SUBSURFACE AND SURFACE WASTE-DISPOSAL PRACTICE ON MAUI

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Maui has an area of 728 square miles (1,890 square kilometers) and is the second largest island in the State. Its population in 1970 was slightly more than 39,000. The principal towns are Wailuku, Kahului, and Lahaina, but resort areas along the western coastlines of Haleakala and West Maui are growing rapidly. The growing of sugarcane in the isthmus area and in the western part of West Maui constitutes the main industry. Pineapple and cattle are important crops that occupy the higher and drier areas. The future economic growth of the island, however, is probably tied to the rapidly-increasing tourist business.

A description of geology and ground-water resources is included in a report by Stearns and Macdonald (1942). The island of Maui is composed of two volcanoes, Haleakala and West Maui. The isthmus connecting the volcanoes was formed by Haleakala's lavas banking against the lower slopes of West Maui. The oldest rocks on the island are the highly permeable basaltic lava flows, which make up the bulk of the two volcanoes. On Haleakala, the basaltic lavas were completely veneered by less permeable andesite in the final stages of mountain building. On West Maui, the basaltic lavas were less completely veneered by andesite and trachyte. Subsequent deep erosion has exposed much of the basaltic lava flows on West Maui. Much of the deeply eroded valleys of Haleakala were filled with post-erosional lava flows, which covered the earlier formed basaltic lavas that were exposed by erosion. The post-erosional flows, which are extensive on the eastern and southern flanks of Haleakala, form a highly permeable surface. Post-erosional lava flows on West Maui are limited to a small area near Lahaina.

At least 43 subsurface waste-disposal sites are on Maui. All except six are along the coastline between Kaanapali and Napili Bay in West Maui and between Kihei and Makena on the western flanks of Haleakala. These coastal sites are used for the disposal of sewage effluent, mostly from small aerobic plants in rapidly-growing resort areas not serviced by sewers. Site 51, near Kahului Bay, consists of 15 drilled wells scattered in a large residential subdivision for disposal of storm runoff. At site 28, liquid wastes from a pineapple cannery are injected into two 300-foot (91-meter) deep wells. The subsurface and surface waste-disposal sites are listed in table 1 and are shown on the simplified geologic map (fig. 1, sheet 3).

Two geohydrologic cross sections are drawn perpendicular to the coastline in areas where most of the subsurface waste-disposal sites are located. One cross section is drawn through disposal site 27 near Kaanapali (fig. 2, sheet 3), and the other through site 2 near Kamaole (fig. 3, sheet 3). The sections were drawn from well-log information. Because the nearshore sediments vary from horizons of highly permeable sand and coral to those of silt and clay with low permeability, well logs and well and casing depths of disposal wells are important data that need to be recorded. This information is necessary if the fate of the waste injected into the subsurface is to be determined and monitored. Many of these data are not available for many of the wells drilled for the disposal of wastes.

Ground water in the sediments is brackish to saline along the drier western coastlines. The chloride content of ground water in the volcanic bedrock is shown by lines of equal chloride content and by scattered measurements on figure 4, sheet 3. Much of the low-chloride content of basal ground water underlying the irrigated sugarcane areas is attributed to recharge from irrigation-water return. This chloride content, however, rises as much as tenfold during the irrigation season because of prolonged pumping of ground water owing to the decrease in the quantity of surface water applied during the late summer months. The rise, however, is not permanent. Tenorio and others (1970), showed the presence of irrigation-water return in the basal ground-water bodies underlying the isthmus and western slopes of Haleakala and the western slopes of West Maui. That study covered a period of 3 years.

Sewage from the sewered areas shown on figure 4 is discharged offshore through outfalls except the sewage from the Kaanapali area, which is used for irrigation. Inhabited areas, not sewered but serviced by cesspools, are also shown on figure 4.

The area sewered in 1972 and that to be sewered by the sewer system proposed for the year 1990 are shown on figure 5, sheet 3. The data on figure 5 are extracted from a consultant's report, prepared in 1971 by R. M. Towill Corp. Waste-disposal sites pending in 1972, are listed in table 2 and shown on figure 5. Nearly all of the coastal areas, serviced by cesspools and small private sewage plants in 1972, will be sewered by the County of Maui by 1990, if the proposals in the Sewage Master Plan are adopted.

Figure 6 is a photograph of the hydroseparator for mill wastes at Paia Sugar Mill. The settling basin and injection wells for storm runoff at the Kahului development are shown in figure 7.

FIGURE 6. PHOTOGRAPH OF HYDROSEPARATOR FOR MILL WASTES AT PAIA SUGAR MILL

FIGURE 7. PHOTOGRAPH OF SITE 50, SETTLING BASIN AND INJECTION WELLS AT KAHULUI DEVELOPMENT

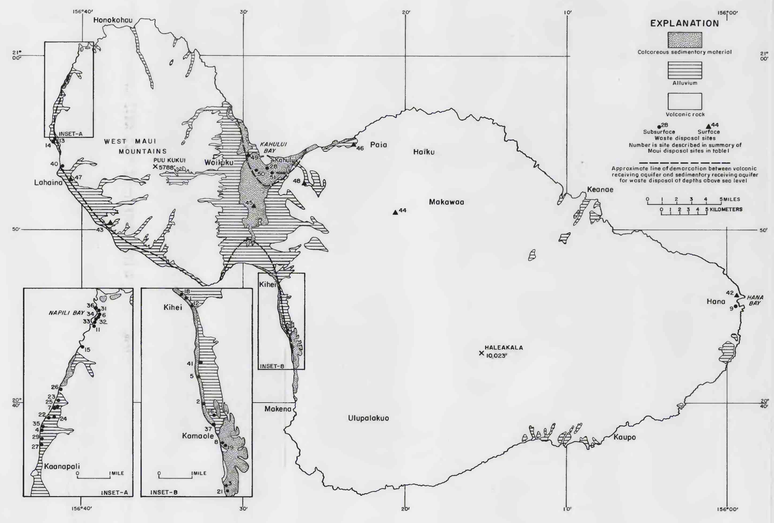

FIGURE 1. MAP OF MAUI SHOWING GENERALIZED GEOLOGY, WASTE-DISPOSAL SITES, AND PRINCIPAL WASTE-RECEIVING AQUIFERS.

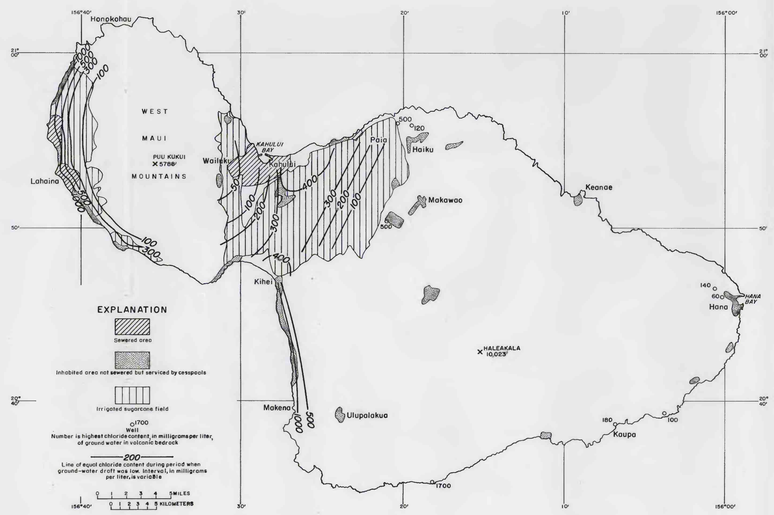

FIGURE 4. MAP OF MAUI SHOWING SEWERED AREAS, INHABITED AREAS NOT SEWERED, SUGARCANE FIELDS, AND CHLORIDE CONTENT OF GROUND WATER IN VOLCANIC BEDROCK.

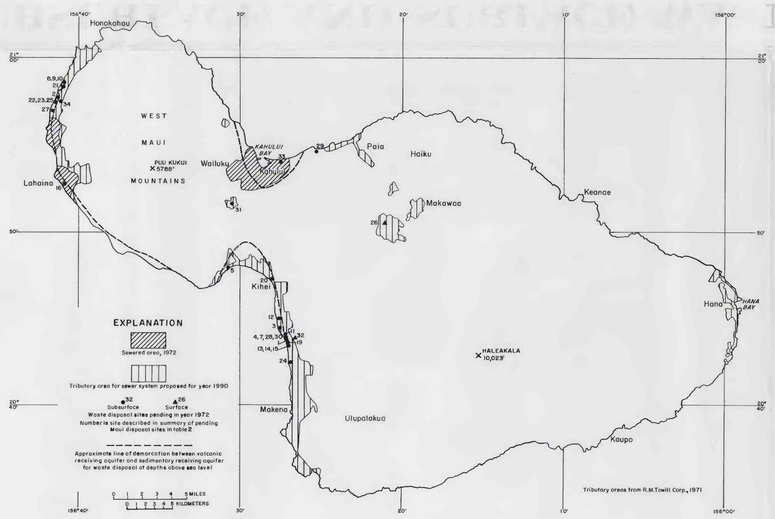

FIGURE 5. MAP OF MAUI SHOWING SEWERED AREAS IN 1972, PENDING WASTE-DISPOSAL SITES, AND TRIBUTARY AREAS TO SEWER SYSTEM PROPOSED FOR YEAR 1990.

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

SITE	NAME	NATURE OF WASTE	TREATMENT	DISPOSAL	GROUND-WATER RESOURCES AFFECTED	REMARKS
1	Alii Kai Condominium c/	Sewage	Aerobic plant	Cesspool	Brackish water-table zone in sediments	
2	Balusan Apartments c/	do	Aerobic, cavittete a/	2 injection wells	do	
3	Hale Rui Kai c/	do	Aerobic plant	do	do	Flow 16,000 gpd
4	Hale Kai c/	do	Aerobic, cavittete	Injection wells	do	
5	Hale Kai O Kihei c/	do	do	do	do	
6	Hale Napili c/	do	do	4 injection wells	Basal ground water in lava flows	
7	Hale Ono Loa Condominium c/	do	Aerobic, cavittete	3 injection wells	Brackish water-table zone in sediments	Flow 14,000 gpd
8	Hale Pau Hana c/	do	Aerobic, chlorinated	Injection wells	do	Flow 18,000 gpd
9	Hana Kai Apartment c/	do	Aerobic, cavittete	2 seepage pits	Basal ground water in lava flows	
10	Hono Kai Condominium c/	do	do	4 injection wells	Brackish water-table zone in alluvium and lava flows	Flow 10,000 gpd
11	Honokeana Cove Apartments c/	do	do	Seepage pit	Basal ground water in lava flows	
12	Hoyer Kai Apartments c/	do	do	Cesspools	Brackish water-table zone in sediments	
13	Kaanapali Sewage Treatment Plant d/	do	Primary	Irrigation water well	Fresh to brackish ground water in sediments and lava flows	Flow 1.1 mgd
14	Kaanapali Iki Golf Course Clubhouse d/	do	Aerobic, cavittete	Seepage pit	Brackish water-table zone in sediments	Flow 1,000 gpd
15	Kahana Sunset c/	do	Aerobic plant	2 injection wells	Basal ground water in lava flows	Flow 30,000 gpd
16	Kalama Terrace c/	do	do	Injection well	Fresh to brackish water-table zone in sediments	62 units
17	Kihei Beach Condominium c/	do	Aerobic plant, chlorinated	2 injection wells	do	Location not available
18	Kihei Kai c/	do	Aerobic, cavittete	Injection well	Brackish ground water in sediments and lava flows	
19	Kihei Kai Nani Condominium c/	do	Aerobic plant	do	Brackish water-table zone in sediments	Flow 27,000 gpd
20	Kihei Sands Condominium c/	do	Aerobic, cavittete	4 injection wells	do	Location not available
21	Roger Knox c/	do	do	Injection well	Basal ground water in lava flows	
22	Kulakane c/	do	Aerobic, cavittete	Wells, cesspool	do	
23	Kuleana c/	do	Aerobic plant	Injection wells	Ground water in sediments and lava flows	
24	Leilani c/	do	do	do	do	
25	Lokelani Condominium c/	do	Aerobic plant, chlorinated	Wells and pit	do	Flow 10,000 gpd
26	Mahina Surf Condominium c/	do	Aerobic, cavittete	2 injection wells	Basal ground water in lava flows	Flow 8,000 gpd
27	Maui Kai c/	do	do	do	do	Flow 16,000 gpd
28	Maui Pineapple Co. d/	Cannery waste	None	Injection wells	do	
29	Maui Sands c/	Sewage	Aerobic plant	Seepage pit, wells	Brackish water-table zone in sediments	Flow 24,000 gpd
30	Napili Apartments c/	do	Aerobic plant, chlorinated	2 injection wells	do	Location not available
31	Napili Lani c/	do	Aerobic plant	Seepage pit, wells	Basal ground water in lava flows	Flow 8,000 gpd
32	Napili Shores Apartment c/	do	Aerobic plant, chlorinated	2 injection wells	do	Flow 30,000 gpd
33	Napili Surf c/	do	do	Seepage pit, wells	do	
34	Napili Village c/	do	do	Seepage pit	do	
35	Pikake c/	do	Aerobic, cavittete	Seepage pit, wells	Water-table zone in sediments	
36	Puna Point Development c/	do	Aerobic plant	do	Basal ground water in lava flows	Flow 4,000 gpd
37	Punahou c/	do	Aerobic, cavittete	Injection wells	Water-table zone in sediments	
38	Tahitian Garden Apartments c/	do	do	do	do	Kihei, location not available
39	David Ting Condominium c/	do	do	Seepage pit	Water-table zone in coral limestone	do
40	Wahikuli Terrace Subdivision c/	do	Aerobic plant	Cesspool	Basal ground water in lava flows	
41	Waipuilani Condominium c/	do	do	Injection well	do	
	SOLID-WASTE DUMPS e/					
42	Hana dump	Leachate	None, burning	Onsite fill	Basal ground water in lava flows	Domestic waste
43	Olowalu dump	do	do	do	do	Do
44	Pukalani dump	do	do	do	do	Do
45	Waikapu dump	do	do	do	do	Do
	SUGARCANE MILL WASTES d/					
46	Paia Sugar Mill	-------	Ponding	Irrigation, land fill	Basal ground water in lava flows	
47	Pioneer Sugar Mill	-------	do	Irrigation, fill, ocean	do	
48	Puunene Sugar Mill	-------	do	Irrigation, land fill	do	
49	Wailuku Sugar Mill	-------	-------	Iao Stream	Fresh water-table zone in sediments	
	STORM WATER					
50	Kahului Development d/	Storm runoff	None	Injection wells	Brackish basal ground water in lava flows	At least 2 wells
51	Maui County b, e/	Storm and street runoff	None	do	Fresh water-table zone in calcareous rock and alluvium	15 wells in subdivision

a/ Small modular aerobic sewage-treatment unit developed by Hanna Enterprises in Hawaii.

b/ - e/ Sources of information: b/ U. S. Geological Survey; c/ State Department of Health; d/ owner; e/ Maui County.

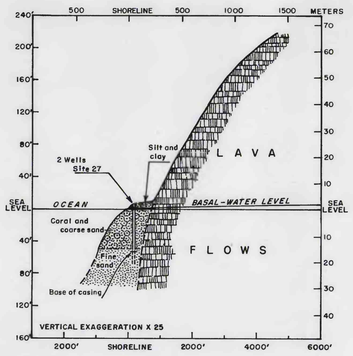

FIGURE 2. GEOHYDROLOGIC SECTION THROUGH DISPOSAL SITE 27 NEAR KAANAPALI.

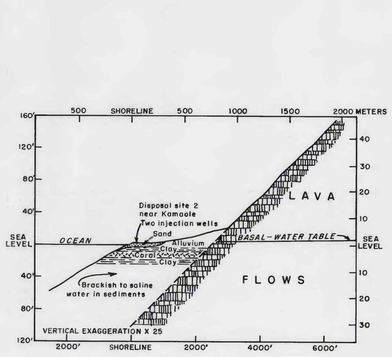

FIGURE 3. GEOHYDROLOGIC SECTION THROUGH DISPOSAL SITE 2 NEAR KAMAOLE.

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

SITE	NAME	NATURE OF WASTE	TREATMENT	DISPOSAL	GROUND-WATER RESOURCES AFFECTED	REMARKS
1	T. R. Chetleburgh c/	Sewage	Aerobic, cavittete a/	Cesspools	Brackish water-table zone in sediments	Flow 4,000 gpd
2	Club Mondiale Kuleana c/	do	do	do	do	Location approximate
3	Glopac c/	do	Aerobic, cavittete	Injection wells	Brackish ground water in sediments and lava flows	Flow 2,000 gpd
4	Hale Kamaole Condominium c/	do	do	do	do	Flow 42,000 gpd
5	Hale Kini Properties c/	do	Aerobic plant	Leaching pits, wells	do	Flow 8,000 gpd
6	Honokai East c/	do	do	do	do	Location not available
7	Island Surf Kapea Condominium c/	do	do	do	Brackish ground water in sediments and lava flows	Flow 20,000 gpd
8	Kahana Beach Apartment c/	do	do	Injection wells	Basal ground water in lava flows	Location approximate
9	Kahana Reef Condominium c/	do	Aerobic plant, chlorinated	do	do	
10	Kahana Surf and Villa c/	do	do	do	do	Flow 60,000 gpd
11	Kauhale Nani Housing c/	do	Septic tanks	do	do	Flow 20,000 gpd
12	Kihei Beach Club c/	do	do	Injection wells	Brackish ground water in sediments and lava flows	Cesspools not approved
13	Kihei Kai Developers c/	do	Aerobic, cavittete	do	Basal ground water in lava flows	Location approximate
14	Kihei Villa Condominium c/	do	do	do	do	Do
15	Kusu Plaza Condominium c/	do	do	Seepage pit	do	Do
16	Lahaina Fashions b/	do	do	Injection wells	Brackish water-table zone in coral limestone	do
17	Lahaina Racquet Club c/	do	Aerobic, cavittete	do	do	Location not available
18	Makani Sands Apartments c/	do	Aerobic plant	do	do	Do
19	Mana Kai Condominium c/	do	do	do	do	Basal ground water in lava flows
20	Nani Kai Hale c/	do	do	do	Brackish ground water in sediments and lava flows	Flow 40,000 gpd
21	Napilihau Housing Project c/	do	Secondary	Injection wells	Basal ground water in lava flows	Flow 10,000 gpd
22	Noelani Apartments c/	do	Aerobic plant	do	Brackish ground water in sediments and lava flows	Flow 90,000 gpd
23	Nohonani Apartment c/	do	Aerobic plant, chlorinated	do	do	Flow 9,000 gpd
24	Outrigger Maui Apartment c/	do	Aerobic, cavittete	Seepage trench	Brackish water-table zone in sediments	Flow 10,000 gpd
25	Polynesian Shores Apartments c/	do	do	Injection wells	Brackish ground water in sediments and lava flows	Flow 2,000 gpd
26	Puukolani Terrace and Country Club c/	do	Aerobic plant	Ponds, irrigation	Basal ground water in lava flows	Flow 12,000 gpd
27	Emiliano Ramos c/	do	Aerobic, cavittete	Injection wells	Ground water in sediments and lava flows	Flow 500,000 gpd
28	The Royal Mauian c/	do	Aerobic plant	do	Brackish ground water in sediments and lava flows	Honokowai, location approximate
29	Spreckelsville 20-unit Development c/	do	Aerobic, cavittete	-------	Basal ground water in lava flows	Kamaole Beach, location approximate
30	Tahitian Apartment c/	do	Chlorinated	-------	do	Flow 6,000 gpd
31	Valley Isle Drive-in Theater c/	do	Aerobic, cavittete	Seepage pits	Basal ground water in lava flows	Kamaole, location approximate
32	Kihei Sewage-Treatment Plant c/	do	Secondary	Irrigation, wells	do	Flow 11,000 gpd
33	Wailuku-Kahului Sewage-Treatment Plant c/	do	do	Injection wells	do	-------
34	Napili-Honokowai Sewage-Treatment Plant c/	do	do	do	do	6 mgd plant
						4 mgd plant

a/ Small modular aerobic sewage-treatment unit developed by Hanna Enterprises in Hawaii.

b/ - e/ Sources of information: b/ U. S. Geological Survey; c/ State Department of Health; d/ owner; e/ Maui County.

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

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