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[12] ABSTRACT (PURPOSE, METHOD, RESULTS, CONCLUSIONS)

In response to the need to identify and describe aquifers for each island of the state of Hawaii 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 first report provides Aquifer Codes and Status Codes for the island of Oahu. 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 employing the DRASTIC approach suggested by the U.S. EPA. Each Aquifer Type within an Aquifer System is assigned an Aquifer Code consisting of an eight-digit number. An Aquifer Code is unique and non-repeatable in the State. Accompanying the Aquifer Code is a Status Code of five digits. A Status Code is specific to an Aquifer Code. The Oahu classification includes 6 Aquifer Sectors, 24 Aquifer Systems, and 90 Aquifer Codes.

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.: 808/956-7847
FAX: 808/956-5044

AQUIFER IDENTIFICATION AND CLASSIFICATION FOR O'AHU:
Groundwater Protection Strategy for Hawai'i

John F. Mink
L. Stephen Lau

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Project Completion Report
for
Identification of Class I: Special Groundwaters
Highly Vulnerable to Contamination, Oahu
Project No.: T-763
Principal Investigator: L. Stephen Lau
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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 first report provides Aquifer Codes and Status Codes for the island of O'ahu.

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 employing the DRASTIC approach suggested by the U.S. EPA.

Each Aquifer Type within an Aquifer System is assigned an Aquifer Code consisting of an eight-digit number. An Aquifer Code is unique and non-repeatable in the State. Accompanying the Aquifer Code is a Status Code of five digits. A Status Code is specific to an Aquifer Code. The O'ahu classification includes 6 Aquifer Sectors, 24 Aquifer Systems, and 90 Aquifer Codes.

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GROUNDWATER CONTAMINATION VULNERABILITY

Until a few years ago, Hawai'i groundwater contamination problems were few in number and investigations comparatively minor in scale (Lau and Mink 1987). The quality of much of Hawai'i groundwater is outstanding; thus, water can be consumed safely without prior treatment. For this and other reasons, groundwater has been the prime source for municipal and general domestic supply throughout Hawai'i, especially on O'ahu, the most populous island in the State. It is not surprising, then, that the discovery of volatile organic chemicals in a number of wells in the Pearl Harbor Aquifer, one of the principal sources of potable groundwater in O'ahu, was a shock to the public as well as to the scientific and engineering community. The Hawaii State Department of Health responded to this discovery by initiating a groundwater protection strategy consistent with the goals of the U.S. Environmental Protection Agency. Aquifer identification and assignment of contamination vulnerability indices to groundwater are important phases of the protection program.

A fundamental objective of groundwater protection strategy is to classify aquifers according to hydrogeologic parameters, and groundwater by quality characteristics relative to beneficial uses. Natural groundwater quality is the result of hydrogeochemical processes; however, this pristine quality can be degraded by anthropogenic activities. Thus, the protection of groundwater resources must contend with land use practices. Aquifer identification and location are therefore fundamental to formulation of the protection strategy.

The quality of native groundwater is the result of the environments through which infiltration water passes and in which water moves and accumulates. Among the obvious contributors to the chemistry of groundwater in an aquifer are the quality of the original water that recharges into the ground, the chemical properties of soils and rocks through which the water passes, residence time of the water in the saturated zone, and quality of waters with which the new water mixes. Seawater intrusion also adds salts to all basal groundwater in Hawai'i.

Activities, such as irrigated agriculture and wastewater injection, may significantly alter groundwater quality. Moderate increases in concentrations of nitrate, chloride, sulfate, and silica are attributable to prolonged irrigation of sugarcane. Introduction of organic chemicals from pesticides, herbicides, and nematicides accompany modern agriculture. Virtually any large-scale use of the land can result in some degree of contamination.

Hawai'i has effectively used land management as a strategy to protect groundwater quality. A good example is the establishment of the Conservation District around the high rainfall zone of the Ko'olau Range on O'ahu. This region is retained in as natural a state as possible to enhance groundwater recharge and to protect the purity of the rainfall that percolates into the

subsurface. Another example is the State regulation that controls underground injection. A "no pass" line sets off regions in which direct injection of wastewater is prohibited.

Between these two lines—the Conservation District and the injection line—falls most of each island's land area. The unregulated areas are largely underlaid by unconfined aquifers that are potentially vulnerable to contamination. Urbanization and agriculture dominate land use. Manifestly, a strategy must be devised to prevent contamination by activities that range from dry cleaning to chemically based agriculture.

The aquifer classification scheme and contamination indices provided in this study are consistent with the U.S. EPA (1984) Groundwater Protection Guidelines. They are also consistent with and complementary to Hawaii State water quality regulations for protecting surface water. In Hawai'i, surface water is classified by ecosystem and associated water quality. In the strategy for groundwater, the resources are classified by hydrogeology and water quality.

INAPPLICABILITY OF DRASTIC RATING SYSTEM OF POLLUTION POTENTIAL IN HAWAI'I

Except in aquifers covered and confined by caprock, virtually all groundwater in O'ahu is accessible to contamination accompanying infiltration. In the Status Codes listed in Table 1, most Aquifer Types are rated as highly vulnerable to contamination.

Evaluating contamination vulnerability by using the DRASTIC approach suggested by EPA is not very useful for the aquifers of O'ahu, or the other islands of the state. DRASTIC is an acronym for a list of physical characteristics that describe a hydrogeological setting. These characteristics are D, depth to water; R, recharge; A, aquifer media; S, soil media; T, topography; I, infiltration in the vadose zone; and C, aquifer conductivity. Two sets of relative weights are assigned to each characteristic: one for areas where agriculture is the dominant land use; the other for mixed usage. The relative weights are as follows:

	Agriculture	Other
D	5	5
R	4	4
A	3	3
S	5	2
T	3	1
I	4	5
C	2	3

Weighting choices are inevitably subject to considerable arbitrariness.

To compute the pollution potential, each DRASTIC factor is divided into a range scale of 1 to 10, in which 1 assigns the least importance to the factor and 10 the most. Thus, the

TABLE 1. AQUIFER AND STATUS CODES FOR O'AHU, HAWAI'I

Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
3	01 Honolulu	01 Palolo	116 121	30101116 30101121	23321 11113	13
			111	30101111	11111	13
			212	30101212	11111	13, 15
		02 Nuuanu	116 121	30102116 30102121	13321 11113	13
			111	30102111	21111	13
			212	30102212	11111	13
		03 Kalihi	116 121	30103116 30103121	13321 11113	13
			111	30103111	11111	13
			215	30103215	11111	12, 13
		04 Moanalua	116 121	30104116 30104121	23321 11113	10, 13
			111	30104111	11111	10, 12, 13
			212	30104212	21111	12, 13
		05 Waialae	116 121	30105116 30105121	23421 21113	13, 15
			111	30105111	11111	13, 15
			212	30105212	21111	13, 15
	02 Pearl Harbor	01 Waimalu	116 121	30201116 30201121	12211 12212	9, 10
			111	30201111	11111	9, 10, 12
			212	30201212	21111	9, 12
		02 Waiawa	116 121	30202116 30202121	12211 12212	9, 10
			111	30202111	11111	8, 9
			212	30202212	21111	8, 9, 11, 12
		03 Waipahu	116 121	30203116 30203121	12211 12212	5, 6, 9, 10
			111	30203111	11111	5, 6, 9
		04 Ewa	116 121	30204116 30204121	13321 13213	6
			111	30204111	11111	5, 6
			212	30204212	21111	5
		05 Kunia	111	30205111	21112	5
			212	30205212	21111	5
	03 Waianae	01 Nanakuli	116 122	30301116 30301122	23421 23423	2, 5
			112	30301112	23321	5, 6
			212	30301212	21121	5

TABLE 1.—*Continued*

Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
3	03 Waianae	02 Lualualei	116 122	30302116 30302122	13311 23323	2,5
			112	30302112	23321	2, 5
			212	30302212	11111	2, 5
		03 Waianae	116 122	30303116 30303122	13311 23223	2
			112	30303112	11111	2
			232	30303232	11111	1, 2, 4, 5
		04 Makaha	116 122	30304116 30304122	13321 11113	2
			112	30304112	11111	2
			232	30304232	11111	1, 2, 4
		05 Keaau	116 122	30305116 30305122	33421 11212	1
			112	30305112	21211	1, 2
			212	30305212	21111	1, 2
	04 North	01 Mokuleia	116 121	30401116 30401121	13221 11113	1, 4
			111	30401111	11111	1, 4
			212	30401212	21111	1, 4, 5
		02 Waialua	116 121	30402116 30402121	12211 11213	4
			111	30402111	11111	4, 8
		03 Kawailoa	116 121	30403116 30403121	12211 12313	3, 4
			111	30403111	11111	3, 4, 7, 8
			112	30403112	11111	3, 7
			116 112	30403116 30403112	12211 21112	3, 7
			212	30403212	21111	3, 7, 8
	05 Central	01 Wahiawa	212	30501212	11111	4, 5, 8, 9
		02 Koolau	212	30502212	11111	8
	06 Windward	01 Koolauloa	116 121	30601116 30601121	12211 12213	7, 8, 11
			111	30601111	11111	7, 8, 11
			212	30601212	21111	7, 8, 11
			112	30601112	11111	7
			116 122	30601116 30601122	22221 21122	7
		02 Kahana	116 122	30602116 30602122	12211 11113	11
			112	30602112	11111	11

TABLE 1.—*Continued*

Is.	Aquifer Sector	Aquifer System	Aquifer Type	Aquifer Code	Status Code	Quadrangle No.
3	06 Windward	02 Kahana	212	30602212	11111	8, 11
		03 Koolaupoko	116 122	30603116 30603122	12211 11122	12
			212	30603212	11111	11, 12, 13
		04 Waimanalo	116 122	30604116 30604122	12211 11113	14, 15
			212	30604212	11111	12, 13, 14, 15

NOTE: Rev. 1990

formula becomes

$$D(w)D(r) + R(w)R(r) + \cdots + C(w)C(r) = \text{potential pollution}$$

in which w refers to the weight and r to the range.

The above may have utility where the surface-subsurface pathways of infiltration take place in a wide variety of natural environments, but in Hawai'i the range is limited and the pathways direct. Each of the DRASTIC factors is relatively simple to describe for Hawai'i conditions on a regional scale and may be capsulized as follows.

D (depth to water). The water table in all unconfined basal aquifers is 40 ft (12.19 m) or less above sea level. In confined basal aquifers the water surface is at the base of the caprock. Depth to water in high level aquifers is variable. For all unconfined aquifers, depth to water does not significantly influence the removal of refractory contaminants, such as many volatile organic compounds. Microbiological pollutants, on the other hand, are commonly attenuated in the relatively thin surface soil.

R (recharge). Natural infiltration is directly related to rainfall, and the highest rainfall occurs at elevations between 1500 and 5000 ft (457.2 and 1 524 m). However, direct recharge to unconfined aquifers takes place everywhere, even in the driest parts of the islands. Nowhere in Hawai'i, no matter how low the average annual rainfall, suffers a complete absence of recharge.

A (aquifer media). Virtually every important potable groundwater aquifer in the Hawaiian Islands is composed of basalts that were extruded during the primary mountain building phase of volcanism. These basalts have similar aquifer properties. The only other regional aquifers are in limestones carrying nonpotable to brackish water. Aquifers in sediments and post erosional volcanics are small.

S (soil media). Soils formed in place on basalts are strikingly similar in being highly permeable and readily infiltrable. These are the most common soils above an elevation of about 100 ft (30.5 m). At lower elevations the hydromorphic soils are less permeable.

T (topography). Land configuration in Hawai'i is generally irrelevant as a direct influence on the recharge of groundwater. In steep topography the runoff-rainfall ratio is high, but even here significant infiltration takes place.

I (infiltration in vadose zone). In unsaturated rock beneath the soil-saprolite cover, infiltration follows a fairly direct path to the unsaturated zone.

C (conductivity of aquifer). All of the main Hawai'i aquifers in basalt are extremely permeable with hydraulic conductivities in excess of 1000 ft (304.8 m)/day on a regional scale. Limestone aquifers are also highly permeable, while sediments are generally poorly permeable. The alkalic series of volcanic rocks that followed the primary basalts are moderately permeable.

The DRASTIC method of estimating pollution potential in Hawai'i has limited applicability, but in a modified form it can be useful in organizing an environmental data base for examining contamination problems.

AQUIFER CLASSIFICATION AND AQUIFER CODES

Shortly before the Hawaii State Department of Health initiated the groundwater protection program, work had begun in classifying and systematizing groundwater occurrences by the University of Hawaii Water Resources Research Center (Mink and Sumida 1984). This work was a follow-up to an earlier classification attempt sponsored by the Department of Health as part of the original Underground Injection Control program (First West Engineers 1978).

The classification scheme reported by Mink and Sumida (1984) is the starting point for developing an Aquifer Code. Classification is based on a hierarchy of descriptors beginning with general location by Island and Aquifer 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 hydrogeologic 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 locator
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 U.S. Geological Survey (1975) protocol. Each Sector is coded with a two-digit number and by a geographic name except where locational confusion might result, in which case the general locators North, South, East,

and West, 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 11 11 111, 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.

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
3	Confined or Unconfined	Where the actual condition is uncertain.

Using the above coding, groundwater can be 11 or 12, or 21 or 22. Where confining conditions are unclear, the second digit is taken as 3.

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 defines the Aquifer Type.

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

3	O'ahu Island
01	Honolulu Sector
04	Moanalua Aquifer System
111	Basal Unconfined Flank

The Aquifer Code for the above is 30104111. There can be no repetition elsewhere in the State. The code is suited to computer data basing having great retrieval flexibility.

A variety of important information related to the aquifers can be appended to each Aquifer Code. Certain hydrogeological 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.

Table 1 lists the Aquifer Codes for the island of O'ahu along with Sector and Aquifer System names. O'ahu includes 6 Sectors, 24 Aquifer Systems, and 90 Aquifer Codes. 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 the same, the code would be 12211.

The categories and their elements are derived from the U.S. EPA (1984) groundwater classification modified by fundamentals of the Hawai'i 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.

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 (>15,000 mg/l): True seawater has a chloride content of 18,980 mg/l.

UNIQUENESS. The classes Irreplaceable and Replaceable are direct EPA derivatives. The island of O'ahu does not have any groundwater of value which could be classified as replaceable.

VULNERABILITY TO CONTAMINATION. In O'ahu because of the 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 (hydrology and geology).

The Status Code contains five digits and, combined with the Aquifer Code, results in a 13-digit code. For example, the code 30104111 (11111) defines an aquifer in O'ahu, Honolulu Sector, Moanalua System, in which the groundwater is unconfined basal in flank lavas. The

last five digits 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 O'ahu 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 fifteen quadrangles for O'ahu (reduced from a scale of 1:24,000) on which are plotted Sector, System, and Type boundaries. Within each Aquifer Type the Aquifer Code is printed, to which is appended the Status Code within parentheses.

In coastal plains where sedimentary caprock aquifers rest on primary basalt aquifers, two Aquifer and Status Codes separated by a slash are printed. The numerator code is for the upper aquifer and the denominator for the lower aquifer.

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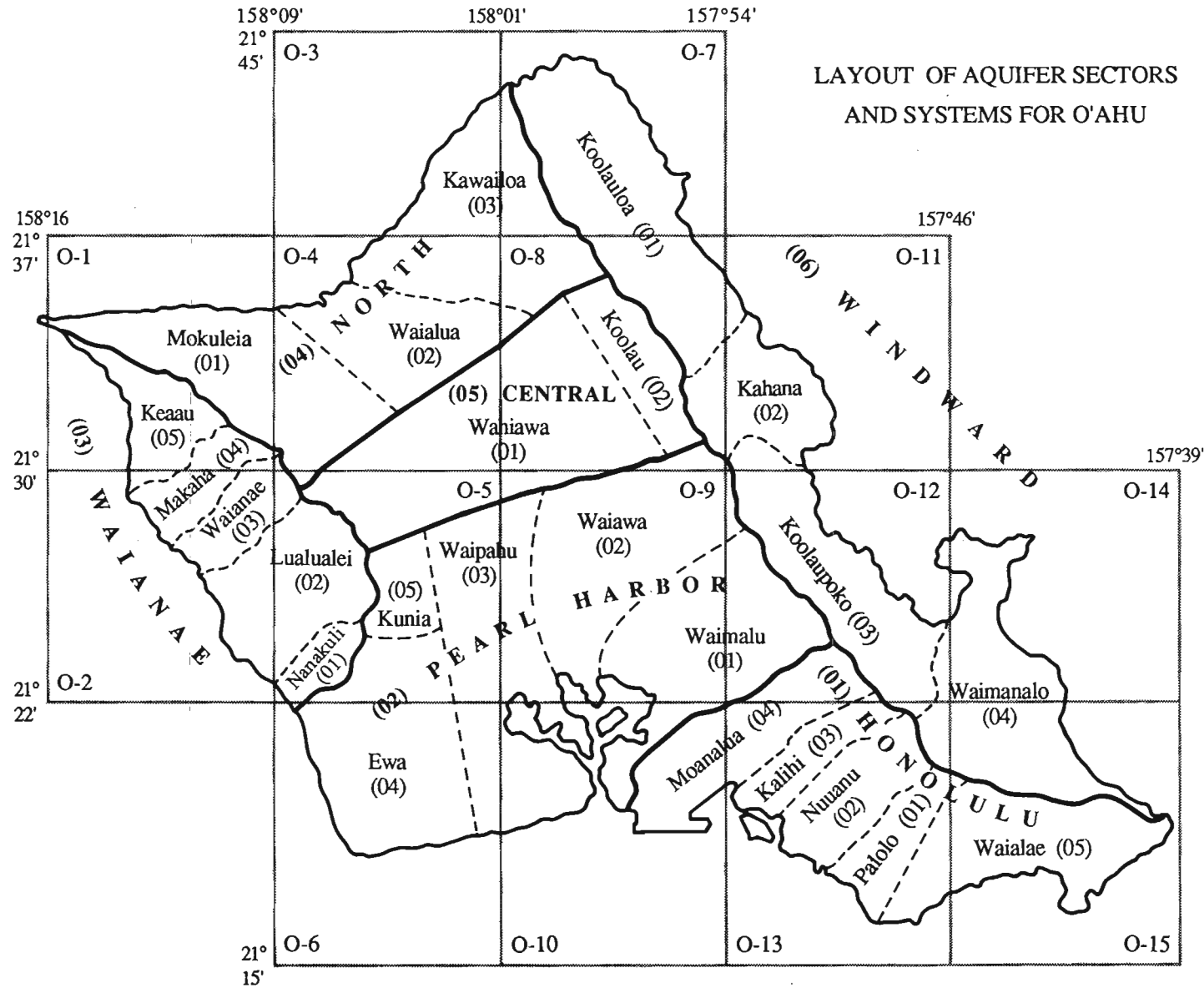
LAYOUT OF AQUIFER SECTORS
AND SYSTEMS FOR O'AHU
158°09'
158°01'
157°54'
158°16
157°46'
157°39'
21° 45'
21° 37'
21° 30'
21° 22'
21° 15'
O-1
O-2
O-3
O-4
O-5
O-6
O-7
O-8
O-9
O-10
O-11
O-12
O-13
O-14
O-15
Kawailoa (03)
Koolauloa (01)
(06) WINDWARD
NORTH
(04)
Waialua (02)
Mokuleia (01)
(05) CENTRAL
Waiahiawa (01)
Koolau (02)
Kahana (02)
(03)
Keaau (05)
Makaha (04)
Waianae (03)
WAIANAE
Lualualei (02)
(05) Kunia
Waipahu (03)
PEARL HARBOR
Waiawa (02)
Waimalu (01)
Koolaupoko (03)
Nanakuli (01)
(02)
Ewa (04)
(01)
Waimanalo (04)
Moanalua (04)
Kalihi (03)
Nuuanu (02)
Palolo (01)
HONOLULU
Waialae (05)

AQUIFER CLASSIFICATION EXPLANATION

AQUIFER AND STATUS CODES*

Aquifer Code = Island
+ Aquifer Sector
+ Aquifer System
+ Aquifer Type

Thus, 30104111 = Aquifer Code
where 3 = Oahu
01 = Honolulu
04 = Moanalua
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	
3	01	Honolulu	01	Palolo
			02	Nuuanu
			03	Kalihi
			04	Moanalua
			05	Waialae
	02	Pearl Harbor	01	Waimalu
			02	Waiawa
			03	Waipahu
			04	Ewa
			05	Kunia
	03	Waianae	01	Nanakuli
			02	Lualualei
			03	Waianae
			04	Makaha
			05	Keaau
	04	North	01	Mokuleia
			02	Waialua
			03	Kawailoa
	05	Central	01	Wahiawa
			02	Koolau
	06	Windward	01	Koolauloa
			02	Kahana
			03	Koolaupoko
			04	Waimanalo

*Where sedimentary caprock aquifers rest on primary basalt aquifers, two Aquifer and Status Codes separated by a slash indicate numerator code is upper aquifer and denominator is lower aquifer.

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

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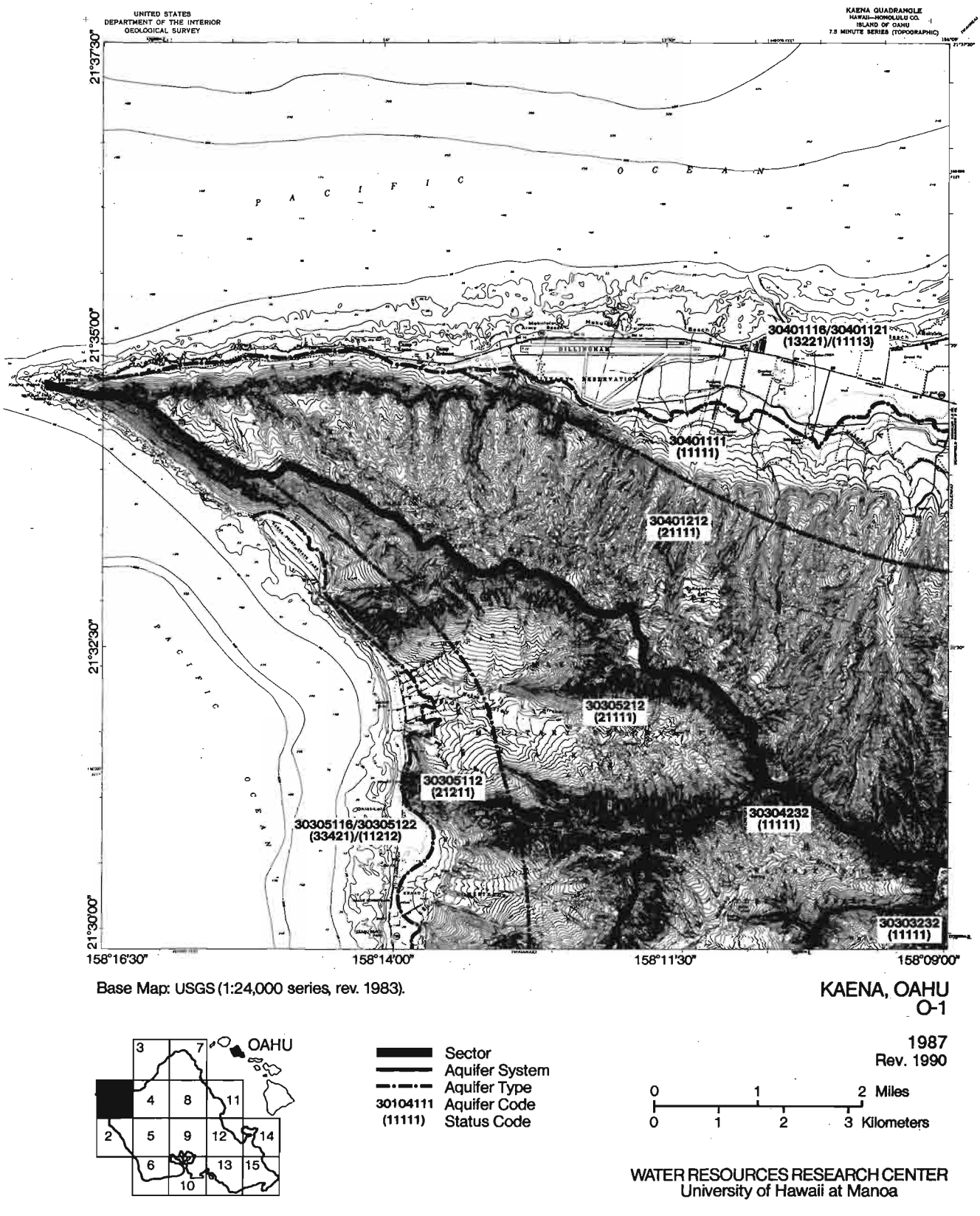

Figure 1.1. Aquifer classification map, Ka'ena, O'ahu, Hawai'i

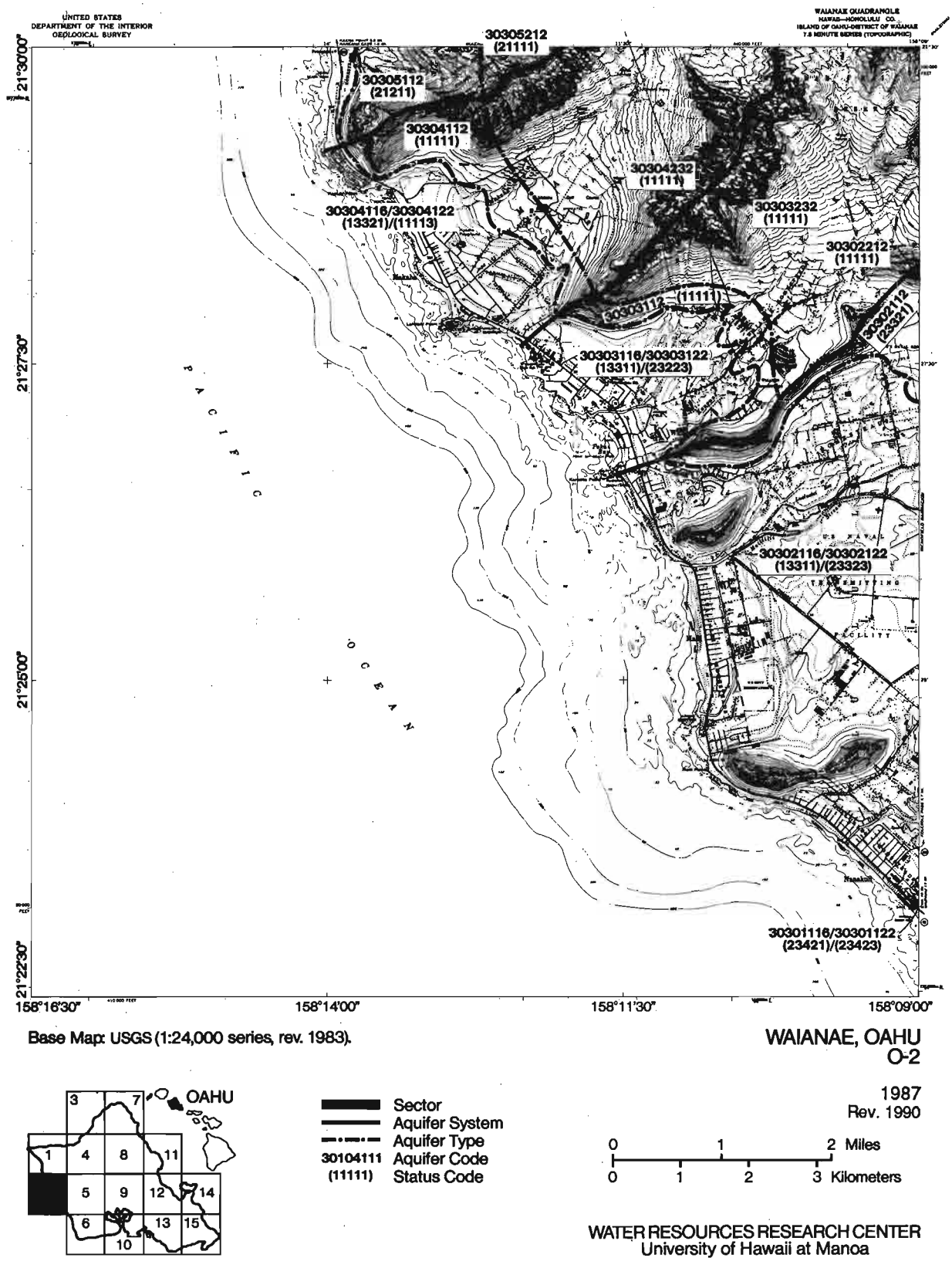

Figure 1.2. Aquifer classification map, Wai'anae, O'ahu, Hawai'i

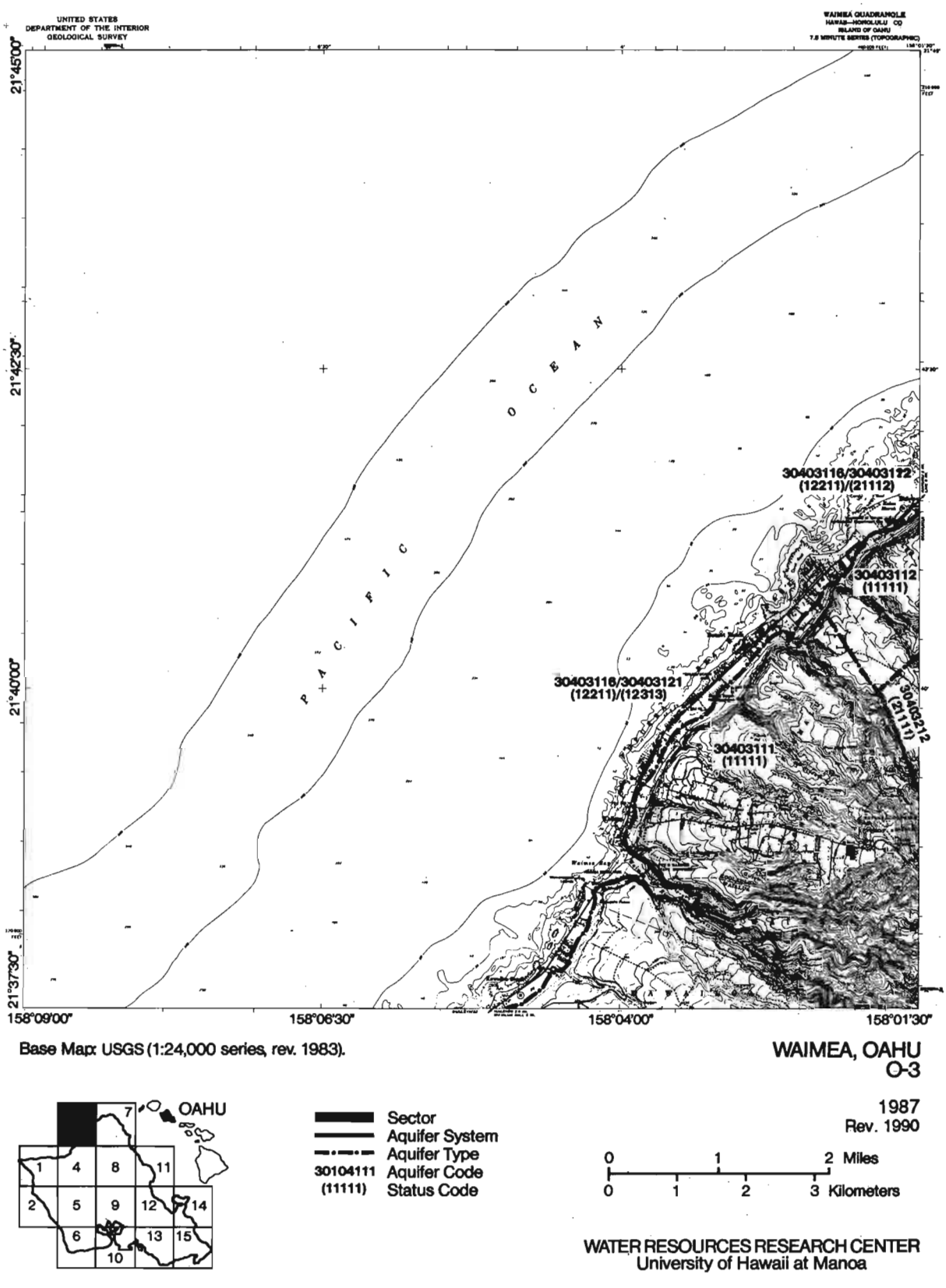

Figure 1.3. Aquifer classification map, Waimea, O'ahu, Hawai'i

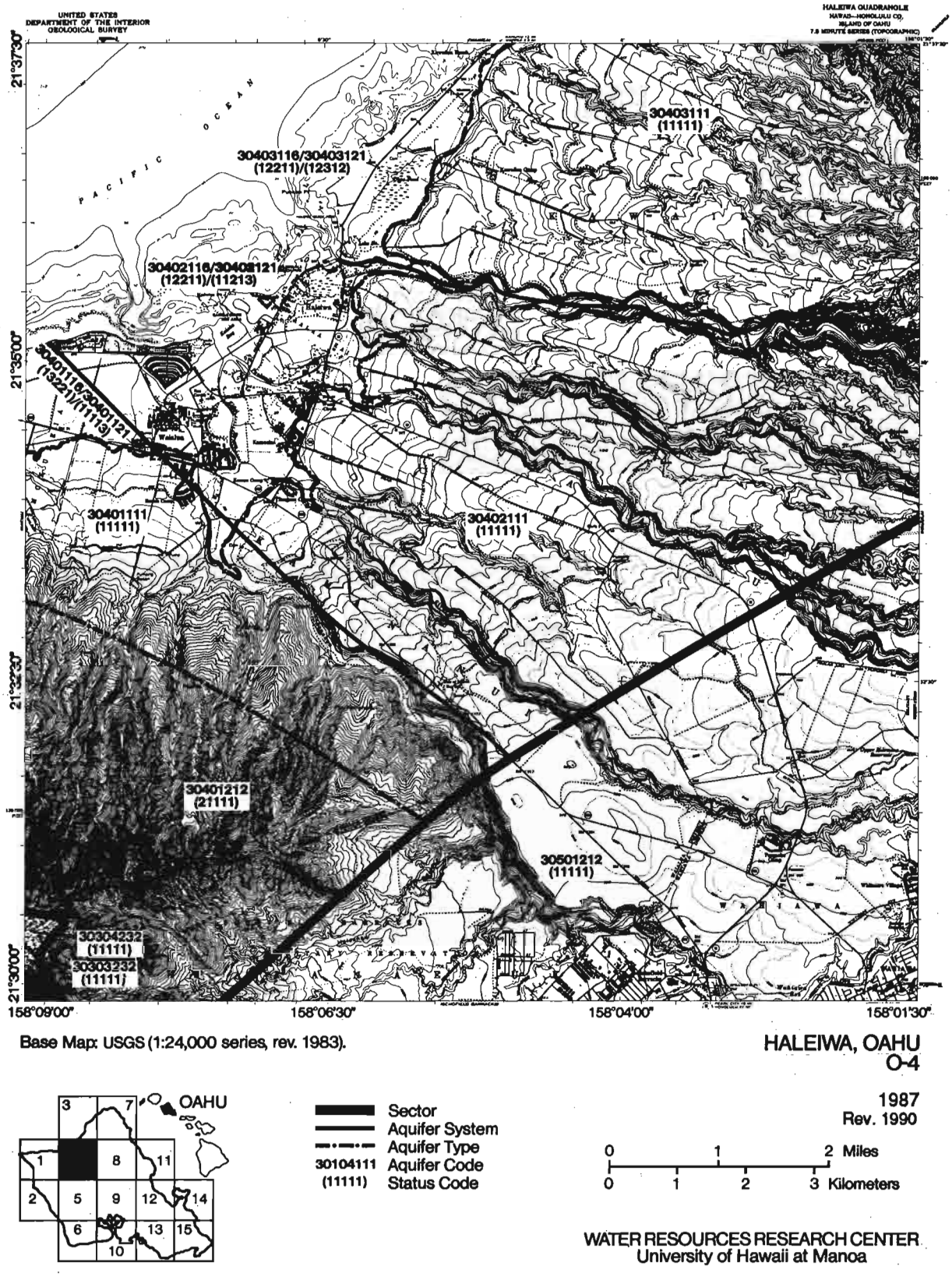

Figure 1.4. Aquifer classification map, Hale'iwa, O'ahu, Hawai'i

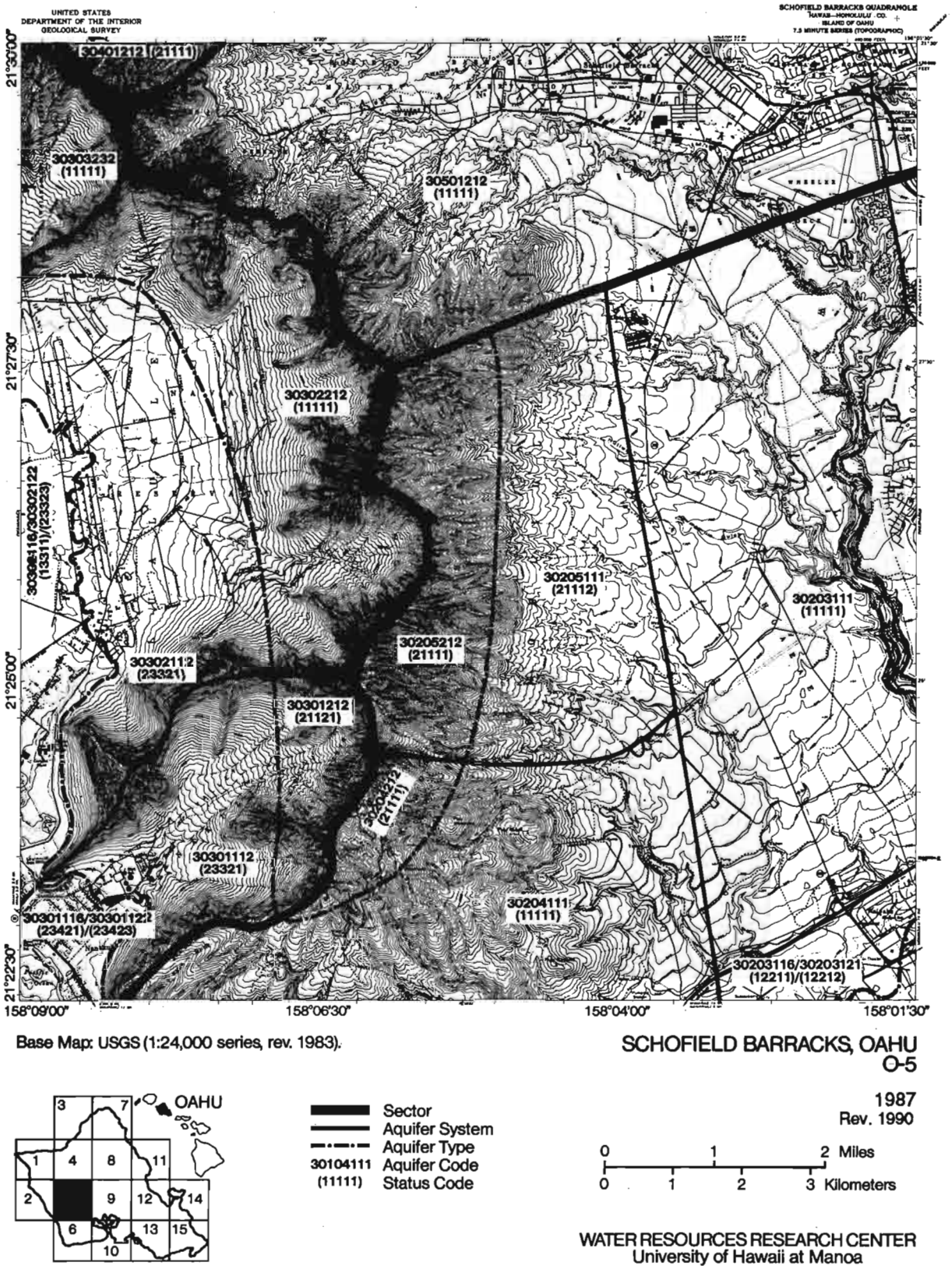

Figure 1.5. Aquifer classification map, Schofield Barracks, O'ahu, Hawai'i

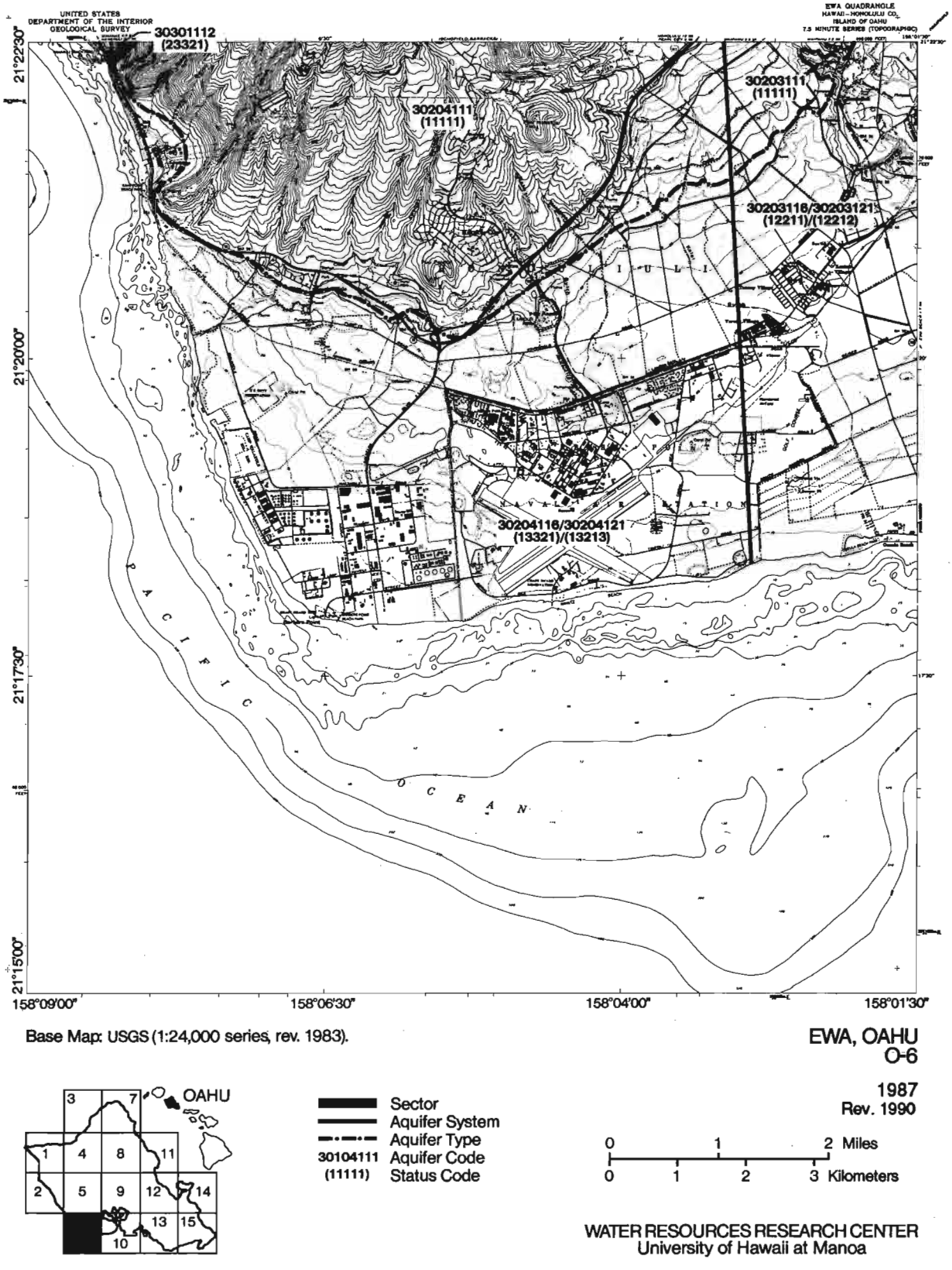

Figure 1.6. Aquifer classification map, 'Ewa, O'ahu, Hawai'i

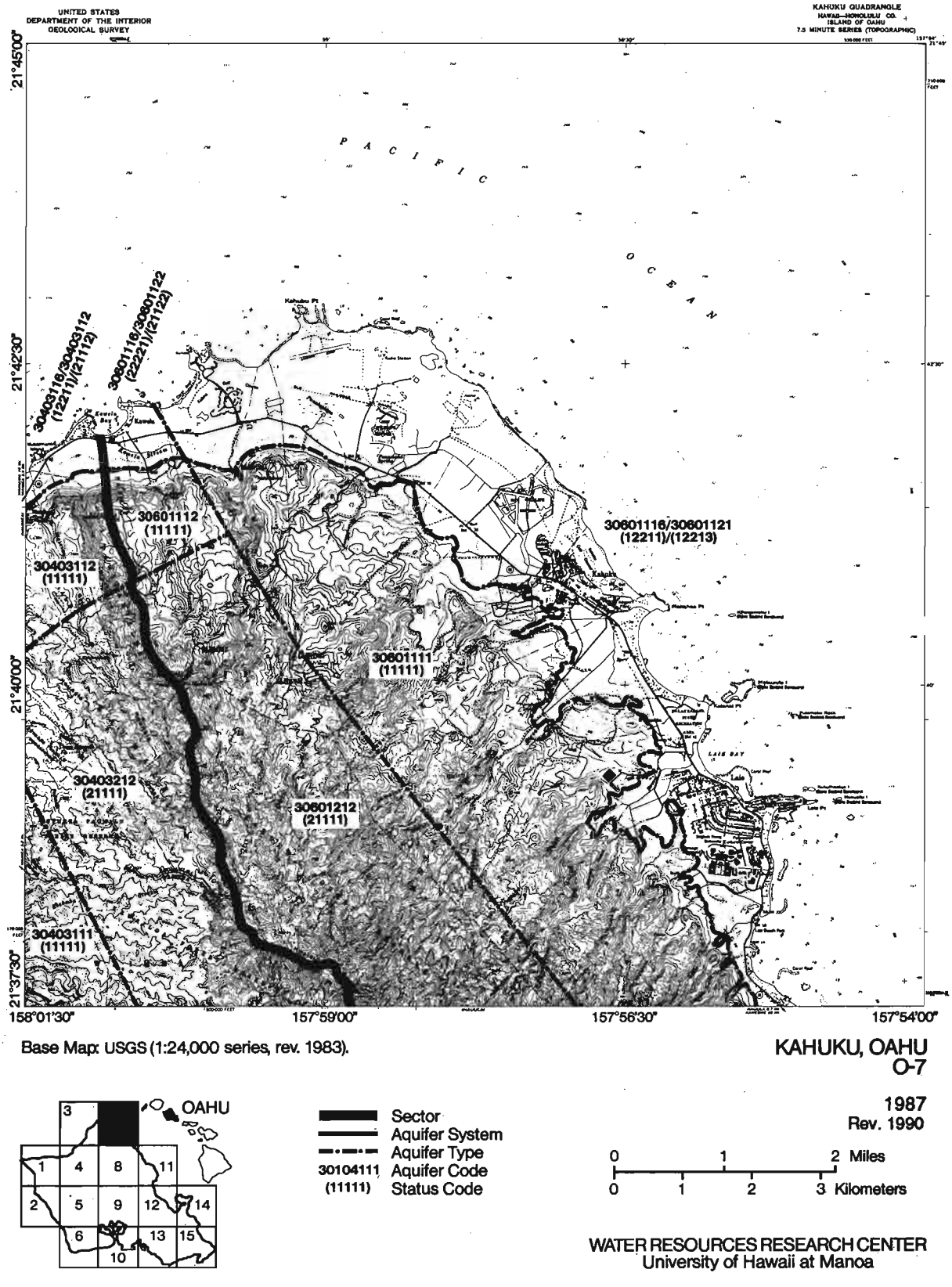

Figure 1.7. Aquifer classification map, Kahuku, O'ahu, Hawai'i

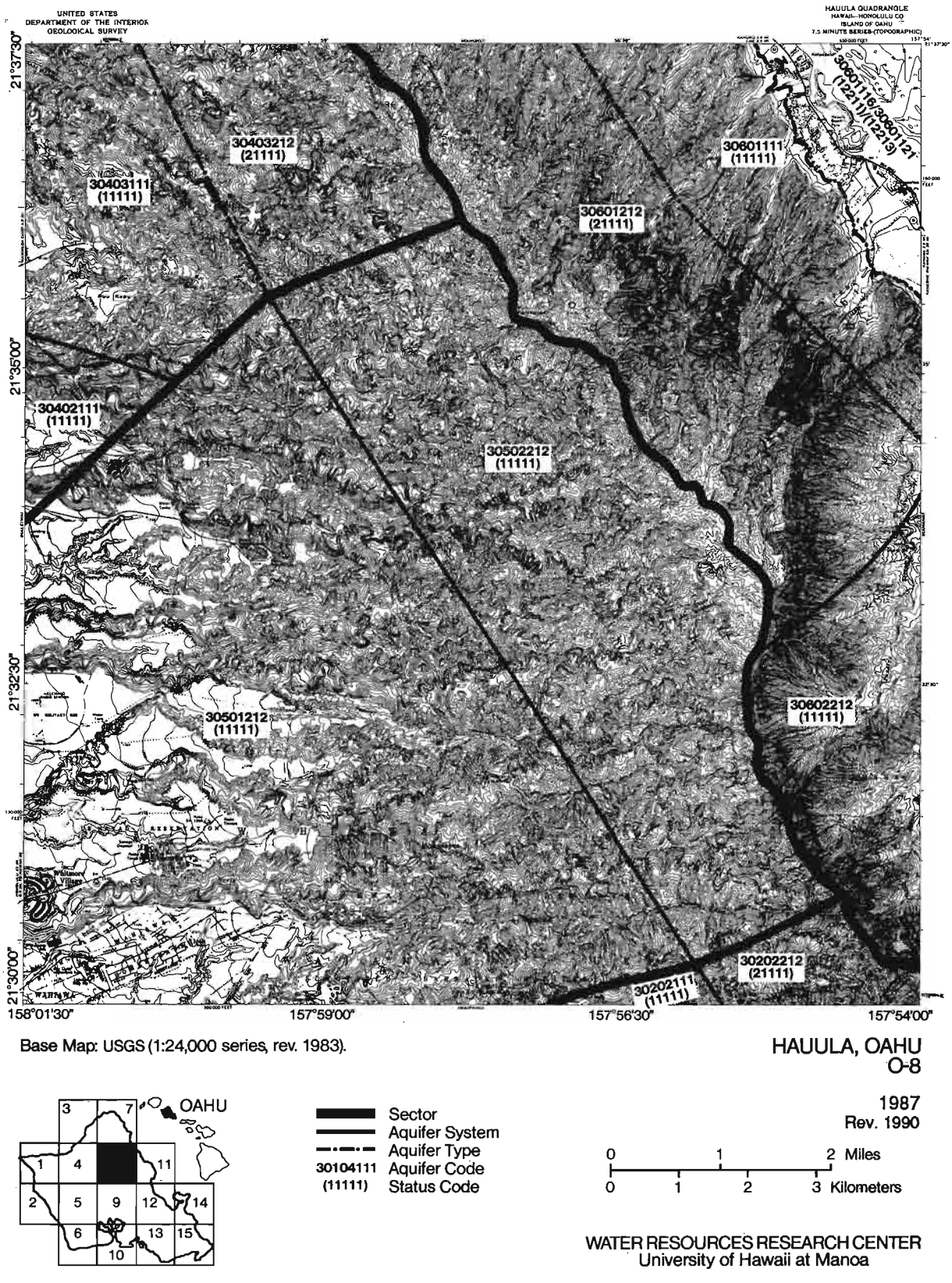

Figure 1.8. Aquifer classification map, Hau'ula, O'ahu, Hawai'i

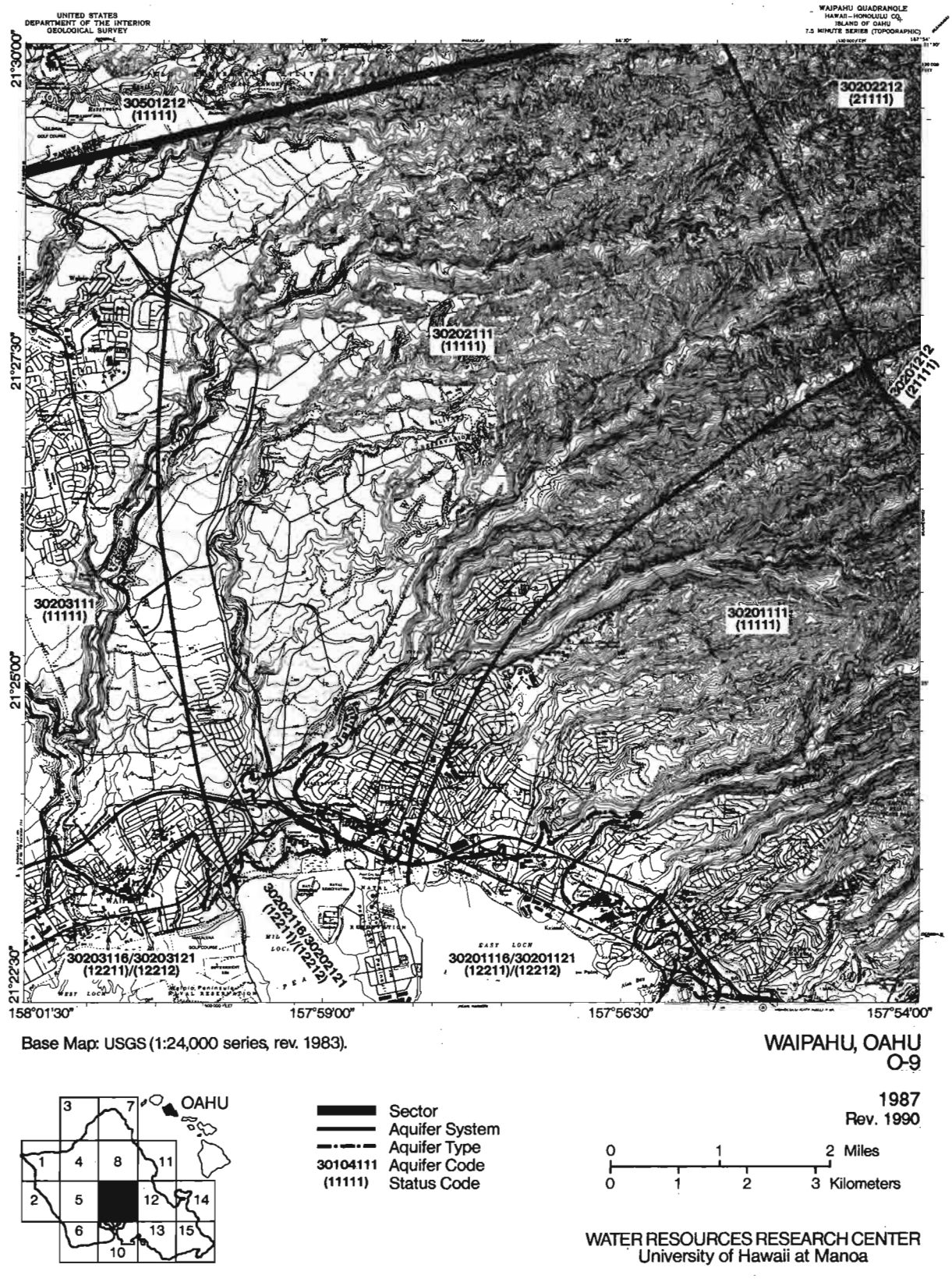

Figure 1.9. Aquifer classification map, Waipahu, O'ahu, Hawai'i

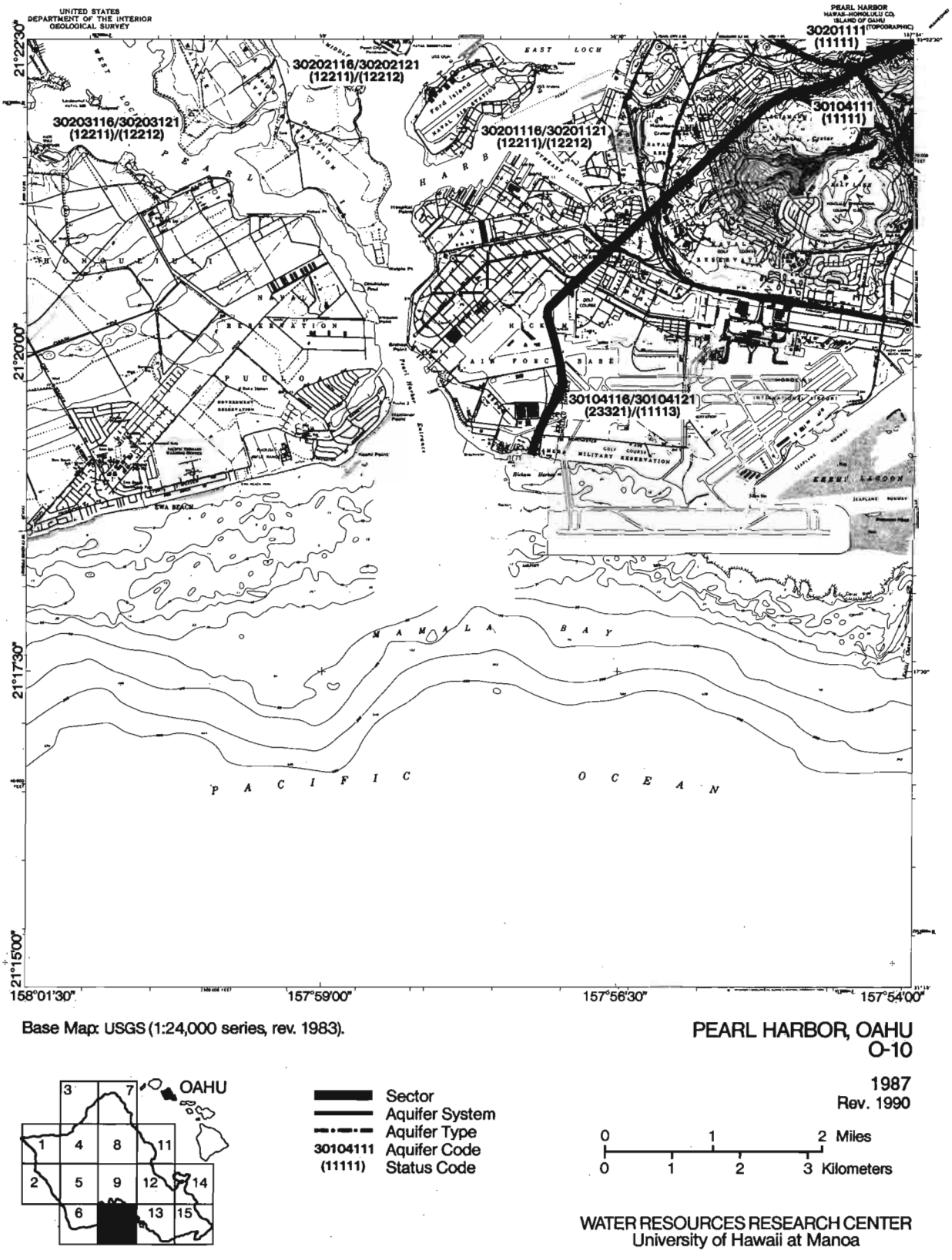

Figure 1.10. Aquifer classification map, Pearl Harbor, O'ahu, Hawai'i

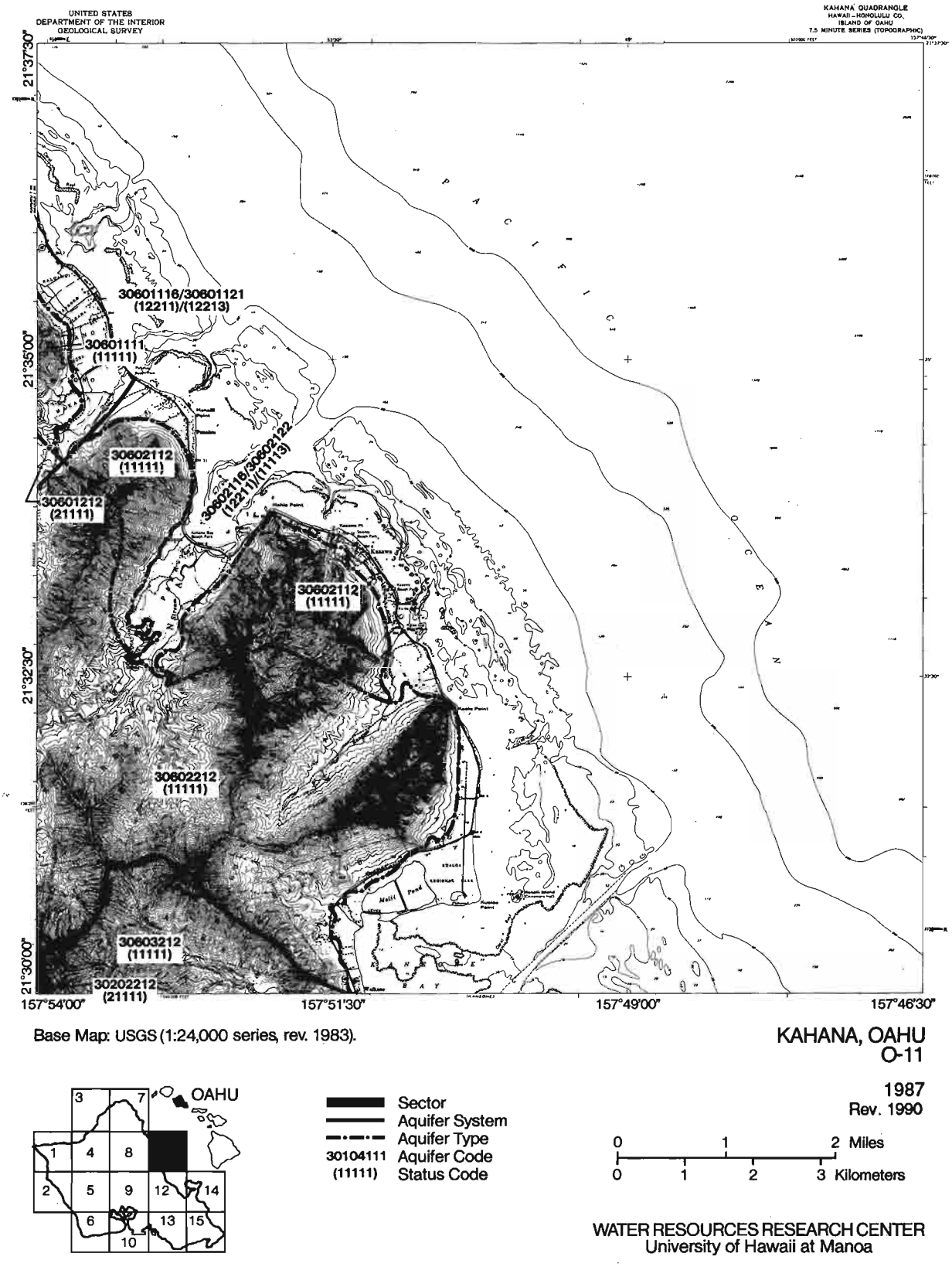

Figure 1.11. Aquifer classification map, Kahana, O'ahu, Hawai'i

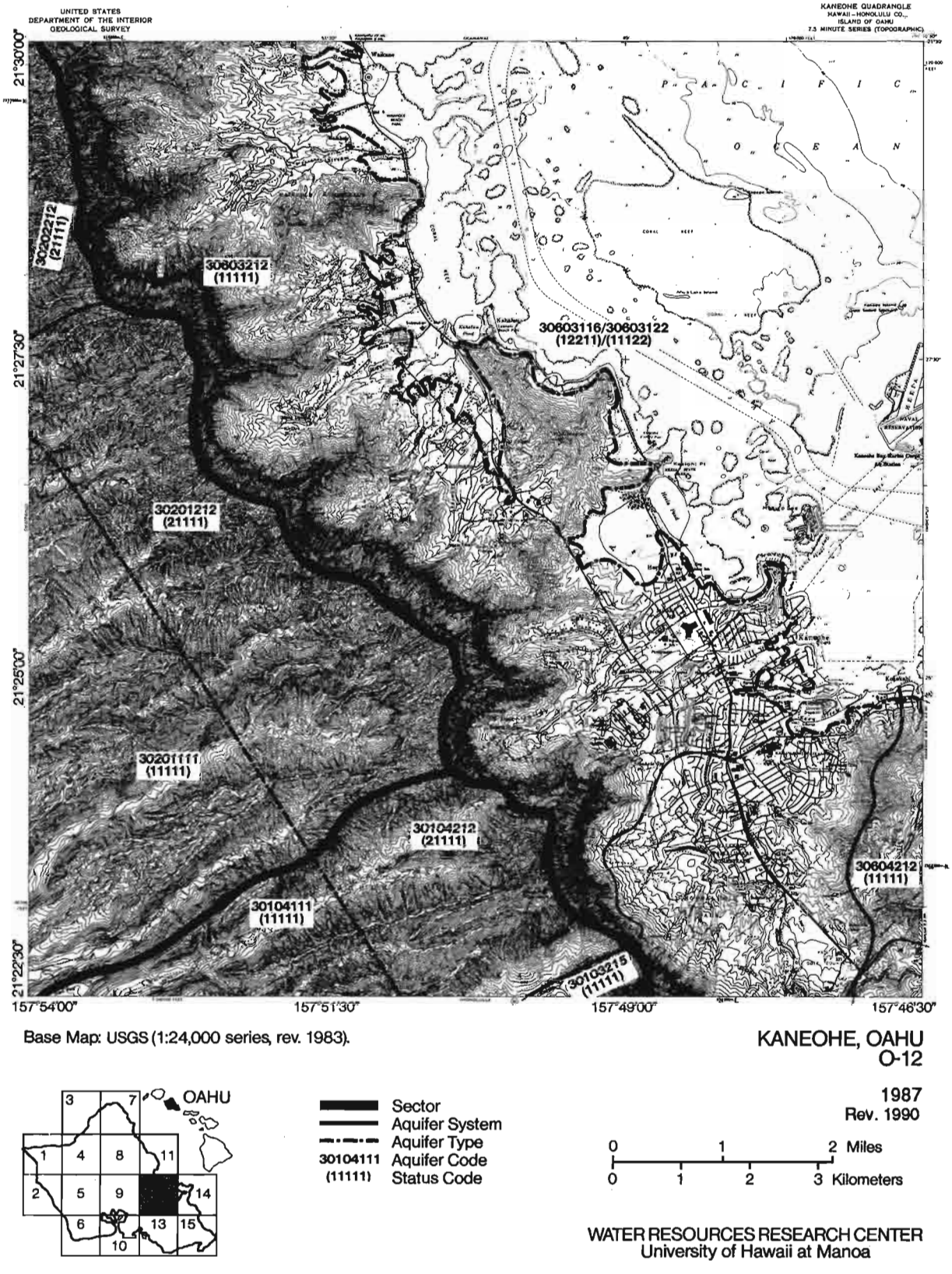

Figure 1.12. Aquifer classification map, Kāne'ohe, O'ahu, Hawai'i

Figure 1.13. Aquifer classification map, Honolulu, O'ahu, Hawai'i

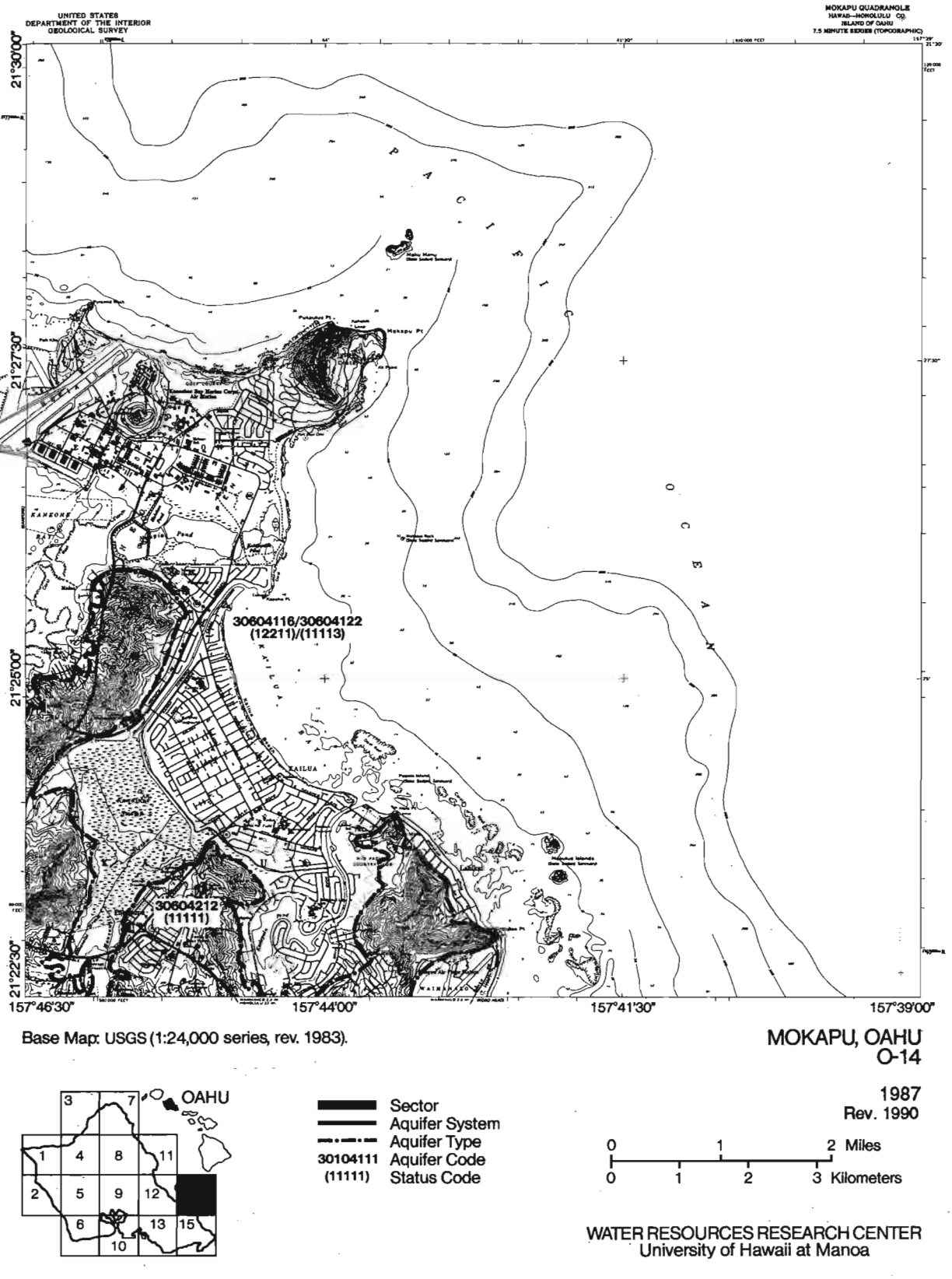

Figure 1.14. Aquifer classification map, Mōkapu, O'ahu, Hawai'i

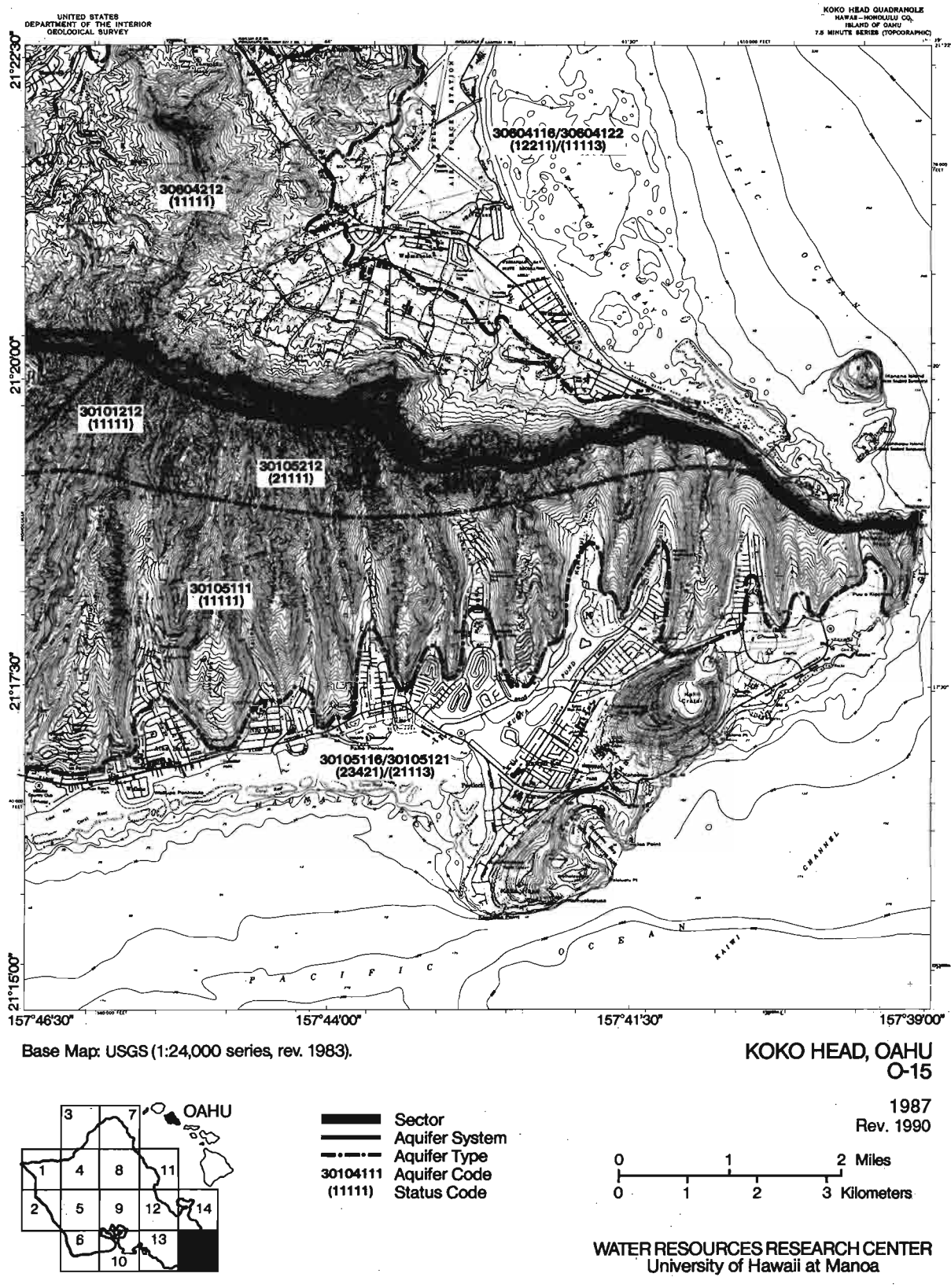

Figure 1.15. Aquifer classification map, Koko Head, O'ahu, Hawai'i