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AUTHORS:

Mr. John F. Mink
Consultant
Water Resources-Earth Sciences
P.O. Box 4452
Honolulu, Hawaii 96813
Tel: 808/737-6136
and
Research Affiliate
Water Resources Research Center
University of Hawaii at Manoa
Honolulu, Hawaii 96822

Dr. L. Stephen Lau
Director
Water Resources Research Center
University of Hawaii at Manoa
2540 Dole Street
Honolulu, Hawaii 96822
Tel: 808/956-7848
FAX: 808/956-5044

**AQUIFER IDENTIFICATION AND CLASSIFICATION FOR MAUI:
Groundwater Protection Strategy for Hawai'i**

John F. Mink
L. Stephen Lau

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for
Identification of Class I: Special Groundwaters
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WATER RESOURCES RESEARCH CENTER
University of Hawaii at Manoa
Honolulu, Hawaii 96822

ABSTRACT

In response to the need to identify and describe aquifers for each island of the state of Hawai'i to serve as a framework for groundwater protection strategy, a program has been initiated to classify and assign codes to the principal aquifers of the State. This second report provides Aquifer Codes and Status Codes for the island of Maui.

The Aquifer Codes incorporate locational and descriptive indices, while the Status codes indicate the developability, utility, quality, uniqueness, and vulnerability to contamination of the groundwater resources. The codes were generated for Hawaiian conditions of groundwater occurrence and behavior in preference to using the DRASTIC approach suggested by the U.S. EPA.

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AQUIFER CLASSIFICATION AND AQUIFER CODES

The classification scheme reported by Mink and Lau (1987) is the starting point for developing an Aquifer Code for the island of Maui. Classification is based on a hierarchy of descriptors beginning with general location by Island and Sector, to which belongs a set of Aquifer Systems, within which are a variety of Aquifer Types. Sectors primarily reflect broad hydrogeological features and, secondarily, geography. Aquifer Systems are more specifically defined by hydrogeological continuity, in particular, hydraulic connections among units; Aquifer Types are differentiated by distinctive features of hydrology and geology.

In brief, the hierarchy is as follows:

- a. Island—The global factor
- b. Sector—A large region with hydrogeological similarities
- c. System—An area within a Sector showing hydrogeological continuity
- d. Type—Portions of a System having the same hydrological and geological features.

Islands are coded by number in conformance with the first digit of the Hawaii State well numbering system originated by the U.S. Geological Survey (1976). Each Sector is coded with a two-digit number and by a Hawaiian geographic name except where locational confusion might result, in which case the general locators North, South, East, West, and Central, or a traditional geographic term such as Windward, are used. A two-digit number is applied to each Aquifer System, which also can be referred to by a geographic name. Three digits describe fundamental hydrology and geology to constitute the Aquifer Type.

The numerical code has the form, 1 01 01 111, in which the first number is the Island, the next two represent the Sector, the following two the System, and the last three the Type. Island numbers are 1 (Ni'ihau), 2 (Kaua'i), 3 (O'ahu), 4 (Moloka'i), 5 (Lāna'i), 6 (Maui), 7 (Kaho'olawe), and 8 (Hawai'i). Sector numbers start at 01 in each Island, and System numbers also start at 01 in each Sector.

Aquifer Type

Hydrology is uniquely described by a pair of digits and geology by a single digit. Identifying characteristics with their codes are as follows.

HYDROLOGY. Aquifer Types are defined as either basal or high-level, and as either unconfined or confined. Their numbers with brief descriptions are as follows:

No.	Type	Description
1	Basal	Fresh water in contact with seawater
2	High Level	Fresh water not in contact with seawater
1	Unconfined	Where the water table is the upper surface of the saturated aquifer
2	Confined	Aquifer is bounded by impermeable or poorly permeable formations; top of the saturated aquifer is below the surface of the groundwater (piezometric surface)
3	Confined or Unconfined	Where the actual condition is uncertain

Using the above coding, groundwater can be 11 (basal, unconfined) or 12 (basal, confined), or 21 (high level, unconfined) or 22 (high level, confined). Where confining conditions are unclear, the second digit is taken as 3 (confined or unconfined).

GEOLOGY. Aquifers are categorized as occurring in the flank lavas of the volcanic domes, in rift zones characterized by dikes, on poorly permeable perching members, or within the sedimentary sequence. Flank aquifers normally are horizontally extensive and display the lowest heads and usually carry basal water; rift aquifers are segmented into compartments by dikes; perched aquifers lie on impermeable formations but are not ordinarily very extensive; and sedimentary aquifers are comprised of alluvial and marine sediments deposited by erosion and biogenic processes. The geologic codes are as follows:

No.	Type	Description
1	Flank	Horizontally extensive lavas
2	Dike	Aquifers in dike compartments
3	Flank/Dike	Indistinguishable
4	Perched	Aquifer on an impermeable layer
5	Dike/Perched	Indistinguishable
6	Sedimentary	Non-volcanic lithology

One of the above numbers attached to the two hydrology numbers completes the Aquifer Type.

The sequence of all numbers from island through geology is called the Aquifer Code. Each Aquifer Code has an eight-digit code which is unique. An example of an Aquifer Code for groundwater occurrence in Maui is

6	Maui (Island)
01	Wailuku (Aquifer Sector)
02	Iao (Aquifer System)
121	Basal, confined; flank (Aquifer Type)

The Aquifer Code for the above is 6 01 02 121. There can be no repetition elsewhere in the State. Suited to computer data basing, the code has great retrieval flexibility.

A variety of important information related to the aquifers can be appended to each Aquifer Code. Certain hydrogeologic parameters and quantities, such as rainfall, infiltration, sustainable yield and storage, can be appended to the code to expand its utility. For example, items relevant to groundwater contamination can be expressed as a separate numerical code and attached to the Aquifer Code.

The hydrology of Maui is not as well understood as for O'ahu; consequently, large areas—especially in East Maui—are broadly defined in comparison to the O'ahu network of Systems and Types. Nevertheless a total of 113 Aquifer Codes has been assigned to the island: 49 in West Maui and 64 in East Maui. For West Maui, which has been more closely examined by investigators than East Maui, two Sectors and ten Systems have been assigned. East Maui has been divided into four Sectors and fifteen Systems (Fig. 1).

Table 1 lists the Aquifer Codes for the island of Maui along with the Aquifer Sector and System names. Also listed is the Status Code of each Aquifer Type. The Status Code, which is described in the next section, summarizes elements crucial to the groundwater protection strategy.

GROUNDWATER PROTECTION: STATUS CODE

Concepts of EPA's groundwater classification conforming to Hawai'i conditions are used to devise a groundwater Status Code that describes development stage, utility, salinity, uniqueness, and vulnerability to contamination of the aquifers. The Status Code is conveniently attached to the Aquifer Code, and the combination is an efficient representation of location, hydrology, geology, utility, water quality, and contamination potential of groundwater resources in every part of the island.

The five digit Status Code consists of a single number from each of five separate descriptive categories. The categories and their status elements with identifying numbers are as follows:

- A. Development Stage
 - 1. Currently used
 - 2. Potential use
 - 3. No potential use

- B. Utility
 - 1. Drinking
 - 2. Ecologically important
 - 3. Neither
- C. Salinity (mg/l Cl⁻)
 - 1. Fresh (<250)
 - 2. Low (250-1000)
 - 3. Moderate (1000-5000)
 - 4. High (5000-15,000)
 - 5. Seawater (>15,000)
- D. Uniqueness
 - 1. Irreplaceable
 - 2. Replaceable
- E. Vulnerability to Contamination
 - 1. High
 - 2. Moderate
 - 3. Low
 - 4. None

Only one number from each major category listed above is allowable in the Status Code. For instance, a currently developed groundwater source (1), used for drinking (1), having a salinity of less than 250 mg/l Cl⁻ (1), being irreplaceable (1), and highly vulnerable to contamination (1), would have the Status Code 11111. If it were ecologically important but not suitable for drinking with a salinity of 750 mg/l Cl⁻, other categories being the same, the code would be 12211.

The categories and their elements are derived from the U.S. EPA (1984) groundwater classifications modified by fundamentals of the Hawaii groundwater environment. Application of a detailed vulnerability assessment, such as a modified form of DRASTIC, could be used in the vulnerability to contamination category.

Brief explanations of the Status Code categories and their elements are as follows.

DEVELOPMENT STAGE. Aquifers are differentiated according to those already being used (currently used), those with potential utility (potential use), and those having no potential developability.

UTILITY. Identifies aquifers by use. Groundwater classed as drinking may also be ecologically important, but that classed as ecologically important may not be used for drinking. Drinking takes precedence over ecologically important.

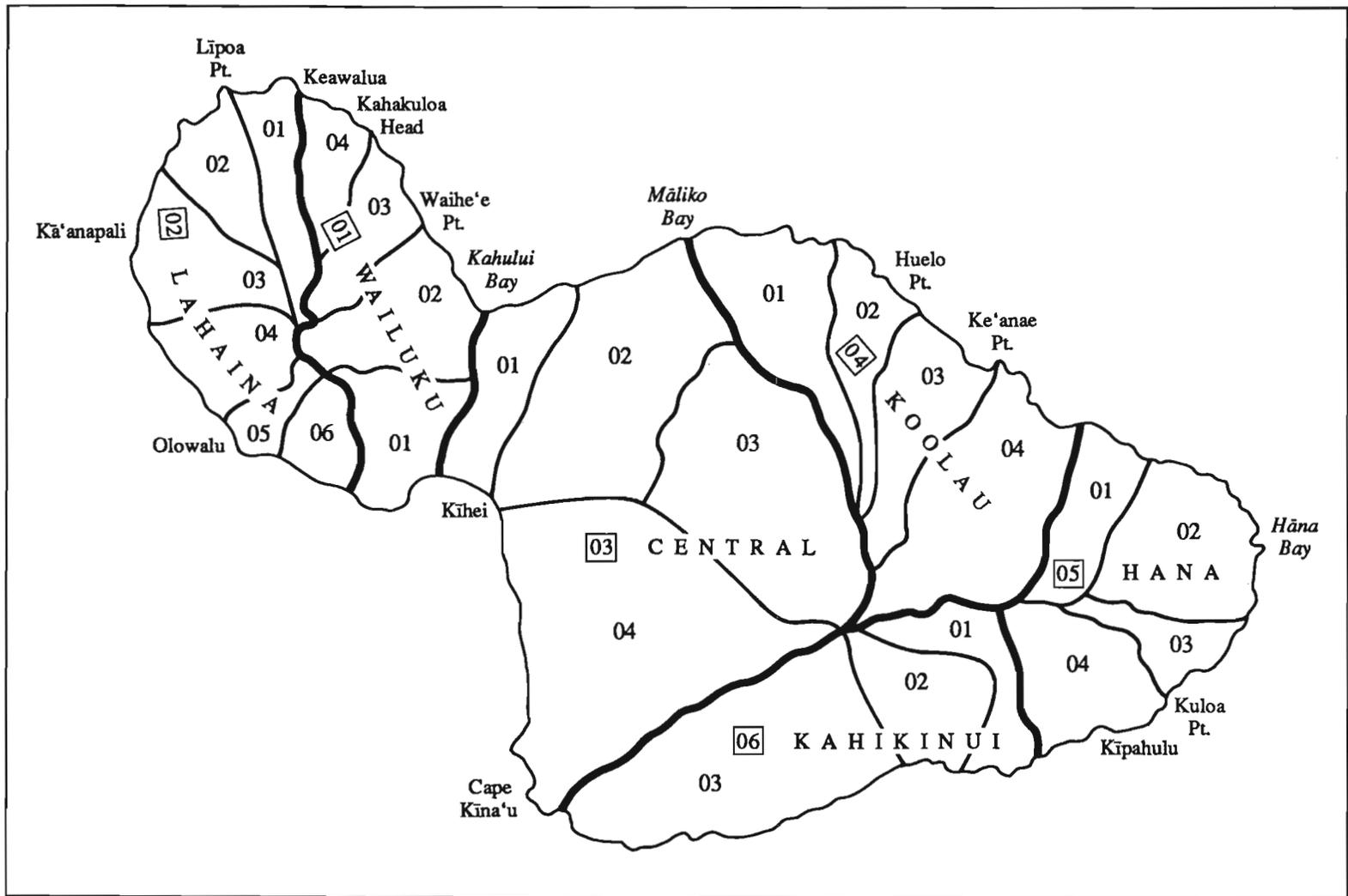


Figure 1. Aquifer codification by Sector and System for Maui, Hawai'i

TABLE 1. AQUIFER AND STATUS CODES FOR MAUI, HAWAII

Maui Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
6	01 Wailuku	01 Waikapu	212	60101212	21111	5, 6
			111	60101111	21221	5, 6
			<u>116</u>	<u>60101116</u>	<u>23222</u>	5, 6
			121	60101121	23223	
		02 Iao	212	60102212	11111	2, 5
			111	60102111	11111	5
			<u>116</u>	<u>60102116</u>	<u>22211</u>	5
			121	60102121	21113	
			<u>116</u>	<u>60102116</u>	<u>33121</u>	5
			111	60102111	11111	
		03 Waihee	212	60103212	11111	2, 5
			<u>214</u>	<u>60103214</u>	<u>11111</u>	4, 5
			212	60103212	21111	
			111	60103111	11111	4, 5
			<u>111</u>	<u>60103111</u>	<u>21221</u>	4, 5
			121	60103121	21223	
	<u>116</u>		<u>60103116</u>	<u>21111</u>	5	
	111		60103111	11111		
	04 Kahakuloa		<u>214</u>	<u>60104214</u>	<u>12111</u>	5
			212	60104212	21112	
		212	60104212	11111	1, 2, 4, 5	
		113	60104113	21111	1, 4	
		<u>116</u>	<u>60104116</u>	<u>12211</u>	4	
		113	60104113	21222		
	02 Lahaina	01 Honokohau	212	60201212	11111	1, 2, 5
			113	60201113	11111	1
			<u>116</u>	<u>60201116</u>	<u>12211</u>	1
			113	60201113	21122	
		02 Honolua	212	60202212	21111	1, 2
			111	60202111	11111	1, 2
			<u>116</u>	<u>60202116</u>	<u>33421</u>	1
			111	60202111	33312	
		03 Honokowai	212	60203212	11111	2
			111	60203111	11111	1, 2
			<u>116</u>	<u>60203116</u>	<u>33421</u>	1, 2
			111	60203111	33322	
		04 Launiupoko	212	60204212	11111	2
			111	60204111	11111	2
			<u>116</u>	<u>60204116</u>	<u>33321</u>	2
			111	60204111	21222	

TABLE 1.—Continued

Maui Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
		05 Olowalu	212	60205212	11111	2, 3, 5
			111	60205111	11111	2, 3
			<u>116</u>	<u>60205116</u>	<u>21221</u>	2, 3
			121	60205121	21212	
		06 Ukumehame	212	60206212	11111	2, 3, 5, 6
			111	60206111	11111	3, 6
			<u>116</u>	<u>60206116</u>	<u>21221</u>	3, 6
			121	60206121	21212	
			112	60206112	21221	6
03 Central	01 Kahului		<u>116</u>	<u>60301116</u>	<u>12211</u>	5, 6, 7
			111	60301111	12212	
			<u>214</u>	<u>60301214</u>	<u>33221</u>	5, 6, 7, 8
			111	60301111	12212	
			<u>116</u>	<u>60301116</u>	<u>12211</u>	5, 7
			121	60301121	12212	
	02 Paia		<u>214</u>	<u>60302214</u>	<u>33221</u>	6, 7, 8, 10
			111	60302111	11112	
			<u>116</u>	<u>60302116</u>	<u>33321</u>	6, 7, 8
			111	60302111	33321	
	03 Makawao		<u>214</u>	<u>60303214</u>	<u>11121</u>	7, 8, 10, 11
			111	60303111	21112	
			<u>214</u>	<u>60303214</u>	<u>21121</u>	10, 11
			212	60303212	21112	
	04 Kamaole		<u>214</u>	<u>60304214</u>	<u>21121</u>	9, 11, 12
			212	60304212	21112	
			<u>214</u>	<u>60304214</u>	<u>21121</u>	8, 11, 12
			111	60304111	11212	
			<u>116</u>	<u>60304116</u>	<u>22321</u>	6, 8, 9
			111	60304111	23322	
04 Koolau	01 Haiku		<u>214</u>	<u>60401214</u>	<u>11111</u>	10, 11
			212	60401212	21112	
			<u>214</u>	<u>60402214</u>	<u>11111</u>	7, 10
			111	60401111	11112	
	02 Honopou		<u>214</u>	<u>60402214</u>	<u>11111</u>	10, 11
			212	60402212	21112	
			<u>214</u>	<u>60401214</u>	<u>11111</u>	10, 11
			111	60402111	11112	
	03 Waikamoi		<u>214</u>	<u>60403214</u>	<u>11111</u>	11, 14
			212	60403212	21112	
			<u>214</u>	<u>60403214</u>	<u>11111</u>	10, 11, 13, 14
			111	60403111	11112	

TABLE 1.—Continued

Maui Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
		04 Keanae	<u>214</u> 212	<u>60404214</u> 60404212	<u>11111</u> 21112	11, 14
			<u>214</u> 111	<u>60404212</u> 60404111	<u>11111</u> 11112	13, 14
	05 Hana	01 Kuhiwa	<u>214</u> 212	<u>60501214</u> 60501212	<u>21111</u> 21112	14
			<u>214</u> 111	<u>60501214</u> 60501111	<u>21111</u> 21112	14, 16
		02 Kawaipapa	<u>214</u> 212	<u>60502214</u> 60502212	<u>21111</u> 21112	14, 16
			111	60502111	11111	14, 16
		03 Waihoi	<u>214</u> 212	<u>60503214</u> 60503212	<u>21111</u> 11112	14, 16
			111	60503111	11111	16, 17
			<u>214</u> 111	<u>60503214</u> 60503111	<u>21111</u> 21112	16, 17
		04 Kipahulu	<u>214</u> 212	<u>60504214</u> 60504212	<u>21111</u> 11112	14, 15, 16, 17
			<u>214</u> 111	<u>60504214</u> 60504111	<u>11111</u> 11112	15, 16, 17
	06 Kahikinui	01 Kaupo	<u>214</u> 212	<u>60601214</u> 60601212	<u>21111</u> 21112	11, 12, 14, 15
			<u>214</u> 111	<u>60601214</u> 60601111	<u>21111</u> 11111	15
		02 Nakuula	<u>214</u> 212	<u>60602214</u> 60602212	<u>21121</u> 21112	11, 12, 15
			<u>214</u> 111	<u>60602214</u> 60602111	<u>21111</u> 21212	12, 15
		03 Lualailua	<u>214</u> 212	<u>60603214</u> 60603212	<u>21121</u> 21112	11, 12
			<u>214</u> 111	<u>60603214</u> 60603111	<u>21111</u> 21212	9, 12

NOTE: Where aquifers are in vertical sequence, the Aquifer and Status Codes are separated by a division line in order of occurrence, with the uppermost aquifer appearing first.

*See Aquifer Classification Explanation, p. 29.

SALINITY. The gradation of groundwater from fresh to seawater is a feature of all basal aquifers in Hawai'i. Basal aquifers comprise, by far, the most voluminous sources of groundwater. Chloride content is the class definer rather than total dissolved solids (TDS) because it is routinely reported in the Hawai'i literature. The class limits inevitably are somewhat arbitrary but incorporate the following logic.

1. Fresh (<250 mg/l): The upper limit of the standard for drinking water is 250 mg/l Cl⁻.
2. Low (250-1000 mg/l): Much agriculture, in particular sugarcane, can be irrigated with water containing up to 1000 mg/l Cl⁻.
3. Moderate (1000-5000 mg/l): Brackish water of this salinity may serve as feed water for desalinization in the future.
4. High (5000-15,000 mg/l): The high salinity class, not yet seawater, is arbitrarily designated for water that is between potentially economically valuable water and seawater.
5. Seawater: True seawater has a chloride content of 18,980 mg/l.

UNIQUENESS. The classes irreplaceable and replaceable are direct EPA derivatives. Over the long term, virtually all potable water in the state of Hawai'i should be considered irreplaceable.

VULNERABILITY TO CONTAMINATION. In the Hawaiian Islands because of the geographical limits of the resources, interconnection among groundwater sources and the relatively rapid time of groundwater travel, aquifers can be described simply as being either vulnerable or not vulnerable to contamination. Most unconfined aquifers are vulnerable; confined aquifers may or may not be. A refinement in the degree of vulnerability may be instituted by employing some modified form of the DRASTIC, or similar, index. The one used in this classification (high, moderate, low, none) is based on familiarity with environmental conditions.

In summary, a groundwater classification scheme which includes source as well as status information has been created. The Aquifer Code consists of locators, hydrology and geology, and reads as follows: Island-Aquifer Sector-Aquifer System-Aquifer Type. The code consists of eight digits: one for the Island, two each for Sector and System, and three for Type (two for hydrology; one for geology).

The Status Code contains five digits and, combined with the Aquifer Code, results in a 13-digit code. For example, the code 60102121 (11111) defines an aquifer in Maui, Wailuku Sector, Iao System, in which the groundwater is basal and confined in flank lavas. The last five digits within parentheses tell that the aquifer is currently used to supply drinking water having less than 250 mg/l Cl⁻, and that it is an irreplaceable source highly vulnerable to pollution.

Although the original scope of the project referred specifically to Class I (special) groundwater, all other groundwaters in Maui have been classified. As a matter of interest, Class I groundwater Status Codes are either 11111 (drinking) or 12n11 (ecologically important), in which n is a number (1-5) defining the salinity range (<250 to >15,000 mg/l Cl⁻).

AQUIFER CLASSIFICATION MAPS

Accompanying this explanation of Aquifer Codes and Status Codes are maps for Maui (reduced from USGS base 1:24,000-scale quadrangles) on which are plotted Sector, System, and Type boundaries. Within each Aquifer Type area is an Aquifer Code to which is appended the Status Code within parentheses.

Where aquifers occur in vertical sequence, Aquifer and Status Codes for each aquifer are separated by a division line. The numerator code is for the upper aquifer and the denominator for the lower aquifer.

General Geology and Hydrology of Maui

The shape, topography, and geology of Maui reflect the island's formation as two separate volcanoes that are joined along the "isthmus" under today's sea level condition. The older, smaller, and more eroded volcanic center constitutes West Maui, while East Maui is the product of a younger, much larger, and less dissected volcanic shield. West Maui comprises two easily defined Aquifer Sectors, Wailuku (01) and Lahaina (02), because of its limited extent and the consistency of its hydrogeological features; however, East Maui is too large and diverse to reduce so simply. Instead it is divided into four Sectors, the most westerly of which, the Central (03) Sector, starts with the isthmus and extends to the northwest and southwest rift zones of the East Maui volcano centered in Haleakalā. Proceeding clockwise, the second Sector (04 Koolau) incorporates the northern slope of the volcano from Māliko Gulch to Nāhiku. The third Sector (05 Hana) wraps around the eastern bulge of the island to Kīpahulu, while the fourth (06 Kahikinui) embraces the steep southern slope of Haleakalā from Kīpahulu to Cape Kīna'u.

In West Maui three principal volcanic formations occur. The oldest, most widespread, and hydrogeologically important is the Wailuku volcanics, which consists of primitive basalt and olivine basalt. Covering the Wailuku formation in many areas are andesitic-trachytic rocks of the Honolua volcanic series. Still later in the volcano's history the Lahaina volcanics erupted, but its distribution is limited to the vicinity of Lahaina.

In addition to the volcanic formations, alluvial deposits play an important role in controlling groundwater occurrence and behavior. The most important sedimentary formation is the “old alluvium”, a moderately indurated agglomeration of clay and gravel. Unconsolidated recent alluvium is normally not important in groundwater hydrology.

The surface of East Maui is dominated by andesitic rocks of the Kula volcanic series and basaltic rocks of the Hana volcanic series, but the oldest formation on which all other formations rest is the Honomanu volcanic series. Although the Honomanu is exposed over just a few square miles of gulch country, it constitutes the principal developable aquifers. The Honomanu consists of basalt and olivine basalt typical of the initial emissions of Hawaiian volcanoes. The more viscous rocks of the Kula series were erupted toward the final construction of the main volcano. Much later, after the volcanic shield had been deeply eroded, the Hana series covered both the Kula and Honomanu formations.

The Honomanu series is the premier aquifer formation. The Kula is important because in places it retards the flow of water while in others it acts as an aquifer. Like the Honomanu series, the Hana basalts constitute excellent aquifers, especially in the eastern portion of the island.

A thick alluvium wedge blankets West Maui from Waihe‘e southward to Waikapū, forming a caprock and an unconformity between the volcanic rocks of East Maui and West Maui in the isthmus. Elsewhere sediments are common but are not critical in the control of groundwater accumulation and flow.

Most groundwater development sites in East Maui are in the Central Aquifer Sector, and from their records a reasonably good understanding of groundwater conditions has evolved. In the Koolau Sector few wells have been drilled; much groundwater is developed, but as low flow runoff from streams. In the Hana Sector several deep wells have been drilled, while in the Kahikinui Sector only one or two deep wells are known.

The West Maui Sectors, on the other hand, contain many wells and infiltration galleries that produce water for municipal and irrigation use in the region extending (clockwise) from Waihe‘e to Honolua. Hydrogeology and aquifer conditions are considerably better known in West than in East Maui.

AQUIFER SECTOR: WAILUKU (601)

Aquifer System: Waikapu (60101)

BOUNDARIES. Lahaina-Wailuku District line along Manawainui Gulch; along coast to Mā‘alaea; Mā‘alaea to Waikapū; along north divide of Waikapū.

GEOLOGY. Wailuku basalt with minor cover of Honolua rocks toward the south; westerly rift zone in Waikapū Valley, southwest rift zone toward McGregor Point; deep old alluvium at base of West Maui Mountains beneath the isthmus; old alluvium in Waikapū Valley.

HYDROLOGY. Volcanic aquifers: unconfined basal; confined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Sugarcane (now being abandoned); pineapple (new acreage); minor urbanization; mostly forest reserve.

GROUNDWATER OCCURRENCE. High-level dike impounded groundwater occurs in Waikapū Valley above an elevation of about 1000 ft (304.8 m) and basal groundwater at lower elevations throughout the System. The Wailuku volcanic series is the basement formation and is exposed over most of the region, but Honolua andesitic lavas cover the surface as thin layers near Pōhākea. The lens is not protected by the caprock at the southern coast of the island, but toward the isthmus a thick wedge of alluvial cover controls groundwater movement to the volcanic rock.

A well and a test hole have been drilled in the basal lens, but in neither case was potable water found. Groundwater is suitable for irrigation but not for drinking. Potable groundwater is limited to the high-level portion of the System.

Aquifer System: Iao (60102)

BOUNDARIES. Northern topographic divide of Waikapū, then southern 'Īao divide to Kahului Bay; Kahului Bay to southern divide of Waihe'e, then southwest along divide to Pu'u Kukui.

GEOLOGY. Wailuku volcanic series, covered in minor areas with Honolua rocks; caldera in 'Īao Valley; rift zone radiates to northeast; deep alluvial caprock on Wailuku basalt; deep valley fill in 'Īao.

HYDROLOGY. Volcanic aquifers: confined basal; unconfined basal; minor confined high-level dike; unconfined high-level dike.

ALLUVIAL AQUIFERS. Unconfined basal; unconfined high level.

ENVIRONMENT. Sugarcane (being abandoned); pineapple (new acreage); macadamia orchards; Wailuku urban area; extensive forest reserve.

GROUNDWATER OCCURENCE. The base perennial flows in 'Īao and Waiehu (North and South) valleys originate as groundwater seepage from high-level aquifers in the caldera and dike complex of the West Maui volcano. However, the principal exploited groundwater resource is the basal lens in the Wailuku series extending between Waikapū and Waihe'e

valleys below an elevation of about 800 ft (244 m). Thick caprock constrains discharge from the lens, which before the start of exploitation had an initial head of approximately 25 ft (8 m).

Aquifer System: Waihee (60103)

BOUNDARIES. South divide of Waihe'e Valley; Waihe'e Point to Kahakuloa Head; southern divide of Kahakuloa Valley to 'Eke Crater.

GEOLOGY. Wailuku basalt, extensively covered by the Honolua series; trachyte "bulbous domes"; rift zone striking northeast; limited effective alluvium at coast; Honolua andesites may behave as caprock in some areas.

HYDROLOGY. Volcanic aquifers: unconfined basal; confined basal; unconfined high-level dike; unconfined high-level perched.

ALLUVIAL AQUIFERS. Insignificant.

ENVIRONMENT. Ranching; scattered residences; no agriculture; mostly forest reserve.

GROUNDWATER OCCURENCE. Between Waihe'e and Kahakuloa valleys high-level groundwater occurs not only in dike compartments of the Wailuku basalt but also on perching members in the Honolua formation. The perched water forms marshes in places. The base flows of Waihe'e and Kahakuloa consist predominantly of dike impounded groundwater, but that of Makamaka'ole is entirely perched water. The thick caprock wedge of the Iao System is truncated by Waihe'e Valley and has no bearing on the basal groundwater of the Waihee System.

A basal lens in the Wailuku basalt, protected along some stretches of the coast by lavas of the Honolua series acting as caprock, may extend inland to about the Forest Reserve line. The testing of two wells drilled on the north bank of Waihe'e Stream has proved the existence of a sizeable groundwater resource that is assumed to be basal.

Aquifer System: Kahakuloa (60104)

BOUNDARIES. South divide of Kahakuloa Valley; Kahakuloa Head (Pu'u Koa'e) to the Wailuku-Lahaina District boundary at Po'elua Bay; convergence of inland boundaries at Pu'u 'Eke.

GEOLOGY. Wailuku basalt with minor coverage by Honolua series; northerly dike zone, probably all the way to the coast; virtually no alluvial coastal plain or caprock.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ALLUVIAL AQUIFERS. Virtually none.

ENVIRONMENT. Ranching; minor farming; village in Kahakuloa; mostly forest reserve.

GROUNDWATER OCCURENCE. The entire Kahakuloa System is probably in a rift zone, but near the coast groundwater is basal, even if impounded in dike compartments.

High-level dike water in the Wailuku formation is known to occur one and a half miles upstream of the coast and to extend inland to the boundary of the System at Pu'u 'Eke. In the upper reaches of the valley marshes sustained by perched water in the Honolua formation add perennial flow to the main stream. Caprock does not rim the coast.

AQUIFER SECTOR: LAHAINA (602)

Aquifer System: Honokohau (60201)

BOUNDARIES. Wailuku-Lahaina District boundary; Po'elua Bay to Līpoa Point; western divide of Pōhakupule Gulch and of Honokōhau Valley.

GEOLOGY. Predominantly Wailuku basalt, minor areas of Honolua rocks; northerly trending rift zone, dikes to coast; no significant alluvial coastal plain; shallow alluvial valley fill.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ALLUVIAL AQUIFERS. Minor at mouth of valley.

ENVIRONMENT. Pineapple on ridge faces; minor grazing; few residences, mostly forest reserve.

GROUNDWATER OCCURENCE. A rift zone extends all the way to the sea but within a mile or so of the coast basal groundwater occurs in Wailuku basalt dike compartments. The perennial flow of Honokōhau Stream is sustained chiefly by high-level dike water; perched water seeping from the Honolua series also contributes to the stream's low flow.

Most of the stream water is diverted by Honokōhau Ditch for use farther south in the Lahaina Sector. Basal groundwater has not been developed. In the lower reaches of the valley alluvial fill behaves as a weak caprock.

The Honokohau System is included in Lahaina District Sector A of previous studies (DOWALD 1977, p. 63).

Aquifer System: Honolua (60202)

BOUNDARIES. Western divide Honokahua (eastern divide Honolua); Līpoa Point to Ka'ea Point; southern divide Kahana Valley.

GEOLOGY. Predominantly Honolua series covering Wailuku series; northwest rift zone several miles inland; virtually no alluvial coastal plain; shallow alluvial valley fill.

HYDROLOGY. Volcanic aquifers: Unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Pineapple; low density tourism along coast; golf courses; scattered residences inland; mostly forest reserve.

GROUNDWATER OCCURENCE. A free basal lens in Wailuku basalt occurs for at least two miles inland of the coast, followed by high-level dike water which extends to the boundary of the System. Honolua lavas cover a part of the System but are not hydrologically important. Stream flow is diverted to the Honokōhau Ditch.

All high-level water is impounded in dike compartments. The basal lens saturates flank lava flows, but widely spaced dikes may reach to the coast. Outflow of the basal lens is not impeded by caprock.

In previous investigations (DOWALD 1977) the System was included in Sector A, along with the Honokohau System, because its hydrology was not influenced by return irrigation flows.

Aquifer System: Honokowai (60203)

BOUNDARIES. South divide Kahana Valley; Ka'ea Point to Pu'unoa Point; north divide of Kahoma Valley.

GEOLOGY. Wailuku series with small areas covered by Honolua rocks; Lahaina series vents and associated rocks at southern boundary; northwest rift zone several miles inland; narrow coastal plain of alluvium; shallow alluvial valley fill.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Pineapple and sugar; dense tourism at coast (Kā'anapali); modest urbanization; much forest reserve.

GROUNDWATER OCCURENCE. That part of the System within three miles of the coast has a basal lens; the remaining mountainous portion contains high-level dike water. The Wailuku basalt is the only important water formation, but local hydrogeology is complicated by the Lahaina series in the southern part of the System.

Perennial flow of streams consists of high-level groundwater seepage, all of which is either diverted or infiltrates to the basal lens before reaching the coast. Basal groundwater saturates flank lavas. At the coast a narrow zone of sediments is ineffective as caprock.

Return irrigation water plays an important role in the water balance of the System. Much of the irrigation supply is transported into the System from the Honolua and Honokohau Systems by way of Honokōhau Ditch.

The Honokowai System is included in Sector B of former studies (DOWALD 1977, Fig. 22).

Aquifer System: Launiupoko (60204)

BOUNDARIES. North divide Kahoma Valley; Pu'unoa Point to Awalua (small drainage north of Olowalu); south divide of Launiupoko.

GEOLOGY. Wailuku basalt with minor areas of Honolua cover; vents and dikes of Honolua affect groundwater occurrence and behavior; main Wailuku rift zone several miles inland; narrow coastal plain of alluvium but insufficient for caprock; "old alluvium" in valleys.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Sugar; Lahaina urban center; modest tourism at coast; mostly forest reserve.

GROUNDWATER OCCURENCE. About two miles (3 km) of basal groundwater in Wailuku basalt extends inland from the coast, beyond which is high-level dike water, also in Wailuku basalt. The System is part of Sector B of previous studies (DOWALD 1977).

The basal groundwater occurs in flank lavas which are covered at the coast by a narrow shelf of sediments. These sediments are ineffective as caprock.

Aquifer System: Olowalu (60205)

BOUNDARIES. South divide Launiupoko; Awalua to south divide Olowalu; south divide Olowalu.

GEOLOGY. Wailuku series intruded by dikes and vents of Honolua series; main Wailuku rift zone easterly, several miles inland; coastal plain of old and recent alluvium forming weak caprock; old alluvium in lower valleys and adjacent ridges.

HYDROLOGY. Volcanic aquifers: unconfined basal; confined basal; unconfined high-level dike; unconfined high-level perched.

ALLUVIAL AQUIFERS. Coastal plain sediments.

ENVIRONMENT. Sugar; minimal urbanization on coastal plain; mostly forest reserve.

GROUNDWATER OCCURENCE. In the seaward two miles of the System is a basal lens in Wailuku basalt. The remaining 2.5 miles (4 km) is part of a rift zone containing high-level groundwater, also in Wailuku basalt. A coastal plain of sediments having a maximum width of one mile (1.6 km) behaves as a weak caprock. The hydrogeology of the high-level water is complicated by intrusions of the Honolua series.

The System is part of Sector C of previous studies (DOWALD 1977).

Aquifer System: Ukumehame (60206)

BOUNDARIES. South divide Olowalu to Lahaina-Wailuku District line in Manawainui Gulch; inland along district line; interior divide separating Ukumehame from 'Āo Valley.

GEOLOGY. Wailuku basalt intruded by Honolua series; Honolua vents and dikes; main Wailuku rift zone at head of valley, westerly trend; coastal plain alluvium forming weak caprock; old alluvium in valleys.

HYDROLOGY. Volcanic aquifers: unconfined basal; confined basal; unconfined high-level dike; unconfined high-level perched.

ALLUVIAL AQUIFERS. Coastal plain sediments.

ENVIRONMENT. Sugar; mostly forest reserve.

GROUNDWATER OCCURENCE. High-level groundwater starts about two miles inland and is found chiefly in dike aquifers. The escape of basal groundwater at the coast is somewhat impeded by a sedimentary caprock wedge about one-half mile wide. All of the exploitable groundwater saturates Wailuku basalt.

Along with the Olowalu System, Ukumehame was included in Sector C of previous DOWALD (1977) reports.

AQUIFER SECTOR: CENTRAL (603)

Aquifer System: Kahului (60301)

BOUNDARIES. Kahului Bay south of Mā'alaea; Kahului Bay east to Papa'ula Point; Papa'ula Point south to Kīhei along the Ha'ikū Ditch (farthest reach of East Maui surface water); Kīhei to Mā'alaea.

GEOLOGY. Recent alluvium, including dune sand, on East Maui lavas, which in the west overlie old alluvium from West Maui; deep residuum on parent East Maui lavas.

HYDROLOGY. Volcanic aquifers; unconfined basal; confined basal; unconfined high-level perched.

ALLUVIAL AQUIFERS. Unconfined basal.

ENVIRONMENT. Large-scale sugar; urbanizations (Kahului, Pu'unēnē, airport); scattered small farms; no forest reserve.

GROUNDWATER OCCURENCE. All of the groundwater is basal and occurs in a complicated arrangement of sediments and volcanics from West and East Maui. The developable groundwater is taken from East Maui volcanics underlying the sedimentary cover of sand and alluvium. Kahului Bay is the northern and Mā'alaea Bay the southern boundary of the System. A moderately effective sedimentary caprock impedes discharge of the lens at either coast.

Return irrigation flows are responsible for complex modern water balances. Ditch flows from the Koolau Aquifer Sector of East Maui and from streams of West Maui contribute enormously to recharge. The groundwater is not potable.

Aquifer System: Paia (60302)

BOUNDARIES. Papa'ula Point south to Kīhei; Papa'ula Point east to Māliko Bay; Māliko Bay south along Māliko Gulch to Wailoa Ditch; Wailoa Ditch west-southwest along Hāmākua Ditch, continue to Waiakoa Gulch (Wailuku-Makawao District line); District line west to Kīhei.

GEOLOGY. Kula series full coverage over Honomanu series; shallow alluvial valley fill; shallow alluvial coastal plain, caprock in places.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level perched.

ALLUVIAL AQUIFERS. Unconfined basal.

ENVIRONMENT. Large-scale sugar; some pineapple; ranching; minor urbanization.

GROUNDWATER OCCURENCE. The entire System is underlaid with basalt of the Honomanu volcanic series covered by andesitic rocks of the Kula volcanic series. Basal groundwater occurs in both formations. An effective sedimentary caprock is absent.

A very large volume of Koolau Sector surface runoff is transported to the System by ditches for irrigation. Before the start of irrigation the sustainable yield would have been potable; now only the reach between Hāmākuapoko and Māliko contains potable basal water.

Aquifer System: Makawao (60303)

BOUNDARIES. Waiakoa Gulch to Hāmākua Ditch, north to Māliko Gulch at Wailoa Ditch; Māliko Gulch at Wailoa Ditch southerly to Pu'u Nianiau to Kalahaku overlook on Haleakalā; Haleakalā Crater divide southwest to Kolekole; Kolekole northwest along Waiakoa Gulch to Hāmākua Ditch (if extended).

GEOLOGY. Kula constitutes entire surface; northwest rift zone from Haleakalā as series of cones; no evidence of dikes; no significant alluvium.

HYDROLOGY. Volcanic aquifer: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Pineapple; little or no sugarcane; ranching; truck farms; minor urbanization.

GROUNDWATER OCCURENCE. Very little is known about the occurrence and distribution of groundwater in the System. The entire region is covered by Kula lava, and nowhere does the System border along a coastline. Basal groundwater in Honomanu basalt underlies about three

fourths of the total area. Where high-level water occurs, it lies far below the surface in the Wailuku basalt.

Minimum elevation in the System is approximately 1000 ft (304.8 m). Drilling of deep wells would be very costly, and operating costs expensive. Virtually no subsurface exploration has been done in the region.

Aquifer System: Kamaole (60304)

BOUNDARIES. Kolekole (Haleakalā) west along Waiakoa Gulch to Kīhei; Kīhei south to Cape Kīna‘u; Cape Kīna‘u northeast along crest of southwest rift of Haleakalā to Kolekole.

GEOLOGY. Predominantly Kula over unexposed Honomanu; some Hana series near southwest rift zone; dikes at depth along rift; virtually no alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Ranching; truck farming; scattered residences; low density tourism along coast; mostly arid, unused areas.

GROUNDWATER OCCURENCE. About three to five mile of basal groundwater extend inland from the coast. The dominant rock is Kula volcanics, but the Hana series covers the Kula formation in the south part of the System. The region beyond the basal sector contains deep high-level water in Honomanu volcanics associated with an original rift zone of Haleakalā. Spotty accumulations of sediments along the coast do not act as caprock.

AQUIFER SECTOR: KOOLAU (604)

Aquifer System: Haiku (60401)

BOUNDARIES. Mālika Bay south along Mālika Gulch to Pu‘u Pi‘iholo, on to Pu‘u Nianiau; Pu‘u Nianiau north along east divide of ‘Ōpana Valley to Pīlale Bay; Pīlale Bay west to Mālika Bay.

GEOLOGY. Only Kula rocks exposed at surface, but contact with underlying Honomanu visible in a road cut; northwest rift from Haleakalā; unconformities in Kula series; little alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched.

ENVIRONMENT. Pineapple; ranching; scattered residences; surface water collection system for transfer of water to sugar irrigation in Central Maui (Wailoa Ditch, Kauhikoa Ditch, Ha‘ikū Ditch); water collection in Olinda Ditch for truck farming in Kula; forest reserve.

GROUNDWATER OCCURENCE. Basal, high-level dike and high-level perched groundwater occurs in the System. The whole of the region is covered by Kula volcanics. The principal developable groundwater in the seaward three to four miles is basal, mostly restricted to the Honomanu basalt. Substantial perched water occurs in the Kula formation. Much of this water is captured by the ditch system of the East Maui Irrigation Company. High-level dike groundwater lies far below the ground surface in the Honomanu volcanics.

Although a sedimentary caprock does not rim the coast, the Kula series locally behaves as variably effective caprock that retards discharge from the basal lens in the underlying Honomanu volcanics.

Aquifer System: Honopou (60402)

BOUNDARIES. Pu'u Nianiau along east divide of Kailua Valley to Kailua; Kailua west to Pīlale Bay; Pīlale Bay south along east divide of 'Ōpana to Pu'u Nianiau.

GEOLOGY. Kula formation completely covers Honomanu series; shallow recent alluvium in streams.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level dike at depth; unconfined high-level perched (source of base flow to ditches).

ENVIRONMENT. Surface water collection for transfer to Central Maui, chiefly by Wailoa and Ha'ikū ditches; scattered but few residences; mostly forest reserve.

GROUNDWATER OCCURENCE. Only surface water resources are understood to some degree because of the collection ditches that transfer water to Central Maui. No exploration has yet been done for basal groundwater. The region is covered by the Kula volcanics. However, for about a mile inland basal water is likely to saturate underlying Honomanu basalt. Sedimentary caprock is absent at the coast, but the Kula may behave as a weak caprock in places.

Perched groundwater in Kula volcanics drains to streams, which are diverted to the ditch system. High-level dike water occurs far inland in the Honomanu basalt but at great depth.

Aquifer System: Waikamoi (60403)

BOUNDARIES. East divide Kailua Valley south to Pu'u Nianiau, on to Kalahaku overlook of Haleakalā; Kalahaku northeast along west divide of Ko'olau Gap to Ke'anae; Ke'anae west to Kailua.

GEOLOGY. Virtually all Kula formation, but Honomanu exposed in Honomanū and Pi'ina'au valleys; no coastal alluvium; shallow recent alluvium in valleys.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched (flow collected by ditches).

ENVIRONMENT. Water collection for transport to Central Maui by Wailoa and Ha'ikū ditches; upper Waikamoi Stream diverted to Olinda Ditch for Kula; few houses; forest reserve.

GROUNDWATER OCCURENCE. Perched high-level groundwater in the Kula series, which mantles the System, extends all the way to the coast. Basal groundwater in the basement of Honomanu basalt probably occurs in a zone several miles wide, followed by high-level dike water, also in the Honomanu but at great depth.

Little is known about the groundwater resources of the System. Much of the perched water is collected by East Maui Irrigation Company ditches. No sedimentary caprock covers the coast.

Aquifer System: Keanae (60404)

BOUNDARIES. West divide of Ko'olau Gap from Kolekole north to Ke'anae; Ke'anae east to Nāhiku; Nāhiku north along west divide of Kūhiwa Valley to northern ridge of Haleakalā Crater (Kalapawili Ridge); Kalapawili Ridge west along topographic divide in Crater to Kolekole.

GEOLOGY. Some Hana series at eastern boundary, but mainly Kula series over unexposed Honomanu; cinder cones in Haleakalā Crater; Ko'olau Gap is ancient valley eroded in Honomanu rocks, then covered with Kula series; small patches of old alluvium; shallow recent alluvium in valleys.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched.

ENVIRONMENT. Collection of surface water by Ko'olau Ditch for transmission to Central Maui; minor urbanization (Ke'anae) and farming at coast; forest reserve.

GROUNDWATER OCCURENCE. Relationships among high-level perched, high-level dike and basal groundwaters are extremely complex. Three volcanic series—Honomanu, Kula and Hana—serve as aquifers and control groundwater accumulation and movement. Perched water extends to the coast. Basal water saturates the basement of Honomanu basalt and may occur in the Hana series at the mouth of Ke'anae Valley. Far inland, high-level dike water in the Honomanu series lies deep below the surface. A coastal caprock of sediments is absent.

AQUIFER SECTOR: HANA (605)**Aquifer System: Kuhiwa (60501)**

BOUNDARIES. West divide of Kūhiwa Valley from Kalapawili Ridge (Haleakalā) north to Nāhiku; Nāhiku east to ‘Ula‘ino; ‘Ula‘ino south along west divide of Kawakoe Gulch south to inner divide of Waiho‘i Valley; west along inner divide of Kīpahulu Valley to Kalapawili Ridge.

GEOLOGY. Exclusively Hana series over Kula and Honomanu series; cinder cones in northerly rift zone; little alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched.

ENVIRONMENT. No economic activity; forest reserve.

GROUNDWATER OCCURENCE. Basal groundwater flows in both the Hana and Honomanu volcanic series. The System is covered by the Hana series, which masks any perched high-level groundwater in the Kula volcanics. High-level dike water in the Honomanu lies deep below the surface in the interior of the System.

Aquifer System: Kawaipapa (60502)

BOUNDARIES. Head of Waiho‘i Valley along west divide of Kawahoe Gulch to ‘Ula‘ino; ‘Ula‘ino east, then south to Hamoā; Hamoā west along north divide of Waiho‘i Valley to inner rim of Waiho‘i.

GEOLOGY. All Hana series except for minor exposures of Kula; cinder cones in rift zone trending easterly; cinder deposits up to 25 ft (7.6 m) thick; minor alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike inland at depth; unconfined high-level perched.

ENVIRONMENT. Ranching; modest urbanization at Hāna; low density tourism; forest reserve.

GROUNDWATER OCCURENCE. Basal groundwater reaches to at least two miles inland, in the Hana series to some extent but chiefly in the Honomanu series. It is not protected at the coast by caprock. Inland, high-level dike water in Honomanu basalt lies far below the surface. Several wells develop potable water from the basal lens.

Aquifer System: Waihoi (60503)

BOUNDARIES. Hamoā west along north divide of Waiho‘i Valley to inner rim of valley; southeast along eastern divide of Kīpahulu Valley to ‘Ohe‘o Gulch and Kūloa Point; Kūloa Point northeast to Hāmoa.

GEOLOGY. Valley fill of Hana series; exposures of Kula; rift zone dikes at head of valley; insignificant alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Ranching; scattered residences along coast; forest reserve.

GROUNDWATER OCCURENCE. Young Hana lavas overlie the Kula series which in turn cover the basement of Honomanu basalt. Groundwater relationships are complicated, as they are wherever this vertical sequence exists. Basal groundwater extends at least a mile inland of the coast, and its outflow is not impeded by caprock. High-level dike water occurs in the Honomanu basement at considerable depth below the surface. High-level perched water in the Kula series is masked by the cover of Hana lavas.

Aquifer System: Kipahulu (60504)

BOUNDARIES. East divide of Kaupō Gap from Kepio Point to Pōhakupālahā overlooking Kaupō and Kīpahulu valleys; east along Kalapawili Ridge and northern divide of Kīpahulu to Kūloa Point; Kūloa Point to Kepio Point.

GEOLOGY. Hana series valley fill in Kīpahulu; some exposures of Kula series; no substantial alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Ranching; few residences; forest reserve.

GROUNDWATER OCCURENCE. All three of the major volcanic series in East Maui have been identified. Basal, high-level perched and high-level dike groundwaters exist. A complicated relationship between high-level perched and basal waters exists in the lower portion of the System. High-level dike water in Honomanu basalt lies deep below the surface farther inland. The Kula series is exposed at the coast where it may act as a weak caprock.

AQUIFER SECTOR: KAHIKINUI (606)

Aquifer System: Kaupo (60601)

BOUNDARIES. Eastern divide of Kaupō Gap; west along Kalapawili Ridge and along topographic divide in Haleakalā Crater to Kolekole; east along south boundary of Haleakalā Crater to the west boundary of Kaupō Gap, then south along divide to Nu‘u.

GEOLOGY. Mostly Hana series over Kula formation; cones in Haleakalā Crater; Kaupō Gap is an ancient valley filled with outpourings of Hana basalt; no alluvium except shallow recent deposits.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike; unconfined high-level perched.

ENVIRONMENT. Ranching; few houses; forest reserve.

GROUNDWATER OCCURENCE. The Hana volcanic series covers the entire System. Some areas may be underlain by Kula rocks, but everywhere the basement is the Honomanu series. Virtually nothing is known about groundwater occurrence. Basal groundwater probably exists in the Hana series at the coast and for some distance inland. It is not protected by caprock. In the interior high-level dike water in Honomanu volcanics lies deep below the ground.

Aquifer System: Nakuula (60602)

BOUNDARIES. Haleakalā Crater and Kaupō Gap divide from Kolekole to Nu‘u; Nu‘u west to mouth of Palaha Gulch; northward along west divide of Palaha Gulch to Kolekole.

GEOLOGY. Virtually full coverage by Kula series; no visible dikes; no alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched.

ENVIRONMENT. Ranching.

GROUNDWATER OCCURENCE. Virtually the entire area is covered by the Kula series. Near the coast basal groundwater occurs in the Kula as well as the underlying Honomanu series. The coast is rimmed with Kula rocks. Far inland, high-level dike water many occur in the Honomanu at great depth. Groundwater explorations has yet to be attempted in the System.

Aquifer System: Lualailua (60603)

BOUNDARIES. Kolekole south along Palaha Gulch to coast; mouth of Palaha Gulch west to Cape Kīna‘u; Cape Kīna‘u northeast along crest of rift zone to Kolekole.

GEOLOGY. Except for very limited exposures of Kula series, all surfaces are Hana formation; cinder cones, especially along southwest rift; historical volcanism in lower part of rift zone; insignificant alluvium.

HYDROLOGY. Volcanic aquifers: unconfined basal; unconfined high-level dike at depth; unconfined high-level perched.

ENVIRONMENT. Ranching; forest reserve.

GROUNDWATER OCCURENCE. Except for a few outliers of Kula lavas, the System is covered by the Hana series. Basal groundwater occurs in Hana rocks near the coast and in the

Honomanu series inland. The coast is rocky and has no caprock. Most of the System may be underlain by basal groundwater; high-level dike water is restricted to the farthest interior.

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AQUIFER CLASSIFICATION EXPLANATION

AQUIFER AND STATUS CODES*	
Aquifer Code	= Island
	+ Aquifer Sector
	+ Aquifer System
	+ Aquifer Type
Thus, 60102111	= Aquifer Code
where 6	= Maui
01	= Wailuku
02	= Iao
1	= basal
1	= unconfined
1	= flank
and	
(11111)	= Status Code
where 1	= currently used
1	= drinking
1	= fresh, <250 mg/l Cl ⁻
1	= irreplaceable
1	= high vulnerability to contamination

IS.	AQUIFER SECTOR	AQUIFER SYSTEM
6	01 Wailuku	01 Waikapu
		02 Iao
		03 Waihee
		04 Kahakuloa
	02 Lahaina	01 Honokohau
		02 Honolulu
		03 Honokowai
		04 Launiupoko
		05 Olowalu
		06 Ukumehame
	03 Central	01 Kahului
		02 Paia
		03 Makawao
		04 Kamaole
	04 Koolau	01 Haiku
		02 Honopou
		03 Waikamoi
		04 Keanae
	05 Hana	01 Kuhiwa
		02 Kawaiipapa
03 Waihoi		
04 Kipahulu		
06 Kahikinui	01 Kaupo	
	02 Nakuula	
	03 Lualailua	

*Where aquifers are in vertical sequence, the Aquifer and Status Codes are separated by a division line in order of occurrence, with the uppermost aquifer appearing first.

	AQUIFER TYPE:	Hydrology [†]
1	Basal	Fresh water in contact with seawater
2	High Level	Fresh water not in contact with seawater
1	Unconfined	Where water table is upper surface of saturated aquifer
2	Confined	Aquifer bounded by impermeable or poorly permeable formations, and top of saturated aquifer is below groundwater surface
3	Confined or Unconfined	Where actual condition is uncertain
	AQUIFER TYPE:	Geology [‡]
1	Flank	Horizontally extensive lavas
2	Dike	Aquifers in dike compartments
3	Flank/Dike	Indistinguishable
4	Perched	Aquifer on an impermeable layer
5	Dike/Perched	Indistinguishable
6	Sedimentary	Nonvolcanic lithology

[†]1st two digits from hydrologic descriptors (pts. 1, 2).

[‡]Last digit from geologic descriptor.

STATUS CODE (GROUNDWATER)

Development Stage

- 1 Currently used
- 2 Potential use
- 3 No potential use

Utility

- 1 Drinking
- 2 Ecologically important
- 3 Neither

Salinity (mg/l Cl⁻)

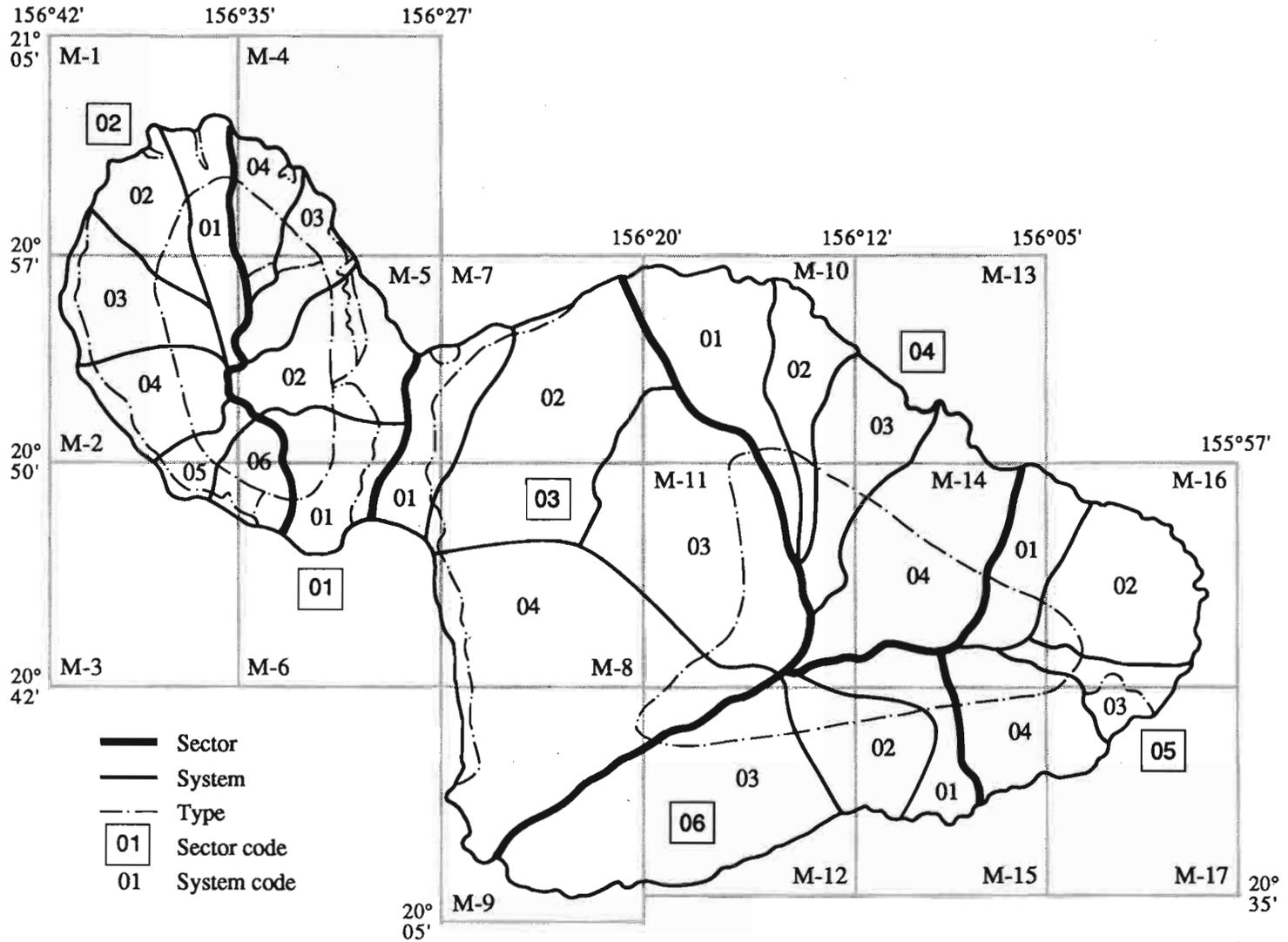
- 1 Fresh (<250)
- 2 Low (250-1000)
- 3 Moderate (1000-5000)
- 4 High (5000-15,000)
- 5 Seawater (>15,000)

Uniqueness

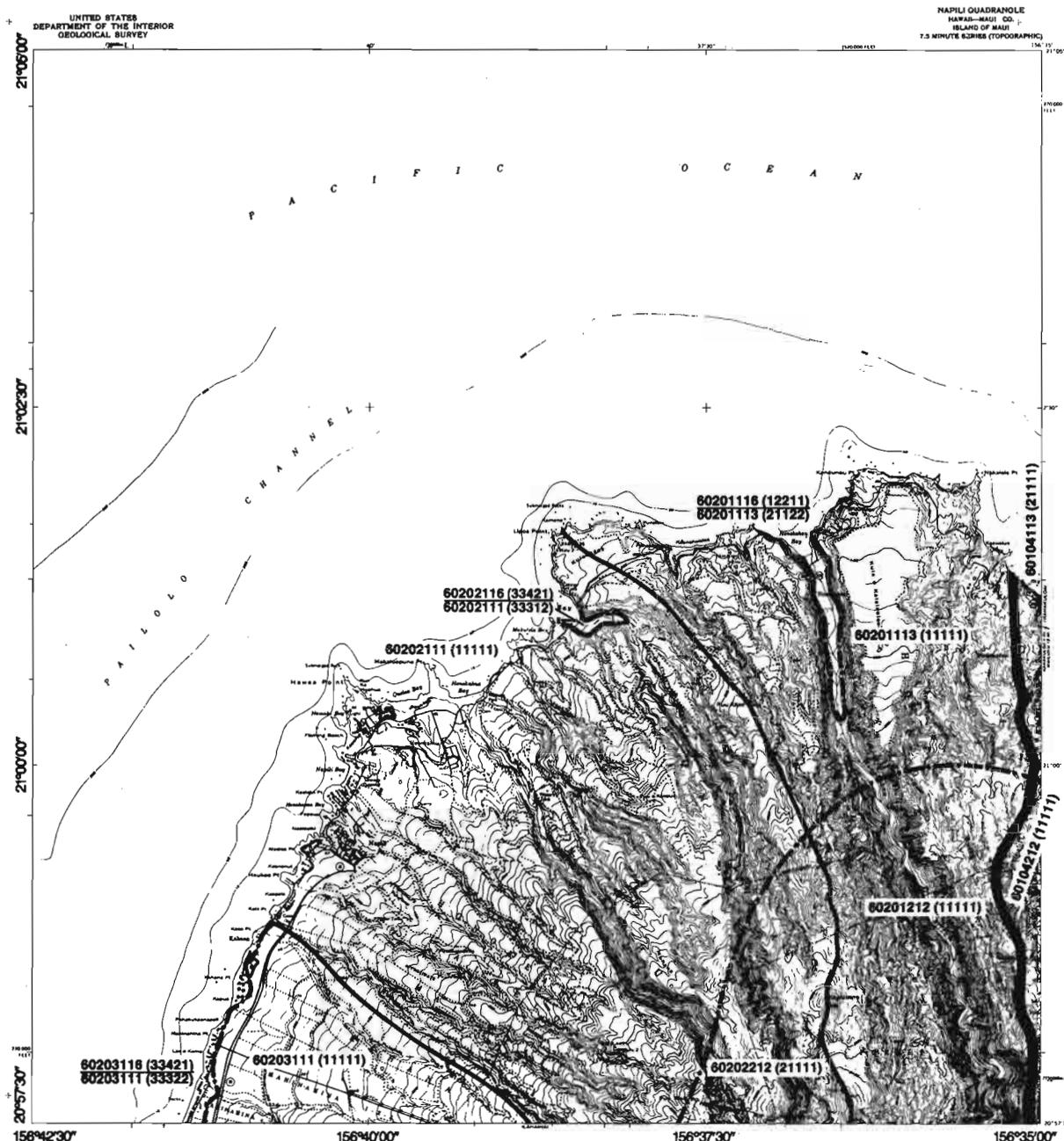
- 1 Irreplaceable
- 2 Replaceable

Vulnerability to Contamination

- 1 High
- 2 Moderate
- 3 Low
- 4 None



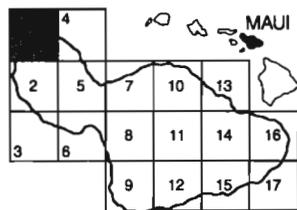
Appendix Figure A.1.0 Layout of aquifer Sectors, Systems, and Types for Maui, Hawai'i



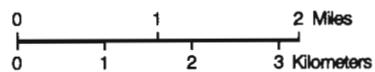
Base Map: USGS (1:24,000 series, rev. 1983).

NAPILI, MAUI
M-1

1990

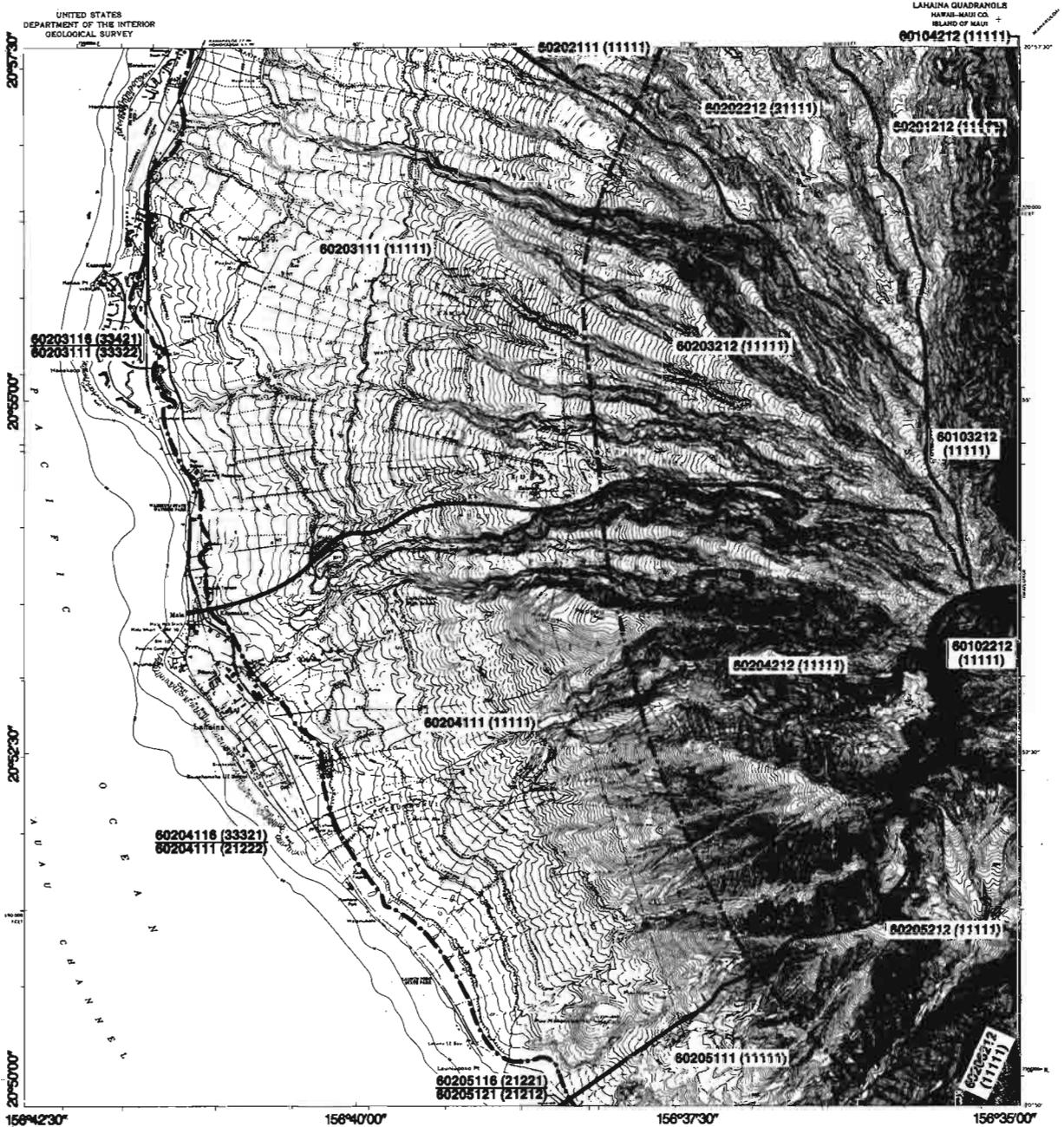


- Sector
- Aquifer System
- Aquifer Type
- 60104212 Aquifer Code
- (11111) Status Code



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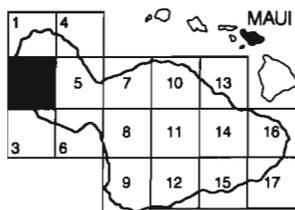
Appendix Figure A.1.1 Aquifer classification map, Nāpili, Maui, Hawai'i



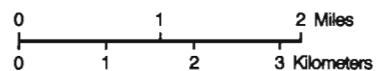
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LAHAINA, MAUI
M-2

1990

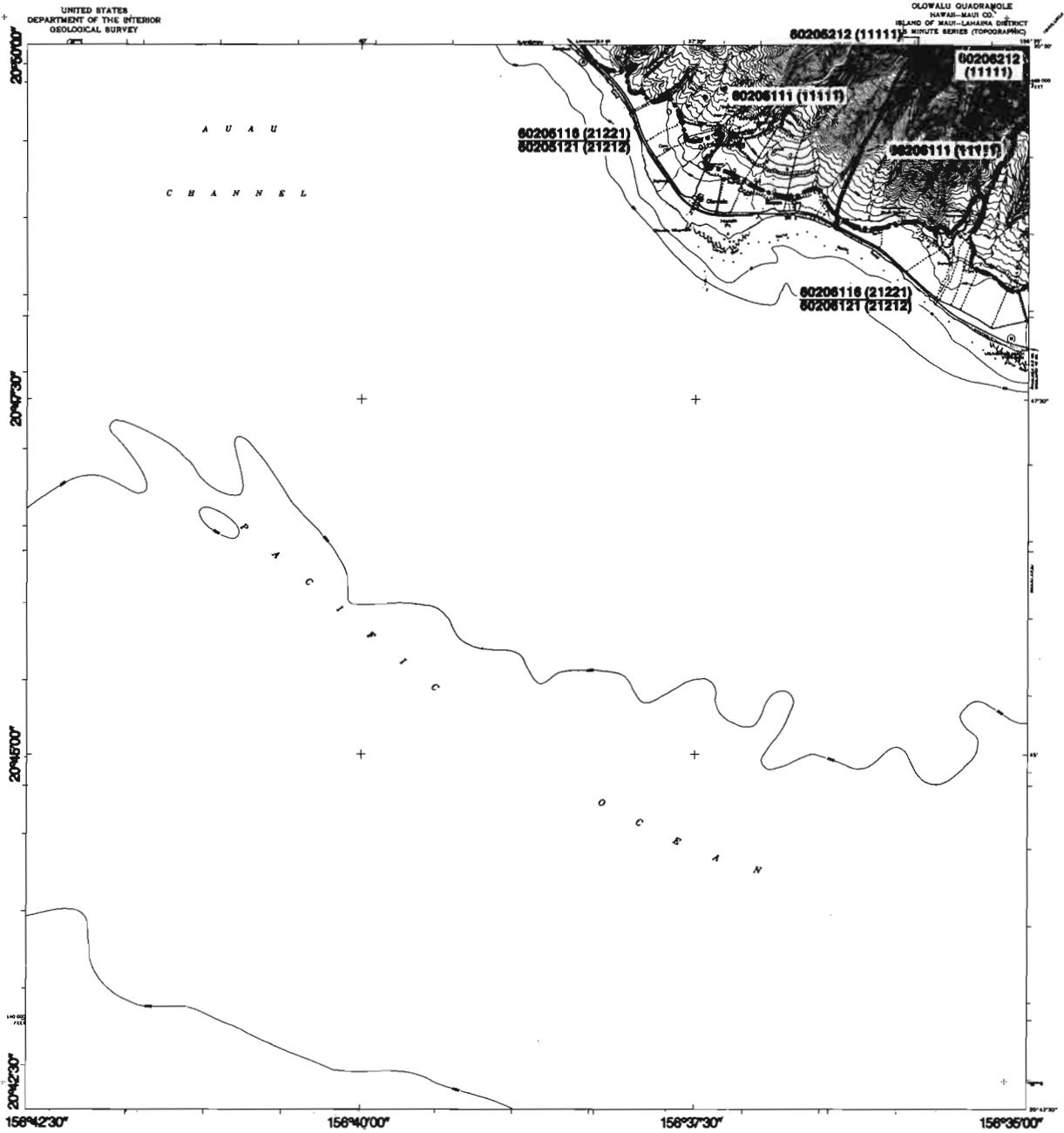


- Sector
- Aquifer System
- Aquifer Type
- Aquifer Code
- Status Code



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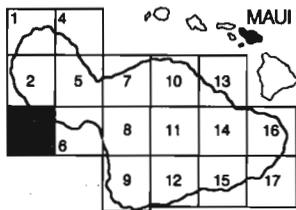
Appendix Figure A.1.2. Aquifer classification map, Lahaina, Maui, Hawai'i



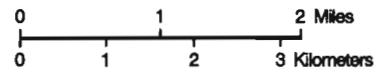
Base Map: USGS (1:24,000 series, rev. 1983).

LOWALU, MAUI
M-3

1990

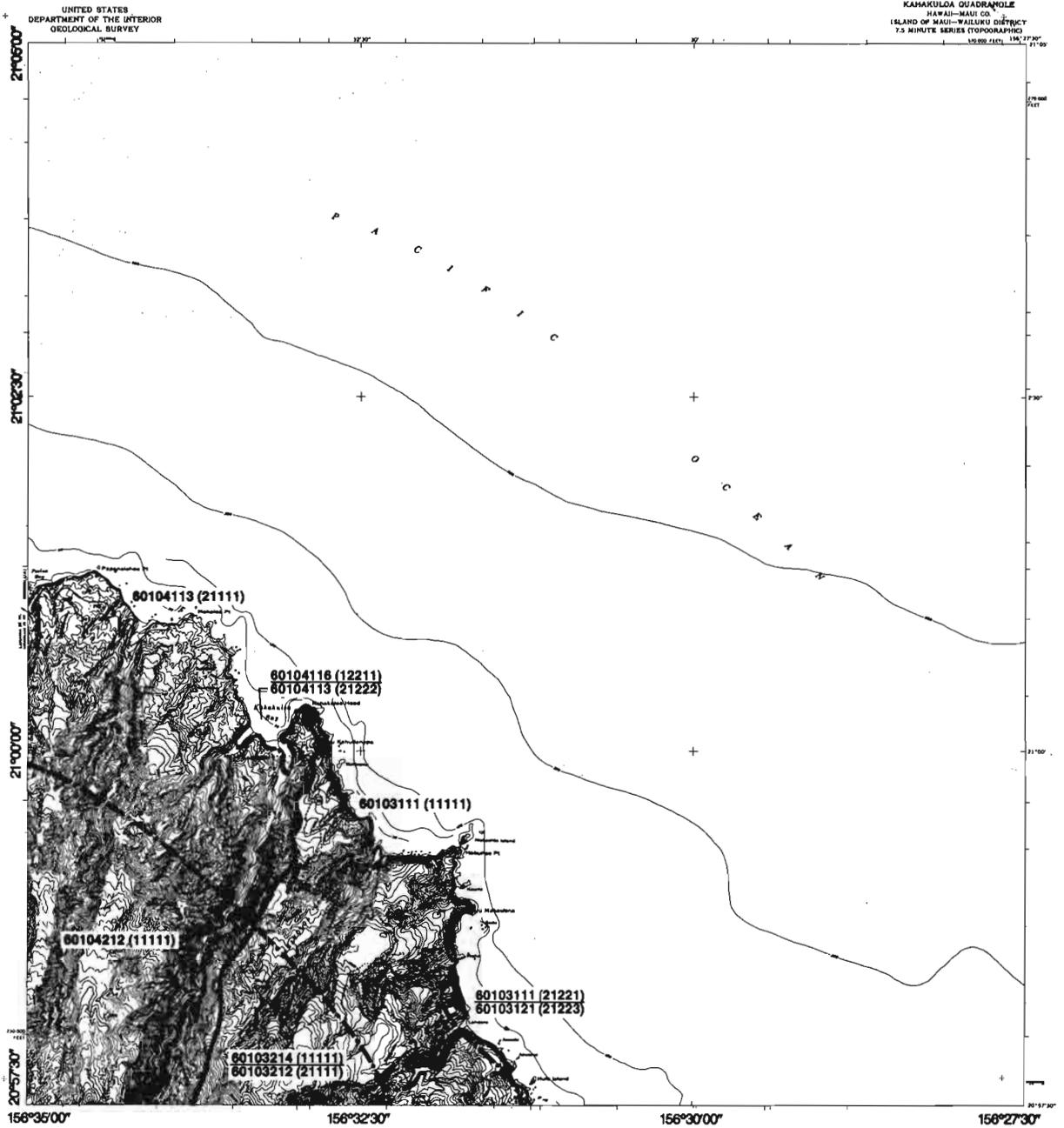


-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
-  Status Code



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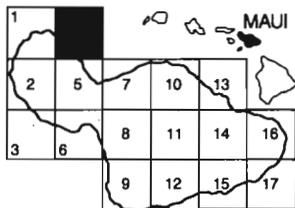
Appendix Figure A.1.3. Aquifer classification map, Olowalu, Maui, Hawai'i



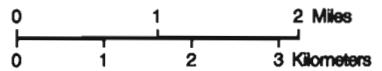
Base Map: USGS (1:24,000 series, rev. 1983).

**KAHAKULOA, MAUI
M-4**

1990

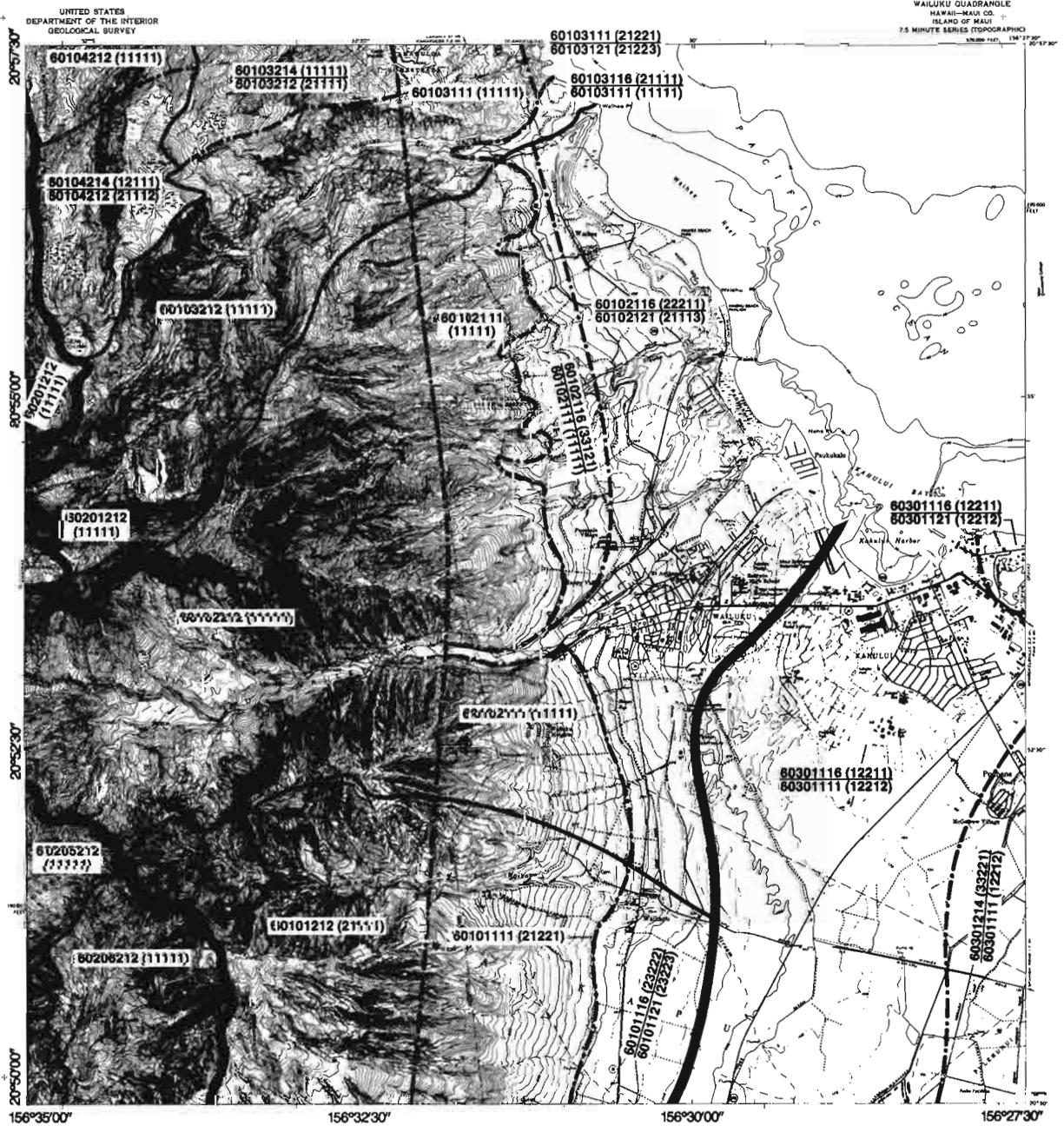


- █ Sector
- Aquifer System
- · — Aquifer Type
- 60104212 Aquifer Code
- (11111) Status Code



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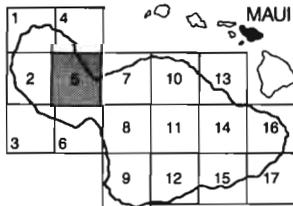
Appendix Figure A.1.4. Aquifer classification map, Kahakuloa, Maui, Hawaii



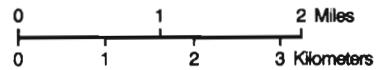
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WAILUKU, MAUI
M-5

1990

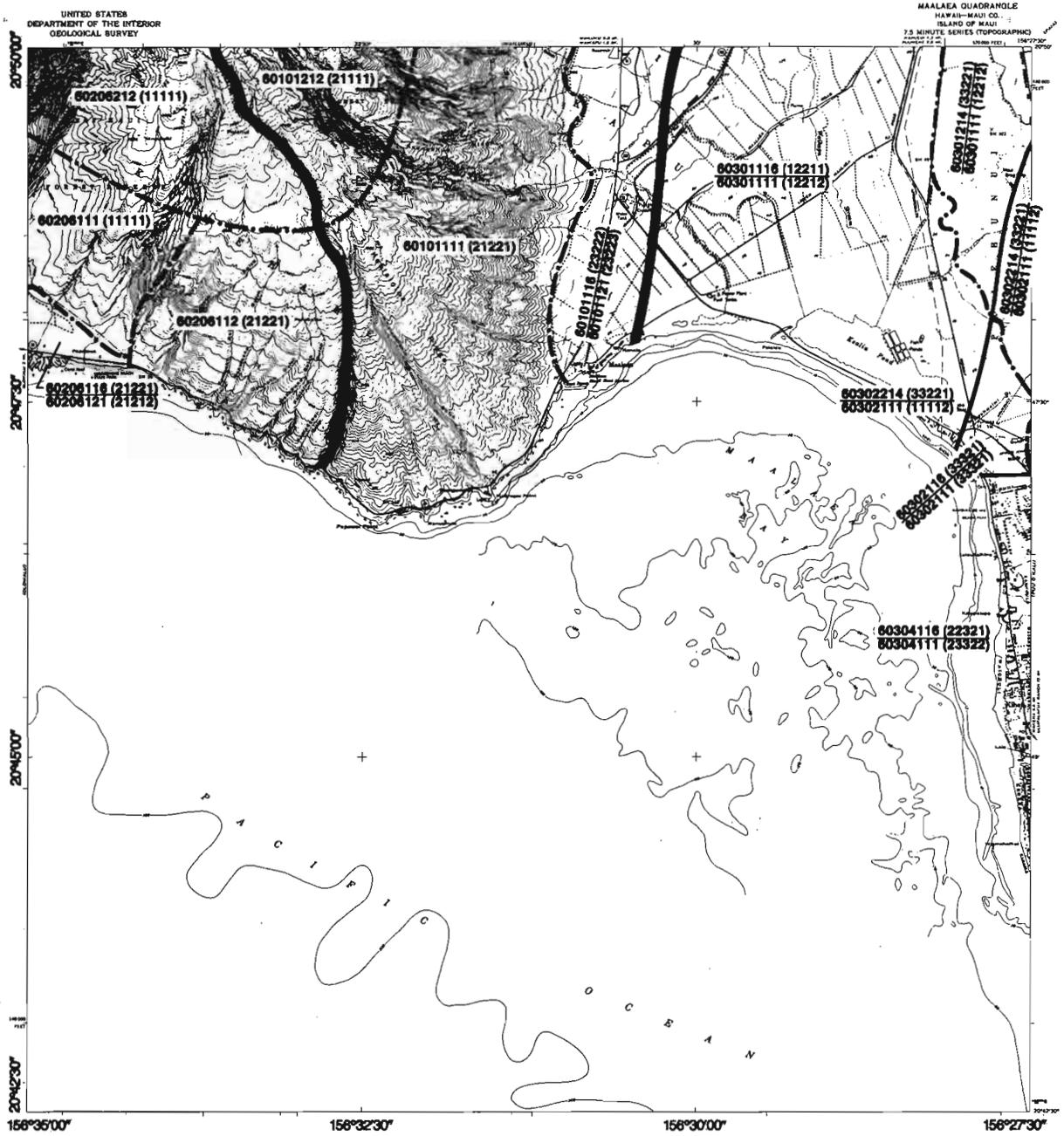


-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
-  Status Code



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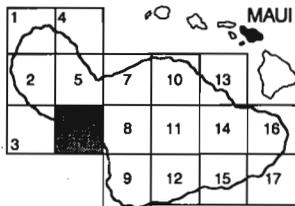
Appendix Figure A.1.5. Aquifer classification map, Wailuku, Maui, Hawai'i



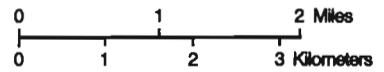
Base Map: USGS (1:24,000 series, rev. 1983).

MAALAEA, MAUI
M-6

1990

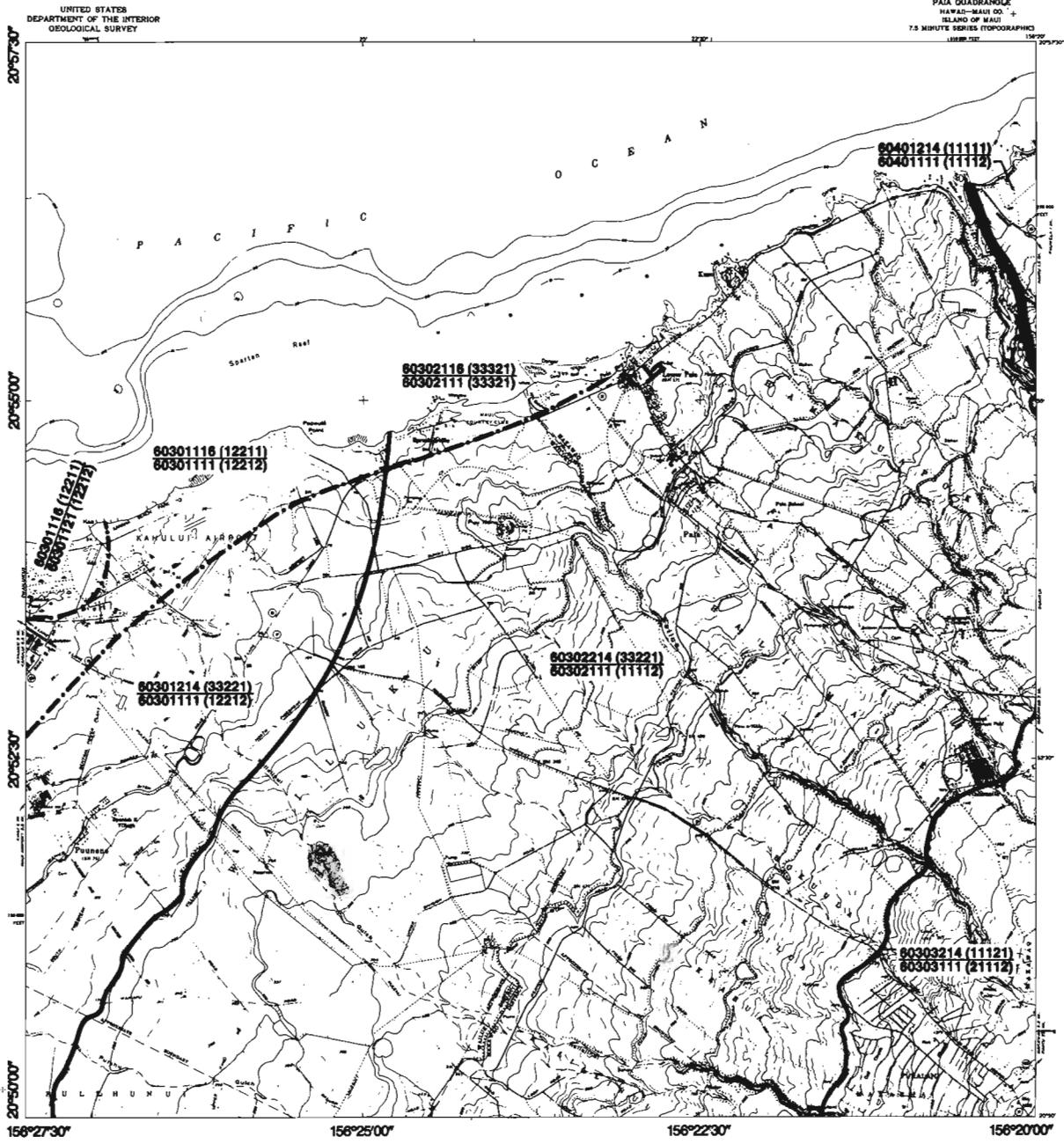


-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
-  Status Code



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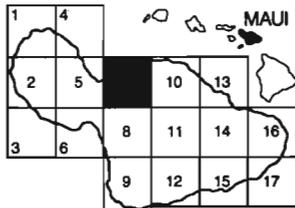
Appendix Figure A.1.6. Aquifer classification map, Mā'alaea, Maui, Hawai'i



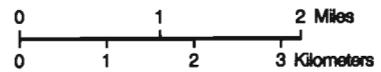
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PAIA, MAUI
M-7

1990

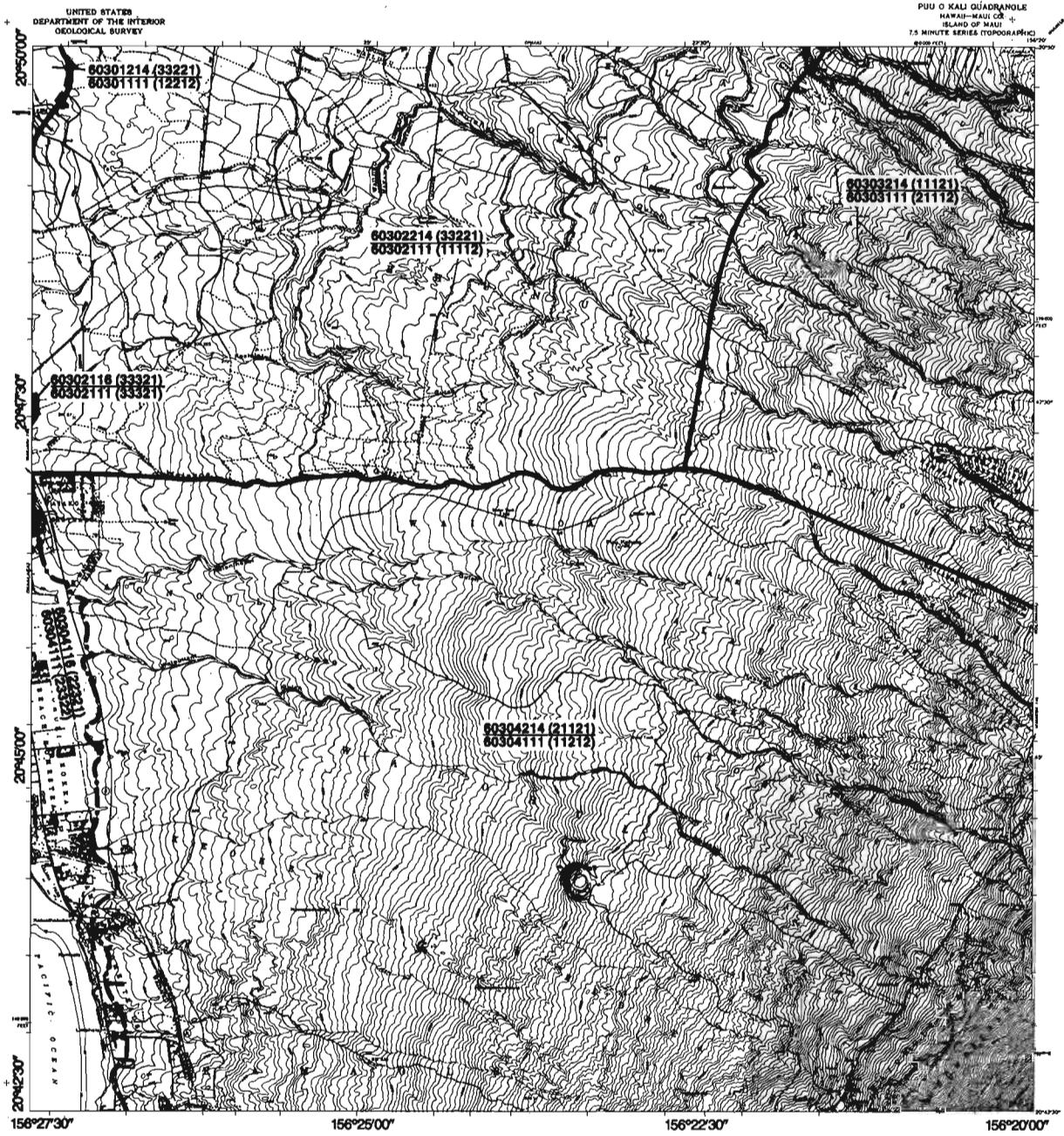


- Sector
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- Aquifer Type
- 60104212 Aquifer Code
- (11111) Status Code



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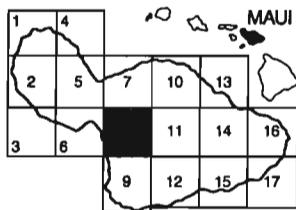
Appendix Figure A.1.7. Aquifer classification map, Pāia, Maui, Hawai'i



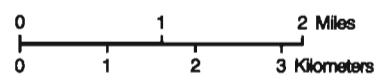
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PUU O KALI, MAUI
M-8

1990

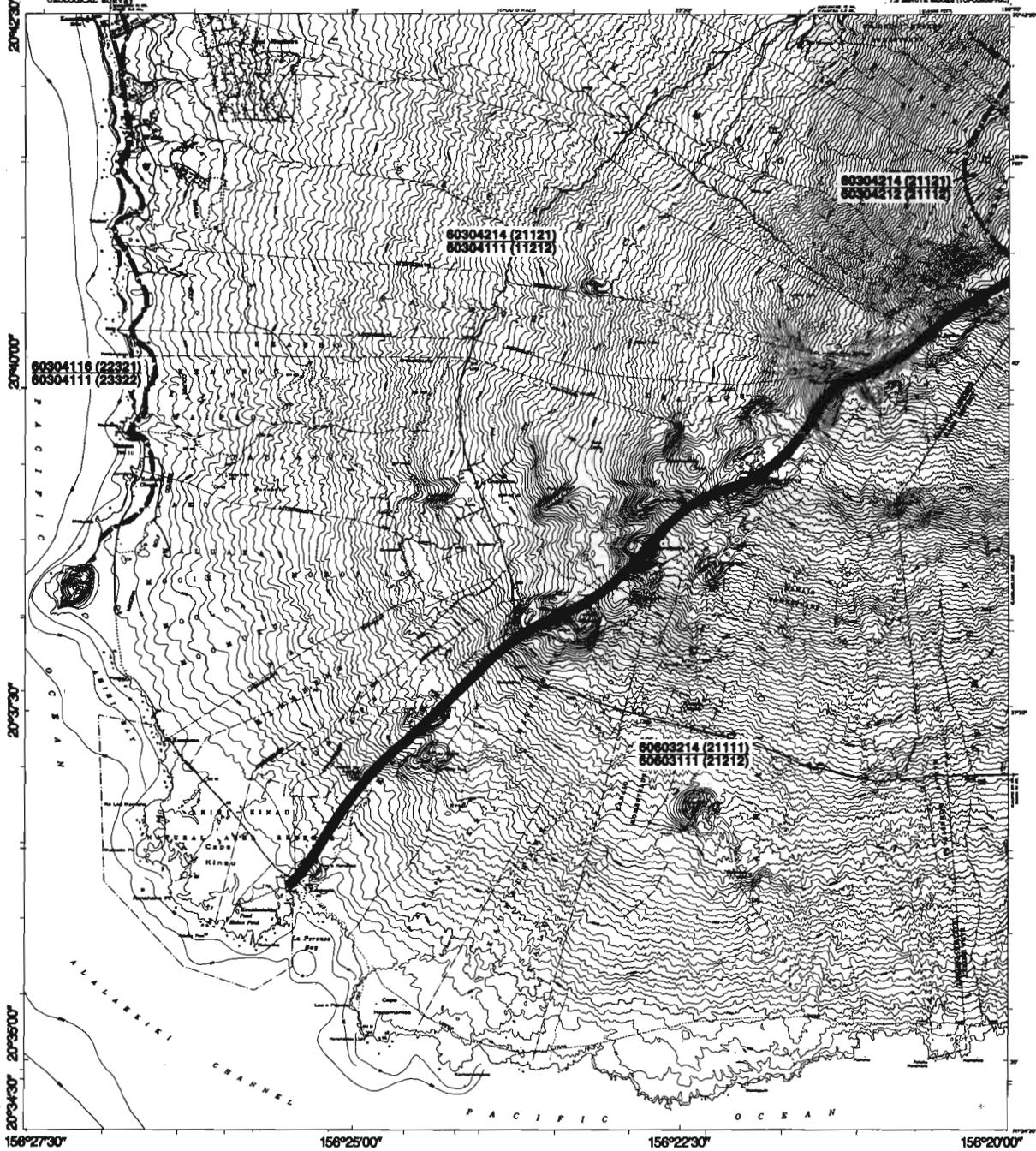


- Sector
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- Aquifer Type
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(11111) Aquifer Code
- (11111)** Status Code



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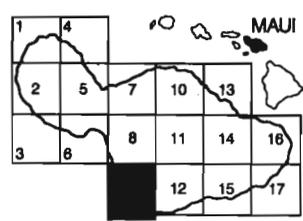
Appendix Figure A.1.8. Aquifer classification map, Pu'u O Kali, Maui, Hawai'i



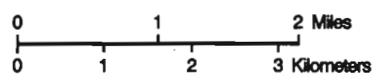
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MAKĒNA, MAUI
M-9

1990

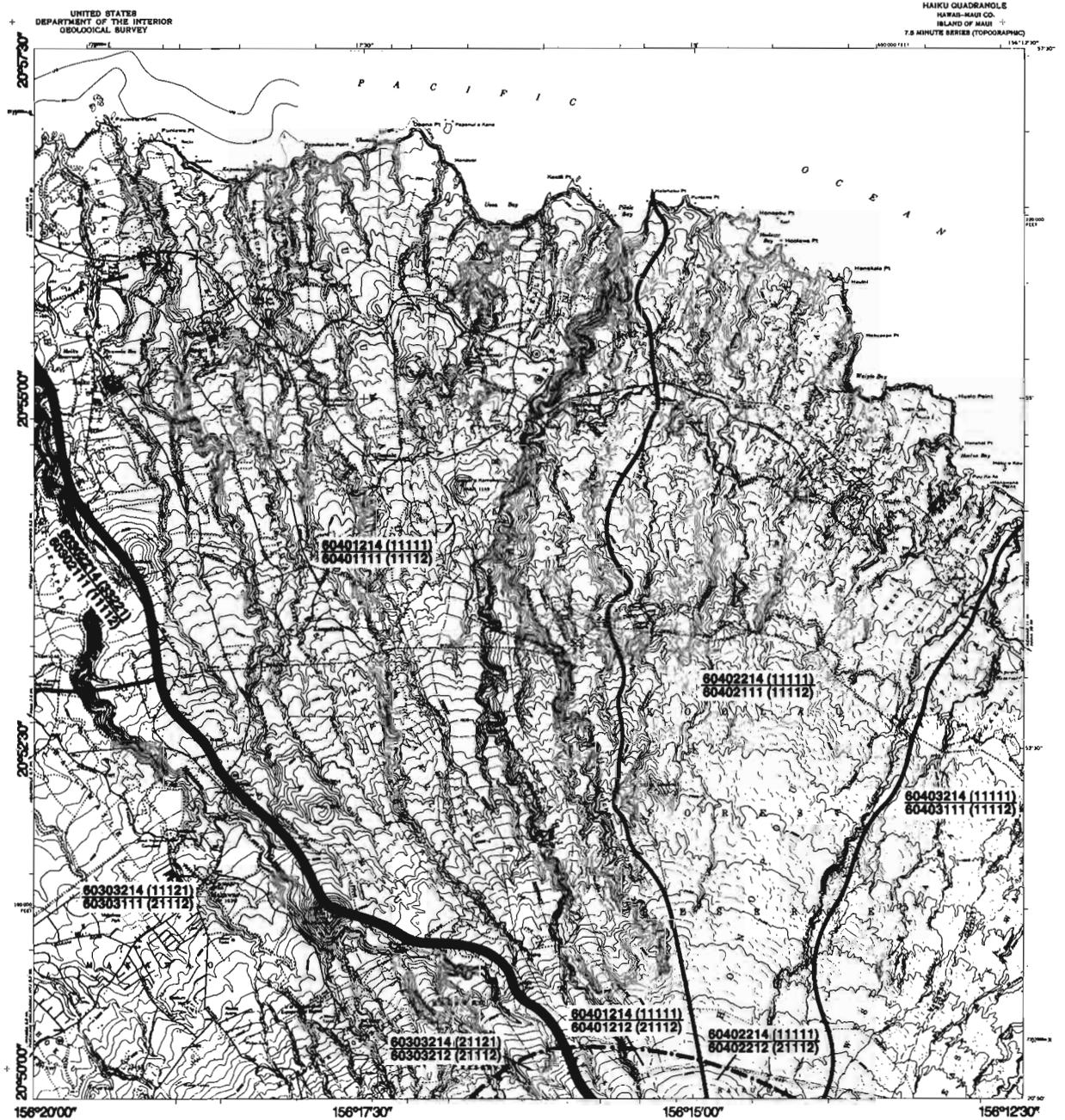


- Sector
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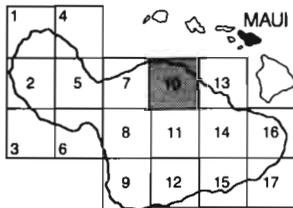
Appendix Figure A.1.9 Aquifer classification map, Mākena, Maui, Hawai'i



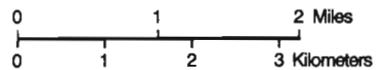
Base Map: USGS (1:24,000 series, rev. 1983).

HAIKU, MAUI
M-10

1990

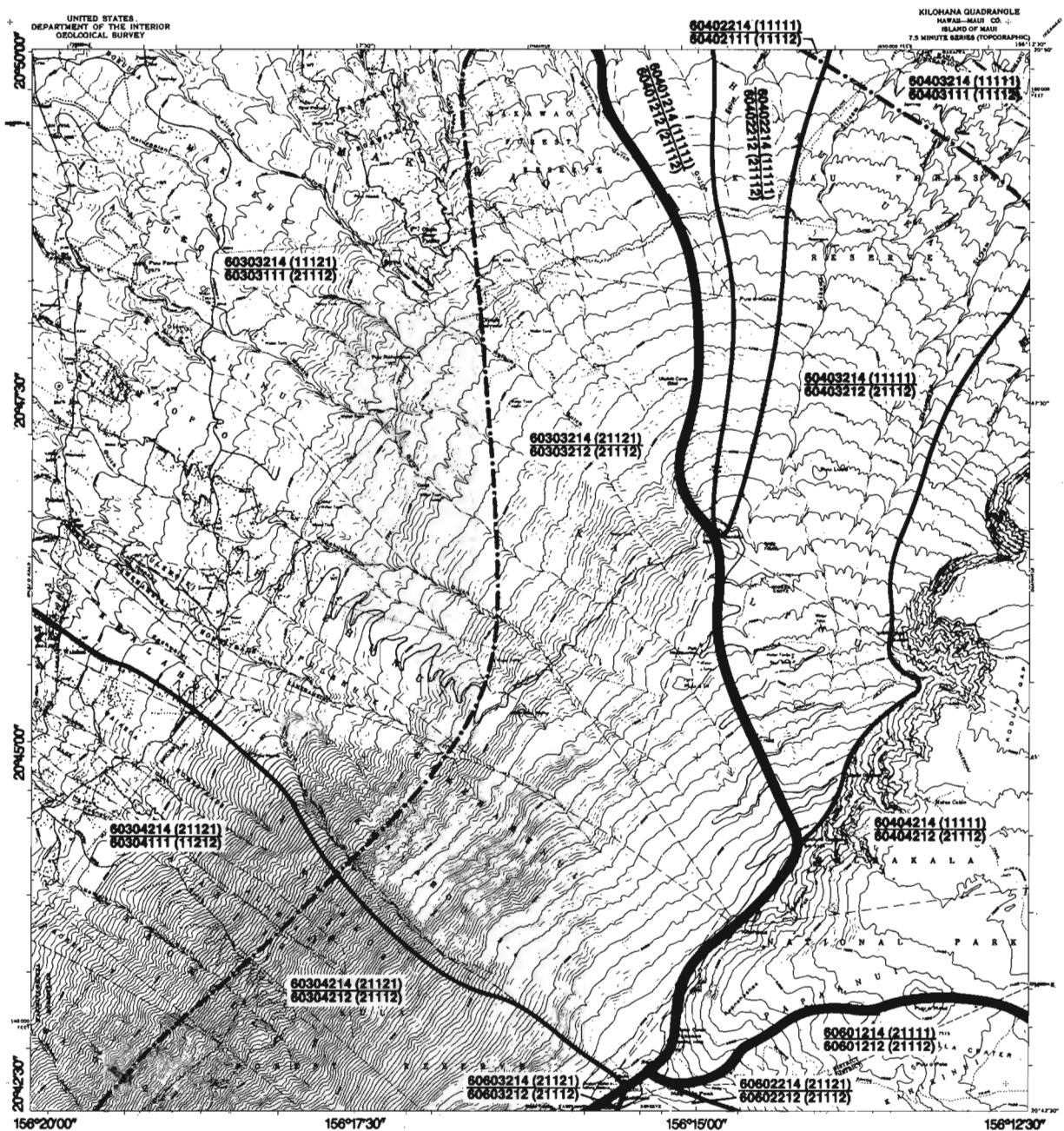


- Sector
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- (11111) Status Code



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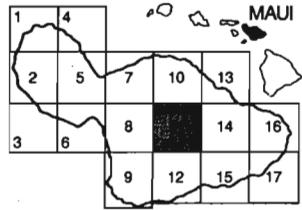
Appendix Figure A.1.10. Aquifer classification map, Ha'ikū, Maui, Hawai'i



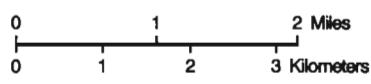
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KILOHANA, MAUI
M-11

1990

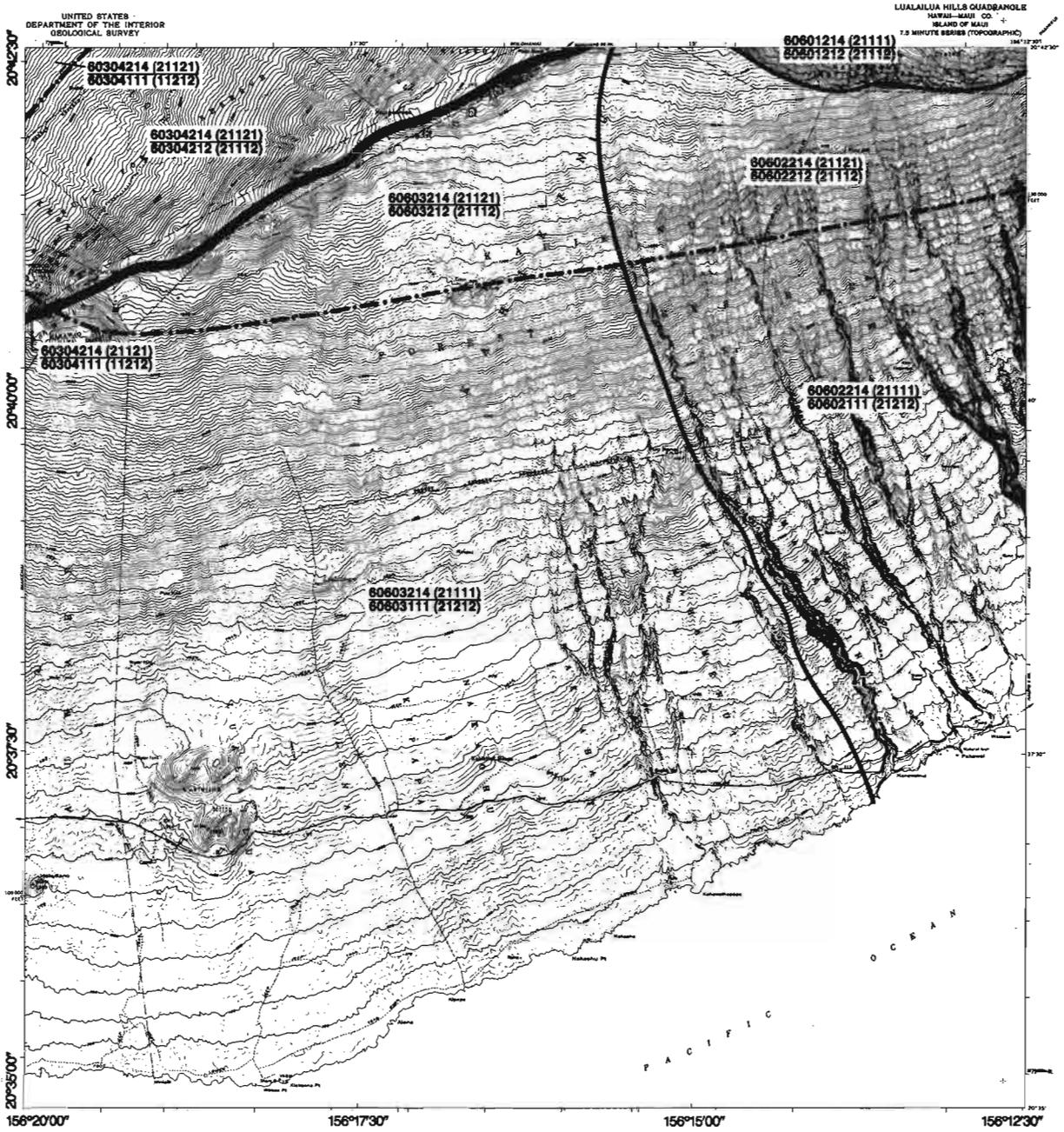


- Sector
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(11111) Aquifer Code
- 60104212
(11111) Status Code



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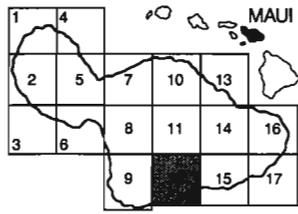
Appendix Figure A.1.11. Aquifer classification map, Kiloohana, Maui, Hawai'i



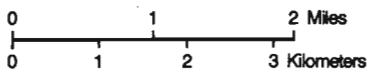
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LUALAILUA HILLS, MAUI
M-12

1990

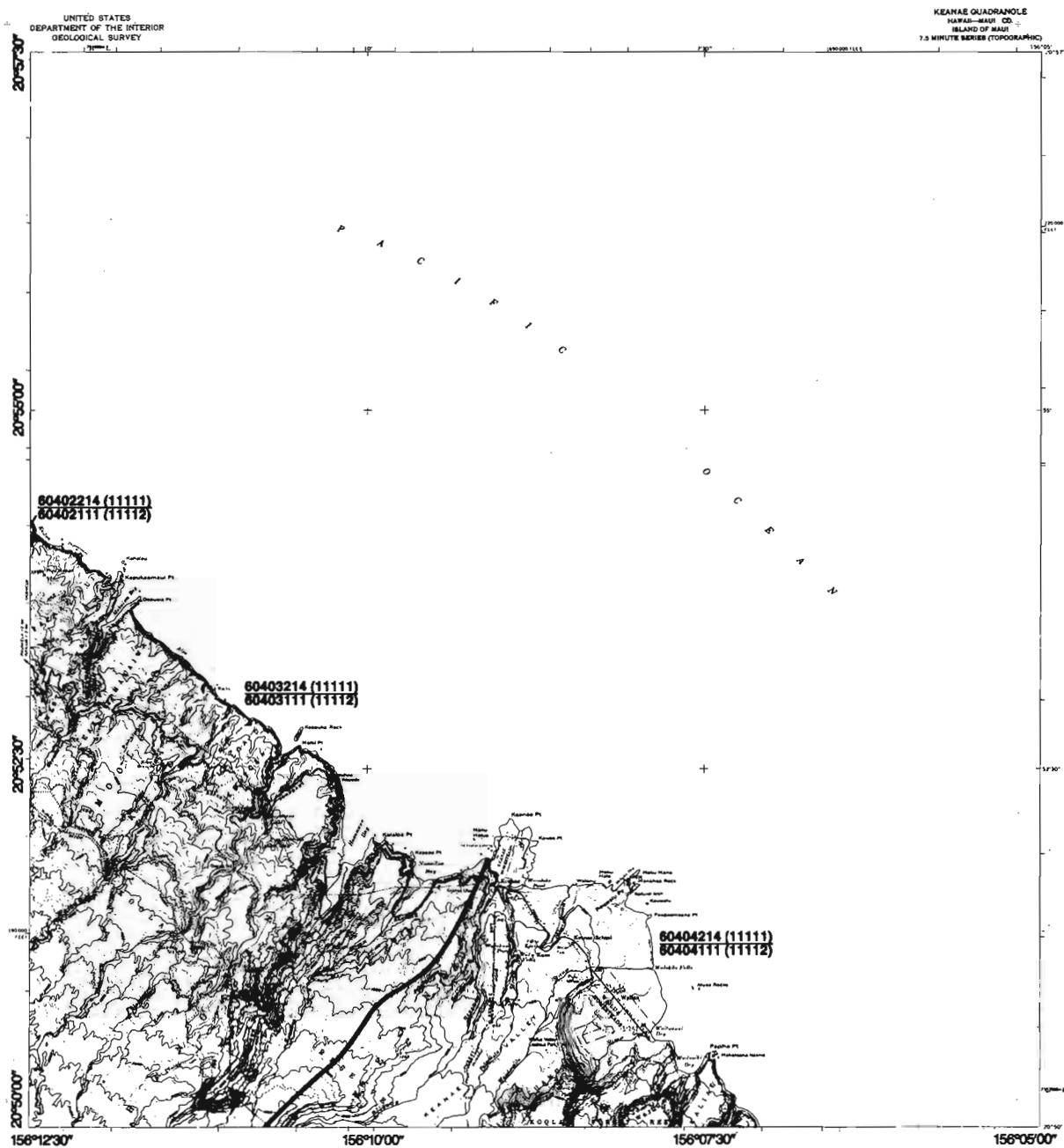


-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
-  Status Code



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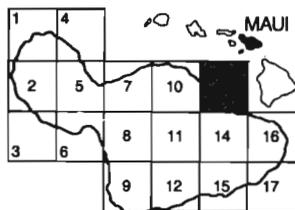
Appendix Figure A.1.12. Aquifer classification map, Lualailua Hills, Maui, Hawaii



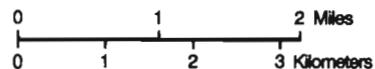
Base Map: USGS (1:24,000 series, rev. 1983).

KEANAË, MAUI
M-13

1990

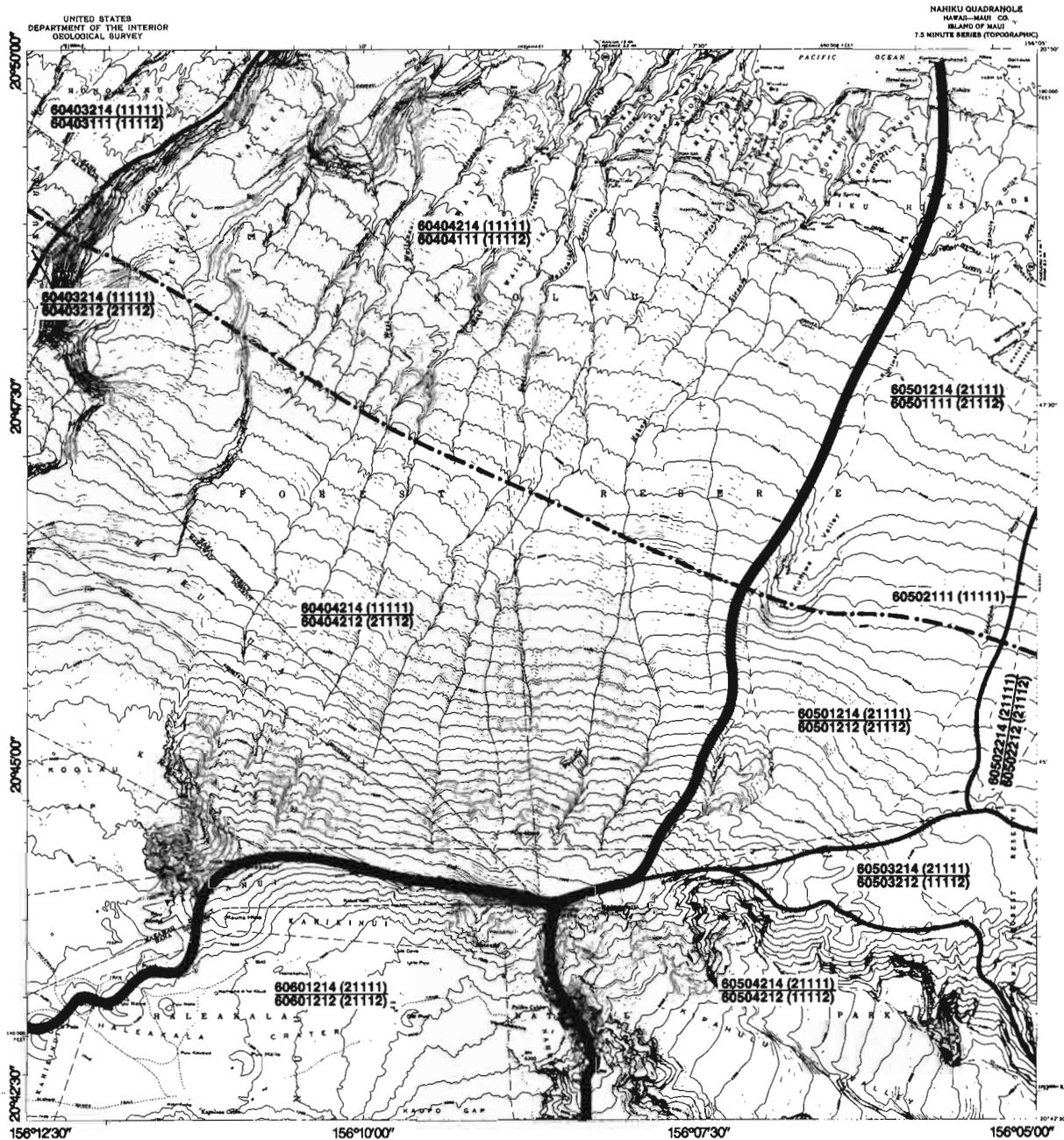


-  Sector
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-  Aquifer Type
- 60104212**
(11111) Aquifer Code
- 11111** Status Code



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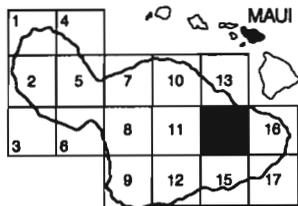
Appendix Figure A.1.13. Aquifer classification map, Ke'anae, Maui, Hawai'i



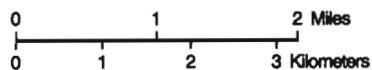
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NAHIKU, MAUI
M-14

1990

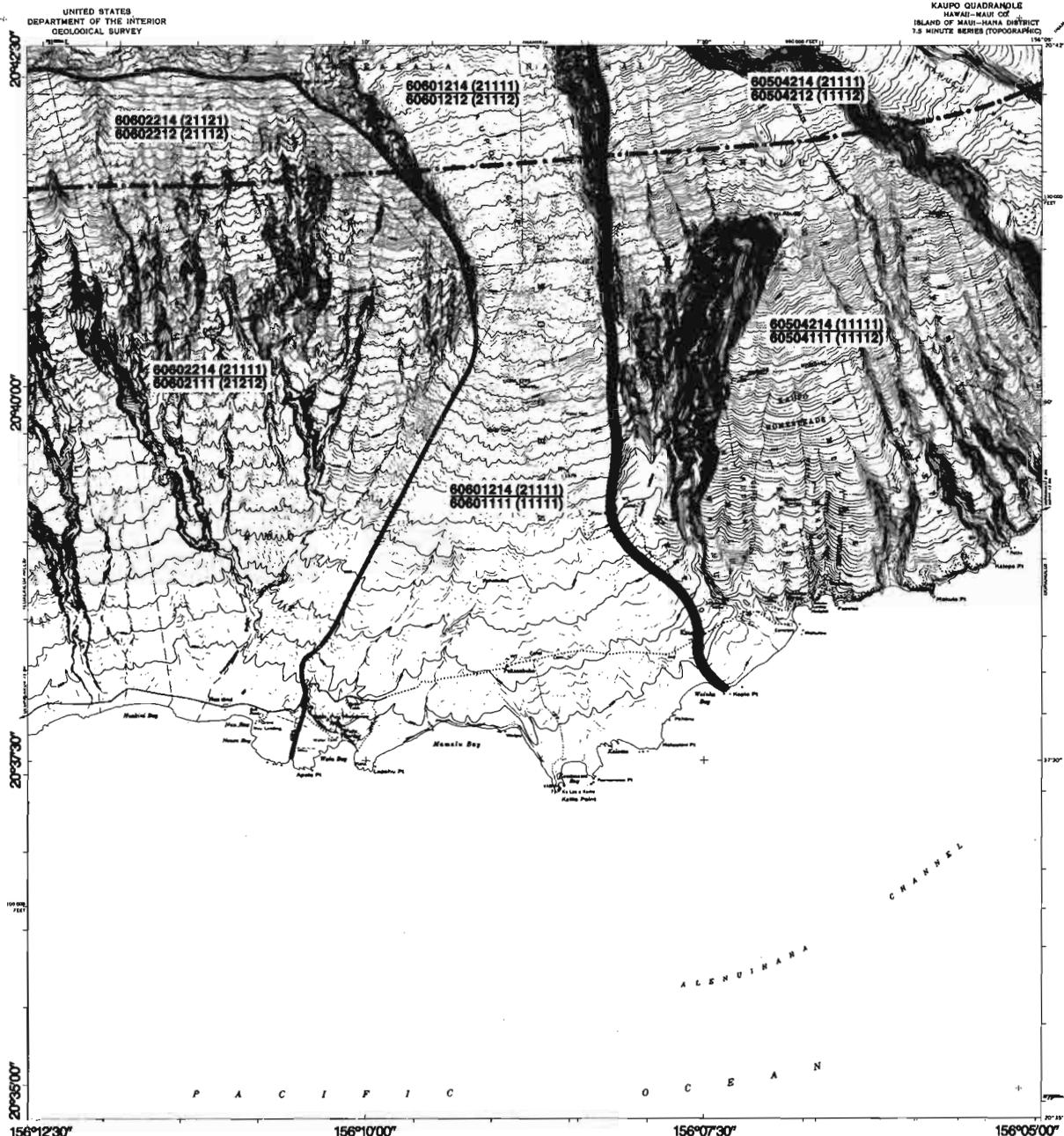


-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
Status Code



WATER RESOURCES RESEARCH CENTER
University of Hawaii at Manoa

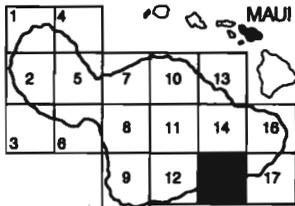
Appendix Figure A.1.14. Aquifer classification map, Nāhiku, Maui, Hawai'i



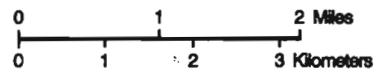
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KAUPO, MAUI
M-15

1990

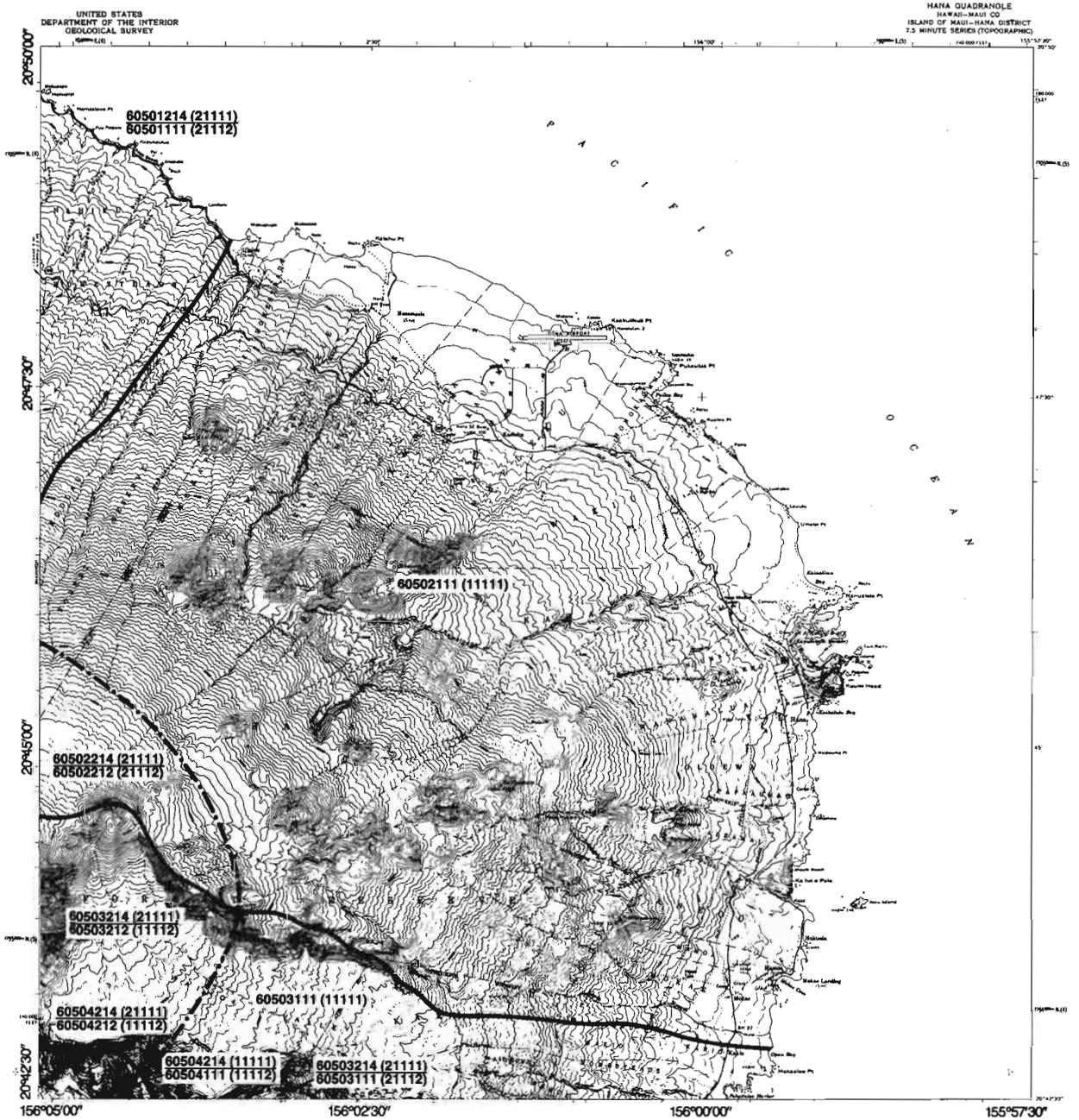


- Sector
- Aquifer System
- Aquifer Type
- 60104212 Aquifer Code
- (11111) Status Code



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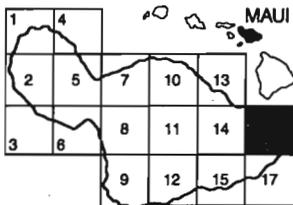
Appendix Figure A.1.15. Aquifer classification map, Kaupō, Maui, Hawai'i



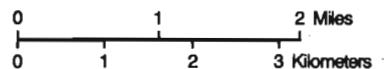
Base Map: USGS (1:24,000 series, rev. 1983).

HANA, MAUI
M-16

1990

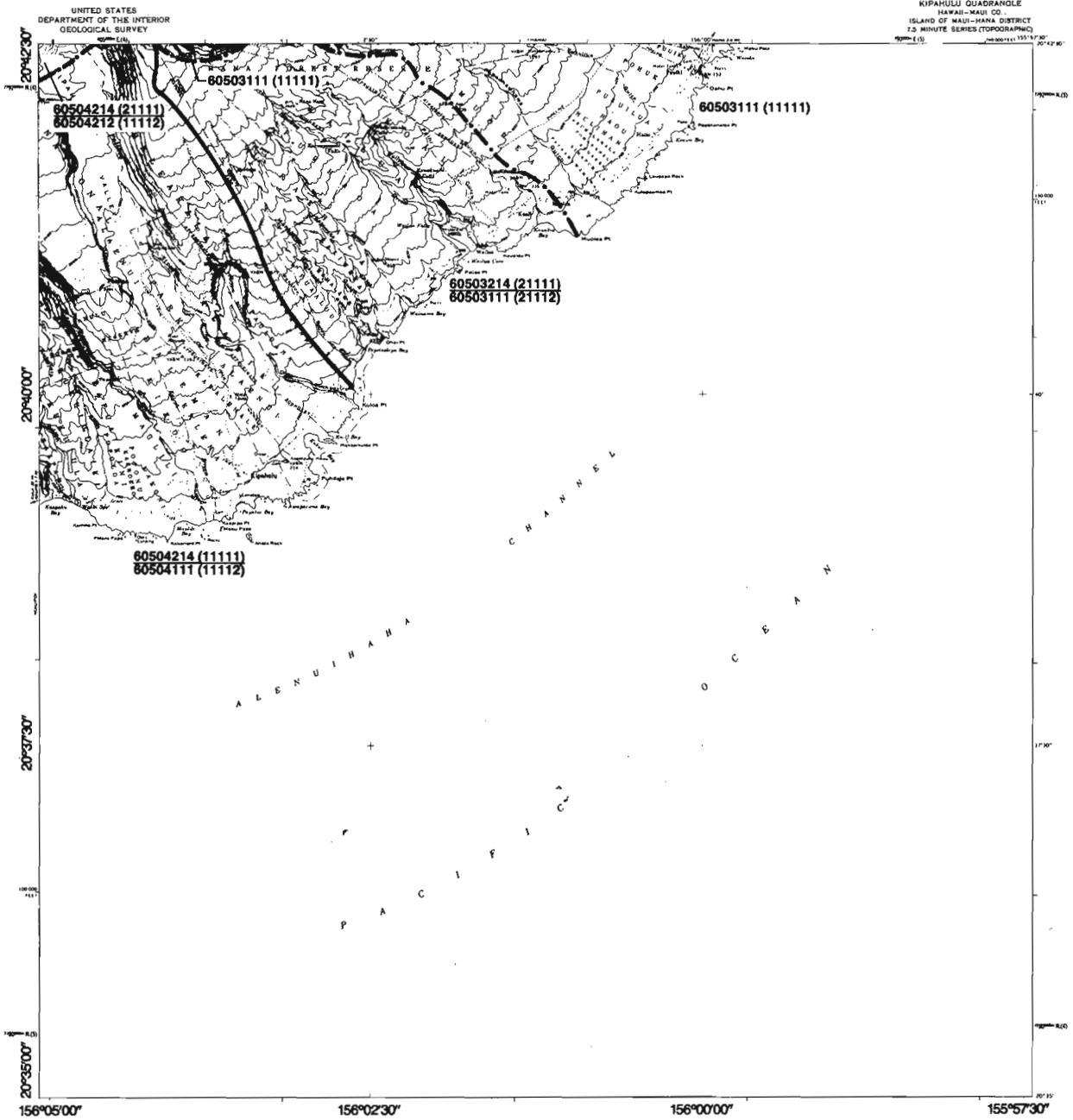


- Sector
- Aquifer System
- Aquifer Type
- 60104212**
(11111) Aquifer Code
Status Code



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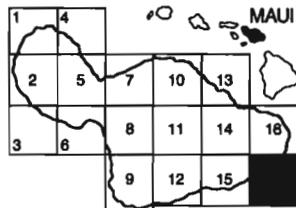
Appendix Figure A.1.16. Aquifer classification map, Hāna, Maui, Hawai'i



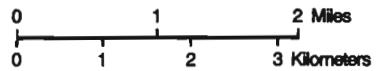
Base Map: USGS (1:24,000 series, rev. 1983).

KIPAHULU, MAUI
M-17

1990



-  Sector
-  Aquifer System
-  Aquifer Type
-  Aquifer Code
-  Status Code



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Appendix Figure A.1.17. Aquifer classification map, Kipahulu, Maui, Hawai'i