shore end, just above the four steps leading to the pier at the east side. A standard disk, stamped "B 5 1928" and set in the concrete floor of the pier. (1.837 meters or 6.027 feet.)

C 5.—In Honolulu, at the northwest corner of the intersection of Ala Moana and Pensacola Street extended. A standard disk, stamped "C 5 1928" and set in the top of a concrete post. (1.794 meters or 5.886 feet.)

D 5.—In Honolulu, on the south side of Ala Moana, about 100 feet east of its intersection with the Ala Wai Canal, and just north of a fence line. A standard disk, stamped "D 5 1928" and set in the top of a concrete post. (1.003 meters or 3.291 feet.)

J 5.—In Honolulu, on the parade ground at Fort De Russey, in the south side of the concrete base of the flag pole. A standard disk, stamped "J 5 1928." (1.340 meters or 4.396 feet.)

K (city of Honolulu).—In Honolulu, at the intersection of Kalakaua Avenue and Lewers Road. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (1.512 meters or 4.961 feet.)

L 6 (U. S. G. S.).—In Honolulu, on Kalakaua Avenue, on the northwest side of the Moana Hotel, in the northeast wing to the tradesmen's entrance. A United States Geological Survey standard disk, stamped "L 6" and set in the top of the concrete wing of the steps. (3.214 meters or 10.545 feet.)

A 5.—In Honolulu, on the southeast side of Kapahulu Road, between Pahi and Leahi Avenues, northeast of the entrance to the Waikiki fire station, under the lamp attached to the wall. A standard disk, stamped "A 5 1928" and set in the concrete floor. (2.605 meters or 8.547 feet.)

L (city of Honolulu).—In Honolulu, at the intersection of Winam Avenue and Kapahulu Road. The top of a brass rod set vertically in the top of a concrete

post, access to which is had through a circular iron cover. (3.824 meters or 12.546 feet.)

M (city of Honolulu).—In Honolulu, at the intersection of Waialae Road and Kapahulu Road. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (12.241 meters or 40.161 feet.)

J 2.—(See p. 9.)

LINE 13, THE PAUOA SPUR LINE, HONOLULU

B. M. 200.—(See p. 14.)

E 5.—In Honolulu, at the northwest corner of the intersection of Pauoa Road and Fort Street, at the edge of a stone wall. A standard disk, stamped "E 5 1928" and set in the top of a concrete post. (30.901 meters or 101.381 feet.)

F 5.—In Honolulu, about 150 yards east of the intersection of Pacific Heights Road and Old Pauoa Valley Road, on the north side of the road, in front of a brown house, at the foot of a short slope, about 20 feet north of a stone wall, and 10 feet northeast of stone steps, in a bowlder. A standard disk, stamped "F 5 1928." (78.828 meters or 258.622 feet.)

G 5.—In Honolulu, about 1,000 feet up Pauoa Valley Road from the first stream crossing, 50 feet above a brown house belonging (1928) to W. Fujita, 30 feet southeast of the road, opposite the first telephone pole above a similar one with an electric light on the top. A standard disk, stamped "G 5 1928" and set nearly flush with the ground in a mass of concrete. (121.569 meters or 398.848 feet.)

H 5.—In Honolulu, about 200 feet northwest of Pauoa Valley Road, 100 feet northwest of Rose Apple Spring, 50 feet northwest of Pauoa Stream, 1.5 feet along the line to Punchbowl triangulation station from the triangle marking the end of the first course of Land Court Application No. 681, in a large bowlder, about 3 feet above the ground. A standard disk, stamped "H 5 1928." (196.661 meters or 645.212 feet.)

LINE 14 AND 15, THE SPURS IN THE KAPALAMA DISTRICT, HONOLULU

B. M. 200.—(See p. 14.)

N (city of Honolulu).—In Honolulu, at the intersection of School Street and Nuuanu Avenue. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (12.108 meters or 39.724 feet.)

P (city of Honolulu).—In Honolulu, at the intersection of School Street and Liliha Street. The southerly of two marks. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (14.642 meters or 48.038 feet.)

U 4.—In Honolulu, at the intersection of School Street and Lanakila Street, in front of the insane asylum, at the north edge of a little park. A standard disk, stamped "U 4 1928" and set in the top of a concrete post. (12.848 meters or 42.152 feet.)

Q (city of Honolulu).—In Honolulu, at the intersection of School Street and Houghtailing Road. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (14.403 meters or 47.254 feet.)

R (city of Honolulu).—In Honolulu, at the intersection of School Street and Kalihi Road. The top of a brass rod set vertically in the top of a concrete post, access to which is had through a circular iron cover. (32.650 meters or 107.119 feet.)

120 (U. S. G. S.).—In Honolulu, on Kalihi Road, about 400 feet north of School Street, and 4 feet west of the pavement. A copper bolt and washer cemented into a bowlder. (36.502 meters or 119.757 feet.)

V 4.—In Honolulu, at the northwest corner of the intersection of Lolena and Iholena Streets, and just outside the curb line on the drive up Alewa Heights. A standard disk, stamped "V 4 1928" and set in the top of a concrete post. (60.920 meters or 199.868 feet.)

W 4.—In Honolulu, on the east side of Alewa Drive, about 100 feet above the intersection of Alewa Drive and Ilima Street, and near a lump post. A standard disk, stamped "W 4 1928" and set in the top of a concrete post. (113.537 meters or 372.496 feet.)

X 4.—In **Honolulu**, in front of the home of Joseph Odenstein, at No. 1332 Alewa Drive, at a semicircular turning space in the road, on top of and near the west end of a retaining wall. A standard disk, stamped "X 4 1928." (168.876 meters or 554.054 feet.)

Y 4.—In **Honolulu**, in front of and across the road from No. 1520 Alewa Drive, on the upper side of the road, and about 8 feet from the north corner of a stone wall. A standard disk, stamped "Y 4 1928" and set in the top of a concrete post. (203.483 meters or 667.594 feet.)

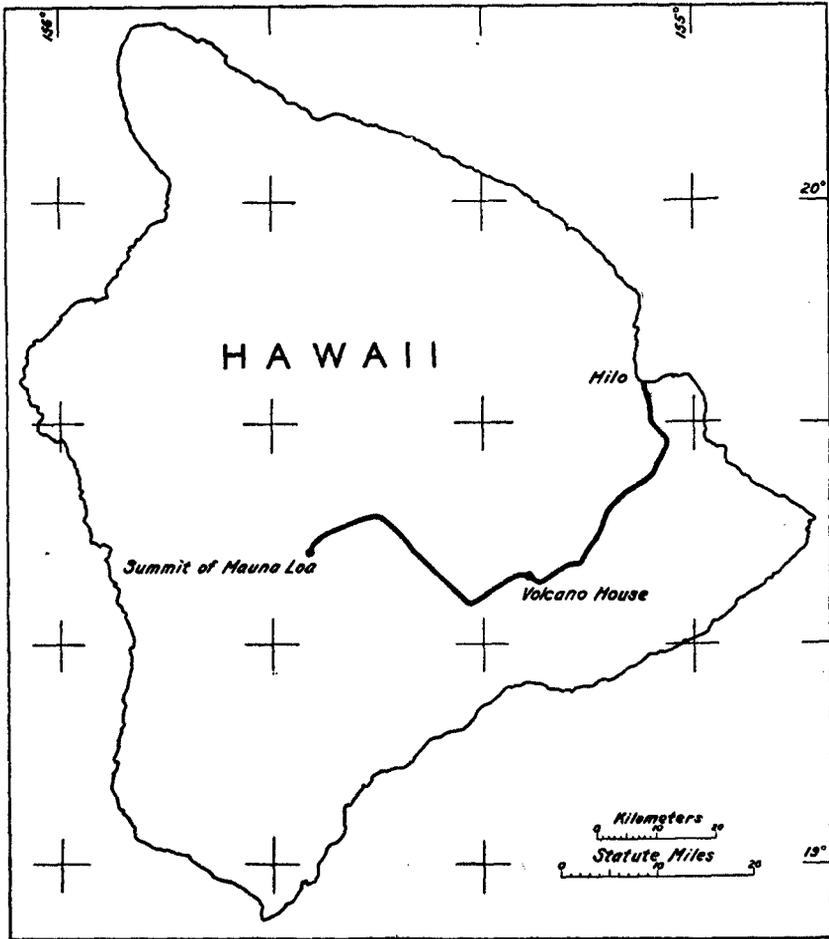


FIGURE 2.—Leveling on the island of Hawaii

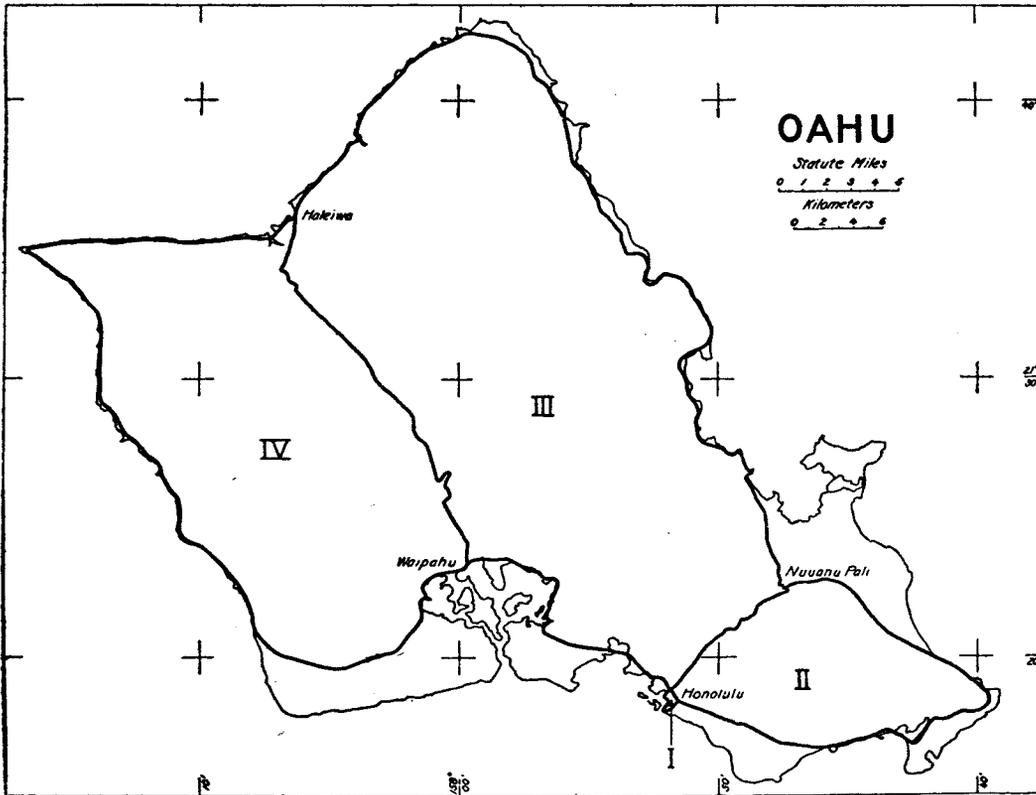


FIGURE 3.—Leveling on the island of Oahu

INDEX TO BENCH-MARK LOCATIONS

ISLAND OF HAWAII	Page	ISLAND OF OAHU—Continued	Page
Brown's ranch.....	7, 8	Kaukonahua Gulch.....	14
Crater Hotel.....	7	Kawahapai Station.....	11, 12
Hilo.....	6	Keeau Siding.....	12
Hilo-Volcano Road.....	6, 7	Kemoo farm store.....	14
Jaggar's Cave.....	8	Kipapa Gulch.....	13
Keeau.....	6, 7	Koko Crater.....	10
Kukui.....	7	Lale.....	11
Kurtistown post office.....	6	Libbyville.....	10
Mauna Loa, summit.....	8	Liliuokalani School.....	9
Mountain View.....	7	Macomb Gate.....	14
Olea.....	6	Mali Siding.....	12
Red Hill.....	8	Makaha.....	12
Volcano House.....	7	Makapuu Head.....	10
Volcano House-Mauna Loa Trail.....	7, 8	Makua.....	12
ISLAND OF OAHU			
Alea.....	13	Makuleia Station.....	11
Ala Moana.....	15	Molilihi Ball Park.....	9
American Factor Building.....	9	Nanakuli Siding.....	12
Bishop estate.....	9	Nuanuu Pali.....	10, 14
Brown's Camp.....	12	Nuanuu Valley.....	14
Carter Gate.....	14	Paumalu.....	11
Central Union Church.....	9	Pauoa spur line.....	16
Ewa.....	13	Pearl City.....	13
Federal Building.....	9	Pier 2.....	8
Fort De Russey.....	15	Puuliki Station.....	11
Gilbert Siding.....	12	Puuloa.....	13
Haleaha Station.....	11	Queen Emma museum.....	14
Haleiwa.....	11, 14	Schofield Barracks.....	13, 14
Hauula.....	11	Sisal Siding.....	12
Hawaiian Electric Co. plant.....	9	Walalee.....	11
Heela.....	10	Walalua Mill.....	14
Hoaeae Station.....	13	Watanae.....	12
Honolulu.....	8, 9, 13, 14, 15, 16, 17	Waikane.....	10
Judiciary Building.....	9	Wailupe Naval Wireless Station.....	9
Kaena Point.....	12	Waimanalo.....	10
Kahana Bay.....	10	Waimanalo Landing.....	10
Kahuku.....	11	Waimoa Bay.....	11
Kalipeemoa triangulation station.....	15	Waipahu Junction.....	13
		Wheeler Field.....	13
		Wilhelmina Rise spur line.....	14, 15

