

SUBSURFACE AND SURFACE WASTE-DISPOSAL PRACTICE ON OAHU

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The island of Oahu has an area of 604 square miles (1,567 square kilometers) and is the third largest of the eight major islands that make up the State. The population of Oahu, in 1970, was about 530,000 or more than 50 percent of the State's population of about 771,000. Honolulu, the State's capital and largest city, is on Oahu and, in 1970, gave the island a very high ratio of urban population (585,000) to rural population (45,000).

The geologic history of Oahu was discussed in considerable detail by Stearns and Vokvik (1951), Stearns (1959, 1960). Oahu has developed through the cooling and consolidation of two shield volcanoes, the older Waianae volcano on the west and the younger Koolau on the east. Waianae volcano became dormant first and was deeply eroded before lavas from Koolau volcano overlapped its eroded east slope. The Koolau volcano is chiefly composed of highly permeable basaltic lava flows, which make up the bulk of the Koolau Range. The less permeable andesitic tuffaceous lavas of the Koolau volcano is absent, and this makes the Koolau Range a highly permeable rock mass. Much of the older Waianae Range is veneered by andesite. Deep initial subsidence of Oahu and subsequent smaller shifts in sea level have caused thick deposits of lagoonal sediments to accumulate behind developing barrier reefs to form wide coastal-plain areas. It is in these coastal-plain areas where land development, both urban and agricultural, is most extensive on Oahu.

About 30 subsurface waste-disposal sites are on Oahu and all but two are in coastal-plain areas (fig. 1, sheet 2). Sites of surface waste disposal include discharge in streams, irrigation use of ponded or treated water, and solid-waste dumps. The approximate line of demarcation between the principal, volcanic, waste-receiving aquifer and the sedimentary waste-receiving aquifer was determined from well logs and by projecting slopes of the volcanic outcrop. A geohydrologic section (after Wentworth, 1951) (fig. 2, sheet 2) is located near disposal sites 4 and 13 in the coastal-plain area of Honolulu. Sites 4 and 13 are drilled wells, 91 and 80 feet (28 and 24 meters) deep, respectively, which are used to inject automobile wash water into the subsurface. The receiving aquifer is coralline limestone in the caprock. Water level in the caprock ranges from less than a foot (0.3 meter) to about 5 feet (1.5 meter) above mean sea level. This thin basal-water body floats on saline ground water, which, in turn, is underlain by confined basal water in the Koolau lava flows with an artesian head of more than 25 feet (7.6 meters) above sea level. Because of the large head difference between the water bodies, waste injected into the caprock in the coastal-plain area will not enter the confined basal-water body. Waste injected into the subsurface inland of the coastal-plain area will be received by the volcanic aquifer.

A sketch of a typical stream channel in the Kaneohe area is shown on figure 3, sheet 2. Alluvium of low permeability overlies and confines dike-impounded ground water. Stream channels have cut into this material to allow discharge from the underlying confined ground water. The streams are gaining, and maximum flow is at low altitudes near the shore. The larger streams are those that cut deepest into the dike-impounded ground-water reservoir. Under present hydraulic conditions, wastes injected into the subsurface in this area will presumably be discharged as effluent flow in nearby stream channels and waste discharged into the stream channels will not infiltrate into the subsurface.

Severed areas, moderately to densely inhabited areas not served but serviced by cesspools, and irrigated sugarcane fields are shown on figure 4, sheet 2. Sewage from nearly all of the severed areas near the shore, is discharged into offshore outfalls. Severed wastes from isolated inland areas receive some degree of treatment, and the effluent is put into irrigation ditches or irrigation reservoirs or discharged into stream gullies. A significant part of the water used to irrigate sugarcane infiltrates the ground surface and recharges underlying ground-water bodies. Studies by Visher and Mink (1964), Takasaki and Valenciano (1969), and Tomoro and others (1970) relate percolating irrigation water to the chemistry of ground water underlying irrigated fields.

Also shown on figure 4 are lines of equal chloride content of ground water in the volcanic aquifer. Where data are sparse, the chloride content of the water from individual sources is shown. Near the end of the irrigation season, owing to upconing by heavy pumping, the chloride content of the irrigation water applied may exceed the chloride content of the underlying ground water in some of the sugarcane areas.

The areas severed in 1972 and the tributary areas for the sewer system proposed in a consultants' report, prepared in 1972 for the City and County of Honolulu, are shown on figure 5. Also shown are the proposed additional waste-disposal sites, which were pending in 1972. Nearly all the inhabited areas serviced by cesspools in 1972 will be severed by 2020, if the proposals and recommendations by the Consortium are adopted.

Photographs of waste-disposal sites at the Hawaiian Independent Refinery and Waimanalo sewage treatment plant are shown in figures 6 and 7, respectively.

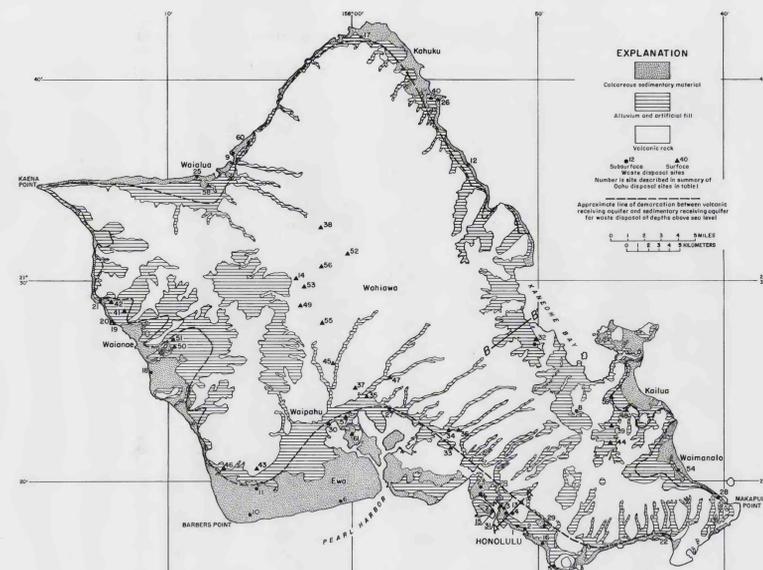


FIGURE 1. MAP OF OAHU SHOWING GENERALIZED GEOLOGY, WASTE-DISPOSAL SITES, AND PRINCIPAL WASTE-RECEIVING AQUIFERS.

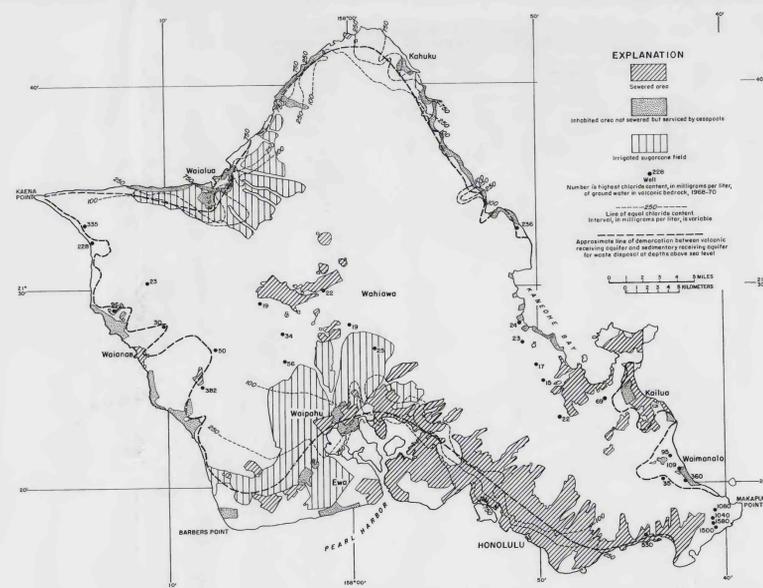


FIGURE 4. MAP OF OAHU SHOWING SEWERAGE AREAS, UNINHABITED AREAS NOT SEWERED, SUGARCANE FIELDS, AND CHLORIDE CONTENT OF GROUND WATER IN VOLCANIC BEDROCK.

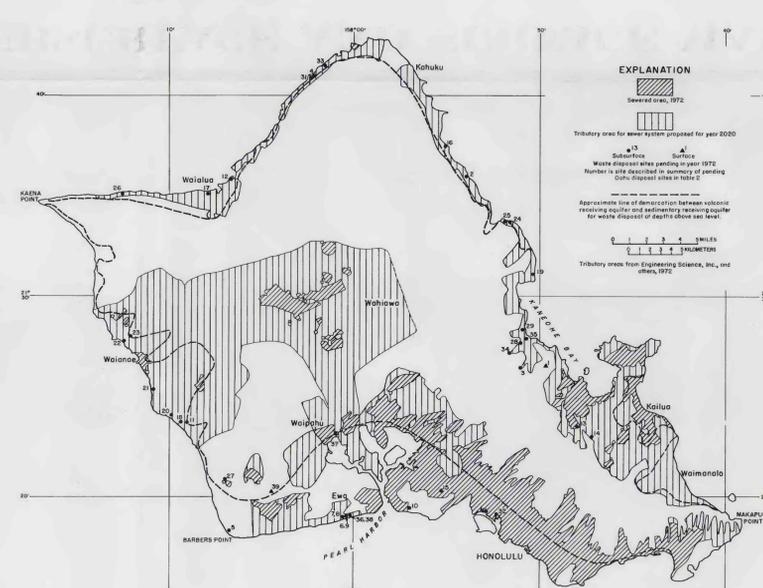


FIGURE 5. MAP OF OAHU SHOWING SEWERAGE AREAS IN 1972, PENDING WASTE-DISPOSAL SITES, AND TRIBUTARY AREAS TO SEWER SYSTEM PROPOSED FOR YEAR 2020.

TABLE 1. SUBSURFACE AND SURFACE WASTE DISPOSAL ON OAHU AS OF DECEMBER 1972

SITE	NAME	NATURE OF WASTE	TREATMENT	DISPOSAL	GROUND-WATER RESOURCES AFFECTED	REMARKS
1	1350 Ala Moana b/	Rain, wash water	None	Injection well	Brackish water-table zone in limestone	Well depth 88 ft., cased to 42
2	Ala Moana Center b/	Rainwater	do	2 injection wells	do	Well depth 40 ft., cased to 9
3	Amfac b/	Air-conditioning water	do	Injection well	Water-table zone in limestone	Well depth 91 ft., cased to 35
4	Bert's Service b/	Car wash return	do	do	do	Well depth 80 ft., cased to 35
5	Bron Hawaiian Apartments c/	Sewage	Aerobic, cavittete g/	do	do	Flow 1,600 gpd
6	Bee (Kalama) Apartments c/	do	Aerobic, chlorinated	Injection well	do	Flow 80,000 gpd
7	Guillermo Care Home c/	do	Aerobic, cavittete	do	Water-table zone in alluvium and lava flows	Flow 1,000 gpd
8	Haku Gardens c/	do	do	do	Water-table zone in lava flows	Flow 7,000 gpd
9	Haleiwa Beach Hotel c/	do	do	Seepage pits	Saline water in beach sands	Flow 4,500 gpd
10	Hawaiian Independent Refinery c/	Refinery waste	do	Injection well	Brackish water-table zone in limestone	Well depth 70 ft.
11	Hawaiian Telephone c/	Car wash return	Aerobic, cavittete	do	do	Well depth 80 ft.
12	Honolulu Hale c/	do	do	Injection well	Water-table zone in limestone	Well depth 70 ft., cased to 12
13	K & Y Service b/	Sewage	None	Injection well	do	Flow 22,000 gpd
14	Kemo-by-the-Lake c/	Sewage	Aerobic, chlorinated	Irrigation reservoir	do	Flow 11,000 gpd
15	Keeli Fisheries c/	do	None	Cesspool, temporary	do	Flow 7,000 gpd
16	Kopya b/	Air-conditioning water	do	Injection well	Brackish water-table zone in limestone	Well depth 105 ft., cased to 54
17	Kuilima Hotel c/	Sewage	do	do	do	do
18	Makaha Beach House c/	do	Aerobic, cavittete	2 injection wells	Brackish water-table zone in limestone	Flow 14,000 gpd
19	Makaha Beach Apartments c/	do	do	do	do	Flow 12,000 gpd
20	Makaha Beach Cottages c/	do	do	2 injection wells	do	Flow 15,000 gpd
21	Makaha Shores c/	do	do	Injection wells	do	do
22	Mumukia Bay Park c/	do	Aerobic, chlorinated	Injection wells	do	do
23	McKinley Motors b/	Car wash return	do	Injection wells	Water-table zone in calcareous sediments	Location not available
24	Mokuleia c/	Sewage	Aerobic, cavittete	Seepage pit	do	do
25	Mokuleia Resorts c/	do	do	Seepage pit	Water-table zone in calcareous sediments	Flow 4,000 gpd
26	North Shore Resort c/	do	do	Seepage pit	Water-table zone in alluvium	Flow 1,000 gpd
27	Pizza Hut c/	do	do	Cesspool	Water-table zone in limestone	Flow 2,000 gpd
28	Sea Life Park b/	Aquarium waste water	None	7 injection wells	Brackish water-table zone in lava flows	Well depths 70-175 ft.
29	Star Market c/	Air-conditioning water	do	Injection well	Water-table zone in limestone	Well depth 28 ft., cased to 15
30	U.S. Navy b/	Accidental fuel spill	Recovery	do	Water-table zone in alluvium	do
31	Wilcox Development b/	Air-conditioning water	None	Injection well	Water-table zone in limestone	Well depth 40 ft., cased to 17
SUGARCANE-TREATMENT PLANTS f/						
32	Ahuimanu	Sewage	Tertiary	Ahuimanu Stream	Water-table zone in alluvium and lava flows	Flow 110,000 gpd
33	Allanama Crater	do	Secondary	Salt Lake	do	Flow 30,000 gpd
34	Animal Quarantine	do	do	So. Waialua Stream	Basal ground water in lava flows	Flow 90,000 gpd
35	Capehart Housing	do	do	Waialua Stream	do	Flow 100,000 gpd
36	City and County Jail	do	do	So. Waialua Stream	do	Flow 90,000 gpd
37	Creastview	do	do	Irrigation ditch	do	Flow 150,000 gpd, discontinued
38	Halemano	do	do	Halemano Stream	do	Flow 50,000 gpd
39	Kukanono	do	do	Well, overflow to swamp	Water-table zone in alluvium and lava flows	Flow 50,000 gpd
40	Lale	do	do	Ditch	Water-table zone in sediments	Flow 200,000 gpd
41	Makaha	do	do	Irrigation	do	Flow 150,000 gpd
42	Makaha Valley	do	Oxidation pond	Wells, irrigation	do	do
43	Makaloa Heights	do	Secondary	Irrigation ditch	Basal ground water in lava flows	Flow 350,000 gpd
44	Mananali, 1 and 2	do	do	Mananali Stream	Water-table zone in alluvium and lava flows	Flow 140,000 gpd
45	Millard	do	do	Riipepe Stream	Basal ground water in lava flows	Flow 120,000 gpd
46	Nanai	do	do	Dry gulch	do	Flow 20,000 gpd
47	Paliades	do	do	Waialua Stream	do	Flow 690,000 gpd
48	Pohokopu	do	do	Wells, irrigation	Water-table zone in alluvium and lava flows	Flow 270,000 gpd
49	U.S. Army Schofield	do	do	Waialae Stream	Dike-impounded water in lava flows	Flow 1.64 mgd
50	U.S. Navy (Lanikai) NAD	do	Oxidation pond	Drainage ditch	Water-table zone in sediments	Flow 800,000 gpd
51	U.S. Navy (Lanikai) NRS	do	do	Fomolo Oaich	do	Flow 50,000 gpd
52	U.S. Navy (Waialae) NRS	do	Secondary	do	do	Flow 280,000 gpd
53	Waialae	do	do	Waialae Reservoir	do	Flow 1.12 mgd
54	Waimanalo	do	do	3 injection wells	Brackish confined zone in limestone	Well depths 210-220 ft., cased to 80
55	Waipahoehoe	do	do	Waialae Stream	Basal ground water in lava flows	Flow 150,000 gpd
56	Waimanalo Village	do	do	Waialae Reservoir	do	Flow 160,000 gpd
SUGARCANE MILL WASTES d/						
57	Oahu Sugar Co.	Cane wash and bagasse	Sedimentation	Spreading	Water-table zone in sediments	do
58	Waialua Agricultural Co.	do	do	Irrigation, spreading	do	do
SOLID-WASTE DUMPS e/						
59	Kaliua dump	Solid waste	None	Fill on site	Water-table zone at surface or in underlying alluvium	Municipal waste
60	Haleiwa dump	do	do	do	do	do
61	Waipahoehoe dump	do	Incineration	do	Water-table zone in underlying sediments	do

a/ Small modular aerobic sewage-treatment unit developed by Hana Enterprises in Hawaii.
b/ - g/ Sources of information: b/ U.S. Geological Survey; c/ State Department of Health; d/ owner; e/ City and County of Honolulu; f/ Engineering Science, Inc. and others, 1972.

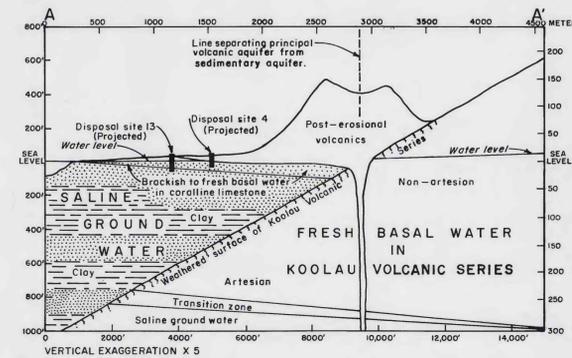


FIGURE 2. GEOHYDROLOGIC SECTION A-A' NEAR DISPOSAL SITES 4 AND 13 IN COASTAL PLAIN OF HONOLULU (AFTER WENTWORTH, 1951).

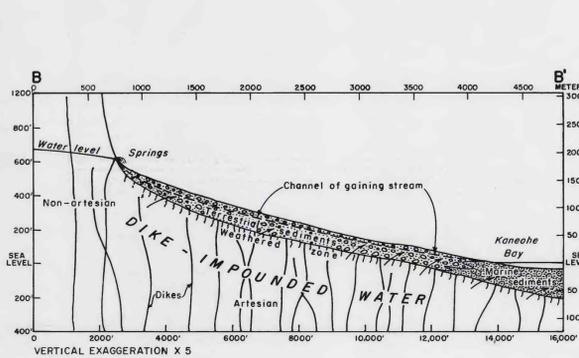


FIGURE 3. SKETCH OF TYPICAL STREAM CHANNEL IN KANEOHE BAY AREA SHOWING POSITIONS OF DISCHARGE ZONES.

TABLE 2. PENDING SUBSURFACE AND SURFACE WASTE DISPOSAL ON OAHU AS OF DECEMBER 1972

SITE	NAME	NATURE OF WASTE	TREATMENT	DISPOSAL	GROUND-WATER RESOURCES AFFECTED	REMARKS
1	Ahuimanu Estate c/	Sewage	Secondary	Effluent to stream	Fresh water-table zone in alluvium and lava flows	do
2	L. Robert Allen c/	do	do	Injection wells	Fresh water-table zone in lava flows	Location not available
3	Frank Arlitz c/	do	do	do	do	do
4	Community Planning, Inc. c/	do	do	do	Fresh to brackish water-table zone in lava flows	do
5	Conoco-Dillingham Refinery g/	Refinery wastes	do	do	Brackish water-table zone in limestone	do
6	Bee Beach Townhouse c/	Sewage	Aerobic plant	do	do	do
7	Bee Colony c/	do	do	do	do	do
8	Berlani Village c/	do	Secondary	do	do	Flow 50,000 gpd
9	Bee Village Estates c/	do	Aerobic plant	do	do	Flow 59,000 gpd
10	PAI Logistic Staging Facility c/	do	do	Seepage pits	do	Flow 1,000 gpd
11	Pergamon Development c/	do	do	Cesspool settling	do	Flow 133,000 gpd
12	Haleiwa Surf Hotel c/	do	Aerobic, cavittete g/	do	Brackish water-table zone in calcareous sediments	51 rooms
13	Halekua Housing Development c/	do	None	Group cesspools	Fresh water-table zone in alluvium and lava flows	Flow 12,000 gpd
14	Hawaii Lea College Student Housing c/	do	do	Injection wells	Fresh water-table zone in limestone	Cesspools not approved
15	Honolulu Airport car wash c/	Car wash return	None	Injection well	Fresh to brackish water-table zone in limestone	do
16	Kaipapa Apartments c/	Sewage	Aerobic, cavittete	do	Brackish water-table zone in sediments	Seepage pits not approved
17	Kaulaie Kai c/	do	do	do	Brackish water-table zone in calcareous sediments	do
18	Keystone Investment Co. c/	do	do	Injection wells	Brackish water-table zone in limestone	do
19	Kualoa Beach Park c/	do	Aerobic plant	do	Brackish water-table zone in sediments	do
20	Lanikai PD Housing c/	do	do	Overflow to wells	Brackish water-table zone in calcareous sediments	Flow 3,000 gpd
21	Waile Beach Tower c/	do	Cesspool settling	do	Brackish water-table zone in limestone	do
22	Makaha Surfside Development c/	do	Aerobic, cavittete	do	Brackish water-table zone in calcareous rock	do
23	Makaha Villa West c/	do	do	do	Fresh water-table zone in lava flows and alluvium	do
24	Makaha Villa East c/	do	do	do	Brackish water-table zone in sediments	do
25	Makaha Planned Development c/	do	do	do	Brackish water-table zone in limestone	do
26	Mokuleia Army Beach c/	do	do	Injection wells	Brackish water-table zone in limestone	do
27	Mokuleia Gardens Housing Project c/	do	do	do	Sugarcane irrigation	Basal ground water in lava flows
28	Park Lane Country Homes c/	do	Secondary	Injection wells	Fresh water-table zone in alluvium	Flow 73,000 gpd
29	Palaia Road Housing Development c/	do	Secondary	Irrigation, wells	Fresh water-table zone in alluvium and lava flows	Flow 52,000 gpd
30	Theodore Smeikal b/	do	do	Injection wells	Fresh water-table zone in lava flows	do
31	Sunset Beach Lots c/	do	Aerobic plant	do	Brackish water-table zone in sediments and lava flows	do
32	Union Oil Co. car wash b/	Car wash return	None	do	Brackish water-table zone in sediments	do
33	University Waialae Extension c/	do	do	Injection well	Fresh water-table zone in weathered lava flows	do
34	Waialae Valley Development c/	Sewage	do	Irrigation reuse	Fresh water-table zone in alluvium and lava flows	do
35	Wailela Terrace c/	do	do	do	Fresh water-table zone in alluvium	626 housing units
36	Uyeda and Island Investment c/	do	do	Aerobic plant	Brackish water-table zone in limestone	do
37	Waipahi High School Field House c/	do	do	None	Fresh water-table zone in sediments	Temporary
38	Waimanalo Young c/	do	Cesspools	do	Brackish water-table zone in limestone	do
39	Waialai Quarry Land Fill g/	Solid waste	None	Sanitary fill	Basal ground water in lava flows	do

a/ Small modular aerobic sewage-treatment unit developed by Hana Enterprises in Hawaii.
b/ - g/ Sources of information: b/ U. S. Geological Survey; c/ State Department of Health; d/ owner.

HYDROLOGIC CONDITIONS RELATED TO SUBSURFACE AND SURFACE DISPOSAL OF WASTES IN HAWAII