Instream Flow Standard Assessment Report

Island of Maui
Hydrologic Unit 6034
Honopou

September 2008 PR-2008-01

State of Hawaii
Department of Land and Natural Resources
Commission on Water Resource Management

COVER
The mouth of Honopou Stream (center) flows across a gravel beach with high sea cliffs on either side before entering the deep water of the Pacific Ocean [Google Earth, 2008].

Note: This report is intended for both print and electronic dissemination and does not include diacritical marks in spelling of Hawaiian words, names, and place names due to problems associated with its use electronically. However, Commission staff has made attempts to include diacritical marks in direct quotations to preserve accuracy.

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Acronyms and Abbreviations

A&B	Alexander & Baldwin
AG	agricultural
ALISH	Agricultural Lands of Importance to the State of Hawaii
ALUM	agricultural land use maps [prepared by HDOA]
BFQ	base flow statistics
BLNR	Board of Land and Natural Resources (State of Hawaii)
C-CAP	Coastal Change Analysis Program
cfs	cubic feet per second
Code	State Water Code (State of Hawaii)
COM	commercial
Commission	Commission on Water Resource Management (DLNR)
CPRC	Compilation of Public Review Comments (PR-2008-07, CWRM)
CWA	Clean Water Act (EPA)
CWRM	Commission on Water Resource Management (State of Hawaii)
DAR	Division of Aquatic Resources (State of Hawaii)
DBEDT	Department of Business, Economic Development and Tourism (State of Hawaii)
DHHL	Department of Hawaiian Home Lands (State of Hawaii)
DLNR	Department of Land and Natural Resources (State of Hawaii)
DOH	Department of Health (State of Hawaii)
DWS	Department of Water Supply (County of Maui)
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMI	East Maui Irrigation Company
EMWP	East Maui Watershed Partnership
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency (Department of Homeland Security)
FILEREF	File Reference [in the Commission's records of registered diversions]
ft	feet
gad	gallons per acre per day
GIS	Geographic Information Systems
G.L.	Government Lease
GOV	government
gpm	gallons per minute
Gr.	Grant
HAR	Hawaii Administrative Rules
HC&S	Hawaiian Commercial and Sugar Company
HDOA	State Department of Agriculture (State of Hawaii)
HI-GAP	Hawaii Gap Analysis Program
HOT	hotel
HRS	Hawaii Revised Statutes
HSA	Hawaii Stream Assessment
IFS	instream flow standard
IFSAR	Instream Flow Standard Assessment Report
IND	industry
IRR	irrigation requirements
IWREDSS	Irrigation Water Requirement Estimation Decision Support System
LCA	Land Commission Award
LUC	Land Use Commission (State of Hawaii)
MECO	Maui Electric Company
MF	multi-family residential
mgd	million gallons per day
mi	mile

MLP	Maui Land and Pineapple Company, Inc.
MOU	Memorandum of Understanding
na	not available
NAWQA	National Water Quality Assessment (USGS)
NHLC	Native Hawaiian Legal Corporation
NIR	net irrigation requirements
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NRCS	Natural Resource Conservation Service (USDA)
NVCS	National Vegetation Classification System
por.	Portion
REL	religious
RMT	R.M. Towill Corporation
SCS	Soil Conservation Service (United States Department of Agriculture)
	Note: The SCS is now called the Natural Resources Conservation Service (NRCS)
SF	single family residential
SPI	Standardized Precipitation Index
sq mi	square miles
TFQ	total flow statistics
TFQ_{50}	50 percent exceedence probability
TFQ_{90}	90 percent exceedence probability
TMDL	Total Maximum Daily Load
TMK	Tax Map Key
UHERO	University of Hawaii's Economic Research Organization
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service (Department of the Interior)
USGS	United States Geological Survey (Department of the Interior)
WQS	Water Quality Standards
WRPP	Water Resource Protection Plan (Commission on Water Resource Management)
WTF	water treatment facility

1.0 Introduction

General Overview

Honopou means "post harbor" in the Hawaiian language (Pukui et al., 1974). The hydrologic unit of Honopou is located northwest of the East Maui Volcano (Haleakala), which forms the eastern part of the Hawaiian island of Maui (Figure 1-3). It covers an area of 2.7 square miles from the lower slopes of Haleakala at 2,286 feet elevation to the sea. Honopou Stream is 4 miles in length, traversing north from its headwaters near Ulalena to the ocean. Tributary to Honopou Stream is Puniawa Stream, which is 2.6 miles in length with intermittent flow. Most of the hydrologic unit is made up of the Koolau Forest Reserve. The lower altitudes are occupied by grasses and shrubs with very few cultivated lands. There is no major village within the unit, making population relatively small – about 146 people (Coral Reef Assessment and Monitoring Program, 2007).

Current Instream Flow Standard

The current interim instream flow standard (IFS) for Honopou Stream was established by way of Hawaii Administrative Rules (HAR) §13-169-44, which, in pertinent part, read as follows:

> Interim instream flow standard for East Maui. The Interim Instream Flow Standard for all streams on East Maui, as adopted by the commission on water resource management on June 15, 1988, shall be that amount of water flowing in each stream on the effective date of this standard, and as that flow may naturally vary throughout the year and from year to year without further amounts of water being diverted offstream through new or expanded diversions, and under the stream conditions existing on the effective date of the standard.

The current interim IFS became effective on October 8, 1988. Streamflow was not measured on that date; therefore, the current interim IFS is not a measurable value.

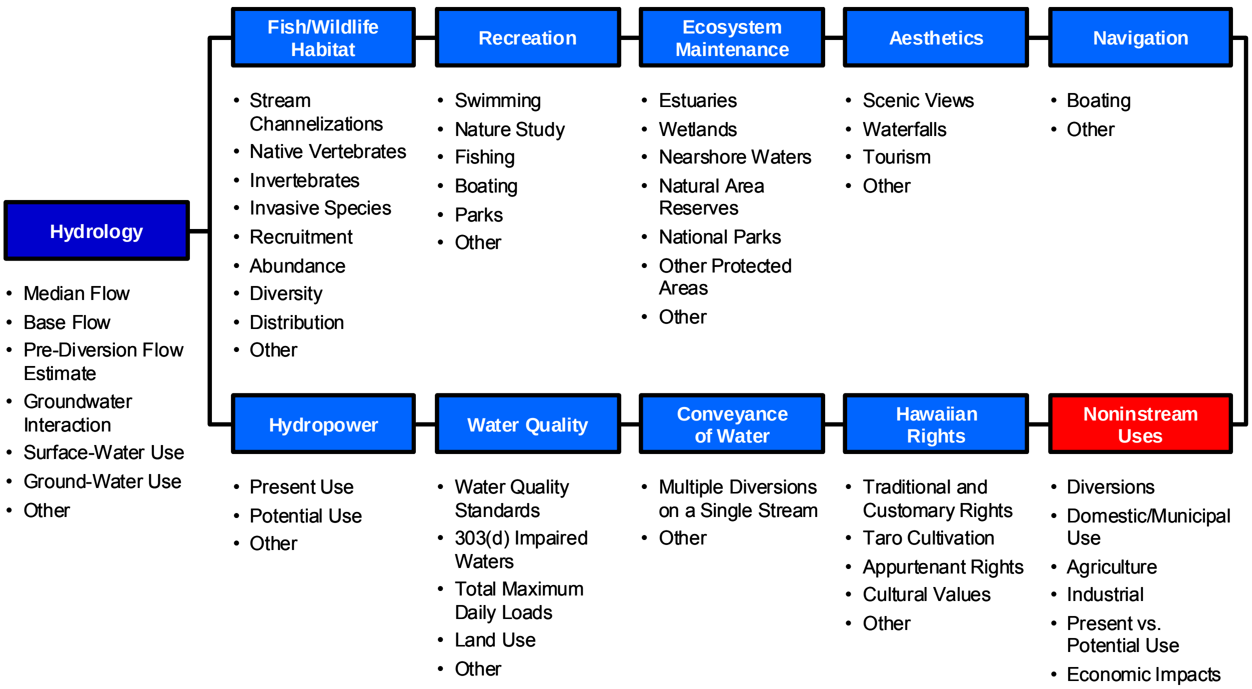
Instream Flow Standards

Under the State Water Code (Code), Chapter 174C, Hawaii Revised Statutes (HRS), the Commission on Water Resource Management (Commission) has the responsibility of establishing IFS on a stream-by-stream basis whenever necessary to protect the public interest in the waters of the State. Early in its history, the Commission recognized the complexity of establishing IFS for the State's estimated 376 perennial streams and instead set interim IFS at "status quo" levels. These interim IFS were defined as the amount of water flowing in each stream (with consideration for the natural variability in stream flow and conditions) at the time the administrative rules governing them were adopted in 1988 and 1989.

The Hawaii Supreme Court, upon reviewing the Waiahole Ditch Contested Case Decision and Order, held that such "status quo" interim IFS were not adequate to protect streams and required the Commission to take immediate steps to assess stream flow characteristics and develop quantitative interim IFS for affected Windward Oahu streams, as well as other streams statewide. The Hawaii Supreme Court also emphasized that "instream flow standards serve as the primary mechanism by which the Commission is to discharge its duty to protect and promote the entire range of public trust purposes dependent upon instream flows."

To the casual observer, IFS may appear relatively simple to establish upon a basic review of the Code provisions. However, the complex nature of IFS becomes apparent upon further review of the individual components that comprise surface water hydrology, instream uses, noninstream uses, and their interrelationships. The Commission has the distinct responsibility of weighing competing uses for a limited resource in a legal realm that is continuing to evolve. The following illustration (Figure 1-1) was developed to illustrate the wide range of information, in relation to hydrology, instream uses, and noninstream uses that should be addressed in conducting a comprehensive IFS assessment.

Figure 1-1. Information to consider in setting measurable instream flow standards.

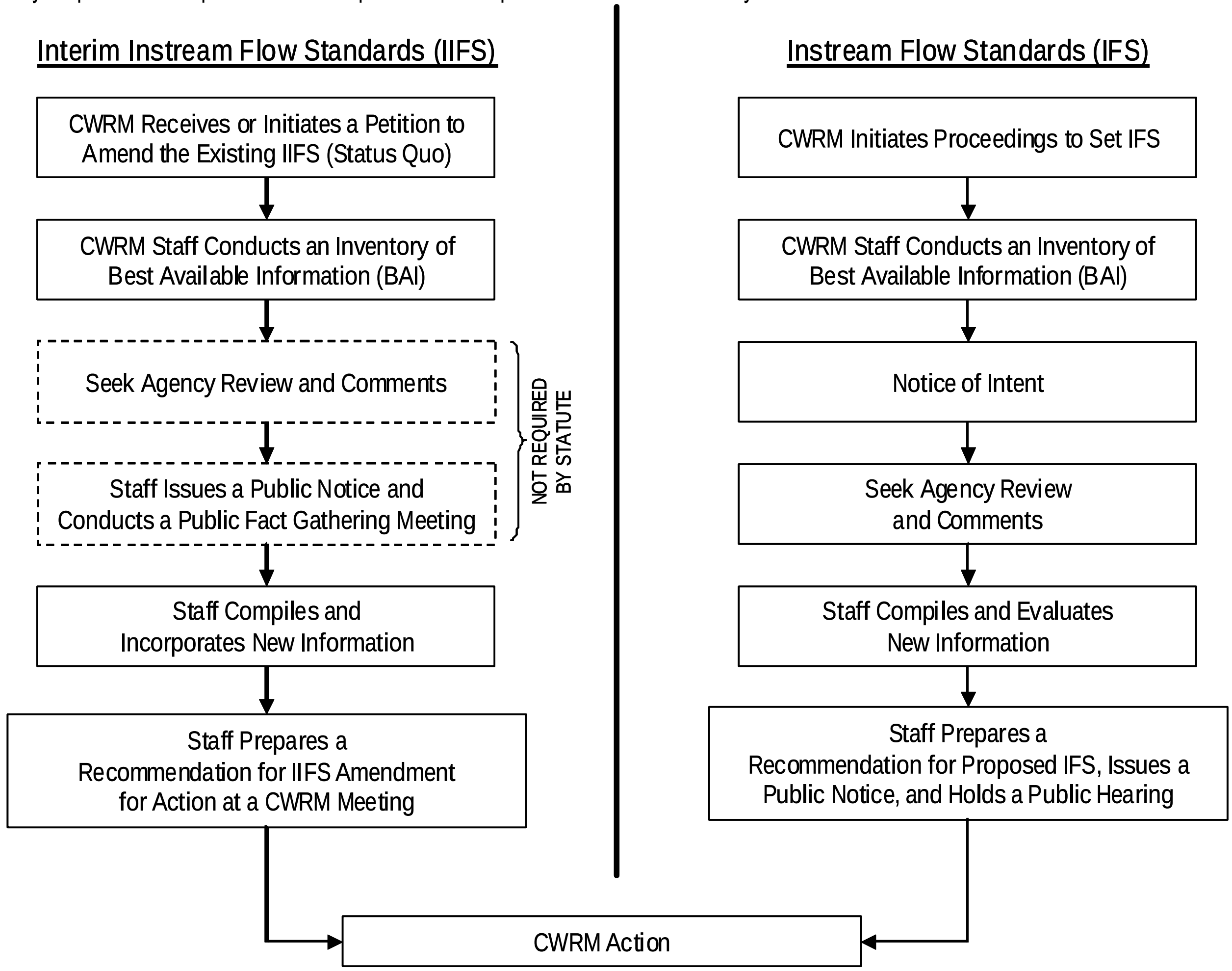


Interim Instream Flow Standard Process

The Code provides for a process to amend an interim IFS in order to protect the public interest pending the establishment of a permanent IFS. The Code, at §174C-71(2), describes this process including the role of the Commission to "weigh the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses."

Recognizing the complexity of establishing measurable IFS, while cognizant of the Hawaii Supreme Court's mandate to designate interim IFS based on best available information under the Waiahole Combined Contested Case, the Commission at its December 13, 2006 meeting authorized staff to initiate and conduct public fact gathering. Under this adopted process (reflected in the left column of Figure 1-2), the Commission staff will conduct a preliminary inventory of best available information upon receipt of a petition to amend an existing interim IFS. The Commission staff shall then seek agency review and comments on the compiled information (compiled in an Instream Flow Standard Assessment Report) in conjunction with issuing a public notice for a public fact gathering meeting. Shortly thereafter (generally within 30 days), the Commission staff will conduct a public fact gathering meeting in, or near, the hydrologic unit of interest.

Figure 1-2. Simplified representation of the interim instream flow standard and permanent instream flow standard processes. Key steps of the adopted interim IFS process are depicted in the left column by the boxes drawn with dotted lines.



Instream Flow Standard Assessment Report

The Instream Flow Standard Assessment Report (IFSAR) is a compilation of the hydrology, instream uses, and noninstream uses related to a specific stream and its respective surface water hydrologic unit. The report is organized in much the same way as the elements of IFS are depicted in Figure 1-1. The purpose of the IFSAR is to present the best available information for a given hydrologic unit. This information is used to determine the interim IFS recommendations, which is compiled as a separate report. The IFSAR is intended to act as a living document that should be updated and revised as necessary, thus also serving as a stand-alone document in the event that the Commission receives a subsequent petition solely for the respective hydrologic unit.

Each report begins with an introduction of the subject hydrologic unit and the current IFS status. Section 2.0 is comprised of the various hydrologic unit characteristics that, both directly and indirectly, impact surface water resources. Section 3.0 contains a summary of available hydrologic information, while Sections 4.0 through 12.0 summarize the best available information for the nine instream uses as defined by the Code. Noninstream uses are summarized in Section 13.0. Maps are provided at the end of each section to help illustrate information presented within the section's text or tables. Finally, Section 14.0 provides a comprehensive listing of cited references and is intended to offer readers the opportunity to review IFSAR references in further detail.

An important component of the IFSAR and the interim IFS process is the Compilation of Public Review Comments (CPRC). The CPRC serves as a supporting document containing the oral and written comments that are submitted as part of the initial public review process. This report refers specifically to PR-2008-07, Compilation of Public Review Comments for the Hydrologic Units of Honopou (6034), Hanehoi (6037), Piinaau (6053), Waiokamilo (6055), and Wailuanui (6056), Island of Maui, September 2008. Comments referred to within the IFSAR will identify both the section and page number where the original comment can be located in the CPRC. For example, a reference to "8.0-3" indicates the third page of comments in Section 8.0 of the CPRC.

Following the preparation of the IFSAR and initial agency and public review, information may be added to the IFSAR at any time. Dates of revision will be reflected as such. Future review of the IFSAR, by agencies and the public, will only be sought when a new petition to amend the interim (or permanent) instream flow standard is pending. Recommendations for IFS amendments are prepared separately as a stand-alone document. Thus, the IFSAR acts solely as a compendium of best available information and may be revised further without the need for subsequent public review following its initial preparation.

Surface Water Hydrologic Units

Early efforts to update the Commission's Water Resource Protection Plan (WRPP) highlighted the need for surface water hydrologic units to delineate and codify Hawaii's surface water resources. Surface water hydrologic units served as an important first-step towards improving the organization and management of surface water information that the Commission collects and maintains, including diversions, stream channel alterations, and water use.

In developing the surface water hydrologic units, the Commission staff reviewed various reports to arrive at a coding system that could meet the requirements for organizing and managing surface water information in a database environment, and could be easily understood by the general public and other agencies. For all intents and purposes, surface water hydrologic units are synonymous with watershed areas. Though Commission staff recognized that while instream uses may generally fall within a true surface drainage area, noninstream uses tend to be land-based and therefore may not always fall within the same drainage area.

In June 2005, the Commission adopted the report on surface water hydrologic units and authorized staff to implement its use in the development of information databases in support of establishing IFS (State of Hawaii, Commission on Water Resource Management, 2005a). The result is a surface water hydrologic unit code that is a unique combination of four digits. This code appears on the cover of each IFSAR above the hydrologic unit name.

Surface Water Definitions

Listed below are the most commonly referenced surface water terms as defined by the Code.

Agricultural use. The use of water for the growing, processing, and treating of crops, livestock, aquatic plants and animals, and ornamental flowers and similar foliage.

Channel alteration. (1) To obstruct, diminish, destroy, modify, or relocate a stream channel; (2) To change the direction of flow of water in a stream channel; (3) To place any material or structures in a stream channel; and (4) To remove any material or structures from a stream channel.

Continuous flowing water. A sufficient flow of water that could provide for migration and movement of fish, and includes those reaches of streams which, in their natural state, normally go dry seasonally at the location of the proposed alteration.

Domestic use. Any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, noncommercial gardening, and sanitation.

Ground water. Any water found beneath the surface of the earth, whether in perched supply, dike-confined, flowing, or percolating in underground channels or streams, under artesian pressure or not, or otherwise.

Hydrologic unit. A surface drainage area or a ground water basin or a combination of the two.

Impoundment. Any lake, reservoir, pond, or other containment of surface water occupying a bed or depression in the earth's surface and having a discernible shoreline.

Instream Flow Standard. A quantity of flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses.

Instream use. Beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream. Instream uses include, but are not limited to:

(1) Maintenance of fish and wildlife habitats;
(2) Outdoor recreational activities;
(3) Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;
(4) Aesthetic values such as waterfalls and scenic waterways;
(5) Navigation;
(6) Instream hydropower generation;
(7) Maintenance of water quality;
(8) The conveyance of irrigation and domestic water supplies to downstream points of diversion; and
(9) The protection of traditional and customary Hawaiian rights.

Interim instream flow standard. A temporary instream flow standard of immediate applicability, adopted by the Commission without the necessity of a public hearing, and terminating upon the establishment of an instream flow standard.

Municipal use. The domestic, industrial, and commercial use of water through public services available to persons of a county for the promotion and protection of their health, comfort, and safety, for the protection of property from fire, and for the purposes listed under the term "domestic use."

Noninstream use. The use of stream water that is diverted or removed from its stream channel and includes the use of stream water outside of the channel for domestic, agricultural, and industrial purposes.

Reasonable-beneficial use. The use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest.

Stream. Any river, creek, slough, or natural watercourse in which water usually flows in a defined bed or channel. It is not essential that the flowing be uniform or uninterrupted. The fact that some parts of the bed or channel have been dredged or improved does not prevent the watercourse from being a stream.

Stream channel. A natural or artificial watercourse with a definite bed and banks which periodically or continuously contains flowing water. The channel referred to is that which exists at the present time, regardless of where the channel may have been located at any time in the past.

Stream diversion. The act of removing water from a stream into a channel, pipeline, or other conduit.

Stream reach. A segment of a stream channel having a defined upstream and downstream point.

Stream system. The aggregate of water features comprising or associated with a stream, including the stream itself and its tributaries, headwaters, ponds, wetlands, and estuary.

Surface water. Both contained surface water--that is, water upon the surface of the earth in bounds created naturally or artificially including, but not limited to, streams, other watercourses, lakes, reservoirs, and coastal waters subject to state jurisdiction--and diffused surface water--that is, water occurring upon the surface of the ground other than in contained water bodies. Water from natural springs is surface water when it exits from the spring onto the earth's surface.

Sustainable yield. The maximum rate at which water may be withdrawn from a water source without impairing the utility or quality of the water source as determined by the Commission.

Time of withdrawal or diversion. In view of the nature, manner, and purposes of a reasonable and beneficial use of water, the most accurate method of describing the time when the water is withdrawn or diverted, including description in terms of hours, days, weeks, months, or physical, operational, or other conditions.

Watercourse. A stream and any canal, ditch, or other artificial watercourse in which water usually flows in a defined bed or channel. It is not essential that the flowing be uniform or uninterrupted.

Figure 1-3. Topographic map of the Honopou hydrologic unit in east Maui, Hawaii (Source: U.S. Geological Survey, 1996).

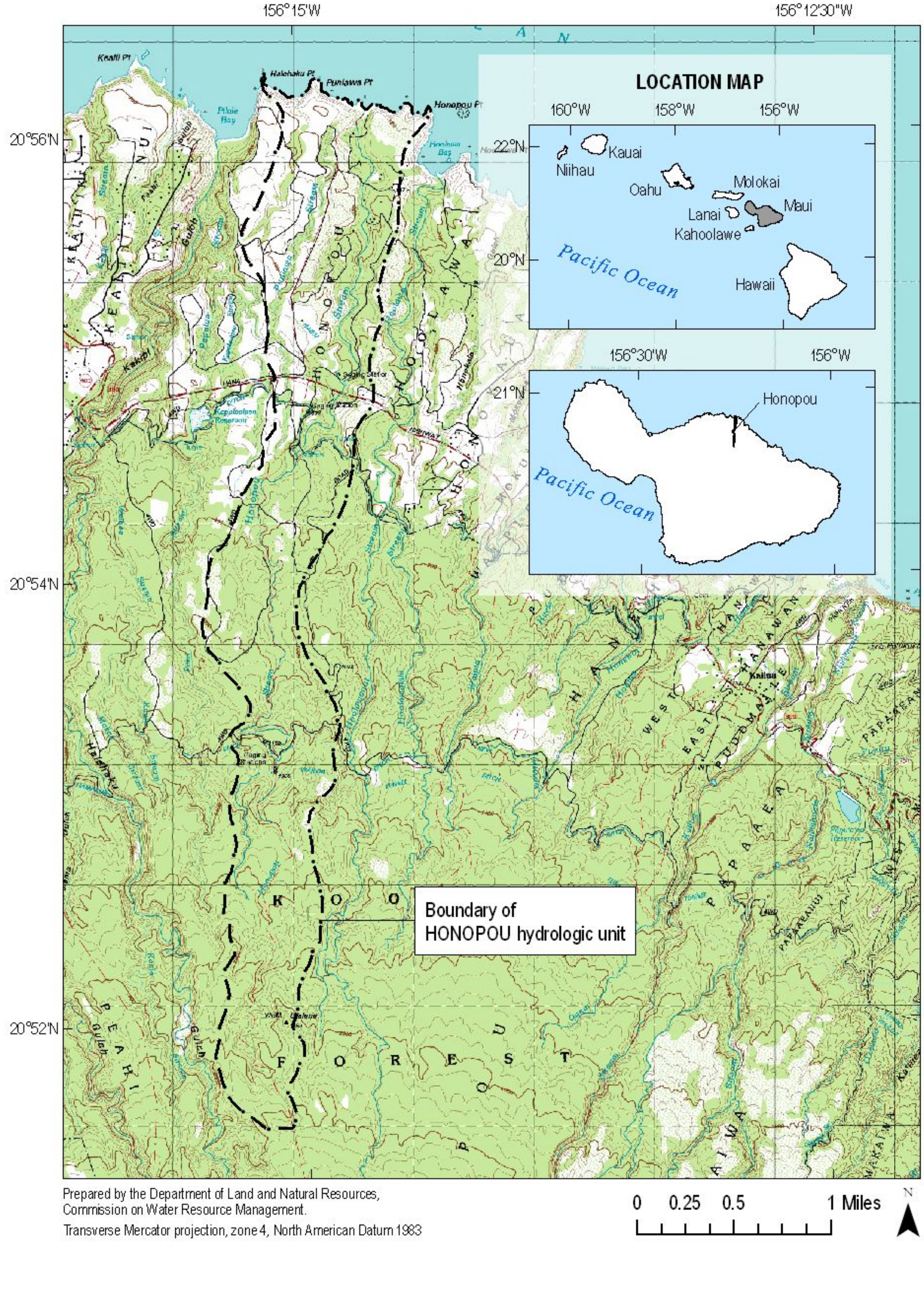


Figure 1-4. Elevation range and the location of Honopou hydrologic unit. (Source: State of Hawaii, Office of Planning, 1983).

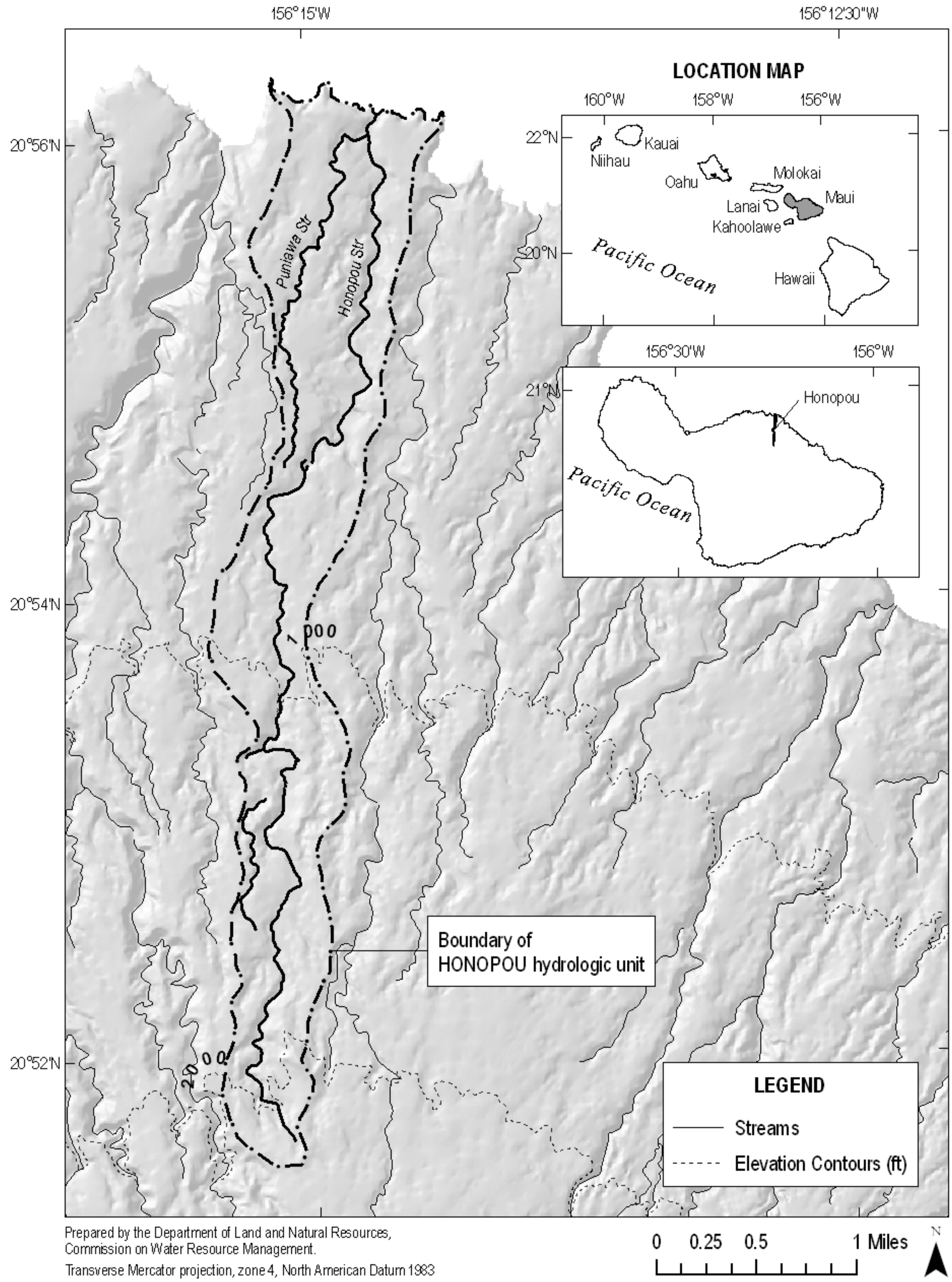


Figure 1-5. Major and minor roads and Tax Map Key (TMK) parcel boundaries for Honopou hydrologic unit (Source: County of Maui, 2006; County of Maui, Geographic Information Systems [GIS] Division, Department of Management, 2006).

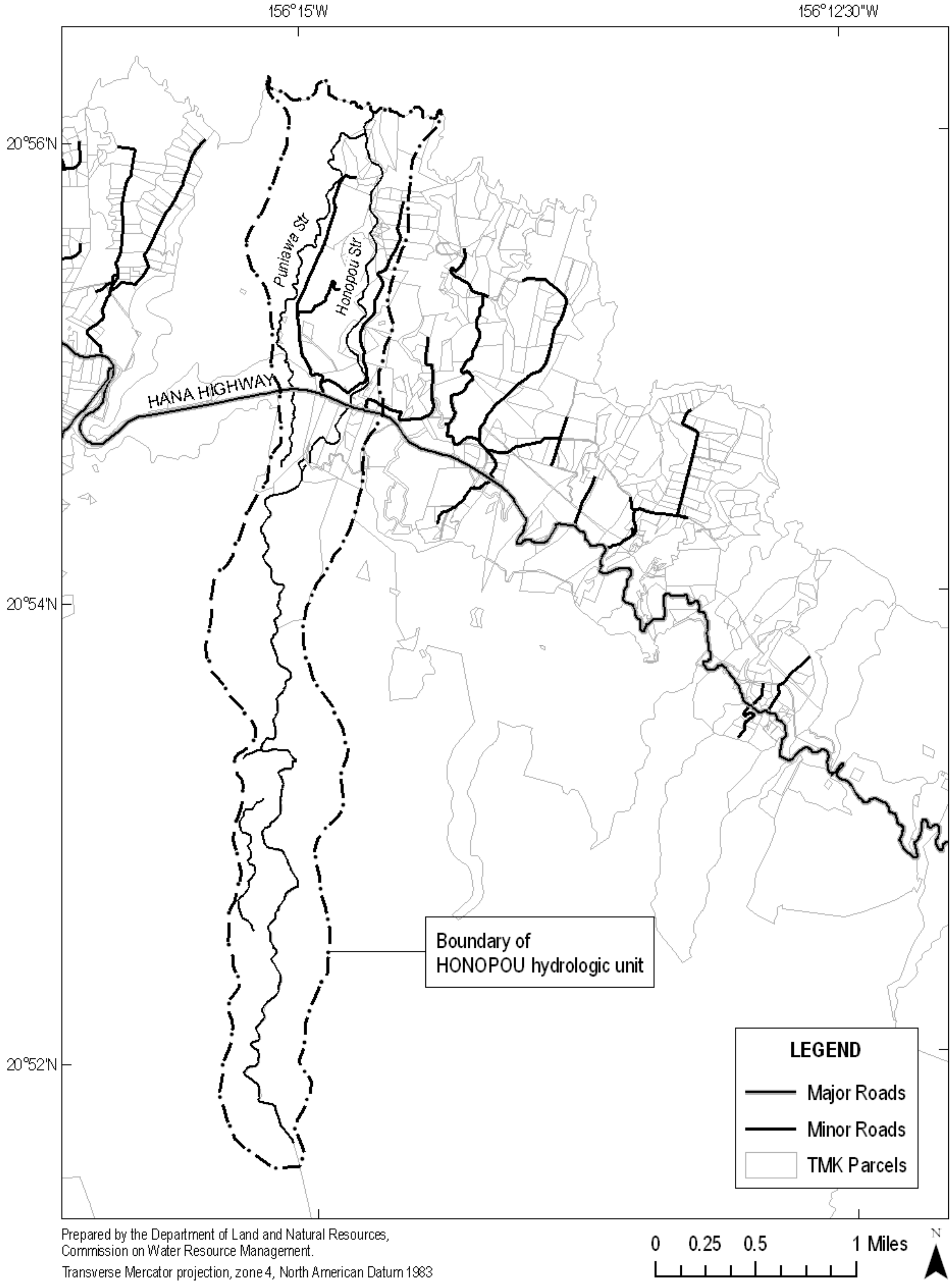
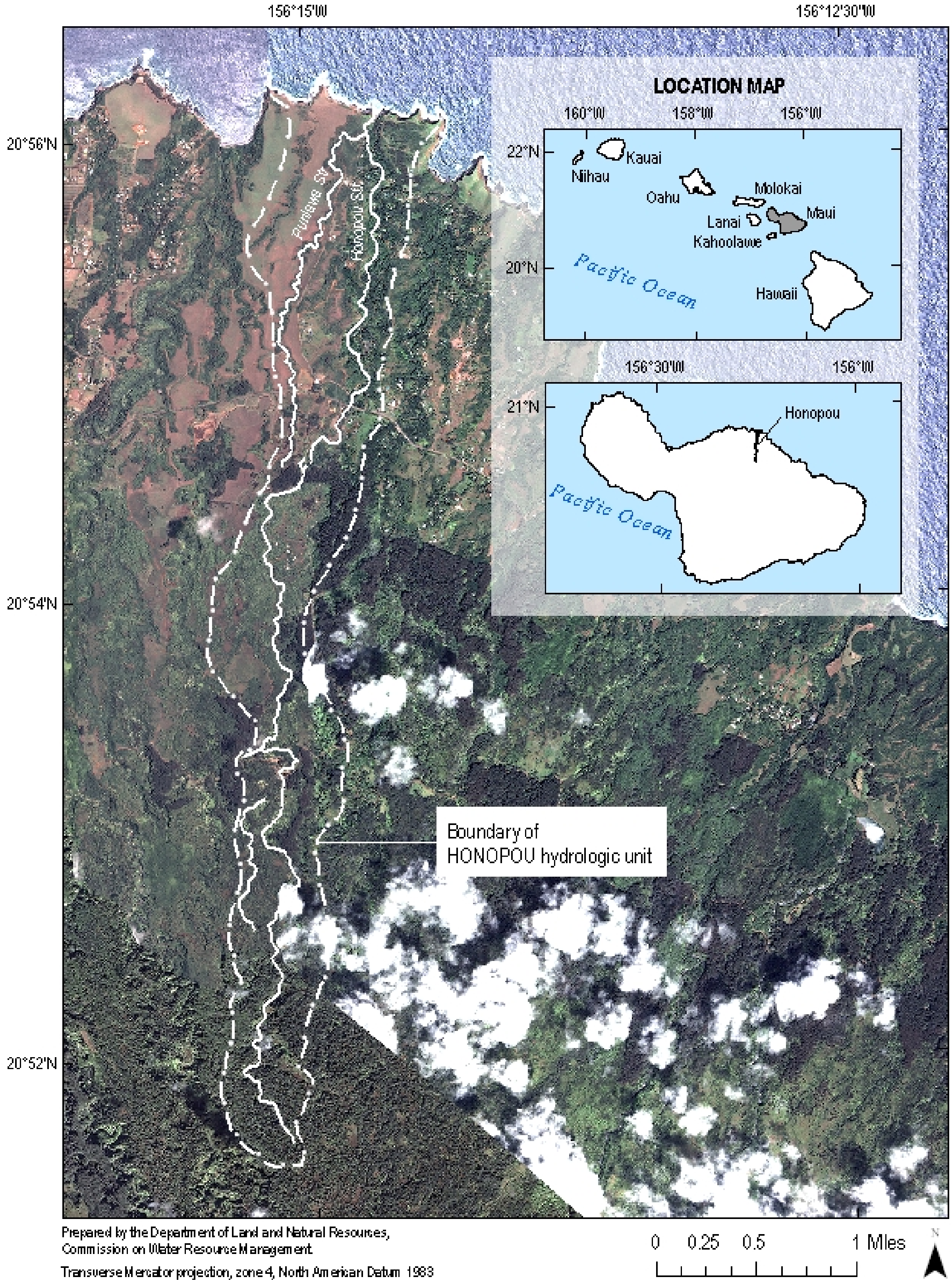


Figure 1-6. Quickbird satellite imagery of Honopou hydrologic unit (Source: County of Maui, Planning Department, 2004).



2.0 Unit Characteristics

Geology

The surface geology of the Honopou hydrologic unit is characterized by Kula volcanics, which are mainly aa flows (lava characterized by jagged, sharp surfaces with massive, relatively dense interior) poured out at progressively longer intervals so that numerous valleys were cut between the younger lava flows (Figure 2-2). The older flows are massive, aggregating 2,000 feet thick on the summit and thin toward the isthmus where they are only about 50 feet thick. In the eastern end of the mountain near Haiku, perched high-level ground water[1] is held up by the relatively low permeability[2] Kula volcanics and associated weathered soils and ash beds (Gingerich, 1999a). Elsewhere they contain fresh water at sea level, but it is brackish along the leeward shore. A small area near the head of the hydrologic unit includes geologic formations (weathered cinders, spatter, and pumice) originally built along fissures by firefountains (sprays of gases carrying magma from vents, spewing up to several hundred feet high, producing “spatter”) at the source of the lava flows, forming a few perched spring water systems. The Honomanu volcanic series, which predates the Kula volcanics, is believed to form the basement of the entire Haleakala mountain to an unknown depth below sea level. They are predominantly pahoehoe flows (lava characterized by a smooth or ropy surface with variable interior, including lava tubes and other voids), ranging from 10 to 75 feet thick and are very vesicular. The Honomanu basalts are extremely permeable and yield water freely (Stearns and MacDonald, 1942). The generalized geology of the Honopou hydrologic unit is depicted in Figure 2-2.

Table 2-1. Area and percentage of surface geologic features for Honopou hydrologic unit.

Symbol	Name	Rock Type	Lithology	Area (mi^2)	Percent of Unit
Qkul	Kula Volcanics	Lava flows	Aa and pahoehoe	2.65	97.9
Qkuv	Kula Volcanics	Cinder and spatter	Coarse near-vent fallout deposits	0.06	2.1

Soils

Honopou consists largely of soils that are fairly permeable, except for parts of the mauka section of the hydrologic unit. In that section, some ridge areas are poorly drained, meaning that water does not move quickly through the soil and the soil remains wet for long periods. Along the stream course, the soils are mixed. The remainder of the hydrologic unit consists of well-drained soils; thus allowing rainwater to feed both streams and ground water.

The mauka section of the hydrologic unit, from the head to near the New Hamakua Ditch, consists of soils called the Honomanu-Amalu association. About 60 percent are well-drained soils, occurring on the steeper slopes. The other 40 percent are poorly drained, occurring on the less sloping tops of ridges and interfluves (regions of higher land between valleys in the same hydrologic unit). In these areas, the substratum is soft, weathered basic igneous rock capped by a horizontal ironstone sheet 1/8 to 1 inch thick. Permeability is restricted by the ironstone sheet, which is impermeable except for cracks, meaning that rain water will infiltrate the top of the soil then move laterally until it either seeps out as springs or base flow[3] in streams; or reaches a more permeable soil type.

[1] Perched water is water confined by an impermeable or slowly permeable layer, thus accumulating in a perched water table above the general regional water table. It is generally near-surface, and may supply springs.
[2] Permeability is the ease with which water passes through material. It is a factor in determining whether precipitation runs off on the surface or descends into the ground.
[3] Base flow is the flow of water into a stream from the ground from persistent, varying sources and maintains stream flow between water-input events (i.e. during periods of no rainfall).

About one-third of the way from the head of the Honopou hydrologic unit to the sea, the soils transition to a well-drained silty clay and rough broken land. The silty clay is moderately permeable with slow runoff and a slight erosion hazard. The soils along the course of Honopou Stream continue as rough broken land from the middle of the hydrologic unit to the coast. This is very steep land broken by numerous intermittent drainage channels. In most places it is not stony. It occurs in gulches and on mountainsides. Runoff is rapid, and geologic erosion is active. The soils of rough broken land are not uniform (U.S. Department of Agriculture, Soil Conservation Service, 1972).

The U.S. Department of Agriculture's Natural Resources Conservation Service (formerly known as the Soil Conservation Service) divides soils into hydrologic soil groups (A, B, C, and D) according to the rate at which infiltration (intake of water) occurs when the soil is wet. The higher the infiltration rate, the faster the water is absorbed into the ground and the less there is to flow as surface runoff. Group A soils have the highest infiltration rates and group D soils have the lowest. In Honopou, 19.8 percent of soils are group A; 25.3 percent group B; and 33.3 percent group C. The remaining 21.2 percent, found at the head of the hydrologic unit, is characterized by the Honomanu-Amalu association which is both group A (Honomanu Series) and D (Amalu Series). The group A soils are in the mid-section of the hydrologic unit, while the lower half consists of group B and C soils which have moderate to low infiltration rates, respectively. Below the New Hamakua Ditch, Honopou Stream runs for a short reach through group A soils, and then mostly through group C soils to the ocean (Figure 2-3) (U. S. Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division,1986).

Table 2-2. Area and percentage of soil types for the Honopou hydrologic unit.

Map Unit	Description	Area (mi^2)	Percent of Unit
KBID	Kailua silty clay, 3 to 25 percent slopes	0.54	19.8
PfB	Pauwela clay, 3 to 7 percent slopes	0.17	6.3
PfC	Pauwela clay, 7 to 15 percent slopes	0.36	13.4
PfD	Pauwela clay, 15 to 25 percent slopes	0.15	5.6
rHR	Honomanu-Amalu association	0.57	21.2
rRR	Rough broken land	0.9	33.3

Rainfall

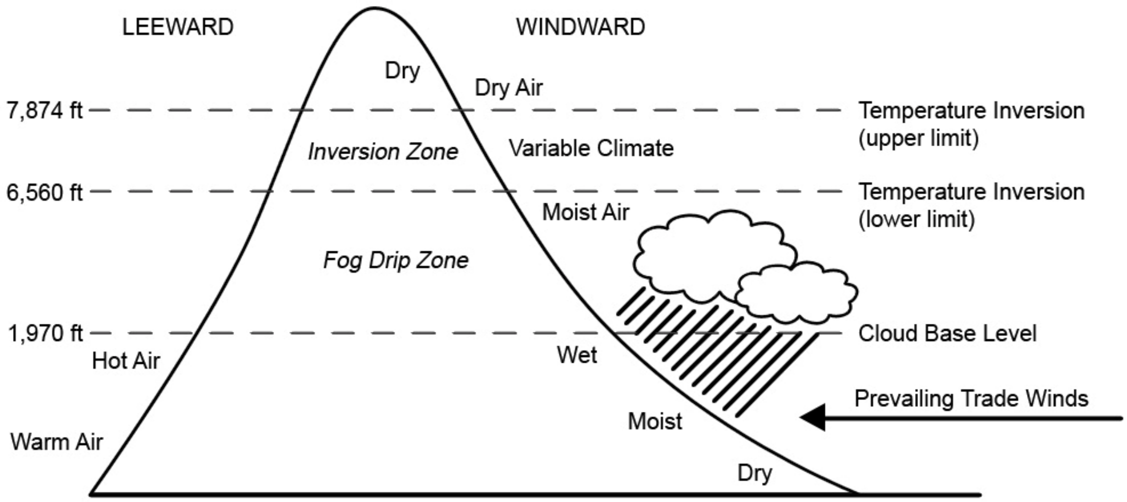
Rainfall distribution in Honopou is governed by the orographic[4] effect (Figure 2-1). Orographic precipitation occurs when the prevailing northeasterly trade winds lift warm air up the windward side of the mountains into higher elevations where cooler temperatures persist. As a result, frequent and heavy rainfall is observed at the windward mountain slopes. Once the moist air reaches the fog drip zone, cloud height is restricted by the temperature inversion, where temperature increases with elevation, thus favoring fog drip over rain-drop formation (Shade, 1999). Fog drip is a result of cloud-water droplets impacting vegetation (Scholl et al., 2002) and it can contribute significantly to ground water recharge. The fog drip zone on the windward side of East Maui Volcano (Haleakala) extends from the cloud base level at 1,970 feet to the lower limit of the most frequent temperature inversion base height at 6,560 feet (Giambelluca and Nullet, 1992).

A majority of the mountains in Hawaii peak in the fog drip zone. In such cases, air passes over the mountains, warming and drying while descending the leeward mountain slopes. When the mountains are at elevations higher than 6,000 feet (e.g. Haleakala), climate is affected by the presence and movement of the inversion. The temperature inversion zone typically extends from 6,560 feet to 7,874 feet. This

[4] Orographic refers to influences of mountains and mountain ranges on airflow, but also used to describe effects on other meteorological quantities such as temperature, humidity, or precipitation distribution.

region is influenced by a layer of moist air below and dry air above, making climate extremely variable (Giambelluca and Nullet, 1992). Above the inversion zone, the air is dry and sky is frequently clear (absence of clouds) with high solar radiation, creating an arid atmosphere with little rainfall.

Figure 2-1. Orographic precipitation in the presence of mountains higher than 6,000 feet.



The hydrologic unit of Honopou is situated on the windward flank of the East Maui Volcano. The hydrologic unit receives near-daily orographic rainfall of 170-190 inches per year in the upper slopes, with little or no rainfall near the coast (Giambelluca et al., 1986). The high spatial variability in rainfall is evident where the mean annual rainfall decreases by about 44 inches with an average 500-foot drop in elevation. Rainfall is highest during the months of March, April, and December where the mean monthly rainfall across the hydrologic unit is approximately 14 inches. In March, rainfall can reach as high as 23 inches in the mountains. For the rest of the year, the mean monthly rainfall ranges from 8 inches to 11 inches. The driest months are May, July, and September, during which only 4-5 inches of rain fall at the coast.

Currently, fog drip data for east Maui are very limited. Shade (1999) used the monthly fog drip to rainfall ratios for the windward slopes of Mauna Loa on the island of Hawaii (Table 2-3) to calculate fog drip contribution to the water-budget in windward east Maui. The fog drip to rainfall ratios were estimated using 1) the fog drip zone boundaries for east Maui (Giambelluca and Nullet, 1992), and 2) an illustration that shows the relationship between fog drip and rainfall for the windward slopes of Mauna Loa, island of Hawaii (Juvik and Nullet, 1995). This method was used to determine the contribution of fog drip in Honopou, which is calculated by multiplying the ratios with the monthly rainfall values (Giambelluca et al., 1986). Calculations show that approximately 5 percent of Honopou lies in the fog drip zone (Figure 2-4) with an estimated average annual fog drip rate of 53 inches per year. Since only a small portion of Honopou lies in the fog drip zone, the contribution of fog to total rainfall is insignificant.

Table 2-3. Fog drip to rainfall ratios for the windward slopes of Mauna Loa on the island of Hawaii.

Month	Ratio (%)
January-March	13
April-June	27
July-September	67
October-November	40
December	27

Solar Radiation

Solar radiation is the sun's energy that arrives at the Earth's surface after considerable amounts have been absorbed by water vapor and gases in the Earth's atmosphere. The amount of solar radiation to reach the surface in a given area is dependent in part upon latitude and the sun's declination angle (angle from the sun to the equator), which is a function of the time of year. Hawaii's trade winds and the temperature inversion layer greatly affect solar radiation levels, the primary heat source for evaporation. High mountain ranges block moist trade-wind air flow and keep moisture beneath the inversion layer (Lau and Mink, 2006). As a result, windward slopes tend to be shaded by clouds and protected from solar radiation, while dry leeward areas receive a greater amount of solar radiation and thus have higher levels of evaporation. In Honopou, estimated daily solar radiation ranges from about 300-350 calories per square centimeter per day. It is greatest at the coast and decreases toward the uplands, where there are more clouds (Figure 2-4).

Evaporation

Evaporation is the loss of water to the atmosphere from soil surfaces and open water bodies (e.g. streams and lakes). Evaporation from plant surfaces (e.g. leaves, stems, flowers) is termed transpiration. Together, these two processes are commonly referred to as evapotranspiration, and it can significantly affect water yield because it determines the amount of rainfall that becomes streamflow. On a global scale, the amount of water that evaporates is about the same as the amount of water that falls on Earth as precipitation. However, more water evaporates from the ocean whereas on land, rainfall often exceeds evaporation. The rate of evaporation is dependent on many climatic factors including solar radiation, albedo[5], rainfall, humidity, wind speed, surface temperature, and sensible heat advection[6]. Higher evaporation rates are generally associated with greater net radiation, high wind speed and surface temperature, and lower humidity.

A common approach to estimating evaporation is to employ a relationship between potential evaporation and the available water in the watershed. Potential evaporation is the maximum rate of evaporation if water is not a limiting factor, and it is often measured with evaporation pans. In Hawaii, pan evaporation measurements were generally made in the lower elevations of the drier leeward slopes where sugarcane was grown. These data have been compiled and mapped by Ekern and Chang (1985). Unfortunately, pan evaporation data are available only for the lower slopes of west and central Maui. This makes estimating the evaporative demand on the watersheds in windward east Maui challenging.

Most of the drainage basins in Hawaii are characterized by a relatively large portion of the rainfall leaving the basin as evaporation and the rest as streamflow (Ekern and Chang, 1985). Based on the available pan evaporation data for Hawaii, evaporation generally decreases with increasing elevation below the temperature inversion[7] and the cloud layer (Figure 2-1). At low elevations near the coast, pan evaporation rates are influenced by sensible heat advection from the ocean (Nullet, 1987). Pan evaporation rates are enhanced in the winter by positive heat advection from the ocean, and the opposite occurs in the summer when pan evaporation rates are diminished by negative heat advection (Giambelluca and Nullet, 1992). With increasing distance from the windward coasts, positive heat advection from dry land surfaces becomes an important factor in determining the evaporative demand at the slopes (Nullet, 1987). Shade (1999, Fig. 9) estimated pan evaporation rates of 30 inches per year below 2,000 feet elevation to 80 inches per year near the coast. Within the cloud layer, evaporation rates are particularly low due to the

[5] Albedo is the proportion of solar radiation that is reflected from the Earth, clouds, and atmosphere without heating the receiving surface.
[6] Sensible heat advection refers to the transfer of heat energy that causes the rise and fall in the air temperature.
[7] Temperature inversion is when temperature increases with elevation.

low radiation and high humidity caused by fog drip. Pan evaporation rates dropped below 30 inches per year in this area as reported in Shade (1999, Fig. 9). Near the average height of the temperature inversion, evaporation rates are highly variable as they are mainly influenced by the movement of dry air from above and moist air from below (Nullet and Giambelluca, 1990). Above the inversion, clear sky and high solar radiation at the summits cause increased evaporation, with pan evaporation rates of about 50 to 70 inches per year (Shade, 1999, Fig. 9). Ekern and Chang (1985) reported evaporation increased to 50 percent more than surface oceanic rates near the Mauna Kea crest on the island of Hawaii.

Land Use

The Hawaii Land Use Commission (LUC) was established under the State Land Use Law (Chapter 205, Hawaii Revised Statutes) enacted in 1961. Prior to the LUC, the development of scattered subdivisions resulted in the loss of prime agricultural land that was being converted for residential use, while creating problems for public services trying to meet the demands of dispersed communities. The purpose of the law and the LUC is to preserve and protect Hawaii's lands while ensuring that lands are used for the purposes they are best suited. Land use is classified into four broad categories: 1) agricultural; 2) conservation; 3) rural; and 4) urban.

Land use classification is an important component of examining the benefits of protecting instream uses and the appropriateness of surface water use for noninstream uses. While some may argue that land use, in general, should be based upon the availability of surface and ground water resources, land use classification continues to serve as a valuable tool for long-range planning purposes.

As of 2006, the LUC designated 57 percent of the land in Honopou as conservation district and 43 percent as agricultural district (State of Hawaii, Office of Planning, 2006d). No lands were designated as rural or urban districts. The conservation district is located in the upper part of the hydrologic unit and along the coast, whereas the agricultural district lies is in the lower part of the hydrologic unit (Figure 2-5).

Land Cover

Land cover for the hydrologic unit of Honopou is represented by two separate 30-meter Landsat satellite images. One of the datasets, developed by the Coastal Change Analysis Program (C-CAP), provides a general overview of the land cover types in Honopou, e.g. forest, shrub land, grassland, developed areas, cultivated areas, and bare land (Table 2-4, Figure 2-6). The second is developed by the Hawaii Gap Analysis Program (HI-GAP), which mapped the National Vegetation Classification System (NVCS) associations for each type of vegetation, creating a more comprehensive land cover dataset (Table 2-5, Figure 2-7).

Based on the two land cover classification systems, the land cover of Honopou consists mainly of forested areas. More than half of the hydrologic unit is made up of alien forests, with some native Koa-Ohia forests that spread throughout the upper slopes as part of the Koolau Forest Reserve. A mixture of uluhe shrub lands, alien grasslands, and low intensity developed areas covers the intermediate slopes. Small farms can be found at lower altitudes near the coast in support of small-scale agriculture.

The land cover maps (Figures 2-6, 2-7) provide a general representation of the land cover types in Honopou. Given that the scale of the maps is relatively large, they may not capture the smaller cultivated lands or other vegetation occupying smaller parcels of land. Land cover types may also have changed slightly since the year when the maps were published.

Table 2-4. C-CAP land cover classes and area distribution in Honopou hydrologic unit (Source: National Oceanographic and Atmospheric Agency, 2000).

Land Cover	Description	Area (mi^2)	Percent of Unit
Evergreen Forest	Areas where more than 67 percent of the trees remain green throughout the year	1.71	63.2
Scrub/Shrub	Areas dominated by woody vegetation less than 6 meters in height	0.49	18.0
Cultivated Land	Herbaceous (cropland) and woody cultivated lands	0.28	10.4
Grassland	Natural and managed herbaceous cover	0.13	4.8
Low Intensity Developed	Constructed surface with substantial amounts of vegetated surface	0.05	1.9
Unconsolidated Shoreline	Material such as silt, sand, or gravel that is subject to inundation and redistribution by water	0.02	0.7
Bare Land	Bare soil, gravel, or other earthen material with little or no vegetation	0.01	0.2

Table 2-5. HI-GAP land cover classes and area distribution in Honopou hydrologic unit (Source: HI-GAP, 2005).

Land Cover	Area (mi^2)	Percent of Unit
Alien Forest	1.77	65.5
Agriculture	0.28	10.5
Uncharacterized Open-Sparse Vegetation	0.17	6.4
Closed Ohia Forest (uluhe)	0.14	5.1
Alien Grassland	0.12	4.3
Low Intensity Developed	0.04	1.6
Closed Ohia Forest (native shrubs)	0.04	1.6
Open Ohia Forest (uluhe)	0.04	1.5
Very Sparse Vegetation to Unvegetated	0.03	1.3
Closed Koa-Ohia Forest (native shrubs)	0.03	1.0
Closed Koa-Ohia Forest (uluhe)	0.03	1.0
Uncharacterized Forest	< 0.01	0.1
Kikuyu Grass Grassland / Pasture	< 0.01	0.1
Undefined	< 0.01	< 0.1

Flood

Floods usually occur following prolonged or heavy rainfall associated with tropical storms or hurricanes. The magnitude of a flood depends on topography, ground cover, and soil conditions. Rain falling on areas with steep slopes and soil saturated from previous rainfall events tends to produce severe floods in low-lying areas. Four types of floods exist in Hawaii. Stream or river flooding occurs when the water level in a stream rises into the flood plain. A 100-year flood refers to the probability of the flood happening once in a hundred years, or 1 percent chance of happening in a given year. Flash floods occur within a few hours after a rainfall event, or they can be caused by breaching of a flood safety structure such as a dam. Flash flooding is common in Hawaii because the small drainage basins often have a short response time, typically less than an hour, from peak rainfall to peak streamflow. They are powerful and dangerous in that they can develop quickly and carry rocks, mud, and all the debris in their path down to the coast, causing water quality problems in the near shore waters. Some floods can even trigger massive landslides, blocking off the entire stream channel. One of the major historic flash flooding events occurred on December 5-6, 1988, when rainfall was at the average annual maximum, causing significant flash flooding in many parts of Maui (Fletcher III et al., 2002). Sheet flooding occurs when runoff builds up on previously saturated ground, flowing from the high mountain slopes to the sea in a shallow sheet

(Pacific Disaster Center, 2007). Coastal flooding is the inundation of coastal land areas from excessive sea level rise associated with strong winds or a tsunami.

The Federal Emergency Management Agency (FEMA) developed maps that identify the flood-risk areas in an effort to mitigate life and property losses associated with flooding events. Figure 2-8 illustrates the flood-risk areas in the hydrologic unit of Honopou (FEMA, 2003). Halehaku Point, Honopou Point, and the mouth of Honopou Stream are prone to coastal flooding with a 1 percent annual chance of inundation due to the their proximity to the sea level.

Drought

Drought is generally defined as a shortage of water supply that usually results from lower than normal rainfall over an extended period of time, though it can also result from human activities that increase water demand (Giambelluca et al., 1991). The National Drought Mitigation Center (State of Hawaii, Commission on Water Resource Management, 2005b) uses two types of drought definitions — conceptual and operational. Conceptual definitions help people understand the general concept of drought. Operational definitions describe the onset and severity of a drought, and they are helpful in planning for drought mitigation efforts. The four operational definitions of drought are meteorological, agricultural, hydrological, and socioeconomic. Meteorological drought describes the departure of rainfall from normal based on meteorological measurements and understanding of the regional climatology. Agricultural drought occurs when not enough water is available to meet the water demands of a crop. Hydrological drought refers to declining surface and ground water levels. Lastly, socioeconomic drought occurs when water shortage affects the general public.

Impacts of drought are complex and can be categorized into three sectors: water supply; agriculture and commerce; and environment, public health, and safety sectors (State of Hawaii, Commission on Water Resource Management, 2005b). The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes ground water supplies due to reduced recharge from rainfall. The agriculture and commerce sector includes the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing. The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It also includes the impact of desiccating streams, such as the reduction of instream habitats for native species.

Droughts have affected the islands throughout Hawaii's recorded history. The most severe events of the past 15 years are associated with the El Niño phenomenon. In January 1998, the National Weather Service's network of 73 rain gauges throughout the State did not record a single above-normal rainfall, with 36 rain gauges recording less than 25 percent of normal rainfall (State of Hawaii, Commission on Water Resource Management, 2005b). The most recent drought occurred in 2000-2002, affecting all islands, especially the southeastern end of the State. During that period, east Maui streams were at record low levels and cattle losses projected at 9 million dollars (State of Hawaii, Commission on Water Resource Management, 2005b).

With Hawaii's limited water resources and growing water demands, droughts will continue to adversely affect the environment, economy, and the residents of the State. Aggressive planning is necessary to make wise decisions regarding the allocation of water at the present time, and conserving water resources for generations to come. The Hawaii Drought Plan was established in 2000 in an effort to mitigate the long-term effects of drought. One of the projects that supplemented the plan was a drought risk and vulnerability assessment of the State, conducted by researchers at the University of Hawaii (2003). In this project, drought risk areas were determined based on rainfall variation in relation to water source, irrigated area, ground water yield, stream density, land form, drainage condition, and land use. Fifteen years of historical rainfall data were used. The Standardized Precipitation Index (SPI) was used as the drought index because of its ability to assess a range of rainfall conditions in Hawaii. It quantifies rainfall deficit for different time periods, i.e. 3 months and 12 months. Results of the study for Maui are summarized in Table 2-6. Based on the 12-month SPI, the Kula region has the greatest risk to drought impact of the Maui regions because of its dependence on surface water sources, which is limited by low rainfall. The growing population in the already densely populated area further stresses the water supply.

Table 2-6. Drought risk areas for Maui (Source: University of Hawaii, 2003).

[Drought classifications of moderate, severe, and extreme have SPI values -1.00 to -1.49, -1.50 to -1.99, and -2.00 or less, respectively]

Sector	Drought Classification (based on 12-month SPI)		
	Moderate	Severe	Extreme
Water Supply	Kula, Kahului, Wailuku, Hana, Lahaina	Kula, Hana	Kula
Agriculture and Commerce	--	--	--
Environment, Public Health and Safety	Kula	Kula	Kula

Figure 2-2. Generalized geology of Honopou hydrologic unit (Source: Sherrod et al., 2007; State of Hawaii, Office of Planning, 2006a, and State of Hawaii, Commission on Water Resource Management, 2008c).

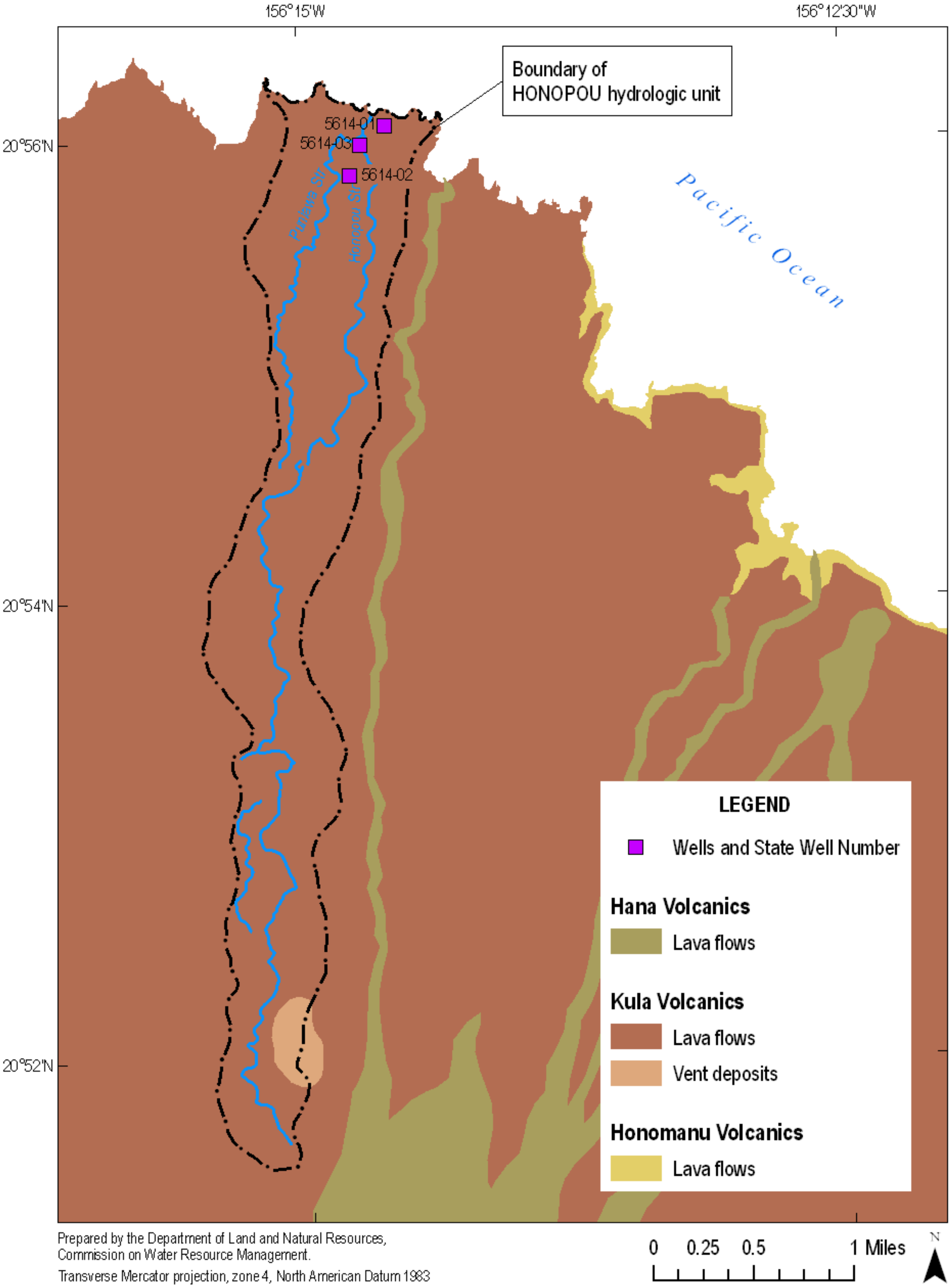


Figure 2-3. Soil classification in Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 2007c).

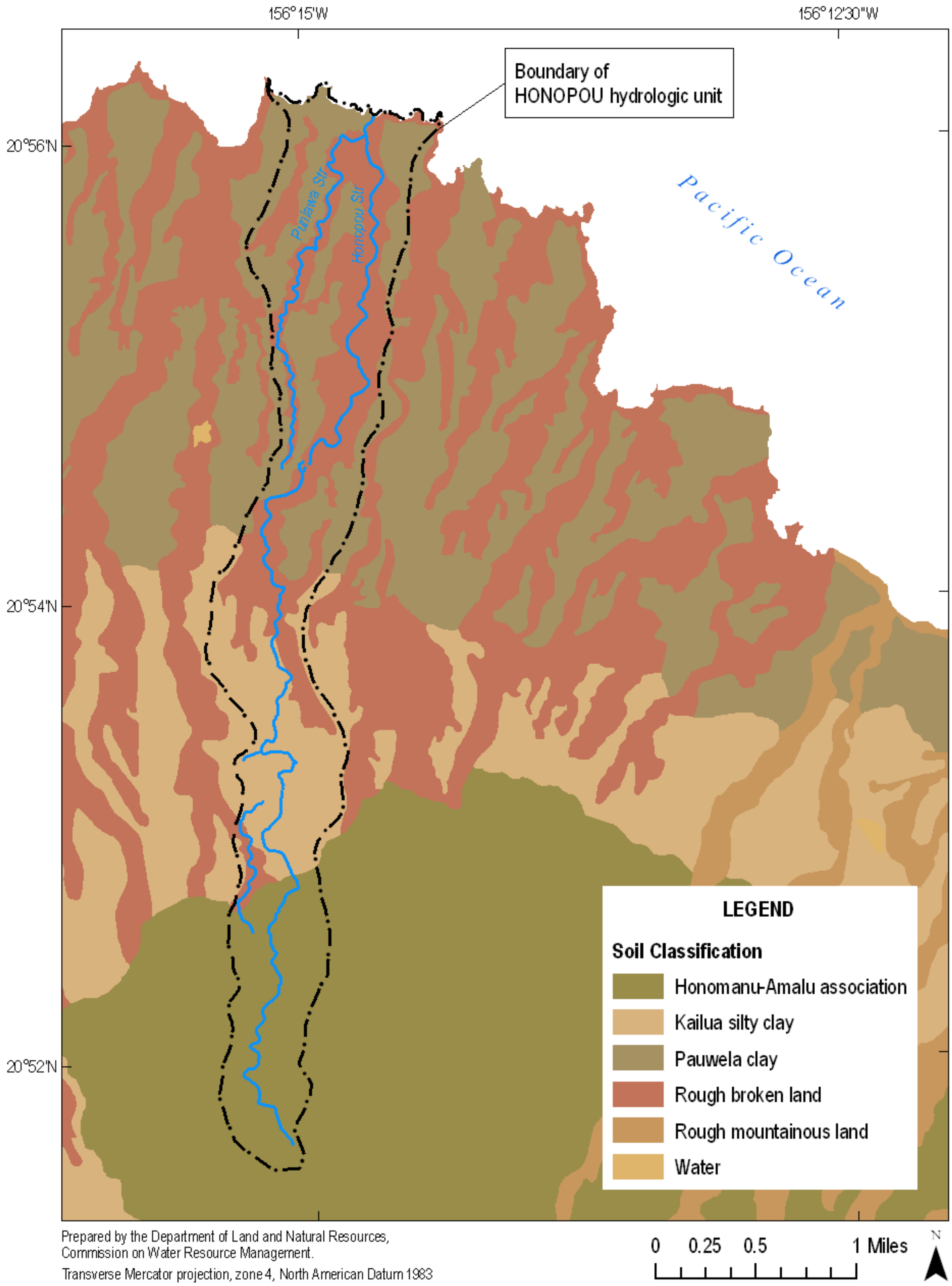


Figure 2-4. Mean annual rainfall and fog area in Honopou; and solar radiation for Honopou and the island of Maui, Hawaii (Source: Giambelluca et al., 1986; State of Hawaii, Office of Planning, 2006b; 2006c).

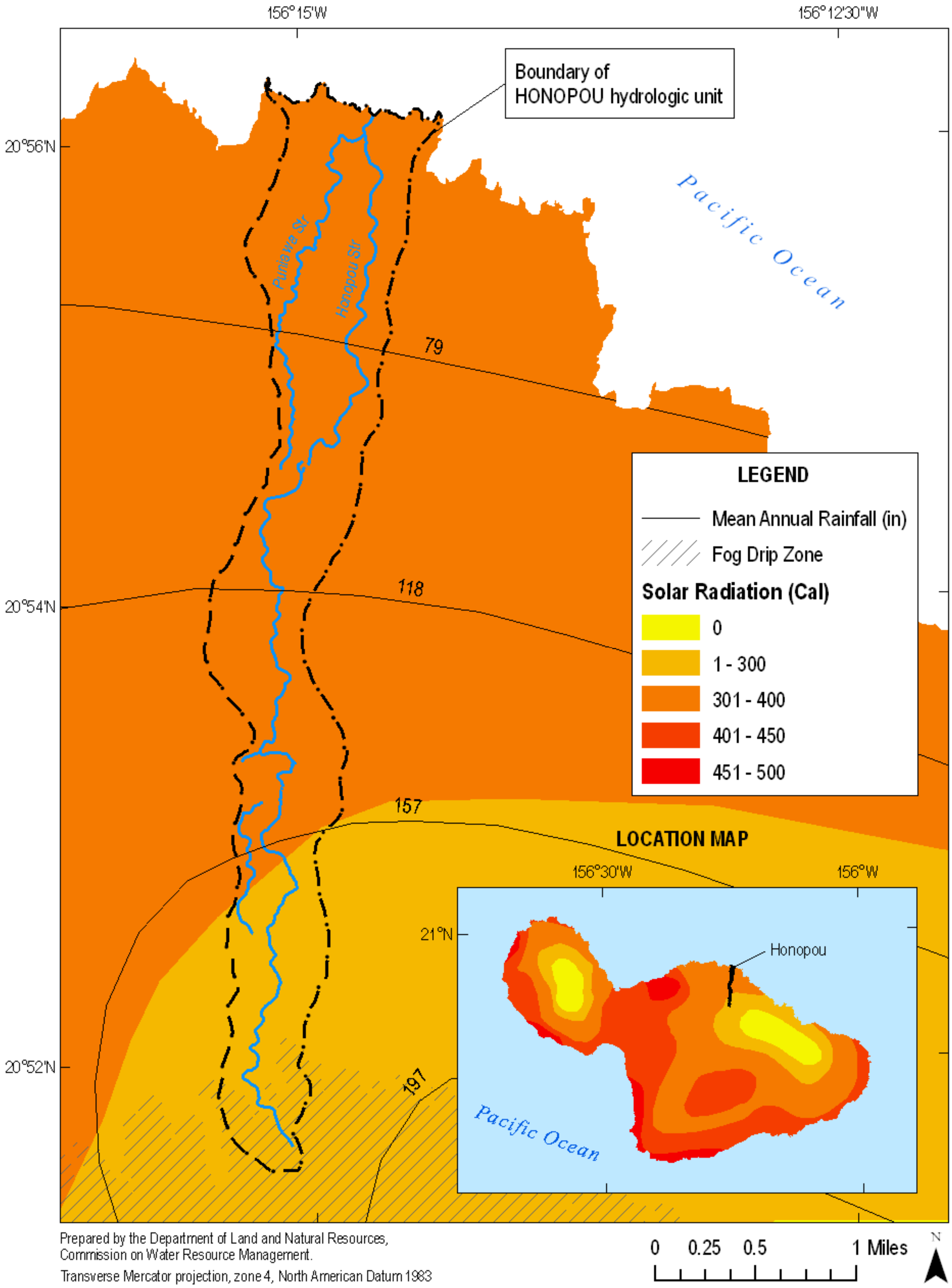


Figure 2-5. State land use district boundaries in Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 2006d).

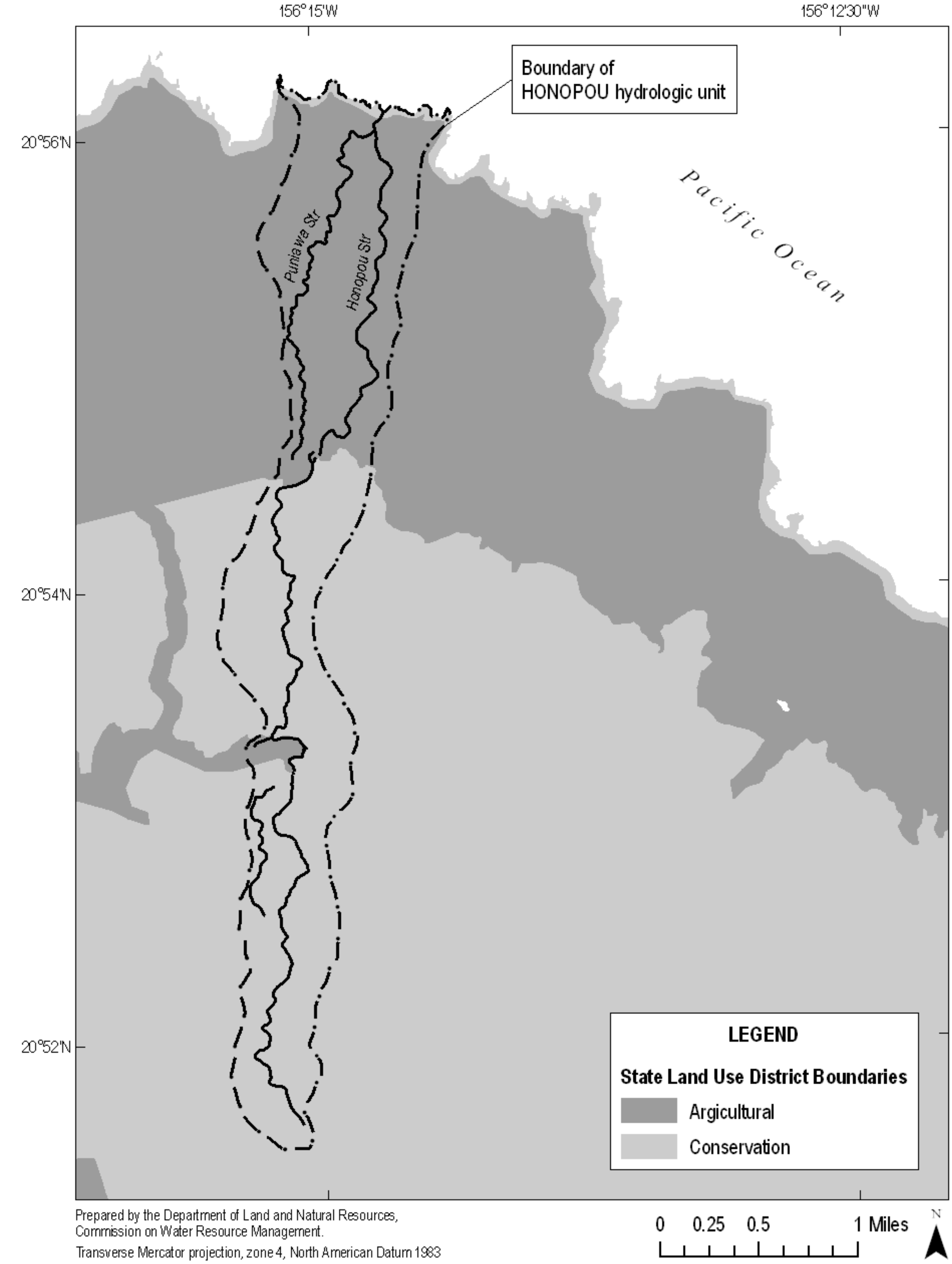


Figure 2-6. C-CAP land cover in Honopou hydrologic unit (Source: National Oceanic and Atmospheric Administration, Coastal Services Center, 2000).

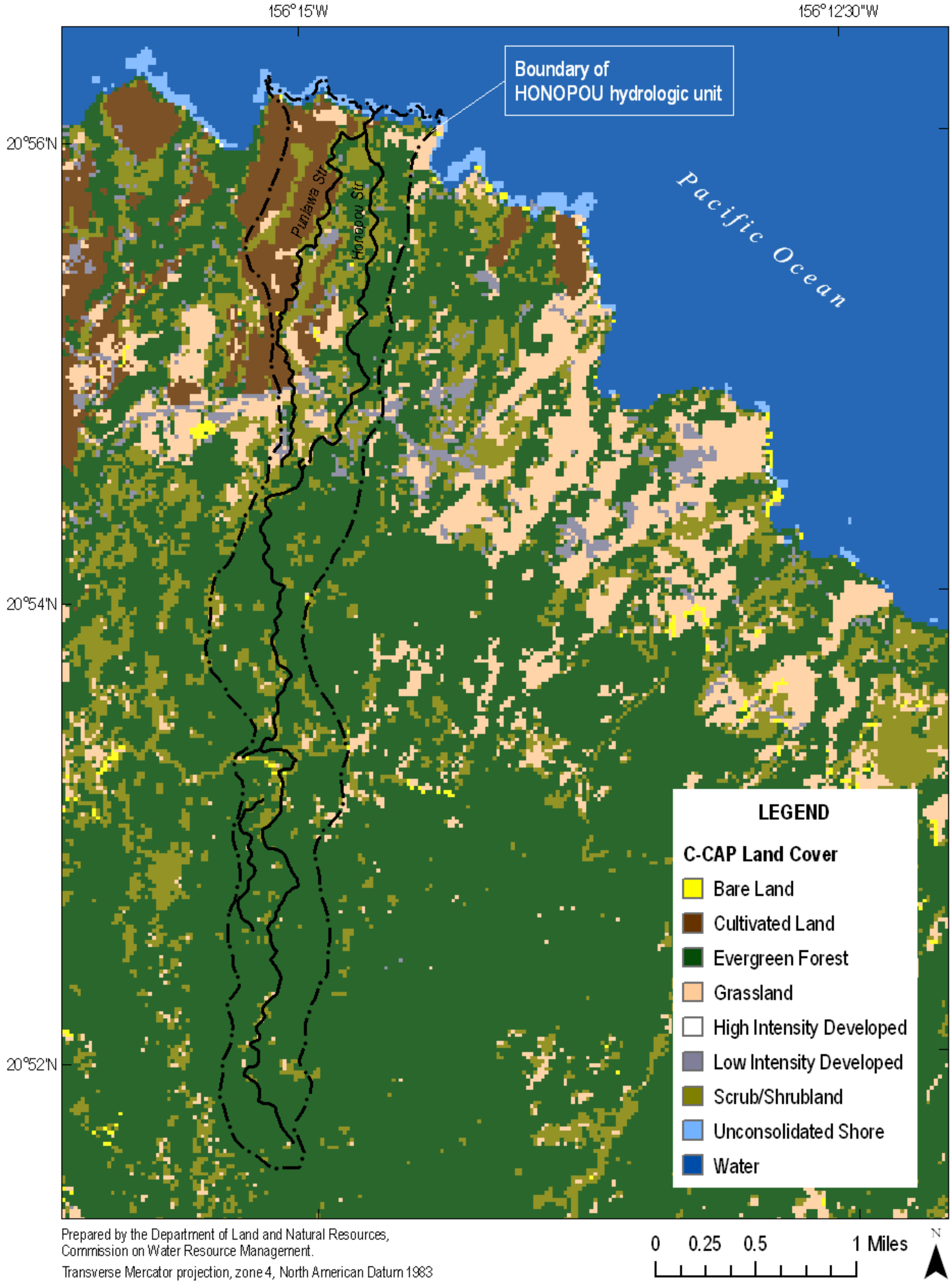


Figure 2-7. Hawaii GAP land cover classes in Honopou hydrologic unit (Source: Hawaii GAP Analysis Program, 2005).

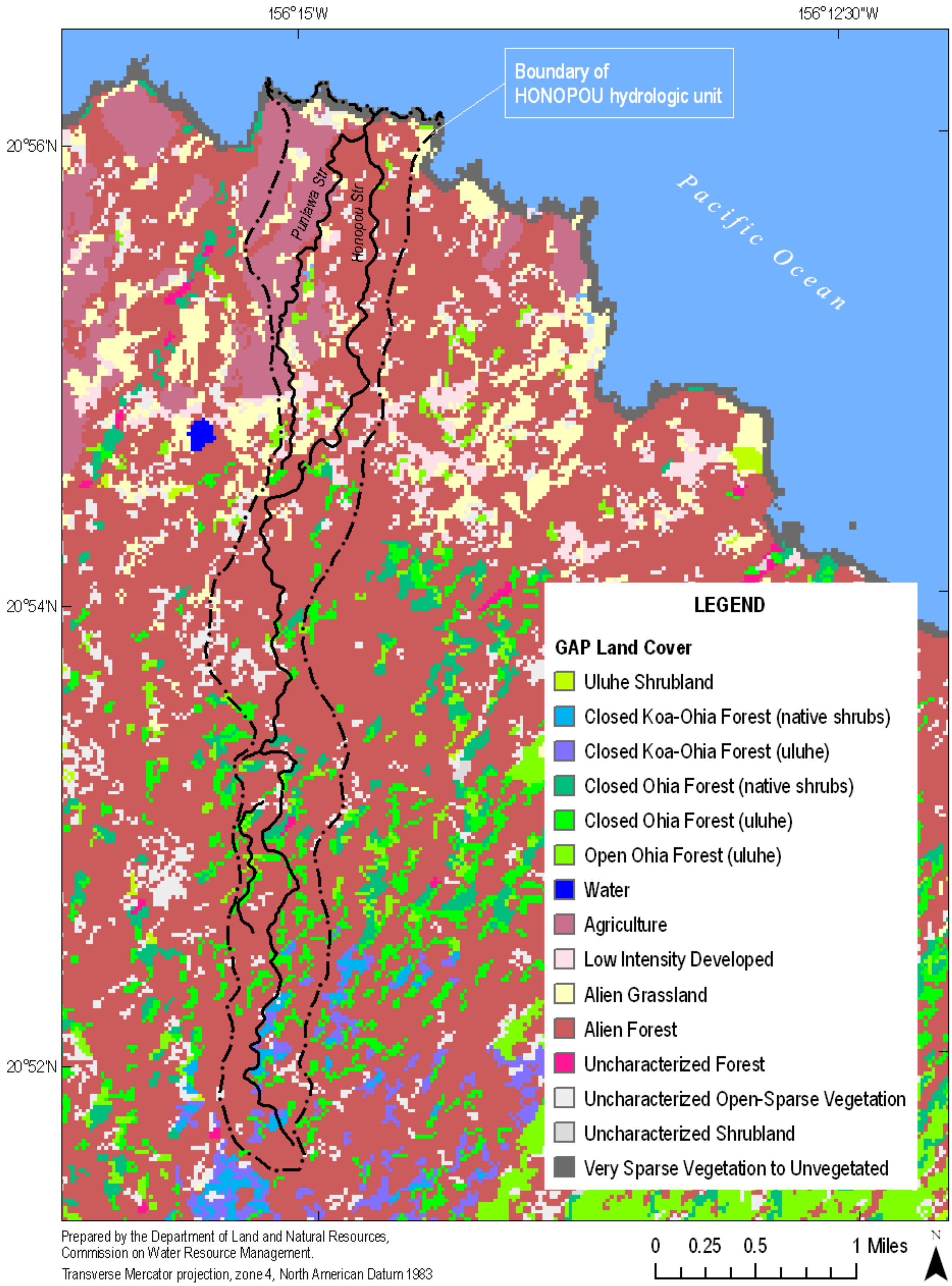
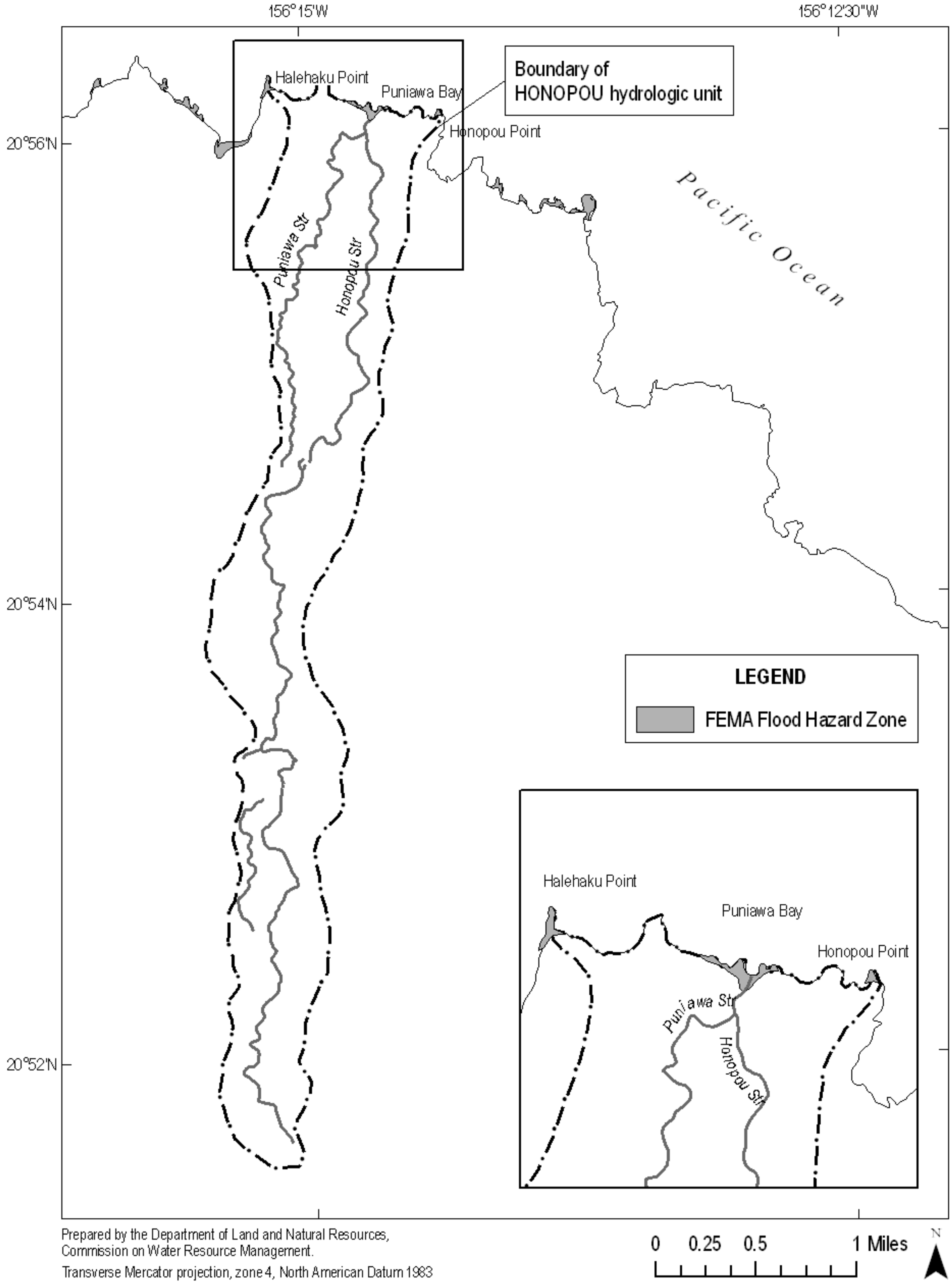


Figure 2-8. FEMA flood hazard zones in Honopou hydrologic unit (Source: Federal Emergency Management Agency, 2003).



3.0 Hydrology

The Commission, under the State Water Code, is tasked with establishing instream flow standards by weighing "the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses." While the Code outlines the instream and offstream uses to be weighed, it assumes that hydrological conditions will also be weighed as part of this equation. The complexity lies in the variability of local surface water conditions that are dependent upon a wide range of factors, including rainfall, geology, and human impacts, as well as the availability of such information. The following is a summary of general hydrology and specific hydrologic characteristics for Honopou Stream.

Streams in Hawaii

Streamflow consists of: 1) direct surface runoff in the form of overland flow and subsurface flow that rapidly returns infiltrated water to the stream; 2) ground water discharge in the form of base flow; 3) water returned from streambank storage; 4) rain that falls directly on streams; and 5) additional water, including excess irrigation water discharged into streams by humans (Oki, 2003). The amount of runoff and ground water that contribute to total streamflow is dependent on the different components of the hydrologic cycle, as well as man-made structures such as diversions and other stream channel alterations (e.g. channelizations and dams).

Streams in Hawaii can either gain or lose water at different locations depending on the geohydrologic conditions. A stream gains water when the ground water table is above the streambed. When the water table is below the streambed, the stream can lose water. Where the streambed is lined with concrete or other low-permeability or impermeable material, interaction between surface water and ground water is unlikely. Another way that ground water influences streamflow is through springs. A spring is formed when a geologic structure (e.g., fault or fracture) or a topographic feature (e.g., side of a hill or a valley) intersects ground water either at or below the water table. It can discharge ground water onto the land surface, directly into the stream, or into the ocean. Figure 3-1 illustrates a valley that has been incised into a high-level water table, resulting in ground water discharges that contribute directly to streamflow and springs that contribute to streamflow. At places where erosion has removed the caprock, ground water discharges either as springs or into the ocean as seeps.

Ground Water

Ground water is an important component of streamflow as it constitutes the base flow[8] of Hawaiian streams. When ground water is withdrawn from a well, the water level in the surrounding area is lowered. Nearby wetlands or ponds may shrink or even dry up if the pumping rate is sufficiently high (Gingerich and Oki, 2000). The long-term effects of ground water withdrawal can include the reduction of streamflow, which may cause a decrease in stream habitats for native species and a reduction in the amount of water available for irrigation. The interaction between surface water and ground water warrants a close look at the ground water recharge and demand within the State as well as the individual hydrologic units.

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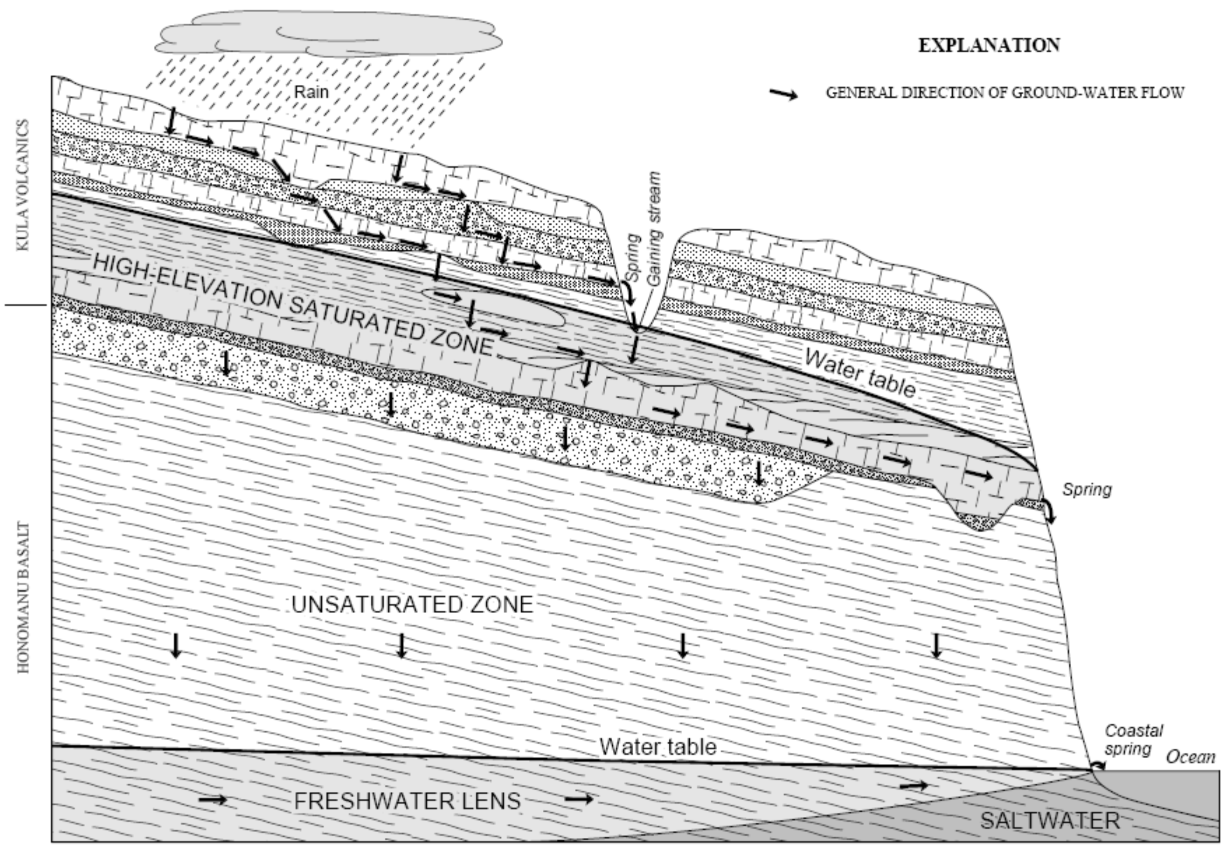
[8] Base flow is the water that enters a stream from persistent, slowly varying sources (such as the seepage of ground water), and maintains stream flow between water-input events (i.e., it is the flow that remains in a stream in times of little or no rainfall).

In Hawaii, ground water is replenished by recharge from rainfall, fog drip, and irrigation water that percolate through the plant root zone to the subsurface rock. Recharge can be captured in three major fresh ground water systems: 1) fresh water-lens system; 2) dike-impounded system; and 3) perched system. The fresh water-lens system provides the most important sources of ground water. It includes a lens-shaped layer of fresh water, an intermediate transition zone of brackish water, and underlying salt water. In northeast Maui, a vertically extensive fresh water-lens system can extend several hundreds or even thousands of feet below mean sea level. A dike-impounded system is found in rift zones and caldera of a volcano where low-permeability dikes compartmentalize areas of permeable volcanic rocks, forming high-level water bodies. On Maui, dikes impound water to as high as 3,300 feet above mean sea level. A perched system is found in areas where low-permeability rocks impede the downward movement of percolated water sufficiently to allow a water body to form in the unsaturated zone above the lowest water table (Gingerich and Oki, 2000).

Figure 3-1. Diagram illustrating the ground water system west of Keanae Valley, northeast Maui, Hawaii. Arrows indicate general direction of ground water flow (Source: Gingerich, 1999b).



The hydrologic unit of Honopou lies within the Honopou aquifer system that has an area of 17.8 square miles. A general overview of the ground water occurrence and movement in this area is described in Gingerich (1999b) and illustrated in Figure 3-1. Ground water is found at high elevations in the Kula Volcanics as well as a fresh water-lens system in the underlying Honomanu Basalt. A thick layer of unsaturated zone separates the high-elevation water body and the fresh water lens. The high-elevation saturated zone is not present near the coast because erosion has removed the low-permeability layers formed by the Kula Volcanics. Withdrawal from wells at or below sea level should not affect the high-elevation water table because the thick unsaturated zone will prevent any significant changes in the vertical flow gradient. However, wells that remove water from the high-elevation water body can reduce streamflow and recharge into the fresh water lens. Three production wells (well numbers 5614-01, 5614-02, and 5614-03) situated in Honopou tap into the aquifer for domestic use and irrigation (Figure 3-2). Detailed information for each well is specified in Table 3-1. Wells drilled after January 2008 may not be included in the table or the figure. As of July 2005, the ground water demand of the Honopou aquifer system is only 0.012 million gallons per day, which is well below the aquifer's current sustainable yield of 29 million gallons per day (State of Hawaii, Commission on Water Resource Management, 2007). Estimated total ground water recharge without accounting for fog drip contribution is 36 million gallons per day, which represents 30 percent of total rainfall (Shade, 1999).

Ground water use information is only available by island. Among the major Hawaiian islands, Maui has the second highest number of production wells following Oahu. Of the 450 productions wells in Maui, 259 are low-capacity wells with a pumping rate of less than 25 gallons per minute. Assuming all the low-capacity production wells in Maui are pumping at 1,700 gallons per day, the island-wide withdrawal rate would be 0.44 million gallons per day. The cumulative impacts of small, domestic wells become particularly important when assessing areas where municipal water is unavailable (State of Hawaii, Commission on Water Resource Management, 2007). A majority of the reported ground water use in Maui is for agriculture (53 percent) and irrigation (34 percent) (Table 3-2).

Table 3-1. Information of wells located in Honopou hydrologic unit (Source: State of Hawaii, Commission on Water Resource Management, 2008d).

[Negative elevation values indicate feet below mean sea level; positive elevation values indicate feet above mean sea level. Pump rate measured in gallons per minute (gpm); -- indicates value is unknown.]

Well number	Well Name	Year drilled	Use	Ground elevation (feet)	Well depth (feet)	Pump elevation (feet)	Pump depth (feet)	Pump rate (gpm)
5614-01	Honopou-Young	1999	Irrigation	50	130	-30	80	2
5614-02	Honopou-Bathelt	--	Domestic	--	20	--	--	--
5614-03	Honopou-Bathelt	2002	Domestic	58	76	-2	60	16

Table 3-2. Summary of ground water use reporting in the island of Maui (Source: State of Hawaii, Commission on Water Resource Management, 2007).

[Agriculture category includes water use for crops, livestock, and nursery plants; irrigation category includes water use for golf courses, landscape features, and other infrastructures. Mgd is million gallons per day.]

Use Category	Use Rate (mgd)	Percent of Total (%)
Agriculture	48.134	53.7
Domestic	0.001	0
Industrial	1.683	1.9
Irrigation	9.611	10.7
Military	0	0
Municipal	30.172	33.7
Total	89.601	100

Streamflow Characteristics

One of the most common statistics used to characterize streamflow is the median value of flow in a particular time period. This statistic is also referred to as the flow at 50 percent exceedence probability, or the flow that is equaled or exceeded 50 percent of the time (TFQ_{50}). The longer the time period that is used to determine the median flow value, the more representative the value is of the average flow conditions in the stream. Median flow is typically lower than the mean or average flow because of the bias in higher flows, especially during floods, present when calculating the mean flow. The flow at the 90 percent exceedence probability (TFQ_{90}) is commonly used to characterize low flows in a stream. In Hawaii, the base flow is usually exceeded less than 90 percent of the time, and in many cases less than 70 percent of the time (Oki, 2003).

Four U.S. Geological Survey (USGS) continuous-record stream gaging stations, one of which (station 16587000) is still taking active measurements, are located along Honopou Stream (Figure 3-3): 1) station 16595000 is located at 383 feet elevation, below the Haiku Ditch; 2) station 16593000 is at 441 feet elevation, above the Haiku Ditch; 3) station 16591000 is at 557 feet, at the Lowrie Ditch; and 4) station 16587000 is at 1,208 feet, near the Wailoa (Koolau) Ditch. According to Gingerich (1999b, Plate 1), Honopou Stream has never been dry at any of the four stream gaging stations. It is gaining flow from ground water upstream of station 16595000. Base flow estimates from long-term streamflow records indicate that the average annual gains from ground water are 2.3 million gallons per day upstream of station 16595000 with 50 percent originating upstream of station 16587000 (Gingerich, 1999b). Three active diversion systems, Haiku Ditch at 440 feet, Lowrie Ditch at 580 feet, and Wailoa (Koolau) Ditch at 1,200 feet capture base flow between the stations (Gingerich, 1999b).

Tables 3-3 through 3-6 contain information on the location and flow-duration characteristics of each gaging station. Based on the available streamflow data, the median flows (TFQ_{50}) at stations 16595000, 16593000, 16591000, and 16587000 are 1.2, 0.68, 0.22, and 2.4 cubic feet per second, respectively. Even though Honopou is mostly a gaining stream, the median flow decreased by 50 percent, from 2.4 cubic feet per second measured at the uppermost gaging station (16587000) to 1.2 cubic feet per second at the lowest station (16595000). This may be attributed to water being diverted at the three major diversion systems (i.e., Haiku Ditch, Lowrie Ditch, and Wailoa [Koolau] Ditch) and various other minor diversions along the stream. Base flows (TFQ_{90}-TFQ_{70}) at the gaging stations range from 0.51-0.87, 0.36-0.50, 0.14-0.19, and 0.72-1.4 cubic feet per second, respectively.

Table 3-3. General information and flow-duration characteristics of USGS stream gaging station at Honopou Stream below Haiku Ditch near Huelo, Maui (station 16595000).

Station number:	16595000		
Station name:	HONOPOU STREAM BELOW HAIKU DITCH NEAR HUELO, MAUI, HI		
Flow diverted or regulated?:	Y	Altitude (feet):	383.41
Latitude (decimal degrees):	20.91567570	Altitude accuracy (feet):	not available
Longitude (decimal degrees):	-156.24552074	Basin area (square miles):	2.3
Latitude/Longitude accuracy:	unknown	Period of record:	1907,1932-1947
Horizontal datum:	nad83	Complete water years:	1933-1946
Minimum daily mean discharge during period of record:		**Maximum daily mean discharge during period of record:**	
Discharge, cubic feet per second:	0.03	Discharge, cubic feet per second:	524
Number of occurrences:	3	Number of occurrences:	1
Most recent occurrence:	08/10/1945	Most recent occurrence:	12/21/1946

Flow-duration characteristics based on complete water years during period of record (14 complete years)												
Percentage of time discharge equaled or exceeded	Mean	50	55	60	65	70	75	80	85	90	95	99
Discharge, in cubic feet per second	7.8	1.2	1.1	1.0	0.96	0.87	0.87	0.71	0.63	0.51	0.45	0.12

Table 3-4. General information and flow-duration characteristics of USGS stream gaging station at Honopou Stream above Haiku Ditch near Huelo, Maui (station 16593000).

Station number:	16593000		
Station name:	HONOPOU STREAM ABOVE HAIKU DITCH NR HUELO, MAUI, HI		
Flow diverted or regulated?:	Y	Altitude (feet):	440.76
Latitude (decimal degrees):	20.91289836	Altitude accuracy (feet):	not available
Longitude (decimal degrees):	-156.24746514	Basin area (square miles):	2.3
Latitude/Longitude accuracy:	unknown	Period of record:	1907,1932-1947
Horizontal datum:	nad83	Complete water years:	1933-1946
Minimum daily mean discharge during period of record:		**Maximum daily mean discharge during period of record:**	
Discharge, cubic feet per second:	0.14	Discharge, cubic feet per second:	181
Number of occurrences:	1	Number of occurrences:	1
Most recent occurrence:	01/09/1934	Most recent occurrence:	10/23/1941

Flow-duration characteristics based on complete water years during period of record (14 complete years)

Percentage of time discharge equaled or exceeded	Mean	50	55	60	65	70	75	80	85	90	95	99
Discharge, in cubic feet per second	2.4	0.68	0.62	0.57	0.56	0.50	0.46	0.45	0.40	0.36	0.26	0.17

Table 3-5. General information and flow-duration characteristics of USGS stream gaging station at Honopou Stream at Lowrie Ditch near Huelo, Maui (station 16591000).

Station number:	16591000		
Station name:	HONOPOU STREAM AT LOWRIE DITCH SIPHON NEAR HUELO, MAUI, HI		
Flow diverted or regulated?:	Y	Altitude (feet):	556.95
Latitude (decimal degrees):	20.91067649	Altitude accuracy (feet):	not available
Longitude (decimal degrees):	-156.24996506	Basin area (square miles):	2
Latitude/Longitude accuracy:	unknown	Period of record:	1932-1947
Horizontal datum:	nad83	Complete water years:	1933-1946
Minimum daily mean discharge during period of record:		**Maximum daily mean discharge during period of record:**	
Discharge, cubic feet per second:	0.05	Discharge, cubic feet per second:	339
Number of occurrences:	1	Number of occurrences:	1
Most recent occurrence:	12/07/1940	Most recent occurrence:	12/21/1946

Flow-duration characteristics based on complete water years during period of record (14 complete years)

Percentage of time discharge equaled or exceeded	Mean	50	55	60	65	70	75	80	85	90	95	99
Discharge, in cubic feet per second	2.0	0.22	0.22	0.20	0.19	0.19	0.17	0.15	0.15	0.14	0.11	0.09

Table 3-6. General information and flow-duration characteristics of USGS stream gaging station at Honopou Stream near Huelo, Maui (station 16587000).

Station number:	16587000		
Station name:	HONOPOU STREAM NEAR HUELO, MAUI, HI		
Flow diverted or regulated?:	N	Altitude (feet):	1208
Latitude (decimal degrees):	20.88567925	Altitude accuracy (feet):	1
Longitude (decimal degrees):	-156.25274314	Basin area (square miles):	0.64
Latitude/Longitude accuracy:	1 second	Period of record:	1911-2005
Horizontal datum:	nad83	Complete water years:	1912-2005
Minimum daily mean discharge during period of record:		**Maximum daily mean discharge during period of record:**	
Discharge, cubic feet per second:	0.11	Discharge, cubic feet per second:	305
Number of occurrences:	9	Number of occurrences:	1
Most recent occurrence:	11/18/1984	Most recent occurrence:	04/07/1989

Flow-duration characteristics based on complete water years during period of record (94 complete years)

Percentage of time discharge equaled or exceeded	Mean	50	55	60	65	70	75	80	85	90	95	99
Discharge, in cubic feet per second	4.8	2.4	2.1	1.9	1.6	1.4	1.2	1.1	0.87	0.72	0.54	0.31

A summary of the natural (undiverted) and diverted median flows at each gaging station is presented in Table 3-7. The natural flows are consistent with the nature of a gaining stream in which the site nearest to the outlet of the drainage basin (station 16595000) has the highest flow at 1.42 million gallons per day according to the 1946 data. Effects of diversions can be assessed by comparing the median flows under natural conditions and those under diverted conditions. Diversion at Wailoa (Koolau) Ditch reduced flows at station 16591000 by at least 67 percent according to the 1933 data. At station 16593000, the diversion at Lowrie Ditch reduced flows by at least 60 percent. The diversion at the Haiku Ditch decreased flows at station 16595000 by as much as 56 percent according to the 1946 data.

Table 3-7. Natural (undiverted) and diverted streamflow in Honopou Stream (Source: Gingerich, 1999b).

[mgd is million gallons per day; ft is feet; 1933 data from Grover and Carson (1936); 1946 data from Paulsen (1950), both as cited in Gingerich, 1999b]

Station number	Stream name	Altitude (ft)	Date	Diverted Streamflow (mgd)	Natural Streamflow (mgd)	Comments
16595000	Honopou	383	10/21/33 7/5/46	0.29 0.67	0.54 1.42	Daily mean
16593000	Honopou	441	10/21/33 7/5/46	0.10 0.20	0.25 0.75	Daily mean; upstream of Haiku Ditch diversion
16591000	Honopou	557	10/21/33 7/5/46	0.05 0.10	0.15 0.55	Daily mean; upstream of Lowrie Ditch diversion
16587000	Honopou	1,208	10/21/33 7/5/46	0.10 0.45	0.10 0.45	Daily mean; upstream of Wailoa Ditch diversion

In cooperation with the Commission on Water Resource Management, the USGS conducted a study (Gingerich, 2005) to assist in determining reasonable and beneficial noninstream and instream uses of water in northeast Maui. The purpose of the study was to develop methods of estimating natural (undiverted) median streamflow, total flow statistics (TFQ), and base flow statistics (BFQ) at ungaged sites where observed data are unavailable. The study area lies between the drainage basins of Kolea Stream to the west and Makapipi Stream to the east. Basin characteristics and hydrologic data for the study area were collected and analyzed. One of the products of the study is a set of regression equations that can be used to estimate natural (undiverted) TFQ_{50}, BFQ_{50}, TFQ_{95}, and BFQ_{95} at gaged and ungaged sites. The subscripts indicate the percentage of time the flow, either total or base flow, is equaled or exceeded.

Although Honopou lies outside of the study area, the regression equations are all the information that is available to estimate natural streamflow at ungaged locations along the streams. The regression equations were applied at four selected ungaged sites; two in Honopou Stream and two in the tributary, Puniawa Stream (Figures 3-3, 3-4): 1) station HonoO is located near the outlet, 69 feet from the coast at 18 feet elevation; 2) station HonoM is in the middle reach of Honopou at 595 feet elevation; 3) station PuniL is in the lower reach of Puniawa at 28 feet elevation; and 4) station PuniM is in the middle reach of Puniawa at 240 feet elevation.

Characteristics for each ungaged drainage basin (Table 3-8) were estimated using Arc Hydro, an ArcGIS-based system for water resource application. The basin characteristics required for the regression equations include drainage area, rainfall rate, basin length, maximum elevation, and elongation ratio[9]. Since Honopou is outside of the study area, some of the basin characteristics fall outside the range of values used in developing the regression equations, including: 1) the maximum elevations for Honopou

[9] Elongation ratio is the ratio of: 1) the diameter of a circle of area equal to that of the basin to 2) the length of the basin.

and Puniawa are 7 percent and 76 percent below the range, respectively; 2) the elongation ratios for stations HonoM and PuniM are 6 percent and 15 percent higher than the range, respectively; and 3) the rainfall rates for the two ungaged sites in Puniawa are well below the range. Since a majority of the basin characteristics for Puniawa fall outside of the range, the estimated flow statistics may not be representative of the flow conditions in Puniawa Stream. In addition, the estimated flow statistics for Honopou Stream are probably high compared to the natural streamflow measured in 1933 and 1946 (Table 3-7), because of the limitations of the regression equations that tend to overestimate flow (See CPRC 38.0-1).

Table 3-8. Characteristics for the ungaged drainage basins of Honopou and Puniawa Streams.

[Sq mi is square miles; cfs is cubic feet per second; mi is miles; ft is feet; values in *italicized font* fall outside of the range of values used in developing the regression equations]

Stream location	Drainage Area (sq mi)	Rainfall Rate (cfs)	Basin Length (mi)	Maximum Elevation (ft)	Elongation Ratio (dimensionless)
Honopou outlet (HonoO)	2.47	22.08	5.7	*2,288*	0.31
Honopou middle (HonoM)	1.43	15.57	3.8	*2,288*	*0.36*
Puniawa lower (PuniL)	0.21	*1.24*	1.5	*604*	0.34
Puniawa middle (PuniM)	0.14	*0.82*	1.1	*604*	*0.39*

Estimated natural (undiverted) flow statistics for the ungaged sites are presented in Table 3-9 and Figure 3-4. The median flows (TFQ_{50}) at stations HonoO, HonoM, PuniL, and PuniM are 15.56, 8.56, 1.87, and 0.94 cubic feet per second, respectively. Since low-flow measurements are unavailable, none of the base flow estimates were adjusted. For the purpose of approximating the relative errors associated with applying the regression equations outside of the study area, the equations were used to estimate flow statistics at gaged sites in Honopou Stream where actual measurements are available. Base flow estimates from long-term streamflow records indicate average ground water gains of 2.3 million gallons per day (3.56 cubic feet per second) at station 16959000, of which 50 percent (1.78 cubic feet per second) originates upstream of station 16587000 (Gingerich, 1999b). Comparison of the measured values with the estimated flow statistics suggests that the regression equations overestimated base flow by 138 percent at the downstream gage, and underestimated base flow by 6 percent at the upstream gage. Based on this analysis, the flow statistics calculated at the ungaged sites (i.e., HonoO, HonoM, PuniL, and PuniM) could be subject to relative errors as high as 138 percent. Gingerich (2005) found relative errors as high as 110 percent when the equations were applied outside of the study area. The difference in geology between the study area and the Honopou hydrologic unit could account for the large errors.

Table 3-9. Flow statistics estimate using regression equation for ungaged basins of Honopou and Puniawa.

[Flows are in cubic feet per second (cfs)]

Stream location	TFQ_{50}	BFQ_{50}	TFQ_{95}	BFQ_{95}	Source of estimate
Honopou outlet (HonoO)	15.59	12.63	7.21	7.75	Regression equation
Honopou middle (HonoM)	8.56	6.51	4.30	4.40	Regression equation
Puniawa lower (PuniL)	1.87	1.45	1.05	1.12	Regression equation
Puniawa middle (PuniM)	0.94	0.67	0.57	0.58	Regression equation

Mathematical models and equations are commonly used to represent hydrologic occurrences in the real world; however, they are typically based on a set of assumptions that oftentimes render their estimates questionable in terms of accuracy and precision. This does not mean the public should entirely discount the estimates produced by these mathematical tools because they do provide quantitative and qualitative relative comparisons that are useful when making management decisions. Objections have been raised by several agencies in regards to the use of regression equations to estimate flow statistics. While the estimated statistics are presented to fulfill the purpose of compiling the best available information that will be considered in determining the interim IFS recommendations, the Commission staff does not intend to rely exclusively on the regression equations to make such important management decisions. The limitations and potential errors of the regression equations must also be considered.

One of the limitations of the regression equations is that they do not account for variable subsurface geology, such as those of intermittent streams and where springs discharge high flow to streams. The equations may overestimate flow statistics in intermittent streams as they do not account for losing reaches. On the other hand, the equations may underestimate the additional streamflow gained from springs. The equations tend to predict more accurately the higher flow statistics, TFQ_{50} and BFQ_{50}, rather than the lower flow statistics, TFQ_{95} and BFQ_{95}. The relative errors between observed and estimated flows ranged from 11 to 20 percent for TFQ_{50} and from 29 to 56 percent for TFQ_{95} and BFQ_{95}. According to Gingerich (2005), the most reliable estimates of natural and diverted streamflow duration statistics at gaged and ungaged sites in the study area were made using a combination of continuous-record gaging station data, low-flow measurements, and values determined from the regression equations. The study found that the average reduction in the low flow of streams due to diversions ranges from 55 to 60 percent.

Long-Term Trends in Streamflow

In a different study, the USGS examined the long-term trends and variations in streamflow on the islands of Hawaii, Maui, Molokai, Oahu, and Kauai, where long-term stream gaging stations exist (Oki, 2004). The study analyzed both total flow and estimated base flow at 16 long-term gaging stations, one of which is located in Honopou Stream near the Wailoa (Koolau) Ditch (station 16587000). See Figure 3-3 for the location of the gaging station. For the 90-year period 1913-2002, monthly mean base flows generally followed an increasing trend above the long-term average from 1913 to early 1940s, and a decreasing trend after the early 1940s to 2002 (Figure 3-5). Monthly mean total flows follow a similar pattern with the exception that the monthly mean total flow increased from mid-1980s to mid-1990s, and decreased from mid-1990s to 2002. Downward trends in the annual total low flow percentiles, TFQ_{75} and TFQ_{90}, were statistically significant at the 5 percent level of significance. This is consistent with the annual base flow percentiles (Oki, 2004).

According to analyses conducted on the remainder of the stream gaging stations, low flows generally decreased from 1913 to 2002, which is consistent with the long-term downward trends in rainfall observed throughout the islands during that period. Monthly mean base flows decreased from the early 1940s to 2002, which is consistent with the measured downward trend of low flows from 1913 to 2002. This long-term downward trend in base flow may imply a reduction of ground water contribution to streams. Changing streamflow characteristics could pose a negative effect on the availability of drinking water for human consumption and habitat for native stream fauna (Oki, 2004).

Figure 3-2. Aquifer system area and well locations in Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 2006b; State of Hawaii, Commission on Water Resource Management, 2008c).

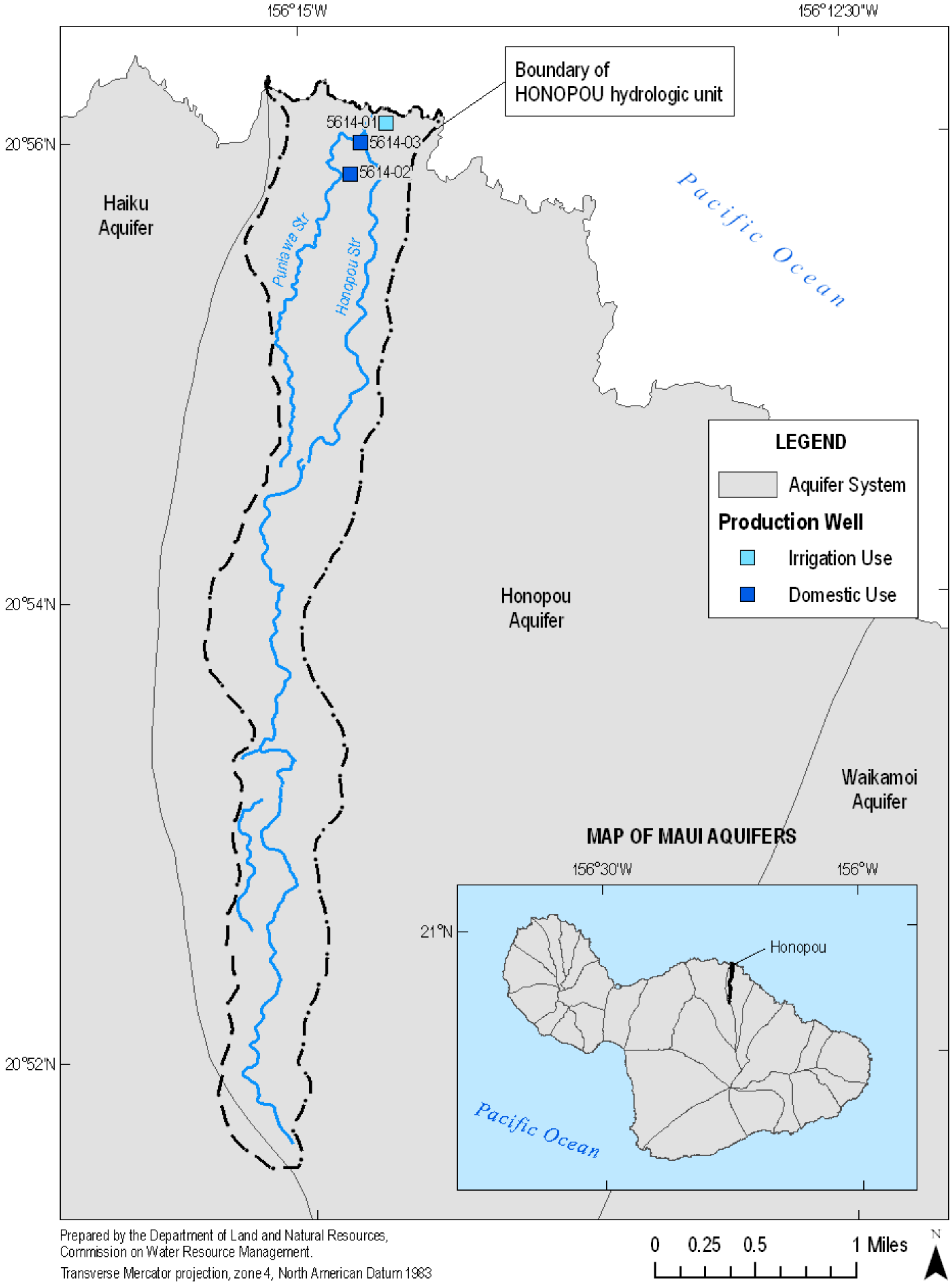
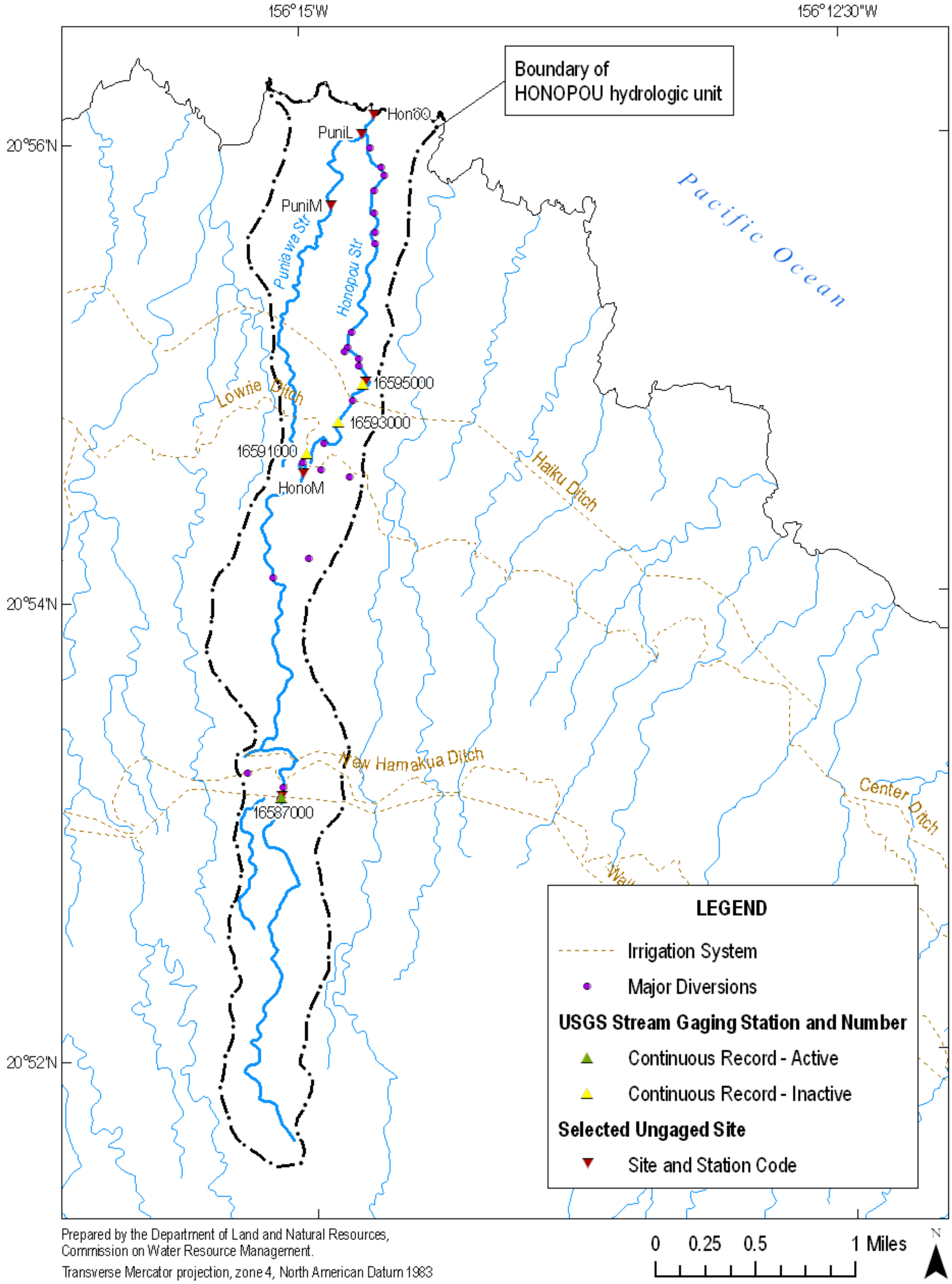


Figure 3-3. Location of diversions, irrigation systems, USGS gaging stations, and selected ungaged sites in Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, n.d.; 1996, 2004c; 2005).



Prepared by the Department of Land and Natural Resources, Commission on Water Resource Management.
Transverse Mercator projection, zone 4, North American Datum 1983

Figure 3-4. Flow statistics for selected ungaged drainage basins of Honopou and Puniawa.

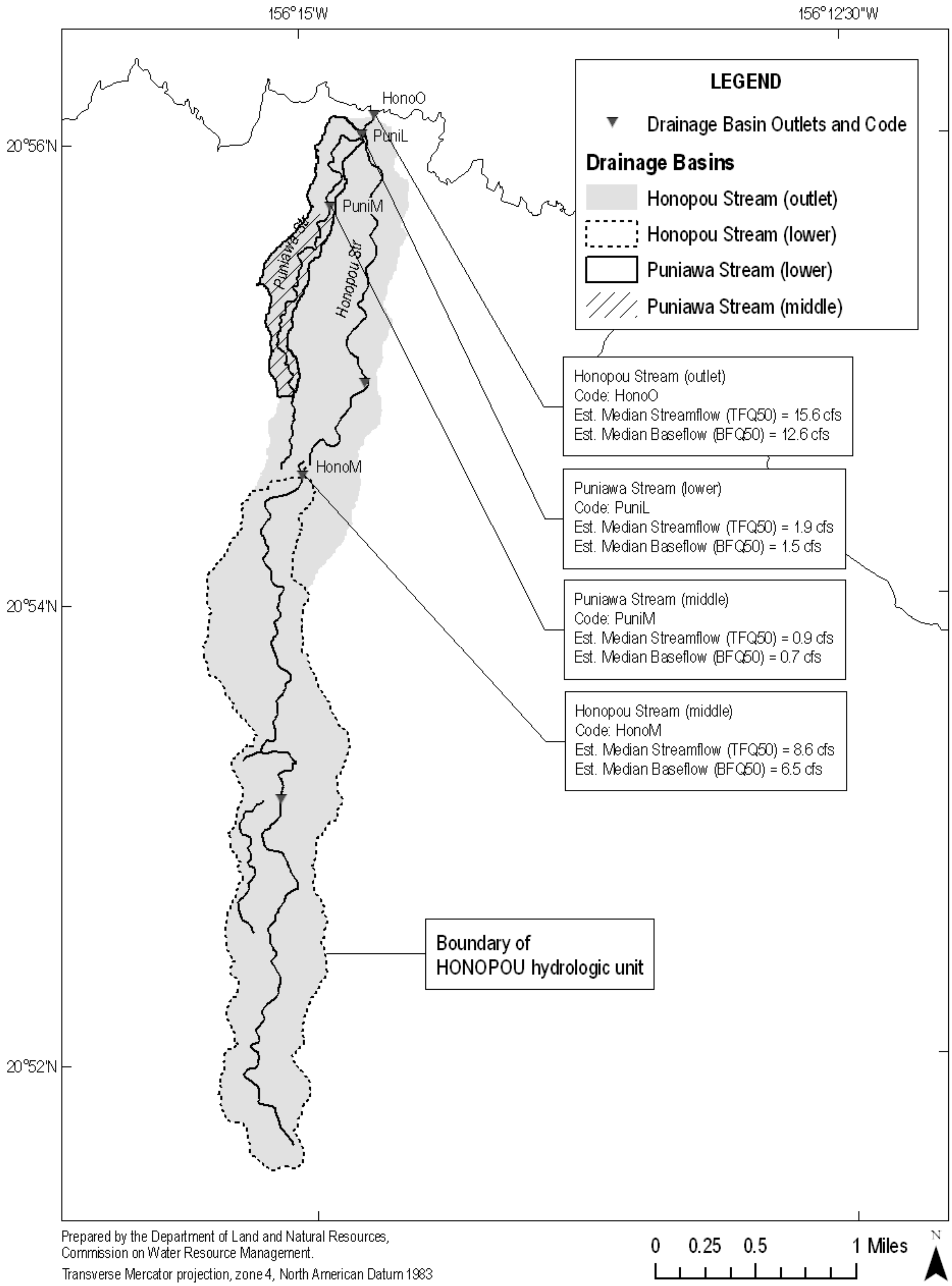
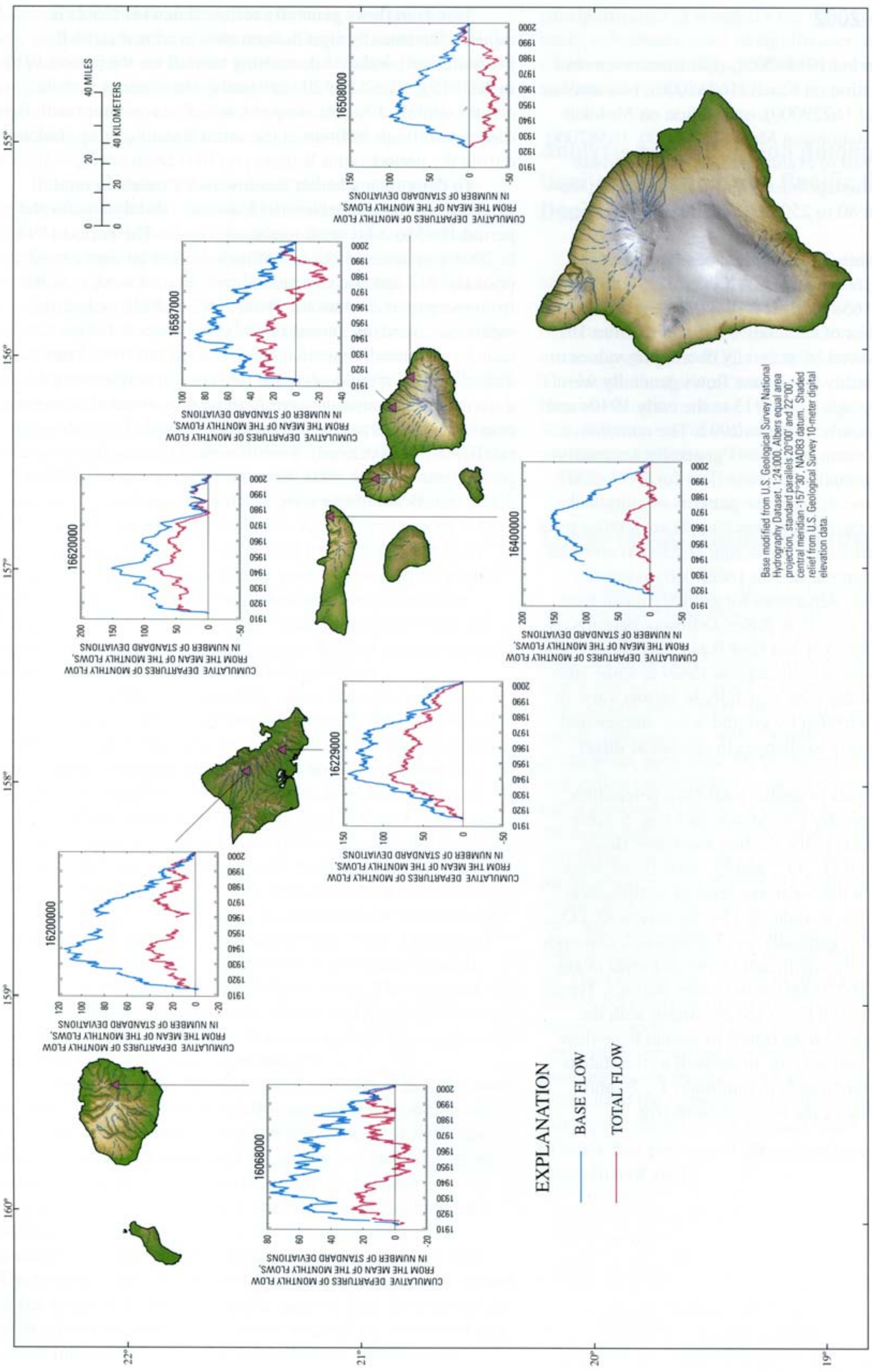


Figure 3-5. Cumulative departures of monthly mean flow from the mean of the monthly flows, Hawaii. This data is based on complete water years from 1913 through 2002. (Oki, 2004, Figure 4).



4.0 Maintenance of Fish and Wildlife Habitat

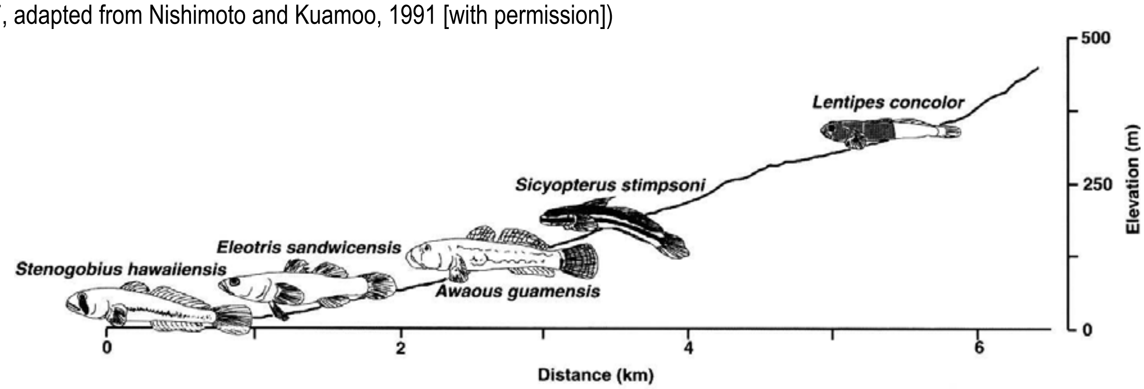
When people in Hawaii consider the protection of instream flows for the maintenance of fish habitat, their thoughts generally focus on just a handful of native species including five native fishes (four gobies and one eleotrid), two snails, one shrimp, and one prawn. Table 4-1 below identifies commonly mentioned native stream animals of Hawaii.

Table 4-1. List of commonly mentioned native stream organisms. (Source: State of Hawaii, Division of Aquatic Resources, 1993).

Scientific Name	Hawaiian Name	Type
Awaous guamensis	‘O‘opu nakea	Goby
Lentipes concolor	‘O‘opu hi‘ukole (alamo‘o)	Goby
Sicyopterus stimpsoni	‘O‘opu nopili	Goby
Stenogobius hawaiiensis	‘O‘opu naniha	Goby
Eleotris sandwicensis	‘O‘opu akupa (okuhe)	Eleotrid
Atyoida bisulcata	‘Opae kala‘ole	Shrimp
Macrobrachium grandimanus	‘Opae ‘oeha‘a	Prawn
Neritina granosa	Hihiwai	Snail
Neritina vespertina	Hapawai	Snail

Hawaii’s native stream animals have amphidromous life cycles (Ego, 1956) meaning that they spend their larval stages in the ocean (salt water), then return to fresh water streams to spend their adult stage and reproduce. Newly hatched fish larvae are carried downstream to the ocean where they become part of the planktonic pool in the open ocean. The larvae remain at sea from a few weeks to a few months, eventually migrating back into a fresh water stream as juvenile *hinana*, or postlarvae (Radtke et al., 1988). Once back in the stream, the distribution of the five native fish species are largely dictated by their climbing ability (Nishimoto and Kuamoo, 1991) along the stream’s longitudinal gradient. This ability to climb is made possible by a fused pelvic fin which forms a suction disk. *Eleotris sandwicensis* lacks fused pelvic fins and is mostly found in lower stream reaches. *Stenogobius hawaiiensis* has fused pelvic fins, but lacks the musculature necessary for climbing (Nishimoto and Kuamoo, 1997). *Awaous guamensis* and *Sicyopterus stimpsoni* are able to ascend moderately high waterfalls (less than ~20 meters) (Fitzsimons and Nishimoto, 1990), while *Lentipes concolor* has the greatest climbing ability and has been observed at elevations higher than 3,000 feet (Fitzsimons and Nishimoto, 1990) and above waterfalls more than 900 feet in vertical height (Englund and Filbert, 1997). Figure 4-1 illustrates the elevational profile of these native fresh water fishes.

Figure 4-1. Elevational profile of a terminal-estuary stream on the Big Island of Hawaii (Hakalau Stream). (Source: McRae, 2007, adapted from Nishimoto and Kuamoo, 1991 [with permission])



The maintenance, or restoration, of stream habitat requires an understanding of and the relationships among the various components that impact fish and wildlife habitat, and ultimately, the overall viability of a desired set of species. These components include, but are not limited to, species distribution and diversity, species abundance, predation and competition among native species, similar impacts by alien species, obstacles to migration, water quality, and streamflow. The Commission does not intend to delve into the biological complexities of Hawaiian streams, but rather to present basic evidence that conveys the general health of the subject stream. The biological aspects of Hawaii's streams have an extensive history, and there is a wealth of knowledge, which continues to grow and improve.

One of the earliest statewide stream assessments was undertaken by the Commission in cooperation with the National Park Service's Hawaii Cooperative Park Service Unit. The 1990 Hawaii Stream Assessment (HSA) brought together a wide range of stakeholders to research and evaluate numerous stream-related attributes (e.g., hydrology, diversions, gaging, channelizations, hydroelectric uses, special areas, etc.). The HSA specifically focused on the inventory and assessment of four resource categories: 1) aquatic; 2) riparian; 3) cultural; and 4) recreational. Though no fieldwork was conducted in its preparation, the HSA involved considerable research and analysis of existing studies and reports. The data were evaluated according to predefined criteria and each stream received one of five ranks (outstanding, substantial, moderate, limited, and unknown). Based on the stream rankings, the HSA offered six different approaches to identifying candidate streams for protection.

Due to the broad scope of the HSA inventory and assessment, it continues to provide a valuable information base for the Commission's Stream Protection and Management Program and will continue to be referred to in various sections throughout this report. Unfortunately, Honopou was not included as part of the inventory of aquatic resources, likely due to a lack of available research studies and reports.

The HSA inventory was general in nature, resulting in major data gaps, especially those related to the distribution and abundance of aquatic organisms – native and introduced – inhabiting the streams. The State of Hawaii Division of Aquatic Resources (DAR) has since continued to expand the knowledge of aquatic biota in Hawaiian streams. Products from their efforts include the compilation and publication of an *Atlas of Hawaiian Watersheds and Their Aquatic Resources* for each of five major islands in the state (Kauai, Hawaii, Oahu, Molokai, and Maui). Each atlas describes watershed and stream features, distribution and abundance of stream animals and insect species, and stream habitat use and availability. Based on these data, a watershed and biological rating is assigned to each stream to allow easy comparison with other streams on the same island and across the state. The data presented in the atlases are collected from various sources, and much of the stream biota data are from stream surveys conducted by DAR. Currently, efforts have been focused on updating the atlases with more recent stream survey data collected statewide, and developing up-to-date reports for Commission use in interim IFS recommendations for east Maui. A copy of the updated inventory report for Honopou Stream is in Appendix A. The following is a brief summary of findings.

- **Point Quadrat Survey.** Native species of fish (*Awaous guamensis*, *Eleotris sandwicensis*, *Lentipes concolor*, and *Sicyopterus stimpsoni*) and crustaceans (*Atyoida bisulcata* and *Macrobrachium grandimanus*) were observed in Honopou Stream and most of them were observed in deeper waters. Based on the survey data, *Lentipes concolor* was observed only in the upper reaches (upstream of Lowrie Ditch), while *Atyoida bisulcata* were seen in the lower (0.2 miles from shore) and upper reaches. *Sicyopterus stimpsoni* were observed in the middle reaches (downstream of Lowrie Ditch). Post larval recruitment of native fish was observed near the mouth of the stream. Diversions that fully dewater streams would likely restrict the upstream passage of larval and adult stream animals. Introduced species of fish, such as swordtails and guppies, were observed in the upper and middle reaches, respectively. These poeciliid fishes dwell in the deep pools created above diversion structures and are known to transmit parasites to native fishes.

- **Insect Survey.** Honopou Stream has degraded insect biota in the lower reaches that have been dewatered by diversions, while native-dominated insect biota are present in the upper reaches above the diversions. Two native dragonflies (*Anax strenuous* and *Pantala flavescens*) and one native damselfly (*Megalagrion pacificum*) were observed. The native damselfly is currently proposed for listing as Endangered under the federal Endangered Species Act. Streamflow restoration may increase insect biota diversity; however, steps must be taken to avoid the release of invasive species from ditch waters into the stream.

- **Analysis of Depth Use versus Availability.** Honopou Stream was mostly continuous excepting sections where diversions have dewatered the stream. The frequency of sampling at a shallow site (10 inches or less) was 23 percent higher than statewide. Depth of survey site decreased slightly with elevation, with an average site depth between 10 to 13 inches. Since Honopou is generally shallower than a typical Hawaiian stream, native adult animal habitat would likely be restricted. The low numbers of native animals observed suggest that large sections of the stream are currently not suitable habitat for native animals. Return of water into the stream would likely have a beneficial effect on the availability of suitable depths for native species in the currently shallow stream sections.

- **Watershed and Biological Rating.** Honopou watershed rates average for Maui and statewide. A combination of small watershed size, moderate rainfall amounts, and low species diversity contribute to the average rating of this watershed. Despite the rating, Honopou has the potential to sustain larger populations of native species than currently observed if flow is restored to the stream. When restoring flow from ditch waters, steps must be taken to prevent the introduction of invasive species (i.e., poeciliid fishes) from the ditch into the stream.

The ditch diversions in Honopou Stream block upstream migration of native amphidromous animals with the use of pipes. At high flows, stream diversions are overtopped and streamflow is continuous from the upper reaches to the sea. When flow returns to normal level, diversions could quickly remove water from the stream, leaving sections dry. This prevents the upstream migration of native stream animals, restricts surviving adult animals to the disconnected deep pools, and causes postlarvae recruits to be stranded at the stream mouth. The diversions also have significantly reduced baseflows in the stream, limiting overall habitat for native species. Restoration of streamflow and increased connectivity could lead to the development of a richer and more native-dominated community in the stream. The potential for introducing species from invasive-dominated terminal reaches to native-dominated mid- and headwater reaches is not a major problem in east Maui due to the presence of large waterfalls. However, care must be taken to not introduce invasive species via release of water from ditches. This could be accomplished through ditch bypasses.

Another important consideration of fish and wildlife habitat is the presence of critical habitat. Under the Endangered Species Act, the U.S. Fish and Wildlife Service is responsible for designating critical habitat for threatened and endangered species. Though there are very few threatened or endangered Hawaiian species that are directly impacted by streamflow (e.g., Newcomb's snail), the availability of surface water may still have indirect consequences for other species. Based upon current designations, there are no known critical habitat areas for fish and wildlife associated with Honopou Stream.

5.0 Outdoor Recreational Activities

Water-related recreation is an integral part of life in Hawaii. Though beaches may attract more users, the value of maintaining streamflow is important to sustaining recreational opportunities for residents and tourists alike. Streams are often utilized for water-based activities, such as boating, fishing, and swimming, while offering added value to land-based activities such as camping, hiking, and hunting. Growing attention to environmental issues worldwide has increased awareness of stream and watershed protection and expanded opportunities for the study of nature; however, this must be weighed in conjunction with the growth of the eco-tourism industry and the burdens that are placed on Hawaii's natural resources.

The State of Hawaii Department of Health (DOH) maintains water quality standards (HAR 11-54) for recreational areas in inland recreational waters based on the geo-mean of *Enterococcus*, a fecal indicator: 33 colony-forming units per 100 mL of water or a single-sample maximum of 89 colonies per 100 mL. This is for full-body contact (swimming, jumping off cliffs, etc.). If *Enterococcus* exceeds those values, the water body is considered to be impaired. DOH also has a standing advisory for *Leptospirosis* in all freshwater streams. The marine recreational zone, which extends from the shoreline seaward to 1,000 feet from shore, requires an *Enterococci* geo-mean of less than 7 colony-forming units per 100 mL of water, to protect human health.

The recreational resources of Honopou Stream were classified as "moderate" by the HSA's regional recreation committee. The HSA only identified swimming as a recreational opportunity and it was not considered to be a high-quality experience (National Park Service, Hawaii Cooperative Park Service Unit, 1990) (Table 5-1).

Table 5-1. Hawaii Stream Assessment survey of recreational opportunities by type of experience.

	Urban		Country		Semi-Natural		Natural	
	Norm	High	Norm	High	Norm	High	Norm	High
Camping								
Hiking								
Fishing								
Hunting								
Swimming			■					
Boating								
Parks								
	Trail		Road		Ocean		Air	
Scenic Views								
	Educational		Botanical					
Nature Study								

According to public hunting data, Hunting Unit B on the island of Maui consists of portions of the Koolau Forest Reserve. The portion of the hunting area unit within the Honopou hydrologic unit is approximately 0.63 square miles or 23.5 percent of the hydrologic unit (Figure 5-1). A permit is required for the hunting of wild pigs and goats, using rifles, shotguns, bows and arrows, and dogs. Bag limits are two pigs and two goats of either sex per day, while the hunting season is open year-round on Saturdays, Sundays, and State holidays. Handguns are allowed for the hunting of pigs with or without dogs.

Since changes to streamflow and stream configurations have raised concerns regarding their impact to on-shore and near-shore activities, the Commission attempted to identify these various activities in relation to Honopou Stream. A 1981 Maui Resource Atlas, prepared by the State of Hawaii Department of Transportation's Harbors Division, inventoried coral reefs and coastal recreational activities. Looking at available GIS data, the Commission identified the following activities that were known to occur or observed at or near Honopou: pole and line fishing, trolling/bottom fishing, and some specialized fisheries (Figure 5-2).

John Clark, in his book *The Beaches of Maui County* (1989), describes the Honopou area as follows:

> The shoreline from Maliko to Honomanū is characterized by high, steep sea cliffs. Within this long reach of cliffs are a number of bays that are usually little more than wide, moderately deep indentations in the shoreline, usually where streams meet the ocean. The beaches in these areas are narrow stretches of large boulders lying directly at the base of the sea cliffs. Many of these boulder beaches are not accessible at all by land, and if they are, it is only by a hazardous climb using a rope or cable to get down the cliffs. During the winter and spring months these bays are assaulted by heavy surf that sweeps completely across the boulders against the sea cliffs. There are no fringing reefs to check the advance of surf or strong currents. Over the years many fishermen have lost their lives along this dangerous coastline. These rough waters have long been excellent grounds for netting *akule* and *ʻōpelu* and for hooking *ʻūʻū*, *ʻāweoweo*, and *āhole*.
>
> There is no public access to any of these shoreline areas except from the ocean. Many of the bays are over one mile away from the Hāna Highway, and all of the land between the highway and the shoreline is private property replete with locked gates and No Trespassing signs.

Another element of recreation is the unique educational opportunities that streams provide for nature study. One way to approach this is to identify established study sites or nature centers that offer structured learning programs. In lieu of that, the Commission considered available GIS data to identify schools in proximity to Honopou Stream that may utilize the stream as part of its curriculum. The Commission did not identify any educational facilities in the area; however, during a Public Fact Gathering Meeting on April 10, 2008, an area resident testified that there used to be a Girl Scout Camp in Honopou Valley, because there used to be beautiful swimming places and places to learn about nature (See CPRC 1.0-21 to 1.0-22). Multiple public comments, both oral and written, indicate that a reduction in streamflow over the last 20-30 years has dramatically reduced recreational opportunities in east Maui streams including Honopou Stream. It was stated that the water turns black from mango debris and it cannot be used (See CPRC 35.0), or, after people swim in Honopou Stream, they have to take a bath because of the black water (See CPRC 1.0-18).

See Figure 5-2 for the locations of various recreation-related points of interest.

Figure 5-1. Public hunting areas for game mammals in Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 2002b).

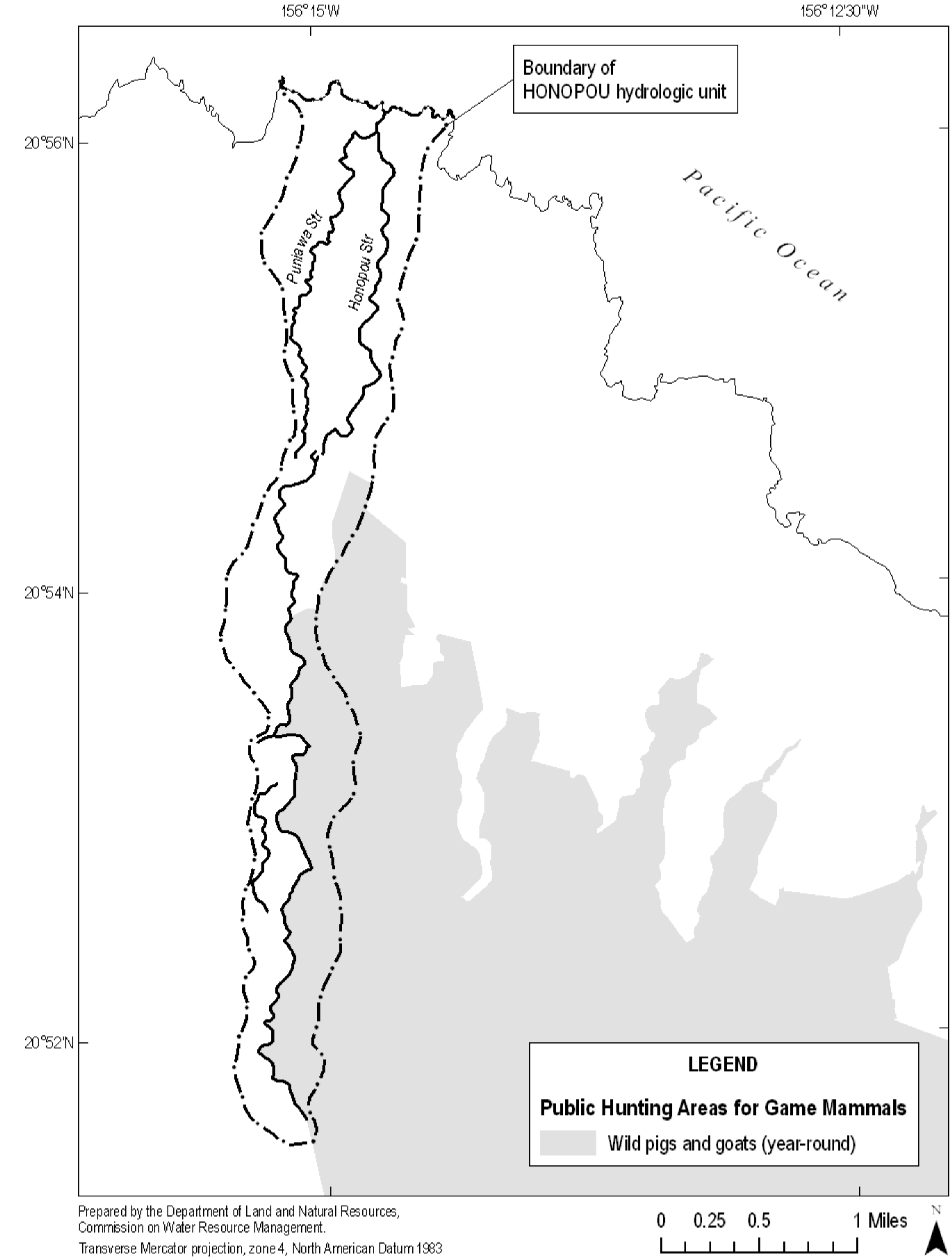
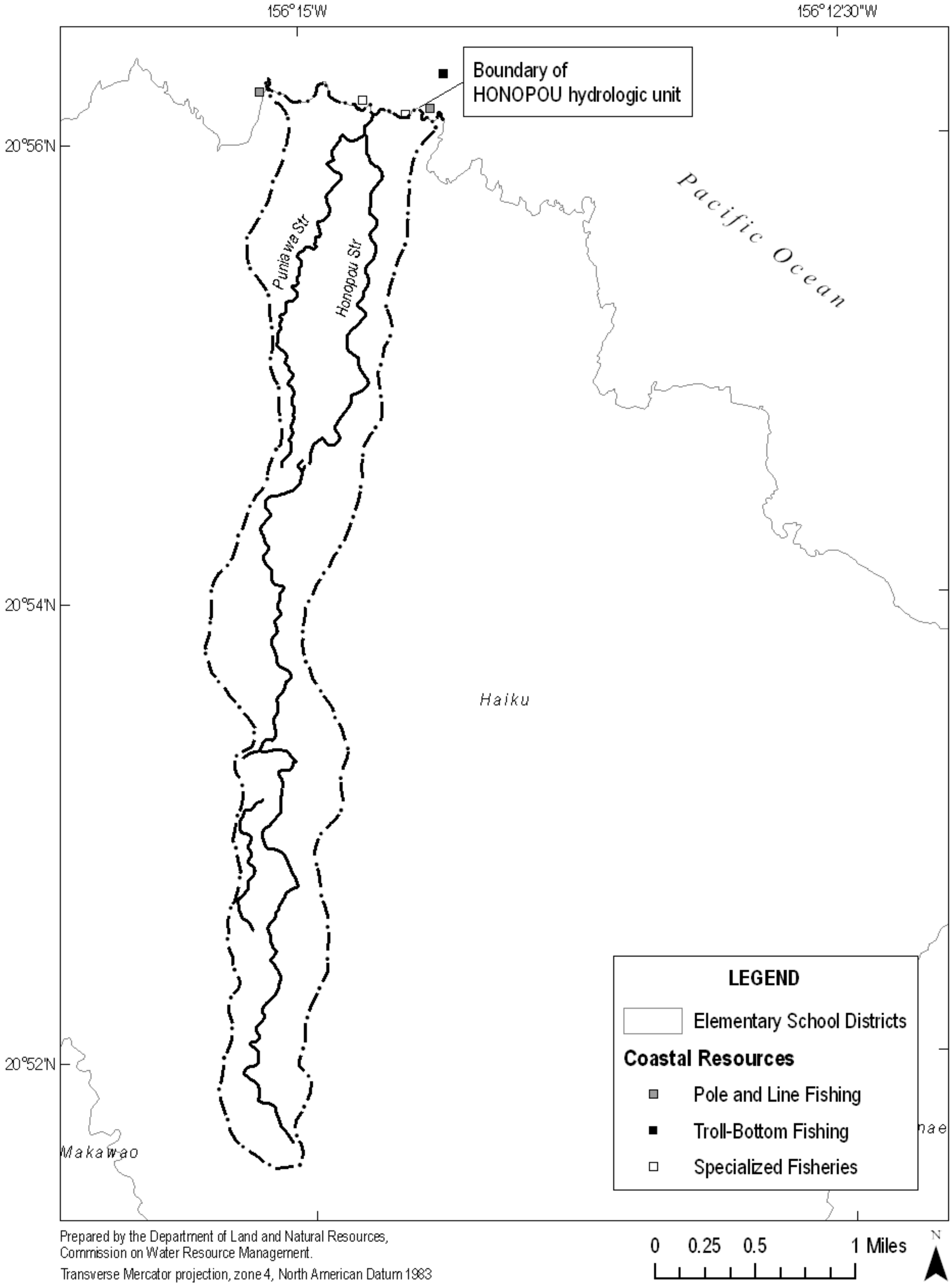


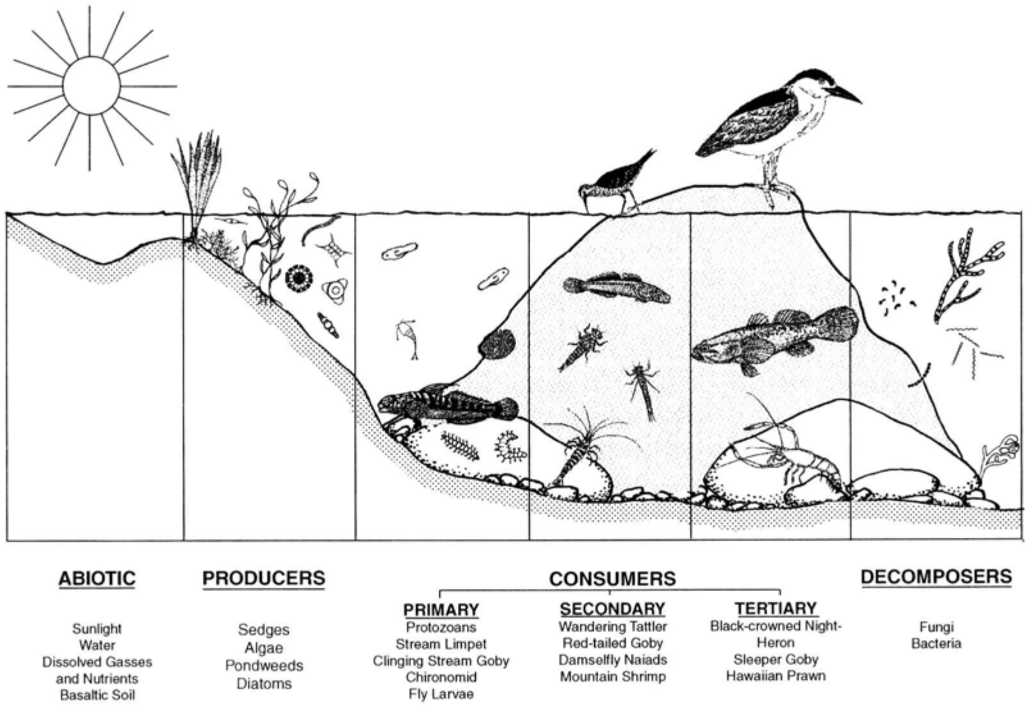
Figure 5-2. Recreational points of interest for Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 1999, 2002a; 2002c; 2002d; 2004a).



6.0 Maintenance of Ecosystems

An ecosystem can be generally defined as the complex interrelationships of living (biotic) organisms and nonliving (abiotic) environmental components functioning as a particular ecological unit. Depending upon consideration of scale, there may be a number of ecosystem types that occur along a given stream such as estuaries, wetlands, and stream vegetation, according to the State Water Code. Figure 6-1 provides a simplified ecosystem represented in a Hawaiian stream. The entire hydrologic unit, as it relates to hydrologic functions of the stream, could also be considered an ecosystem in a very broad context.

Figure 6-1. Simplified ecosystem illustrated in a Hawaiian stream. (Source: Ziegler, 2002, illustration by Keith Kruger).



The Hawaiian resource-use concept of ahupuaa is closely related to the Western concepts of ecosystem maintenance. Native Hawaiians generally utilized natural resources within the limits of their ahupuaa; therefore, it was important to manage and conserve the resources within their living unit. Likewise, watershed resources must be properly managed and conserved to sustain the health of the stream and the instream uses that are dependent upon it.

The riparian resources of Honopou Stream were not classified by the HSA (National Park Service, Hawaii Cooperative Park Service Unit, 1990). The HSA ranked the streams according to a scoring system using six of the seven variables presented in Table 6-1. Detrimental organisms were not considered in the final ranking; however, their presence and abundance are considerable ecosystem variables.

Table 6-1. Hawaii Stream Assessment indicators of riparian resources for Honopou Stream.

Category	Value
Listed threatened and endangered species: These species are generally dependent upon undisturbed habitat. Their presence is, therefore an indication of the integrity of the native vegetation. The presence of these species along a stream course was considered to be a positive attribute; with the more types of threatened and endangered species associated with a stream the higher the value of the resource. Only federally listed threatened or endangered forest or water birds that have been extensively documented within the last 15 years were included.	None
Recovery habitat: Recovery habitat consists of those areas identified by the USFWS and DLNR as essential habitat for the recovery of threatened and endangered species. Streams that have recovery habitat anywhere along their length were included.	None
Other rare organisms and communities: Many species that are candidates for endangered or threatened status have not been processed through all of the requirements of the Endangered Species Act. Also a number of plant communities associated with streams have become extremely rare. These rare organisms and communities were considered to be as indicative of natural Hawaiian biological processes as are listed threatened and endangered species.	None
Protected areas: The riparian resources of streams that pass through natural area reserves, refuges and other protected areas are accorded special protection from degradation. Protected areas were so designated because of features other than their riparian resources. The presence of these areas along a stream, however, indicates that native processes are promoted and alien influences controlled.	None
Wetlands: Wetlands are important riparian resources. They provide habitat for many species and are often important nursery areas. Because they are often extensive areas of flat land generally with deep soil, many have been drained and converted to agricultural or urban uses. Those that remain are, therefore, invaluable as well as being indicators of lack of disturbance.	Less than ½-square mi. of palustrine wetlands identified by USFWS
Native forest: The proportion of a stream course flowing through native forest provides an indication of the potential "naturalness" of the quality of a stream's watershed; the greater the percentage of a stream flowing through native forest most of which is protected in forest reserves the more significant the resource. Only the length of the main course of a stream (to the nearest 10 percent) that passes through native forest was recorded.	0%
Detrimental organisms: Some animals and plants have a negative influence on streams. Wild animals (e.g., pigs, goats, deer) destroy vegetation, open forests, accelerate soil erosion, and contaminate the water with fecal material. Weedy plants can dramatically alter the nature of a stream generally by impeding water flow. Three species, California grass, hau, and red mangrove, are considered to have the greatest influence. The presence of any of these animals or plants along a stream course was considered a potentially negative factor, while the degree of detriment is dependent on the number of species present.	2 (Hau, Pigs)

For the purpose of this section, management areas are those locales that have been identified by federal, state, county, or private entities as having natural or cultural resources of particular value. The result of various government programs and privately-funded initiatives has been a wide assortment of management areas with often common goals. Such designated areas include forest reserves, private preserves, natural area reserves, wildlife sanctuaries, national parks, historic landmarks, and so on. In Honopou, nearly 25 percent of the hydrologic unit falls within the Koolau Forest Reserve (Table 6-2).

Table 6-2. Management areas located within Honopou hydrologic unit. (Source: State of Hawaii, Division of Forestry and Wildlife, 2008a; State of Hawaii, Office of Planning, 2007b).

Management Area	Managed by	Area (mi^2)	Percent of Unit
Koolau Forest Reserve	State Division of Forestry and Wildlife	0.66	24.5
The Koolau Forest Reserve, consisting of over 31,000 acres (48.45 square miles) is one of eight reserves on the Island of Maui that are managed by the State Department of Land and Natural Resources (DLNR)'s Division of Forestry and Wildlife. These reserves are established as multi-use land areas that incorporate various, and often competing, public uses and benefits. The management goals of the Forest Reserve System include: 1) Protect and manage forested watersheds for production of fresh water supply for public uses now and into the future; 2) Maintain biological integrity of native ecosystems; 3) Provide public recreational opportunities; and 4) Strengthen the economy by assisting in the production of high quality forest products in support of a sustainable forest industry.			

In addition to the individual management areas outlined above, Watershed Partnerships are another valuable component of ecosystem maintenance. Watershed Partnerships are voluntary alliances between public and private landowners who are committed to responsible management, protection, and enhancement of their forested watershed lands. There are currently nine partnerships established statewide, three of which are on Maui. Table 6-3 provides a summary of the partnership area, partners, and management goals of the East Maui Watershed Partnership.

Table 6-3. Watershed partnerships associated with Honopou hydrologic unit. (Source: State of Hawaii, Division of Forestry and Wildlife, 2008b; East Maui Watershed Partnership, 1993).

Management Area	Year Established	Total Area (mi^2)	Area (mi^2)	Percent of Unit
East Maui Watershed Partnership	1991	186.73	1.06	39.3
The East Maui Watershed Partnership (EMWP) is comprised of the County of Maui, State Department of Land and Natural Resources, East Maui Irrigation Co. Ltd., Haleakala National Park, Haleakala Ranch Company, Keola Hana Maui, Inc. (Hana Ranch Company), and The Nature Conservancy. The management priorities of the EMWP include: 1) Watershed resource monitoring; 2) Animal control; 3) Weed control; 4) Management infrastructure; and 5) Public education and awareness programs. The EMWP has conducted various projects including the construction of over seven miles of fence construction and on-going fence maintenance, the survey and removal of invasive plant species, eradication of animal species through an expanded hunting program, implementation of runoff and stream protection measures, water quality monitoring, and extensive public education and outreach campaigns.				

In 1974, the U.S. Fish and Wildlife Service (USFWS) initiated a National Wetlands Inventory that was considerably broader in scope than an earlier 1954 inventory that had focused solely on valuable waterfowl habitat. The inventory for Hawaii was completed in 1978 and utilized a hierarchical structure in the classification of various lands. The USFWS defines wetlands as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" (Cowardin et al., 1979). Nearly 21 percent (0.6 square miles) of Honopou is classified as seasonal, non-tidal palustrine wetlands occurring in the headwaters of the hydrologic unit (Figure 6-2). Palustrine wetlands are nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, or wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent.

A series of vegetation maps describing upland plant communities was prepared as part of a USFWS survey in 1976 to 1981 to determine the current status of native forest birds and their associated habitats. Table 6-4 and Figure 6-3 present the portion of the hydrologic unit (~1000 feet above mean sea level) that was surveyed and the degree of disturbance of native forest. Approximately 19 percent (0.51 square miles) of the unit is predominately native species with little or no alien species.

Table 6-4. Distribution of native and alien plant species for Honopou hydrologic unit. (Source: Jacobi, 1989).

Canopy Type	Area (mi^2)	Percent of Unit
Communities totally dominated by native species of plants	0.51	18.7

The density of threatened and endangered plant species is high at elevations above 1,300 feet, while the majority of the Honopou hydrologic unit, roughly 72 percent, has a low concentration of threatened and endangered plant species at lower elevations (Table 6-5 and Figure 6-3).

Table 6-5. Density of threatened and endangered plants for Honopou hydrologic unit. (Source: State of Hawaii, Office of Planning, 1992).

Density	Area (mi^2)	Percent of Unit
High concentration of threatened and endangered species	0.75	27.9
Low concentration of threatened and endangered species	1.95	72.1

A current working paper is being developed by the University of Hawaii's Economic Research Organization (UHERO), entitled *Environmental Valuation and the Hawaiian Economy*, which discusses the use of existing measures of economic performance and alternative statistical devices to provide an economic valuation of threatened environmental resources. The paper focuses on the Koolau, Oahu watershed and illustrates three categories of positive natural capital (forest resources, shoreline resources, and water resources) against a fourth category (alien species) that degrades natural capital. In the case of the Oahu Koolau forests, a benchmark level of degradation is first defined for comparison against the current value of the Oahu Koolau system. The Oahu Koolau case study considers a hypothetical major disturbance caused by a substantial increased population of pigs with a major forest conversion from native trees to the non-indigenous Miconia (*Miconia calvescens*), along with the continued "creep" of urban areas into the upper watershed (Kaiser, B. et al., n.d.).

Recognizing that in the United States, the incorporation of environmental and natural resource considerations into economic measures is still very limited, the paper provides the estimated Net Present Value (NPV) for "Koolau [Oahu] Forest Amenities." These values are presented in Table 6-6 below.

Table 6-6. Estimated Net Present Value (NPV) for Koolau (Oahu) Forest Amenities (Source: Kaiser, B. et al., n.d.).

Amenity	Estimated Net Present Value (NPV)	Important limitations
Ground water quantity	$4.57 to $8.52 billion NPV	Optimal extraction assumed.
Water quality	$83.7 to $394 million NPV	Using averted dredging cost estimates.
In-stream uses	$82.4 to $242.4 million NPV	Contingent valuation estimate for a single small fish species.
Species habitat	$487 to $1,434 million NPV	Contingent valuation estimate for a single small bird species.
Biodiversity	$660,000 to $5.5 million NPV	Average cost of listing 11 species in Koolaus.
Subsistence	$34.7 to $131 million NPV	Based on replacement value of pigs hunted.
Hunting	$62.8 to $237 million NPV	Based on fraction of hunting expenditures in state. Does not include damages from pigs to the other amenities.
Aesthetic values	$1.04 to $3.07 million NPV	Contingent valuation; Households value open space for aesthetic reasons.
Commercial harvests	$600,000 to $2.4 million NPV	Based on small sustainable extraction of koa.
Ecotourism	$1.0 to $2.98 billion NPV	Based on fraction of direct revenues to ecotourism activities.
Climate control	$82.2 million	Based on replacement costs of contribution of all tropical forests to carbon sequestration.

Estimated value of joint services:	$7.444 to $14.032 billion

Following upon the results of the Oahu Koolau case study, the paper provides a brief comparison with the east Maui forests, noting the particular importance of the east Maui watershed as the single largest source of surface water in the state, home to some of the most intact and extensive native forests left in Hawaii, along with having the State's largest concentration of endangered forest birds. In both cases, the Oahu Koolaus and east Maui, the most valuable aspects of the forested areas are believed to be ecotourism, aesthetic pleasure, species habitat, water quality, and water quantity. Both regions are roughly the same size; however, the east Maui forests may have greater value due to greater species diversity and native habitat, and the County of Maui's dependence upon surface water as a drinking water source (water quality) (Kaiser, B. et al., n.d.).

Figure 6-2. Reserves and wetlands for the Honopou hydrologic unit (Source: State of Hawaii, Office of Planning, 2003; 2007b).

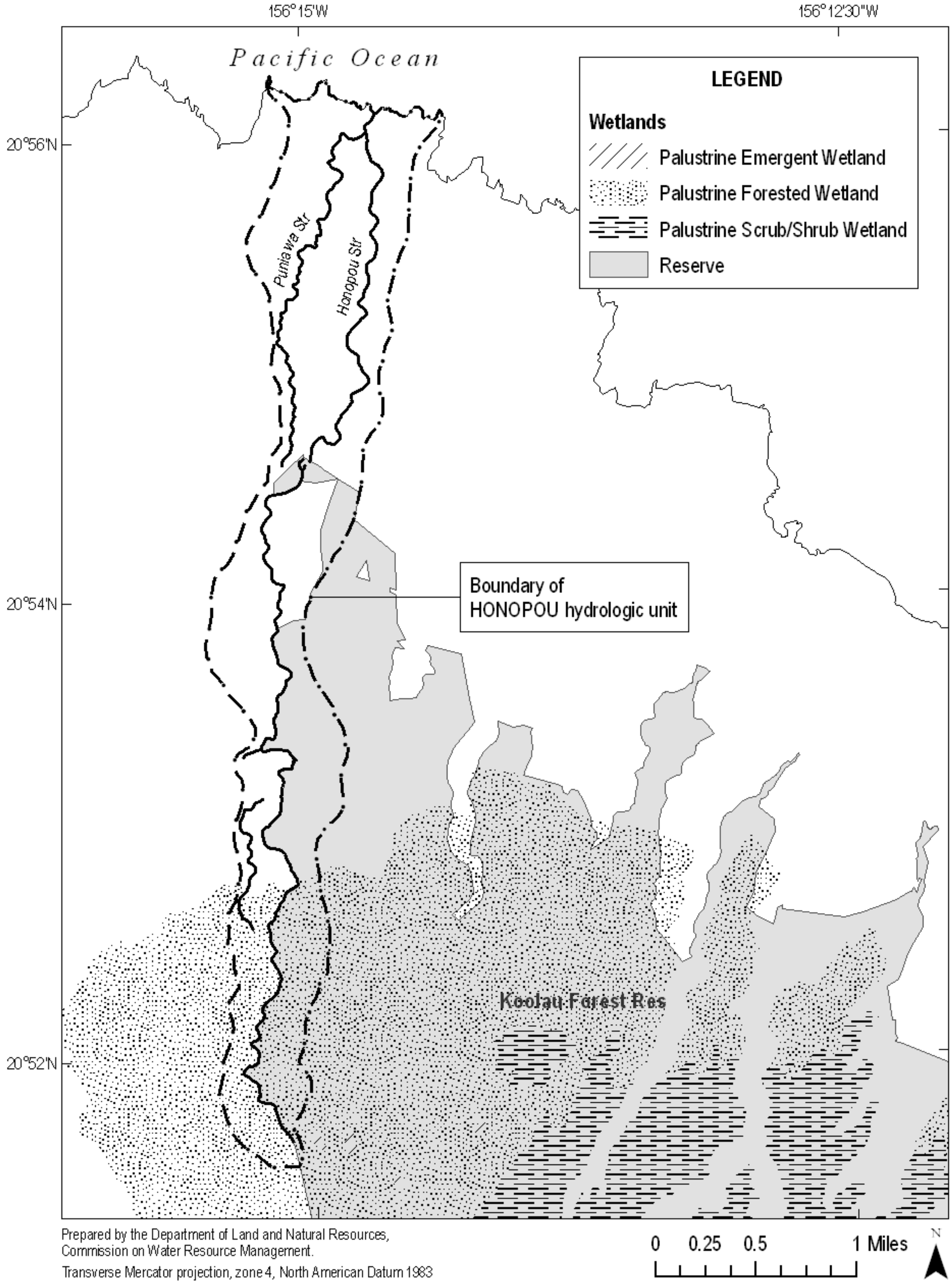
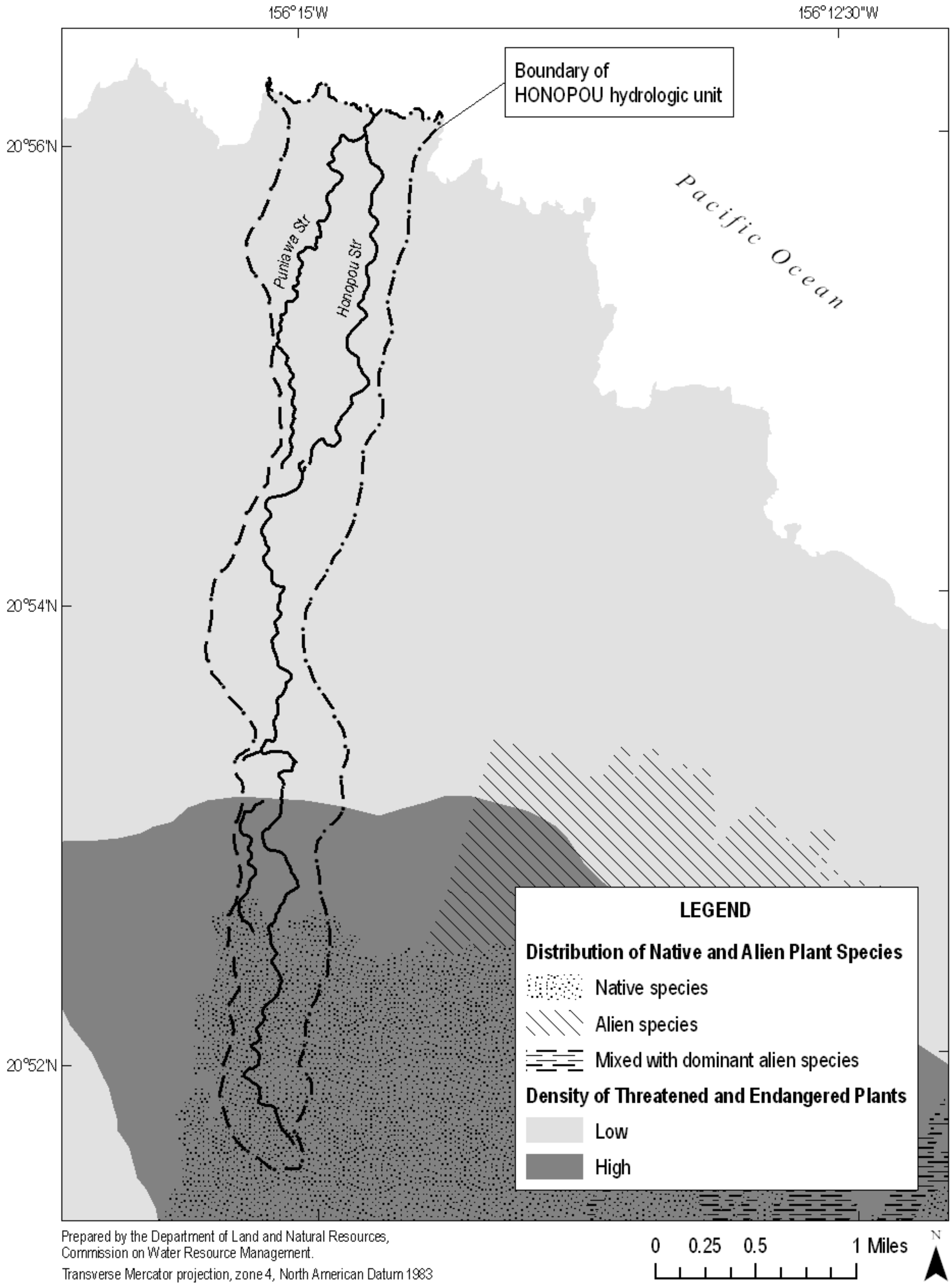


Figure 6-3. Distribution of native and alien plant species, and threatened and endangered plant species for Honopou hydrologic unit (Source: Jacobi, 1989; Scott et al., 1986; State of Hawaii, Office of Planning, 1992, 2004b; 2004d).



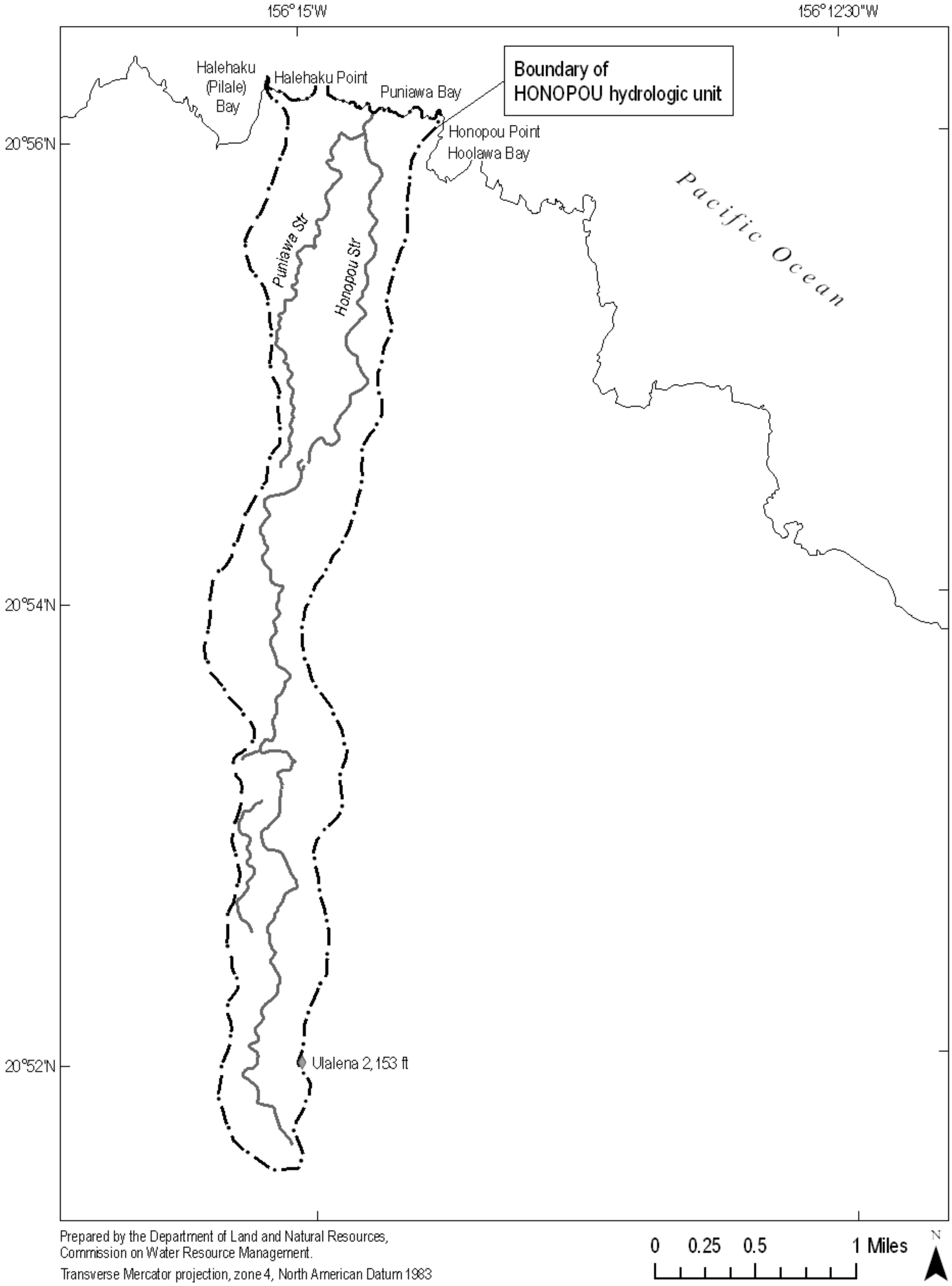
7.0 Aesthetic Values

Aesthetics is a multi-sensory experience related to an individual's perception of beauty. Since aesthetics by definition is a subjective observation, a stream's aesthetic value cannot be determined quantitatively (Wilson Okamoto & Associates, Inc., 1983). However, there are certain elements, either within or surrounding a stream, which appeal to an observer's visual and auditory senses, such as waterfalls and cascading plunge pools. Several assumptions were made in identifying the elements that give Honopou Stream a particular aesthetic quality.

The headwaters of Honopou Stream originate in the lush tropical forests of the Koolau Forest Reserve. It flows through approximately 2 miles of evergreen forests before reaching an elevation where the surrounding vegetation changes to mainly grasses and shrubs. At about the same elevation, the tributary of Puniawa Stream begins and flows through cultivated and shrub lands. Honopou Stream empties into Puniawa Bay, which can be viewed above the ocean cliffs at Honopou Point (Figure 7-1).

In a 2007 Hawaii State Parks Survey, released by the Hawaii Tourism Authority (OmniTrak Group Inc., 2007), scenic views accounted for 21 percent of the park visits statewide, though that was a decrease from 25 percent in a 2003 survey. Other aesthetic-related motivations include viewing famous landmarks (9 percent), hiking trails and walks (7 percent), guided tour stops (6 percent), and viewing of flora and fauna (2 percent). On the island of Maui, visitors' preference to visit state parks for scenic views (26 percent) was second only to uses for outings with family and friends (29 percent). In comparison, residents primarily used state parks for ocean/water activities (30 percent), followed by outings with friends and family (28 percent), and then scenic views (9 percent). Overall, Maui residents were very satisfied with scenic views giving a score of 9.7 (on a scale of 1 to 10, with 10 being outstanding), with out-of-state visitors giving a score of 9.3. Though there are no state parks located in the hydrologic unit, it is assumed that where Honopou Stream crosses Hana Highway there may be opportunities for scenic enjoyment.

Figure 7-1. Aesthetic points of interest for the Honopou hydrologic unit (Source: U.S. Geological Survey, 1996).



8.0 Navigation

The State Water Code, Chapter 174C, HRS, includes navigation as one of nine identified instream uses; however, it fails to further define navigation. Navigational water use is largely defined as water utilized for commercial, and sometimes recreational, transportation. In the continental United States, this includes water used to lift a vessel in a lock or to maintain a navigable channel level. Under the provisions of the Clean Water Act, navigable waters also include wetlands (State of Nevada, Department of Conservation and Natural Resources, Division of Water Resources, n.d.).

Hawaii streams are generally too short and steep to support navigable uses. If recreational boating (primarily kayaks and small boats) is included under the definition of navigation, then there are only a handful of streams statewide that actually support recreational boating and even fewer that support commercial boating operations. Kauai's Wailua River is the only fresh water waterway where large boat commercial operations exist, and no streams are believed to serve as a means for the commercial transportation of goods.

The hydrologic unit of Honopou is not known to support any instream uses of navigation.

9.0 Instream Hydropower Generation

The generation of hydropower is typically accomplished through instream dams and power generators; however, the relatively short lengths and flashy nature of Hawaii's streams often require water to be diverted to offstream power generators. In these "run-of-river" (i.e., utilizes water flow without dams or reservoirs) designs, water is diverted through a series of ditches, pipes, and penstocks to the powerplant, and then returned to the stream. Some designs call for the powerplant to be situated such that the drop of water level (head) exiting the plant can be sent to fields for crop irrigation.

Considering the definition of instream hydropower generation, there are no known true instream hydropower systems located on Honopou Stream, nor has the potential for hydropower generation been identified in previous reports (W.A. Hirai & Associates, Inc., 1981).

While the following information should perhaps be a part of Section 13.0, Noninstream uses, it has been included here for further consideration. Carol Wilcox, in her book *Sugar Water: Hawaii's Plantation Ditches* (1996), describes the use of surface water for generating hydroelectricity by Hawaiian Commercial and Sugar Company as follows:

> On Maui, Hawaiian Commercial and Sugar Company (HC&S) had three hydroelectric plants, all utilizing water collected by the East Maui Irrigation Company (EMI) irrigation system. The earliest, Paia Hydro, was built by Maui Agricultural Company in 1912 with a 800-kilowatt capacity. In 1923, the penstock was extended to a higher elevation, thus increasing the capacity to 1000 kilowatts. HC&S built a 4000-kilowatt hydroplant at Kaheka in 1924. In 1982, a 500-kilowatt hydroelectric powerplant was installed at the Hamakua Ditch above Paia. Located only 50 feet below the Wailoa Forebay, this "low-head" hydroplant takes water through a 36-inch pipe and discharges it into the Hamakua Ditch.
>
> Besides these three hydros, HC&S has a bagasse-powered steam powerplant at the Paia factory, and the Central Powerplant, built in 1918, located at Kahului. In 1921, electric lighting was brought to the camp houses. By the 1930s this was the largest plantation power system in Hawaii, with a 12,000-kilowatt capacity. The largest consumer was the water pumps (6000 kilowatts), then the factory (1500 kilowatts), and general uses such as lighting, feed mill, dairy, carpentry shop, refrigerator plants, machine shops, and "talkie movie houses" (400 kilowatts). Surplus power (900 kilowatts) was sold to Kahului Railroad Company and to Maui Electric Company. The Central Powerplant supplied power for all of central Maui until after World War II. In 1984, the combined total capacity of all HC&S power-generating systems was rated at 37,300 kilowatts.

HC&S continues to operate three run-of-river hydroelectric facilities on the Wailoa Ditch, which is supplied with water from several sources including Honopou Stream. Power generated from these facilities is used to satisfy sugar mill power requirements first, while remaining electricity not used by the mill is sold to Maui Electric Company (MECO). According to MECO, power is sold as available, with an estimated oil savings of 16,200 barrels per year. The hydraulic turbine generators located at the Kaheka, Paia, and Hamakua facilities on the Wailoa Ditch are capable of producing 4.5, 0.9, and 0.4 megawatts, respectively (MECO, 2008b).

An "Amended and Restated Power Purchase Agreement" between HC&S and MECO, dated 1989, details the terms. "Force Majeure" events are listed in the agreement, releasing HC&S from their obligation to provide the agreed-upon amount of power to MECO if events beyond their control prevent them from delivering energy (Alexander and Baldwin [A&B] Hawaii and Maui Electric Company, Limited, 1989). Therefore, an order to reduce ditch flow may release HC&S and MECO from this agreement, thereby reducing the amount of power that MECO can provide to its customers.

10.0 Maintenance of Water Quality

The maintenance of water quality is important due to its direct impact upon the maintenance of other instream uses such as fish and wildlife habitat, outdoor recreation, ecosystems, aesthetics, and traditional and customary Hawaiian rights. There are several factors that affect a stream's water quality, including physical, chemical, and biological attributes. The State of Hawaii Department of Health (DOH) is responsible for water quality management duties statewide. The DOH Environmental Health Administration oversees the collection, assessment, and reporting of numerous water quality parameters in three high-priority categories:

- Possible presence of water-borne human pathogens;
- Long-term physical, chemical and biological components of inland, coastal, and oceanic waters; and
- Watershed use-attainment assessments, identification of sources of contamination, allocation of those contributing sources, and implementation of pollution control actions.

The Environmental Health Administration is also responsible for regulating discharges into State waters, through permits and enforcement actions. Examples include federal National Pollutant Discharge Elimination System (NPDES) permits for storm water, and discharge of treated effluent from wastewater treatment plants into the ocean or injection wells.

Sediment and temperature are among the primary physical constituents of water quality evaluations. They are directly impacted by the amount of water in a stream. The reduction of streamflow often results in increased water temperatures, whereas higher flows can aid in quickly diluting stream contamination events. According to a book published by the Instream Flow Council, "[w]ater temperature is one of the most important environmental factors in flowing water, affecting all forms of aquatic life (Amear et al, 2004)." While this statement is true for continental rivers, fish in Hawaii are similar, but their main requirement is flowing water. Surface water temperatures may fluctuate in response to seasonal and diurnal variations, but only a few degrees Celsius in natural streams, mainly because streams in Hawaii are so short. However, temperatures in streams with concrete-lined channels, and dewatered streams, may fluctuate widely due to the vertical solar contact. Surface water temperatures may also fluctuate widely due to water column depth, channel substrate, presence of riparian vegetation, and ground water influx. Surface water also differs considerably from ground water, generally exhibiting lower concentrations of total dissolved solids, chlorides, and other major ions, along with higher concentrations of suspended solids, turbidity, microorganisms, and organic forms of nutrients (Lau and Mink, 2006). Findings of a 2004 USGS National Water Quality Assessment (NAWQA) Program report identified land use, storm-related runoff, and ground water inflow as major contributors of surface water contaminants (Anthony, S.S. et al., 2004).

Water body types can be freshwater, marine, or brackish. They can be further delineated as inland fresh waters, estuaries, embayments, open coastal waters, and oceanic waters (HAR 11-54-5 to 11-54-6). Each water body type has its own numeric criteria for State of Hawaii Water Quality Standards (WQS).

Fresh waters are classified for regulatory purposes, according to the adjacent land's conservation zoning. There are two classes for the inland fresh waters. Class 1 inland waters are protected to "remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source." These waters are used for a number of purposes including domestic water supply, protection of native breeding stock, and baseline references from which human-caused changes can be measured.

Class 2 inland waters are protected for uses such as recreational purposes, support of aquatic life, and agricultural water supplies.

Class 1 waters are further separated into Classes 1a and 1b. Class 1a waters are protected for the following uses: scientific and educational purposes, protection of native breeding stock, baseline references from which human-caused changes can be measured, compatible recreation, aesthetic enjoyment, and other non-degrading uses which are compatible with the protection of the ecosystems associated with waters of this class. Streams that run through natural reserves, preserves, sanctuaries, refuges, national and state parks, and state or federal fish and wildlife refuges are Class 1a. Streams adjacent to the most environmentally sensitive conservation subzone, "protective" are Class 1b, and are protected for the same uses as Class 1a waters, with the addition of domestic water supplies, food processing, and the support and propagation of aquatic life (HAR 11-54-3). These classifications are used for regulatory purposes, restricting what is permitted on the land around receiving waters. For example, public access to Class 1b waters may be restricted to protect drinking water supplies.

Land use affects water quality because direct runoff (rainfall that flows overland into the stream) can transport sediment and its chemical contaminants into the stream. According to the U.S. Environmental Protection Agency (EPA), "[a] TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Water quality standards are set by States, Territories, and Tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing as well as ecological health), and the scientific criteria required to support those uses. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. The Clean Water Act, section 303, establishes the water quality standards and TMDL programs (EPA, 2008)."

The DOH, Environmental Health Administration maintains the State of Hawaii Water Quality Standards (WQS), a requirement under the Federal Clean Water Act (CWA) regulated by the EPA. The CWA aims to keep waters safe for plants and animals to live and people to wade, swim, and fish. Water Quality Standards are the measures that states use to ensure protection of the physical, chemical, and biological health of their waters. "A water quality standard defines the water quality goals of a water body, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses (CWA §131.2)." Each state specifies its own water uses to be achieved and protected ("designated uses"), but CWA §131.10 specifically protects "existing uses", which it defines as "…those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards (CWA §131.3)."[1] Although the State WQS do not specify any designated uses in terms of traditional and customary Hawaiian rights, the "protection of native breeding stock," "aesthetic enjoyment," and "compatible recreation" are among the designated uses of Class 1 inland

[1] Existing uses as defined in the CWA should not be confused with existing uses as defined in the State Water Code, although there is some overlap and linkage between the two. Under the Water Code, if there are serious threats to or disputes over water resources, the Commission may designate a "water management area." Water quality impairments, including threats to CWA existing uses, are factors that the Commission may consider in its designation decisions. Once such a management area is designated, people who are already diverting water at the time of designation may apply for water use permits for their "existing uses." The Commission then must weigh if the existing use is "reasonable and beneficial." The Water Code defines "reasonable-beneficial use" as "the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest." The relationships between a Commission existing use and a CWA existing use can help determine the appropriateness of the use and its consistency with the public interest.

waters, and "recreational purposes, the support and propagation of aquatic life, and agricultural and industrial water supplies" are among the designated uses of Class 2 inland waters. This means that uses tied to the exercise of traditional and customary Hawaiian rights that are protected by the State Constitution and the State Water Code (Section 12.0, Protection of Traditional and Customary Hawaiian Rights), including but not limited to gathering, recreation, healing, and religious practices are also protected under the CWA and the WQS as designated and/or existing uses. Therefore, the Commission's interim IFS recommendation may impact the attainment of designated and existing uses, water quality criteria, and the DOH antidegradation policy, which together define the WQS and are part of the joint Commission and DOH obligation to assure sufficient water quality for instream and noninstream uses.

State of Hawaii WQS define: 1) the classification system for State surface waters, which assigns different protected uses to different water classes; 2) the specific numeric or narrative water quality criteria needed to protect that use; and 3) a general antidegradation policy, which maintains and protects water quality for the uses defined for a class. Quantitative and qualitative data are utilized. Numeric water quality criteria have specific concentrations (levels of pollutants) that must be attained based on water body type, e.g. fresh water stream. Qualitative standards are general narrative statements that are applicable to all State waters, such as "all waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants (State of Hawaii, Department of Health, 2004)." Conventional pollutants include nutrients and sediments. Toxic pollutants include pesticides and heavy metals. Indicator bacteria are utilized to assess bacterial levels. Biological assessments of aquatic communities are also included in the data collected.

Once data are gathered and evaluated for quality and deemed to be representative of the waterbody segment, a decision is made as to whether the appropriate designated uses are being attained. This set of decisions are then tabulated into a report to the EPA that integrates two CWA sections; (§) 305(b) and §303(d). This Integrated Report is federally required every even-numbered year. CWA §305(b) requires states to describe the overall water quality statewide. They must also describe the extent to which water quality provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water. Additionally, they determine whether the designated uses of a water body segment are being attained, and if not, what are the potential causes and sources of pollution. The CWA §303(d) requires states to submit a list of Water-Quality Limited Segments, which are waters that do not meet state water quality standards and those waters' associated uses. States must also provide a priority ranking of waters listed for implementation of pollution controls, which are prioritized based on the severity of pollution and the uses of the waters. In sum, the §303(d) list leads to action.

The sources for the 2006 Integrated Report are Hawaii's 2004 §303(d) list, plus readily-available data collected from any State water bodies over the preceding 6 years (State of Hawaii, Department of Health, 2007). Per §303(d), impaired waters are listed after review of "'all existing and readily available water quality-related data and information' from a broad set of data sources" (State of Hawaii, Department of Health, 2004, p.57). However, available data are not comprehensive of all the streams in the State. According to the Hawaii Administrative Rules Title 11 Chapter 54 (HAR 11-54) all State waters are subject to monitoring; however, in the most recent list published (from the 2006 list that was published in 2007), only 74 streams statewide had sufficient data for evaluation of whether exceedence of WQS occurred. Honopou Stream does not appear on the 2006 List of Impaired Waters in Hawaii, Clean Water Act §303(d). While some data exist for Honopou, there were not sufficient data for decision-making; therefore, no decision was made pertaining to the attainment of WQS or the applicable designated uses. Some samples were collected at Honopou, and no exceedence of Water Quality Standards was found.

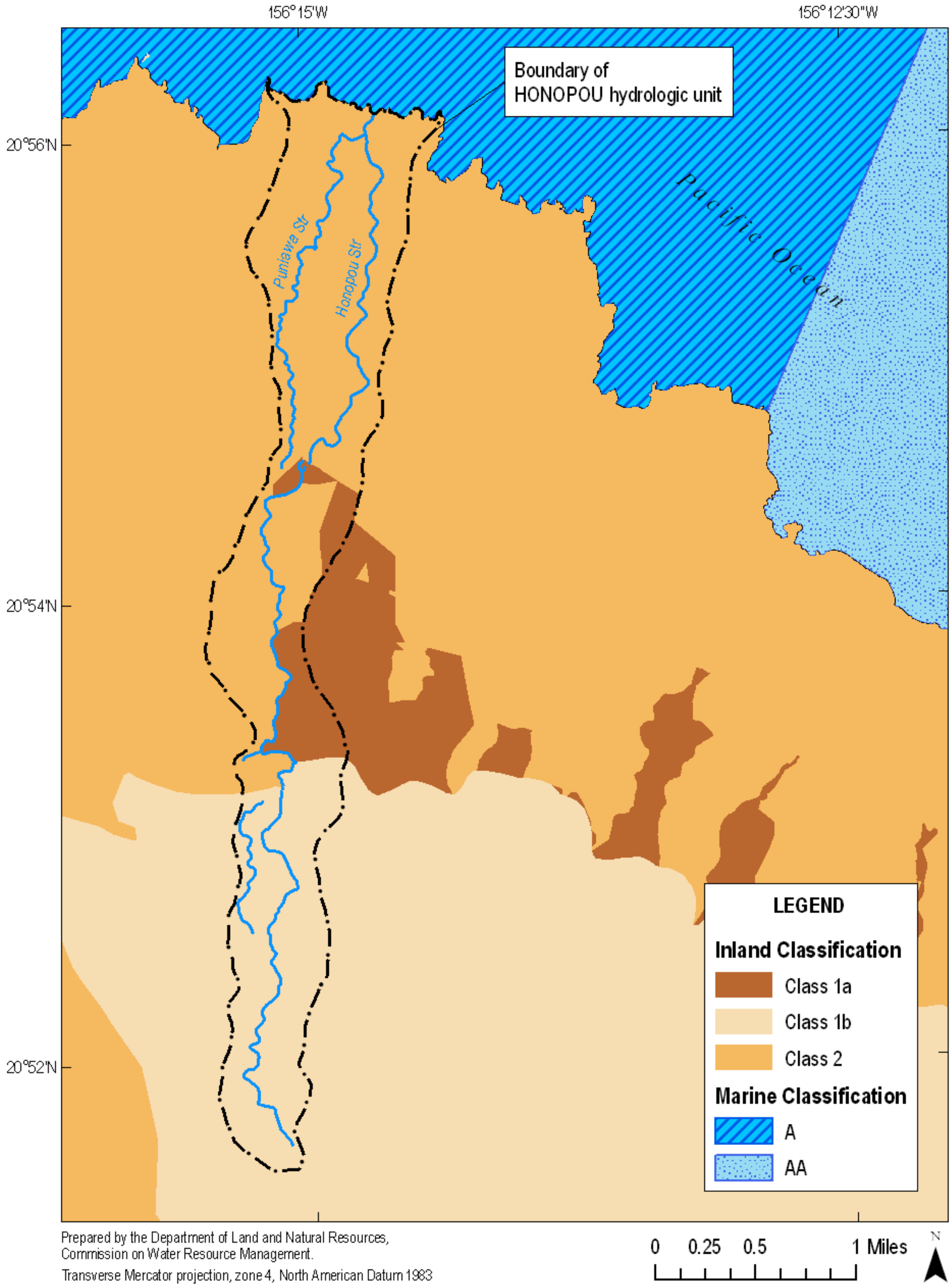
The 2006 Integrated Report indicates that the current WQS require the use of *Enterococci* as the indicator bacteria for evaluating public health risks in the waters of the State; however, no new data were available for this parameter in inland waters. As mentioned in Section 5.0, Outdoor Recreational Activities, DOH maintains WQS for inland recreational waters based on the geo-mean statistic of *Enterococci*: 33 colony-forming units per 100 mL of water or a single-sample maximum of 89 colonies per 100 mL. This is for full-body contact (swimming, jumping off cliffs into waterfall pools, etc.). If *Enterococci* count exceeds those values, the water body is considered to be impaired. DOH Clean Water Branch efforts have been focused on coastal areas (State of Hawaii, Department of Health, 2006, Chapter II, p.20). The marine recreational zone, which extends from the shoreline seaward to 1,000 feet from shore, requires an *Enterococci* geo-mean of less than 7 colony-forming units per 100 mL of water to protect human health (HAR 11-54-8.)

The 2006 Integrated Report also states: "Public health concerns may be underreported. *Leptospirosis* is not included as a specific water quality standard parameter. However, all fresh waters within the state are considered potential sources of *Leptospirosis* infection by the epidemiology section of the Hawaii State Department of Health. No direct tests have been approved or utilized to ascertain the extent of the public health threat through water sampling. Epidemiologic evidence has linked several illness outbreaks to contact with fresh water, leading authorities to issue blanket advisories for all fresh waters of the state (State of Hawaii, Department of Health, 2006, Chapter II, p.3)."

Honopou Stream is classified as Class 1b inland waters from its headwaters to approximately 1,200 foot elevation, as the surrounding land is in the conservation subzone "protective." From there down to approximately 900 feet elevation, Honopou Stream is classified as Class 1a inland waters, because, while not in the protective subzone, it is adjacent to the Koolau Forest Reserve (it forms part of the reserve boundary). From there to the sea, it is Class 2, except for an approximately 1,500-foot section between 600 and 700 feet elevation, which is within the Koolau Forest Reserve and therefore Class 1a. Puniawa Stream is classified as Class 2 inland waters. It should be noted that the conservation subzone map utilized for this interpretation is general and elevations are not exact. It should also be noted that there is no direct relationship between elevation and attainment of water quality standards.

Marine water body types are delineated by depth and coastal topography. Open coastal waters are classified for protection purposes from the shoreline at mean sea level laterally to where the depth reaches 100 fathoms (600 feet). Marine water classifications are based on marine conservation areas. The objective of Class AA waters is that they "remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions." Class A waters are protected for recreational purposes and aesthetic enjoyment; and protection of fish, shellfish, and wildlife. Discharge into these waters is permitted under regulation. The marine waters at the mouth of the entire Honopou hydrologic unit are Class A waters. Figure 10-1 shows the Honopou hydrologic unit, including inland and marine (coastal) water classifications.

Figure 10-1. Water quality standards for the Honopou hydrologic unit. (Source: State of Hawaii, Office of Planning, 2002e; 2008). The classifications are general in nature and should be used in conjunction with Hawaii Administrative Rules, Chapter 11-54, Water Quality Standards.



11.0 Conveyance of Irrigation and Domestic Water Supplies

Under the State Water Code, the conveyance of irrigation and domestic water supplies to downstream points of diversion is included as one of nine listed instream uses. The thought of the stream as a conveyance mechanism for noninstream purposes almost seems contrary to the concept of instream flow standards. However, the inclusion of this instream use is intended to ensure the availability of water to all those who may have a legally protected right to the water flowing in a stream. Of particular importance in this section is the diversion of surface water for domestic purposes. In its August 2000 decision on the Waiahole Ditch Combined Contested Case Hearing, the Hawaii Supreme Court identified domestic water use of the general public, particularly drinking water, as one of, ultimately, four trust purposes.

Neither the State nor the County keeps a comprehensive database of households whose domestic water supply is not part of a municipal system (i.e. who use stream and / or catchment water). The County of Maui Department of Water Supply does not have data for water users who are not on the county system and may be using catchment or surface water for domestic use (Ellen Kraftsow, personal communication, June 23, 2008). The State of Hawaii Department of Health Safe Drinking Water Branch administers Federal and State safe drinking water regulations to public water systems in the State of Hawaii to assure that the water served by these systems meets State and Federal standards. Any system which services 25 or more people for a minimum of 60 days per year or has at least 15 service connections is subject to these standards and regulations. Once a system is regulated by the Safe Drinking Water Branch, the water must undergo an approved filtration and disinfection process when it has been removed from the stream. It would also be subject to regulatory monitoring. According to DOH, the Safe Drinking Water Branch does not currently regulate any private water systems in the Honopou hydrologic unit (Mike Miyahira, personal communication, August 1, 2008).

The Commission's records for the hydrologic unit of Honopou indicate that there are a total of 22 registered diversions, of which seven are East Maui Irrigation Company (EMI) diversions. Since EMI diversions transport water to locations outside of this hydrologic unit, EMI's information is not discussed in this section; rather, it is included in Section 13.0, Noninstream uses. Of the remaining 15 diversions, 13 were declared for domestic purposes, in part, with a total of 15 service connections. All 15 diversions are utilized for irrigation of various crops and livestock, including the cultivation of taro.

This information is derived from original registration documents, much of which has not been field verified and may have changed. In 2007, the Commission contracted R.M. Towill Corporation to conduct a statewide diversion verification inventory starting with priority areas across the island of Maui. Data from this study, along with information collected from Commission staff site visits, and information extracted from the original registration files regarding the registered diversions may be found in Table 13-1 of Section 13.0, Noninstream uses.

12.0 Protection of Traditional and Customary Hawaiian Rights

The maintenance of instream flows is important to the protection of traditional and customary Hawaiian rights, as they relate to the maintenance of stream resources (e.g., hihiwai, opae, oopu) for gathering, recreation, and the cultivation of taro. Article XII, Section 7 of the State Constitution addresses traditional and customary rights: "The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ahupuaʻa tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights." Case notes listed in this section indicate, "Native Hawaiian rights protected by this section may extend beyond the ahupuaʻa in which a native Hawaiian resides where such rights have been customarily and traditionally exercised in this manner. 73 H.578, 837 P.2d 1247."

It is difficult to fully represent in words the depth of the cultural aspects of streamflow, including traditions handed down through the generations regarding gathering, ceremonial and religious rites, and the ties to water that are pronounced in Hawaiian legend and lore. "There is a great traditional significance of water in Hawaiian beliefs and cultural practices…The flow of water from mountain to sea is integral to the health of the land. A healthy land makes for healthy people, and healthy people have the ability to sustain themselves (Kumu Pono Associates, 2001b, p.II:8)."

Taro cultivation is addressed in this section of the report as well as the next section, 13.0 Noninstream Uses. This is because instream flow standards take into account both social and scientific information. For sociological and cultural purposes, taro cultivation can be considered an instream use as part of the "protection of traditional and customary Hawaiian rights," that is specifically listed as an instream use in the Water Code. Taro cultivation can also be considered a noninstream use since it removes water from a stream (even if water from taro loi is later returned to the stream). It could be argued that for scientific analysis, taro cultivation is an instream use since taro loi provide habitat for stream biota, but because the water is physically taken out of the stream, it is also a noninstream use. Another way to look at the approach of indentifying taro cultivation as both instream and noninstream uses is that when the Commission addresses taro cultivation as an instream use, it is generally in the context of traditional and customary Hawaiian rights; whereas when the Commission addresses taro cultivation as a noninstream use, it is approaching the issue from the aspects of agriculture and water use.

In ancient Hawaii, the islands (*moku*) were subdivided into political subdivisions, or ahupuaa, for the purposes of taxation. The term ahupuaa in fact comes from the altar (*ahu*) that marked the seaward boundary of each subdivision upon which a wooden head of a pig (*puaa*) was placed at the time of the *Makahiki* festival when harvest offerings were collected for the rain god and his earthly representative (Handy et al., 1972). Each ahupuaa had fixed boundaries that were usually delineated by natural features of the land, such as mountain ridges, and typically ran like a wedge from the mountains to the ocean thus providing its inhabitants with access to all the natural resources necessary for sustenance. The beach, with its fishing rights, were referred to as *ipu kai* (meat bowl), while the upland areas for cultivation were called *umeke ai* (poi container hung in a net) (Handy et al., 1972). As noted earlier in Section 6.0, Maintenance of Ecosystems, Western concepts of ecosystem maintenance and watersheds are similar to the Hawaiian concept of ahupuaa, and so the Commission's surface water hydrologic units often coincide with or overlap ahupuaa boundaries. The hydrologic unit of Honopou includes parts of the ahupuaa of Honopou and Haleaku as shown in Figure 12-2.

An appurtenant water right is a legally recognized right to a specific amount of surface freshwater – usually from a stream – on the specific property that has that right. This right traces back to the use of water on a given parcel of land at the time of its original conversion into fee simple land. When the land allotted during the 1848 Mahele was confirmed to the awardee by the Land Commission and/or when the Royal Patent was issued based on such award, the conveyance of the parcel of land carried with it the appurtenant right to water if water was being used on that land at or shortly before the time of the Mahele (State of Hawaii, Commission on Water Resource Management, 2007).

An appurtenant right is different from a riparian right, but they are not mutually exclusive. Riparian rights are held by owners of land adjacent to a stream. They and other riparian landowners have the right to reasonable use of the stream's waters on those lands. Unlike riparian lands, the lands to which appurtenant rights attach are not necessarily adjacent to the freshwater source (i.e., the water may be carried to the lands via auwai or ditches), but some pieces of land could have both appurtenant and riparian rights.

Appurtenant rights are provided for under the State Water Code, HRS §174C-101, Sections (c) and (d), as follows:

- Section (c). Traditional and customary rights of ahupuaa tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778 shall not be abridged or denied by this chapter. Such traditional and customary rights shall include, but not be limited to, the cultivation or propagation of taro on one's own kuleana and the gathering of hihiwai, opae, oopu, limu, thatch, ti leaf, aho cord, and medicinal plants for subsistence, cultural, and religious purposes.

- Section (d). The appurtenant water rights of kuleana and taro lands, along with those traditional and customary rights assured by this section, shall not be diminished or extinguished by a failure to apply for or to receive a permit under this chapter.

The exercise of an appurtenant water right is still subject to the water use permit requirements of the Water Code, but there is no deadline to exercise that right without losing it, as is the case for correlative and riparian rights, which must have been exercised before designation of a water management area.

In August 2000, the Hawaii Supreme Court issued its decision in the Waiahole Ditch Combined Contested Case Hearing, upholding the exercise of Native Hawaiian and traditional and customary rights as a public trust purpose. These rights are described in the Commission's 2007 *Water Resource Protection Plan – Public Review Draft*, incorporating a later revision[1] as follows:

> Appurtenant water rights are rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple lands i.e., when land allotted by the 1848 Mahele was confirmed to the awardee by the Land Commission and/or when the Royal Patent was issued based on such award, the conveyance of the parcel of land carried with it the appurtenant right to water.[2] The amount of water under an appurtenant right is the amount that was being used at the time of the Land Commission award and is established by cultivation methods that approximate the methods utilized at the time of the Mahele, for example, growing wetland taro.[3] Once established, future uses are not limited to the cultivation of traditional products approximating those utilized at the time of the Mahele[4], as long as those uses are reasonable, and if in a water management area, meets the State Water Code's test of reasonable and beneficial use ("the use of

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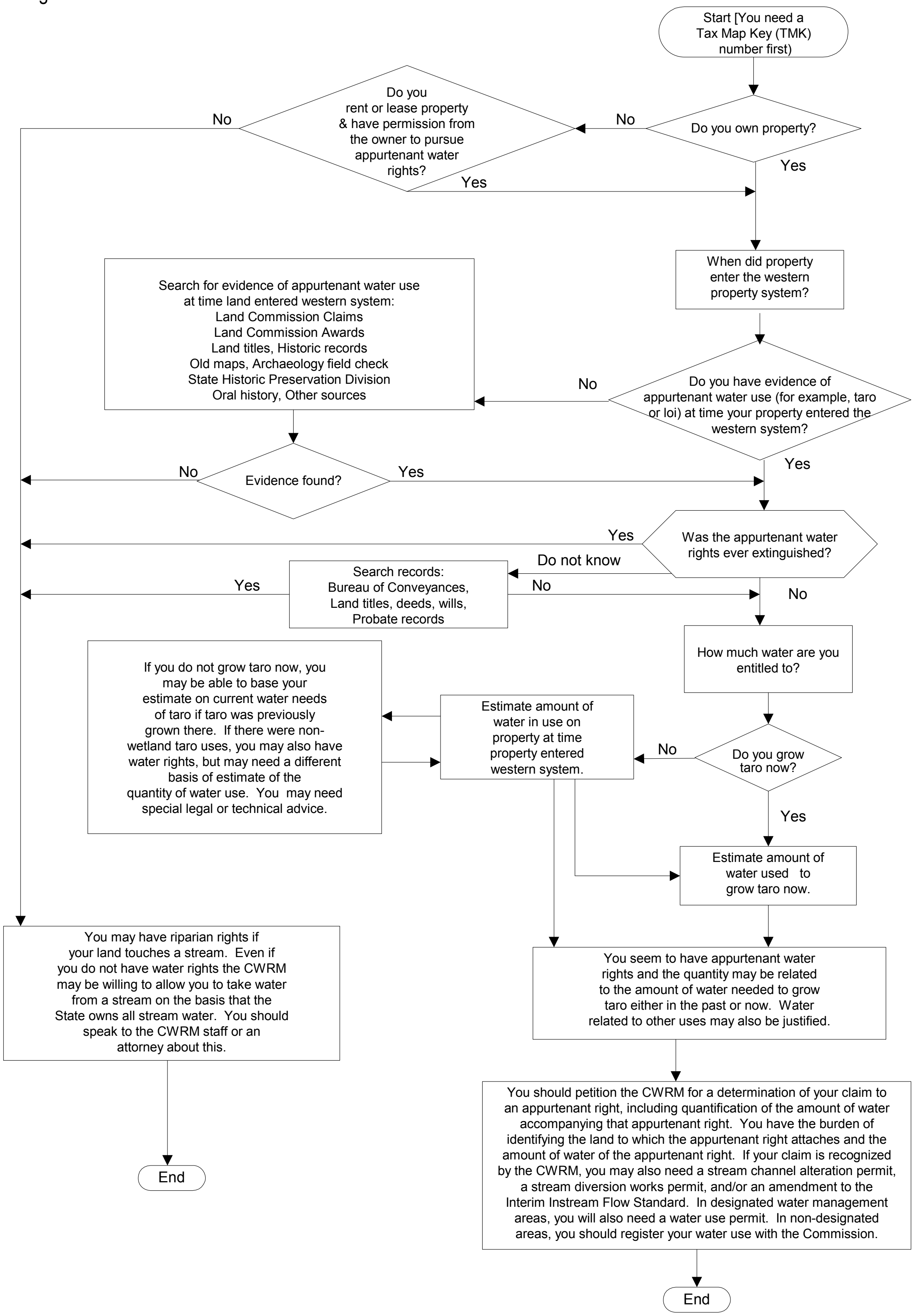
[1] Although the final Water Resource Protection Plan had not been printed as of the date of this report, most edits had already been incorporated into the latest version, which the Commission utilized for this report.
[2] 54 Haw. 174, at 188; 504 .2d 1330, at 1339.
[3] 65 Haw. 531, at 554; 656 P.2d 57, at 72.
[4] *Peck v Bailey*, 8 Haw. 658, at 665 (1867).

water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the State and county land use plans and the public interest"). As mentioned earlier, appurtenant rights are preserved under the State Water Code, so even in designated water management areas, an unexercised appurtenant right is not extinguished and must be issued a water use permit when applied for, as long as the water use permit requirements are met [Figure 12-1].

Figure 12-1. Generalized process for determining appurtenant water rights. This process is generalized and may not fully explain all possible situations. It does not apply to Hawaiian Homes Lands. If you are Native Hawaiian you may have other water rights.



The Hawaii Legislative Session of 2002 clarified that the Commission is empowered to "determine appurtenant rights, including quantification of the amount of water entitled to by that right," (HRS §174C-5(15)). In those cases where a Commission decision may affect an appurtenant right, it is the claimant's duty to assert the appurtenant right and to gather the information required by the Commission to rule on the claim. The Commission is currently in the process of developing a procedural manual to aid in the understanding and assembling of information to substantiate an appurtenant rights claim.

Tables 12-1 and 12-2 provide references to historical documentation that has been submitted to the Commission in support of the appurtenant rights claims by two landowners in the hydrologic unit of Honopou.

Table 12-1. Information submitted in support of the appurtenant rights claim for Land Commission Award 5459-X:2.

Landowner	Tax Map Key	Land Commission Award	Claimant	Parcel Area (Acres)
Lokana Kepani, Jr., etal.	2-2-9-001:016	5459-X:2	Imihia	0.69*
Claim filed by:	Native Hawaiian Legal Corporation (Moses K.N. Haia III) on behalf of Beatrice Kekahuna			
Land Comm. Award:	L.C.Aw. 5459-X, Book 8, p. 299 Awardee: Imihia Location: Honopou, Hamakualoa, Maui R.P. 3241, Book 14, p. 275			
Native Register:	Vol. 6, p. 300, No. 5459X – Imihia Here is my land: Puniawa and Kaulukanu in Honopou, in Hamakualoa. IMIHIA			
Native Testimony:	Vol. 5, p. 489, No. 5459 X, Imihia, July 17, 1849 Nakaikuaana sworn Imihia's land is in 4 sections. Section 2 – Taro, potato at Kaulukanu, from Kamakahihipuni in 1839, 1 poalima here. Section 2: Mauka by Nakaikuaana Koolau by Honopou pali Makai by Kepaa Wailuku by Honopou pali			
Foreign Testimony:	Vol. 8, p. 112, July 17, 1849 Nakaikuaana, sworn, claimant's land are of four pieces in Honopou. No. 2 Kalo land in the ʻili of Kalukanu. The claimant received…No. 2 from Makahihipuni, the acting konohiki in 1839… His title has never been disputed. There are two poalimas in No. 1… No. 2 is bounded: Mauka by my land Koolau by pali of Honopou Makai by Kepaa's land Wailuku by pali of Honopou.			
Original Source of Title:	None provided.			
Property Interest Owners:	Dana Kay Kepani[2]; Herman Kepani, Jr.[2]			
Additional Notes:	* Waihona lists 0.69 acres as the area for this award. The TMK identifies the total parcel area as 0.34 acres. [2]Fee Owner			

Table 12-2. Information submitted in support of the appurtenant rights claim for Land Commission Award 5595-E.

Landowner	Tax Map Key	Land Commission Award	Claimant	Parcel Area (Acres)
E. Mailani Brown-Cramer	2-2-9-001:014	5595-E	Kepaa	4.79[1]

Claim filed by:	Native Hawaiian Legal Corporation (Moses K.N. Haia III) on behalf of Beatrice Kekahuna and Marjorie Wallett
Land Comm. Award:	L.C.Aw. 5595-E, Book 8, p. 320 Awardee: Kepaa Location: Honopou, Hamakualoa, Maui R.P. 3242, Book 14, p. 277
Native Register:	Vol. 6, p. 305-306, No. 5595E – Kepaa, January 23, 1848 Here ye: Here is my explanation to you. Hanapou [sic] is the Ahupuaʻa. Here is my claim for land. At Kunananiho are 14 loʻi, 2 kalawa*, 1 row of steep potato planting. My lopa (tenant) has 13 loʻi and 1 kalawa. In the upland of this ʻIli of Kunananiho, from Keauhou to Waihiloa, are six koa (trees). 4 fresh water shrimp catching places are at Halawa. One koa (tree) is at Halehaku, making the seventh of the koa (trees). KEPAA (*Probably an irregular planting.)
Native Testimony:	Vol. 5, p. 496, Kepaa, July 18, 1849 Kaumakahano, sworn, Kepaa has 2 land sections. These are taro lands and pasture at Hunananiho of Honopou ahupuaa, which Ku had given at the time of Kamehameha II, 2 poalimas there, no one has objected to Kepaa. Section 1: Mauka by Kaina Koolau and Makai by Honopou pali Wailuku by Stream. Section 2: Mauka by Aupuni Koolau by Honopou Stream Makai and Wailuku by Aupuni
Foreign Testimony:	Vol. 8, p. 119 Kaumakahano, sworn, the claimant's land are of two pieces in Honopou No. 1 is kalo land in the ili of Hunananiho. No. 2 is kalo land in the ili of Hunananiho. The claimant received them from Ku, konohiki for Honopou [at] that time in the days of Kamehameha II. His title has never been disputed. There are two poalima in it. No. 1 is bounded: Mauka by Kaina'a land Koolau by pali of Honopou Makai by pali of Honopou Wailuku by creek of Honopou. No. 2 is bounded: Mauka by Kauluhala's land Koolau by creek of Honopou On the other two sides by Aupuni.
Original Source of Title:	None provided.
Property Interest Owners:	Virginia K. Amaral[2]; Edmund K. Amaral[2]; Robert K. Amaral[2]; Lynn L. Asagra[2]; E.M. Brown-Cramer[2]; Nancy Chastang[2]; Imogene U. Cordero[2]; Dora U.K. Givilancz[2,3]; Tanya K. Hicks[2]; Mathew K. Kahue[2]; Julia Kaina[2]; George Kaleialoha; Jacob Kaleialoha[2]; John K. Kaleialoha[2]; Rodney Kaleialoha[2]; Beatrice K. Kekahuna[2]; Abel Kepani[2,3]; Elizabeth S. (Brown) Kepani; Henry Kepani[2,3]; Jonah Kepani[2,3]; Kelly Kepani[2]; Matthew K. Kepani[2]; Barbara J. Maa[2]; Maude E. Sadosky[2]; Esther K. Vierra[2,3]; Marjorie Wallett[2]
Additional Notes:	[1]Waihona lists 4.79 acres as the area of this award. The TMK identifies this award as a portion of the parcel, which has a total area of 22.81 acres. [2]Fee Owner [3]Deceased

The Commission conducted a cursory assessment of tax map key parcels to identify their associated Land Commission Awards, in an attempt to identify the potential for future appurtenant rights claims within the hydrologic unit of Honopou. In addition to the original reference documents, a 2001 inventory conducted by Kumu Pono Associates, under contract by East Maui Irrigation Company, serves as a valuable reference of historical accounts of the lands of Hamakua Poko, Hamakua Loa, and Koolau, Maui Hikina (east Maui). Table 12-3 presents the results of the Commission's assessment.

Table 12-3. Tax map key parcels with associated Land Commission Awards for the Honopou hydrologic unit.

[LCA is Land Commission Award; Gr. is Grant; por. is portion; and G.L. is Government Lease.]

TMK	Landowner	LCA	Grants/Leases	Notes
(2)2-8-007:003	East Maui Irrigation Co. Ltd.	5499 5506:2 5459-W	none	
(2)2-8-007:005	East Maui Irrigation Co. Ltd. /Etal	5508:1	none	
(2)2-8-007:006	East Maui Irrigation Co. Ltd. /Etal	5508:2	none	
(2)2-8-007:999	Road	N/A	none	
(2)2-8-008:007	East Maui Irrigation Co. Ltd.	8515:3	none	
(2)2-9-001:001	Appleby,Michael Wayne /Etal	5521:2	none	
(2)2-9-001:002	Perry,Christine Louise	5521-B	none	
(2)2-9-001:003	Appleby,Michael W /Etal	5522-B:2	none	
(2)2-9-001:006	Bathelt,F & T Trust /Etal	none	Gr. 3101:1	
(2)2-9-001:007	Bathelt,Friedrich/Thorunn Tr	5459-X:1	Gr. 1916:5	Gr. 1916:5 applies only to a small portion of the parcel.
(2)2-9-001:009	Souza,Barron T /Etal	4796:2II	none	
(2)2-9-001:010	Young,Beverly A Trust /Etal	4796:2I	none	
(2)2-9-001:012	Tavakoli,Homayon M /Etal	none	Gr. 1081	
(2)2-9-001:013	Chastang,Nancy E /Etal	5392-K	Gr. 1916	Gr. 1916 applies to dropped parcel 45.
(2)2-9-001:014	Amaral,Edmund Kalauapa /Etal	5595-E:1	Gr. 1082 Gr. 3101:2 Gr. 1918:1	
(2)2-9-001:016	Kepani,Dana Kay /Etal	5459-X:2	none	
(2)2-9-001:017	Browne,Roan Trust /Etal	none	Gr. 1267	
(2)2-9-001:019	Hodgins,William K	5521:1	none	
(2)2-9-001:022	Manini,Eulalia Gay	6510-D:5	none	
(2)2-9-001:023	Basques,Clifford Wayne Keliipualani /Etal	none	Gr. 1903	
(2)2-9-001:024	Kepani,Dana Kay /Etal	10650:1	none	
(2)2-9-001:025	Basques,Clifford Wayne Keliipualani /Etal	5516:2	none	
(2)2-9-001:026	Bowman,Misha Leah	5451-B:2	none	
(2)2-9-001:027	Mattson,John P Estate	none	Gr. 3110	
(2)2-9-001:030	Ling,Edmund K M Trustee /Etal	none	Gr. 1169	Gr. 1169 applies to dropped parcel 36.
(2)2-9-001:031	Ayers,Manaohia K /Etal	none	Gr. 1265	
(2)2-9-001:047	Kahle,Richard Daryl	none	Gr. 12380	

Table 12-3. Continued. Tax map key parcels with associated Land Commission Awards for the Honopou hydrologic unit.

[LCA is Land Commission Award; Gr. is Grant; por. is portion; and G.L. is Government Lease.]

TMK	Landowner	LCA	Grants/Leases	Notes
(2)2-9-001:048	Manini,Eulalia Gay	5522-B:1	none	
(2)2-9-001:050	Sorensen,Stanley Michael	5522-B:1	none	
(2)2-9-001:051	Crozier,Franklin R Trust	5522-B:1	none	
(2)2-9-001:052	Carpenter,Valerie	5522-B:1	none	
(2)2-9-001:053	Crozier,Franklin R /Etal	5522-B:1	none	
(2)2-9-001:054	Kahiamoe,Mary Mae N Trustee	5522-B:1 5459-X:3:II	Gr. 1916:1	
(2)2-9-001:055	Koma,Thomas K Tr	5521:3	none	
(2)2-9-001:056	Koma,Thomas K Tr	5521:3	none	
(2)2-9-001:057	Magligato,Nila N	5521:3	none	
(2)2-9-001:058	Magligato,Nila N	5521:3	none	
(2)2-9-001:059	Manini,Eulalia Gay	5521:3	none	
(2)2-9-001:060	Tmk 2901-48 /Etal	5522-B:1	none	
(2)2-9-001:061	Tmk 2901-55 /Etal	5521:3	none	
(2)2-9-001:062	Brown,Mark /Etal	none	Gr. 1266	Gr. 1266 applies to parcels 62, 63, and 64.
(2)2-9-001:063	Richards,Jill Marie /Etal	none	Gr. 1266	Gr. 1266 applies to parcels 62, 63, and 64.
(2)2-9-001:064	Ollech,Dana /Etal	none	Gr. 1266	Gr. 1266 applies to parcels 62, 63, and 64.
(2)2-9-001:065	Sajdak,Linda Jean /Etal	none	Gr. 1264	
(2)2-9-001:077	Tavakoli,Homayon M /Etal	none	Gr. 1077	
(2)2-9-003:010	Iwankiw,Brian /Etal	none	Gr. 1263	
(2)2-9-003:012	Stark,Lani Norries	6510-Q:2	none	
(2)2-9-003:013	East Maui Irrigation Co. Ltd.	none	Gr. 538:3	
(2)2-9-003:014	Bauer,Ann R Tr	none	Gr. 972	Gr. 972 applies to parcels 14, 57, and dropped parcel 52.
(2)2-9-003:018	Fisher,Ian	none	Gr. 9267	
(2)2-9-003:019	Young,Beverly A Trust /Etal	none	Gr. 9267	
(2)2-9-003:022	Martin,Carl W /Etal	5459-O	none	
(2)2-9-003:035	Basques,Clifford Wayne Keliipualani /Etal	none	Gr. 3087	
(2)2-9-003:036	Coleman,Catherine	5451-B:1	none	
(2)2-9-003:037	East Maui Irrigation Co. Ltd.	10650:2&3	none	
(2)2-9-003:055	East Maui Irrigation Co. Ltd.	none	Gr. 538:3	
(2)2-9-003:057	Botonis,Felicia Bright	none	Gr. 972	Gr. 972 applies to parcels 14, 57, and dropped parcel 52.
(2)2-9-004:030	East Maui Irrigation Co. Ltd. /Etal	none	Gr. 1075 (por.)	
(2)2-9-004:031	Anderson Land Ltd. /Etal	none	Gr. 1075 (por.)	
(2)2-9-004:065	Anderson Land Ltd. /Etal	none	Gr. 1075 (por.)	
(2)2-9-004:066	Anderson Land Ltd. /Etal	none	Gr. 1075 (por.)	

Table 12-3. Continued. Tax map key parcels with associated Land Commission Awards for the Honopou hydrologic unit.

[LCA is Land Commission Award; Gr. is Grant; por. is portion; and G.L. is Government Lease.]

TMK	Landowner	LCA	Grants/Leases	Notes
(2)2-9-014:001	State Of Hawaii	none	G.L. 3578 (por.) (Water License)	
(2)2-9-014:009	East Maui Irrigation Co. Ltd.	2937	none	
(2)2-9-014:016	Amico,Erich /Etal	none	Gr. 538:1 (Water Agreement)	
(2)2-9-014:017	State Of Hawaii	none	G.L. 3578 (por.) (Water License)	

In accordance with the State Water Code and the Supreme Court's decision in the Waiahole Ditch Combined Contested Case Hearing, the Commission is focused on the assertion and exercise of appurtenant rights as it largely relates to the cultivation of taro. Wetland kalo or taro (*Colocasia esculenta* (L.) Schott) is an integral part of Hawaiian culture and agricultural tradition. The preferred method of wetland taro cultivation, where terrain and access to water permitted, was the construction of loi (flooded terraces) and loi complexes. These terraces traditionally received stream water via carefully engineered open channels called auwai. The auwai carried water, sometimes great distances, from the stream to the loi via gravity flow. In a system of multiple loi, water may either be fed to individual loi through separate little ditches if possible, or in the case of steeper slopes, water would overflow and drain from one loi to the next. Outflow from the loi may eventually be returned to the stream.

The loi also served other needs including the farming of subsidiary crops such as banana, sugar cane, and ti plants that were planted on its banks, and the raising of fish such as oopu, awa, and aholehole within the waters of the loi itself. At least 85 varieties of taro were collected in 1931, each of which varied in color, locale, and growing conditions. The water needs of taro under wet conditions depend upon: 1) climate; 2) location and season (weather); 3) evaporation rate; 4) soil type; 5) ground water hydrology; 5) water temperature; and 6) agronomic conditions (crop stage; planting density and arrangement; taro variety; soil amendment and fertilization regime; loi drainage scheme; irrigation system management; and weed, pest, and disease prevalence and management).

Among its comments to the draft version of this and the other concurrent IFSARs, Native Hawaiian Legal Corporation submitted testimony from 2001 relating to taro cultivation and gathering practices in east Maui streams. The pre-printed forms were completed by several east Maui residents. The information relating to taro cultivation is collected in Table 12-4 (See CPRC 29.2-1 through 29.2-56).

Table 12-4. Summary of the 2001 testimonies submitted by NHLC related to taro cultivation.

Declarant (CPRC Reference)	Stream Adjacent To Property	Stream Adjacent To Property Where Kalo Is Grown	Stream Source For Auwai Adjacent To Property	Stream Source For Auwai Adjacent To Property Where Kalo Is Grown	Streams Where Kalo Would Be Grown If Water Were Available
Charles L. Barclay (CPRC 29.2-3)	Wailuanui	Lakini	Lakini	Kualani, Waiokamilo (Kamilo)	Makapipi
	Problem Statement (Kalo): "No constant water flow. Also because of lack of water flow at Lakini we are unable to open all of our patches at Wailua-Nui."				
Awapuhi Carmichael (CPRC 29.2-55)					

Table 12-4. Continued. Summary of the 2001 testimonies submitted by NHLC related to taro cultivation.

Declarant (CPRC Reference)	Stream Adjacent To Property	Stream Adjacent To Property Where Kalo Is Grown	Stream Source For Auwai Adjacent To Property	Stream Source For Auwai Adjacent To Property Where Kalo Is Grown	Streams Where Kalo Would Be Grown If Water Were Available
Daniel Carmichael (CPRC 29.2-33)					
Puanani Holokai (CPRC 29.2-17)	(lease) Piinaau & Palahulu	(lease) Piinaau & Palahulu	(lease) Piinaau & Palahulu	(lease) Piinaau & Palahulu	
Cindy Ku'uipo Ka'auamo (CPRC 29.2-21)	Waiokamilo			Waiokamilo, Kulani, Wailuanui, Palauhulu, Piinaau	
Darlene Kaauamo (CPRC 29.2-19)	Waiokamilo			Waiokamilo, Kulani, Wailuanui, Palauhulu, Piinaau	
Frances Kaauamo (CPRC 29.2-45)			Waikani		
Hannah K. Kaauamo (CPRC 29.2-27)	Ka'amilo (Wai O'Ka Milo)	La'Kine, Wai O'Ka Milo, Kulani	Wai'Lua'Nui, Wai'O'Kamilo	La'Kine, Wai'Lua'Nui, Kulani, Wai Kani, Wai O'Ka Milo,	Wai'Lua'Nui
	<u>Problem Statement (Kalo):</u> "There is not enough water flowing through the streams, - That is one of the reason why we have a lot diseases destroying our taro - We have to depend on the rain to get more water flow - In the above streams but some of the stream have no life (note enough flow)."				
Leolani R. Kaauamo (CPRC 29.2-41)	Ka'a Hiio (?)	Laikaine-moii (?, illegible)	Wailuanui, Waiokamoii	Wailuanui, Waiokamoii, Lakai, Waiokani	Wailuanui
	<u>Problem Statement (Kalo):</u> "Water way was constructed by the State of HI but insufficient water to feed water way has diminished since not enough water to fill 8" of pipe on a continuous flow."				
Mary Kaauamo (CPRC 29.2-43)			Wailuanui and Waiokamilo	Wailuanui and Waiokamilo	
Samuel E. Kaauamo (CPRC 29.2-25)	Lakini, Kaamilo	Lakini, Kaamilo	Lakini, Kaamilo	Lakini, Kaamilo	Lakin, Kamilo
Solomon Kaauamo Jr. (CPRC 29.2-29)	Kaamilo (Waiokamilo)	Lakini, Kulani, Waiokamilo, Wailuanui	Wailuanui, Waiokamilo	Wailuanui, Waiokamilo, Lakini, Kulani	Wailuanui
	<u>Problem Statement (Kalo):</u> "Water way was constructed by the State of HI, but insufficient water to feed water way. Water has diminished since. Not enough water to fill 8" of pipe, on a continuous flow."				
Gladys Kanoa (CPRC 29.2-31)	Waiokamilo, Piinaau, Palauhulu, Kulani	Waiokamilo, Piinaau, Palauhulu, Kulani	Waiokamilo, Piinaau, Palauhulu, Kulani	Lakini, Makilo, Waiokamilo, Palauhulu, Kualani	

Table 12-4. Continued. Summary of the 2001 testimonies submitted by NHLC related to taro cultivation.

Declarant (CPRC Reference)	Stream Adjacent To Property	Stream Adjacent To Property Where Kalo Is Grown	Stream Source For Auwai Adjacent To Property	Stream Source For Auwai Adjacent To Property Where Kalo Is Grown	Streams Where Kalo Would Be Grown If Water Were Available
Jerome Kekiwi, Jr. (CPRC 29.2-49)	Lakini, Kulani, Kamilo	Wai O Kamilo, Lakini, Kulani	Wai O Kamilo, Lakini, Kulani		Waikau, Wailua
	Problem Statement (Kalo): "The water is unable to reach the land because there is no access or irrigation to go to the kalo patch."				
Puaala Kekiwi (CPRC 29.2-47)			(lease) Kulani, Waiokamilo	Kulani, Waiokamilo	
Chauncey K. Kimokeo (CPRC 29.2-5)			Palahulu	Keanae Flume	
Ihe Kimokeo (CPRC 29.2-11)			Palahulu	Keanae Flume	
Lincoln A. Kimokeo (CPRC 29.2-9)			Palahulu	Palahulu	Kolea to Makapipi
	Problem Statement (Kalo): "Because of low water pressure water is unable to reach loi furthest from flume catchments and production is minimal and could be of higher quality. This prevents all kalo farmers & residents of this ahupua'a from utilizing all of the resources in this ahupua'a and making higher productivity depending on the streams."				
Pualani Kimokeo (CPRC 29.2-7)			Palahulu	Palahulu	Any property next to me
	Problem Statement (Kalo): "We need constant flowing water at all times. Patches next to the flume catch is more likely to have a better growth than the patches at the end cause the water pressure gets smaller and warmer."				
Willie K. Kimokeo (CPRC 29.2-13)	Palahulu	Keanae Flume	Keanae Flume	Keanae Flume	
Norman D. Martin Jr. (CPRC 29.2-15)	Waikane, Kulani, Waiokamilo	Waikane, Kulani, Waiokamilo	Waikane, Kulani, Waiokamilo	Waikane, Kulani, Waiokamilo	Waikane
	Problem Statement (Kalo): "Lack of water."				
B. Tau-a M. Pahukoa (CPRC 29.2-51)	Waiakamilo (sic), Piinaua (sic)	Palauhulu, Waiakamilo & Piinaua But [illegible] water from flume that comes from Palauhulu also.	Waiakamilo, Palauhulu, Piinaua & also Waipio	Waiokamilo & Piinaau	Waipio
	Problem Statement (Kalo): "There is lack of water to even push (?) the stream."				
Benjamin Smith Sr. (CPRC 29.2-37)	Wailua Nui		Wailua Nui, Ka Milo		
	Problem Statement (Kalo): "We subsist on whatever water that is not diverted. Since 1985 our streams are dry. We need more water that we are accustomed to before Hawaii became a state."				
Lucille L. Smith (CPRC 29.2-39)	Wailua Nui		Wailua Nui, Kamilo		

Table 12-4. Continued. Summary of the 2001 testimonies submitted by NHLC related to taro cultivation.

Declarant (CPRC Reference)	Stream Adjacent To Property	Stream Adjacent To Property Where Kalo Is Grown	Stream Source For Auwai Adjacent To Property	Stream Source For Auwai Adjacent To Property Where Kalo Is Grown	Streams Where Kalo Would Be Grown If Water Were Available
Edward Wendt (CPRC 29.2-53)	Lakini and Waiokamilo, Kulani	Lakini and Waiokamilo, Kulani	Lakini, Kulani, Waiokamilo	Lakini, Kulani, Waiokamilo	

In 2002, the State Office of Hawaiian Affairs cosponsored a "No Ka Lo'i Conference", in the hopes of bringing together taro farmers from around the state to share knowledge on the cultivation of taro. An outcome of the conference was an acknowledgement that farmers needed to better understand the water requirements of their taro crops to ensure and protect their water resource interests. The result of this effort was a 2007 USGS wetland kalo water use study, prepared in cooperation with the State Office of Hawaiian Affairs, which specifically examined flow and water temperature data in a total of 10 cultivation areas on four islands in Hawaii. Two of the loi (flooded terrace) complexes are located in east Maui (Wailua and Keanae).

The study reiterated the importance of water temperature in preventing root rot. Typically, the water in the taro loi is warmer than water in the stream because of solar heating. Consequently, a taro loi needs continuous flow of water to maintain the water temperature at an optimum level. Multiple studies cited in Gingerich, et al., 2007, suggest that water temperature should not exceed 77ºF (25ºC). Low water temperatures slow taro growth, while high temperatures may result in root rot (Penn, 1997). When the flow of water in the stream is low, possibly as a result of diversions or losing reaches, the warmer water in the taro loi is not replaced with the cooler water from the stream at a quick enough rate to maintain a constant water temperature. As a result, the temperature of the water in the taro loi rises, triggering root rot.

The 2007 USGS study noted that "although irrigation flows for kalo cultivation have been measured with varying degrees of scientific accuracy, there is disagreement regarding the amount of water used and needed for successful kalo cultivation, with water temperature recognized as a critical factor. Most studies have focused on the amount of water consumed rather than the amount needed to flow through the irrigation system for successful kalo cultivation (Gingerich, et al., 2007)." As a result, the study was designed to measure the throughflow of water in commercially viable loi complexes, rather than measuring the consumption of water during taro growth.

Because water requirements for taro vary with the stage of maturity of the plants, all the cultivation areas selected for the study were at approximately the same stage (i.e. near harvesting, when continuous flooding is required). Temperature measurements were made every 15 minutes for approximately 2 months. Flow measurements were collected at the beginning and the end of that period. Data were collected during the dry season (June – October), when water requirements for cooling kalo are higher. Surface water temperatures generally begin to rise in April and remain elevated through September, due to increased solar heating. Water inflow temperature was measured in 17 loi complexes, and only three had inflow temperatures rising above 27ºC (the threshold temperature above which wetland kalo is more susceptible to fungi and associated rotting diseases).

The average and median inflows from all 10 cultivation areas studied are listed in Table 12-5 below. The study indicated that the "values are consistent with previously reported inflow and are significantly higher than values generally estimated for consumption during kalo cultivation." It should also be noted that farmers were interviewed during field visits; most "believed that their supply of irrigation water was insufficient for proper kalo cultivation."

Table 12-5. Summary of water use calculated from loi and loi complexes by island, State of Hawaii (Source: Gingerich et al., 2007, Table 10).

[gad = gallons per acre per day; na = not available]

Island	Complex				Loi			
	Number	Average water use (gad)	Average windward water use (gad)	Average leeward water use (gad)	Number	Average water use (gad)	Average windward water use (gad)	Average leeward water use (gad)
Kauai	6	120,000	97,000	260,000	2	220,000	220,000	na
Oahu	5	310,000	380,000	44,000	4	400,000	460,000	210,000
Maui	6	230,000	230,000	na	na	na	na	na
Hawaii	2	710,000	710,000	na	na	na	na	na
Average of all measurements		260,000	270,000	150,000		350,000	370,000	210,000
Median of all measurements		150,000	150,000	150,000		270,000	320,000	210,000

The windward Maui areas chosen for the study were Waihee, Wailua, and Keanae. Wailua and Keanae each have numerous individual loi and loi complexes. Three of the Wailua area complexes were available for study: 1) Lakini complex, supplied through an auwai with water diverted from Hamau Stream, which in turn receives diverted water from Waiokamilo Stream; 2) Wailua complex, supplied through an auwai with water diverted from Waiokamilo Stream; and 3) Waikani complex, supplied through an auwai with water diverted from Wailuanui Stream. The loi in Keanae were treated as a single complex supplied by the Keanae Flume, which diverts water from Palauhulu Stream. The study results are presented below in Table 12-6 (discharge measurements) and Table 12-7 (water-temperature statistics).

Table 12-6. Summary of discharge measurements and areas for selected loi complexes, island of Maui (Source: Gingerich et al., 2007, Table 6).

[mgd = million gallons per day; gad = gallons per acre per day; na = not applicable; average water use is determined by summing the averages of each complex or loi and dividing by the number of complexes or loi.]

Area	Complex						
	Station	Irrigation area (acre)	Date	Measurement time	Discharge (mgd)	Water use (gad)	Remarks
Waihee	Ma08A-CI	2.3	7/29/2006	1501	0.34	150,000	total flow for upper and lower complexes
			9/22/2006	1158	0.30	130,000	total flow for upper and lower complexes
	Ma08B-CIR	na	7/29/2006	1500	0.025		
	Ma08B-CIL	na			0.06		
		0.76		na	0.085	110,000	combined right and left complex inflows
	Ma08B-CIR	na	9/22/2006	1150	0.058		
	Ma08B-CIL	na		1055	0.067		
		0.76		na	0.13	160,000	combined right and left complex inflows
Wailua (Lakini)	Ma09-CIR	na	7/30/2006	1004	0.26		
	Ma09-CIL	na		947	0.30		
		0.74		na	0.56	750,000	combined right and left complex inflows
	Ma09-CIR	na	9/21/2006	1015	0.16		
	Ma09-CIL	na		1049	0.06		
	Ma09-CIM	na		1206	0.19		
		0.74		na	0.41	550,000	combined right, left, and middle complex inflows
Wailua	Ma10-CI	3.32	7/30/2006	1136	0.59	180,000	
			9/21/2006	845	0.46	140,000	
Wailua (Waikani)	Ma11-CI	2.80	7/30/2006	1236	0.54	190,000	
			9/21/2006	1608	0.26	93,000	
Keanae	Ma12-CI	10.53	7/31/2006	836	1.90	180,000	former USGS streamflow-gaging station
			9/21/2006	1415	1.60	150,000	
number		6.00				6	
minimum		0.74				93,000	
maximum		10.53				750,000	
average		3.41				230,000	

Table 12-7. Water-temperature statistics based on measurements collected at 15-minute intervals for loi complexes on the island of Maui (Source: Gingerich et al., 2007, Table 7).

[ºC = degrees Celsius; na = not applicable]

Geographic designation	Area	Station	Period of record	Temperature (ºC) Mean	Range	Mean daily range	Temperature measurements greater that 27ºC (percent)
Windward	Waihee	Ma08A-CI	7/29/2006 - 9/22/2006	21.6	19.9 - 24.0	2.0	0.0
		Ma08B-CIL	7/29/2006 - 9/22/2006	24.9	20.3 - 34.0	7.6	25.4
		Ma08B-CO	7/29/2006 - 9/22/2006	25.5	20.0 - 35.5	5.7	27.0
Windward	Wailua (Lakini)	Ma09-CIT	7/30/2006 - 9/21/2006	20.7	18.5 - 23.4	2.3	0.0
		Ma09-CO	7/30/2006 - 9/21/2006	23.2	18.4 - 31.7	7.4	16.9
Windward	Wailua	Ma10-CI	7/30/2006 - 9/21/2006	22.5	20.5 - 25.9	1.9	0.0
Windward	Wailua (Waikani)	Ma11-CI	7/30/2006 - 9/21/2006	22.2	21.0 - 24.0	0.7	0.0
		Ma11-CO	7/30/2006 - 9/21/2006	26.1	22.1 - 31.8	3.3	29.1
Windward	Keanae	Ma12-CI	7/31/2006 - 9/21/2006	20.0	19.0 - 21.9	1.0	0.0
		Ma12-CO	equipment malfunction	na	na	na	na

The Commission's records for the hydrologic unit of Honopou indicate that there are a total of 22 registered diversions, of which seven are EMI diversions. Of the 15 non-EMI diversions, six registrants declared water use for taro cultivation with an estimated cultivable area of 34.55 acres (0.05 square miles). Data from the statewide diversion verification study conducted by R.M. Towill Corporation, along with information collected from Commission staff site visits, and information extracted from the original registration files regarding the registered diversions may be found in Table 13-1 of Section 13.0, Noninstream Uses.

Commission staff held a Public Fact Gathering Meeting on April 10, 2008 in east Maui to gather comments on the draft version of this and the other four IFSARs published simultaneously. Written comments were also accepted over a 2-month period. A great deal of the oral and written testimony addressed traditional and customary rights, including taro cultivation and gathering practices. Dozens of east Maui residents testified that there is insufficient water in the streams to cultivate as much taro as desired; and that often the water that does flow is too warm, resulting in root rot. Some of this testimony related directly to Honopou Stream: Testimony indicated that Honopou Stream is diverted into ditches four times. A family whose auwai is 2 miles below the ditches states that they do not get enough water; water is 76ºF going into the loi and 82ºF going out of the loi, resulting in "rot and pythium and pit-rot" (See CPRC 1.0-18).

Further, testimony indicated that there is insufficient native fauna for gathering, and the water is also not sufficient for recreation. Testimony before the Board of Land and Natural Resources from May 2001 was also provided, with six long-time east Maui residents all stating that the streamflow in east Maui has diminished within their lifetimes (See CPRC 29.3-1 through 29.3-12). Some of the same six residents also provided oral testimony on April 10, 2008 and/or in writing. They, and others, state that the reduction in streamflow has impacted their ability to survive off the land and to perpetuate the Hawaiian culture (See CPRC).

As part of their written comments, Native Hawaii Legal Corporation also submitted testimony dated 2001, related to taro cultivation and gathering in east Maui streams. The testimony consisted of a form in which people completed pre-designated sections. The information in these forms, as it relates to gathering, is collected in Table 12-8 (See CPRC 29.2-1 through 29.2-56).

Table 12-8. Summary of the 2001 testimonies submitted by NHLC related to gathering practices.

Declarant (CPRC Reference)	What Is Gathered By The Family	Streams Where Gathering Is Practiced	What Would Be Gathered If Water Were Available	Streams Where Gathering Would Be Practiced If Water Were Available
Charles L. Barclay (CPRC 29.2-3)	opae, hihiwai, o'opu	Honomanu to Makapipi	opae, hihiwai, o'opu	Honomanu, Waiokamilo
	Problem Statement (Gathering): "Not enough free-flowing water to maintain the kalo, opae, hihiwai & o'opu."			
Awapuhi Carmichael (CPRC 29.2-55)	opae, hi hi wais, oopu	from Honomanu to Makapipi	opai (?)	Palauhulu, West Wailuaiki
	Problem Statement (Gathering): "As a child we had all the water we needed to gather & grow healthy taro. When Hawaii became a state, our ahupua'a is left with little or no water to grow healthy taro and gather. Our fishing areas are depleted. We need the water for this native (Kanaka maoli) ahupuaa whose people have existed here since time immemorial."			
Daniel Carmichael (CPRC 29.2-33)	opaes, hihiwais, oopu, and a variety of fishes in the ocean	Hanawi - Palauhulu, Piinaau Haepuaena - Wailuanui Stream - Waioka Milo aka Kamilo - Kapa'akea - Waiohue, Kapiliula, Wailuaiki East and West, Makapipi	a variety of species	all streams between Kolea & Kuahiwi
	Problem Statement (Gathering): "We do not have enough water in all streams from Kolea to Kuahiwi Nahiku for us to gather from mountain to ocean and from boundary in the ahupua'a of Keanae - Wailuanui within the Koolau District."			
Puanani Holokai (CPRC 29.2-17)	hihiwai, opae	Makapipi - Honomanu	opae, hihiwai	Palahulu
	Problem Statement (Gathering): "Can not gather opae in Palahulu stream because no water flow."			

Table 12-8. Continued. Summary of the 2001 testimonies submitted by NHLC related to gathering practices.

Declarant (CPRC Reference)	What Is Gathered By The Family	Streams Where Gathering Is Practiced	What Would Be Gathered If Water Were Available	Streams Where Gathering Would Be Practiced If Water Were Available
Cindy Ku'uipo Ka'auamo (CPRC 29.2-21)	opae, hi'iwai, prawns, o'opu, gold fish, haha	Makapipi to Honomanu	opae, hi'iwai	Wailuanui, Waiokamilo, Kulani, Palauhulu, Piinaau, Honomanu
	Problem Statement (Gathering): "Water is a source of life to land and man. It is not for man to possess, but simply for man to use. However, the right to use water depends entirely upon the use of it. The people of Keanae-Wailuanui Ahupua'a have respected the rights of water use for many generations. Our ancestors have taught us that water is of great value. Without it there is no life. "The decrease of water flow affects all life in, around and on this land. It prevents spawning of 'opae & 'o'opu, disrupting the natural process of reproduction resulting in decrease food supply. In addition, making it harder for people to gather. "Insufficient water flow decreases water temperature causing stagnation, allowing small ponds to become host of bacteria, spreading disease among striving creatures, plant life and even man. "Finally, the interruption of natural water flow affects taro. Diseases, foreign pest, decrease in production, frustration among farmers and a threat to our Hawaiian Culture as well as our way of life. "Like our ancestors, the people of Keanae-Wailuanui Ahupua'a understand the importance of water for all life. Because of this, we have inherited the rights of trusteeship over our natural resources. "As a trustee, I ask that you answer this question… Do you value the comfort of man or the life of man?... Think about it and do what is right. Restore our streams… Give life not death!"			
Darlene Kaauamo (CPRC 29.2-19)	opae, hihiwai, haha, prawn, gold fish, prawns	Makapipi to Honomanu	opae, hihiwai, haha, gold fish	Wailuanui, Waiokamilo, Kulani, Palauhulu, Piinaau, Honomanu
	Problem Statement (Gathering): "Insufficient water flow in our streams causes multiple problems. It decreases the production of food supply in our streams, causes an increase of bacteria in the water that remain in our streams causing hazard to the people & life that live in and around that area. Most importantly, it destroys the essence of our lifestyle of a taro farming community by causing damage to our taro."			
Frances Kaauamo (CPRC 29.2-45)				
	Problem Statement (Gathering): "Water flow in streams at times are reduced to 0 which years back the same streams would flow continuously."			
Hannah K. Kaauamo (CPRC 29.2-27)	pohole, leko, polu (?), opai, o'opu, hihiwai, HaHa	Makapipi to Kolea		
Leolani R. Kaauamo (CPRC 29.2-41)	Po-ne (sic), leko, poiup (?), ooipi (?), opoe (opae?), oopu, hihiwai, haha, pula, leko, pohole	Makapip (sic) to Kolea		in most of these streams but not enough water to sustain life
	Problem Statement (Gathering): "Not enough water for oopu to move downstream to spawn. Today there is no oopu."			
Mary Kaauamo (CPRC 29.2-43)			opae, oopu, hihiwai	Wailuanui and Waiokamilo

Table 12-8. Continued. Summary of the 2001 testimonies submitted by NHLC related to gathering practices.

Declarant (CPRC Reference)	What Is Gathered By The Family	Streams Where Gathering Is Practiced	What Would Be Gathered If Water Were Available	Streams Where Gathering Would Be Practiced If Water Were Available
Samuel E. Kaauamo (CPRC 29.2-25)	pupu, kalo, paholi [possibly means pohole?], haha, luau	Kuhiwa - Kolea		Kuhiwai Kolea
	<u>Problem Statement (Gathering):</u> "EMI is taking too much water."			
Solomon Kaauamo Jr. (CPRC 29.2-29)	opae, oopu, hihiwai, pulu, leko, pohole	Makapipi to Kolea		in most of these streams but not enough water to sustain life
	<u>Problem Statement (Gathering):</u> "Not enough water for oopu to move downstream to spawn. Today there is no oopu."			
Gladys Kanoa (CPRC 29.2-31)	hihiwai, opae, oopu, prawns, ahole, mullet	Honomanu to Makapipi	hihiwai, opae, oopu, prawns	Honomanu to Makapipi
	<u>Problem Statement (Gathering):</u> "Most years we have losses to our taro crops due to drought. Water temperatures cannot be maintained cold enough to keep taro healthy. Taro farmers shouldn't have to compete for use of limited water."			
Jerome Kekiwi, Jr. (CPRC 29.2-49)	opae, hihiwai, oopu	from Honomanu to Makapipi	opae, hihiwai, oopu	Kolea, Honomanu
	<u>Problem Statement (Gathering):</u> "When the rain stops, the water flow in Wailua streams drop to almost nothing. It is hard to grow kalo with no water in the patches."			
Puaala Kekiwi (CPRC 29.2-47)	opae, hihiwai, oopu	from Makapipi to Honomanu	opae	Palahulu in Keanae
	<u>Problem Statement (Gathering):</u> "Getting water to a few of our patches when my neighbor doesn't let any water down."			
Chauncey K. Kimokeo (CPRC 29.2-5)	opae, hihiwai, o'opu, ferns, plants	from Kolea to Makapipi		
Ihe Kimokeo (CPRC 29.2-11)	oopu, hihiwai, opae, pig hunting, prons (sic)	Kolea to Makapipi		
Lincoln A. Kimokeo (CPRC 29.2-9)	opae, hihiwai, prawns, Hawaiian herbs, ferns shoots, ti leaves, flowers, plants to make leis	all streams (Kolea to Makapipi)	Everything of use	Kolea to Makapipi
	<u>Problem Statement (Gathering):</u> "Regular water flow once sustained the right environment for great populations of fish and other stream life, today disturbed water flow prevents stream life to increase population."			
Pualani Kimokeo (CPRC 29.2-7)	opae, hihiwai, o'opu, Hawaiian herbs, ferns shoots, ti leaves, flowers, lei making ferns	all streams of the Koolau	Everything	All (along the Koolau Valley)
	<u>Problem Statement (Gathering):</u> "Our kalo growth would be massive if the water was left alone. We would not have all these sickness in our loi. Worked the loi all my life and never did see all the problems on our kalo & water till the years of late 1960 through now."			

Table 12-8. Continued. Summary of the 2001 testimonies submitted by NHLC related to gathering practices.

Declarant (CPRC Reference)	What Is Gathered By The Family	Streams Where Gathering Is Practiced	What Would Be Gathered If Water Were Available	Streams Where Gathering Would Be Practiced If Water Were Available
Willie K. Kimokeo (CPRC 29.2-13)	oopu, hihiwai, opae, water cress, mountain kalo, haha	Kolea to Makapipi	oopu, hihiwai, opae, water cress	Kolea to Makapipi
	Problem Statement (Gathering): "Lack of water."			
Norman D. Martin Jr. (CPRC 29.2-15)	oopu, hihiwai, opai, everything	Kolea to Makapipi	oopu, opai, hihiwai	Kolea to Makapipi
	Problem Statement (Gathering): "Lack of water."			
B. Tau-a M. Pahukoa (CPRC 29.2-51)	opae, hihiwai	from Kolea to Makapipi		from Makapipi to Kolea & Waipio, Honomanu, Wailuaiki & Waialohe which is the muliwai of Palauhulu & Piinaau
	Problem Statement (Gathering): "The problem is not all of the water in the streams meet the sea."			
Benjamin Smith Sr. (CPRC 29.2-37)	opai, hihiwai, oopu	Hanawi, Kapaula, Kopiliula, Kapa'akea, East and West Wailua Iki , Honomanu, Makapipi	opai, hihiwai, oopu	all streams between Kolea & Kuahiwa
Lucille L. Smith (CPRC 29.2-39)	opai, hihiwai & oopu	Hanawi, Makapipi, Kopiliula, Kapa'akea, East and West Wailua Iki , Kapahula, Waiohue, Honomanu	opai, hihiwai, oopu	streams between Kolea & Kuahiwa
Edward Wendt (CPRC 29.2-53)	opae, hihiwai, oopu		opai, hihiwai, oopu	Waiokamilo - Wailua Stream
	Problem Statement (Gathering): "Cause not enough free flowing to enhance aquatic life and to assist in good taro growth."			

Historical uses of Honopou Stream can also provide some insight into the protection of traditional and customary Hawaiian rights. Without delving into the extensive archive of literature (refer to Kumu Pono Associates, 2001a), Handy et al., in *Native Planters of Old Hawaii* (1972), provides a limited regional description as follows:

> East of Maliko the number of named *ahupua'a* is evidence of habitation along this coast.
>
> Two *kama'aina* at Ke'anae said that there were small *lo'i* developments watered by Ho'olawa, Waipi'o, Hanehoi, Hoalua, Kailua, and Na'ili'ilihaele Streams, all of which flow in deep gulches. Stream taro was probably planted along the watercourses well up into the higher *kula* land and forest taro throughout the lower forest zone. The number of very narrow *ahupua'a* thus utilized along the whole of the Hamakua coast indicates that there must have been a very considerable population. This would be despite the fact that it is an area of only moderate precipitation because of being too low to draw rain out of trade winds flowing down the coast from the rugged and wet northeast Ko'olau area that lies beyond. It was probably a favorable region for

> breadfruit, banana, sugar cane, arrowroot; and for yams and *'awa* in the interior. The slopes between the gulches were covered with good soil, excellent for sweet-potato planting. The low coast is indented by a number of small bays offering good opportunity for fishing. The *Alaloa*, or 'Long-road,' that went around Maui passed through Hamakua close to the shore, crossing streams where the gulches opened to the sea.

The HSA classified the cultural resources of Honopou Stream as "very limited." Data were collected in three general areas of: 1) archaeological; 2) historical; and 3) modern practices. Archaeological data were originally compiled by the State Historic Preservation Division and are only current to the date of the HSA (Table 12-9).

Table 12-9. Cultural resource elements evaluated as part of the Hawaii Stream Assessment for Honopou Stream.

Category	Value
Survey coverage: The extent of archaeological survey coverage was analyzed and recorded as complete, partial, very limited, and none. Few valleys are completely surveyed. Many have little or no survey coverage.	Very limited
Predictability: The ability to predict what historic sites might be in unsurveyed areas was scored as high, medium, or low predictability or unable to predict. A high score was assigned if archaeologists were able to predict likely site patterns in a valley given historic documents, extensive archaeological surveys in nearby or similar valleys, and/or partial survey coverage. A low score was assigned if archaeologists were unable to predict site patterns in a valley because of a lack of historical or archaeological information. A medium score was assigned to all other cases.	Low
Number of Sites: The actual number of historic sites known in each valley is straightforward yet very time consuming to count. Instead, archaeologists used survey information to estimate the number of sites in each valley. These figures, adequate for this broad-based assessment, are only rough estimates.	1
Valley significance as a Whole District: The overall evaluation of each valley's significance was made considering each valley a district. The significance criteria of the National and Hawaii Registers of Historic Places was used. Criterion A applies if the district is significant in addressing broad patterns of prehistory or early history. Criterion B applies if the district is associated with important people (rulers) or deities. Criterion C applies if the district contains excellent examples of site types. Criterion D applies if the district is significant for information contained in its sites. Finally, Criterion E applies if the district is culturally significant for traditionally known places or events or for sites such as burials, religious structures, trails, and other culturally noteworthy sites.	A, D, E
Site Density: The density patterns of historic sites make up a variable extremely important to planners. Three ranks were assigned: low for very few sites due either to normal site patterning or extensive land alteration, moderate for scattered clusters of sites, and high for continuous sites. Valleys with moderate or high density patterns are generally considered moderate or high sensitivity areas.	Low

Table 12-9. Continued. Cultural resource elements evaluated as part of the Hawaii Stream Assessment for Honopou Stream.

Category	Value
Site Specific Significance: The site specific significance variable was developed for valleys that had low densities of sites (very few sites) due either to normal site patterning or to extensive land alteration. An example of the first type might be a valley with housing sites on the side but too narrow for taro or housing sites on the valley floor. The second type might be a valley in which there had been sugar cane cultivation but a large heiau was left. The site specific significance of these valleys was categorized as either: 1) sites significant solely for information content which can undergo archaeological data recovery; or 2) sites significant for multiple criteria and merit preservation consideration. Those categorized as meriting preservation consideration would likely include large heiau, burial sites, and excellent examples of site types.	Sites significant for preservation
Overall Sensitivity: The overall sensitivity of a valley was ranked very high, high, moderate, low, or unknown. Very high sensitivity areas have moderate or high densities of sites with little or no land alteration. They are extremely important archaeological and/or cultural areas. High sensitivity areas have moderate or high densities of sites with little or no land alteration. Moderate sensitivity areas have very few sites with the sites meriting preservation consideration due to multiple criteria or moderate densities of sites with moderate land alteration. Low sensitivity areas have very few sites due to normal site patterning or due to extensive land alteration. The sites present are significant solely for their informational content, which enable mitigation through data recovery. Those valleys where no surveying had been undertaken and the ability to predict what might be found was low were ranked unknown.	Moderate
Historic Resources: Several types of sites were considered by inclusion in this section, particularly bridges, sugar mills and irrigation systems. Those that are listed on the State or National register were inventoried, but none of them assessed.	None
Taro Cultivation: Streams and stream water have been and continue to be an integral part of the Hawaiian lifestyle. The committee identified a number of factors important to current Hawaiian practices. These include current taro cultivation, the potential for taro cultivation, appurtenant rights, subsistence gathering areas, and stream-related mythology. The committee felt that a complete assessment of the cultural resources of Hawaii's streams should include these items but, due to limits of information, only the current cultivation of taro was included.	10 to 50 acres of taro

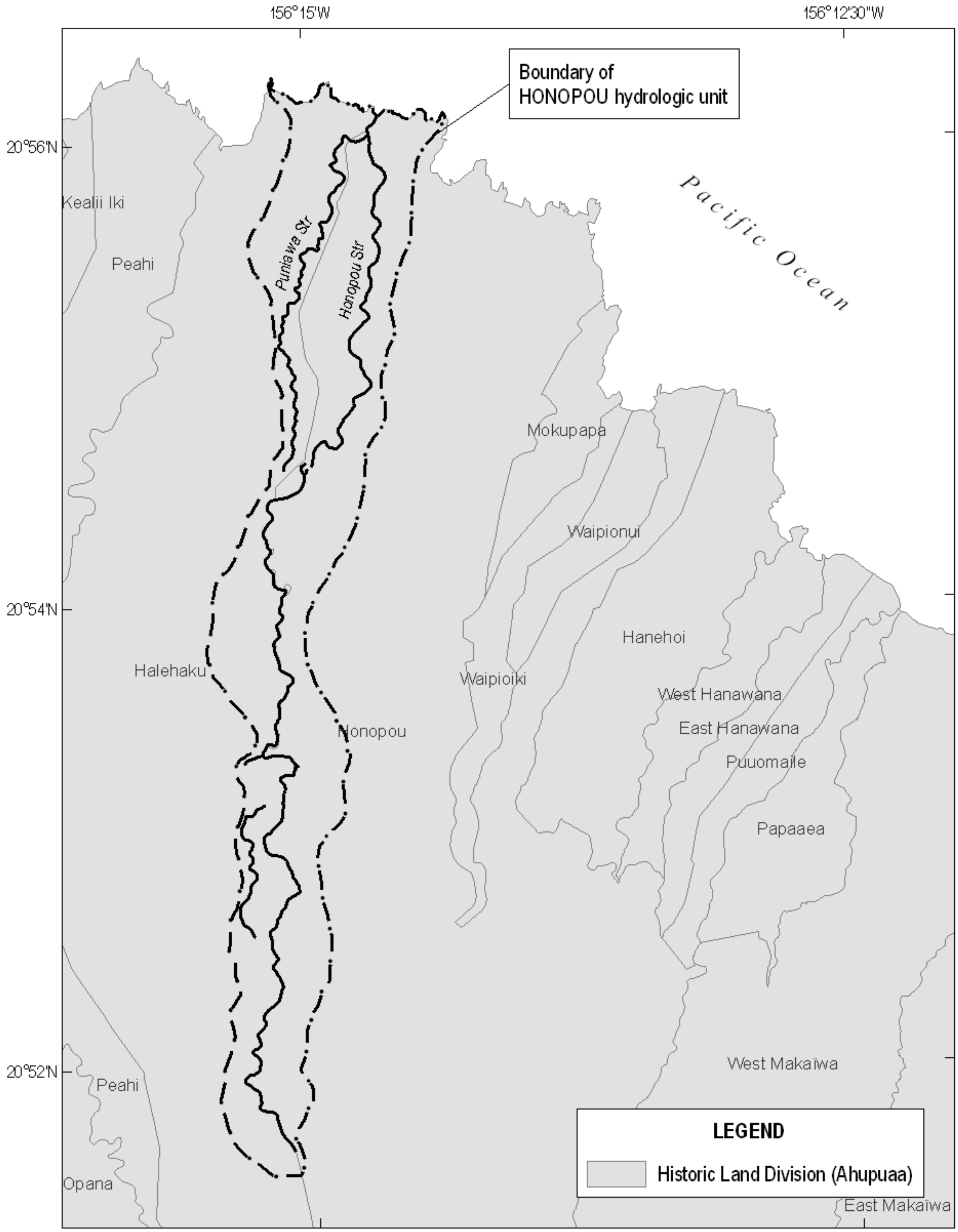
Fishponds are another integral part of traditional Hawaiian culture, which speaks volumes of Native Hawaiian skill and knowledge of aquaculture, which has also seen a resurgence of interest in recent years. Fishponds are found throughout the Hawaiian Islands and were either man-made or natural enclosures of water used for the raising and harvesting of fish and other aquatic organisms. Kikuchi (1973) identified six main types of fishponds, two of which are associated with streams (*loko wai*, *loko ia kalo*) and one type is associated with fresh water springs (*kaheka* or *hapunapuna*).

- Type III – *Loko Wai*: An inland fresh water fishpond which is usually either a natural lake or swamp, which can contain ditches connected to a river, stream, or the sea, and which can contain sluice grates. Although most frequently occurring inland, *loko wai* are also located along the coast near the outlet of a stream.
- Type IV – *Loko Ia Kalo*: A fishpond utilizing irrigated taro plots. *Loko ia kalo* are located inland along streams and on the coast in deltas and marshes.
- Type VI – *Kaheka* and *Hapunapuna*: A natural pool or holding pond. The majority, if not all of these types of ponds, are anchialine ponds with naturally occurring shrimp and mollusks.

According to a 1990 Hawaii Coastal Zone Management Program *Hawaiian Fishpond Study for the Islands of Hawaii, Maui, Lanai, and Kauai*, there are no fishponds present in the Honopou hydrologic unit (DHM, Inc., 1990).

Another component in the assessment of traditional and customary Hawaiian rights is the presence of Department of Hawaiian Home Lands (DHHL) parcels within the surface water hydrologic unit. The mission of DHHL is to effectively manage the Hawaiian Home Lands trust and to develop and deliver land to native Hawaiians (PBR Hawaii, 2004). In September 2004, DHHL published the Maui Island Plan which served to examine infrastructure needs, provide development cost estimates, and identify priority areas for homestead development. Of the more than 31,000 acres of DHHL land on the island of Maui, no parcels occur within the Honopou unit.

Figure 12-2. Traditional ahupuaa boundaries in the vicinity of Honopou hydrologic unit. This hydrologic unit spans two ahupuaa — Honopou and Haleaku (Source: State of Hawaii, Office of Planning, 2007a).



Prepared by the Department of Land and Natural Resources,
Commission on Water Resource Management.
Transverse Mercator projection, zone 4, North American Datum 1983

0 0.25 0.5 1 Miles

N

13.0 Noninstream Uses

Under the State Water Code, noninstream uses are defined as “water that is diverted or removed from its stream channel…and includes the use of stream water outside of the channel for domestic, agricultural, and industrial purposes.” Article XI, Section 3 of the State Constitution states: “The State shall conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally sustainable lands.” Water is crucial to agriculture and agricultural sustainability. Article XI, Section 3 also states, “Lands identified by the State as important agricultural lands needed to fulfill the purposes above shall not be reclassified by the State or rezoned by its political subdivisions without meeting the standards and criteria established by the legislature and approved by a two-thirds vote of the body responsible for the reclassification or rezoning action. [Add Const Con 1978 and election Nov 7, 1978].” It is the availability of water that allows for the designation of Important Agricultural Lands. In its comments to the draft version of this and the other four IFSARs published concurrently, the Hawaii Farm Bureau Federation, Hawaii’s largest advocacy organization for General Agriculture, states that agriculture is a public trust entity worthy of protection, as demonstrated in its inclusion in the State Constitution. They, along with the Maui County Farm Bureau on behalf of farmers and ranchers on Maui, point to the importance of large-scale agriculture to sustainability and self-sufficiency of our islands, particularly in times of catastrophe when imports are cut off (See CPRC 12.0 and 22.0).

In most cases, water is diverted from the stream channel via a physical diversion structure. Diversions take many forms, from small PVC pipes in the stream that remove relatively small amounts of water, to earthen auwai (ditches), hand-built rock walls, and concrete dams that remove relatively larger amounts of water. Water is most often used away from the stream channel and is not returned; however, as in the case of taro fields, water may be returned to the stream at some point downstream of its use. While the return of surface water to the stream would generally be considered a positive value, this introduces the need to consider water quality variables such as increased temperature, nutrients, and dissolved oxygen, which may impact other instream uses. Additionally, discharge of water from a ditch system into a stream may introduce invasive species.

In addition to the amount of water currently (or potentially) being diverted offstream, the Commission must also consider the diversion structure and the type of use, all of which impact instream uses in different ways. The wide range of diversion structures, as noted above, is what makes regulation of surface water particularly difficult, since one standard method cannot be depended upon for monitoring and measuring flow. The ease of diverting streamflow, whether it be by gravity-flow PVC pipe, pump, or a dug channel, also plays a role in the convenience of diverting surface water and the abundance of illegal, non-permitted diversions.

Upon the enactment of the State Water Code and subsequent adoption of the Hawaii Administrative Rules, the Commission required the registration of all existing stream diversions statewide. The Commission categorized the diversions and filed registrations according to the registrant’s last name or company name. While it is recognized that the ownership and/or lease of many of the properties with diversions has changed since then, the file reference (FILEREF) remains the name of the original registrant file (Table 13-1). Locations are depicted in Figure 13-14.

In 2007, the Commission initiated a contract for the purpose of conducting statewide field investigations to verify and inventory surface water uses and stream diversions, and update existing surface water information. Priority 1 Areas, under this contract, include all east Maui streams that are part of the pending Petition to Amend Interim Instream Flow Standards. Data from this study, along with information collected from Commission staff site visits, and information extracted from the original registration files are included in Table 13-1 and Table 13-2.

In the Honopou hydrologic unit, East Maui Irrigation Company (EMI) operates four parallel ditch systems, running from east to west, as part of the larger East Maui Irrigation System. Though EMI registered all of its "major" diversions (included in Table 13-1), the Commission did not require EMI to register their "minor" diversions and instead were provided with a map, lists, and photographs. These minor diversions may vary widely in construction. One example consists of a small concrete basin collecting ground water seepage, which then transports the collected water via a gravity-flow PVC pipe to a larger ditch, ultimately joining one of the primary systems. The contribution of these small seeps and springs to total streamflow is unknown. Information on EMI's minor diversions is listed in Table 13-2, and their locations depicted in Figure 13-13.

Since the enactment of HAR Title 13 Chapter 168, stream diversion works permits are required for the construction of new diversions or alteration of existing diversions, with the exception of routine maintenance. These permitted (as opposed to "registered") diversion works are not part of the Commission's verification effort, nor have any diversions been permitted in the Honopou hydrologic unit.

Table 13-1. Registered diversions in the Honopou hydrologic unit.

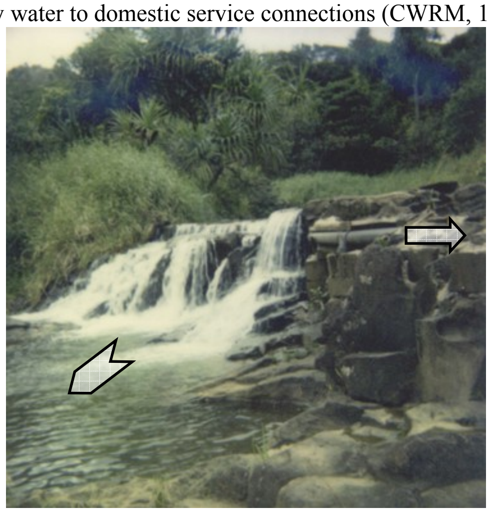
[Source of photos are denoted at the end of each description; CWRM, Commission on Water Resource Management; DAR, Division of Aquatic Resources; EMI, East Maui Irrigation Company, Inc.; RMT, R.M. Towill Cooperation (R.M. Towill conducted field verifications on the island of Maui under contract with the Commission on Water Resource Management in late 2007); Arrows (⇨) indicate general direction of water flow to, into, and through noninstream diversions; Chevrons (⋗) indicate general direction of natural surface water flow]

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.35.6	BAKER NW	2-9-004:057		Yes	Yes	Yes	Yes

Water is diverted from Honopou Stream via a CRM dam and 4-inch PVC pipe, which branches off to one 2-inch PVC pipe and one 4-inch PVC pipe (gravity flow). The 2-inch pipe provides water for domestic purposes to three service connections, and irrigation of a half-acre orchard of orange and lime trees. The 4-inch pipe was previously used to spin an electricity-generating water wheel, but is planned to provide water for livestock.

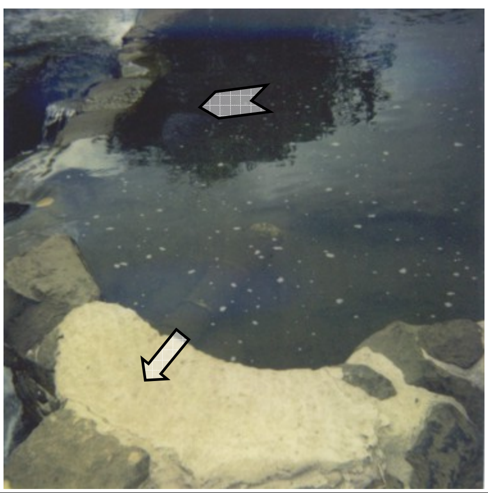
Photos. a) 4-inch line in concrete dam (CWRM, 10/1993); b) Concrete dam for diversion across stream channel (CWRM, 10/1993); c) 4-inch PVC pipe with filter located on right bank (CWRM, 10/1993); d) 2-inch pipe crossing the stream to carry water to domestic service connections (CWRM, 10/1993).

a)



b)

c)



d)

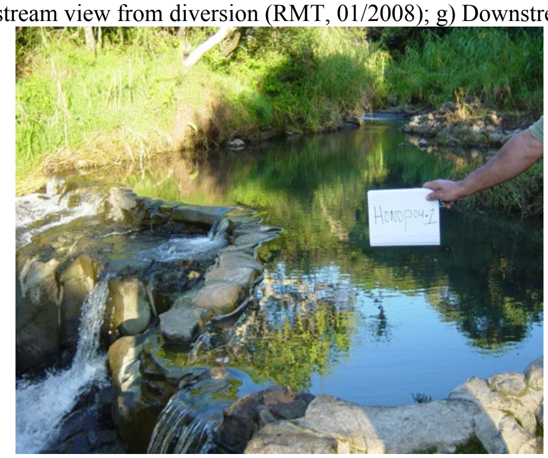
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.35.6	BAKER NW	2-9-004:057		Yes	Yes	Yes	Yes

(Continued)

Photos. e) Diversion dam on Honopou Stream with submersed pipe intake in lower right of photo (RMT, 01/2008); f) Upstream view from diversion (RMT, 01/2008); g) Downstream view from diversion (RMT, 01/2008).

e)



f)

g)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.82.6	CARPENTER VA	2-9-001:052		Yes	Yes	Yes	No

Water is diverted from Honopou Stream into a 2 feet by 4 feet unlined ditch. An electric pump is used to pump water from the ditch to fill a 500 gallon storage tank roughly three times a week. Water in storage tank provides water for domestic purposes to two service connections. Remaining water in the ditch is used for irrigation of 0.25 acres of taro (possibly more), medicinal plants, and aquaculture of prawns. File contains three declarations; however, all declarants appear to be registering the same source and for the same purpose. The field verification was conducted for only one individual.

Photos. a) Pump (within housing) located on 2 feet by 4 feet unlined ditch diverting water from Honopou Stream (CWRM, 04/1994); b) Diversion dam located in stream channel with ditch intake located on right bank (RMT, 12/2007); c) Diversion ditch intake on right bank (RMT, 12/2007); d) Downstream view of Honopou Stream from diversion dam, with ditch running adjacent to stream atop right bank (RMT, 12/2007).

a)

b)

c)

d)

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.110.6	CHASTANG N	2-9-001:013			No	Yes	Yes

Water is diverted from Honopou Stream via a CRM dam and 6-inch PVC pipe. Water is used for domestic purposes to one service connection, irrigation of two acres of taro and flowers, and watering of livestock. One 0.75-inch line conveys water to a house for domestic use, while another 0.75-inch line conveys water to a trough for watering horses. The declarant also identified aquaculture of prawns in the future. Honopou Stream is also used for gathering. Declarant claims appurtenant and riparian rights. Declaration is filed under HALL I.

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.133.6	DOWIS J&V	2-9-003:021	0.00019	Yes	Yes	Yes	No

Water is captured from Honopou Stream within a 3.5 feet by 8 feet concrete catchment structure and diverted through a 1-inch pipe. Water is pumped up to a 5,000 gallon storage tank and provides water for domestic purposes to one service connection, landscaping and irrigation of tropical flowers and vegetables on approximately 8 acres of land. File indicates that shortly after registration, the declarant sold the property. The new landowner planned to install a pump with a 2-inch intake line to divert water from a different location to fill a new tank.

Photos. a) Honopou Stream upstream of diversion REG.133.6 (RMT, 12/2007); b) Honopou Stream upstream of diversion (RMT, 12/2007); c) Diversion REG.133.6 located on right bank of stream (RMT, 12/2007).

a)

b)

c)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

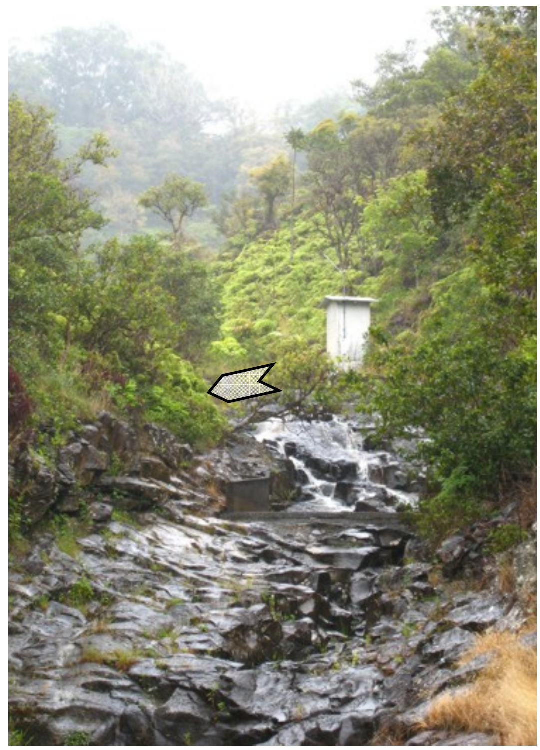
Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.152.6	EAST MAUI IRR	2-9-014:		Yes	Yes		

Water is diverted from Honopou Stream at Intake W-22 into the Wailoa Ditch (tunnel). Registrant identified water use is for municipal (County of Maui), irrigation of approximately 36,000 acres of sugar, pineapple, and a variety of other crops, industrial cooling, manufacturing, and milling, hydroelectric, and livestock. The diversion structure is concrete and has a divertable capacity of 30 mgd. Measurement of total flow of Wailoa Ditch, including this and other intakes, is available from USGS gaging station 16588000 (Wailoa Ditch at Honopou near Huelo). Please note that the diversion capacity of 30 mgd far exceeds the estimated median flow of the stream (see CPRC 38.0-2).

Photos. a) Wailoa Ditch diversion from downstream view looking upstream (EMI, 05/1989); b) Wailoa Ditch diversion, looking upstream (CWRM, 08/2008); c) Wailoa Ditch diversion intake(DAR,03/2008); d) Photo of stream channel immediately below Wailoa Ditch diversion, looking downstream, with diversion REG.247.6 located on left bank (DAR, 03/2008).

a)

b)



c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.189.6	EAST MAUI IRR	2-9-003:		Yes	Yes		

Water is diverted from Honopou Stream at Intake H-8 into the Haiku Ditch (tunnel). Registrant identified water use is for irrigation of approximately 36,000 acres of sugar, industrial manufacturing and milling, and livestock. The diversion structure is concrete with iron rails used as strainers on top an open ditch. The divertable capacity is 5 mgd. Measurement of total flow of Wailoa Ditch, including this and other intakes, is available from USGS gaging station 16594000 (Haiku Ditch at Honopou Gulch near Kailua). Declarant noted that there are two 4-inch aluminum pipes which pass water over the intake structure to supply Kuleana users downstream (users known) for the cultivation of taro.

Photos. a) Haiku Ditch diversion intake from right bank of Honopou Stream (EMI, 05/1989); b) Haiku Ditch diversion intake from right bank (CWRM, 06/2003); c) Upstream view of Honopou Stream from diversion intake (CWRM, 06/2003); d) Two bypass pipes carry water across and over the Haiku Ditch intake nearest to the right bank of Honopou Stream (CWRM, 06/2003).

a)

b)

c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.189.6 (Continued)	EAST MAUI IRR	2-9-003:		Yes	Yes		

Photos. e) Control gate structures on Haiku Ditch on left bank of Honopou Stream (RMT, 10/2007); f) Downstream view from just below diversion structure (RMT, 01/2008); g) Three bypass pipes now carry water across and over the Haiku Ditch Diversion on Honopou Stream (DAR, 11/2007); h) Upstream view of diversion from just below structure on left bank (DAR, 11/2007); i) High flood waters flow into and over the Haiku Ditch (DAR, 01/2008)

e)

f)

g)

h)

i)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

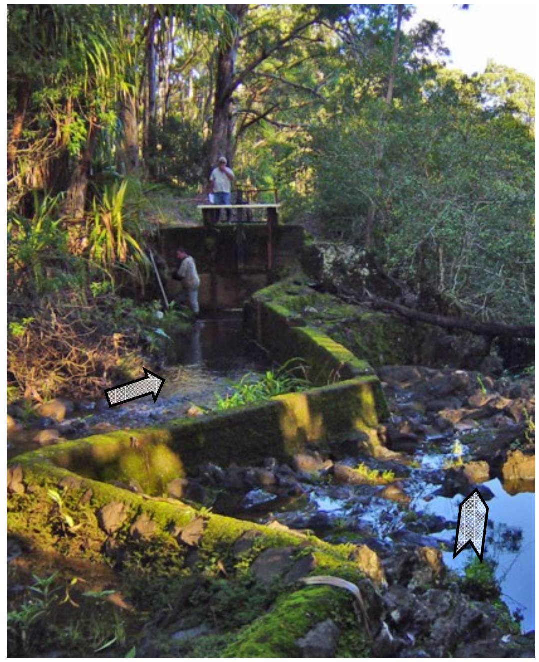
Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.210.6	EAST MAUI IRR	2-9-014:		Yes	Yes		

Water is diverted from Honopou Stream at Intake L-17 (Honopou Side Ditch Intake) into the Lowrie Ditch. Registrant identified water use is for irrigation of approximately 36,000 acres of sugar and pineapple, industrial manufacturing and milling, and livestock. The diversion structure is concrete and has a divertable capacity of 35 mgd. Measurement of total flow of Lowrie Ditch, including this and other intakes, is available from USGS gaging station 16592000 (Lowrie Ditch at Honopou Gulch near Huelo).

Photos. a) Honopou Side Ditch Intake to Lowrie Ditch on left bank of Honopou Stream (EMI, 05/1989); b) Diversion intake from right bank of Honopou Stream (RMT, 12/2007); c) Diversion intake with collection pool (CWRM, 08/2008); d) Control gate at head of Honopou Side Ditch (CWRM, 08/2008).

a)

b)



c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.210.6 (Continued)	EAST MAUI IRR	2-9-014:		Yes	Yes		

Photos. e) Honopou Side Ditch just downstream of control gate at diversion intake (RMT, 12/2007); f) View from same location as previous photo (CWRM, 08/2008).

e)

f)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.246.6	EAST MAUI IRR	2-8-008:		Yes	Yes		

Water is diverted from East Honopou Stream at Intake NH-23 (Wailole Intake) into the New Hamakua Ditch (tunnel). Registrant identified water use is for irrigation of approximately 36,000 acres of sugar, pineapple, and a variety of other crops, industrial manufacturing and milling, and livestock. The diversion structure is concrete and has a divertable capacity of 7 mgd. Measurement of total flow of Wailoa Ditch, including this and other intakes, is available from USGS gaging station 16602000 (Kauhikoa Ditch at Opana Weir near Huelo).

Photos. a) Wailole Intake on East Honopou Stream (EMI, 05/1989).

a)

b)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.247.6	EAST MAUI IRR	2-9-014:		Yes	Yes		

Water is diverted from Honopou Stream at Intake NH-22 into the New Hamakua Ditch (tunnel). Registrant identified water use is for irrigation of approximately 36,000 acres of sugar, pineapple, and a variety of other crops, industrial manufacturing and milling, and livestock. The diversion structure is concrete and has a divertable capacity of 30 mgd. Measurement of total flow of Wailoa Ditch, including this and other intakes, is available from USGS gaging station 16589000 (New Hamakua Ditch at Honopou near Huelo).

Actual diversion appears to be much less than divertable capacity, since New Hamakua Ditch only receives overflow water that does not go into the Wailoa Ditch Intake diversion REG.152.6 located upstream.

Photos. a) New Hamakua Ditch Intake NH-22 from upstream of diversion structure on left bank (EMI, 05/1989); b) Upstream view from just below diversion intake structure (DAR, 11/2007); c) Diversion intake at collection structure on left bank (CWRM, 08/2008); d) Intake grates at collection structure on left bank (CWRM, 08/2008).

a)

b)

c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.247.6	EAST MAUI IRR	2-9-014:		Yes	Yes		

(Continued)

Photos. e) Downstream view from diversion intake structure (CWRM, 08/2008); f) New Hamakua Ditch located just downstream of intake (CWRM, 08/2008).

e)

f)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.257.6	EAST MAUI IRR	2-9-004:		Yes	Yes		

Water is diverted from East Honopou Stream at Intake L-16 (Honopou Siphon Intake) into the Lowrie Ditch. Registrant identified water use is for irrigation of approximately 36,000 acres of sugar and pineapple, industrial manufacturing and milling, and livestock. The diversion structure is an unlined channel. Measurement of total flow of Lowrie Ditch, including this and other intakes, is available from USGS gaging station 16592000 (Lowrie Ditch at Honopou Gulch near Huelo).

Photos. a) East Honopou Stream at Intake L-16 flows directly into Lowrie Ditch (EMI, 05/1989); b) Intake L-16 at Lowrie Ditch (RMT, 10/2007); c) Lowrie Ditch flow downstream of Intake L-16 (RMT, 10/2007).

a)

b)

c)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.266.6	EAST MAUI IRR	2-9-004:		Yes	Yes		

Water is diverted from East Honopou Stream at Intake L-15 (Honopou Long Strainer Intake) into the Lowrie Ditch. Registrant identified water use is for irrigation of approximately 36,000 acres of sugar and pineapple, industrial manufacturing and milling, and livestock. The diversion structure is an unlined channel. Measurement of total flow of Lowrie Ditch, including this and other intakes, is available from USGS gaging station 16592000 (Lowrie Ditch at Honopou Gulch near Huelo).

Photos. a) East Honopou Stream at Intake L-15 flows directly into Lowrie Ditch (EMI, 05/1989); b) Intake L-15 at Lowrie Ditch (RMT, 10/2007); c) Lowrie Ditch flow downstream of Intake L-15 (RMT, 10/2007).

a)

b)

c)

d)

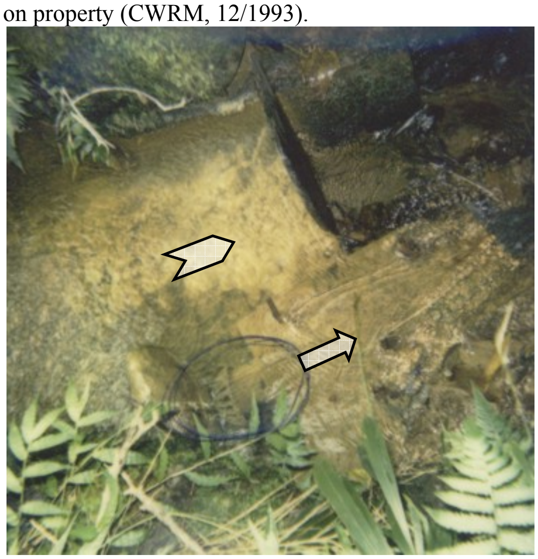
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.386.6	GEBB C	2-9-014:016	2.05086	Yes	Yes	Yes	No

Water is diverted from spring-fed Koahou Stream via a 4-inch PVC pipe with filter, and later branches into two 2-inch pipes. Water is used for domestic purposes to one service connection (office) and for irrigation of approximately 7 acres of taro, water lilies, palm trees, and a nursery. Declarant intends to build two 5,000 gallon storage tanks to irrigate more taro and other exotic plants. The eight owners of the parcel have partitioned the lot into eight 13-acre sections. The diversion is maintained and operated by the declarant, while the other co-owners did not register water use.

Photos. a) 4-inch intake pipe with filter submersed in stream (CWRM, 12/1993); b) 4-inch pipe branches into two 2-inch lines (CWRM, 12/1993); c) Future location of taro patches (CWRM, 12/1993); d) Diverted water is used to fill 5,000-gallon tank on property (CWRM, 12/1993).

a)



b)

c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.387.6	GEBB C	2-9-014:016		Yes	Yes	Yes	Yes

Water is diverted from Honopou Stream via a 2-inch PVC pipe with filter. Water is used to irrigate approximately ¼-acre of ginger and heliconia located on or near the stream bank. The eight owners of the parcel have partitioned the lot into eight 13-acre sections. The diversion is maintained and operated by the declarant, while the other co-owners did not register water use.

Status of diversion REG.387.6 is uncertain. A diversion currently maintained by a different co-owner of the parcel (other than the original registrant) appears to be located downstream of diversion REG.387.6. End use of diverted water is unknown.

Photos. a) Diverted water is used to fill 10,000-gallon tank on property (CWRM, 12/1993); b) 5-hp pump with 2-inch PVC pipe with filter pumping water from stream (CWRM, 12/1993).

a)

b)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.387.6 (Continued)	GEBB C	2-9-014:016		Yes	No	Yes	Yes

Photos. c) 2-inch PVC pipe diversion on right bank of Honopou Stream (RMT, 01/2008); d) Upstream view of Honopou Stream from diversion location (RMT, 01/2008); e) Downstream view of Honopou Stream from diversion location (RMT, 01/2008).

c)

d)

e)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.445.6	HAROLD FL	2-9-001:009			No	Yes	Yes
Water is pumped from Honopou Stream via a PVC pipe to two parcels. On parcel 2-2-9-001:009, water is used for domestic purposes to one service connection, and irrigation of approximately 1.3 acres of vegetables. On parcel 2-2-9-001:010, water is used for domestic purposes to one service connection, and irrigation of approximately 0.8 acres of taro.							
REG.446.6	HAROLD FL	2-9-001:011			No	Yes	Yes
Water is pumped from Honopou Stream via a PVC pipe to parcel 2-2-9-001:012. Water is used for domestic purposes to one service connection, irrigation of approximately 27 acres of vegetables, and watering of livestock.							

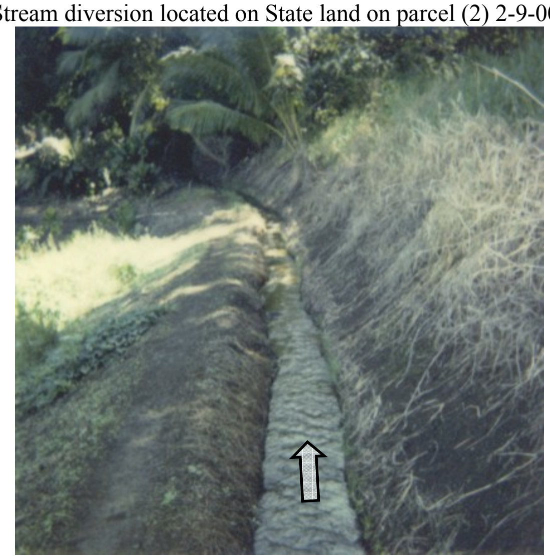
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.623.6	KEKAHUNA B	2-9-001:018		Yes	Yes	No	No

Water is diverted from Honopou Stream via a 12-inch concrete pipe which conveys water into a 2 feet wide, 1 feet deep unlined ditch. The ditch carries water through this and other parcels. Water is used for domestic purposes to at least one service connection, irrigation of approximately 24 acres of taro, fruit trees, vegetables, and ornamentals, and watering of livestock. Another second declarant (KEPANI L) registered the same diversion and declared use of water for domestic purposes and irrigation of 10 acres of taro. A group declaration filed in EAST MAUI TARO indicates irrigation of 100+ acres of wetland taro, fruit trees, vegetables, and ornamentals, and watering of livestock.

Photos. a) Unlined ditch carrying water from diversion to taro loi on parcel (2) 2-9-001:014 (CWRM, 11/1993); b) Taro loi on parcel (2) 2-9-001:014 (CWRM, 11/1993); c) Ditch located on State land on parcel (2) 2-9-001:018 (CWRM, 11/1993); d) Stream diversion located on State land on parcel (2) 2-9-001:018 (CWRM, 11/1993).

a)



b)

c)

d)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

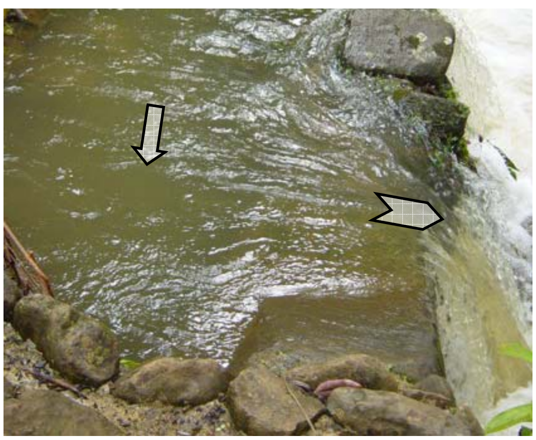
Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.623.6 (Continued)	KEKAHUNA B	2-9-001:018		Yes	Yes	No	No

Photos. e) Fields in preparation for planting taro (CWRM, 06/2003); f) Terraced areas on Kekahuna/Wallett property (CWRM, 06/2003); g) High flood waters overtopping diversion intake wall on right bank of Honopou Stream (RMT, 10/2007); h) Size of diversion pipe limits amount of water flowing into unlined ditch (RMT, 10/2007); i) More fields are open for planting taro (CWRM, 08/2008); j) Portion of unlined ditch carrying water to east end of property (CWRM, 08/2008).

e)

f)

g)



h)

i)

j)

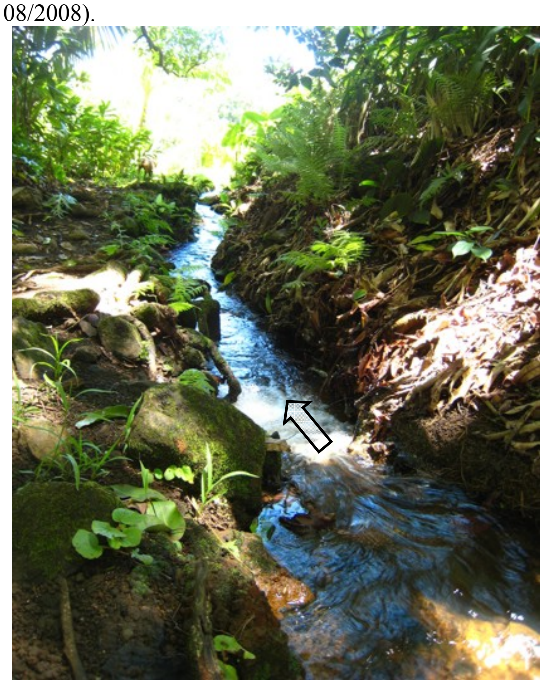
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.623.6	KEKAHUNA B	2-9-001:018		Yes	Yes	No	No
(Continued)							

Photos. k) Ms. Kekahuna and CWRM staff standing near diversion intake structure on right bank of Honopou Stream (CWRM, 08/2008); l) Water flows in the unlined ditch through a State-owned parcel (CWRM, 08/2008); m) Water continues to flow in unlined ditch onto Ms. Wallett's property, where a portion of flow is going downhill to the left to feed a lower taro field, while remaining water continues to east end of property and other taro fields (CWRM, 08/2008); n) Portion of diverted ditch water flows downhill to lower taro field (CWRM, 08/2008).

k)

l)



m)

n)

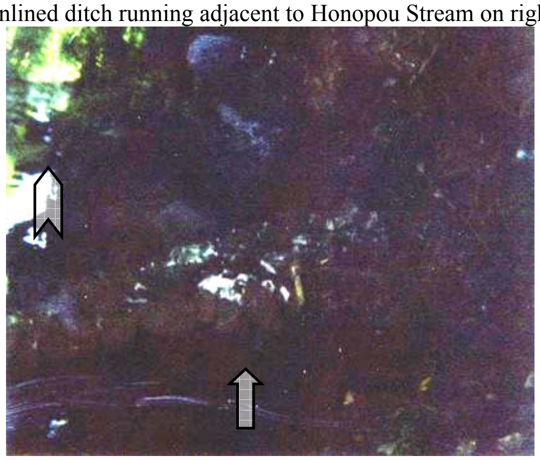
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.754.6	MANINI EG	2-9-001:025		Yes	Yes	Yes	Yes

Water is diverted from Honopou Stream via a CRM dam into an unlined ditch. Water is used for irrigation of approximately 0.5 acres of taro and banana. Diversion is maintained by neighbors (parcel 2-2-9-001:025) and water flows through parcel 2-2-9-001:048 owned by declarant, where it is used.

Photos. a) Concrete dam on neighboring parcel (CWRM, 12/1993); b) Water flowing in unlined ditch through declarant's property to taro loi (CWRM, 12/1993); c) Diversion intake structure on right bank during high stream flow (RMT, 12/2007); d) Unlined ditch running adjacent to Honopou Stream on right bank (RMT, 12/2007).

a)



b)

c)

d)

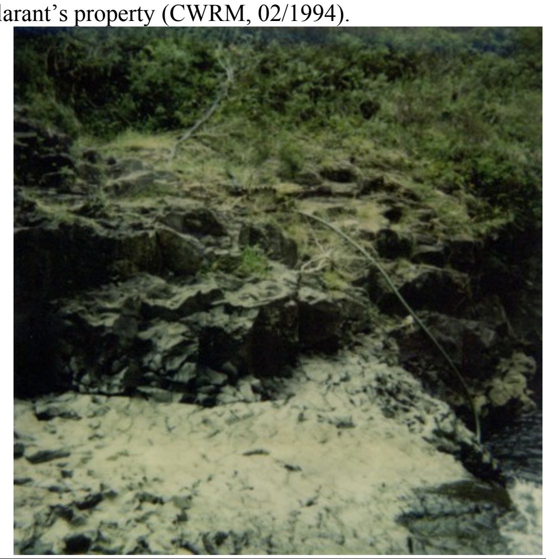
Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.921.6	PALMER S	2-9-001:018	0.00258		No	Yes	No

Water is pumped from Honopou Stream via a pipe. Divertable capacity is 7200 gpm. Water is used on the declarant's parcel 2-2-9-001:062 for domestic purposes and irrigation of 2 acres of flowers, fruit, landscaping, and a nursery. The applicant plans to use water for watering livestock, hydroelectric generation, and aquaculture in the future. The pipe traverses parcels 2-2-9-001:015 and 2-2-9-001:018 (State land). Declarant claims to be diverting 50,000 gallons per month.

Photos. a) 2-inch PVC pipe diversion on State parcel (2) 2-9-001:018 (CWRM, 02/1994); b) 10,000-gallon storage tank on declarant's property (CWRM, 02/1994).

a)



b)

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.975.6	RAY JW	2-9-003:021			No	Yes	No
Water is diverted from Honopou Stream via a pipe. Together with diversions REG.976.6 and REG.977.6, declarant estimated 0.01 cfs (5,200 gallons per day) of water use. Water is used for domestic purposes and irrigation of 16 acres of banana, coconut, papaya, and a nursery.							
REG.976.6	RAY JW	2-9-003:021			No	Yes	No
Water is diverted from Honopou Stream via a pipe. Together with diversions REG.975.6 and REG.977.6, declarant estimated 0.01 cfs (5,200 gallons per day) of water use. Water is used for domestic purposes and irrigation of 16 acres of banana, coconut, papaya, and a nursery.							
REG.977.6	RAY JW	2-9-003:021			No	Yes	No
Water is diverted from an unnamed spring-fed stream on the declarant's property via a pipe. Together with diversions REG.975.6 and REG.976.6, declarant estimated 0.01 cfs (5,200 gallons per day) of water use. Water is used for domestic purposes and irrigation of 16 acres of banana, coconut, papaya, and a nursery.							

Table 13-1. Continued. Registered diversions in the Honopou hydrologic unit.

Event ID	File Reference	Tax Map Key	Diversion Amount (cfs)	Active (Yes/No)	Verified (Yes/No)	Riparian (Yes/No)	Rights Claim (Yes/No)
REG.1003.6	SCHUETZE F	2-9-003:056	0.00178	Yes	No	Yes	No

Water is pumped from Honopou Stream via a 2-inch PVC pipe to a 1,500-gallon storage tank. Divertible capacity is 5 gpm. Water is used for domestic purposes and irrigation of 1.2 acres of fruit trees and gardens.

Photos. a) Downstream view of Honopou Stream from diversion intake on left bank (RMT, 12/ 2007); Upstream view from diversion intake (RMT, 12/ 2007); c) Pump connection from diversion hose to a 2-inch PVC pipe (RMT, 12/2007).

a)

b)

c)

Table 13-2. Minor diversions on the EMI System in the Honopou hydrologic unit.

[Source of photos are denoted at the end of each description; CWRM, Commission on Water Resource Management; DAR, Division of Aquatic Resources; EMI, East Maui Irrigation Company, Inc.; RMT, R.M. Towill Corporation (R.M. Towill conducted field verifications on the island of Maui under contract with the Commission on Water Resource Management in late 2007); Arrows ( )generally indicate direction of water flow to, into, and through noninstream diversions; Chevrons ( ) generally indicated direction of natural surface water flow]

Diversion ID	EMI Ditch System	Description
W-22a	Wailoa	Honopou – Lupi long intake. Concrete diversion structure.

Photos. a) Diversion intake structure (EMI, 05/1989); b) Diversion intake structure (RMT, 12/2007); c) View of tributary upstream of diversion structure (RMT, 12/2007).

a)

b)

c)

d)

Table 13-2. Continued. Minor diversions on the EMI System in the Honopou hydrologic unit.

Diversion ID	EMI Ditch System	Description
W-22b	Wailoa	Honopou – Wailole Stream diversion to Honopou Stream. Concrete diversion structure.

Photos. a) Waiolele Stream diversion intake conveys water via a tunnel to the main Honopou Stream channel (EMI, 05/1989); b) View of water from tunnel flowing into main Honopou stream channel (RMT, 11/2007); c) Downstream view from point where Wailole Stream diversion enters the main Honopou Stream channel on left bank (RMT, 11/2007); f) Upstream view from same point on Honopou Stream (RMT, 11/2007).

a)

b)

c)

d)

Table 13-2. Continued. Minor diversions on the EMI System in the Honopou hydrologic unit.

Diversion ID	EMI Ditch System	Description
W-22b	Wailoa	Honopou – Wailole Stream diversion to Honopou Stream. Concrete diversion structure.

Photos. e) Upstream view of water flowing from tunnel towards main Honopou Stream channel (DAR, 03/2008); Downstream view of water flowing towards main Honopou Stream channel (DAR, 03/2008).

e)

f)

Table 13-2. Continued. Minor diversions on the EMI System in the Honopou hydrologic unit.

Diversion ID	EMI Ditch System	Description
W-22b	Wailoa	Honopou – Wailole Stream diversion to Honopou Stream. Concrete diversion structure.

Photos. a) Waiolele Stream diversion intake (EMI, 05/1989); b) Upstream of diversion intake structure (RMT, 11/2007); c) Downstream view from just upstream of diversion structure, with intake grate on left of picture (RMT, 11/2007); d) Upstream view from just above diversion intake grate.

a)

b)

c)

d)

Data available for the major EMI diversions near Honopou allow for further analysis via a flow duration curve, which is a cumulative-frequency curve that shows the percentage of time a daily median discharge is equaled or exceeded during a given time period. It is a common and effective way to assess streamflow variability and availability. Generally, flow duration curves for large streams with persistent input from ground water sources are flatter than those for streams where ground water inflow is minimal, making streamflow rather responsive to each rainfall event. The flows at 50 (Q_{50}) and 90 (Q_{90}) percent exceedence probability are common indices of median total flow and low flow, respectively. When a flow duration curve is plotted for measurements made at a ditch, it shows the variability in the amount of water diverted for agricultural or domestic uses. The Q_{50} flow indicates the average amount of water diverted during the period of record. Flow duration curves were plotted for each of the USGS gaging stations located at a ditch at Honopou Stream.

USGS Gaging Station 16588000 at Wailoa Ditch. Figure 13-1 is a flow duration curve for USGS gaging station 16588000 at the Wailoa Ditch near Honopou Stream. Between 1922 and 1987, the amount of water diverted ranged from 1.8 to 328 cubic feet per second per day, with an average daily diversion of 168.4 cubic feet per second. The slope of the curve is relatively flat, indicating minor variability in the average daily diversions throughout the period of record. Comparison of the daily median total flows for each month at the ditch shows that more water was diverted in the summer months of April, May, July and August probably due to higher evaporation rates (Table 13-3). Approximately 12 days out of a year, the amount of diverted water exceeded 272 cubic feet per second. Less than 65.7 cubic feet per second of water was diverted about 5 days out of a year.

Figure 13-1. Flow duration curve for USGS gaging station 16588000 near Honopou Stream.

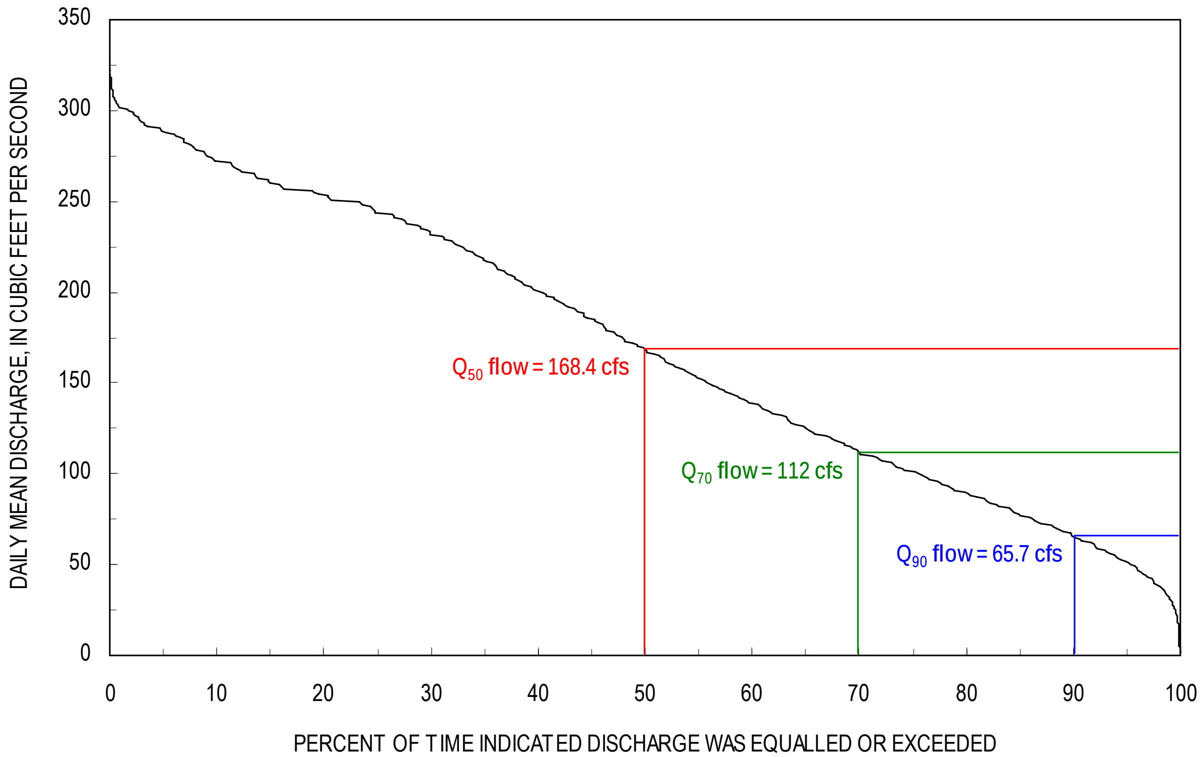


Table 13-3. Daily median total flows for each month at USGS gaging station 16588000 near Honopou Stream.

[Flows in cubic feet per second (cfs)]

Month	Water diverted	Month	Water diverted	Month	Water diverted
January	135	May	201	September	128
February	122	June	133	October	132
March	192	July	203	November	185.5
April	238.5	August	198	December	156

USGS Gaging Station 16589000 at New Hamakua Ditch. Figure 13-2 is a flow duration curve for USGS gaging station 16589000 at the New Hamakua Ditch in Honopou Stream. Between 1918 and 1985, the amount of water diverted ranged from zero (no diversion) to 186 cubic feet per second per day, with an average daily diversion of 4.47 cubic feet per second. The steepness of the flow duration curve indicates large variability in the average daily diversions throughout the period of record. Comparison of the daily median total flows for each month at the ditch shows no particular seasonal consistency in amount of diverted water (Table 13-4). Diversion was highest in April during which an average 28.75 cubic feet per second of water was diverted per day, and lowest in January, February, June, September, and October during which less than 2 cubic feet per second of water was diverted per day. Approximately 14 days out of a year, the amount of diverted water exceeded 126 cubic feet per second. Less than 0.42 cubic feet per second of water was diverted about 4 days out of a year.

Figure 13-2. Flow duration curve for USGS gaging station 16589000 in Honopou Stream.

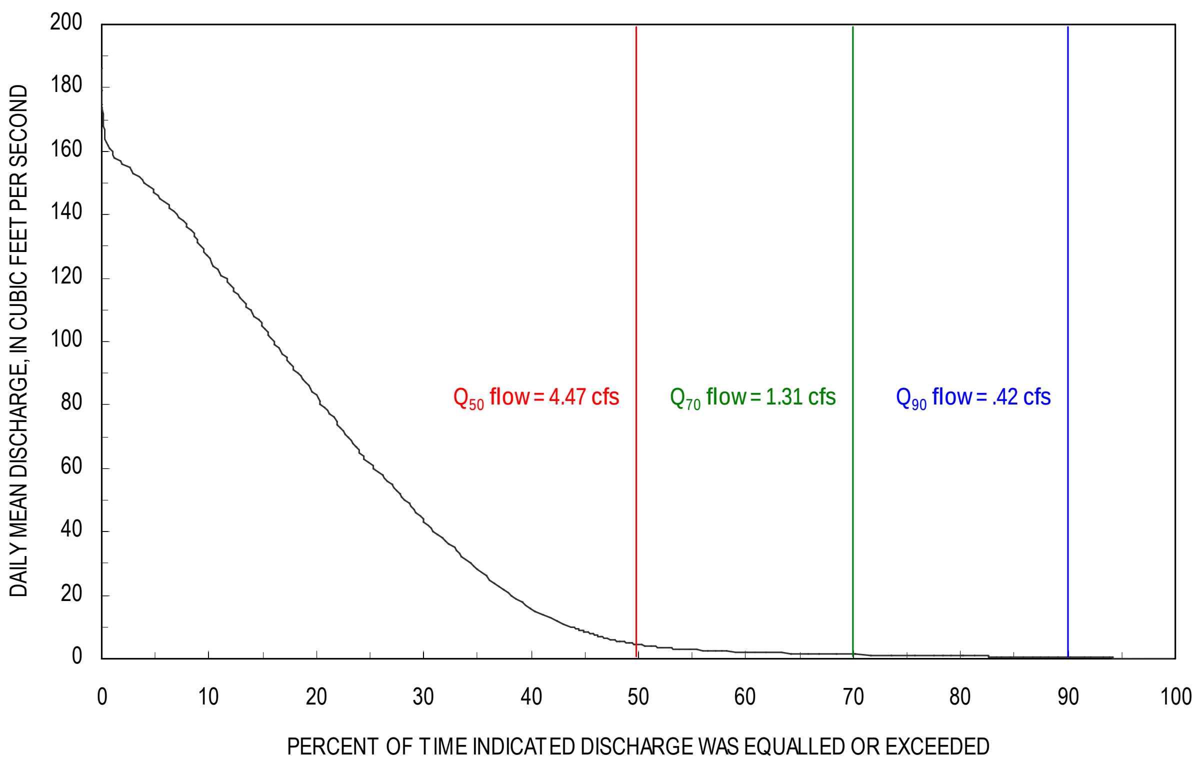


Table 13-4. Daily median total flows for each month at USGS gaging station 16589000 in Honopou Stream.

[Flows in cubic feet per second (cfs)]

Month	Water diverted	Month	Water diverted	Month	Water diverted
January	1.8	May	12	September	1.7
February	1.6	June	1.7	October	1.75
March	15	July	8.55	November	8.95
April	28.75	August	6.05	December	2.3

USGS Gaging Station 16590000 at Old Hamakua Ditch. Figure 13-3 is a flow duration curve for USGS gaging station 16590000 at the Old Hamakua Ditch in Honopou Stream. Between 1918 and 1965, the amount of water diverted ranged from zero (no diversion) to 61 cubic feet per second per day, with an average daily diversion of 0.076 cubic feet per second. The steepness of the flow duration curve indicates large variability in the average daily diversions throughout the period of record. Comparison of the daily median total flows for each month at the ditch shows no particular seasonal consistency in amount of diverted water (Table 13-5). Diversion was highest in March in which an average 0.17 cubic feet per second of water was diverted per day, and lowest in June in which an average 0.05 cubic feet per second of water was diverted per day. Approximately 14 days out of a year, the amount of diverted water exceeded 11 cubic feet per second.

Figure 13-3. Flow duration curve for USGS gaging station 16590000 in Honopou Stream.

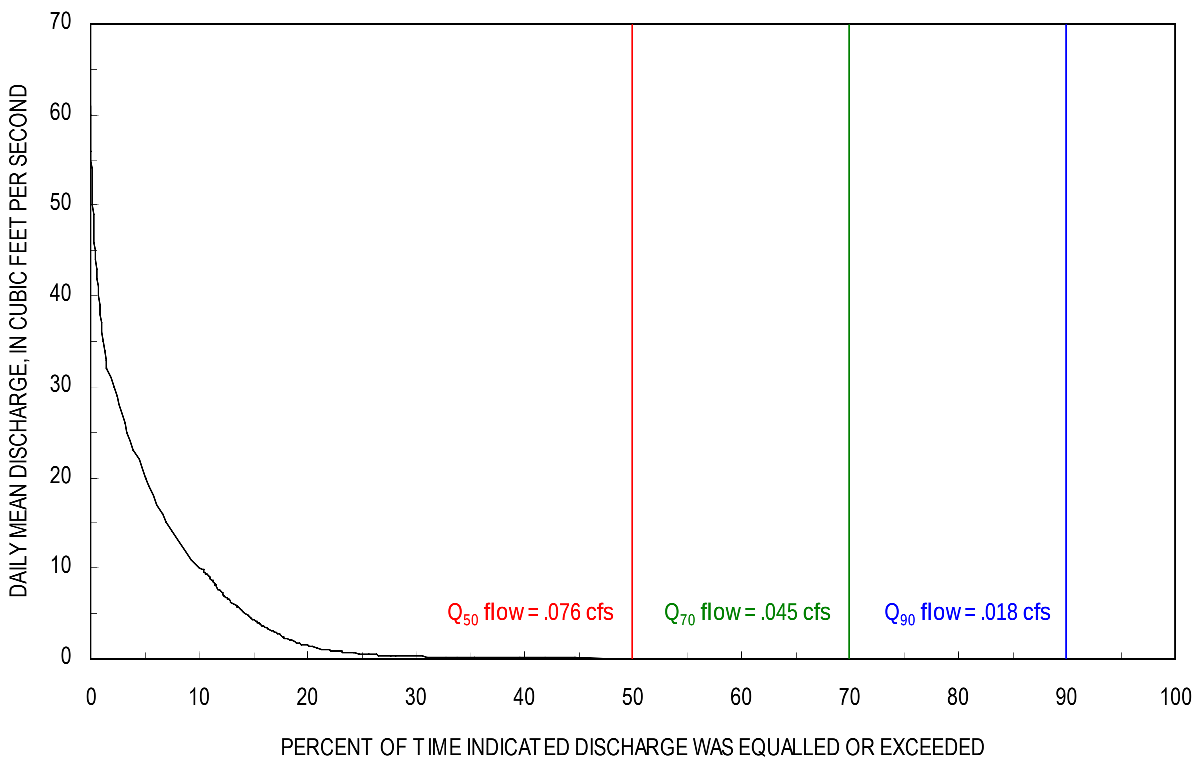


Table 13-5. Daily median total flows for each month at USGS gaging station 16590000 in Honopou Stream.

[Flows in cubic feet per second (cfs)]

Month	Water diverted	Month	Water diverted	Month	Water diverted
January	0.08	May	0.08	September	0.06
February	0.065	June	0.05	October	0.06
March	0.17	July	0.08	November	0.1175
April	0.0975	August	0.085	December	0.085

USGS Gaging Station 16592000 at Lowrie Ditch. Figure 13-4 is a flow duration curve for USGS gaging station 16592000 at the Lowrie Ditch in Honopou Stream. Between 1910 and 1985, the amount of water diverted ranged from zero (no diversion) to 116 cubic feet per second per day, with an average daily diversion of 25.1 cubic feet per second. Steepness of the flow duration curve indicates relatively large variability in the average daily diversions throughout the period of record. Comparison of the daily median total flows for each month at the ditch shows that amount of water diverted is generally above the average level during the summer and below the average level in the winter (Table 13-6). Diversion was highest in April, during which an average 38.25 cubic feet per second of water was diverted per day, and lowest in February in which an average 12.75 cubic feet per second of water was diverted per day. Approximately 8 days out of a year, the amount of diverted water exceeded 85 cubic feet per second. Less than 4.2 cubic feet per second of water was diverted about 5 days out of a year.

Figure 13-4. Flow duration curve for USGS gaging station 16592000 in Honopou Stream.

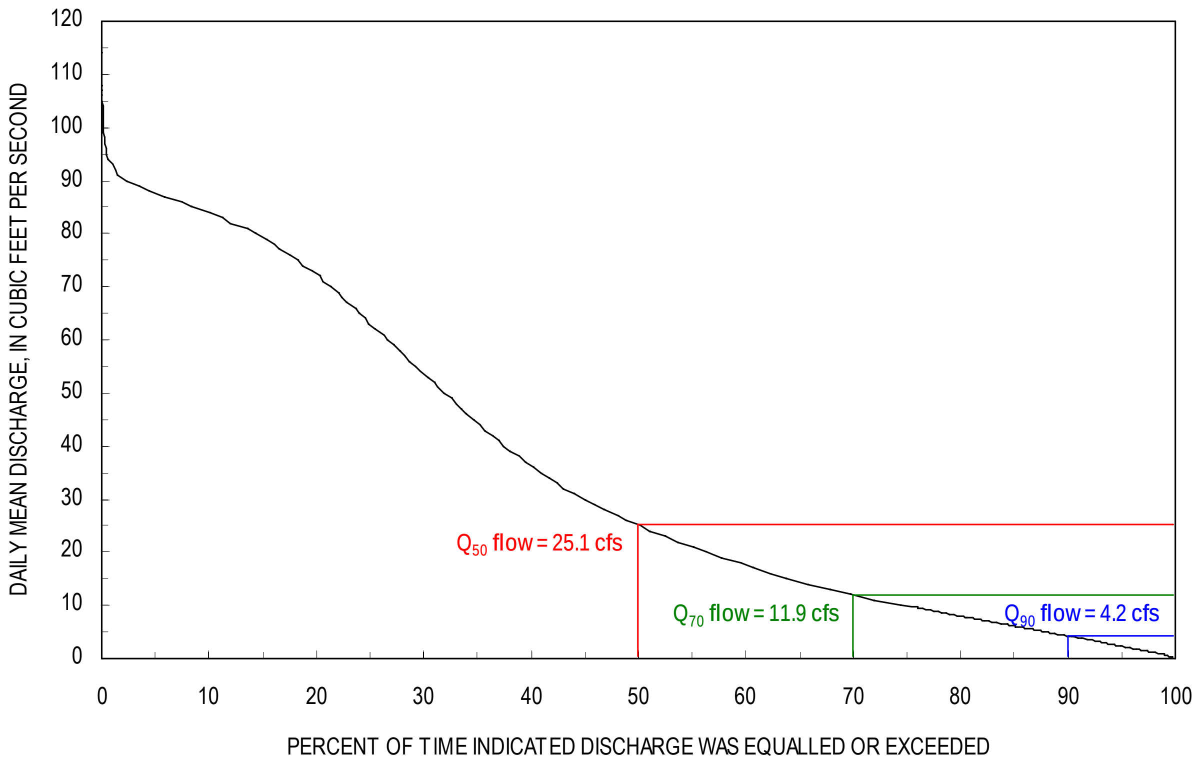


Table 13-6. Daily median total flows for each month at USGS gaging station 16592000 in Honopou Stream.

[Flows in cubic feet per second (cfs)]

Month	Water diverted	Month	Water diverted	Month	Water diverted
January	17	May	29.5	September	18.5
February	12.75	June	16.5	October	19.5
March	33	July	30.5	November	29.75
April	38.25	August	31.5	December	20

USGS Gaging Station 16594000 at Haiku Ditch. Figure 13-5 is a flow duration curve for USGS gaging station 16594000 at the Haiku Ditch in Honopou Stream. Between 1910 and 1985, the amount of water diverted ranged from zero (no diversion) to 209 cubic feet per second per day, with an average daily diversion of 4.4 cubic feet per second. The steepness of the flow duration curve indicates relatively large variability in the average daily diversions throughout the period of record. Comparison of the daily median total flows for each month at the ditch shows no particular seasonal consistency in amount of diverted water (Table 13-7). Diversion was highest in April, during which an average 24 cubic feet per second of water was diverted per day, and lowest in September in which an average 1.825 cubic feet per second of water was diverted per day. Approximately 12 days out of a year, the amount of diverted water exceeded 84 cubic feet per second. Less than 0.56 cubic feet per second of water was diverted about 3 days out of a year.

Figure 13-5. Flow duration curve for USGS gaging station 16594000 in Honopou Stream.

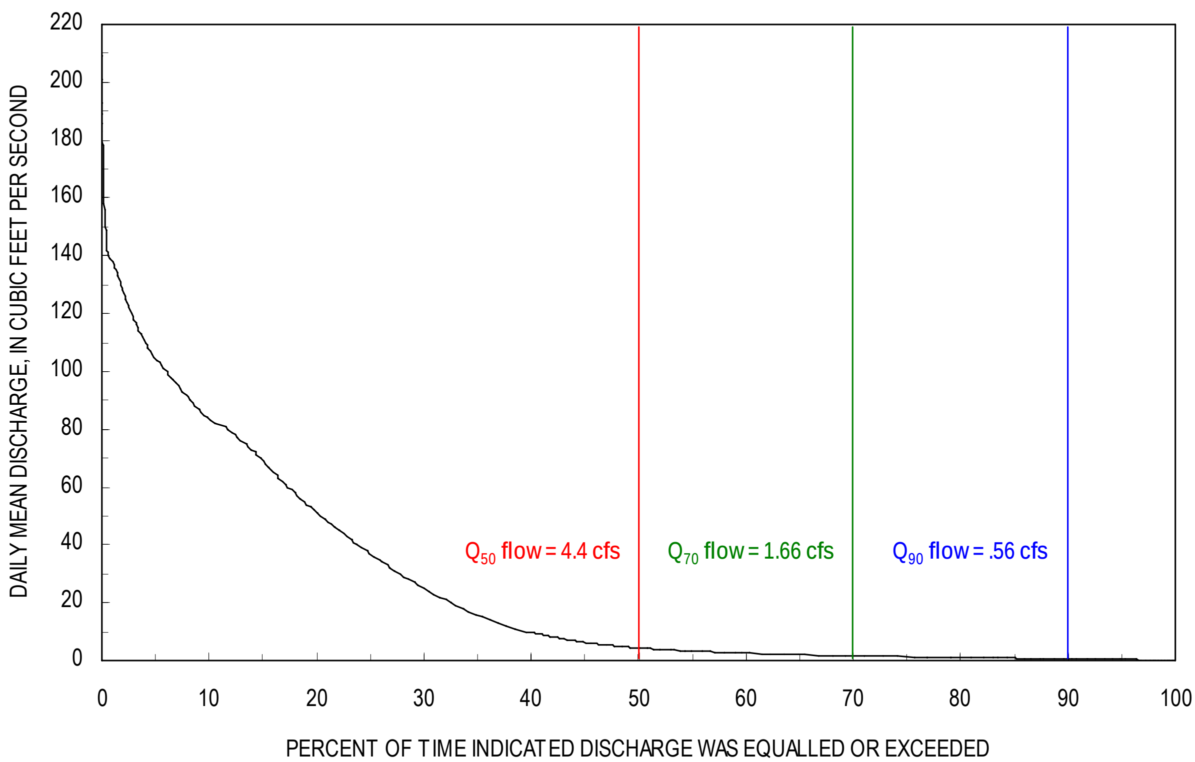


Table 13-7. Daily median total flows for each month at USGS gaging station 16594000 in Honopou Stream.

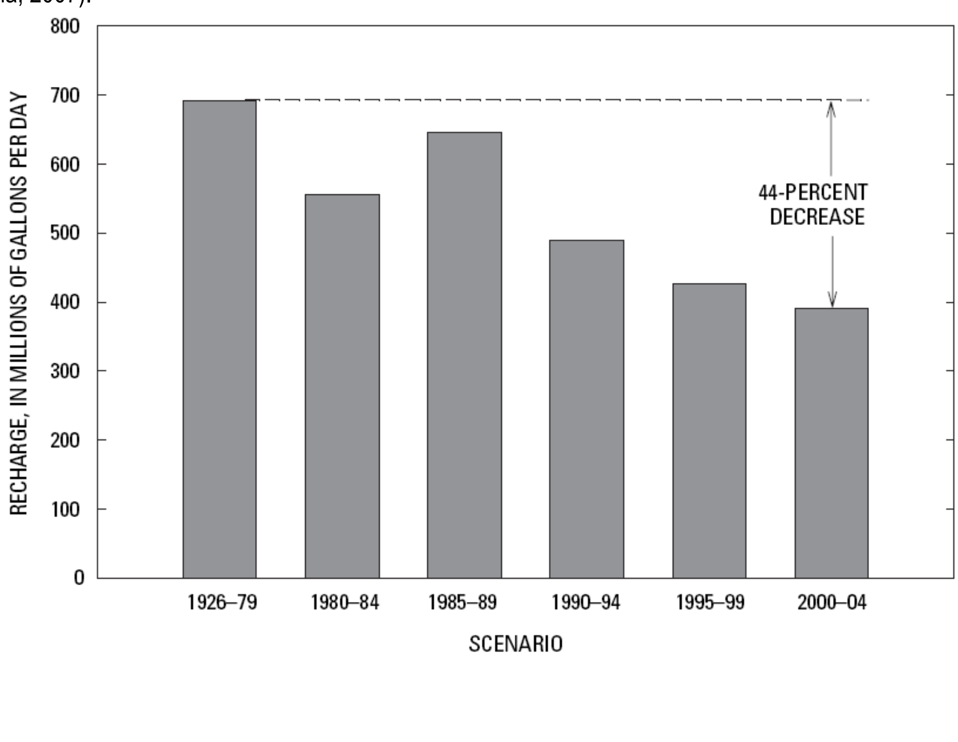
[Flows in cubic feet per second (cfs)]

Month	Water diverted	Month	Water diverted	Month	Water diverted
January	3.8	May	5.2	September	1.825
February	3	June	1.925	October	2.6
March	8.15	July	2.95	November	6.05
April	24	August	2.95	December	3.6

Following the establishment of instream flow standards, one of the proposed measures to increase streamflow may be to decrease the amount of water diverted from streams. Such a measure has important implications to ground water recharge because it affects the amount of water available for irrigation. Decreasing the amount of water diverted at the ditches located in east Maui affects the amount of water available for the irrigation of crops in west and central Maui. Since the early 20th century, about 100 billion gallons of water (274 million gallons per day) have been diverted each year from Maui streams for irrigation in west and central Maui. More than half of this diverted water, 59 billion gallons per year (162 million gallons per day), comes from east Maui (Engott and Vana, 2007).

The effects of irrigation water on ground water recharge can be analyzed using the water budget equation[5]. Engott and Vana (2007) at the USGS conducted a study that estimated each of the water budget components for west and central Maui using data from 1926 to 2004. Components of the water budget include rainfall, fog drip, irrigation, runoff, evapotranspiration, and recharge. Results of the study were separated into six historical periods: 1926-79, 1980-84, 1985-89, 1990-94, 1995-99, and 2000-04. From 1979 to 2004, ground water recharge decreased 44 percent from 693 million gallons per day to 391 million gallons per day (Figure 13-6). The low recharge rate in 2004 coincides with the lowest irrigation and rainfall rates that were 46 percent and 11 percent lower than those in 1979, respectively. During this period, agricultural lands decreased 21 percent from 112,657 acres in 1979 to 88,847 acres in 2004. Further analysis revealed that a 20 percent decrease in irrigation rate could result in a 9 percent reduction in recharge. A similar study by Izuka et al. (2005) reported that a 34 percent decrease in irrigation rate constituted a 7 percent reduction in recharge in the Lihue basin in Kauai, Hawaii. Since over half of the irrigation water for west and central Maui comes from east Maui, a 20 percent decrease in the amount of water diverted from streams in the east can potentially reduce recharge in the west and central parts of Maui by 5 percent.

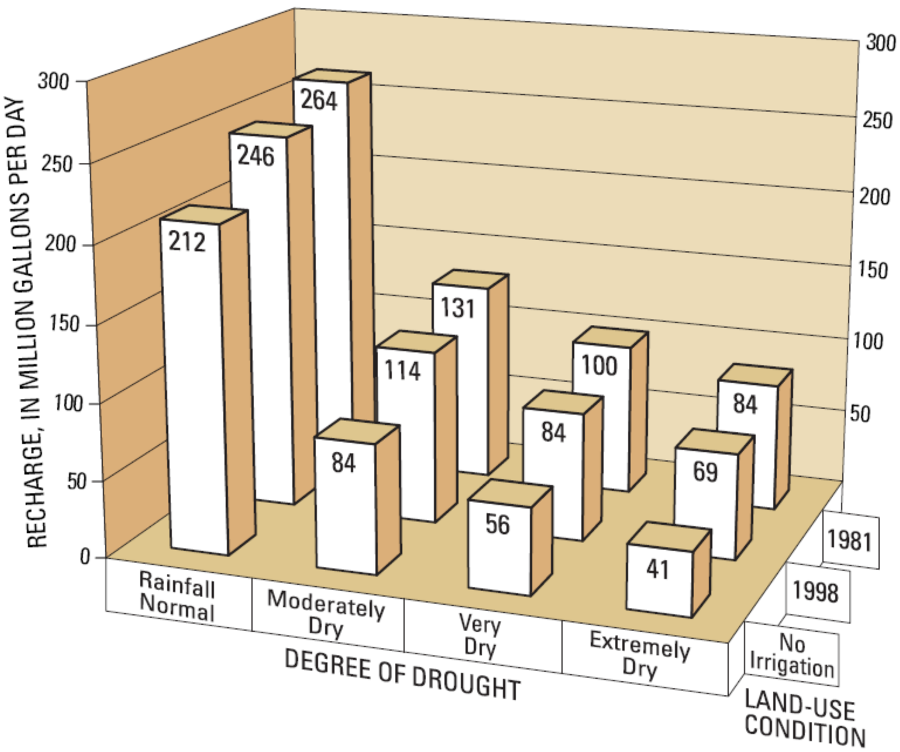
Figure 13-6. Estimated recharge for six historical periods between 1926 and 2004, central and west Maui, Hawaii (Source: Engott and Vana, 2007).



[5] Water-budget is a balance between the amount of water leaving, entering, and being stored in the plant-soil system. The water budget method/equation is often used to estimate ground water recharge.

Droughts, or periods of lower than average rainfall, have been shown to drastically decrease ground water recharge (Figure 13-7). The period of drought that occurred in 1998-2002, during which rainfall was at least 30 percent lower than the average annual rainfall, was estimated to reduce recharge by 27 percent in west and central Maui (Engott and Vana, 2007). For example, on the island of Kauai, the drought conditions reduced recharge in Lihue basin by 34-37 percent (Izuka et al., 2005). Even though droughts can have exacerbating effects on ground water recharge, these effects are transient and are usually mitigated by periods of higher than average rainfall (Engott and Vana, 2007). However, prolonged loss of irrigation water caused by a decrease in the amount of water diverted by irrigation ditches has greater effects on the long-term trends of ground water levels.

Figure 13-7. Summary of estimated recharge, in million gallons per day, for various land-use and rainfall conditions in the Lihue Basin, Kauai, Hawaii (Source: Izuka et. al., 2005).



The Agricultural Lands of Importance to the State of Hawaii (ALISH) were completed by the State Department of Agriculture (HDOA) in 1977, with the assistance of the Soil Conservation Service (SCS), U.S. Department of Agriculture, and the College of Tropical Agriculture, University of Hawaii. Three classes of agriculturally important lands were established for Hawaii in conjunction with the SCS in an effort to inventory prime agricultural lands nationwide. Hawaii's effort resulted in the classification system of lands as: 1) Prime agricultural land; 2) Unique agricultural land; and 3) Other important agricultural land. Each classification was based on specific criteria such as soil characteristics, slope, flood frequency, and water supply. ALISH was intended to serve as a long-term planning guidance for land use decisions related to important agricultural lands. HDOA is currently in the process of developing agricultural incentives based on classifications of Important Agricultural Lands. Honopou is comprised of nearly 20 percent of prime agricultural land (Table 13-8).

Table 13-8. Agricultural Lands of Importance to the State of Hawaii and area distributions in the Honopou hydrologic unit.

Density	Area (mi^2)	Percent of Unit
Prime agricultural land	0.53	19.7
Unclassified	0.05	1.8

From 1978 to 1980, HDOA prepared agricultural land use maps (ALUM) based on data from its Planning and Development Section and from SCS. The maps identified key commodity areas (with subclasses) consisting of: 1) Animal husbandry; 2) Field crops; 3) Orchards; 4) Pineapple; 5) Aquaculture; 6) Sugarcane; and Wetlands (Table 13-9).

Table 13-9. Agricultural land uses and area distributions in the Honopou hydrologic unit.

Density	Area (mi^2)	Percent of Unit
Pineapple	0.31	11.6
Animal husbandry, grazing	0.76	28.1

Though both ALISH and ALUM datasets are considerably outdated, many of the same agricultural assumptions may still hold true. The information is presented here to provide the Commission with present or potential noninstream use information (Figure 13-15).

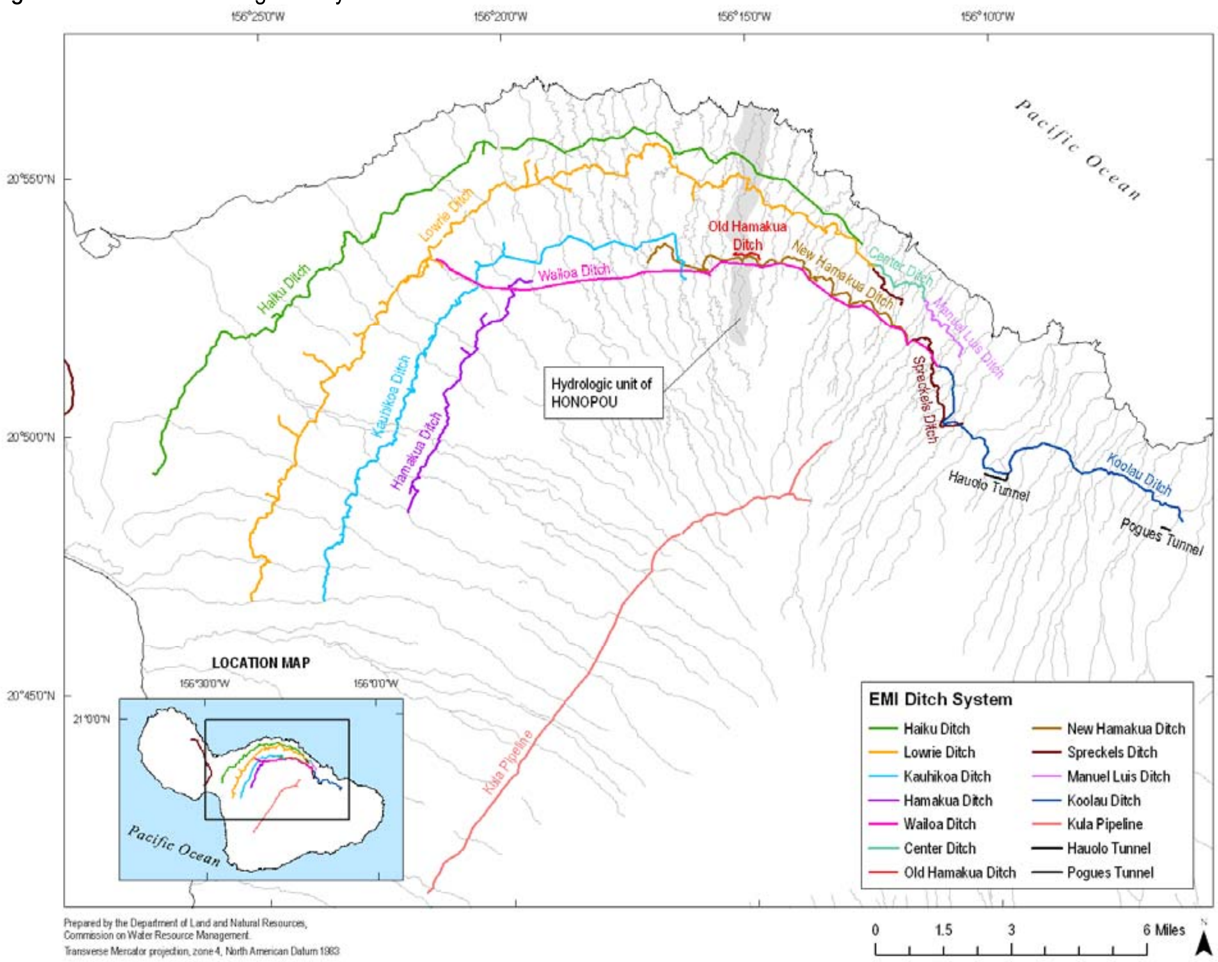
The presence of the EMI system adds considerable complexity to the Commission's role in weighing instream and noninstream uses. While this is largely due to the transfer of water from one hydrologic unit to another, the importance of the system to both agriculture and municipal water supply in Upcountry and Central Maui play a pivotal role in the consideration of economic impacts. The complexity of the EMI system is detailed in Table 13-10 and illustrated in Figure 13-8.

Table 13-10. Historic Timeline of the East Maui Irrigation System (Source: Wilcox, 1996)

1869	-	Samuel Alexander and Henry Baldwin partner to purchase 11.94 acres of Bush Ranch.
1876	-	Alexander and Baldwin form the Hamakua Ditch Company on Maui.
1878	-	Construction of the Hamakua Ditch is completed (not to be confused with the Upper and Lower Hamakua Ditches on the island of Hawaii).
1894	-	Alexander & Baldwin (A&B) is established as an agency.
1898	-	A&B gain control of Hawaiian Commercial & Sugar (HC&S), then become its agent shortly thereafter.
	-	Construction of Lowrie Ditch is started about this time. The Lowrie Ditch emanates from the Kailua watershed in the Makawao District, and receives water from a reservoir in Papaaea and Kailua Stream where the diversion intercepts the source of the older Haiku Ditch.
1900	-	A&B is incorporated with accumulated assets of $1.5 million, compared with a net profit of just $2,627.20 in 1895
	-	Lowrie Ditch is completed with a capacity of 60 million gallons per day and is able to irrigate 6,000 acres. The 22-mile system is 75 percent open ditch, but also includes 74 tunnels, 19 flumes, and a total of 4760 feet of siphons.
1904	-	Construction begins on Koolau Ditch, which extends the system 10 miles toward Hana.
1905	-	Koolau Ditch is completed with a capacity of 85 million gallons per day, and consists of 7.5 miles of tunnel and 2.5 miles of open ditch and flume.
1908	-	The East Maui Irrigation Company (EMI) is formed to develop and administer the surface water for all the plantations owned, controlled, or managed by A&B.
	-	A&B gains control of Kihei Plantation.
1912	-	The old Haiku Ditch is abandoned between 1912 and 1929.
1914	-	New Haiku Ditch is completed with a capacity of 100 million gallons per day. The system is mostly tunnel, partially lined, with a length of 54,044 feet.
1915	-	Kauhikoa Ditch is completed with a capacity of 110 million gallons per day and a length of 29,910 feet.
1918	-	Construction of Wailoa Ditch is started.
1923	-	Wailoa Ditch is completed with a capacity of 160 million gallons per day. The system is mostly tunnel, completely lined, with a length of 51,256 feet. Capacity was later increased to 195 million gallons per day (date unknown).

In total, the EMI system consists of 388 separate intakes, 24 miles of ditch, 50 miles of tunnel, twelve inverted siphons, and numerous small feeders, dams, intakes, pipes, and flumes (Figure 13-8). Supporting infrastructure includes 62 miles of private roads and 15 miles of telephone lines. The system primarily captures surface water from multiple watersheds in east Maui with a combined area of approximately 56,000 acres, of which 18,000 acres are owned by EMI, and the rest by the State of Hawaii (Wilcox, 1996).

Figure 13-8. East Maui Irrigation System.



The EMI system has a delivery capacity of 450 million gallons per day, but delivers an average of 165 million gallons per day. However, the average water delivery can vary considerably due to variable climate conditions that affect surface water availability. Approximately 70 percent of the water delivered via the EMI system emanates from State lands, for which Alexander and Baldwin (A&B) and EMI currently hold revocable permits for the four license areas identified in Table 13-11.

Leases and water licenses have been granted in this area as early as 1876, immediately after the signing and ratification of a Reciprocity Treaty between the Kingdom of Hawaii and the United States (Kumu Pono Associates, 2001a, p.443), thus making sugar cultivation a more reliable economic prospect. At one point there were five licenses issued for this area. Two were subsequently combined, resulting in the four license areas. As the licenses expired, they were not reissued; instead, revocable permits were issued to the license holders. The intent was to eventually issue one license to cover all areas once the existing licenses had all expired. The licenses, and also the subsequent revocable permits, included clauses protecting the water rights of the native tenants for domestic use, including cultivation of taro. The licenses, and subsequent revocable permits, allow the taking of surface water and development of ground water via tunneling from state land. Commission staff reviewed 20 files pertaining to the water licenses/revocable permits that are housed in the Department of Land and Natural Resources' Land Division (State of Hawaii, Land Division, 2008). Documents in those files date from 1876 to present.

According to a collection of native traditions and historical accounts of east Maui, "While testimonies in some public hearings have expressed the sentiment that 'the waters were taken without permission'…, the initial development of the ditch system was authorized as a part of the Hawaiian Kingdom's program to promote prosperity for all the people of the Kingdom…Of importance to the native Hawaiian families of the land, each of the Water Licenses issued under the Kingdom included clauses which protected the pono wai (water rights) of native tenants of the respective lands through which the ditch system was developed (Kumu Pono Associates, 2001a, p.444)." Yet, as early as 1913, the USGS was reporting that "the present system of ditches takes practically the entire water supply of the region at times when the streams are low (Martin and Pierce, 1913, p.259).

In 1938, the "East Maui Water Agreement" was signed between the Territory of Hawaii and EMI, which by then had been incorporated (in 1908, through an Agreement between five agricultural companies) and which had consolidated the ditch system through leases of all ditches, water rights and easements, etc. (Kumu Pono Associates, 2001a, p.494). Under the terms of the East Maui Water Agreement, both parties granted to each other perpetual easements with a right to convey all waters, without charge, through any and all aqueducts owned respectively by EMI and the Territory, and over all lands owned by the two parties extending from Nahiku to Honopou inclusive. This agreement was made because the system traverses partly through government land and partly through EMI lands. Language in the Agreement allows for entities other than EMI to bid on the Water Licenses, but EMI has successfully bid on those licenses whenever they have been up for bid or renewal (State of Hawaii, Land Division, 2008).

The licenses were for different terms and with different covenants, and were renewed and changed from time to time. The final terms of the licenses follow; after which revocable permits were issued.

Table 13-11. Terms of last license, before they became revocable permits

License area	General Lease number	Term
Huelo	GL 3578	1960-1981
Honomanu	GL 3695	1962-1986
Keanae	GL 3349	1950-1971
Nahiku	GL 3505	1955-1976

When the first of the four licenses expired, the State commissioned an appraisal to recommend rates to be charged for the Keanae License. The resulting report, published in 1972, summarizes some of the results of the 1938 Agreement. Because of the perpetual easements, "each party is assured of being able to convey its water through the aqueduct, with each paying the operation and maintenance cost in proportion to their respective use of it. So long as [EMI] is the successful bidder for all four State water licenses, it pays all the operation and maintenance costs…Subsequent to the agreement, the question of how much water was owned by each party was in effect settled by means of a study made in 1949 by Luna B. Leopold, Meteorologist…This map was used by [EMI] to determine the percentage of the rainfall on the government and private lands that are mauka of and tributary to the collection system for each of the four watersheds. It was assumed that the yields of the water collected in the aqueduct system are in proportion to the amount of rainfall on the respective land ownerships (Hull, 1972)." In other words, the ditch system collected water from both State and private lands. Ditch flow measurements were only collected at certain points, and included water originating on government as well as on private lands. In order to determine the amount of money to charge EMI for the water licenses, the State had to calculate the percentage of water in the ditch that came from government land and the percentage that came from private land (Table 13-12), and they did this using rainfall isohyets and acreage of the license areas. Those numbers were still in use as of 1972, and presumably until the end of all four water license agreements, as the other three (besides the then-recently expired Keanae License) were still in place at the time the 1972 report was published (Hull, 1972).

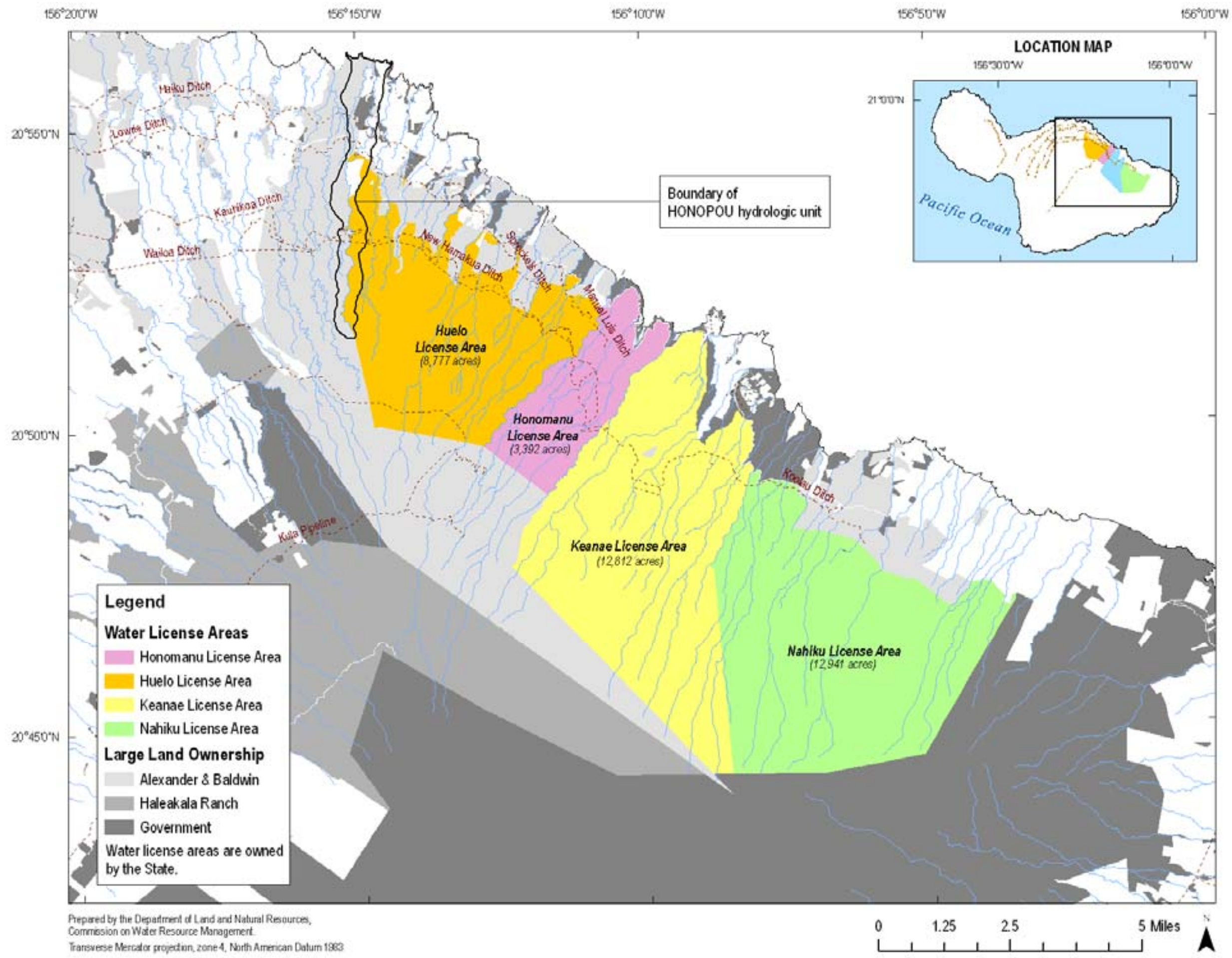
Table 13-12. Percentage of water yield from the four license areas (as of 1972).

Watershed	Government (%)	Private (%)
Huelo	64.49	35.53
Honomanu	47.39	52.61
Keanae	79.19	20.81
Nahiku	95.02	4.98

The correspondence and discussions over the course of many years indicate that the water was viewed as a commodity and that water permitted to flow into the ocean was considered waste. Originally the rates charged for the water licenses were low, to allow for construction costs. For many years after construction, lease amounts were determined according to the price of sugar, the annual quantity of water carried through the system, and the percentages of government and private lands from which the water contributed to the system (State of Hawaii, Land Division, 2008). Water yields were measured for each license area. Rate of the licenses fluctuated with the price of sugar, but the licenses included minimum and maximum sugar prices that could be used in the calculations, e.g. if the price of sugar exceeded the price ceiling in the license, the rental rate would be frozen for the remainder of the license period, using that maximum amount to calculate rent. The terms of the long-term licenses were renegotiated at the expiration of the license period, i.e. roughly every 20-35 years. Under the long-term lease, A&B was required to pay for a minimal take of water even if it was not available due to low flow, or not necessary due to high rainfall on the plantations (State of Hawaii, Land Division, 2008 and Hull, 1972).

Water yield is no longer measured per license area; flow for all four license areas is totaled at the Honopou Boundary. Total water supply is classified either as water runoff from EMI land or water runoff from State-owned land. The water license areas are shown in Figure 13-9, along with other large landowners.

Figure 13-9. East Maui Water License Areas.



In 1965, HRS 171-58, as amended, required water rights to be leased through public auction or permitted on a month-to-month basis up to one year. The existing leases were grandfathered until their expiration. As mentioned above, the last water license agreement expired in 1986, after which all four license areas were disposed of as month-to-month revocable permits that were renewed annually, alternating in issuance to EMI and A&B. A&B proposed the consolidation of the four leases into a single lease, and in 1985 the Land Board approved a public auction sale for a 30-year water license incorporating the four licenses into a single license. In 1986, Native Hawaiian Legal Corporation (NHLC) challenged the Department of Land and Natural Resources (DLNR)'s decision that an Environmental Impact Statement (EIS) was not required and an Environmental Assessment (EA) was sufficient for the issuance of the 30-year lease. The Circuit Court agreed that an EA was adequate, and NHLC appealed to the Supreme Court, who remanded back to Circuit Court to conduct a hearing pursuant to HRS section 343-7(b) on the matter. Further discussions resulted in several decisions, including that the Board of Land and Natural Resources (BLNR) and DLNR must work towards long-term resolution; and that interested parties work together to develop a watershed management plan for the water lease areas. The latter resulted in the creation of the East Maui Watershed Partnership and development of the East Maui Watershed Management Plan.

In 1987, the rate structure of the revocable permits was altered to a fixed flat fee independent of the amount of water diverted by A&B, and the rates were reduced by 25% to discount for the uncertainty that the annual permits would be renewed. However, the payments after 1987 were increased by 25% to remove the discount and convert the rates to long-term lease rentals. In 1988, the State performed an independent audit and set the benchmark rate based on the audit rate of five dollars per million gallons. In fiscal year 1999-2000, the permits were issued to A&B and EMI, with the fixed rates based on an assumed annual flow. The current revocable permits state that their rates are based on a staff appraisal dated May 7, 2001.

The revocable permits are currently regulated by the DLNR's Land Division, which collects fees for the permits. Those permits were most recently renewed in November 2007, with the following rental payments:

Table 13-13. Current revocable permits issued to A&B/EMI.

Revocable Permit No.	License Area	Area (acres)	Monthly Rent in 2008
S-7264	Huelo	8,752.69	$6,588
S-7263	Honomanu	3,381.00	$1,698
S-7265	Keanae	10,768.00	$3,477
S-7266	Nahiku	10,111.22	$1,427

In May 2001, A&B and EMI filed an Application for a Long Term Water License with the BLNR seeking a long-term 30-year lease rather than continue with year-to-year revocable permits. Shortly thereafter, Na Moku Aupuni O Koolau Hui, Inc. ("Na Moku") and Maui Tomorrow requested a contested case hearing, with NHLC filing on behalf of petitioners Na Moku, Elizabeth Lapenia, Beatrice Kekahuna, and Marjorie Wallett. (In May 2007, Elizabeth Lapenia withdrew from the case and is no longer represented in it.) Concurrently, the Petitioners filed with the Commission a Petition to Amend the Interim Instream Flow Standard for 27 Streams in East Maui.

In May 2002 the BLNR deferred the reissuance of interim revocable permits and granted a holdover of the existing revocable permits on a month-to-month basis pending the results of the contested case hearing. A January 2003 BLNR "Findings of Fact and Conclusions of Law and Order" indicates that the "BLNR may enter into a lease of water emanating from State lands for transfer outside of the watershed of origin provided that such lease is issued in accordance with the procedures set forth in HRS Chapter 171 and provided that all diversions of stream water shall remain subject to the Interim Instream Flow Standards set by CWRM, and to any judgment of a court of competent jurisdiction establishing appurtenant or riparian rights in favor of downstream users (p.12)." This part of the Order was reversed by Circuit Court in October 2003 and the BLNR advised that if it does not believe it has the requisite expertise, it should wait until CWRM has acted or make its own application to establish instream flows. However, the Court Order goes on to state that the BLNR cannot "rubber-stamp" any Commission determination, meaning that at any BLNR contested case hearing, any party may challenge a Commission decision "if its methodology is wrong or some other error is committed." The Order also indicates legal precedent suggests that an EA should be required for issuance of a long-term lease, and perhaps an EIS depending upon the result of the EA.

In March 2005, the Petitioners filed Motions For Summary Relief contesting the "Holdover Decision" that allowed continued renewal of the revocable permits. The motions for summary relief were denied. However, in the Order denying the motions for summary relief, the Hearings Officer indicated that an evidentiary hearing could be held upon request to determine if interim releases of water were required in order for the Board to fulfill its public trust duties pending the completion of an environmental assessment and determination of amendments to interim IFS. At an early pre-hearing conference the parties agreed the streams in issue in the evidentiary hearing concerning interim relief were Honopou, Puolua, and Hanehoi Streams in the Huelo license area, and Wailuanui, Waiokamilo, and Palauhulu Streams in Keanae. Accordingly, the evidentiary hearing was held in October and November 2005.

The resulting "Findings of Fact, Conclusions of Law, and Decision and Order ('Interim Order')" was issued by the Board of Land and Natural Resources in March 2007. This was intended to provide interim relief based on evidence introduced in the 2005 evidentiary hearing, and is not intended to foreshadow the Board's final decision in the case. The Interim Order concluded and ordered, among other things:

- That the DLNR "appoint an appropriate monitor… to ensure compliance with its order and to investigate and resolve if possible all complaints regarding stream flows by any of the parties to this proceeding."
- That A&B/EMI be immediately ordered to decrease current diversions on Waiokamilo Stream such that the water flow can be measured below Dam #3 at the rate of 6,000,000 gallons per day based on a monthly moving average on an annual basis.
- In the event that Beatrice Kekahuna increases the amount of acreage that she has in cultivation as taro loi, A&B/EMI may be required to decrease diversions (from Honopou Stream) to allow her sufficient water to irrigate her loi.

In May 2008, NHLC on behalf of the petitioners filed a Motion to Enforce the March 2007 Interim Order. Though there has been release of water into Waiokamilo and Kualani Streams, NHLC contends that the Interim Order has not been fully implemented largely due to the ability of the monitor to perform certain actions. Additionally, NHLC claims that Beatrice Kekahuna, Marjorie Wallett, and others still do not have adequate water to cultivate their taro.

As mentioned above, it is not the intention of this IFSAR to enumerate all the details of the contested case; however, more detail, specifically contrasting claims by NHLC and HC&S, is provided in the recommendations to the Commissioners to amend the interim IFS.

There have been few changes to the EMI system since the Wailoa Ditch was completed in 1923. EMI continues to provide water to HC&S, which is the largest producer of raw sugar in Hawaii, and only one of two remaining sugar plantations in the state. In 2006, HC&S produced about 81 percent of the total raw sugar in Hawaii, or approximately 173,600 tons, amounting to about 3 percent of total U.S. sugar produced (A&B, 2007). HC&S also produces molasses, a by-product of sugar production, and specialty food grade sugars sold under their Maui Brand® trademark. Table 13-14 summarizes the harvest and production yields for HC&S from 2000 to 2006.

Table 13-14. Summary of sugar-related harvests by HC&S for 2000-2006 (Source: A&B, 2002; 2003; 2005; 2007).

[* Data were not reported]

Year	Raw sugar produced (tons)	Percent of total raw sugar produced In Hawaii	Area harvested (acres)	Yield per acre (tons)	Average cost per ton (dollars)	Molasses produced (tons)	Specialty food-grade sugar produced (tons)
2006	173,600	81.0	16,950	10.2	*	55,900	15,500
2005	192,700	76.0	16,639	11.6	*	57,100	18,900
2004	198,800	77.0	16,890	11.8	435	65,100	15,500
2003	205,700	79.0	15,660	13.1	422	72,500	12,100
2002	215,900	79.0	16,557	13.0	332	74,300	11,000
2001	191,500	70.0	15,101	12.7	371	71,200	8,848
2000	210,269	*	17,266	12.2	331	70,551	*

The HC&S sugar plantation currently consists of approximately 43,300 acres of land. Sugar is cultivated on roughly 37,000 acres, while the balance is leased to third parties, is not suitable for cultivation, or is used for plantation purposes (A&B, 2007). Approximately 30,000 acres are irrigated with water delivered by EMI, with 5,000 acres irrigated solely with EMI water, and the remaining 25,000 acres are irrigated with a mix of EMI water and supplemental ground water pumped by HC&S.

According to the Board findings in the contested case hearing regarding the east Maui water licenses, the total amount of water HC&S needs from EMI varies largely with weather and seasonal conditions, but ranges from a low of 134 million gallons per day in the winter months to a high of 268 million gallons per day during peak usage in the months of May to October (Findings of Fact, Conclusions of Law, and Decision and Order, 2007). From 2002 to 2004, HC&S received 71 percent of its water supply from EMI (surface water), while the remaining 29 percent was supplemental ground water. The EMI system was designed and constructed to take full advantage of the gravity flow of water from higher to lower elevations, thus minimizing pumping and the additional consumption of electrical power. As a result, HC&S attempts to divert the maximum possible amount of water into the EMI system at the Wailoa Ditch, which has a capacity of 195 million gallons per day.

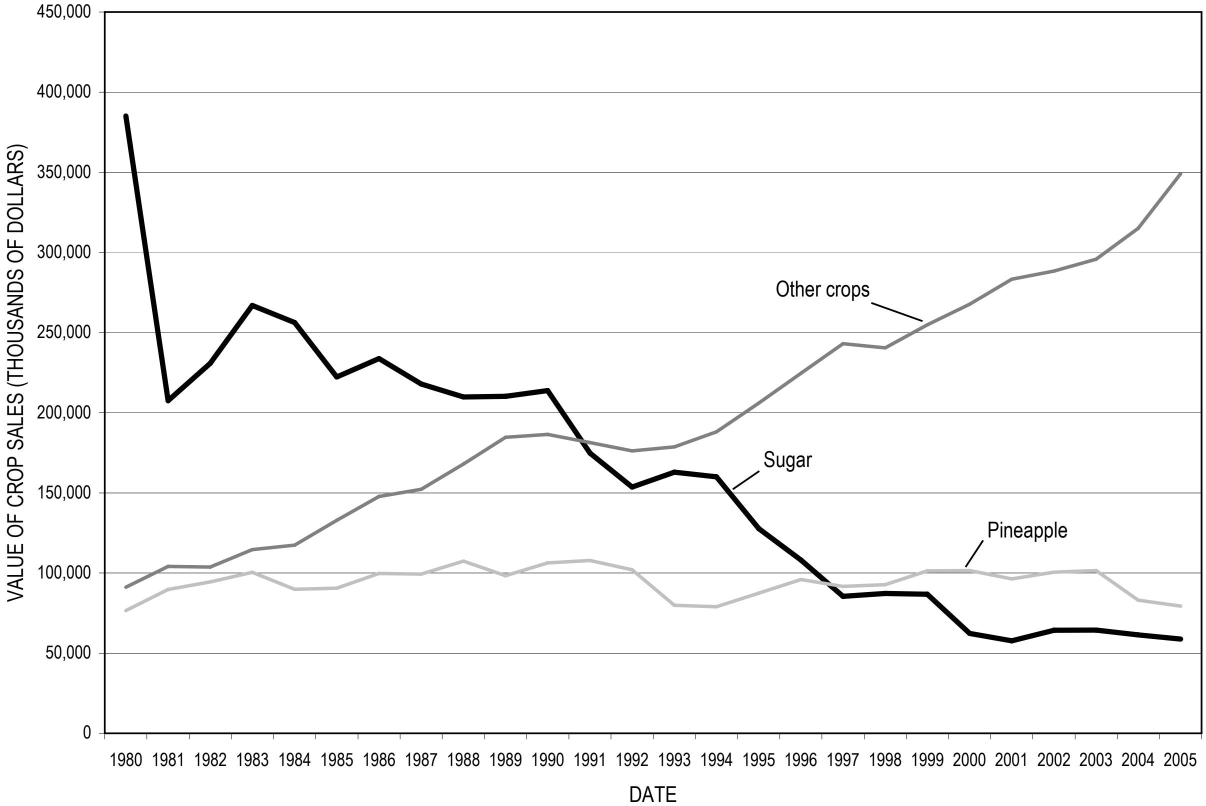
Of the estimated 1,750 agriculture-related jobs on Maui (Department of Business, Economic Development and Tourism [DBEDT], 2007), HC&S employs approximately 800 full-time workers, while EMI employs an additional 17 workers. The Agribusiness sector of HC&S saw a revenue increase of 3 percent, or $4.2 million, in 2006 over the previous year. This increase was attributed to higher revenues in repair services and trucking, higher-power sales, higher equipment rentals and soil sales, and higher specialty sugar and molasses sales. In comparison, lower revenues were reported in the bulk sugar sales (A&B, 2007). Table 13-15 provides a summary of HC&S' agribusiness revenues for 2000 to 2006.

Table 13-15. Summary of HC&S' agribusiness revenues for 2000 to 2006 (Source: A&B, 2002; 2005; 2007).

Year	Revenue (dollars)	Operating Profit (dollars)	Operating Profit Margin (percent)
2006	$ 127,400,000	$ 6,900,000	5.4
2005	$ 123,200,000	$ 11,200,000	9.1
2004	$ 112,800,000	$ 4,800,000	4.3
2003	$ 112,900,000	$ 5,100,000	4.5
2002	$ 112,700,000	$ 13,800,000	12.2
2001	$ 105,976,000	$ 5,660,000	5.3
2000	$ 107,510,000	$ 7,522,000	7.0

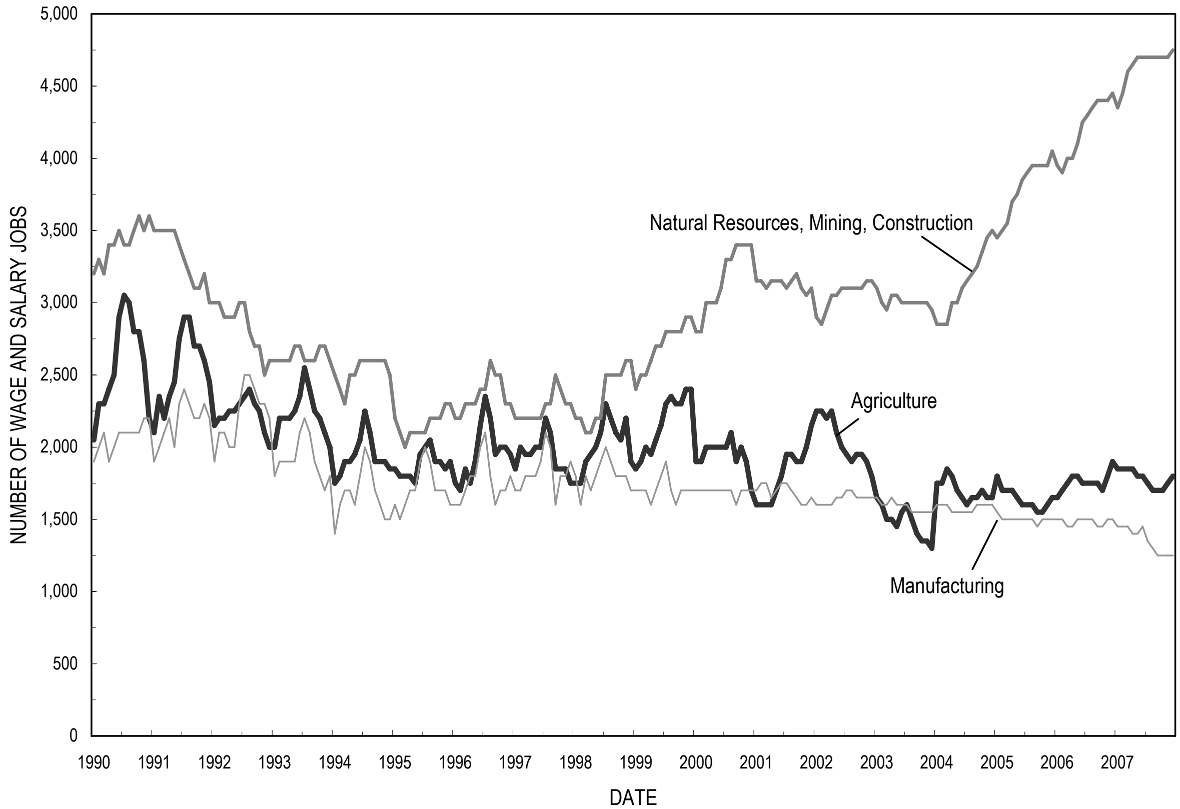
Overall, Hawaii sugar growers produce more sugar per acre than most other sugar-producing areas of the world; however, this advantage is offset by Hawaii's higher labor costs and higher transportation costs resulting from the longer distance to the U.S. mainland market. The DBEDT *State of Hawaii Data Book* shows the dramatic decline in sugar crop sales as plantations have closed over the last 25 years (DBEDT, 2006). Figure 13-10 illustrates the decline of sugar, the steady value of pineapple sales, and the increase of other crops generally considered as diversified agriculture.

Figure 13-10. Value of crop sales for sugar, pineapple and other crops from 1980 to 2005 (Source: DBEDT, 2006).



Examination of monthly economic indicators shows that, in general, agricultural jobs have slowly decreased on the island of Maui over the past 15 years. This trend is illustrated in Figure 13-11 along with trends for: 1) Natural resources, mining, and construction; and 2) Manufacturing.

Figure 13-11. Monthly number of wage and salary jobs, for three sectors including agriculture, for the island of Maui from 1990 to 2007 (Source: DBEDT, 2008).



In addition to sugar crops, HC&S receives revenue from its sale of electricity to Maui Electric Company (MECO). The HC&S Puunene Sugar Mill continues to provide a renewable energy alternative in the form of sugar cane bagasse, a fibrous byproduct of the sugar extraction process. Bagasse is the primary fuel used in boilers to generate steam, a requirement for sugar processing and for driving steam turbine generators to produce electricity. The electricity that is not used by the sugar mill is sold to MECO for distribution. HC&S is under contract with MECO to supply, at specified rates, 12 megawatts of power from 7:00 a.m. to 9:00 p.m. daily except Sunday and 8 megawatts at all other times. The contract provides for monetary penalties if these requirements are not met by HC&S. The approximate oil savings is 44,700 barrels per year (MECO, 2008a).

HC&S also receives revenue from the delivery of water to the County of Maui Department of Water Supply's (DWS) Upcountry system, and to Maui Land and Pineapple Company, Inc. (MLP) for its east Maui pineapple fields. MLP cultivates roughly 6,000 acres of pineapple, of which over 2,800 acres are situated in east Maui and rely on the EMI system for water. While there are indications that MLP has leased, or is planning to lease, 400 additional acres in east Maui to expand their pineapple growing operations (Findings of Fact, Conclusions of Law, and Decision and Order, 2007), MLP has also expressed their intention of shifting plantings from Upcountry Maui to agricultural land in west Maui due to the susceptibility of their east Maui fields to drought conditions. MLP states that their west Maui lands are less susceptible to drought and irrigation storage capacity is being increased (MLP, 2007).

MLP estimates their water requirements from the EMI system at 4.5 million gallons per day from 2004 through 2009, and a reduction to approximately 4.4 million gallons per day from 2009 to 2016. Under a

License and Water Agreement between MLP and EMI, two "classes" of water are transported via the EMI system. The first class of water, which represents the majority of MLP's usage, is pumped by Maui Pineapple Co., Ltd. into the Koolau Ditch from Hanawi Stream at Nahiku near the start of the EMI system. The second class of water is what MLP is contractually allowed to withdraw, for a fee, from the EMI system when flow exceeds 100 million gallons per day.

According to MLP's Annual Reports to the U.S. Securities and Exchange Commission, the last year that MLP had an operating profit for their pineapple operations was in 1999. Table 13-16 provides a summary of revenue and operating losses from 1999 to 2006. Some of the revenue losses can be attributed to increased importation of oversees pineapple products (specifically from Thailand); though it appears that the U.S. had begun imposing antidumping duties, as canned pineapple imports had decreased in 2001. Regardless, in June 2007, MLP ceased pineapple canning operations on Maui, attributing the closure to increased imports of cheaper canned pineapple. MLP is instead choosing to focus on the production of pineapple juice and fresh fruit. The closure of Hawaii's last canned pineapple producer resulted in the loss of 120 jobs, or 27 percent of the company's workforce (Hao, 2007).

Table 13-16. Summary of MLP's revenues and operating losses for 1999 to 2006 (Source: MLP, 2002; 2004; 2005; 2007).

[Numbers in parentheses indicate operating losses; numbers not in parentheses are gains.]

Year	Revenue (dollars)	Operating Loss (dollars)
2006	$ 65,200,000	$ (18,600,000)
2005	$ 74,500,000	$ (11,400,000)
2004	$ 80,000,000	$ (10,800,000)
2003	$ 105,000,000	$ (921,000)
2002	$ 92,500,000	$ (8,500,000)
2001	$ 92,000,000	$ (3,000,000)
2000	$ 85,900,000	$ (2,900,000)
1999	$ 94,400,000	$ 6,100,000

The other major user of EMI surface water, Maui DWS, receives approximately 8.2 million gallons per day, a portion of which goes directly to the Kula Agricultural Park. Under a December 31, 1973 agreement between EMI, HC&S, and the County of Maui, EMI agreed to collect and deliver to the County 12 million gallons per 24-hour period for a term of 20 years, with an option for the County to receive an additional 4 million gallons after giving one year's written notice to EMI. Set to expire in 1993, this agreement was extended on several occasions, with the last extension expiring on April 30, 2000.

EMI currently delivers water to the County under a Memorandum of Understanding (MOU) that was executed on April 13, 2000, which provides for the County to continue to receive 12 million gallons per day from the Wailoa Ditch with an option to receive an additional 4 million gallons. However, the MOU also includes stipulations for periods of low flow, whereby the County will receive a minimum allotment of 8.2 million gallons per day while HC&S will also receive 8.2 millions gallons per day, or 9.4 million gallons per day should fire flow be required (Maui DWS, 2007b). The MOU has a term of 25 years and sets water delivery rates at $0.06 per thousand gallons. For the 2006 fiscal year, Maui DWS reported purchasing a total of 2,601 million gallons from EMI, at a cost of $156,848, which includes various other sources in addition to the Wailoa Ditch (Maui DWS, 2007a).

Of the five separate water systems operated by DWS, the Upcountry Maui (sometimes referred to as Makawao) system is the second largest system and is supported by Maui's largest surface water treatment facility (WTF), the Kamole Weir WTF. Surface water, for the most part, supplements the primary ground water sources (Haiku and Kuapakalua wells) for the region, but serves as backup in the event of pump failure or drought. The Kamole Weir WTF produces an average 3.6 million gallons per day, but is capable of producing 8 million gallons per day at maximum capacity. DWS also plans to increase capacity by 2.3 million gallons per day in 2015 (Findings of Fact, Conclusions of Law, and Decision and Order, 2007; Maui DWS, 2007e).

The Kamole Weir WTF receives water from the Wailoa Ditch and supplies water to approximately 6,571 water service connections and is capable of providing water to the entire Upcountry region (9,708 connections) if necessary (Maui DWS, 2007e). The EMI ditch system provides water to the Nahiku community, to Maui Land & Pine, and to the Maui County Board of Water Supply for use in upcountry Maui. There are three upcountry Maui County Department of Water Supply (DWS) water systems served by east Maui streams: Maui DWS Makawao is served by Wailoa Ditch, part of the EMI system; Maui DWS Upper Kula is served by Haipuaena and Waikamoi Streams; and Maui DWS Lower Kula by Honomanu, Haipuaena, and Waikamoi Streams. Maui DWS themselves divert the streams for the Upper and Lower Kula pipelines; it is only the Makawao system whose source is the EMI system (Mike Miyahira, DOH Safe Drinking Water Branch, personal communication, August 1, 2008.)

The Upcountry system includes the communities of Kula, Pukalani, Makawao, and Haiku, with an estimated population of 30,981 people (Findings of Fact, Conclusions of Law, and Decision and Order, 2007). Metered water usage in the Upcountry system has steadily climbed over the past 10 years, with the largest portion going towards potable water use (Table 13-17).

Table 13-17. Historical metered consumption for the Upcountry system, Maui (Source: Maui DWS, 2007d).

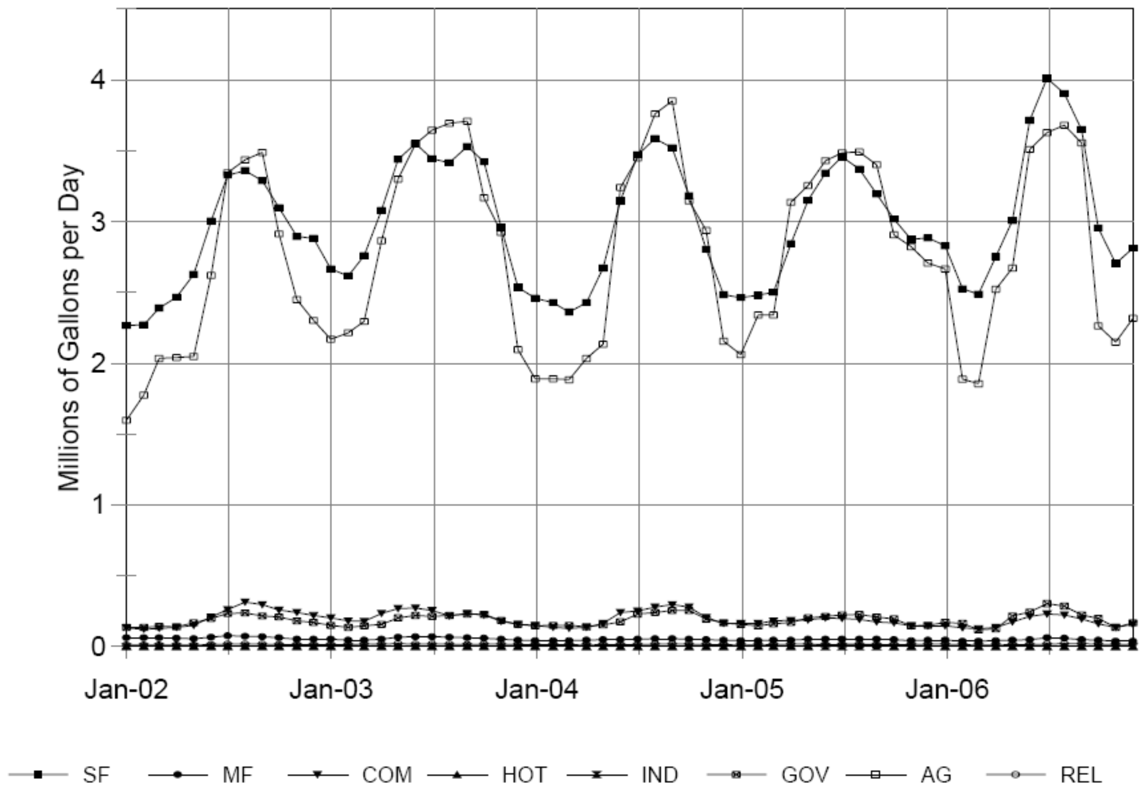
[Data reported in million gallons per day]

Year	General	Agriculture Potable	Total Potable	Agriculture Non-potable	Total
2005	4.441	2.378	6.820	0.571	7.391
2004	4.387	2.138	6.525	0.575	7.100
2003	4.778	2.320	7.098	0.582	7.680
2002	4.461	1.908	6.368	0.433	6.801
2001	4.823	2.563	7.387	0.690	8.077
2000	4.370	2.504	6.873	0.505	7.379
1999	4.146	2.474	6.620	0.555	7.175
1998	4.003	2.382	6.384	0.512	6.897
1997	3.693	1.829	5.521	0.374	5.895
1996	4.083	1.923	6.007	0.481	6.487
1995	4.382	2.300	6.682	0.634	7.317
1994	3.871	1.931	5.802	0.504	6.306

For the Makawao-Pukalani-Kula Community Plan District, water use for agriculture and single-family residences has been very similar over the past 5 years. The two uses also have strong annual patterns, with water use rising approximately 1.5 million gallons per day during summer months versus winter months (Figure 13-12). Other water uses within the district are relatively low (Maui DWS, 2007d).

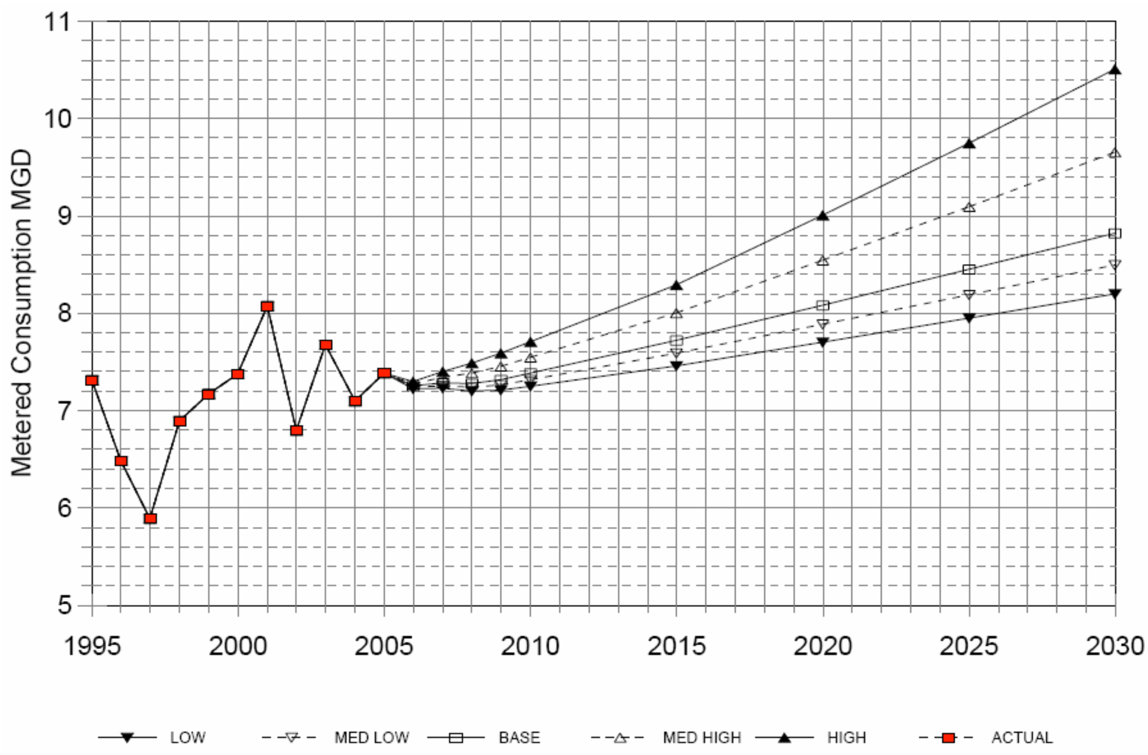
Figure 13-12. Historical monthly water consumption by use class code for the Makawao-Pukalani-Kula Community Plan District, Maui (Source: Maui DWS, 2007d).

[SF is single family residential; MF is multi-family residential; COM is commercial; HOT is hotel; IND is industry; GOV is government; AG is agricultural; REL is religious]



The County of Maui, as part of its current effort to update the Maui County Water Use and Development Plan, is examining various resource options to meet the forecasted water needs and planning objectives of the Upcountry district over a 25 year planning period. Expansion of the Kamole Weir WTF is the primary long-term option affecting water delivered via the Wailoa Ditch; however, other options for the entire district include developing additional ground water sources, expanding/upgrading interconnections (booster pumps) between systems, and increasing water storage capacity (Maui DWS, 2007c). Upcountry water demands are expected to increase, as depicted in Figure 13-13, based upon five water demand projections derived from varying growth scenarios (low, medium low, base, medium high, and high) to the year 2030.

Figure 13-13. Actual and projected water demands of all metered use classes for the Upcountry District, Maui (Source: Maui DWS, 2007d).



Hawaiian Commercial & Sugar Company has become the largest sugarcane plantation in Hawaii. With roughly 37,000 acres under cultivation, HC&S aims to produce 225,000 tons of raw sugar per year, accounting for 80 percent of the state's total production (see CPRC 13.20-80). The sugar industry in Hawaii is unique because more sugar is produced per acre than any other area in the world (Hawaiian Sugar Planters' Association, 1972). Hawaii is also the only area where sugarcane is grown on a two-year cycle from planting to the time of harvest.

Sugarcane is planted with seedcane, which are pieces of cane stalks obtained from special plots of cane. When sugarcane is harvested, it grows again from the old root system without replanting. This is the ratoon crop. The average age of the cane is 22 to 24 months at the time of harvest (Hawaiian Sugar Planters' Association, 1972). Sugarcane typically needs the most water during the initial stages of the crop cycle for vegetative growth, while less water is needed during the later stages of growth to bring the crop to maturity. The amount of water HC&S needs to irrigate its sugarcane fields varies largely with climate and rainfall. When the amount of rainfall does not meet the water demand of the sugarcane, especially during the summer season, HC&S depends on ditch water diverted from streams and brackish water pumped from ground water wells for irrigation. Since sugarcane cultivation uses a relatively significant amount of surface water for irrigation, determining the irrigation requirement with the changing weather conditions becomes important in weighing the noninstream and instream uses.

Irrigation Water Requirement Estimation Decision Support System, IWREDSS (State of Hawaii, Commission on Water Resource Management, 2008b), is developed by the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa for the State of Hawaii. IWREDSS is an ArcGIS-based numerical simulation model that estimates irrigation requirements (IRR) and water budget components for different crops grown in the Hawaiian environment. The model accounts for different irrigation application systems (e.g., drip, sprinkler, flood), and water application practices (e.g., field capacity versus fixed depth). Model input parameters include rainfall, evaporation, soil water holding capacities, depth of water table, and various crop water management parameters including length of growing season, crop coefficient[6], rooting depth, and crop evapotranspiration.

Calibration and validation of the model was based on the crop water requirement data for different crops from the Hawaii region United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) Handbook 38 (NRCS-USDA, 1996). Relative errors between the net irrigation requirements (NIR) estimated by the model and those estimated by NRCS range from less than 1 percent to a 26 percent overestimate. This difference may be attributed to the general nature of the technique NRCS used in estimating NIR. Results of the regression analysis indicate a good correlation ($R^2 = 0.97$) between the two techniques; however, the NIR calculations by NRCS were consistently 8 percent higher than those of the IWREDSS model. Overall, the model is an appropriate and practical tool that can be used to assess the IRR of crops in Hawaii.

The model was used to estimate the IRR of sugarcane grown on HC&S plantations. A GIS map of the sugarcane fields was provided by HC&S as part of their comment submission (see CPRC 13.1-20). Simulations were conducted on 188 fields with the following fixed input parameters: 1) drip irrigation with 85 percent efficiency; 2) irrigation water applied to field capacity; and 3) maximum leaf index of 5.5 by default. A number of scenarios were selected to determine an average range of IRR for sugarcane grown on all 188 fields. The first set of scenarios (Table 13-18) focuses on the effects of differing periods of water application on the IRR. All of the scenarios excluding No. 1 assume that irrigation has stopped in the last two months of the crop cycle to initiate crop maturity. The second set of scenarios (Table 13-19) highlights the seasonal effects on the IRR.

According to the simulation results, the average IRR for sugarcane ranges from 1,400 to 6,000 gallons per acre per day. Applying irrigation water in the last two months of the crop cycle has insignificant effects on the IRR. As expected, IRR is lowest in the winter season when rainfall is high, and highest in the summer season when rainfall is low. The model calculates IRR based on long-term rainfall records available at the weather stations located nearest to the sugarcane fields. Thus, the estimated IRR represents an average value for average weather conditions as opposed to wet or dry year conditions. However, the estimated IRR for the winter and summer seasons could be extrapolated to represent the IRR for wet years and dry years, respectively.

Table 13-18. Scenarios modeled with IWREDSS that focuses on crop cycle changes, and average IRR in gallons per acre per day (gad) for sugarcane cultivated in all 188 fields for each scenario.

Scenario	Crop Cycle			Irrigation Period			IRR
	Total (months)	Planting (1st year)	Harvest (2nd year)	Total (days)	Start (1st year)	End (2nd year)	(gad)
1	24	Mar	Mar	730	Mar	Feb	4,711
2	24	Mar	Feb	671	Mar	Dec	4,957
3	24	May	May	669	May	Feb	4,443
4	22	May	Feb	610	May	Dec	4,771

Table 13-19. Scenarios modeled with IWREDSS that focuses on seasonal changes, and average IRR in gallons per acre per day (gad) for sugarcane cultivated in all 188 fields for each scenario.

Scenario	Season	Months	IRR (gad)
5	Fall	Sep-Nov	3,467
6	Winter	Dec-Feb	1,431
7	Spring	Mar-May	3,771
8	Summer	Jun-Aug	5,788

[6] Crop coefficient is an empirically derived dimensionless number that relates potential evapotranspiration to the crop evapotranspiration. The coefficient is crop-specific.

Figure 13-14. All registered diversions and EMI minor diversions identified in the Honopou hydrologic unit (Source: East Maui Irrigation Company, 1970; State of Hawaii, Commission on Water Resource Management, 2008e).

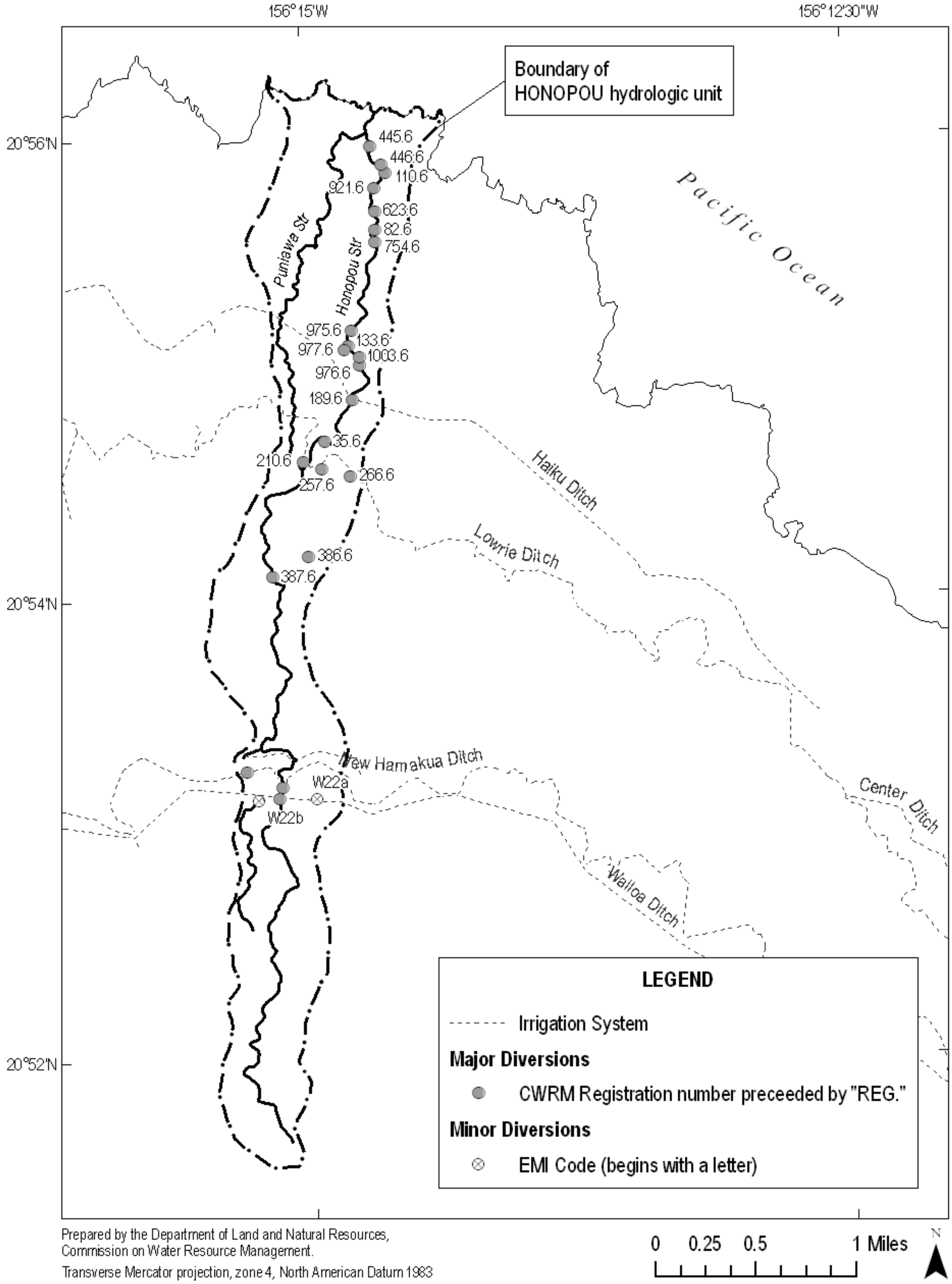
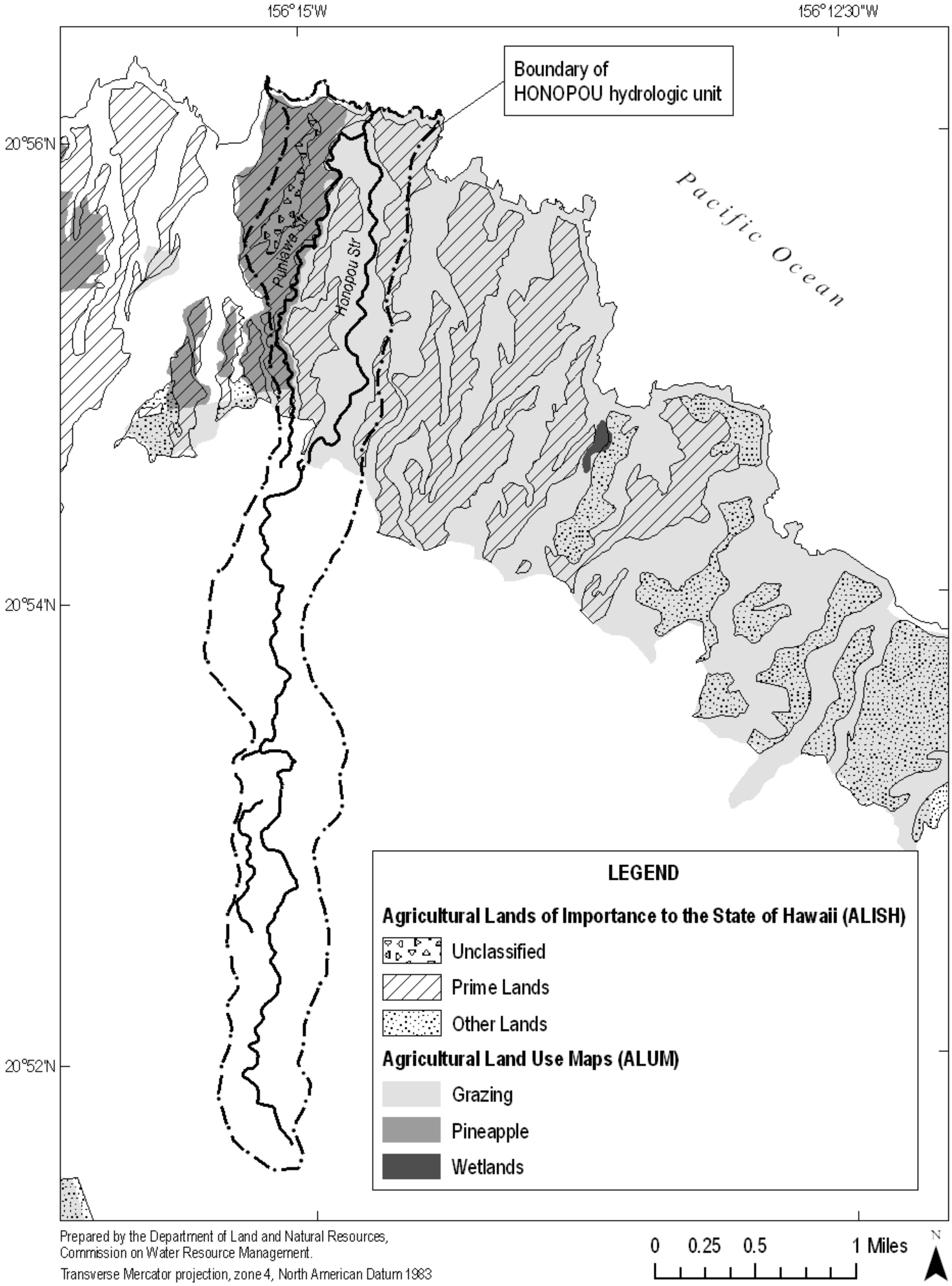


Figure 13-15. Potential agricultural land use for the Honopou hydrologic unit based on the ALISH and ALUM classification systems (Source: State of Hawaii, Office of Planning, 1977; 1980).



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15.0 Appendices

Appendix A	Report on Honopou Stream, Maui, Hawaii. June 2008. *State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources.*
Appendix B	Petition to Amend Interim Instream Flow Standards. Honopou Stream, East Maui. *State of Hawaii, Department of Land and Natural Resources, Commission on Water Resource Management.*

Appendix A

Report on Honopou Stream
Maui, Hawaii

June 2008

State of Hawai'i
Department of Land and Natural Resources
Division of Aquatic Resources

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Report on Honopou Stream
Maui, Hawai‘i

June 2008

Prepared for
Commission on Water Resource Management
Department of Land and Natural Resources
State of Hawai‘i

Prepared by
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Section 1: Overview

Introduction:

This report is an accounting of the aquatic resources that have been observed in Honopou Stream, Maui. The report was generated to provide some information to aid in the instream flow determination for the East Maui Streams at the request of the Commission on Water Resource Management (CWRM). The focus of this report is the animals that live in the stream and the data collected during surveys of the stream. The report covers six main sections, including:

- Overview
- Watershed Atlas Report
- DAR Point Quadrat Survey Report
- DAR Insect Survey Report
- An Analysis of Depth Use vs. Availability
- Photographs of stream taken during stream surveys

The overview provides the introduction for the purpose of this report, a summary of the findings on the stream and its animals, and a discussion of the importance of the findings and how stream conditions influence native species populations. The Watershed Atlas Report provides a description of the watershed and its aquatic resources from Divisiion of Aquatic Resources (DAR) and other published and unpublished surveys as well as a rating of the condition of the stream compared to other streams on Maui as well as statewide. The DAR Point Quadrat Survey Report describes the distribution, habitats, and species observed during the standardized DAR stream surveys. The DAR Insect Survey Report describes the distribution, habitats, and species of insects observed in the stream. The analysis of depth use vs. availability looks at habitat use by native species and the availability of suitable depths in the stream. Finally, the photographs provide context to the conditions that the stream surveyors encountered in the stream.

This overview reports on the highlights of these findings and provides a discussion of the importance of the information presented. We hope that this format provides the reader with a simplified, general discussion and understanding of the condition of Honopou Stream while also providing substantial evidence to support the conclusions presented.

Findings for Honopou Stream, Maui:

Honopou is a small (2.8 square miles), narrow watershed. Its zoning status is split between conservation (57%) and agricultural (47%) and the land cover is mostly evergreen forest (60%), scrub (19%), cultivated land (12%), and grassland (5%). Stream surveys were completed in Honopou Stream during 2007 and 2008. This watershed rates average in comparison to other watersheds in Maui and statewide. It has a total watershed rating of 5 out of 10, a total biological rating of 5 out of 10, and a combined

overall rating of 5 out of 10. Native species observed in the stream include the following categories and species:

Fish - *Awaous guamensis, Eleotris sandwicensis, Lentipes concolor,* and *Sicyopterus stimpsoni.*

Crustaceans - *Atyoida bisulcata* and *Macrobrachium grandimanus*

Mollusks – No native mollusks were observed

Introduced species observed in this stream includes the following categories and species:

Fish - *Poecilia reticulata, Poecilia sp.* and *Xiphophorus helleri*

Crustaceans - *Macrobrachium lar*

Mollusks – *Melanoides tuberculata*

Also observed in this watershed are the two native dragonflies, *Anax strenuus* and *Pantala flavescens* and the native damselfly, *Megalagrion pacificum*, which is currently a candidate for listings as an endangered species.

Most native animals were observed using sites with deeper water, although the low number of native species made depth suitability determination impossible. In general, Honopou stream is shallower then would be expected in a normal stream. This is likely restricting native adult animal habitat.

Photographs were taken of interesting features of stream habitat and diversions. Photographs show that dry sections exist downstream of diversions. The photographs document a problem with the use of water passing through PVC pipes that limit upstream migration.

Discussion for Honopou Stream, Maui:

Honopou is a moderately steep watershed that has good access and much of the stream can be hiked. There are several waterfalls on this stream and several deep pools are being used as swimming holes by local residents. This stream does not have a terminal waterfall and ends in a rocky beach. This stream is very dependent on rainfall for stream flow. Typical stream discharge in the lower end is not enough for downstream taro users that depend on an auwai intake from the stream. There are other agricultural uses next to the lower stream including organic farming and tropical flowers.

This watershed rates average for Maui and statewide. This average rating reflects the findings of native animals and introduced species as well as the fact that this watershed is not overly large or contains large amounts of diverse habitats. Although, the rating is about average, Honopou has the potential to sustain much larger populations of native species than are currently observed.

The presence of many of the native fishes in this stream is a positive sign that some habitat exists in this stream. The availability of suitable depths suggest that large sections of stream are currently not highly suitable for native animals and this supported by the low numbers of native amphidromous animals observed. The amount and availability of suitable habitat for adult amphidromous animals may be enhanced by increased flows and increased stream connectivity.

Honopou Stream contains a highly degraded aquatic insect biota in its lower reaches that have been dewatered by ditch diversions, while by contrast supporting a robust, native-dominated aquatic insect assemblage in the upper reaches above the points of diversion. The latter assemblage also contains one species, the native damselfly *Megalagrion pacificum*, which is currently proposed for listing as Endangered under the federal Endangered Species Act. Restoration of flow to the dewatered sections of this catchment would in all likelihood result in a corresponding restoration of native aquatic insect diversity, but only if steps were taken to avoid utilizing ditch waters that are heavily colonized by invasive poeciliid fishes.

Post larval recruitment of native fish and macroinvertebrates was observed near the mouth of this stream. The diversions that fully dewater the stream under normal flows likely restrict larval upstream migration. The Haiku Ditch Diversion has three pipes that allow surface water to pass over the ditch. Unfortunately, the water falls from the pipes back into the streambed and will not allow upstream passage of native stream animals unless there are high flood flows. Additionally, this stream flows directly into the Lowrie irrigation ditch and likely entrains downstream drifting larvae.

Swordtails were in the upper reach and guppies were in the middle reach. These introduced species live in the deep pools created above the diversion structure and in the ditches. These poeciliid fishes have been known to carry and transmit parasites to native fishes. High flows alone are unlikely to remove all poeciliid fish populations as they can reestablish themselves from the ditch populations.

This stream is continuous through much of its length although there is a grating at the upper diversion at Wailoa ditch which diverts all of the water under most discharge conditions.

There are at least two different diversion sites on this stream. The main problem with the diversions in this stream is the blockage of upstream migration with the use of pipes (see photographs for more information). The diversions have significantly reduced baseflows in this stream which limits overall habitat for native species.

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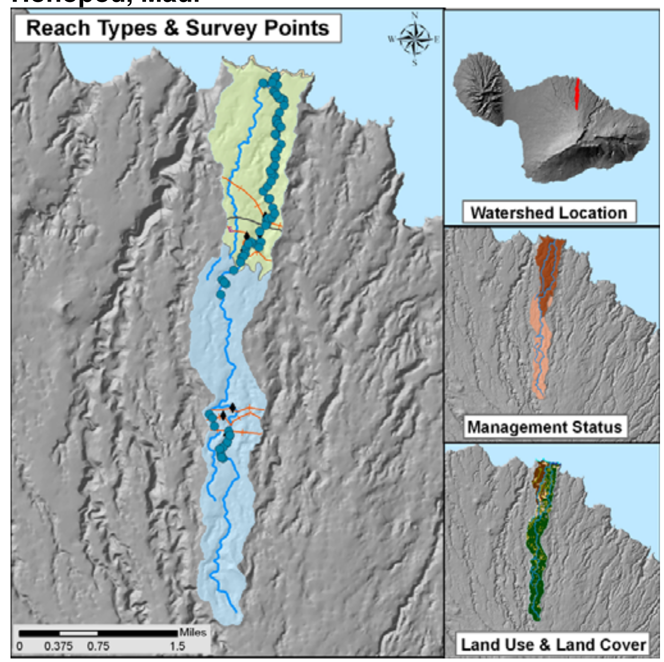
DAR Watershed Code: 63008

Honopou, Maui



WATERSHED FEATURES

Honopou watershed occurs on the island of Maui. The Hawaiian meaning of the name is "post Harbor". The area of the watershed is 2.8 square mi (7.3 square km), with maximum elevation of 2287 ft (697 m). The watershed's DAR cluster code is 3, meaning that the watershed is medium small, steep in the upper watershed, and with some embayment. The percent of the watershed in the different land use districts is as follows: 42.9% agricultural, 57.1% conservation, 0% rural, and 0% urban.

Land Stewardship: Percentage of the land in the watershed managed or controlled by the corresponding agency or entity. Note that this is not necessarily ownership.

Military	Federal	State	OHA	County	Nature Conservancy	Other Private
0.0	0.0	51.4	0.0	0.0	0.0	48.

Land Management Status: Percentage of the watershed in the categories of biodiversity protection and management created by the Hawaii GAP program.

Permanent Biodiversity Protection	Managed for Multiple Uses	Protected but Unmanaged	Unprotected
0.0	51.4	0.0	48.6

Land Use: Areas of the various categories of land use. These data are based on NOAA C-CAP remote sensing project.

	Percent	Square mi	Square km
High Intensity Developed	0.0	0.00	0.00
Low Intensity Developed	1.9	0.05	0.14
Cultivated	11.8	0.33	0.86
Grassland	5.2	0.15	0.38
Scrub/Shrub	18.7	0.53	1.36
Evergreen Forest	60.1	1.69	4.37
Palustrine Forested	0.0	0.00	0.00
Palustrine Scrub/Shrub	0.0	0.00	0.00
Palustrine Emergent	0.0	0.00	0.00
Estuarine Forested	0.0	0.00	0.00
Bare Land	0.2	0.01	0.01
Unconsolidated Shoreline	1.2	0.03	0.08
Water	0.9	0.03	0.06
Unclassified	0.0	0.00	0.00

STREAM FEATURES

Honopou is a perennial stream. Total stream length is 10.2 mi (16.5 km). The terminal stream order is 2.

Reach Type Percentages: The percentage of the stream's channel length in each of the reach type categories.

Estuary	Lower	Middle	Upper	Headwaters
0.0	3.4	43.0	53.7	0.0

The following stream(s) occur in the watershed:
Honopou

BIOTIC SAMPLING EFFORT

Biotic samples were gathered in the following year(s):
2007 2008

Distribution of Biotic Sampling: The number of survey locations that were sampled in the various reach types.

Survey type	Estuary	Lower	Middle	Upper	Headwaters
DAR Point Quadrat	0	12	60	24	0

BIOTA INFORMATION

Species List

Native Species

Crustaceans	*Atyoida bisulcata*
	Macrobrachium grandimanus
Fish	*Awaous guamensis*
	Eleotris sandwicensis
	Lentipes concolor
	Sicyopterus stimpsoni

Native Species

Insects	*Anax strenuus*
	Campsicnemus exiguus

Introduced Species

Amphibians	*Bufo marinus*
	Rana rugosa
	Ranidae sp.
Crustaceans	*Macrobrachium lar*
Fish	*Poecilia reticulata*
	Poeciliidae sp.
	Xiphophorus helleri
Snails	*Melanoides tuberculata*

Species Size Data: Species size (inches) observed in DAR Point Quadrat Surveys.

Scientific Name	Status	Minimum Size	Maximum Size	Average Size
Bufo marinus	Introduced	0.25	2.5	0.5
Rana rugosa	Introduced	2	3.5	2.8
Ranidae sp.	Introduced	1	1	1.0
Atyoida bisulcata	Endemic	0.25	1.5	1.2
Macrobrachium grandimanus	Endemic	1.25	1.25	1.3
Macrobrachium lar	Introduced	0.5	6	2.8
Eleotris sandwicensis	Endemic	2	2	2.0
Lentipes concolor	Endemic	2.25	2.25	2.3
Sicyopterus stimpsoni	Endemic	2.25	4	3.1
Awaous guamensis	Indigenous	1.25	7	4.2
Poecilia reticulata	Introduced	0.5	1	0.7
Poeciliidae sp.	Introduced	0.25	0.25	0.3
Xiphophorus helleri	Introduced	0.75	2	1.2
Campsicnemus exiguus	Endemic	1.5	1.5	1.5
Melanoides tuberculata	Introduced	0.75	0.75	0.8

Average Density: The densities (#/square yard) for species observed in DAR Point Quadrat Surveys averaged over all sample dates in each reach type.

Scientific Name	Status	Estuary	Low	Mid	Upper	Headwaters
Atyoida bisulcata	Endemic		0.43		0.69	
Campsicnemus exiguus	Endemic			0.06		
Lentipes concolor	Endemic				0.14	
Macrobrachium grandimanus	Endemic		0.43			

Sicyopterus stimpsoni	Endemic			0.06		
Awaous guamensis	Indigenous		0.86	0.38		
Bufo marinus	Introduced				1.24	
Macrobrachium lar	Introduced		3	2.76		
Melanoides tuberculata	Introduced				0.14	
Poecilia reticulata	Introduced			0.25		
Rana rugosa	Introduced				0.41	
Xiphophorus helleri	Introduced				0.41	

Species Distributions: Presence (P) of species in different stream reaches.

Scientific Name	Status	Estuary	Lower	Middle	Upper	Headwaters
Atyoida bisulcata	Endemic		P		P	
Macrobrachium grandimanus	Endemic		P			
Eleotris sandwicensis	Endemic		P			
Lentipes concolor	Endemic				P	
Sicyopterus stimpsoni	Endemic			P		
Anax strenuus	Endemic		P			
Campsicnemus exiguus	Endemic			P		
Awaous guamensis	Indigenous		P	P		
Bufo marinus	Introduced				P	
Rana rugosa	Introduced				P	
Ranidae sp.	Introduced				P	
Macrobrachium lar	Introduced		P	P	P	
Poecilia reticulata	Introduced			P		
Poeciliidae sp.	Introduced		P	P		
Xiphophorus helleri	Introduced			P	P	
Melanoides tuberculata	Introduced				P	

HISTORIC RANKINGS

Historic Rankings: These are rankings of streams from historical studies. "Yes" means the stream was considered worthy of protection by that method. Some methods include non-biotic data in their determination. See Atlas Key for details.

Multi-Attribute Prioritization of Streams - Potential Heritage Streams (1998): No

Hawaii Stream Assessment Rank (1990): not ranked

U.S. Fish and Wildlife Service High Quality Stream (1988): No

The Nature Conservancy- Priority Aquatic Sites (1985): No

National Park Service - Nationwide Rivers Inventory (1982): No

Current DAR Decision Rule Status: The following criteria are used by DAR to consider the biotic importance of streams. "Yes" means that watershed has that quality.

Native Insect Diversity > 19 spp.	Native Macrofauna Diversity > 5 spp.	Absence of Priority 1 Introduced
No	Yes	No
Abundance of Any Native Species	Presence of Candidate Endangered Species	Endangered Newcomb's Snail Habitat
No	Yes	No

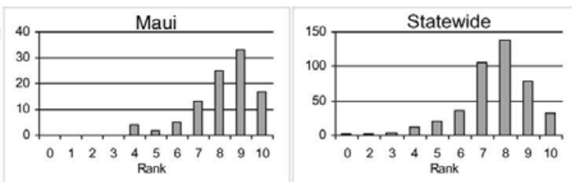
CURRENT WATERSHED AND STREAM RATINGS

The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding of the meaning of a particular ranking and how it compares to other streams. The ratings are standardized to range from 0 to 10 (0 is lowest and 10 is highest rating) for each variable and the totals are also standardized so that the rating is not the average of each component rating. These ratings are subject to change as more data are entered into the DAR Aquatic Surveys Database and can be automatically recalculated as the data improve. In addition to the ratings, we have also provided an estimate of the confidence level of the ratings. This is called rating strength. The higher the rating strength the more likely the data and rankings represent the actual condition of the watershed, stream, and aquatic biota.

WATERSHED RATING: Honopou, Maui

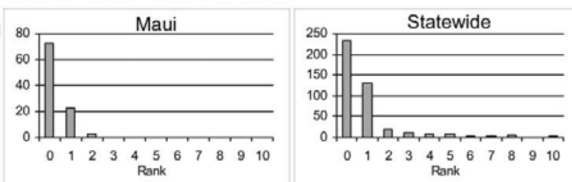
Land Cover Rating: Rating is based on a scoring sytem where in general forested lands score positively and developed lands score negatively.

Watershed Rating
8



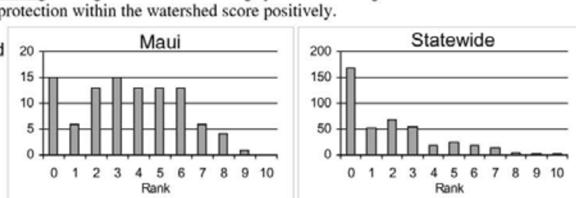
Shallow Waters Rating: Rating is based on a combination of the extent of estuarine and shallow marine areas associated with the watershed and stream.

Watershed Rating
1



Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

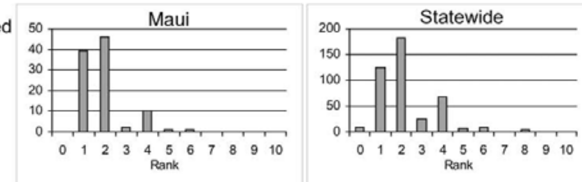
Watershed Rating
3



WATERSHED RATING (Cont): Honopou, Maui

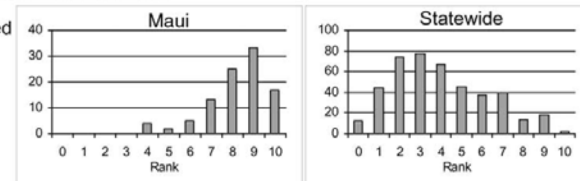
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.

Watershed Rating
2



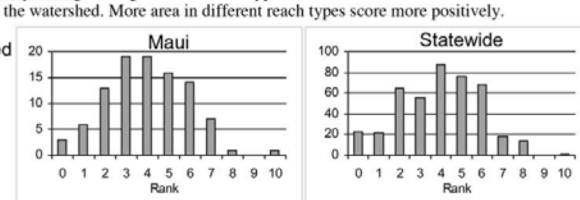
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.

Watershed Rating
5



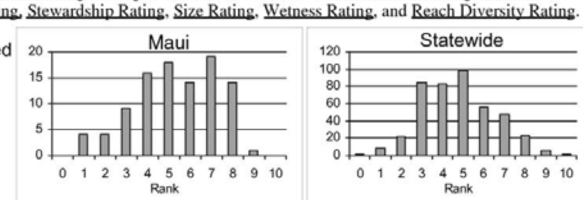
Reach Diversity Rating: Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.

Watershed Rating
4



Total Watershed Rating: Rating is based on combination of Land Cover Rating, Shallow Waters Rating, Stewardship Rating, Size Rating, Wetness Rating, and Reach Diversity Rating.

Watershed Rating
5

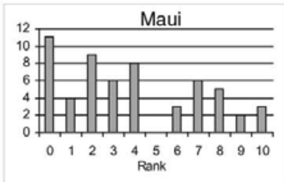


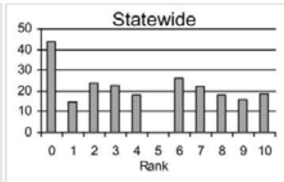
BIOLOGICAL RATING: Honopou, Maui

Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating

7

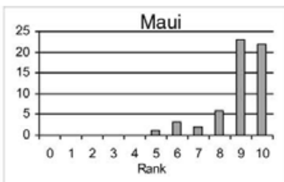


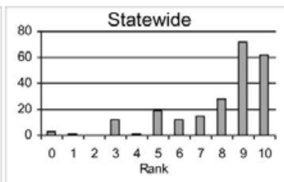


Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating

6

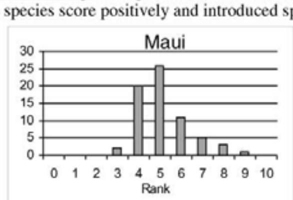


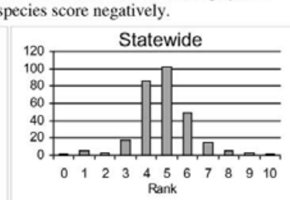


All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating

4

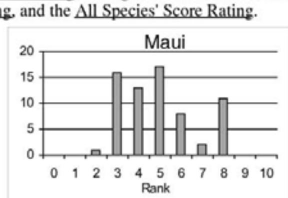


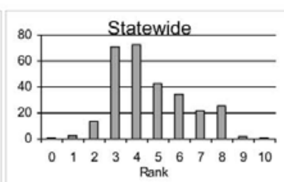


Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating

5



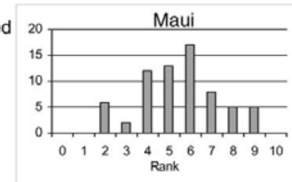


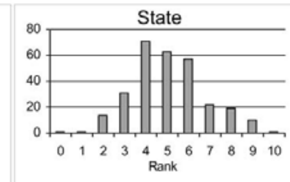
OVERALL RATING: Honopou, Maui

Overall Rating: Rating is a combination of the Total Watershed Rating and the Total Biological Rating.

Watershed Rating

5



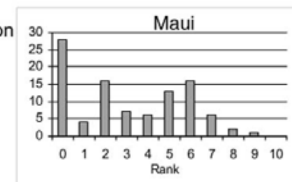


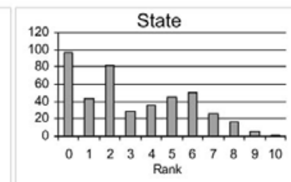
RATING STRENGTH: Honopou, Maui

Rating Strength: Represents an estimate of the overall study effort in the stream and is a combination of the number of studies, number of different reaches surveyed, and the number of different survey types.

Information Rating

6





REFERENCES

2008. Hawai‘i Division of Aquatic Resources. DAR Point Quadrat Survey Data from the DAR Aquatic Surveys Database.

2008. Hawai‘i Division of Aquatic Resources. DAR Insect Survey Data from Dan Polhemus spreadsheets.

Appendix 1: Scientific and Common Names

Appendix 1: Scientific and Common Names

CN = Common Name and HN = Hawaiian Name

Amphibian

Introduced

Bufo marinus
CN: marine toad; HN: none.

Rana rugosa
CN: wrinkled frog; HN: none.

Ranidae sp.
CN: none; HN: none.

Ranidae sp.
CN: unidentified frog; HN: none.

Ranidae sp.
CN: unidentified frog tadpole; HN: none.

Crustacean

Endemic

Atyoida bisulcata
CN: Mountain opae; HN: `opae kala`ole.

Macrobrachium grandimanus
CN: Hawaiian prawn; HN: opae 'oeha'a.

Introduced

Macrobrachium lar
CN: none; HN: none.

Fish

Endemic

Eleotris sandwicensis
CN: Hawaiian sleeper; HN: `O`opu akupa.

Lentipes concolor
CN: `O`opu alamo`o; HN: `O`opu alamo`o.

Sicyopterus stimpsoni
CN: `O`opu nōpili; HN: `O`opu nopili.

Indigenous

Awaous guamensis
CN: none; HN: `O`opu nakea.

Introduced

Poecilia reticulata
CN: Guppy (AFS), Rainbow fish (Yamamoto & Tagawa, 2000), Millions fish (Yamamoto & Tagawa, 2000); HN: none.

Poeciliidae sp.
CN: unidentified livebearers; HN: none.

Xiphophorus helleri
CN: Green swordtail; HN: none.

Appendix 1: Scientific and Common Names (continued)

CN = Common Name and HN = Hawaiian Name

Insect

Endemic

Anax strenuus
CN: blue dragonfly; HN: Pinao.

Campsicnemus exiguus
CN: none; HN: none.

Snail

Introduced

Melanoides tuberculata
CN: none; HN: none.

Section 3: DAR Point Quadrat Survey Report

DAR Point Quadrat Survey Report for Honopou Stream, Maui for surveys from 11/27/2007 to 3/7/2008

This Division of Aquatic Resources (DAR) stream surveys report is produced using the Point Quadrat Methodology. Trained biologists and technicians survey a series of randomly located points in a stream to generate an assessment of composition of species and habitats in the stream. The Point Quadrat Methodology is only one of several different techniques that could be chosen for the surveys and is used to develop a statistically comparable stream survey. The following information represents an accounting of the observations that will be used in overall stream management efforts by DAR. All density measurements are in number of animals per square yard in the reach.

Table 1. The watersheds (and watershed ID), region, and island surveyed in this report are:

Honopou (ID: 63008), Makawao, Maui

Table 2. Survey Team Personnel:

- Hau, Skippy
- Higashi, Glenn
- Kuamoo, Darrell
- Nishimoto, Robert
- Nishiura, Lance
- Sakihara, Troy
- Shimoda, Troy

Table 3. The distribution of sites by reach during this survey effort.

Stream Name	Estuary	Lower	Middle	Upper	Headwater	**Total**
Honopou		9	52	15		**76**

Lower Reach of Honopou Stream, Maui.

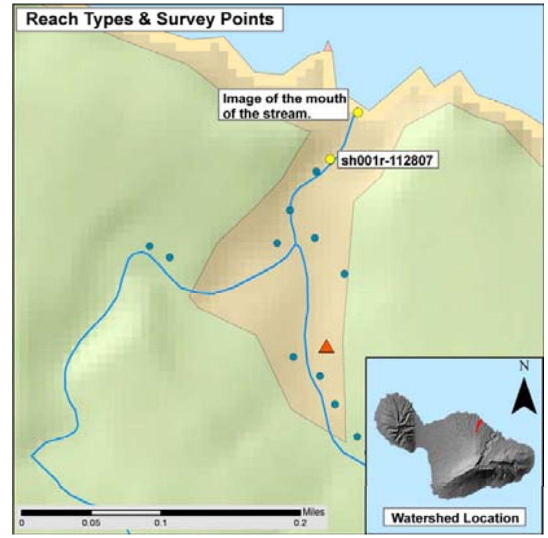


Figure 1. Represents the Point Quadrat Surveys done in the low reach of Honopou Stream. Blue Dots are the survey locations, the colors are the reach delineations, orange triangles are the diversions and yellow dots have pictures associated with them.

Lower Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No water
	2	2	3			

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
3	3	0	4	21	33	34

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Crustaceans	Introduced	*Macrobrachium lar*	Lower	4.47	10
Crustaceans	Endemic	*Atyoida bisulcata*	Lower	0.45	1
Fish	Endemic	*Eleotris sandwicensis*	Lower	0.45	1
Fish	Indigenous	*Awaous guamensis*	Lower	0.45	1

Middle Reach of Honopou stream, Maui.

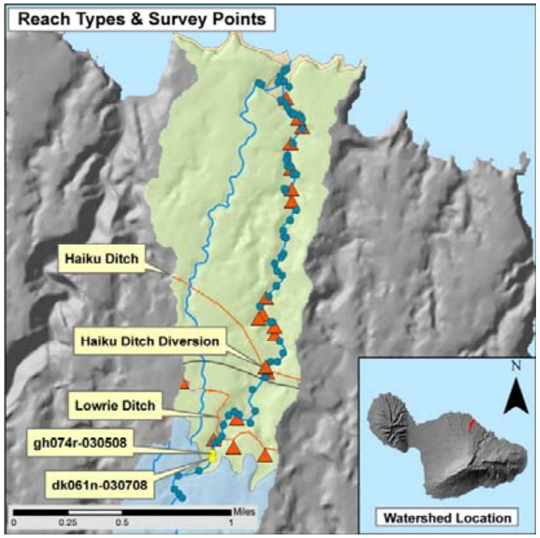


Figure 2. Locations of the Point Quadrat Surveys done in the middles reach of Honopou Stream. Blue dots are the survey locations, orange triangles are the diversions, orange hatched lines are the ditches, the colors are the reach delineations, and the dark gray line is a road. Yellow dots are site with associated photographs.

Middle Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No Water
2	6	13	23	1	4	

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
7	5	2	11	16	30	30

Category	Status	Scientific Name	Reach	Avg. Density	Total # observed
Crustaceans	Introduced	*Macrobrachium lar*	Middle	2.4	36
Fish	Introduced	*Poecilia reticulata*	Middle	0.27	4
Fish	Indigenous	*Awaous guamensis*	Middle	0.27	4

Category	Status	Scientific Name	Reach	Avg. Density	Total # observed
Fish	Endemic	*Sicyopterus stimpsoni*	Middle	0.07	1
Insects	Endemic	*Campsicnemus exiguus*	Middle	0.07	1

Upper Reach of Honopou Stream, Maui.

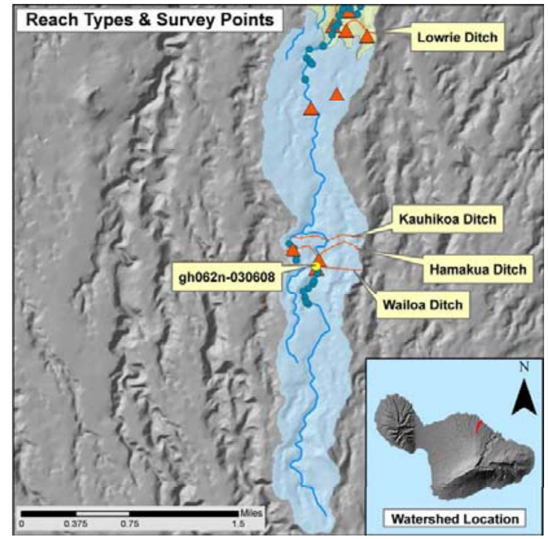


Figure 3. Locations of the Point Quadrat Surveys done in the upper reach of Honopou Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the green labeled dots are site with associated photographs. The orange hatched lines are the location of irrigation ditches.

Upper Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No Water
		8	3	2		1

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
3	2	0	10	16	24	45

DAR Point Quadrat Report Honopou, Maui

Category	Status	Scientific Name	Reach	Avg. Density	Total # observed
Amphibians	Introduced	*Bufo marinus*	Upper	0.83	4
Crustaceans	Endemic	*Atyoida bisulcata*	Upper	0.42	2
Fish	Introduced	*Xiphophorus helleri*	Upper	0.62	3
Fish	Endemic	*Lentipes concolor*	Upper	0.21	1
Snails	Introduced	*Melanoides tuberculata*	Upper	0.21	1

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Section 4: DAR Aquatic Insect Report

AN ASSESSMENT OF AQUATIC INSECT DIVERSITY IN HONOPOU STREAM, EAST MAUI WATERSHED

Introduction

From 26 November 2007 to 16 May 2008, collections of aquatic insects were made from the Hanopou Stream catchment of eastern Maui, at elevations ranging from 90 to 1320 feet. This work, conducted in conjunction with more comprehensive biological surveys conducted by the State of Hawaii's Division of Aquatic Resources, and hydrological surveys conducted by the State's Commission on Water Resource Management, was intended to provide a preliminary estimate of aquatic insect species diversity in this stream system.

Aquatic insects are defined herein as those species spending some significant portion of their life cycle within the stream itself or in the immediately adjacent wet riparian zone. Ecological terms follow those defined in Polhemus et al. (1992).

Description of study site

The Honopou catchment lies on the northern slope of Haleakala volcano in eastern Maui. Honopou Stream is approximately 5 miles in length, heading at an elevation near 2200 feet on the flanks of a small secondary cone called Ulalena, and entering the sea between Puniawa Point and Honopou Point. The catchment occupies part of a broad planeze bounded on the west by the deep valley of Opana Stream, and on the east by the similarly deep valley of Kailua Stream, both of which head at elevations above 4000 feet. All of the other drainages lying within the roughly trapezoidal sector bounded by these two large gulches, including Honopou Stream, occupy less deeply incised valleys and have headwaters at or below 2500 feet elevation. The general surface geology of this portion of Haleakala consists of flows from the Kula lava series, over which the streams cascade in a stair step profile of alternating vertical falls and lower gradient reaches. Along the lower sections of these streams, within a mile of the sea, the older, underlying Honomanu series lavas have also been exposed, generally forming large waterfalls that create significant interruptions in the bed profiles, often marking the transition from the terminal reach to the midreach as one progresses upstream.

The general hydrology and physical characteristics of the Honopou catchment has been studied in detail by the State of Hawaii's Commission on Water Resource Management, and is not considered in further detail here.

Four stations were sampled along Honopou Stream between 90 and 1320 feet elevation. Details on the locations of these 4 sampling stations may be found in Tables 1–4. These stations were a subset of those used by other DAR biologists making point quadrat censuses of native fish populations along this same stream.

Methods

A total of 3 days of sampling time were spent making collections along Hanehoi Stream, using hand netting and localized pyrethrin fogging of hygropetric habitats. Insects were taken both within and beside the stream, and from the air above. The specimens collected were stored in 75 percent ethanol in the field, and subsequently transported to the Bishop Museum in Honolulu for curation and identification. For Odonata, some specimens were dry vouchered in glassine envelopes, and for large, easily recognized species of Anisoptera (dragonflies) sight records were taken in lieu of field captures.

Water temperatures were measured at all sampling stations, and varied from 18° to 23.5° C. The water temperatures and elevations at individual stations may be found in Tables 1-4.

Results

A total of 23 species of aquatic insects were collected during 2 days of sampling along Honopou Stream. These taxa are detailed in Tables 1–5 below. Of the taxa collected across all stations, 11 species, or 48 percent of the total, were taxa considered native to the Hawaiian Islands.

In the subsequent tables, the following taxon codes are used: N = native species, I = introduced species.

Table 1: Aquatic insect taxa sampled from Honopou Stream, Station 1, terminal reach, 3.5 mi. N. of Hana Hwy., 90 ft., water temp. 22 °C., 16 May 2008, 09:30–10:00 hrs. 20°55'54.4"N, 156°14'39.6"W

Insect Taxon	Taxon Type
DIPTERA	
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
Number of taxa present	
Native	1
Introduced	3
Total	4
Percentage of native species richness	25 %

Table 2: Aquatic insect taxa sampled from Honopou Stream, Station 2, terminal reach, 3.3 mi. N. of Hana Hwy., 150 ft., water temp. 22 °C., 16 May 2008, 08:30–09:30 hrs. 20°55'42.3"N, 156°14'29.0"W

Insect Taxon	Taxon Type
DIPTERA	
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Tipulidae	
Limonia jacoba (Alexander)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax junius	I
Libellulidae	
Orthemis ferruginea (Fabricius)	I
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Number of taxa present	
Native	4
Introduced	7
Total	11
Percentage of native species richness	36 %

Table 3: Aquatic insect taxa sampled from Honopou Stream, Station 3, at Haiku Ditch diversion point, below Hana Road, 430 ft., water temp. 23.5 °C., 27 November 2007, 15:00–15:45hrs.; 16 May 2008, 10:30-11:30 hrs. 20°54'53.1"N, 156°14'47.1"W

Insect Taxon	Taxon Type
COLEOPTERA	
Carabidae	
Bembidion sp. undet.	N
DIPTERA	
Chironomidae	
Chironomus esakii Tokunaga	I
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella amnica (Tenorio)	N
Scatella cilipes (Tenorio)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Micracanthia humilis (Say)	I
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Libellulidae	
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Ischnura posita (Hagen)	I
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I
Number of taxa present	
Native	6
Introduced	9
Total	15
Percentage of native species richness	40 %

Table 4: Aquatic insect taxa sampled from Honopou Stream, Station 4, from Wailoa Ditch diversion point upstream to second fall, 1200–1320 ft., water temp was 19 °C., 27 November, 2007, 09:45–13:30 hrs. 20°53'14.2"N, 156°15'08.8"W

Insect Taxon	Taxon Type
DIPTERA	
Chironomidae	
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella cilipes (Tenorio)	N
Scatella clavipes (Tenorio)	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacoba (Alexander)	N
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax strenuous Hagen	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Ischnura ramburii (Selys-Longchamps)	I
Megalagrion pacificum (McLachlan)	N
Libellulidae	
Pantala flavescens (Fabricius)	N
Number of taxa present	
Native	7
Introduced	6
Total	13
Percentage of native species richness	54 %

Table 5: Summary of aquatic insect species taken across all combined sampling stations on Honopou Stream, from 90–1320 ft. elevation

Insect Taxon	Taxon Type
COLEOPTERA	
Carabidae	
Bembidion sp. undet.	N
DIPTERA	
Chironomidae	
Chironomus esakii Tokunaga	I
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella amnica (Tenorio)	N
Scatella cilipes (Tenorio)	N
Scatella clavipes (Tenorio)	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacoba (Alexander)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Micracanthia humilis (Say)	I
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax junius	I
Anax strenuous Hagen	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Ischnura ramburii (Selys-Longchamps)	I
Megalagrion pacificum (McLachlan)	N
Libellulidae	
Orthemis ferruginea (Fabricius)	I
Pantala flavescens (Fabricius)	N
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I

Insect Taxon	Taxon Type
Number of taxa present	
Native	11
Introduced	12
Total	23
Percentage of native species richness	48 %

Table 6: Species richness versus elevations of sampling stations on Honopou Stream

Stream and Sampling Station	Elevation	% Native Species Richness
Station 1	90	25
Station 2	150	36
Station 3	430	40
Station 4	1200*	54

* = above point of uppermost diversion on system

Discussion

The present surveys clearly demonstrate that for aquatic insects, both the species richness and the percentage of native species representation decrease steadily as one moves downward in elevation through both the Honopou catchment (see Tables 1–6). In particular the aquatic insect biota of the dewatered mid- and terminal reaches is a highly reduced subset of that which would otherwise prevail. In the dewatered reaches of Hanehoi stream, the aquatic insect community of the remnant pools is reduced to a two species community consisting of the introduced mosquito *Aedes albopictus*, and the small native water bug *Microvelia vagans*. The latter is an adaptable generalist that feeds on fallen insects that become trapped in the surface film, and as such can also colonize temporary pools in roads and trails. In areas where some degree of flow is present, this basic community of "mozzies and micros" may be further augmented by two species of introduced dolichopodid flies, *Chrysotus longipalpus* and *Dolichopus exsul* which are ubiquitous components of disturbed aquatic ecosystems in lowland Hawaii. Native species that formerly occupied such stream reaches, such as the native damselfly *Megalagrion pacificum*, were notably absent from such dewatered reaches.

By contrast, the uppermost station sampled during this survey, lying along stream reach above the highest point of diversion in the system, supported a rich aquatic insect assemblage with 14 species present, with 70 percent of these being native species. These assemblages also included native damselflies in the genus *Megalagrion*, including *M. pacificum*, which is currently a candidate for listing as Endangered under the federal

Endangered Species Act. *Megalagrion pacificum* was found above the ditch diversions, but was not found at any sampling station below the diversions. This strongly implies that the diversions are to some extent limiting the range of this federal listing candidate in this catchment.

This can be illustrated by comparing the terminal reach stations along both streams to the lower reach of Hanawi Stream further to the east on the Hana Coast (Englund and Polhemus, 1993), which is fed by resurgent groundwater from Big Spring and thus retains a flow regime representative of undiverted East Maui streams. This comparative data is provided in Tables 9 and 10.

Table 7: Aquatic insect taxa sampled from Hanawi Stream, Station 1, nr. Nahiku, 0-100 ft.,water temp. 19.5° C., 8 October 1992. 20°49'40"N, 156°05'55"W

Insect Taxon	Taxon Type
DIPTERA	
Canaceidae	
Procanace acuminata Hardy & Delfinado	N
Procanace constricta Hardy & Delfinado	N
Ceratopogonidae	
Forcipomyia sp. undet.	N
Chironomidae	
Telmatogeton torrenticola (Terry)	N
Calopsectra hawaiiensis Hardy	N
Culicidae	
Aedes albopictus (Skuse)	I
Ephydridae	
Neoscatella amnica Tenorio	N
Neoscatella clavipes Wirth	N
Neoscatella warreni (Cresson)	N
Dolichopodidae	
Chrysosoma fraternum Van Duzee	N
Chrysotus pallidipalpus Van Duzee	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacobus (Alexander)	N
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Saldula exulans (White)	N

LEPIDOPTERA	
Cosmopterigidae	
Hyposmocoma sp. undet. 1	N
Hyposmocoma sp. undet. 2	N
ODONATA	
Aeschnidae	
Anax strenuus Hagen	N
Libellulidae	
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Megalagrion blackburni McLachlan	N
Megalagrion pacificum (McLachlan)	N
Megalagrion calliphya (McLachlan)	N
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I
Number of taxa present	
Native	20
Introduced	4
Total	24
Percentage of native species richness	83 %

Table 8: Species richness at lower elevation sampling stations on Hanehoi Stream, and comparison to lower Hanawi Stream

Stream and Sampling Station	Elevation	Total Species	% Native Species Richness
Honopou Stream			
Station 1	90	4	25
Station 2	150	11	36
Hanawi Stream			
Station 1	100	24	83

By contrast, the uppermost stations sampled during this survey, lying along stream reaches above the highest point of diversion in each system, supported rich aquatic insect assemblages with 13 species present, with 54 percent of these being native species. These assemblages consistently included native damselflies in the genus *Megalagrion*, including *M. pacificum*, which is currently a candidate for listing as Endangered under the federal Endangered Species Act. *Megalagrion pacificum* was found in the both the Honopou and Hanehoi stream catchments above the ditch diversions, but was not found

at any sampling station below the diversions. This strongly implies that the diversions are to some extent limiting the range of this federal listing candidate in these catchments.

Restoration of stream flows could potentially lead to the gradual development of a richer and more native aquatic insect community in the dewatered sections of these stream catchments. However, such flow restoration would need to be conducted with great care to ensure that the restored waters were derived from the streams themselves, and not commingled with ditch flows. Utilizing ditch flows would result in the introduction of invasive species which would effectively preclude the establishment of native species even if more water were provided. Therefore, stream waters and ditch waters should be segregated as strictly as possible to avoid biological contamination of target catchments by restoration flows.

For example, surveys along the New Hamakua Ditch found it to be swarming with alien poeciliid fishes, which were concentrated due to the low flow conditions. As a result, no native aquatic insects were present in or along the ditch, even though its clear waters provided potentially suitable habitat. The presence of Poeciliidae illustrates how the ditches provide lateral conduits for invasive species, and why simple flow restoration based on ditch water will not necessarily result in restoration of native biota. Because of the design of the intakes, particularly those on the Wailoa Ditch which have sharp, steep internal drops, the poeciliids due not bleed upstream past the diversion points. On gaining systems such as the Hoolawanui and the Nailiilihaele, where the ditch waters do not intermingle with those of the seepage fed pools that form downstream of the diversions in the otherwise dry bed due to hyporheic resurgence, species such as *Megalagrion pacificum* can successfully colonize the habitats thus formed. In such cases, restoration of flow from a direct ditch release would in fact probably be deleterious. A preferable solution for obtaining restoration flows would be ditch bypasses, via which water from upstream of the ditch intake could be shunted around the intake to a point downstream, thus bypassing the biologically contaminated ditch.

An alternate problem that was discussed in the context of the Waiahole Stream restoration case on Oahu was the possibility that restoration flows could re-establish connectivity between invasive-dominated terminal reaches and native-dominated mid- and headwater reaches. This does not seem to be a major problem in the case of the East Maui Watershed due to the presence of numerous large waterfalls that have formed along these stream courses as they cut into the Honomanu and Kula series lavas. Such natural breaks in the stream profile, which are effective filters to the upstream migration of invasive fishes, were not present in the Waiahole system, but are by contrast commonplace on Oahu.

Summary

In summary, the Honopou catchment contains a highly degraded aquatic insect biota in its lower reaches that have been dewatered by ditch diversions, while by contrast supporting a robust, native-dominated aquatic insect assemblage in the upper reaches above the points of diversion. The latter assemblage also contains one species, the native damselfly *Megalagrion pacificum*, that is currently proposed for listing as Endangered under the federal Endangered Species Act. Restoration of flow to the dewatered sections of this catchment would in all likelihood result in a corresponding restoration of native aquatic insect diversity, but only if steps were taken to avoid utilizing ditch waters that are heavily colonized by invasive poeciliid fishes.

Literature Cited

Englund, R. and D. A. Polhemus. 1993. A survey of the fish and aquatic insect fauna of the Hanawi and Makamakaole Streams, Maui, Hawaii. Unpublished consultant's report prepared for Natural Area Reserves System, Hawaii State Dept. of Land and Natural Resources. 64 pp.

Polhemus, D. A., J. Maciolek and J. Ford. 1992. An ecosystem classification of inland waters for the tropical Pacific islands. Micronesica, 25 (2): 155–173.

Habitat where the native damselfly, *M. pacificum* (inset) were observed. Taken by Dan Polhemus.

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Section 5: An Analysis of Depth Use vs. Availability

Introduction:

As part of an ongoing collaboration between the Division of Aquatic Resources and Bishop Museum, we have been analyzing the relationship between instream measures of habitat and the occurrence of native animals. The intention of this research is to better understand the habitat requirements of these animals to improve management of the stream environment. While this research effort is not complete, we have tried to provide some information to aid in the instream flow determination for the East Maui Streams given the deadlines for comment set by the Commission on Water Resource Management on these streams.

The amount of water in a stream is important to the fishes and macroinvertebrates that inhabit the stream. One measure of the amount of water needed in the stream to create suitable habitat is the depth of the water in a survey site. The deeper areas of a stream may be important to the animals to provide safety from predatory birds, a refuge from fluctuations in discharge, or as a buffer to changes in temperature as larger volumes of water heat or cool more slowly than smaller water volumes. Depth is also closely related to stream discharge. Given a specific stream bed form, increased discharge results in increases in depth and velocity. Conversely, if water is diverted from a stream, the decrease in downstream discharge results in slower, shallower water. Surveyors record the quadrat depth when using the DAR Point Quadrat technique, but do not measure velocity; therefore we used the depth in this analysis.

In this report, we compare the depth measured for each site during the DAR Point Quadrat Surveys of Honopou Stream, Maui to the depths where animals were observed. Additionally, we also compared the observations for Honopou Stream to depth observations for all streams statewide surveyed using Point Quadrat Surveys to see if the pattern for Honopou Stream is consistent with other Hawaiian streams. Finally, the distribution of average site depth by elevation groups is provided.

Methods:

All data reflected in this report came from the DAR Aquatics Surveys Database. For each random survey site in Honopou Stream, Maui (Watershed code = 63008) the depth and animals observed were queried from the database. Additionally, the same information was collected for all survey sites statewide.

To compare the depth suitability for the stream animals, availability, utilization, and suitability criteria were developed following standardized procedures (Bovee 1982). In general, this method based habitat utilization on the presence/absence data, and does not take into account site density. Depth availability is the frequency of each depth category based on the distribution of depths observed in the field survey. Percent availability is calculated by dividing the number of observations for a depth category by the total number of observations and multiplying by 100. Utilization is the frequency of occurrence for an individual species in each depth category. Percent utilization is calculated by dividing the number of sites with a species observed for a depth category

by the total number of sites with a species observed and multiplying by 100. Suitability is developed by dividing the percent utilization for each depth category with the percent availability for each depth category. The standardized suitability has the range adjusted so that the largest value for each species equals 1 (suitable) and the lowest value equals 0 (unsuitable).

To compare the site depths observed in the stream to the average site depths statewide, the percent frequency of occurrence for each depth bin was calculated from the data for Honopou Stream and for all sites statewide in the DAR Point Quadrat Surveys. Additionally, the difference between the percent frequencies for each depth bin wash plotted in a histogram to clearly show where the differences occurred.

To examine where in the stream changes in available depths occurred, the average depth was determined for a number of elevation bins. The determination of the distribution of the elevation bins was influenced by the number of samples in a depth bin. Where possible at least 5 samples were needed to create a depth bin.

Results:

There were insufficient observations of any native amphidromous animals to develop depth suitability criteria. In the random point quadrats, only three sites with *Atyoida bisulcata* were observed with an average depth of 12.7 inches, five sites with *Awaous guamensis* were observed with an average depth of 17.6 inches, and one site each for *Eleotris sandwicensis* (15 inches depth), *Lentipes concolor* (15 inches depth), and *Sicyopterus stimpsoni* (7 inches depth). In contrast to sites with native species, 34 sites with no animals of any type were observed and averaged 8.2 inches depth.

The pattern of the distribution of observed depths in Honopou Stream in comparison to the statewide average depths reveals that shallow sites are much more common in Honopou than in most Hawaiian Streams (Figure 1). The sample size was 72 sites for Honopou Stream in comparison to 6084 sites statewide. There were approximately 23% more shallow sites (10 inches or less) than observed in the statewide data set (Figure 2). In contrast to the increase in dry sites, there was a decrease in all depth bins 14 inches depth or deeper.

When observing the distribution of average depth as a function of elevation, the depths were generally stable or decreased slightly in a downstream direction (Figure 3). Most of the elevations bins had an average site depth between 10 and 13 inches.

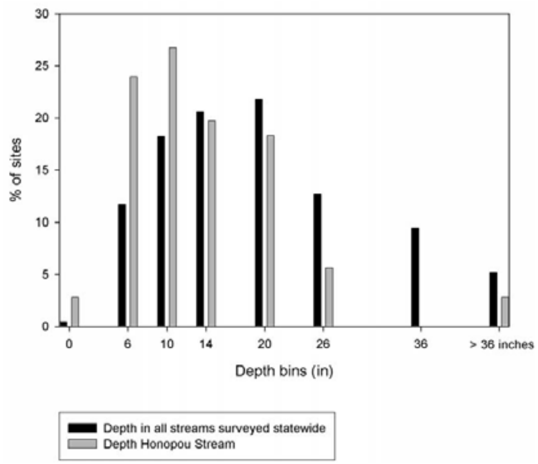

Figure 1. Comparison of percent availability for depth categories between Honopou Stream, Maui and all streams statewide in the DAR Aquatics Surveys Database.

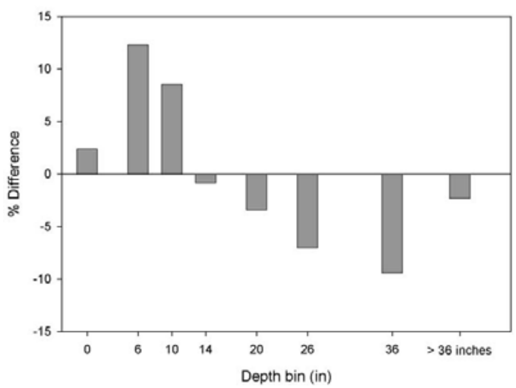

Figure 2. Percent difference in depth categories between Honopou Stream, Maui and all streams statewide in DAR Aquatics Surveys Database. Positive values denote an increase in the percent frequency of a depth category in Honopou Stream as compared to streams statewide. Negative values denote a decrease in the percent frequency of a depth category in Honopou Stream as compared to streams statewide.

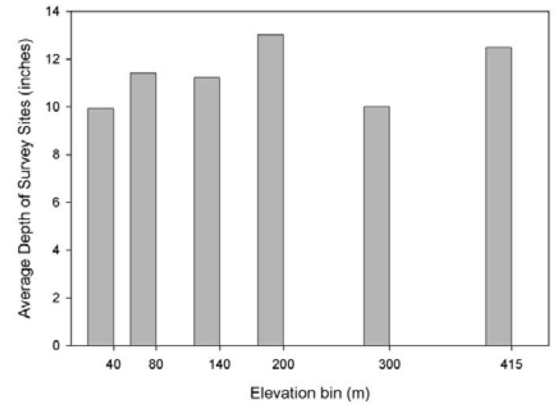

Figure 3. Average depth observed in Point Quadrat Survey Sites for different elevation bins. The elevation bins include all sites up to and including the elevation value. For example, the first bin would include all sites with elevations from 0 to and including 30 m, the second bin would include all sites greater than 30 m to and including 50 m, and so on.

Conclusions:

Although little data was collected for native amphidromous animals in Honopou stream, it did appear that most animals were observed in deeper then average site depths. This general pattern was followed by most of the native fishes and macroinvertebrates observed, except for *Sicyopterus stimpsoni* which was observed in a single shallow site. With the exception of the observation for *Sicyopterus stimpsoni* , the general pattern observed in Honopou Stream was consistent with depth suitability findings for these species statewide suggesting that the native animals in Honopou behave in a fairly typical pattern.

The availability of depths was different in Honopou Stream than observed in streams statewide. The frequency of sampling a site 10 inches in depth or less went from about 3 in 10 sites statewide to more than 1 in 2 sites in Honopou. The availability of very deep sites was also different. In streams statewide sites deeper than 26 inches were sampled in about 15 in 100 sites, while in Honopou Stream sites this deep were uncommonly observed at about 3 in 100 sites.

Field surveyors noted that this stream was mostly continuous and dewatered sections were associated with stream diversions and this is supported by images in the photograph section of this report. When the distribution of average depths were plotted as a function of elevation, little pattern was observed. This stream appears to be shallower on average than a typical Hawaiian stream. The available depths suggest that large sections of the stream are currently not highly suitable for native animals and this supported by the low numbers of native amphidromous animals observed.

Return of water into Honopou Stream would likely have a beneficial effect on the availability of suitable depths for native species in the currently shallow stream sections. In comparison to other completely dewatered stream in East Maui, Honopou appears to lack the highly suitable deep pools, but is generally deeper than the other streams.

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Section 6: Photographs taken during stream surveys

Estuary

No estuary in this watershed.

Lower Reach

Honopou Stream flows into a boulder beach at the ocean.

Upstream view of large pool near site sh001r-112807

Fence and barb wire placed across stream tributary limited further access in this stream section.

Lower Honopou Stream with boulders & bedrock.

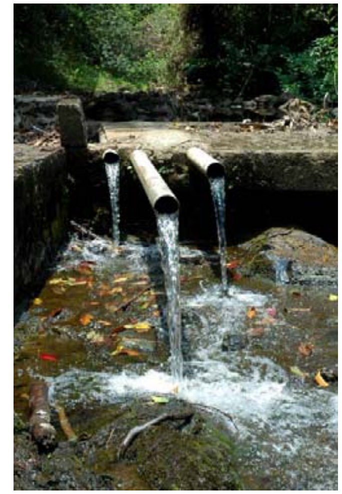
Middle Reach

Middle reach of Honopou stream, Maui, Hawai‘i. 11/28/2007

Auwai for taro lo’i downstream.

Large plunge pool below the three by-pass pipe diversion on Haiku diversion & ditch.

Water flows through three by-pass pipes across the Haiku diversion irrigation ditch. The pipes prevent the upstream movement of native amphidromous animals. An improved design eliminating the pipe overhang with water trickling down a continuous sloping hard surface might provide access upstream with no change in the amount of discharge.



Close up of the three bypass pipes on Haiku diversion.

High flood waters over the irrigation ditch with the three bypass pipes. Note the lack of a simple passage way even at these high flows.

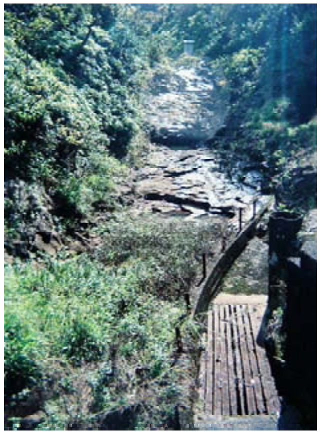
Upstream view of dry waterfall at site gh074r-030508. Note concrete diversion structure (yellow arrow) below fallen tree at the top of the cliff.

Downstream view of diversion just above the dry water valley in the previous photograph. Note the flume gate (yellow oval) in the middle.

Upper Reach

Looking upstream from below the first upper reach diversion on Honopou Stream. Image taken on 3/6/08.

Photo taken downstream, immediately below first diversion. Note the difference in flow from previous photo taken above diversion.



Mostly dry stream bed in the upper reaches of Honopou stream, Maui. Image was close to survey book number gh062n-030608.

Water tunnel (left) in mountain flows into irrigation ditch (right).

Waterfall pool above upper diversion (identified by Hilo staff as first diversion).

Upper reach Honopou Stream, Maui. Taken by Dan Polhemus 5/15/2008

Headwaters

No headwaters reach in this watershed.

Appendix B

State of Hawaii
COMMISSION ON WATER RESOURCE MANAGEMENT
Department of Land and Natural Resources

PETITION TO AMEND INTERIM INSTREAM FLOW STANDARDS

HONOPOU STREAM, EAST MAUI

Instructions: Please print in ink or type and send completed petition with attachments to the Commission on Water Resource Management, P.O. Box 621, Honolulu, Hawaii 96809. Petition must be accompanied by a non-refundable filing fee of $25.00 payable to the Dept. of Land and Natural Resources. The Commission may not accept incomplete applications. For assistance, call the Regulation Branch at 587-0225.

1. **PETITIONER**

Firm/Name Beatrice Kepani Kekahuna & Marjorie Wallet c/o Native Hawaiian Legal Corp.
Contact Person Alan Murakami, Attorney Ph: 521-2302
Address 1164 Bishop Street, Honolulu, HI 96813

2. **STREAMFLOW DATA**

USGS stream gaging station 16587000, 16588000, 16590000, 16591000, 16593000, 16595000 Period of Record DATA TO FOLLOW.
Location/Reach SEE ATTACHED.
(Attach a USGS map, scale 1"=2000', and a property tax map showing diversion location referenced to established property boundaries.)

TABLE 1. PERIOD OF RECORD AVERAGE MONTHLY STREAMFLOW WITHIN THE AFFECTED STREAM REACH, IN CFS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual

STREAMFLOW DATA TO FOLLOW.

Annual Median flow in cfs =

TABLE 2. PROPOSED AVERAGE MONTHLY STREAMFLOW DIVERSION FROM AFFECTED STREAM REACH, IN CFS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual

UNDETERMINED; SUFFICIENT FOR TARO FARMING AND/OR GATHERING.

Annual Median flow in cfs =

TABLE 3. AVERAGE MONTHLY STREAMFLOW IN AFFECTED STREAM REACH AFTER DIVERSION (min release flow), IN CFS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual

NATURAL STREAMFLOW EXCEPT FOR EXERCISE OF APPURTENANT WATER RIGHTS.

Annual Median flow in cfs =

3. **EXISTING INSTREAM AND OFFSTREAM WATER USES FOR ENTIRE STREAM REACH**

TMK	OWNER	USE
RESEARCH IN PROGRESS.		

(If more space is necessary, attach an extended list following above format)

4. **ANTICIPATED IMPACTS ON STREAM AND BASIS FOR SUCH IMPACTS:**

RESTORATION OF INSTREAM NATURAL HABITAT AND BIOTA, AND BENEFICIAL APPURTENANT AND GATHERING USES.

(Attach supporting documentation, plans, letters, etc.)

NATIVE HAWAIIAN LEGAL CORPORATION

May 24, 2001
Date

Signature
Alan Murakami
Attorney for Beatrice Kepani Kekahuna and Marjorie Wallet
Petitioner

For Official Use
Date Received
Date Accepted

HONOPOU

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1947 1947									7	9	20	48	42	34	37	45	29	29	19	12	8	5	3	4	6	2	3	2				1			
1948 1948										10	6	30	50	42	56	35	21	32	18	16	10	11	11	6	3	5	2		1			1			
1949 1949									8	39	19	48	38	49	30	41	19	20	12	17	9	5	5	4	1			1							
1950 1950								11	9	19	8	24	33	52	38	30	30	19	23	20	12	13	8	3	6	2	2	2		1					
1951 1951							1	40	15	64	19	34	27	18	45	23	17	18	7	12	6	5	7	2	1	2	1	1							
1952 1952								3	7	22	4	24	33	51	59	44	34	33	19	16	3	5	5	1	2	1									
1953 1953							8	42	19	59	18	60	31	21	24	16	11	16	10	9	7	2	7	2	1	1	1								
1954 1954			2		11	15	7	5	4	17	10	21	40	36	42	31	36	28	30	9	11	7	1	1		1									
1955 1955								8	10	38	4	20	21	27	39	31	33	41	27	21	14	7	10	4	3	3	4								
1956 1956							12	28	13	30	12	19	17	19	33	19	41	33	26	25	14	11	2	2	2	3	2	1			1			1	
1957 1957						4	6	9	11	52	21	52	34	25	31	23	18	21	10	15	7	5	9	2	4	4	1		1						
1958 1958										17	3	21	40	39	56	37	26	25	28	18	21	14	7	3	3	6		1							
1959 1959										45	8	26	17	34	57	41	36	26	23	18	8	8	6	4	2	1	3	2							
1960 1960								14	11	24	11	42	46	18	53	32	29	25	14	16	9	5	8	4	1	2	1			1					
1961 1961						5	2	37	24	73	11	41	34	16	29	16	21	11	10	9	6	5	4	3	4	2			1		1				
1962 1962					1	6	17	53	15	65	18	30	31	25	39	16	13	12	7	4	6	1	4			1	1								
1963 1963			16		22	3	4	22	7	26	19	49	41	37	29	17	14	19	8	12	4	6	4	1	4				1						
1964 1964										9	14	50	69	36	59	38	30	21	9	15	7	5	2		2										
1965 1965							6	16	6	31	15	34	38	35	50	26	25	24	15	13	8	5	8	5	1	1	1	2							
1966 1966						8	7	18	6	25	4	26	35	46	48	33	21	20	16	18	13	8	3	5	1		1	2			1				
1967 1967								11	24	32	30	26	31	31	47	30	26	16	16	14	13	2	4	4	5		2	1							
1968 1968						6	5	34	36	31	30	21	27	19	24	17	21	17	19	16	12	11	11	1	2	3	2			1					
1969 1969					6	18	4	22	4	2	4	11	13	10	33	34	36	37	24	28	16	18	13	10	3	6	5	3	4		1				
1970 1970									12	28	25	29	41	43	47	23	32	19	14	17	9	8	9	2		2	3	1		1					
1971 1971						23	16	29	27	15	23	28	19	20	29	22	19	20	10	18	13	9	8	3	7	2	2	1		1		1			
1972 1972						12	11	31	36	42	37	33	39	35	32	23	11	9	2	5	3	1	1	1	2										
1973 1973				2	9	27	12	18	13	11	21	44	37	33	35	14	15	17	14	14	13	5	5		3	2	1								
1974 1974					17	29	9	42	33	22	14	15	32	25	36	18	27	13	7	9	4	5	3	2	1	1		1							
1975 1975		1		8	8	8	3	30	12	22	20	17	34	23	44	50	26	18	18	12	5	2	1			2						1			
1976 1976								11	23	49	25	39	65	25	39	16	21	20	10	10	3	3	6			1									
1977 1977							19	26	17	34	35	17	35	30	34	21	27	18	18	10	6	4	4	4	1	1	2	2							
1978 1978							4	37	6	23	18	13	37	42	57	35	42	17	13	10	5	1	2	1	1			1							
1979 1979								5	7	21	14	15	48	59	40	28	28	20	19	18	10	7	6	5	2	2	7	1	2	1					
1980 1980								16	9	14	8	8	18	45	49	36	21	28	19	17	19	14	13	5	6	7	6	3	3		2				
1981 1981					4	14	18	53	26	65	45	35	39	19	11	11	9	6	3	1	2	2					1	1							

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1912 1912									4	39	9	44	47	48	29	17	28	32	19	20	16	8	3	2	1										
1913 1913									14	11	5	33	36	62	52	41	29	23	17	11	10	4	9	3	3	1	1								
1914 1914										15	4	8	30	5	17	17	20	35	27	50	38	36	22	23	11	4	1	2							
1915 1915									8	10	4	5	37	33	45	44	52	45	27	13	18	12	5	3	2		1	1							
1916 1916												1	7	21	50	45	38	41	39	33	33	17	12	9	4	2	8	3	2	1					
1917 1917						14				82		48		77	42	26	21	13	8	7	10	5	3	1	4	3		1							
1918 1918						32				21		27	8	20	26	46	38	34	21	22	26	9	13	6	5	2	5	2		1	1				
1919 1919									8	31	17	17	33	45	68	32	46	18	12	17	6	8	2	1	1		3								
1920 1920						14		15	61	103	18	27	34	21	16	15	12	3	4	5	2	10	1					5							
1921 1921						3		12	19	41	33	30	20	32	27	28	34	21	25	13	9	5	2	4	1	2	1	1	1	1					
1922 1922								21	30	42	15	20	19	42	19	20	28	18	10	18	12	8	11	3	8	5	9	3		1	2	1			
1923 1923									1	29	7	13	27	88	42	45	37	25	12	11	6	4	5	2	2	4	2	1		1	1				
1924 1924									21	42	12	34	18	60	34	25	32	23	17	14	11	4	4	1	6	4	1	2		1					
1925 1925										15	23	25	32	78	48	27	31	19	23	11	9	15	3	1	3		1						1		
1926 1926									3	57	44	54	56	65	24	14	18	10	7	6	1	2		3		1									
1927 1927										6	15	34	16	44	58	41	61	23	19	16	5	4	9	8	2	1		1	1		1				
1928 1928										33	14	29	21	31	42	44	55	36	16	18	7	5	4	5	3	2		1							
1929 1929										23	41	34	27	76	19	28	30	23	10	12	15	5	8	4	4	2	3	1							
1930 1930										29	18	2	5	21	18	47	55	42	22	18	34	30	6	7	3	3	4	1							
1931 1931									19	14	10	29	31	76	39	27	37	28	13	17	9	2	3	6	4					1					
1932 1932										6	2	19	19	41	43	47	29	43	45	20	17	4	13	11	4	3									
1933 1933			18			20		30	50	57	13	24	16	35	31	15	19	15	10	2	3	3	1		3										
1934 1934			20			20			5	41	34	54	16	26	29	25	32	20	9	7	10	7	2	1	3	1	1	1		1					
1935 1935								10	8	12	20	52	40	42	42	35	28	17	15	15	7	8	5	1	3	2	3								
1936 1936							2		17	34	43	28	10	14	20	49	45	33	26	18	12	7	5	3											
1937 1937											1	13	18	26	38	42	44	42	29	31	15	11	28	10	6	4	3	3		1					
1938 1938											7	22	48	40	37	41	37	33	22	17	13	14	9	9	9	2	3	1			1				
1939 1939											12	17	27	30	57	64	46	35	23	17	14	12	4	3	1	3									
1940 1940								3	9	24	57	67	45	29	26	19	19	18	13	10	7	9	1	3	4		2	1							
1941 1941									14	13	6	38	36	23	51	43	32	30	25	14	14	12	5	1	5	2				1					
1942 1942									5	19	21	58	39	28	29	25	21	23	17	15	17	11	9	7	9	2	1	4	3	1		1			
1943 1943									5	21	29	73	38	34	37	34	18	21	15	12	12	4	7	1	2	1	1								
1944 1944						1	13	40	31	19	28	45	39	39	34	36	15	9	4	4	2	1	4	2											
1945 1945								15	67	37	25	25	31	21	35	28	25	17	13	12	6	5	1	2											
1946 1946								1	36	55	38	43	28	25	27	16	16	19	20	12	8	9	5	4	2	1									

DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16587000 Honopou Stream near Huelo, Maui, HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.54	(LOG = -0.26812)
90.0	0.74	(LOG = -0.12964)
85.0	0.87	(LOG = -0.05883)
80.0	1.07	(LOG = 0.02900)
75.0	1.29	(LOG = 0.11162)
70.0	1.48	(LOG = 0.17000)
65.0	1.71	(LOG = 0.23248)
60.0	1.95	(LOG = 0.28926)
55.0	2.20	(LOG = 0.34330)
50.0	2.48	(LOG = 0.39502)
45.0	2.83	(LOG = 0.45142)
40.0	3.20	(LOG = 0.50535)
35.0	3.69	(LOG = 0.56665)
30.0	4.30	(LOG = 0.63313)
25.0	5.01	(LOG = 0.69946)
20.0	6.03	(LOG = 0.78031)
15.0	7.64	(LOG = 0.88281)
10.0	10.0	(LOG = 1.00207)
5.0	16.0	(LOG = 1.20384)

MEAN OF LOGS = 0.41259

STANDARD DEVIATION OF LOGS = 0.39607 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = 0.95996

COEFFICIENT OF SKEW = 0.20701

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1982 1982									1	10	12	10	15	26	28	35	39	36	36	33	27	17	16	7	4	5	3	1	2	1					1
1983 1983						5	11	29	6	17	12	22	60	46	61	34	21	13	15	5	1	3		3	1										
1984 1984			13		6	21	12	13	16	35	22	29	37	24	30	24	28	24	12	4	6	2	3	2	3										
1985 1985		13	31	6	6	4	17	21	34	36	23	14	21	16	20	14	19	14	16	7	11	7	6	4	2	1	1		1						
1986 1986							1	9	16	23	20	29	33	38	35	29	37	16	19	11	14	5	8	7	4	2	3	2	1	1	2				
1987 1987							5	6	10	8	24	21	29	27	37	43	38	32	18	15	18	11	9	5	3	2		1	1	1		1			
1988 1988							2	12	28	39	25	18	21	29	36	33	27	30	20	13	6	9	4	1	5		3	3	1	1					
1989 1989							2	16	10	4	7	11	27	40	49	33	39	23	23	17	10	14	8	6	8	6	4	2	2	1		1		1	1
1990 1990									12	28	19	33	48	40	40	25	17	22	17	18	8	9	10	4	6	3	3		1	1		1			
1991 1991									6	8	20	39	54	44	28	37	24	28	13	7	13	7	12	7	1	6	1		2	4	2	1		1	
1992 1992						7	20	38	53	29	20	25	32	19	12	22	25	13	14	5	9	5	5	2	3	1	3	1	3						
1993 1993									7	27	32	43	36	38	45	26	34	12	11	12	15	5	6	6	3	2	4		1						
1994 1994									13	1	9	21	22	36	38	44	46	29	27	17	12	15	9	8	3	2	5	5		1		1		1	
1995 1995						4	8	9	12	30	32	35	33	46	34	25	21	19	18	16	5	11	2		5										
1996 1996							4	12	34	40	40	44	36	33	28	26	16	16	10	5	6	3	2		2	2	2	1	2		1			1	
1997 1997					7	21	13			9	18	22	27	38	46	37	34	20	20	20	9	10	4	3	2	2	1		1			1			
1998 1998								13	31	21	18	23	16	40	32	24	27	35	28	21	16	7	6	2		3		2							
1999 1999						15	22	17	31	23	19	17	18	25	24	22	25	24	25	16	11	9	7	5	3	3	2		1	1					
2000 2000					9	11	24	34	35	20	23	23	24	29	19	26	18	22	11	9	7	5	4	6	3		4								

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	0	32508	100.00	13	1.50	2775	22573	69.44	25	26.00	259	756	2.33
2	0.11	14	32508	100.00	14	1.90	3151	19798	60.90	26	33.00	163	497	1.53
3	0.14	100	32494	99.96	15	2.40	3304	16647	51.21	27	42.00	147	334	1.03
4	0.18	16	32394	99.65	16	3.10	2679	13343	41.05	28	54.00	82	187	0.58
5	0.22	106	32378	99.60	17	3.90	2528	10664	32.80	29	68.00	39	105	0.32
6	0.29	370	32272	99.27	18	5.00	2063	8136	25.03	30	86.00	29	66	0.20
7	0.36	327	31902	98.14	19	6.30	1524	6073	18.68	31	110.00	17	37	0.11
8	0.46	1047	31575	97.13	20	8.00	1283	4549	13.99	32	139.00	12	20	0.06
9	0.58	1247	30528	93.91	21	10.00	954	3266	10.05	33	176.00	1	8	0.02
10	0.74	2474	29281	90.07	22	13.00	689	2312	7.11	34	224.00	5	7	0.02
11	0.94	1613	26807	82.46	23	16.00	545	1623	4.99	35	284.00	2	2	0.01
12	1.20	2621	25194	77.50	24	21.00	322	1078	3.32					

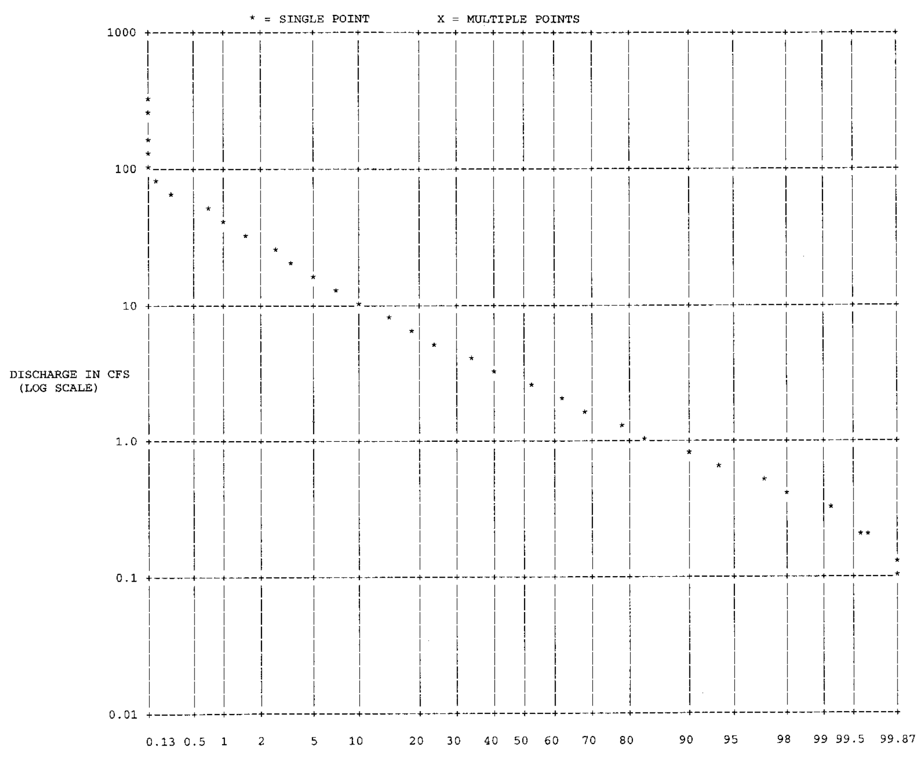
DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1912 1912	.60 56	.60 55	.69 61	.78 62	1.16 69	1.17 41	1.38 30	1.45 26	3.09 46
1913 1913	.60 57	.60 56	.60 53	1.22 84	1.27 76	1.86 66	2.10 59	2.17 53	3.44 50
1914 1914	.93 83	.93 83	.93 81	.95 78	1.38 78	3.02 84	4.54 85	5.14 84	6.21 84
1915 1915	.67 70	.68 65	.69 63	.74 58	1.01 61	2.37 80	3.45 79	3.13 69	3.59 56
1916 1916	1.20 89	1.60 89	1.86 89	2.18 89	2.97 89	4.23 89	4.02 83	5.48 86	8.71 88
1917 1917	.31 18	.31 17	.31 15	.31 14	.56 28	.74 22	.81 11	1.12 15	2.36 31
1918 1918	.31 19	.31 18	.31 16	.38 19	.45 17	.65 14	1.18 25	2.02 49	5.37 78
1919 1919	.62 62	.62 59	.75 69	.84 72	.94 53	1.26 44	1.74 48	2.01 48	2.80 41
1920 1920	.31 20	.31 19	.31 17	.31 15	.43 15	.59 11	.69 8	.85 7	1.68 13
1921 1921	.31 21	.31 20	.40 27	.47 32	.56 29	.79 24	1.41 32	1.67 33	2.34 30
1922 1922	.46 42	.46 39	.46 35	.49 35	.52 22	.60 12	.78 9	.86 8	1.51 7
1923 1923	.62 63	.72 72	.75 68	.77 61	.94 55	2.03 71	2.15 61	2.16 52	2.99 44
1924 1924	.62 64	.62 60	.62 54	.63 48	.76 44	1.35 50	1.85 53	1.70 34	3.13 47
1925 1925	.77 77	.88 81	1.00 84	1.07 82	1.18 73	1.48 57	1.58 39	2.29 54	3.47 51
1926 1926	.62 65	.72 73	.77 75	.87 73	.98 57	1.70 64	1.65 44	1.79 41	1.88 17
1927 1927	.77 78	.77 77	.82 79	1.08 83	1.54 80	2.46 81	2.70 69	3.97 79	4.72 73
1928 1928	.77 79	.77 78	.77 73	.84 71	1.10 66	2.01 70	2.48 65	3.41 72	3.69 58
1929 1929	.93 84	.93 84	.93 82	.99 79	1.10 67	1.59 59	1.74 49	1.71 35	2.29 29
1930 1930	.77 80	.77 79	.77 74	.94 77	1.03 62	3.59 87	5.04 87	5.54 88	6.51 86
1931 1931	.62 66	.62 61	.62 55	.63 49	.71 41	1.28 46	1.53 37	1.79 42	2.42 34
1932 1932	.93 85	.93 85	1.07 86	1.25 85	1.88 84	2.30 78	3.70 82	3.37 70	4.96 76
1933 1933	.15 3	.15 2	.15 2	.15 2	.23 3	.61 13	.88 14	1.18 17	1.32 1
1934 1934	.15 4	.15 3	.15 3	.15 3	.20 2	.90 30	1.43 33	1.39 25	1.48 5
1935 1935	.54 52	.55 54	.57 49	.57 42	1.11 68	1.39 52	1.61 41	1.90 45	2.68 39
1936 1936	.39 32	.47 42	.59 51	.73 57	1.00 60	1.33 49	1.28 28	1.51 30	2.25 27
1937 1937	1.10 88	1.20 88	1.39 88	1.71 88	2.27 88	3.28 86	5.49 89	5.51 87	6.11 81
1938 1938	1.00 86	1.07 87	1.10 87	1.34 86	1.76 83	2.29 77	2.71 70	3.58 76	5.96 79
1939 1939	1.00 87	1.00 86	1.03 85	1.57 87	2.09 86	2.18 75	2.84 71	3.76 78	4.75 74
1940 1940	.46 43	.51 49	.59 50	.71 54	1.03 63	1.30 47	1.46 35	1.75 38	1.95 19
1941 1941	.70 71	.70 68	.70 65	.74 60	.95 56	1.31 48	2.39 64	2.55 56	3.89 64
1942 1942	.70 72	.75 76	.75 70	.82 69	.94 54	1.65 62	1.93 56	1.95 46	3.83 61
1943 1943	.70 73	.70 69	.80 77	.91 75	1.58 81	1.79 65	2.61 67	2.93 63	3.52 53
1944 1944	.31 22	.36 29	.39 26	.41 25	.47 19	.55 9	1.32 29	1.47 29	1.50 6
1945 1945	.46 44	.51 50	.53 45	.57 40	.64 36	.93 32	.91 17	1.34 22	1.94 18
1946 1946	.54 53	.62 62	.65 58	.71 55	.92 52	1.19 42	1.61 42	2.56 57	3.58 55
1947 1947	.70 74	.70 70	.70 66	.81 65	1.23 74	1.97 68	2.26 63	2.61 58	3.86 62
1948 1948	.77 81	.80 80	.88 80	1.00 80	1.28 77	2.00 69	2.50 66	2.68 60	4.77 75

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1911 - 2001)
STATION ID: 16587000 Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1986 1986	.43 39	.48 44	.54 47	.61 47	.81 48	1.36 51	2.13 60	3.56 75	6.12 82
1987 1987	.40 37	.41 35	.63 56	.70 53	.99 59	2.14 74	3.54 80	4.00 80	4.62 72
1988 1988	.43 40	.47 43	.49 39	.51 36	.58 31	.82 26	.96 19	1.11 14	2.66 38
1989 1989	.42 38	.44 37	.49 40	.66 52	.72 42	1.88 67	2.91 73	5.19 85	6.21 85
1990 1990	.60 58	.60 58	.66 59	.78 63	1.04 64	1.44 55	1.94 58	3.60 77	3.63 57
1991 1991	.60 59	.65 64	.69 62	.81 67	1.16 71	2.35 79	2.66 68	3.03 67	4.25 68
1992 1992	.34 26	.35 25	.37 24	.39 22	.56 30	.67 16	.99 23	1.04 12	1.56 9
1993 1993	.60 60	.69 67	.78 76	.89 74	1.26 75	1.66 63	3.43 78	3.55 74	4.16 66
1994 1994	.60 61	.60 57	.64 57	.72 56	1.65 82	2.84 83	4.92 86	4.97 83	6.03 80
1995 1995	.35 29	.35 28	.47 37	.49 34	.53 25	.90 29	1.45 34	2.12 51	2.55 36
1996 1996	.43 41	.43 36	.46 36	.57 41	.83 50	.99 34	1.50 36	1.45 27	2.37 33
1997 1997	.23 11	.23 9	.25 11	.28 9	.32 7	1.43 54	2.18 62	2.73 61	3.31 49
1998 1998	.50 51	.51 48	.52 43	.58 43	.80 47	1.09 38	1.75 50	3.00 65	3.90 65
1999 1999	.29 16	.29 15	.31 19	.38 18	.43 14	.51 8	.60 5	.88 9	1.59 10
2000 2000	.22 9	.24 12	.25 10	.28 10	.36 11	.67 15	1.00 24	1.29 21	1.82 15

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1949 1949	.62 67	.62 63	.70 64	.81 66	.99 58	1.23 43	1.65 45	1.71 36	2.12 25
1950 1950	.54 54	.54 52	.54 46	.59 44	.80 46	2.08 73	3.12 76	3.00 64	4.20 67
1951 1951	.40 36	.44 38	.45 34	.53 37	.71 40	.80 25	.85 12	1.03 11	1.54 8
1952 1952	.46 45	.49 46	.68 60	.74 59	1.17 72	2.24 76	3.09 75	3.49 73	3.88 63
1953 1953	.39 33	.39 32	.40 30	.42 26	.49 21	.88 27	1.27 27	1.34 23	1.86 16
1954 1954	.17 5	.21 7	.24 7	.27 8	.39 13	.96 33	1.67 46	1.80 43	2.36 32
1955 1955	.46 46	.53 51	.55 48	.64 51	.84 51	1.01 35	3.40 77	3.08 68	4.28 69
1956 1956	.39 34	.39 33	.40 31	.42 27	.68 39	.72 20	.93 18	1.38 24	5.35 77
1957 1957	.31 23	.31 21	.35 23	.43 29	.59 32	.89 28	1.69 47	2.85 62	2.98 43
1958 1958	.74 75	.74 74	.75 71	.79 64	1.98 85	2.71 82	2.93 74	3.01 66	3.48 52
1959 1959	.74 76	.74 75	.75 72	.82 68	1.16 70	1.27 45	1.94 57	2.04 50	3.73 60
1960 1960	.46 47	.46 40	.50 42	.54 38	.60 34	1.45 56	1.63 43	1.76 39	4.29 70
1961 1961	.31 24	.31 22	.33 21	.49 33	.55 27	.71 18	.88 13	1.16 16	2.56 37
1962 1962	.23 10	.31 23	.40 29	.41 24	.46 18	.70 17	.98 22	1.07 13	1.37 3
1963 1963	.17 6	.17 4	.17 4	.19 5	.23 4	.29 2	.98 21	1.19 18	1.43 4
1964 1964	.84 82	.90 82	.94 83	1.06 81	1.39 79	1.59 60	1.60 40	1.84 44	2.81 42
1965 1965	.39 35	.39 34	.43 32	.44 30	.53 24	1.08 36	1.86 54	1.72 37	2.52 35
1966 1966	.31 25	.31 24	.31 18	.41 23	.66 38	1.40 53	1.56 38	1.98 47	2.27 28
1967 1967	.47 50	.50 47	.53 44	.60 45	.77 45	1.08 37	1.76 51	2.61 59	3.70 59
1968 1968	.35 27	.35 26	.40 28	.43 28	.54 26	1.10 39	1.21 26	1.19 19	3.00 45
1969 1969	.24 12	.24 10	.25 12	.30 12	.33 8	2.06 72	3.60 81	4.23 81	6.20 83
1970 1970	.63 68	.69 66	.75 67	.83 70	1.05 65	1.49 58	2.88 72	3.39 71	4.35 71
1971 1971	.29 15	.29 14	.31 14	.31 16	.37 12	.49 7	.54 3	.65 2	3.52 54
1972 1972	.35 28	.35 27	.35 22	.39 20	.52 23	.91 31	1.39 31	1.52 31	2.04 23
1973 1973	.19 8	.22 8	.25 9	.26 7	.29 6	.36 3	.49 1	.72 4	1.65 12
1974 1974	.24 13	.24 11	.24 8	.29 11	.34 9	.45 5	.66 7	.75 5	2.11 24
1975 1975	.12 2	.19 6	.20 6	.25 6	.59 33	.72 21	.89 15	1.46 28	2.02 21
1976 1976	.46 48	.49 45	.49 41	.54 39	.63 35	.77 23	.89 16	.90 10	2.02 22
1977 1977	.38 30	.38 30	.38 25	.39 21	.44 16	.57 10	.98 20	1.63 32	2.75 40
1978 1978	.38 31	.38 31	.44 33	.45 31	.66 37	1.10 40	1.76 52	1.76 40	1.99 20
1979 1979	.54 55	.54 53	.60 52	.63 50	.83 49	1.60 61	1.88 55	2.30 55	2.24 26
1980 1980	.46 49	.46 41	.47 38	.60 46	.76 43	3.20 85	4.36 84	4.49 82	8.00 87
1981 1981	.24 14	.26 13	.28 13	.31 13	.36 10	.46 6	.65 6	.84 6	1.33 2
1982 1982	.64 69	.71 71	.81 78	.94 76	2.21 87	4.11 88	5.29 88	6.28 89	8.78 89
1983 1983	.30 17	.30 16	.32 20	.36 17	.47 20	.71 19	.81 10	1.28 20	1.82 14
1984 1984	.17 7	.17 5	.17 5	.18 4	.25 5	.43 4	.56 4	.70 3	1.64 11
1985 1985	.11 1	.11 1	.11 1	.13 1	.14 1	.25 1	.53 2	.54 1	3.25 48

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1949 1949	67.0 47	39.0 58	27.4 48	19.7 46	14.5 41	10.5 42	8.55 44	7.06 51	5.66 54
1950 1950	88.0 38	55.7 33	46.3 22	36.9 10	24.4 11	17.5 11	13.2 18	11.0 18	8.90 21
1951 1951	60.0 56	39.3 55	24.0 60	21.4 39	14.3 43	10.0 47	8.21 46	7.35 46	5.62 55
1952 1952	36.0 77	21.7 78	13.6 82	8.95 85	7.95 78	6.27 78	5.41 79	5.08 77	4.96 71
1953 1953	48.0 69	25.4 71	15.3 77	12.3 71	9.48 71	8.64 60	6.56 67	5.18 75	4.11 77
1954 1954	39.0 74	23.7 74	16.4 74	11.8 73	8.92 74	6.36 76	6.24 72	6.32 61	5.37 63
1955 1955	49.0 68	35.7 60	29.3 45	19.5 47	14.2 45	11.0 38	11.0 28	10.1 23	8.81 22
1956 1956	227 6	138 4	74.1 4	41.7 7	23.1 13	15.4 18	13.3 17	12.1 13	9.81 14
1957 1957	77.0 42	34.7 61	24.8 57	15.9 60	13.2 51	8.55 61	6.16 73	5.45 71	5.25 66
1958 1958	60.0 57	40.0 53	24.3 59	18.1 53	15.9 37	12.0 32	9.07 40	7.64 44	6.14 47
1959 1959	60.0 58	39.3 56	22.2 63	17.4 57	11.1 61	10.0 48	8.39 45	7.67 43	7.74 30
1960 1960	94.0 33	51.7 39	31.0 38	21.1 40	14.2 46	10.4 44	9.29 37	7.88 40	6.90 39
1961 1961	110 24	66.3 26	34.1 33	19.1 49	11.6 57	10.5 43	7.58 53	7.10 50	6.19 45
1962 1962	44.0 72	23.8 73	19.1 69	11.5 74	8.58 76	5.81 80	4.32 85	3.43 86	3.58 83
1963 1963	69.0 43	39.3 57	30.6 39	21.5 38	14.4 42	9.58 52	7.28 56	6.55 58	4.99 70
1964 1964	31.0 82	20.3 80	14.5 80	9.87 82	6.86 84	4.99 85	4.89 81	4.91 78	4.17 76
1965 1965	67.0 48	43.3 47	25.7 54	18.6 50	13.6 50	9.02 55	6.95 62	7.02 52	6.49 44
1966 1966	133 18	73.0 22	44.1 24	26.5 24	19.6 23	13.3 26	10.5 30	10.0 24	7.63 31
1967 1967	65.0 49	43.3 48	23.3 62	14.0 66	9.69 69	7.83 71	6.29 70	6.25 63	5.29 64
1968 1968	86.0 39	53.3 36	33.1 36	19.9 45	14.0 47	11.9 33	9.09 39	7.31 48	7.59 33
1969 1969	110 25	74.7 19	43.7 25	26.3 28	24.5 10	24.0 3	20.3 3	16.9 3	13.9 3
1970 1970	95.0 31	54.7 34	35.6 32	27.9 23	16.6 34	9.98 50	7.26 57	7.82 41	6.74 41
1971 1971	155 10	79.7 16	46.0 23	26.4 26	18.3 27	13.9 22	11.5 24	9.33 31	9.25 18
1972 1972	29.0 84	19.4 83	10.7 86	8.72 86	5.65 88	3.35 89	3.65 87	3.13 87	2.78 87
1973 1973	50.0 66	22.9 76	16.2 75	14.9 62	12.9 52	10.0 49	8.20 47	6.83 53	5.52 57
1974 1974	58.0 61	30.0 67	18.4 70	12.1 72	7.64 80	5.74 81	5.91 77	5.32 73	4.69 73
1975 1975	147 13	57.4 31	28.4 46	14.9 63	8.60 75	7.88 69	7.08 59	6.47 59	5.39 62
1976 1976	36.0 78	18.3 84	15.5 76	11.5 75	8.94 73	7.61 72	6.29 71	5.29 74	4.34 75
1977 1977	63.0 52	57.0 32	43.7 26	26.4 27	16.8 33	11.8 35	9.18 38	7.21 49	6.09 49
1978 1978	62.0 53	25.7 70	14.9 79	9.45 83	6.84 85	6.31 77	5.58 78	5.12 76	4.37 74
1979 1979	89.0 36	59.3 29	42.9 27	29.5 21	17.7 30	14.2 20	13.6 15	12.6 11	9.64 16
1980 1980	117 21	83.7 12	66.0 8	47.1 4	38.1 2	27.4 1	20.5 2	16.6 4	13.2 5
1981 1981	65.0 50	42.7 50	21.5 64	11.5 76	6.49 86	3.81 87	3.16 89	2.62 89	2.11 89
1982 1982	284 2	105 8	49.4 17	31.1 19	22.1 14	18.3 9	15.2 8	13.7 7	11.7 8
1983 1983	26.0 86	13.1 89	10.2 87	8.43 87	7.19 82	5.31 84	4.43 84	4.08 83	3.49 85
1984 1984	27.0 85	13.8 88	11.4 85	8.99 84	8.02 77	6.08 79	4.58 82	4.31 82	4.04 79
1985 1985	68.0 44	42.3 51	27.0 50	20.4 44	16.1 36	10.6 40	10.3 31	8.35 36	6.13 48

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1912 1912	32.0 80	22.0 77	19.1 68	14.2 64	10.0 67	8.37 64	6.85 63	5.62 67	5.48 59
1913 1913	49.0 67	26.0 69	20.4 65	15.1 61	9.78 68	7.60 73	7.03 61	6.46 60	6.05 50
1914 1914	67.0 45	39.3 54	27.9 47	25.1 31	20.4 20	16.5 15	14.8 10	14.8 5	13.5 4
1915 1915	57.0 62	31.3 64	19.2 67	13.2 69	10.9 64	8.89 58	8.60 42	7.35 45	6.60 42
1916 1916	102 30	74.3 20	63.1 9	42.8 5	26.0 8	17.2 14	13.7 14	12.0 15	10.7 12
1917 1917	59.0 59	40.7 52	26.7 51	17.4 56	13.9 48	10.0 46	7.89 49	6.30 62	5.51 58
1918 1918	116 22	77.0 17	51.9 14	41.3 8	26.7 7	20.3 6	16.0 7	13.4 8	11.4 9
1919 1919	50.0 65	30.0 66	25.1 56	18.1 52	12.3 53	8.21 67	6.38 69	6.58 57	5.46 60
1920 1920	59.0 60	59.0 30	46.4 21	28.7 22	16.4 35	9.30 53	6.52 68	5.55 68	4.01 81
1921 1921	108 26	81.0 14	49.7 16	34.1 15	21.5 16	14.5 19	11.2 25	9.08 33	7.15 35
1922 1922	175 8	120 6	72.9 5	42.3 6	25.5 9	21.7 4	20.6 1	20.0 1	14.2 2
1923 1923	113 23	67.7 25	54.4 12	34.4 14	18.9 24	13.6 23	11.1 26	9.48 30	7.59 32
1924 1924	108 27	65.3 27	33.5 34	20.6 43	13.9 49	10.3 45	8.93 41	8.47 35	6.95 38
1925 1925	184 7	80.7 15	39.5 29	20.9 41	11.9 55	9.18 54	6.77 65	5.52 70	5.28 65
1926 1926	37.0 75	15.2 86	8.81 89	6.57 89	5.80 87	3.62 88	3.29 88	2.87 88	2.50 88
1927 1927	128 19	54.0 35	33.3 35	22.8 33	14.9 39	10.6 39	8.59 43	8.61 34	7.10 36
1928 1928	60.0 54	31.0 65	17.7 71	11.0 77	9.18 72	8.02 68	7.42 55	5.96 66	5.42 61
1929 1929	67.0 46	52.0 38	38.4 31	25.8 30	20.6 18	13.0 27	11.1 27	9.72 28	7.80 27
1930 1930	56.0 63	43.0 49	31.0 37	22.4 35	17.2 31	12.8 29	10.5 29	10.4 20	9.72 15
1931 1931	107 28	49.0 40	30.1 40	19.2 48	11.1 60	7.87 70	6.84 64	5.53 69	5.04 69
1932 1932	34.0 79	34.0 63	25.7 53	22.4 36	17.1 32	11.5 37	10.2 32	9.66 29	8.21 26
1933 1933	30.0 83	25.3 72	17.2 73	10.5 78	7.09 83	5.54 82	5.17 80	4.63 81	3.49 84
1934 1934	94.0 32	46.0 43	29.7 42	22.5 34	18.1 28	11.7 36	9.41 36	8.01 38	5.94 52
1935 1935	51.0 64	49.0 41	29.8 41	16.8 59	11.7 56	8.35 65	7.05 60	7.32 47	6.55 43
1936 1936	24.0 88	20.0 81	14.3 81	12.4 70	11.4 58	9.00 56	7.98 48	6.76 56	6.18 46
1937 1937	91.0 35	69.3 24	47.0 19	32.9 17	24.2 12	17.3 12	16.7 6	14.5 6	11.9 7
1938 1938	136 17	71.3 23	52.0 13	31.8 18	20.6 19	15.6 17	13.8 13	11.7 16	10.2 13
1939 1939	41.0 73	26.3 68	19.5 66	13.8 67	10.9 65	9.68 51	7.88 50	8.08 37	6.85 40
1940 1940	60.0 55	44.3 46	29.7 43	20.7 42	14.2 44	8.39 63	6.13 74	4.87 79	4.02 80
1941 1941	104 29	45.0 45	25.4 55	17.3 58	11.0 62	8.33 66	7.52 54	7.72 42	6.99 37
1942 1942	149 12	102 9	84.6 3	55.5 2	34.1 3	21.7 5	16.9 5	13.2 9	10.8 11
1943 1943	46.0 70	19.7 82	14.9 78	10.4 80	7.92 79	7.30 74	5.95 75	5.35 72	4.89 72
1944 1944	25.0 87	16.9 85	10.1 88	6.79 88	5.16 89	4.36 86	3.75 86	3.66 84	3.20 86
1945 1945	21.0 89	14.9 87	12.6 83	10.3 81	7.28 81	5.41 83	4.43 83	3.55 85	3.92 82
1946 1946	37.0 76	23.0 75	17.4 72	13.7 68	11.3 59	8.95 57	7.11 58	6.77 55	5.05 68
1947 1947	155 9	91.0 10	60.1 10	34.8 13	21.8 15	13.5 25	10.2 33	9.74 27	8.25 25
1948 1948	141 16	86.3 11	47.0 20	26.4 25	18.4 26	12.5 30	13.1 19	10.8 19	8.97 20

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)		WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)	
1912 1912	3.89	32	1912 1912	3.89	58
1913 1913	4.24	38	1913 1913	4.24	52
1914 1914	9.88	89	1914 1914	9.88	1
1915 1915	5.21	62	1915 1915	5.21	28
1916 1916	9.12	88	1916 1916	9.12	2
1917 1917	3.58	23	1917 1917	3.58	67
1918 1918	7.21	78	1918 1918	7.21	12
1919 1919	3.97	34	1919 1919	3.97	56
1920 1920	2.70	7	1920 1920	2.70	83
1921 1921	4.47	44	1921 1921	4.47	46
1922 1922	7.80	80	1922 1922	7.80	10
1923 1923	5.08	60	1923 1923	5.08	30
1924 1924	4.93	55	1924 1924	4.93	35
1925 1925	4.69	49	1925 1925	4.69	41
1926 1926	2.43	6	1926 1926	2.43	84
1927 1927	5.34	64	1927 1927	5.34	26
1928 1928	4.63	46	1928 1928	4.63	44
1929 1929	4.79	52	1929 1929	4.79	38
1930 1930	7.11	77	1930 1930	7.11	13
1931 1931	4.31	42	1931 1931	4.31	48
1932 1932	6.08	74	1932 1932	6.08	16
1933 1933	2.21	3	1933 1933	2.21	87
1934 1934	3.69	27	1934 1934	3.69	63
1935 1935	4.27	39	1935 1935	4.27	51
1936 1936	4.12	35	1936 1936	4.12	55
1937 1937	8.32	83	1937 1937	8.32	7
1938 1938	6.72	76	1938 1938	6.72	14
1939 1939	4.99	57	1939 1939	4.99	33
1940 1940	3.70	28	1940 1940	3.70	62
1941 1941	5.01	58	1941 1941	5.01	32
1942 1942	7.24	79	1942 1942	7.24	11
1943 1943	3.79	30	1943 1943	3.79	60
1944 1944	2.29	4	1944 1944	2.29	86
1945 1945	2.81	11	1945 1945	2.81	79
1946 1946	3.57	22	1946 1946	3.57	68
1947 1947	5.44	65	1947 1947	5.44	25
1948 1948	6.06	73	1948 1948	6.06	17
1949 1949	3.76	29	1949 1949	3.76	61
1950 1950	5.75	68	1950 1950	5.75	22
1951 1951	3.50	19	1951 1951	3.50	71
1952 1952	3.96	33	1952 1952	3.96	57

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1986 1986	126 20	76.0 18	51.7 15	30.7 20	27.7 5	19.4 7	14.0 12	12.1 14	9.55 17
1987 1987	146 14	108 7	55.7 11	34.9 12	20.8 17	14.1 21	11.9 21	10.4 21	7.76 28
1988 1988	89.0 37	73.7 21	41.0 28	22.0 37	18.7 25	12.3 31	11.7 22	10.2 22	8.77 23
1989 1989	305 1	219 1	112 1	65.0 1	44.1 1	26.0 2	18.9 4	17.8 2	14.3 1
1990 1990	150 11	81.3 13	49.1 18	33.4 16	20.2 21	19.1 8	14.4 11	11.3 17	9.05 19
1991 1991	229 5	132 5	71.7 6	40.7 9	28.5 4	17.6 10	13.5 16	12.3 12	12.0 6
1992 1992	80.0 41	63.0 28	39.4 30	24.1 32	15.1 38	12.9 28	9.84 34	7.93 39	5.57 56
1993 1993	81.0 40	45.3 44	24.5 58	14.2 65	12.0 54	8.40 62	6.60 66	6.17 64	5.96 51
1994 1994	269 4	172 2	91.4 2	47.9 3	27.6 6	17.3 13	15.0 9	12.7 10	11.2 10
1995 1995	32.0 81	21.0 79	12.5 84	10.5 79	9.69 70	7.05 75	5.93 76	4.76 80	4.10 78
1996 1996	279 3	150 3	70.3 7	35.4 11	20.2 22	16.5 16	12.2 20	9.98 25	7.75 29
1997 1997	142 15	52.6 37	26.4 52	17.8 55	14.8 40	11.9 34	9.63 35	9.11 32	7.51 34
1998 1998	64.0 51	34.7 62	24.0 61	18.5 51	11.0 63	8.77 59	7.82 51	6.79 54	5.89 53
1999 1999	94.0 34	46.7 42	29.6 44	26.3 29	18.0 29	13.6 24	11.7 23	9.76 26	8.52 24
2000 2000	46.0 71	36.0 59	27.3 49	18.1 54	10.8 66	10.6 41	7.73 52	6.02 65	5.13 67

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1994 1994	8.23	82
1995 1995	3.55	21
1996 1996	4.66	47
1997 1997	4.93	54
1998 1998	4.73	50
1999 1999	4.98	56
2000 2000	3.69	26

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1994 1994	8.23	8
1995 1995	3.55	69
1996 1996	4.66	43
1997 1997	4.93	36
1998 1998	4.73	40
1999 1999	4.98	34
2000 2000	3.69	64

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16587000
Honopou Stream near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1953 1953	2.99	13
1954 1954	3.64	24
1955 1955	5.60	66
1956 1956	5.85	69
1957 1957	4.28	40
1958 1958	5.64	67
1959 1959	5.03	59
1960 1960	4.42	43
1961 1961	3.66	25
1962 1962	2.37	5
1963 1963	3.15	14
1964 1964	3.41	17
1965 1965	4.30	41
1966 1966	4.68	48
1967 1967	4.18	37
1968 1968	4.53	45
1969 1969	8.47	85
1970 1970	4.76	51
1971 1971	5.25	63
1972 1972	2.09	2
1973 1973	3.51	20
1974 1974	2.79	9
1975 1975	3.40	16
1976 1976	2.80	10
1977 1977	3.82	31
1978 1978	3.18	15
1979 1979	5.95	71
1980 1980	8.37	84
1981 1981	1.73	1
1982 1982	8.91	86
1983 1983	2.78	8
1984 1984	2.84	12
1985 1985	3.42	18
1986 1986	6.32	75
1987 1987	5.99	72
1988 1988	5.11	61
1989 1989	9.11	87
1990 1990	5.89	70
1991 1991	8.05	81
1992 1992	4.17	36
1993 1993	4.82	53

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1953 1953	2.99	77
1954 1954	3.64	66
1955 1955	5.60	24
1956 1956	5.85	21
1957 1957	4.28	50
1958 1958	5.64	23
1959 1959	5.03	31
1960 1960	4.42	47
1961 1961	3.66	65
1962 1962	2.37	85
1963 1963	3.15	76
1964 1964	3.41	73
1965 1965	4.30	49
1966 1966	4.68	42
1967 1967	4.18	53
1968 1968	4.53	45
1969 1969	8.47	5
1970 1970	4.76	39
1971 1971	5.25	27
1972 1972	2.09	88
1973 1973	3.51	70
1974 1974	2.79	81
1975 1975	3.40	74
1976 1976	2.80	80
1977 1977	3.82	59
1978 1978	3.18	75
1979 1979	5.95	19
1980 1980	8.37	6
1981 1981	1.73	89
1982 1982	8.91	4
1983 1983	2.78	82
1984 1984	2.84	78
1985 1985	3.42	72
1986 1986	6.32	15
1987 1987	5.99	18
1988 1988	5.11	29
1989 1989	9.11	3
1990 1990	5.89	20
1991 1991	8.05	9
1992 1992	4.17	54
1993 1993	4.82	37

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1959 1959																								2		5	12	31	45	52	43	44	62	69	
1960 1960																								2	6	17	24	32	37	36	37	40	43	92	
1961 1961																								2	15	30	37	58	43	34	34	39	32	41	
1962 1962																							21	21	15	24	41	42	32	32	24	27	31	55	
1963 1963																						10	15	17	24	21	28	32	36	26	22	24	36	74	
1964 1964																										3	23	31	42	66	42	39	44	76	
1965 1965																							4	7	12	14	20	37	39	43	45	60	34	50	
1966 1966																						5	5	11	9	11	8	24	26	46	40	46	90	44	
1967 1967																								1	9	11	27	38	34	38	36	35	41	94	1
1968 1968															1		3	2	3	4	7	3	5	13	12	21	27	33	40	22	33	23	62	52	
1969 1969																						3	13	11	10	12	17	48	13	29	27	47	56	79	
1970 1970										2	1	1								1			1		4	17	27	34	29	41	35	49	53	70	
1971 1971						2	6	1	1	1		1	1	2	2	1	1	1				2	9	30	27	35	26	33	26	30	27	25	38	37	
1972 1972																								15	25	28	38	36	41	38	34	29	49	33	
1973 1973														2	5	1					7	10	15	11	10	24	37	29	25	32	22	28	45	62	
1974 1974																				1	10	10	18	19	27	31	24	30	29	36	33	45	25	27	
1975 1975																				14	5	1	2		15	25	30	25	22	40	35	49	37	65	
1976 1976																								9	16	18	41	34	38	35	45	45	34	51	
1977 1977																					14	14	10	5	14	23	29	29	34	26	25	38	42	62	
1978 1978																							19	28	21	17	17	18	12	38	39	31	58	67	
1979 1979																								8	13	14	17	32	35	48	65	43	42	48	
1980 1980															1	2		1					2	4	13	16	28	15	18	40	34	49	119	24	
1981 1981																				3	17	30	27	36	27	35	40	36	26	18	15	17	20	18	
1982 1982																										4	14	21	20	32	47	65	65	96	1
1983 1983								2	1												9	9	17	18	14	4	14	28	20	42	35	37	58	57	
1984 1984																					2	13	6	18	34	33	24	43	22	26	23	31	40	51	
1985 1985																			17	13	7	3	7	19	9	21	28	29	24	18	22	25	35	88	
1986 1986																		1			1	7	7	12	16	13	24	20	21	29	37	34	33	110	
1987 1987																								6	7	14	21	28	26	29	29	37	50	118	

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1924 1924																									18	25	23	41	39	58	41	54	67		
1925 1925																										26	16	22	27	51	44	44	135		
1926 1926																							1	21	47	52	41	21	35	44	30	45	28		
1927 1927																									11	25	22	26	30	37	41	50	123		
1928 1928																									8	6	13	29	30	40	37	51	152		
1929 1929																									11	15	13	27	44	44	40	44	123	4	
1930 1930																									15	11	11	15	15	15	28	49	182	24	
1931 1931																								4	11	18	17	20	41	38	29	48	139		
1932 1932																									3	7	6	17	26	42	35	44	186		
1933 1933																							3	22	38	28	30	40	35	43	24	45	57		
1934 1934																					1	20	13	22	18	35	24	19	22	15	15	24	137		
1935 1935																									1	7	16	21	47	42	38	57	136		
1936 1936																							3	8	21	25	27	13	20	15	19	35	180		
1937 1937																											2	4	12	13	17	39	278		
1938 1938																											4	19	27	43	36	58	178		
1939 1939																											3	7	24	22	46	51	212		
1940 1940																							1	8	9	25	26	42	35	32	33	41	94	20	
1941 1941																								3	9	13	18	23	29	29	38	48	111	44	
1942 1942																								1	7	8	13	25	21	33	31	42	118	66	
1943 1943																									12	28	32	39	26	34	33	52	91	18	
1944 1944																						8	17	28	19	25	25	45	21	44	33	35	54	12	
1945 1945																						3	15	15	24	28	31	34	24	20	25	33	75	38	
1946 1946																				3		1	1	7	23	33	33	53	26	31	31	24	48	51	
1947 1947																								4	8	9	24	29	46	49	32	45	76	43	
1948 1948																									2	1	8	37	43	58	48	63	73	33	
1949 1949																									5	31	32	42	28	49	44	51	59	24	
1950 1950																								3	6	17	21	34	40	38	41	73	81	11	
1951 1951																									10	39	29	42	44	45	59	50	47		
1952 1952																								6	8	3	13	23	25	40	52	59	136	1	
1953 1953																						2	17	17	16	35	29	41	27	30	32	32	81	6	
1954 1954																						5	8	15	13	15	23	27	23	22	27	24	46	117	
1955 1955																								5	9	10	11	35	47	44	48	30	25	101	
1956 1956																								2	13	31	22	37	25	40	33	31	38	94	
1957 1957																								2	13	30	33	50	40	32	22	38	44	61	
1958 1958																								2	11	16	17	27	36	34	35	42	50	95	

DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16588000 Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	52.3	(LOG = 1.71854)
90.0	66.6	(LOG = 1.82368)
85.0	78.3	(LOG = 1.89377)
80.0	90.4	(LOG = 1.95599)
75.0	101.7	(LOG = 2.00749)
70.0	113.6	(LOG = 2.05533)
65.0	126.3	(LOG = 2.10131)
60.0	139.7	(LOG = 2.14532)
55.0	153.5	(LOG = 2.18620)
50.0	169.3	(LOG = 2.22870)
45.0	185.8	(LOG = 2.26898)
40.0	202.5	(LOG = 2.30638)
35.0	219.2	(LOG = 2.34090)
30.0	232.2	(LOG = 2.36591)
25.0	242.7	(LOG = 2.38502)
20.0	253.1	(LOG = 2.40333)
15.0	263.6	(LOG = 2.42089)
10.0	277.9	(LOG = 2.44395)
5.0	302.0	(LOG = 2.48000)

MEAN OF LOGS = 2.18588

STANDARD DEVIATION OF LOGS = 0.22613 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = 0.10345

COEFFICIENT OF SKEW = -0.58790

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	0	23376	100.00	13	5.80	1	23357	99.92	25	52.00	823	22230	95.10
2	0.77	0	23376	100.00	14	6.90	4	23356	99.91	26	63.00	1218	21407	91.58
3	0.92	0	23376	100.00	15	8.30	9	23352	99.90	27	75.00	1451	20189	86.37
4	1.10	0	23376	100.00	16	10.00	4	23343	99.86	28	90.00	1952	18738	80.16
5	1.30	0	23376	100.00	17	12.00	4	23339	99.84	29	109.00	1935	16786	71.81
6	1.60	2	23376	100.00	18	14.00	5	23335	99.82	30	130.00	2288	14851	63.53
7	1.90	6	23374	99.99	19	17.00	20	23330	99.80	31	157.00	2202	12563	53.74
8	2.30	3	23368	99.97	20	21.00	39	23310	99.72	32	188.00	2652	10361	44.32
9	2.80	2	23365	99.95	21	25.00	80	23271	99.55	33	226.00	5034	7709	32.98
10	3.30	3	23363	99.94	22	30.00	159	23191	99.21	34	271.00	2673	2675	11.44
11	4.00	1	23360	99.93	23	36.00	282	23032	98.53	35	326.00	2	2	0.01
12	4.80	2	23359	99.93	24	43.00	520	22750	97.32					

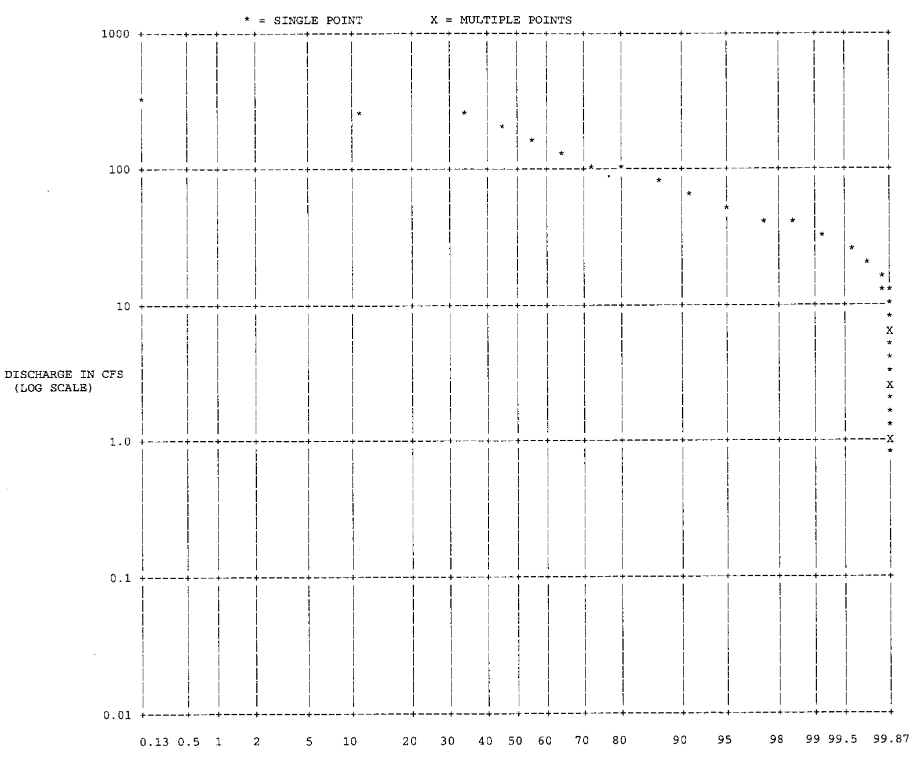
DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1924 1924	53.0 48	54.0 47	57.1 46	62.5 41	78.3 39	105 35	134 44	128 32	140 26
1925 1925	65.0 60	66.7 59	71.0 55	83.4 56	94.9 55	112 44	120 31	133 38	149 38
1926 1926	42.0 29	43.3 29	44.4 25	50.9 25	55.3 19	79.6 20	85.2 10	86.0 7	91.8 3
1927 1927	53.0 49	55.0 50	58.7 50	63.7 42	80.1 42	99.9 30	118 28	130 33	143 32
1928 1928	56.0 54	57.3 53	58.6 48	65.9 47	86.1 47	134 54	152 52	155 48	168 49
1929 1929	53.0 50	54.0 48	55.3 40	59.9 36	75.7 35	126 51	126 40	131 35	146 34
1930 1930	53.0 51	55.0 51	57.4 47	60.1 37	70.2 27	125 50	152 51	164 53	177 54
1931 1931	50.0 42	51.3 43	56.6 42	65.1 45	86.3 48	124 49	120 32	132 36	146 35
1932 1932	57.0 57	60.3 55	73.7 58	93.9 60	109 56	163 61	181 62	176 61	192 60
1933 1933	40.0 27	41.3 27	46.7 28	49.6 22	52.3 18	77.1 17	105 22	113 20	122 10
1934 1934	29.0 14	30.3 15	30.9 12	34.1 12	39.2 7	54.0 5	65.9 4	80.3 4	91.1 2
1935 1935	62.0 58	66.3 58	71.3 56	91.2 58	116 60	143 58	160 59	165 54	179 57
1936 1936	39.0 26	39.7 26	43.7 23	51.1 26	73.0 31	81.6 21	88.1 13	102 15	129 17
1937 1937	84.0 64	88.7 64	98.0 63	120 63	158 63	185 64	206 64	217 64	230 64
1938 1938	82.0 63	86.7 63	94.6 62	115 62	141 62	177 63	174 61	188 62	200 62
1939 1939	77.0 62	82.3 62	114 64	125 64	161 64	174 62	186 63	197 63	206 63
1940 1940	40.0 28	42.0 28	44.3 24	50.3 23	70.7 28	99.1 29	103 20	111 19	127 16
1941 1941	50.0 43	50.0 36	52.6 37	61.6 40	82.9 45	101 32	127 41	137 41	163 46
1942 1942	50.0 44	52.0 44	56.7 43	65.3 46	77.6 37	120 47	160 57	173 59	188 59
1943 1943	54.0 52	54.7 49	58.6 49	67.6 50	87.6 51	97.4 26	112 27	117 23	142 31
1944 1944	32.0 19	32.0 17	34.3 16	38.4 14	45.5 12	62.2 8	92.1 15	92.9 12	98.2 4
1945 1945	34.0 21	34.7 21	36.3 18	39.5 15	52.1 17	77.7 18	97.9 17	108 17	125 12
1946 1946	23.0 10	23.0 9	51.6 34	59.3 34	72.0 30	90.6 22	108 25	126 29	146 36
1947 1947	47.0 37	48.0 33	50.3 31	55.4 31	75.5 34	120 48	142 48	158 51	164 47
1948 1948	56.0 55	69.0 60	85.0 61	98.7 61	114 57	137 55	152 53	160 52	170 50
1949 1949	56.0 56	58.0 54	61.6 54	69.4 52	86.7 50	107 37	124 36	146 44	142 30
1950 1950	43.0 30	50.7 39	59.3 52	75.0 54	86.4 49	126 52	141 47	147 45	158 44
1951 1951	54.0 53	55.7 52	58.7 51	63.9 43	81.4 44	96.0 25	106 24	119 25	130 18
1952 1952	43.0 31	45.0 31	56.0 41	61.4 39	92.2 54	143 59	147 49	157 50	171 52
1953 1953	32.0 20	34.0 20	37.4 19	37.9 13	45.1 11	77.8 19	112 26	106 16	126 14
1954 1954	31.0 17	32.3 18	34.1 14	42.5 20	60.2 23	99.9 31	126 39	126 28	135 23
1955 1955	47.0 38	48.0 34	49.1 30	53.9 28	75.4 32	97.6 27	122 34	127 30	150 39
1956 1956	47.0 39	51.0 42	53.6 38	58.8 33	78.8 40	102 33	104 21	109 18	132 21
1957 1957	47.0 40	49.7 35	51.3 33	57.1 32	68.7 26	97.6 28	131 42	138 42	147 37
1958 1958	46.0 36	53.3 46	56.9 44	69.9 53	88.5 52	110 42	122 35	132 37	160 45
1959 1959	45.0 35	61.0 56	71.9 57	82.5 55	115 58	138 56	158 56	166 55	176 53
1960 1960	50.0 45	50.7 40	56.9 45	64.4 44	71.7 29	110 43	160 58	168 57	178 56

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1923 - 1987)
STATION ID: 16588000 Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1924 1924	257 59	247 64	237 64	225 63	215 61	201 60	183 61	165 62	165 59
1925 1925	257 60	257 58	257 58	248 58	241 54	237 41	233 29	223 28	214 24
1926 1926	263 51	255 61	248 62	239 61	211 62	185 63	154 63	140 63	122 63
1927 1927	260 58	258 57	257 57	255 53	243 52	230 49	214 46	198 45	203 37
1928 1928	269 50	265 50	261 50	253 56	247 49	242 33	235 27	214 34	206 33
1929 1929	275 45	273 44	264 47	263 41	262 31	232 45	232 31	227 23	215 23
1930 1930	272 47	272 45	272 42	270 37	267 22	261 14	255 10	248 8	243 5
1931 1931	257 61	257 59	255 59	253 54	247 50	244 30	235 25	212 35	206 34
1932 1932	257 62	257 60	254 60	252 57	250 47	245 29	233 30	227 24	209 28
1933 1933	251 63	251 62	251 61	248 59	225 59	205 58	192 54	187 51	172 54
1934 1934	263 52	263 51	260 52	258 51	257 37	252 21	248 16	247 9	218 21
1935 1935	263 53	263 52	260 53	258 50	243 53	218 53	217 44	204 43	192 43
1936 1936	263 54	263 53	260 55	259 47	258 36	252 22	248 15	241 11	241 6
1937 1937	263 55	263 54	261 51	259 46	258 33	254 19	254 12	253 4	250 1
1938 1938	263 56	263 55	260 54	258 48	252 43	248 25	244 19	241 12	226 13
1939 1939	263 57	261 56	260 56	258 49	252 45	239 37	237 23	235 17	233 9
1940 1940	282 38	282 35	281 31	276 29	265 24	243 32	222 40	198 44	184 46
1941 1941	288 35	282 36	277 35	274 30	262 29	230 47	231 33	222 30	220 19
1942 1942	278 39	278 38	278 34	277 26	273 18	268 11	257 7	227 25	210 27
1943 1943	278 40	276 39	271 44	268 38	257 38	239 38	222 39	216 32	208 31
1944 1944	275 46	272 46	265 46	239 62	220 60	196 61	187 59	188 49	178 50
1945 1945	278 41	276 40	274 39	273 33	263 28	239 39	204 51	173 58	177 52
1946 1946	286 36	276 41	273 41	272 34	267 23	259 16	220 42	192 47	182 49
1947 1947	286 37	279 37	274 40	253 55	238 57	207 57	206 50	192 48	194 41
1948 1948	278 42	276 42	275 38	273 32	262 30	237 42	228 35	210 37	209 29
1949 1949	278 43	274 43	272 43	261 44	246 51	232 46	208 49	194 46	177 51
1950 1950	272 48	272 47	263 49	260 45	240 55	230 48	214 45	205 41	199 39
1951 1951	251 64	248 63	240 63	222 64	202 63	186 62	179 62	171 60	169 57
1952 1952	272 49	268 49	263 48	262 43	256 39	238 40	237 24	230 20	220 20
1953 1953	278 44	272 48	266 45	262 42	256 40	249 24	213 47	176 57	162 61
1954 1954	302 18	302 14	302 10	302 4	297 5	293 1	274 3	276 1	244 2
1955 1955	302 19	302 15	302 11	302 6	300 1	268 10	255 11	239 14	237 7
1956 1956	302 20	302 16	302 12	302 5	292 6	283 3	275 2	258 3	244 4
1957 1957	291 26	291 25	291 17	289 15	270 19	240 36	209 48	180 56	182 48
1958 1958	291 27	291 26	291 21	288 16	282 12	271 8	250 13	250 7	223 16
1959 1959	291 28	291 27	286 28	280 22	258 34	240 34	226 37	205 42	205 35
1960 1960	291 29	291 28	291 18	282 19	276 14	251 23	229 34	215 33	222 17

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1961 1961	50.0 46	50.7 41	54.4 39	66.9 49	80.2 43	114 45	124 37	134 39	138 25
1962 1962	36.0 23	36.0 23	37.4 20	40.4 17	50.7 16	69.9 14	105 23	113 21	125 13
1963 1963	30.0 16	30.7 16	32.1 13	33.9 11	41.9 9	69.2 13	90.4 14	89.7 11	99.9 5
1964 1964	72.0 61	75.7 61	82.0 60	93.6 59	116 59	142 57	148 50	157 49	170 51
1965 1965	37.0 24	37.7 24	45.3 26	50.6 24	60.1 22	107 38	139 46	148 46	156 43
1966 1966	31.0 18	32.3 19	34.1 15	47.4 21	59.9 21	114 46	138 45	148 47	166 48
1967 1967	50.0 47	53.0 45	61.1 53	66.6 48	88.5 53	132 53	156 55	167 56	177 55
1968 1968	8.50 5	11.8 6	17.5 4	23.1 3	48.5 13	63.5 10	99.1 18	127 31	153 42
1969 1969	34.0 22	35.3 22	38.0 21	41.3 19	49.9 15	70.8 15	86.9 12	89.3 10	130 19
1970 1970	3.70 3	4.00 3	20.2 5	60.2 38	82.9 46	110 41	122 33	124 27	131 20
1971 1971	1.80 1	1.83 1	2.27 1	3.60 1	30.2 2	63.6 11	76.9 8	85.4 6	121 8
1972 1972	43.0 32	47.0 32	51.9 36	53.8 27	65.2 25	105 36	125 38	130 34	142 29
1973 1973	7.50 4	7.93 4	8.63 2	32.6 10	34.5 4	48.3 3	76.7 6	95.4 13	134 22
1974 1974	24.0 11	24.7 12	26.0 8	27.9 6	42.3 10	63.2 9	76.7 7	88.0 8	127 15
1975 1975	21.0 9	21.0 8	23.0 6	25.0 4	62.0 24	92.8 23	102 19	120 26	141 28
1976 1976	47.0 41	50.0 37	51.7 35	55.3 30	78.1 38	103 34	119 30	114 22	151 41
1977 1977	25.0 13	25.3 13	27.7 10	31.1 8	36.3 6	42.9 1	65.1 3	97.9 14	138 24
1978 1978	37.0 25	37.7 25	39.9 22	41.1 18	55.3 20	68.8 12	86.0 11	88.4 9	109 7
1979 1979	43.0 33	43.7 30	45.9 27	54.3 29	76.5 36	109 40	133 43	142 43	144 33
1980 1980	9.60 6	10.5 5	47.4 29	67.6 51	75.4 33	92.9 24	118 29	137 40	140 27
1981 1981	24.0 12	24.0 10	24.7 7	26.6 5	31.7 3	44.0 2	56.0 2	75.8 2	85.6 1
1982 1982	63.0 59	65.3 57	80.7 59	86.7 57	136 61	147 60	161 60	169 58	184 58
1983 1983	2.50 2	2.77 2	27.6 9	29.9 7	35.4 5	49.1 4	55.8 1	75.5 1	102 6
1984 1984	29.0 15	30.0 14	30.7 11	31.4 9	39.7 8	59.5 7	69.4 5	79.9 3	122 11
1985 1985	17.0 8	17.0 7	17.4 3	18.0 2	20.9 1	54.6 6	83.3 9	81.9 5	122 9
1986 1986	14.0 7	24.0 11	34.6 17	39.5 16	49.5 14	76.4 16	97.0 16	119 24	150 40
1987 1987	44.0 34	50.0 38	51.1 32	59.4 35	80.0 41	108 39	156 54	173 60	196 61

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)		WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)	
1924 1924	153	13	1924 1924	153	52
1925 1925	179	38	1925 1925	179	27
1926 1926	122	2	1926 1926	122	63
1927 1927	173	33	1927 1927	173	32
1928 1928	186	49	1928 1928	186	16
1929 1929	177	36	1929 1929	177	29
1930 1930	208	61	1930 1930	208	4
1931 1931	177	35	1931 1931	177	30
1932 1932	199	57	1932 1932	199	8
1933 1933	135	5	1933 1933	135	60
1934 1934	154	15	1934 1934	154	50
1935 1935	186	48	1935 1935	186	17
1936 1936	184	44	1936 1936	184	21
1937 1937	232	64	1937 1937	232	1
1938 1938	204	60	1938 1938	204	5
1939 1939	215	63	1939 1939	215	2
1940 1940	167	28	1940 1940	167	37
1941 1941	191	56	1941 1941	191	9
1942 1942	202	59	1942 1942	202	6
1943 1943	167	29	1943 1943	167	36
1944 1944	137	6	1944 1944	137	59
1945 1945	155	17	1945 1945	155	48
1946 1946	153	14	1946 1946	153	51
1947 1947	176	34	1947 1947	176	31
1948 1948	181	41	1948 1948	181	24
1949 1949	163	23	1949 1949	163	42
1950 1950	169	32	1950 1950	169	33
1951 1951	146	8	1951 1951	146	57
1952 1952	187	52	1952 1952	187	13
1953 1953	146	9	1953 1953	146	56
1954 1954	189	54	1954 1954	189	11
1955 1955	187	51	1955 1955	187	14
1956 1956	181	42	1956 1956	181	23
1957 1957	164	24	1957 1957	164	41
1958 1958	190	55	1958 1958	190	10
1959 1959	188	53	1959 1959	188	12
1960 1960	186	47	1960 1960	186	18
1961 1961	151	12	1961 1961	151	53
1962 1962	146	10	1962 1962	146	55
1963 1963	155	18	1963 1963	155	47
1964 1964	184	45	1964 1964	184	20

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1961 1961	291 30	291 29	291 19	282 18	252 44	224 52	189 56	188 50	170 56
1962 1962	291 31	291 30	281 32	276 27	251 46	226 51	199 52	170 61	170 55
1963 1963	291 32	291 31	290 22	288 17	286 9	263 13	250 14	244 10	214 25
1964 1964	291 33	291 32	289 24	282 20	265 26	233 44	223 38	207 39	198 40
1965 1965	291 34	291 33	291 20	270 36	237 58	210 55	192 53	186 52	184 45
1966 1966	302 21	295 23	284 29	281 21	268 20	248 27	235 26	225 26	213 26
1967 1967	326 2	321 1	310 4	297 11	264 27	244 31	218 43	222 29	207 32
1968 1968	319 6	314 6	308 5	305 2	285 11	268 9	227 36	207 40	184 47
1969 1969	317 8	302 13	288 26	280 24	274 17	260 15	255 9	225 27	230 11
1970 1970	322 3	319 4	314 2	300 8	265 25	253 20	246 17	230 21	233 10
1971 1971	318 7	307 9	294 14	276 28	267 21	204 59	188 58	172 59	150 62
1972 1972	313 10	307 8	279 33	265 39	248 48	208 56	184 60	182 54	175 53
1973 1973	322 4	319 3	313 3	306 1	298 4	274 7	245 18	230 22	200 38
1974 1974	298 24	294 24	276 37	256 52	240 56	213 54	190 55	181 55	163 60
1975 1975	298 25	291 34	288 25	274 31	260 32	240 35	241 21	233 18	220 18
1976 1976	311 12	300 19	293 15	292 13	280 13	257 17	239 22	219 31	188 44
1977 1977	302 22	298 20	296 13	293 12	285 10	256 18	244 20	211 36	204 36
1978 1978	313 11	301 18	290 23	280 23	275 15	266 12	256 8	240 13	226 14
1979 1979	306 17	298 21	288 27	264 40	256 41	236 43	221 41	209 38	193 42
1980 1980	300 23	297 22	282 30	271 35	255 42	246 28	235 28	237 16	225 15
1981 1981	322 5	318 5	276 36	239 60	192 64	162 64	129 64	111 64	110 64
1982 1982	328 1	319 2	317 1	304 3	291 7	276 6	265 4	238 15	234 8
1983 1983	314 9	308 7	306 6	290 14	258 35	248 26	232 32	231 19	208 30
1984 1984	311 13	301 17	292 16	279 25	274 16	227 50	189 57	184 53	169 58
1985 1985	311 14	306 10	302 9	300 7	299 2	280 4	279 1	251 6	229 12
1986 1986	307 16	306 11	305 7	299 9	299 3	283 2	260 6	269 2	244 3
1987 1987	308 15	306 12	304 8	298 10	290 8	279 5	264 5	252 5	217 22

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1919 1919									17			59	31		9	20	18	1	13	10	9	15	17	14	8	7	16	11	16	48	8	13	5		
1920 1920	17					76		9	82			78	11		15	16	6	2	15	1		1	2		1	1	6	14			1	11	1		
1921 1921	59	15	11		15	14	1	16	44		14	48	12	4	5	9	3	3	3	7	3	2	2	10	6	3	6	4	11	5	14	9	7		
1938 1938		4	17		86	62	18	12	19	28	23	5	8	2	7	3	2	5	4	2	5	5	2	6	3	6	5	7	3	3	5	6	2		
1939 1939		1	13		93	48	26	13	18	7	5	2	7	7	5	15	6	11	9	4	7	11	12	4	10	4	6	7	9	3	1	1			
1940 1940	37	49	79		68	22	9	3	4	5	2	4	5	3	4	4	1	2	6	7	3	5	2	6	2	3	4	7	9	1	2	5	3		
1941 1941	4	84	38		73	22	6	11	4	7	1	2	3	1	2	1	2	7	4	6	7	7	10	8	8	5	9	7	6	8	7	5			
1942 1942	2	55	62		59	29	6	6	10	6	6	6	3	4	2	1	12	1	7	4	3	8	7	11	6	2	7	10	5	14	9	2			
1943 1943	12	119	63		44	10	2	4	13	2	1	3	6	2	2	2	4		3	1	2	6	6	11	5	3	15	8	8	2	5	1			
1944 1944	60	40	70		91	17	8	7	8	4	1	3	4	2	3	3	1	6	3	3	1	4	4	2	2	2	4	5	1	3	2	2			
1945 1945	57	27	73		71	16	12	3	9	9	3	1	1	2	1	1	1	1	4	2	2	7		5	3	6	6	13	8	13	8				
1946 1946	10	24	128		60	10	2	4	6		1	2	2	2	2	5	12	10	5	5	2	5	5	8	4	5	5	4	5	5	12	10	5		
1947 1947	37	27	66		80	27	7	5	13	6	1		2	3	2	5	3	2	1	8	3	6	6	8	6	8	5	7	7	7	4	2	1		
1948 1948		6	53		90	20	4	7	8	8	4	2	6	9	9	10	3	7	11	9	2	3	6	9	4	5	14	10	10	13	24				
1949 1949	3	19	104		58	12	9	5	7	10	8	8	20	11	2	4	6	12	8	8	4	7	4	4	10	2	9	8	3						
1950 1950	6	36	57		60	28	12	5	16	9	2	4	5	4	5	5	2	4	4	5	4	6	7	10	8	3	10	11	16	17	4				
1951 1951	39	44	38		86	36	14	18	15	6	3	4	3	2	6	3	2	1			5	1	3	3	8	4	10	5	2	2	1	1			
1952 1952	2	4	44		41	40	25	63	14	14	5	8	5		2	3	4	1	4	5	10	3	5	5	11	7	10	15	13	3					
1953 1953	2	36	126		74	18	7	12	7	5	8	3			2	3	2	2		6	1	8	5	6	1	5	9	2	5	6	1	3			
1954 1954	26	4	8		58	32	16	45	20	21	16	16	11	5	3	2	1	2	5	5	5	5	4	6	3	5	5	10	8	8	7	1	2		
1955 1955			19		55	39	44	70	23	28	23	9	6	4	5	3	6	1	1	3		2	7		4	1	3	2		3	1	3			
1956 1956		12	26		34	29	24	73	15	21	30	14	4	4	3	2	1	4	4	3	11	4	4	3	6	4	10	7	3	7	3	1			
1957 1957			27		89	55	27	35	25	15	15	19	6	4	2	3		4	2	3		2	4	3	3	3	3	3	5	6	2				
1958 1958		6	51		65	58	37	45	10	21	9	6	1	1	3				1		3	2	2	3	4	5	4	6	6	15	1				
1959 1959		3	23		63	59	27	36	11	17	4	4	1	2	1	2	1	3	9	6	2	4	9	6	9	4	11	8	7	8	25				
1960 1960		21	31		167	19	22	17	7	8	9	4	4	2	6	1	4	3	1	1	3	3	7	1	1	5	7	4	2	3	1	2			
1961 1961		16	62		172	29	11	15	7	10	1	4	9	4	1	1	1	2	4	2	4	1	2	1	1		1	2	2						
1962 1962		26	68		107	30	22	24	20	7	4	3	2	3	4	4	2	1	1	3	1	3	3	6	3	1	4	5	2	3	3				
1963 1963	40	35	40		161	22	13	11	9	9		2	2	2			1	1			1	2	1	3	2	1	4	3							
1964 1964	42	22	15		189	37	14	10	5	10	1		4							1	3	1	1	1	1	4	2	2		1					

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DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16588000
Wailoa Ditch at Honopou near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1965 1965	166	27
1966 1966	181	40
1967 1967	187	50
1968 1968	159	20
1969 1969	178	37
1970 1970	181	39
1971 1971	133	4
1972 1972	150	11
1973 1973	154	16
1974 1974	131	3
1975 1975	165	26
1976 1976	161	22
1977 1977	156	19
1978 1978	168	30
1979 1979	169	31
1980 1980	182	43
1981 1981	101	1
1982 1982	211	62
1983 1983	164	25
1984 1984	145	7
1985 1985	159	21
1986 1986	185	46
1987 1987	200	58

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1965 1965	166	38
1966 1966	181	25
1967 1967	187	15
1968 1968	159	45
1969 1969	178	28
1970 1970	181	26
1971 1971	133	61
1972 1972	150	54
1973 1973	154	49
1974 1974	131	62
1975 1975	165	39
1976 1976	161	43
1977 1977	156	46
1978 1978	168	35
1979 1979	169	34
1980 1980	182	22
1981 1981	101	64
1982 1982	211	3
1983 1983	164	40
1984 1984	145	58
1985 1985	159	44
1986 1986	185	19
1987 1987	200	7

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DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16590000 OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.02	(LOG = -1.67236)
90.0	0.03	(LOG = -1.54184)
85.0	0.03	(LOG = -1.47869)
80.0	0.04	(LOG = -1.43070)
75.0	0.05	(LOG = -1.29081)
70.0	0.06	(LOG = -1.25230)
65.0	0.06	(LOG = -1.21694)
60.0	0.07	(LOG = -1.18423)
55.0	0.07	(LOG = -1.15219)
50.0	0.08	(LOG = -1.08406)
45.0	0.10	(LOG = -1.00258)
40.0	0.13	(LOG = -0.89763)
35.0	0.16	(LOG = -0.78355)
30.0	0.25	(LOG = -0.59743)
25.0	0.42	(LOG = -0.37200)
20.0	1.37	(LOG = 0.13797)
15.0	4.05	(LOG = 0.60708)
10.0	10.1	(LOG = 1.00584)
5.0	20.5	(LOG = 1.31182)

MEAN OF LOGS = -0.73129

STANDARD DEVIATION OF LOGS = 0.87899 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = -1.20197

COEFFICIENT OF SKEW = 1.28738

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	455	10958	100.00
2	0.02	735	10503	95.85
3	0.03	1412	9768	89.14
4	0.04	0	8356	76.25
5	0.05	2309	8356	76.25
6	0.07	916	6047	55.18
7	0.09	425	5131	46.82
8	0.11	584	4706	42.95
9	0.14	466	4122	37.62
10	0.18	293	3656	33.36
11	0.23	200	3363	30.69
12	0.29	323	3163	28.86
13	0.37	184	2840	25.92
14	0.47	89	2656	24.24
15	0.61	113	2567	23.43
16	0.77	131	2454	22.39
17	0.99	107	2323	21.20
18	1.30	99	2216	20.22
19	1.60	132	2117	19.32
20	2.00	120	1985	18.11
21	2.60	106	1865	17.02
22	3.30	139	1759	16.05
23	4.20	149	1620	14.78
24	5.40	163	1471	13.42
25	6.90	143	1308	11.94
26	8.80	114	1165	10.63
27	11.00	210	1051	9.59
28	14.00	207	841	7.67
29	18.00	172	634	5.79
30	23.00	207	462	4.22
31	30.00	151	255	2.33
32	38.00	78	104	0.95
33	49.00	26	26	0.24
34	62.00	0	0	0.00
35	0.00	0	0	0.00

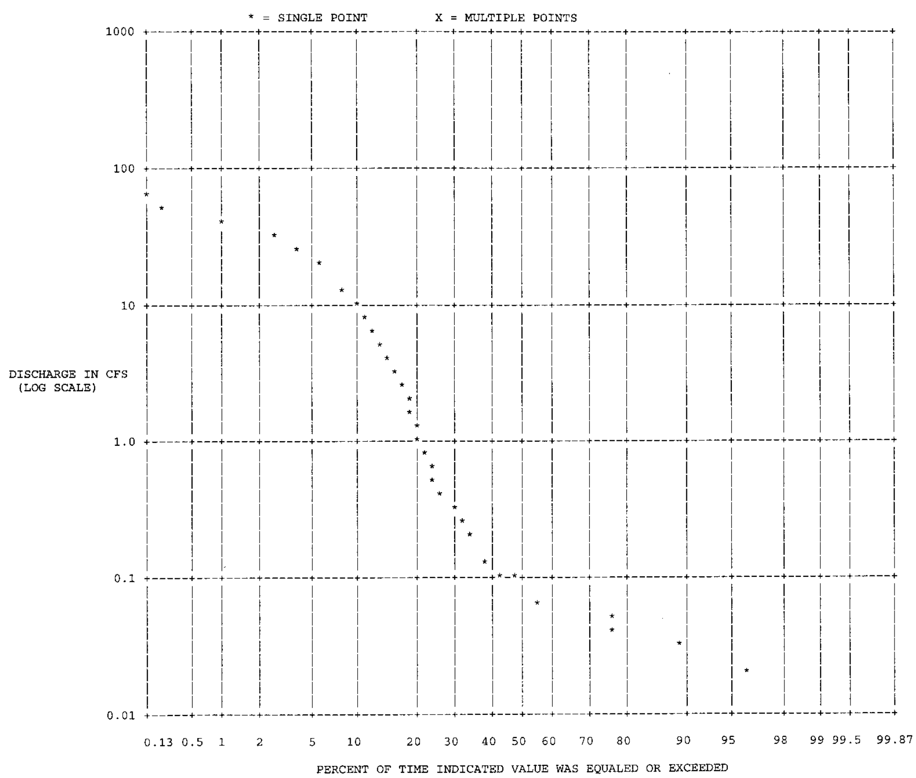
DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1919 1919	.15 30	.15 30	.20 30	.20 30	.25 29	1.02 30	2.49 30	3.15 30	5.21 30
1920 1920	.0000 1	.0000 1	.0000 1	.0000 1	.040 20	.079 15	.17 11	.21 6	1.46 17
1921 1921	.0000 2	.0000 2	.0000 2	.0000 2	.0000 1	.047 10	.36 16	.46 10	.70 7
1938 1938	.020 19	.023 26	.027 24	.031 26	.073 27	.30 25	.69 23	1.07 21	2.59 23
1939 1939	.020 20	.030 27	.037 29	.063 29	.27 30	.88 29	1.31 29	1.35 27	1.50 18
1940 1940	.0000 3	.0000 3	.0000 3	.003 10	.019 7	.079 16	.22 12	.69 15	.90 8
1941 1941	.0000 4	.0000 4	.017 16	.020 14	.024 13	.17 22	.71 24	.83 18	2.30 22
1942 1942	.0000 5	.007 16	.014 15	.020 15	.022 9	.24 24	.79 25	.99 20	3.02 27
1943 1943	.0000 6	.0000 5	.0000 4	.009 11	.041 21	.67 27	1.27 28	1.11 22	2.19 20
1944 1944	.0000 7	.0000 6	.0000 5	.0000 3	.001 3	.031 5	.37 17	.92 19	.91 10
1945 1945	.0000 8	.0000 7	.0000 6	.0000 4	.001 4	.021 3	.16 10	1.24 26	2.59 24
1946 1946	.0000 9	.0000 8	.0000 7	.018 13	.022 10	.035 6	1.13 27	1.50 28	4.30 28
1947 1947	.0000 10	.0000 9	.0000 8	.0000 5	.031 15	.039 7	.65 22	1.16 24	2.59 25
1948 1948	.020 21	.020 19	.023 21	.028 23	.042 22	.72 28	1.12 26	1.71 29	4.76 29
1949 1949	.0000 11	.0000 10	.011 14	.016 12	.021 8	.20 23	.41 18	.54 13	.92 11
1950 1950	.0000 12	.0000 11	.009 13	.021 18	.030 14	.34 26	.60 21	1.21 25	2.17 19
1951 1951	.0000 13	.0000 12	.0000 9	.0000 6	.017 6	.024 4	.30 13	.48 11	1.00 13
1952 1952	.0000 14	.007 17	.023 22	.026 21	.083 28	.087 19	.089 5	1.13 23	2.25 21
1953 1953	.0000 15	.013 18	.019 17	.020 16	.022 11	.041 8	.44 19	.66 14	1.14 15
1954 1954	.0000 16	.0000 13	.0000 10	.001 9	.049 25	.16 21	.50 20	.74 17	1.34 16
1955 1955	.030 28	.030 28	.030 27	.037 28	.060 26	.10 20	.36 15	.38 8	.90 9
1956 1956	.020 22	.020 20	.021 20	.022 20	.039 19	.080 18	.092 6	.14 5	.64 6
1957 1957	.030 29	.030 29	.030 28	.030 24	.044 23	.070 14	.11 7	.14 4	.96 12
1958 1958	.020 23	.020 21	.027 25	.030 25	.037 17	.041 9	.045 2	.058 3	.066 2
1959 1959	.020 24	.020 22	.029 26	.035 27	.045 24	.064 12	.077 4	.48 12	2.84 26
1960 1960	.020 25	.020 23	.020 18	.021 19	.037 18	.059 11	.34 14	.73 16	1.01 14
1961 1961	.020 26	.020 24	.023 23	.026 22	.032 16	.069 13	.11 8	.31 7	.35 4
1962 1962	.020 27	.020 25	.020 19	.020 17	.023 12	.079 17	.13 9	.44 9	.46 5
1963 1963	.0000 17	.0000 14	.0000 11	.0000 7	.0000 2	.014 1	.050 3	.051 2	.19 3
1964 1964	.0000 18	.0000 15	.0000 12	.0000 8	.003 5	.014 2	.027 1	.026 1	.054 1

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1918 - 1965)
STATION ID: 16590000 OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)		WATER YEAR RANGE	MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)	
1919 1919	9.40	30	1919 1919	9.40	1
1920 1920	2.72	18	1920 1920	2.72	13
1921 1921	5.34	29	1921 1921	5.34	2
1938 1938	2.93	20	1938 1938	2.93	11
1939 1939	2.36	14	1939 1939	2.36	17
1940 1940	2.61	16	1940 1940	2.61	15
1941 1941	3.48	23	1941 1941	3.48	8
1942 1942	3.69	24	1942 1942	3.69	7
1943 1943	2.50	15	1943 1943	2.50	16
1944 1944	1.35	6	1944 1944	1.35	25
1945 1945	3.27	22	1945 1945	3.27	9
1946 1946	4.58	26	1946 1946	4.58	5
1947 1947	2.80	19	1947 1947	2.80	12
1948 1948	5.15	28	1948 1948	5.15	3
1949 1949	1.54	9	1949 1949	1.54	22
1950 1950	3.97	25	1950 1950	3.97	6
1951 1951	1.49	8	1951 1951	1.49	23
1952 1952	2.68	17	1952 1952	2.68	14
1953 1953	1.99	11	1953 1953	1.99	20
1954 1954	3.24	21	1954 1954	3.24	10
1955 1955	1.25	4	1955 1955	1.25	27
1956 1956	2.30	12	1956 1956	2.30	19
1957 1957	1.55	10	1957 1957	1.55	21
1958 1958	2.31	13	1958 1958	2.31	18
1959 1959	4.63	27	1959 1959	4.63	4
1960 1960	1.46	7	1960 1960	1.46	24
1961 1961	.46	1	1961 1961	.46	30
1962 1962	1.33	5	1962 1962	1.33	26
1963 1963	.49	3	1963 1963	.49	28
1964 1964	.49	2	1964 1964	.49	29

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1919 1919	53.0 7	51.3 2	48.3 1	37.2 2	26.8 3	20.0 2	15.6 2	16.6 1	14.2 1
1920 1920	54.0 5	46.0 3	46.0 2	31.4 4	16.4 8	8.68 9	6.38 11	5.58 12	4.01 14
1921 1921	60.0 2	57.3 1	43.9 3	38.4 1	27.9 2	23.2 1	17.5 1	14.1 2	9.26 2
1938 1938	61.0 1	45.7 4	29.8 8	14.6 16	12.2 12	7.80 11	7.55 8	5.99 10	5.14 9
1939 1939	45.0 10	26.3 23	23.1 15	14.2 17	9.61 16	6.10 18	5.19 15	4.16 17	3.34 18
1940 1940	54.0 6	41.7 7	32.9 5	24.7 8	14.0 9	7.41 13	5.09 17	3.83 19	2.98 19
1941 1941	44.0 11	39.3 8	24.1 13	14.1 18	10.8 14	6.69 15	5.89 13	6.24 9	5.69 8
1942 1942	41.0 13	37.3 9	26.4 12	18.4 11	13.6 10	9.99 8	8.77 7	6.70 8	4.79 11
1943 1943	39.0 17	27.7 21	18.4 17	11.9 20	8.77 17	6.48 16	4.84 20	4.25 16	3.92 16
1944 1944	41.0 14	25.0 24	12.9 26	6.41 27	4.01 27	3.57 26	2.82 23	2.69 22	1.98 27
1945 1945	36.0 20	29.3 18	23.9 14	19.4 9	13.6 11	7.64 12	5.11 16	4.10 18	4.82 10
1946 1946	56.0 3	43.7 6	42.6 4	33.4 3	25.6 4	19.7 3	13.9 5	11.1 5	8.14 5
1947 1947	49.0 8	29.6 17	16.2 21	10.1 22	7.20 20	6.23 17	5.90 12	4.50 15	4.01 15
1948 1948	34.0 23	32.7 11	31.9 7	30.5 5	28.2 1	19.3 4	14.7 4	11.6 4	8.53 3
1949 1949	21.0 29	15.7 27	13.5 25	7.30 26	5.06 25	4.20 21	3.09 21	2.46 25	2.50 21
1950 1950	32.0 24	30.7 13	28.3 10	25.2 7	17.9 6	14.7 6	11.5 6	9.03 6	7.04 6
1951 1951	41.0 15	32.3 12	17.0 20	9.93 23	5.17 24	3.44 27	2.49 27	2.53 24	2.04 26
1952 1952	27.0 27	22.3 26	22.0 16	15.3 14	8.54 18	5.59 20	4.93 18	5.12 13	4.18 13
1953 1953	43.0 12	28.3 20	17.1 19	15.7 13	10.3 15	6.84 14	4.86 19	3.66 20	2.82 20
1954 1954	55.0 4	45.0 5	32.1 6	16.4 12	11.7 13	8.33 10	6.89 10	7.20 7	5.75 7
1955 1955	47.0 9	22.7 25	12.5 27	8.87 25	4.77 26	3.83 23	2.96 22	2.85 21	2.17 24
1956 1956	39.0 18	27.7 22	17.9 18	15.1 15	8.23 19	5.68 19	5.41 14	4.91 14	4.35 12
1957 1957	35.0 21	30.7 14	15.0 23	10.3 21	6.19 22	4.15 22	2.79 24	2.17 27	2.30 22
1958 1958	31.0 25	29.7 16	26.7 11	19.3 10	16.8 7	10.8 7	7.46 9	5.61 11	3.69 17
1959 1959	35.0 22	33.7 10	29.6 9	25.5 6	20.1 5	18.3 5	15.6 3	11.7 3	8.29 4
1960 1960	40.0 16	30.3 15	16.1 22	9.13 24	6.03 23	3.81 24	2.56 26	2.40 26	2.07 25
1961 1961	22.0 28	13.1 29	6.46 29	3.23 30	1.71 30	.99 30	.69 30	.72 30	.63 29
1962 1962	37.0 19	29.3 19	14.3 24	12.1 19	6.32 21	3.72 25	2.68 25	2.68 23	2.20 23
1963 1963	17.0 30	11.4 30	7.49 28	3.52 29	2.13 29	1.38 29	.96 29	.73 29	.50 30
1964 1964	28.0 26	13.7 28	5.97 30	4.76 28	3.29 28	2.37 28	1.73 28	1.37 28	.92 28

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16591000
HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

WATER YEAR RANGE \ CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1933 1933				9	3	64	151	29	38	2	8	13	17	8	6	4	4	2		1				2		1	2			1					
1934 1934				67	46	81	61	15	52	7	7	1	2	2	1	3		1	1	4	3	2	2		1	2	1	1	1			1			
1935 1935					9	66	137	22	54	34	12	5	4	3	2	2	2	1		1	2	2		2		1		2	1	1					
1936 1936				3	14	146	88	22	49	6	7	4	1	3	5	2	2	1	3	1	1	3	2	1		1	1								
1937 1937						57	86	44	65	12	16	5	10	1	10	8	5	3	6	3	4	3	6	2	6	3	2	2	3	2			1		
1938 1938						9	88	56	88	21	22	8	9	4	3	5	6	7	6	5	2	3	5	2	3	3	5	3			1				1
1939 1939						31	88	83	84	4	8	1	6	1	5	6	5	2	1	2	2	1	4	5	3	6	9	5	2		1				
1940 1940					24	81	128	38	45	8	5	3	4	2	3	1	6	3	1	1	1	2	3	4				1	2						
1941 1941		1			51	57	101	46	46	8	7	6	3	5	4	2	3	2	2	5	3	2	1	2	2	5					1				
1942 1942						9	53	30	110	32	42	10	8	3	9	7	8	5	3	1	3		3	5	5	4	4	4	1	3	1	1	1		
1943 1943					5	61	103	46	69	4	6	7	8	8	9	5	6	4	3	3	3	3	3	2	2	1	2	1	1						
1944 1944				32	129	141	47	5	2		1		1	1	1	2	1	1	1			1													
1945 1945					60	139	93	30	15	4	4	1	4		1	1	1	3	4	2			2	1											
1946 1946					55	36	133	76	21	3	3		2	1		1	2	4		6	1	1	2	6	2	5	3	1	1						

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	0	5113	100.00	13	0.89	79	633	12.38	25	21.00	24	133	2.60
2	0.05	1	5113	100.00	14	1.20	42	554	10.84	26	27.00	32	109	2.13
3	0.06	0	5112	99.98	15	1.50	59	512	10.01	27	35.00	29	77	1.51
4	0.08	111	5112	99.98	16	2.00	49	453	8.86	28	45.00	20	48	0.94
5	0.11	396	5001	97.81	17	2.50	51	404	7.90	29	59.00	12	28	0.55
6	0.14	978	4605	90.06	18	3.30	39	353	6.90	30	76.00	7	16	0.31
7	0.19	1357	3627	70.94	19	4.30	31	314	6.14	31	99.00	4	9	0.18
8	0.24	542	2270	44.40	20	5.60	35	283	5.53	32	129.00	2	5	0.10
9	0.31	738	1728	33.80	21	7.20	25	248	4.85	33	168.00	2	3	0.06
10	0.41	145	990	19.36	22	9.40	23	223	4.36	34	218.00	0	1	0.02
11	0.53	148	845	16.53	23	12.00	33	200	3.91	35	283.00	1	1	0.02
12	0.69	64	697	13.63	24	16.00	34	167	3.27					

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16590000
OLD HAMAKUA DITCH AT HONOPOU NR HUELO, MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

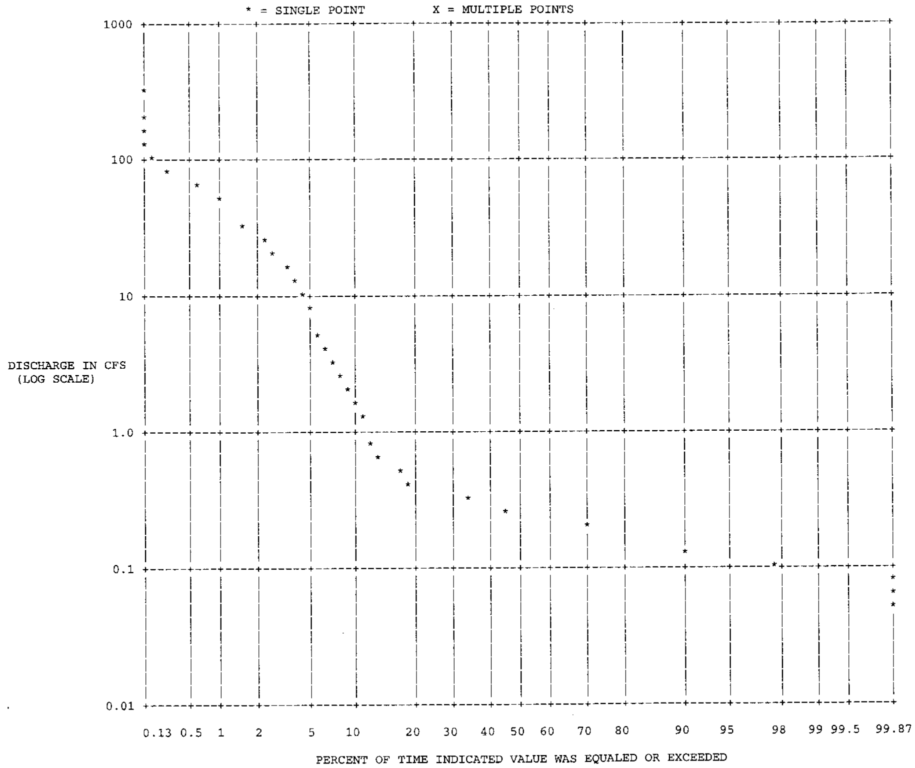
MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN LOW-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR
RANGE

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN HIGH-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR
RANGE

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1932 - 1947)
STATION ID: 16591000 HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16591000 HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.12	(LOG = -0.91764)
90.0	0.14	(LOG = -0.85335)
85.0	0.15	(LOG = -0.81463)
80.0	0.17	(LOG = -0.77908)
75.0	0.18	(LOG = -0.74623)
70.0	0.19	(LOG = -0.71723)
65.0	0.20	(LOG = -0.69641)
60.0	0.21	(LOG = -0.67653)
55.0	0.22	(LOG = -0.65753)
50.0	0.23	(LOG = -0.63932)
45.0	0.24	(LOG = -0.62185)
40.0	0.27	(LOG = -0.57019)
35.0	0.30	(LOG = -0.51992)
30.0	0.34	(LOG = -0.47327)
25.0	0.37	(LOG = -0.43069)
20.0	0.41	(LOG = -0.39192)
15.0	0.61	(LOG = -0.21156)
10.0	1.51	(LOG = 0.17781)
5.0	6.85	(LOG = 0.83571)

MEAN OF LOGS = -0.51073

STANDARD DEVIATION OF LOGS = 0.41230 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = -0.80728

COEFFICIENT OF SKEW = 2.30487

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16591000
HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1933 1933	91.0 7	37.0 10	17.6 10	8.69 10	5.20 10	3.12 11	3.46 8	2.83 9	1.93 10
1934 1934	153 4	62.9 5	29.3 7	22.1 6	14.3 6	7.71 6	5.40 6	4.19 6	2.84 6
1935 1935	79.0 8	65.7 4	31.1 6	14.8 7	9.09 7	5.43 7	3.72 7	3.01 7	2.31 8
1936 1936	43.0 12	15.2 12	7.24 12	3.77 12	3.51 12	2.48 12	1.88 12	1.53 12	1.24 12
1937 1937	169 3	106 3	59.6 3	31.0 5	17.9 5	11.6 4	10.9 3	8.71 3	6.29 3
1938 1938	283 1	110 2	74.7 2	39.3 2	20.2 3	13.4 3	9.66 4	7.73 4	6.21 4
1939 1939	119 5	55.3 6	53.1 4	37.8 3	22.4 2	20.8 1	14.2 1	10.9 1	7.37 2
1940 1940	71.0 9	40.3 7	22.3 8	13.6 8	8.82 8	4.52 8	3.06 10	2.46 11	1.75 11
1941 1941	110 6	39.7 9	21.8 9	11.1 9	5.64 9	3.25 10	2.75 11	2.68 10	2.20 9
1942 1942	178 2	114 1	76.1 1	56.5 1	31.1 1	17.2 2	12.3 2	9.30 2	8.56 1
1943 1943	59.0 11	23.3 11	14.5 11	8.61 11	4.92 11	3.61 9	3.24 9	2.98 8	2.42 7
1944 1944	11.0 14	4.22 14	1.94 14	1.36 14	.79 14	.55 14	.42 14	.36 14	.31 14
1945 1945	16.0 13	5.72 13	4.81 13	2.72 13	1.45 13	1.00 13	.78 13	.72 13	.68 13
1946 1946	68.0 10	40.3 8	37.7 5	32.5 4	18.9 4	9.62 5	6.92 5	5.33 5	3.63 5

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16591000
HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1933 1933	.090 4	.090 3	.096 3	.10 3	.12 4	.16 8	.19 5	.19 2	.31 3
1934 1934	.080 2	.080 1	.083 2	.086 1	.089 1	.12 2	.22 7	.19 3	.33 4
1935 1935	.11 6	.11 6	.11 7	.13 9	.16 10	.20 9	.21 6	.26 5	.50 7
1936 1936	.090 5	.10 5	.10 4	.11 4	.14 8	.16 7	.16 3	.28 6	.50 8
1937 1937	.15 11	.16 14	.17 13	.17 12	.18 12	.20 10	.91 13	.84 12	1.31 13
1938 1938	.15 12	.15 11	.17 14	.18 13	.22 14	.27 14	.99 14	1.08 14	1.89 14
1939 1939	.15 13	.15 12	.15 11	.15 11	.17 11	.22 12	.32 9	.40 9	.70 9
1940 1940	.11 7	.12 9	.12 9	.12 8	.13 7	.14 5	.16 4	.35 7	.43 6
1941 1941	.050 1	.093 4	.11 6	.12 6	.12 3	.14 6	.57 11	.87 13	1.29 12
1942 1942	.15 14	.15 13	.16 12	.18 14	.20 13	.22 13	.42 10	.45 10	1.15 11
1943 1943	.12 10	.13 10	.14 10	.15 10	.16 9	.21 11	.67 12	.77 11	1.06 10
1944 1944	.080 3	.080 2	.080 1	.086 2	.10 2	.11 1	.14 1	.14 1	.17 1
1945 1945	.11 8	.11 7	.11 5	.11 5	.13 6	.13 4	.14 2	.19 4	.26 2
1946 1946	.11 9	.11 8	.12 8	.12 7	.12 5	.13 3	.24 8	.39 8	.42 5

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16593000
HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1933 1933			2	17	66	37	94	29	15	31	13	9	26	5	5	4	3	3			1			2			2	1							
1934 1934		48	48	29	44	18	33	19	26	30	11	12	13	4	6	2	2		2	2	6		1	2	1	1	1	1	2				1		
1935 1935					25	10	53	83	47	50	23	20	19	8	5	3	2	3	1	2		3	1	1	1	1		1	1	1	1				
1936 1936			6	22	66	16	47	31	34	47	28	12	21	3	4	9	3	7		1	1	1	3		2		2								
1937 1937							13	32	52	49	29	25	31	25	18	11	17	15	3	7	2	4	4	5	3	7	2	4	2	3	1		1		
1938 1938							2	54	60	74	34	24	18	10	16	12	9	4	6	7	5	6	2	5	2	4	5	1	3		1				1
1939 1939							22	55	64	76	18	17	15	16	8	6	8	7	7	5	4	2		3	5	4	7	5	8	3					
1940 1940						9	90	81	52	46	18	8	13	7	6	4	5	5	2	3	4		5	3	2			2	1						
1941 1941						42	32	58	69	66	20	15	17	3	6	5	5	2	3	4	3	3	5	1	2	2	1				1				
1942 1942							18	21	106	67	24	22	20	8	9	13	5	8	6		4	2	1	2	5	4	6	2	6	1	2	1	1		1
1943 1943							6	92	114	39	23	12	16	11	7	7	8	5	3	2	4	2	2	5	3	2		1	1						
1944 1944					52	46	69	64	64	22	15	14	4	3	1	5		5			1	1													
1945 1945			1	3	17	22	74	67	50	21	26	14	18	11	9	8	6	4	4	5	1	2		1		1									
1946 1946				3	6	29	67	63	59	25	20	21	26	6		2	3	4	5	3	2	1		4	4	2	5	2	2	1					

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	0	5113	100.00	13	1.40	257	1078	21.08	25	18.00	30	156	3.05
2	0.14	48	5113	100.00	14	1.80	120	821	16.06	26	22.00	28	126	2.46
3	0.17	57	5065	99.06	15	2.20	100	701	13.71	27	28.00	31	98	1.92
4	0.21	74	5008	97.95	16	2.70	91	601	11.75	28	34.00	20	67	1.31
5	0.26	276	4934	96.50	17	3.30	76	510	9.97	29	42.00	26	47	0.92
6	0.33	229	4658	91.10	18	4.10	72	434	8.49	30	52.00	9	21	0.41
7	0.40	620	4429	86.62	19	5.10	42	362	7.08	31	64.00	6	12	0.23
8	0.50	749	3809	74.50	20	6.30	41	320	6.26	32	80.00	1	6	0.12
9	0.61	812	3060	59.85	21	7.80	38	279	5.46	33	98.00	3	5	0.10
10	0.76	643	2248	43.97	22	9.60	27	241	4.71	34	121.00	0	2	0.04
11	0.94	302	1605	31.39	23	12.00	24	214	4.19	35	150.00	2	2	0.04
12	1.20	225	1303	25.48	24	15.00	34	190	3.72					

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16591000
HONOPOU STR AT LOWRIE DITCH SIPHON NR HUELO,MAUI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

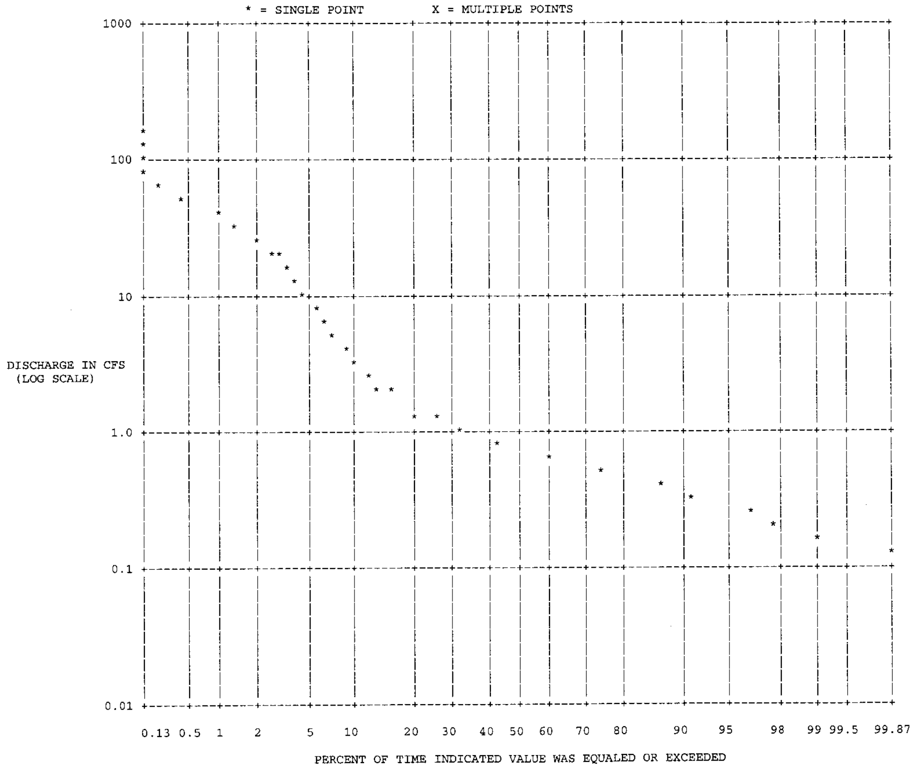
MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN LOW-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE		
1933 1933	1.06	4
1934 1934	1.58	8
1935 1935	1.27	6
1936 1936	.77	3
1937 1937	3.64	12
1938 1938	3.51	11
1939 1939	3.92	13
1940 1940	1.23	5
1941 1941	1.54	7
1942 1942	4.81	14
1943 1943	1.60	9
1944 1944	.22	1
1945 1945	.44	2
1946 1946	1.97	10

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN HIGH-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE		
1933 1933	1.06	11
1934 1934	1.58	7
1935 1935	1.27	9
1936 1936	.77	12
1937 1937	3.64	3
1938 1938	3.51	4
1939 1939	3.92	2
1940 1940	1.23	10
1941 1941	1.54	8
1942 1942	4.81	1
1943 1943	1.60	6
1944 1944	.22	14
1945 1945	.44	13
1946 1946	1.97	5

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1932 - 1947)
STATION ID: 16593000 HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16593000 HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.28	(LOG = -0.55371)
90.0	0.35	(LOG = -0.45941)
85.0	0.41	(LOG = -0.38365)
80.0	0.45	(LOG = -0.34236)
75.0	0.50	(LOG = -0.30465)
70.0	0.53	(LOG = -0.27265)
65.0	0.57	(LOG = -0.24313)
60.0	0.61	(LOG = -0.21549)
55.0	0.66	(LOG = -0.18324)
50.0	0.70	(LOG = -0.15304)
45.0	0.75	(LOG = -0.12480)
40.0	0.82	(LOG = -0.08790)
35.0	0.89	(LOG = -0.05142)
30.0	1.00	(LOG = 0.00053)
25.0	1.22	(LOG = 0.08707)
20.0	1.49	(LOG = 0.17208)
15.0	1.98	(LOG = 0.29670)
10.0	3.29	(LOG = 0.51738)
5.0	8.91	(LOG = 0.94969)

MEAN OF LOGS = -0.07116

STANDARD DEVIATION OF LOGS = 0.36027 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = -5.06299

COEFFICIENT OF SKEW = 1.43904

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16593000
HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1933 1933	39.0 11	33.3 8	16.7 9	8.48 11	5.39 10	3.40 11	2.85 11	2.46 11	1.78 12
1934 1934	107 4	49.0 6	27.7 7	19.3 6	13.3 6	7.55 6	5.54 6	4.40 6	3.05 6
1935 1935	71.0 5	58.7 4	29.6 6	14.6 7	9.19 7	5.70 7	4.02 7	3.48 7	2.85 7
1936 1936	31.0 12	16.7 12	9.03 12	5.53 12	4.80 12	3.60 10	2.81 12	2.24 12	1.86 11
1937 1937	111 3	80.3 2	50.0 3	27.5 4	16.9 4	11.8 3	11.1 3	9.05 2	6.83 3
1938 1938	150 2	66.0 3	50.9 2	27.5 5	14.9 5	11.0 4	8.46 4	6.82 4	6.05 4
1939 1939	63.0 7	50.0 5	48.4 4	35.9 2	21.3 2	20.0 1	13.9 1	11.3 1	7.93 2
1940 1940	48.0 9	33.3 9	19.9 8	12.2 8	8.13 8	4.45 8	3.11 9	2.52 10	2.03 10
1941 1941	71.0 6	27.8 10	16.3 10	9.26 9	5.02 11	3.34 12	3.08 10	2.70 9	2.45 9
1942 1942	181 1	96.3 1	67.3 1	44.7 1	26.0 1	15.1 2	11.3 2	8.68 3	8.34 1
1943 1943	45.0 10	20.7 11	12.3 11	8.56 10	5.67 9	4.20 9	3.58 8	3.44 8	2.76 8
1944 1944	11.0 14	5.10 14	2.89 14	2.47 14	1.71 14	1.34 14	1.13 14	1.09 14	.94 14
1945 1945	24.0 13	9.27 13	5.77 13	4.48 13	2.85 13	2.17 13	1.81 13	1.58 13	1.68 13
1946 1946	53.0 8	40.7 7	37.6 5	31.3 3	18.8 3	9.82 5	7.41 5	5.90 5	4.22 5

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16593000
HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1933 1933	.20 2	.21 3	.23 3	.23 3	.24 2	.30 2	.34 2	.34 2	.47 2
1934 1934	.14 1	.15 1	.15 1	.15 1	.16 1	.20 1	.34 1	.33 1	.39 1
1935 1935	.26 6	.26 6	.27 5	.28 5	.47 9	.48 7	.50 5	.62 5	.87 6
1936 1936	.20 3	.20 2	.20 2	.22 2	.25 3	.37 4	.37 3	.58 4	.68 4
1937 1937	.40 10	.43 11	.45 11	.47 11	.75 14	1.03 14	1.87 14	1.77 14	2.37 13
1938 1938	.45 13	.47 14	.50 14	.53 14	.63 13	.70 13	1.29 13	1.53 13	2.80 14
1939 1939	.40 11	.40 10	.42 10	.44 10	.57 12	.65 11	.85 9	1.21 11	1.72 11
1940 1940	.36 9	.36 9	.37 9	.38 9	.41 8	.44 6	.51 7	.77 7	.86 5
1941 1941	.34 8	.34 8	.36 8	.36 8	.37 5	.41 5	1.10 11	1.03 10	1.46 9
1942 1942	.43 12	.44 12	.46 12	.48 12	.50 10	.60 10	.85 10	.86 9	1.73 12
1943 1943	.46 14	.46 13	.48 13	.52 13	.56 11	.67 12	1.22 12	1.22 12	1.52 10
1944 1944	.26 7	.26 7	.26 4	.27 4	.28 4	.36 3	.46 4	.44 3	.58 3
1945 1945	.20 4	.24 4	.28 7	.32 6	.38 6	.48 8	.51 6	.69 6	.89 7
1946 1946	.23 5	.24 5	.27 6	.33 7	.39 7	.50 9	.76 8	.83 8	.97 8

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16595000
HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1933 1933						1			3	2	3	50	89	139	45	3	2	1
1934 1934										2	17	75	81	102	15	5	4	5
1935 1935							2	2	9	1	2	25	90	128	29	7	2	7
1936 1936									1	2	1	9	96	53	82	25	13	9
1937 1937										4	8	12	21	74	68	30	17	16
1938 1938					1	3	2	5	7	5	7	17	54	58	66	25	6	5
1939 1939					10	5	5	1	1		2	7	22	116	58	17	5	5
1940 1940						4	4	1	2		2	13	38	174	49	13	11	1
1941 1941					1	1			1		6	12	49	104	78	13	4	4
1942 1942									4	2	6	12	21	122	64	24	11	3
1943 1943				2	2		3		1	14	13	25	29	66	67	60	6	5
1944 1944				1		2	3	6	21	10	136	121	17	2	7	7	1	3
1945 1945		3		8	6	1	2	1	4	10	131	92	38	6	3	1	2	2
1946 1946								1			1	41	89	74	62	15	5	7

CLASS / WATER YEAR RANGE	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1933 1933	6	1	6	4	2		3		1		2	2					
1934 1934	6	4	4	6	6	5	7	3	7	5	4	1			1		
1935 1935	7	2	3	5	6	6	8	7	5	7	2	2	1				
1936 1936	11	3	4	7	15	8	6	12	6	2	1						
1937 1937	9	7	11	9	7	7	11	12	25	8	3	1	1	4			
1938 1938	7	4	8	7	9	11	8	11	15	10	9	3		1		1	
1939 1939	9	7	6	7	8	4	4	18	17	6	6	2	4	5	5	2	1
1940 1940	7	3	2	4	5	4	7	9	7	2	3	1					
1941 1941	11	12	7	7	10	12	8	8	7	5	3	1	1				
1942 1942	3	7	10	8	8	10	12	8	9	9	4	3	2	2	1		
1943 1943	5	6	7	5	5	7	13	5	8	9	1	1					
1944 1944			4	3	6	6	5	1	4								
1945 1945	3	6	3	5	6	7	12	8	4	1							
1946 1946	1	2	8	1	4	12	12	10	10	9	1						

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	0	5113	100.00	13	0.72	734	4072	79.64	25	23.00	116	514	10.05
2	0.03	3	5113	100.00	14	0.96	1218	3338	65.28	26	31.00	112	398	7.78
3	0.04	0	5110	99.94	15	1.30	693	2120	41.46	27	41.00	125	286	5.59
4	0.05	11	5110	99.94	16	1.70	245	1427	27.91	28	55.00	73	161	3.15
5	0.07	20	5099	99.73	17	2.30	89	1182	23.12	29	74.00	39	88	1.72
6	0.10	17	5079	99.34	18	3.10	73	1093	21.38	30	98.00	17	49	0.96
7	0.13	21	5062	99.00	19	4.10	85	1020	19.95	31	131.00	9	32	0.63
8	0.17	17	5041	98.59	20	5.50	64	935	18.29	32	176.00	12	23	0.45
9	0.23	54	5024	98.26	21	7.30	83	871	17.04	33	234.00	7	11	0.22
10	0.30	52	4970	97.20	22	9.70	78	788	15.41	34	313.00	3	4	0.08
11	0.40	335	4918	96.19	23	13.00	97	710	13.89	35	418.00	1	1	0.02
12	0.54	511	4583	89.63	24	17.00	99	613	11.99					

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16593000
HONOPOU STR AB HAIKU DITCH NR HUELO, MAUI, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

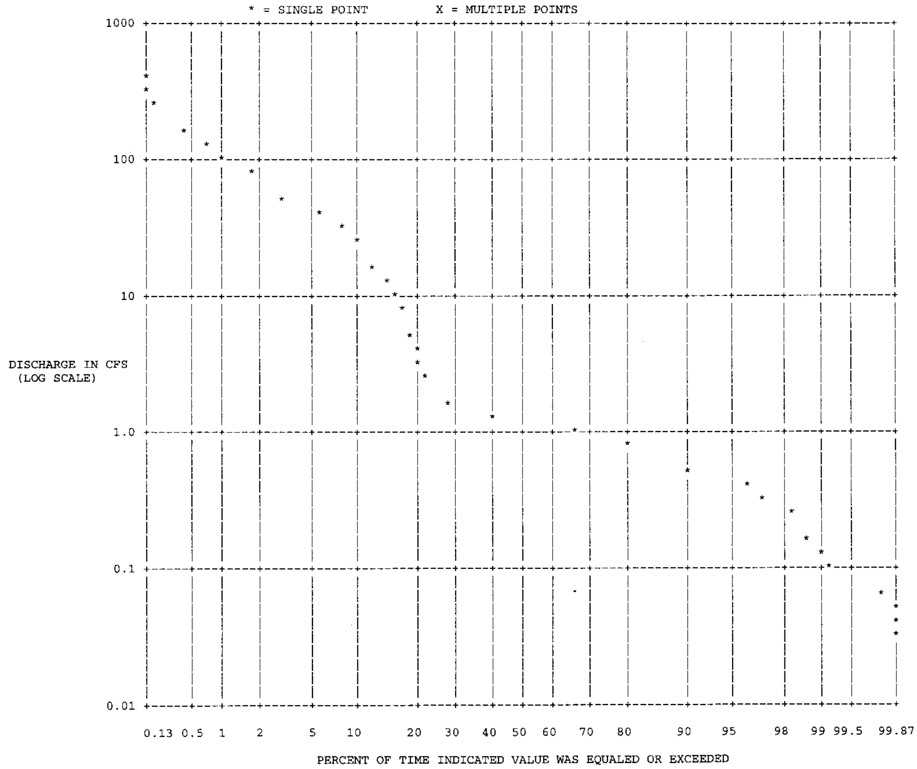
MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1933 1933	1.07	2
1934 1934	1.72	7
1935 1935	1.71	5
1936 1936	1.24	4
1937 1937	4.41	12
1938 1938	3.71	11
1939 1939	4.47	13
1940 1940	1.71	6
1941 1941	1.83	8
1942 1942	4.94	14
1943 1943	1.96	9
1944 1944	.71	1
1945 1945	1.20	3
1946 1946	2.48	10

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)

WATER YEAR RANGE		
1933 1933	1.07	13
1934 1934	1.72	8
1935 1935	1.71	10
1936 1936	1.24	11
1937 1937	4.41	3
1938 1938	3.71	4
1939 1939	4.47	2
1940 1940	1.71	9
1941 1941	1.83	7
1942 1942	4.94	1
1943 1943	1.96	6
1944 1944	.71	14
1945 1945	1.20	12
1946 1946	2.48	5

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1907 - 1947)
STATION ID: 16595000 HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16595000 HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.43	(LOG = -0.37126)
90.0	0.53	(LOG = -0.27394)
85.0	0.62	(LOG = -0.20519)
80.0	0.71	(LOG = -0.14659)
75.0	0.80	(LOG = -0.09823)
70.0	0.88	(LOG = -0.05494)
65.0	0.96	(LOG = -0.01590)
60.0	1.04	(LOG = 0.01512)
55.0	1.11	(LOG = 0.04406)
50.0	1.18	(LOG = 0.07120)
45.0	1.25	(LOG = 0.09674)
40.0	1.34	(LOG = 0.12813)
35.0	1.49	(LOG = 0.17340)
30.0	1.64	(LOG = 0.21439)
25.0	2.06	(LOG = 0.31477)
20.0	4.06	(LOG = 0.60899)
15.0	10.6	(LOG = 1.02492)
10.0	23.2	(LOG = 1.36523)
5.0	44.4	(LOG = 1.64738)

MEAN OF LOGS = 0.23886

STANDARD DEVIATION OF LOGS = 0.54836 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = 2.29575

COEFFICIENT OF SKEW = 1.56104

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16595000
HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1933 1933	114 9	98.3 7	48.6 7	23.5 12	13.6 13	8.07 13	7.61 12	6.35 12	4.58 13
1934 1934	234 4	116 5	79.4 5	52.8 5	41.1 5	24.6 5	19.0 5	15.2 6	10.7 6
1935 1935	135 7	116 6	61.1 6	30.1 8	16.1 11	14.2 9	10.9 10	11.8 7	10.1 7
1936 1936	82.0 12	57.7 11	41.3 10	32.2 7	24.6 7	16.7 7	13.4 7	10.7 9	8.70 10
1937 1937	210 5	200 2	131 2	77.0 3	54.2 3	35.6 2	30.5 2	24.5 2	18.9 3
1938 1938	343 2	162 4	125 3	69.7 4	42.7 4	34.7 3	30.4 3	24.5 3	19.3 2
1939 1939	418 1	345 1	318 1	182 1	98.1 1	83.5 1	57.9 1	51.3 1	37.2 1
1940 1940	104 10	71.0 8	46.7 9	29.0 9	20.8 8	11.5 11	8.18 11	6.77 11	5.78 11
1941 1941	167 6	68.0 9	40.6 11	24.3 11	16.2 10	11.6 10	11.6 8	10.7 10	10.0 8
1942 1942	274 3	176 3	113 4	81.3 2	55.9 2	33.6 4	24.7 4	18.9 4	18.4 4
1943 1943	118 8	65.7 10	39.8 12	26.7 10	18.7 9	14.7 8	11.1 9	11.3 8	8.77 9
1944 1944	53.0 14	34.5 14	19.6 14	11.1 14	6.82 14	5.64 14	4.41 14	4.00 14	3.18 14
1945 1945	63.0 13	37.0 13	29.9 13	19.2 13	14.3 12	8.52 12	6.79 13	5.19 13	5.66 12
1946 1946	88.0 11	54.7 12	48.3 8	34.4 6	25.7 6	19.0 6	18.2 6	15.5 5	11.4 5

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16595000
HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1933 1933	.11 7	.31 8	.66 11	.68 5	.70 4	.77 3	.88 2	.94 1	1.11 1
1934 1934	.34 13	.45 10	.47 8	.49 3	.54 3	.80 4	1.51 5	1.44 3	1.79 3
1935 1935	.15 9	.16 6	.30 7	.71 8	.80 6	1.60 10	1.57 6	2.35 6	3.97 7
1936 1936	.29 12	.65 14	.67 12	.80 11	.83 7	1.56 9	1.36 4	1.63 5	2.49 5
1937 1937	.34 14	.36 9	.48 9	.84 12	1.51 13	3.70 14	5.98 14	5.77 13	7.60 12
1938 1938	.090 4	.11 4	.22 4	.73 10	1.08 9	1.90 11	3.80 11	5.46 12	9.15 13
1939 1939	.090 5	.090 3	.099 2	1.15 14	2.31 14	2.73 13	3.72 10	7.06 14	11.4 14
1940 1940	.12 8	.13 5	.16 3	.54 4	1.04 8	1.46 8	1.73 7	2.50 7	3.00 6
1941 1941	.090 6	.51 11	.63 10	.72 9	1.16 11	1.33 7	3.96 12	3.86 10	5.42 10
1942 1942	.25 11	.53 12	.83 14	.94 13	1.10 10	1.31 6	2.14 9	2.62 8	4.24 8
1943 1943	.060 3	.070 2	.29 6	.69 6	1.41 12	2.62 12	4.36 13	4.55 11	6.29 11
1944 1944	.050 2	.19 7	.25 5	.29 2	.47 2	.69 2	1.26 3	1.50 4	1.74 2
1945 1945	.030 1	.060 1	.069 1	.10 1	.34 1	.44 1	.78 1	1.04 2	2.11 4
1946 1946	.19 10	.63 13	.69 13	.71 7	.73 5	.84 5	2.05 8	2.69 9	5.00 9

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1911 1911																											1	7	15	38	148	156			
1912 1912																1	2	1			1				2		14	25	49	59	160	52			
1913 1913	2																					1		1	1			16	48	74	132	90			
1914 1914																				10	1			1	2	1	8	25	23	28	74	192			
1915 1915																												7	45	62	143	108			
1916 1916	14											1					2		1	4			2	2	5	2	17	8	14	34	78	182			
1917 1917																			2				1	2	1	25	26	33	38	54	115	68			
1918 1918																							1	7	17	12	13	14	16	54	91	140			
1919 1919	4																1								1		1	23	39	50	155	91			
1920 1920																								6	15	32	57	52	41	51	86	26			
1921 1921																											11	21	40	52	205	36			
1922 1922																										14	19	25	49	70	161	26	1		
1923 1923																2	1					1	2	3	1	4	3	17	30	45	245	11			
1924 1924																			1	11	21	20	34	36	34	20	18	11	17	34	76	33			
1925 1925															2	8	17	37	24	12	12	19	22	21	21	14	17	17	10	19	31	62			
1926 1926													1			5	10	36	32	45	53	47	50	24	18	8	11	4	14	4	3				
1931 1931									2			14	11	25	17	34	16	10	9	4	5	3		17	24	24	13	18	23	30	30	36			
1932 1932															1			2			2		2	6	52	39	33	41	29	39	79	41			
1933 1933																				6	34	56	72	39	31	13	18	23	18	28	26	1			
1934 1934																	3	1	10	36	40	24	13	48	15	24	16	13	17	16	46	43			
1935 1935												1	1			6	3	2	7		1	1	13	25	54	65	30	22	22	34	46	32			
1936 1936																				6	6	13	34	40	32	29	18	22	21	34	54	57			
1937 1937	3																					1	1	8	26	25	31	31	30	50	72	87			
1938 1938																							6	27	43	45	42	29	26	37	62	48			
1939 1939																								12	48	41	44	29	30	50	77	34			
1940 1940																				4	1	3	43	61	63	27	22	21	25	31	49	16			
1941 1941																						9	19	40	49	24	34	25	28	39	77	21			
1942 1942																					4	15	15	23	49	30	26	26	29	46	62	40			
1943 1943																			12	28	22	15	42	24	42	23	24	24	26	31	43	9			
1944 1944																9	40	16	19	10	8	17	33	32	46	19	17	23	22	26	28	1			
1945 1945																			21	14	28	34	28	25	32	19	26	15	30	31	39	23			
1946 1946																				3	38	48	46	40	31	18	10	17	17	25	37	35			
1947 1947																	1	5	4	3	10	25	45	40	34	27	24	26	29	37	55				
1948 1948																			4	12	3	4	17	19	47	36	42	45	34	35	68				

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16595000
HONOPOU STR BELOW HAIKU DITCH NR HUELO,MAUI,HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN LOW-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE		
1933 1933	2.76	2
1934 1934	6.25	7
1935 1935	6.21	6
1936 1936	5.53	5
1937 1937	12.5	13
1938 1938	12.1	12
1939 1939	20.9	14
1940 1940	5.30	4
1941 1941	7.12	10
1942 1942	11.3	11
1943 1943	6.52	8
1944 1944	2.23	1
1945 1945	3.80	3
1946 1946	6.77	9

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN HIGH-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE		
1933 1933	2.76	13
1934 1934	6.25	8
1935 1935	6.21	9
1936 1936	5.53	10
1937 1937	12.5	2
1938 1938	12.1	3
1939 1939	20.9	1
1940 1940	5.30	11
1941 1941	7.12	5
1942 1942	11.3	4
1943 1943	6.52	7
1944 1944	2.23	14
1945 1945	3.80	12
1946 1946	6.77	6

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1984 1984												1					1	12	14	14	27	18	32	27	30	34	36	42	27	21	26	4			
1985 1985															5	10	11	15	12	23	29	23	14	22	38	29	29	24	22	19	31	9			

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	70	25933	100.00	13	0.40	61	25799	99.48	25	12.00	2145	18670	71.99
2	0.01	1	25863	99.73	14	0.53	68	25738	99.25	26	16.00	1917	16525	63.72
3	0.02	1	25862	99.73	15	0.70	77	25670	98.99	27	21.00	2158	14608	56.33
4	0.03	1	25861	99.72	16	0.93	169	25593	98.69	28	28.00	2036	12450	48.01
5	0.04	0	25860	99.72	17	1.20	231	25424	98.04	29	37.00	1864	10414	40.16
6	0.05	4	25860	99.72	18	1.60	405	25193	97.15	30	49.00	2189	8550	32.97
7	0.07	5	25856	99.70	19	2.20	481	24788	95.58	31	65.00	4194	6361	24.53
8	0.10	1	25851	99.68	20	2.90	586	24307	93.73	32	86.00	2164	2167	8.36
9	0.13	4	25850	99.68	21	3.80	967	23721	91.47	33	114.00	3	3	0.01
10	0.17	1	25846	99.66	22	5.10	1034	22754	87.74	34	0.00	0	0	0.00
11	0.23	7	25845	99.66	23	6.70	1492	21720	83.75	35	0.00	0	0	0.00
12	0.30	39	25838	99.63	24	8.90	1558	20228	78.00					

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

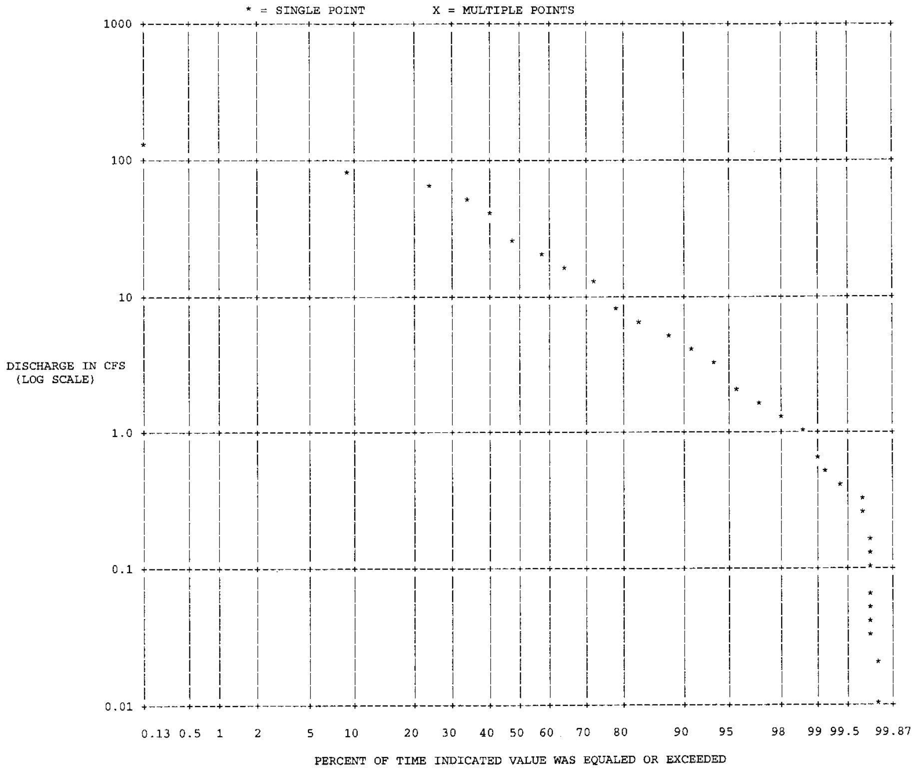
STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1949 1949														4	10	17	11	4	11	8	10	9	39	40	40	23	34	19	27	31	28				
1950 1950																		1		11	19	9	24	31	40	38	46	29	37	43	36	1			
1951 1951															2	8	8	7	3	1	14	36	54	30	31	26	43	30	25	18	24	5			
1952 1952																		1	4		12	7	7	7	38	42	49	35	34	47	80	3			
1953 1953																			4	7	34	28	46	45	40	37	27	19	12	14	48	4			
1954 1954																			10	13	12	13	17	16	34	29	34	45	32	34	60	16			
1955 1955															1	1	4	13	12	8	21	14	7	21	36	31	29	29	28	25	78	7			
1956 1956						2	4		1					4	3	2	6	3	7	7	6	21	25	23	23	28	26	31	28	27	64	25			
1957 1957							1				1									1	12	18	29	32	51	44	44	37	27	25	31	12			
1958 1958											4	20	43	13	13	5	1	7	1	1	2	10	18	26	21	20	22	35	20	28	44	11			
1959 1959															1	3	1	11	3	6	12	11	35	30	30	38	37	36	39	22	37	13			
1960 1960																						8	23	37	49	40	39	39	30	40	51	10			
1961 1961																			3		9	14	51	41	56	39	51	41	18	17	22	3			
1962 1962																1		5	12	15	27	31	38	35	32	47	40	29	18	8	22	5			
1963 1963	4		1	1		1			1			1	2	3	2	3		18	19	11	20	13	18	25	37	44	36	21	21	16	36	11			
1964 1964																			1	1	7	4	9	26	56	71	67	34	17	25	23	24	1		
1965 1965																1	4	9	6	10	11	12	15	30	43	46	42	28	28	19	27	33	1		
1966 1966																		5	26	25	22	19	27	24	36	35	48	36	28	13	19	2			
1967 1967	2														1	13	9	11	8	4	9	16	24	25	39	44	47	33	28	21	26	5			
1968 1968																2	6	12	10	13	26	27	33	29	32	23	32	28	22	26	37	8			
1969 1969														4	5	13	15	19	13	19	23	18	9	12	16	18	20	39	29	24	65	4			
1970 1970														3	2	2	8	3	3	1	2	4	24	19	44	36	46	65	28	23	46	6			
1971 1971														10	4	4	7	18	30	17	21	10	23	21	28	22	30	26	26	21	40	7			
1972 1972																			9	4	17	34	40	28	58	37	38	35	26	19	16	5			
1973 1973	35					1		1		1	2	1	3	2	3	5		9	20	17	17	14	20	17	31	38	26	21	14	14	41	12			
1974 1974																	3	17	14	12	31	31	34	31	36	18	37	41	21	15	16	8			
1975 1975																	6	15	2	2	29	29	24	23	20	36	42	40	30	23	35	9			
1976 1976																			2	10	21	44	38	21	42	32	42	32	25	15	38	4			
1977 1977																			12	20	23	27	28	24	20	24	54	44	20	18	25	26			
1978 1978	6	1														1				13	35	19	23	14	18	21	54	54	34	29	32	11			
1979 1979															1	2	12	17	7	8	25	14	14	31	26	46	46	47	14	20	23	12			
1980 1980																		19	27	15	21	12	15	6	17	22	52	56	30	26	24	24			
1981 1981																		15	17	38	45	33	34	22	35	41	37	13	10	10	9	6			
1982 1982															4	7	21	25	13	12	7	10	17	12	35	24	25	33	25	27	52	16			
1983 1983																4	1	4		11	19	18	23	26	51	34	65	35	20	19	29	6			

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1910 - 1986)
STATION ID: 16592000 Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16592000 Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	2.42	(LOG = 0.38394)
90.0	4.31	(LOG = 0.63474)
85.0	6.20	(LOG = 0.79240)
80.0	8.14	(LOG = 0.91039)
75.0	10.4	(LOG = 1.01905)
70.0	13.0	(LOG = 1.11274)
65.0	15.4	(LOG = 1.18701)
60.0	18.5	(LOG = 1.26758)
55.0	22.1	(LOG = 1.34476)
50.0	26.3	(LOG = 1.42036)
45.0	31.4	(LOG = 1.49760)
40.0	37.3	(LOG = 1.57127)
35.0	45.6	(LOG = 1.65906)
30.0	54.6	(LOG = 1.73742)
25.0	64.1	(LOG = 1.80690)
20.0	70.9	(LOG = 1.85053)
15.0	77.4	(LOG = 1.88859)
10.0	83.9	(LOG = 1.92358)
5.0	97.3	(LOG = 1.98794)

MEAN OF LOGS = 1.36820

STANDARD DEVIATION OF LOGS = 0.46837 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = 0.34232

COEFFICIENT OF SKEW = -0.52498

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1951 1951	.71 20	.80 15	.98 14	1.71 19	7.90 46	9.80 30	12.0 28	14.3 27	19.0 27
1952 1952	2.10 43	2.23 42	4.30 48	5.47 48	12.0 53	24.1 54	24.0 52	28.0 52	34.8 52
1953 1953	2.80 54	2.80 50	3.01 41	3.39 35	4.81 24	9.55 29	13.8 34	12.6 22	16.6 17
1954 1954	2.20 46	2.33 45	2.41 34	3.29 34	7.67 45	14.6 45	19.8 46	19.8 41	23.7 39
1955 1955	.87 26	1.09 25	1.42 23	1.76 22	3.48 17	12.4 37	13.1 33	14.5 28	22.1 35
1956 1956	.060 9	.073 7	.084 5	2.78 30	5.76 33	10.4 33	11.1 25	12.0 20	18.6 22
1957 1957	.080 10	1.45 34	4.89 52	5.40 47	5.99 35	9.50 28	16.0 40	19.9 42	22.4 36
1958 1958	.29 12	.29 9	.33 6	.38 3	.48 2	.50 1	.52 1	1.34 2	8.29 3
1959 1959	.87 27	1.02 24	1.28 20	1.61 16	6.02 36	7.60 20	9.57 18	17.2 36	25.2 42
1960 1960	5.30 62	5.47 62	6.19 58	6.87 54	8.16 47	18.5 51	20.6 47	21.5 47	30.4 49
1961 1961	2.20 47	2.50 47	4.76 51	5.99 49	7.41 42	12.2 36	13.0 32	16.9 35	19.7 28
1962 1962	.94 29	1.55 35	2.59 38	3.26 33	4.12 19	9.08 25	12.3 30	15.6 31	17.2 19
1963 1963	.0000 5	.0000 4	.080 4	.70 5	2.66 14	5.20 13	10.6 21	12.1 21	15.8 15
1964 1964	2.20 48	3.77 59	5.01 53	7.86 55	14.7 55	20.9 53	22.9 51	24.0 50	28.3 48
1965 1965	1.10 34	1.17 27	1.36 22	1.75 21	5.02 25	12.4 38	16.5 42	20.0 44	25.7 43
1966 1966	1.90 42	1.97 40	2.30 33	3.39 36	5.58 31	12.9 42	14.6 37	17.9 37	18.6 23
1967 1967	.0000 6	.33 10	1.10 17	1.31 13	5.38 29	9.34 26	13.9 35	15.9 32	17.0 18
1968 1968	1.00 32	1.27 30	1.44 24	1.67 18	7.20 40	13.2 43	12.6 31	16.0 33	22.6 37
1969 1969	.60 16	.68 14	.80 10	1.15 10	1.50 7	5.14 12	5.67 7	7.07 5	12.3 5
1970 1970	.60 17	.65 12	.83 11	1.16 11	4.26 21	12.5 41	15.5 38	17.9 38	20.5 31
1971 1971	.60 18	.60 11	.60 8	.92 7	1.84 10	4.49 11	8.14 10	8.81 8	21.6 34
1972 1972	2.20 49	2.27 43	2.44 35	4.86 45	6.15 37	10.9 35	14.4 36	18.7 40	20.3 29
1973 1973	.0000 7	.0000 5	.0000 2	.0000 1	.41 1	1.97 4	3.72 4	9.48 10	17.7 20
1974 1974	1.20 36	1.30 31	1.56 26	1.92 24	4.71 23	6.16 16	8.71 11	9.93 12	18.9 26
1975 1975	1.30 37	1.40 33	1.53 25	1.66 17	5.85 34	8.47 22	9.82 19	13.3 24	18.6 24
1976 1976	2.80 55	3.20 53	3.29 42	3.75 38	5.39 30	9.34 27	11.5 26	10.6 17	20.3 30
1977 1977	2.20 50	2.27 44	2.50 37	2.71 29	3.01 15	3.98 8	8.74 12	16.3 34	27.1 44
1978 1978	.0000 8	.0000 6	.001 3	4.22 42	5.35 28	8.65 23	15.6 39	13.8 25	18.6 25
1979 1979	.81 23	.97 21	1.24 19	1.74 20	5.60 32	10.4 34	10.8 22	14.8 29	16.5 16
1980 1980	1.60 39	1.60 37	1.71 27	2.05 26	3.37 16	12.4 39	11.6 27	12.7 23	18.0 21
1981 1981	1.60 40	1.60 38	1.71 28	1.85 23	2.22 12	3.69 6	7.81 9	11.0 19	12.8 8
1982 1982	.83 25	.87 18	.95 13	1.29 12	1.62 9	4.33 10	11.0 24	9.42 9	14.2 10
1983 1983	.97 30	.99 22	1.32 21	3.62 37	4.67 22	7.45 19	8.75 13	10.3 16	14.7 12
1984 1984	.36 14	1.09 26	1.83 31	1.99 25	2.64 13	5.60 15	7.09 8	8.61 7	14.8 13
1985 1985	.82 24	.85 17	.91 12	.98 8	1.22 5	5.29 14	9.14 15	8.25 6	14.5 11

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1911 1911	23.0 69	31.3 70	35.6 70	41.0 70	55.5 71	68.2 71	75.1 71	78.4 71	77.0 71
1912 1912	1.10 33	1.23 29	25.7 69	28.4 67	36.4 66	51.0 67	54.9 64	56.6 64	62.9 65
1913 1913	.0000 1	1.70 39	21.6 67	38.6 69	49.8 69	54.9 69	59.5 68	61.1 68	64.3 67
1914 1914	2.90 56	3.20 52	3.31 43	19.5 63	35.1 65	46.2 65	55.3 65	59.2 65	64.6 68
1915 1915	31.0 71	33.0 71	36.4 71	42.8 71	52.1 70	62.7 70	64.0 70	66.4 70	67.5 70
1916 1916	.0000 2	.0000 1	.0000 1	.022 2	11.5 52	26.0 58	39.0 61	43.7 61	52.9 59
1917 1917	2.50 51	4.03 60	13.4 65	18.0 62	20.5 60	29.7 60	35.3 58	43.3 59	55.0 62
1918 1918	8.80 65	9.17 65	10.4 63	13.8 60	16.6 57	32.0 62	44.7 62	48.7 62	56.8 63
1919 1919	.0000 3	.0000 2	9.49 61	35.0 68	39.9 67	51.3 68	61.1 69	60.3 67	64.8 69
1920 1920	9.30 66	9.47 67	10.0 62	13.3 58	17.8 58	24.6 55	31.7 56	34.6 57	41.4 56
1921 1921	23.0 70	23.7 69	24.1 68	27.9 66	34.6 64	47.4 66	56.9 66	61.7 69	59.3 64
1922 1922	16.0 68	18.0 68	19.6 66	20.2 64	22.2 61	29.6 59	37.4 60	43.4 60	53.0 60
1923 1923	.93 28	2.77 49	9.33 60	20.9 65	41.7 68	46.1 64	57.1 67	59.7 66	63.7 66
1924 1924	2.20 44	3.37 56	3.69 46	3.96 39	5.03 26	9.98 31	10.5 20	10.3 15	28.0 46
1925 1925	.77 21	.82 16	1.01 15	1.09 9	1.90 11	2.79 5	3.79 5	5.59 4	11.4 4
1926 1926	.46 15	.93 19	1.17 18	1.50 15	1.55 8	4.01 9	4.15 6	4.69 3	5.34 1
1931 1931	.15 11	.26 8	.35 7	.43 4	.51 3	.67 2	.86 2	.96 1	6.59 2
1932 1932	.77 22	1.32 32	6.14 57	13.6 59	19.7 59	24.7 56	35.0 57	33.5 55	43.0 58
1933 1933	2.90 57	3.33 55	3.64 45	4.16 41	5.20 27	7.43 18	9.37 17	10.1 13	12.6 6
1934 1934	1.20 35	1.20 28	2.04 32	2.40 27	3.59 18	7.42 17	8.82 14	10.2 14	13.5 9
1935 1935	.31 13	.93 20	1.75 29	6.22 50	13.5 54	20.8 52	22.2 50	25.2 51	31.6 51
1936 1936	3.10 59	3.27 54	3.60 44	4.84 44	8.77 48	12.5 40	12.2 29	15.6 30	23.7 38
1937 1937	.0000 4	.0000 3	5.84 54	10.6 56	22.7 62	33.2 63	46.2 63	49.3 63	54.1 61
1938 1938	7.60 64	7.90 64	8.66 59	11.0 57	15.9 56	25.3 57	27.6 55	34.3 56	42.0 57
1939 1939	9.30 67	9.30 66	12.1 64	15.4 61	28.9 63	30.7 61	35.7 59	40.6 58	40.7 55
1940 1940	3.00 58	3.07 51	4.51 50	6.45 51	10.0 50	17.6 48	18.0 44	20.8 45	21.6 33
1941 1941	5.80 63	5.87 63	6.04 56	6.61 53	10.8 51	14.9 46	20.8 48	22.9 49	30.6 50
1942 1942	4.70 61	4.90 61	5.93 55	6.52 52	7.26 41	14.2 44	25.9 54	28.4 53	37.5 54
1943 1943	2.50 52	2.50 46	2.64 39	2.96 31	9.30 49	14.9 47	16.7 43	18.2 39	27.4 45
1944 1944	1.00 31	1.00 23	1.07 16	1.34 14	1.48 6	3.96 7	10.9 23	9.90 11	12.7 7
1945 1945	2.20 45	2.23 41	2.46 36	3.96 40	4.16 20	8.44 21	9.33 16	13.9 26	21.2 32
1946 1946	3.30 60	3.63 58	4.41 49	4.83 43	6.60 38	10.1 32	16.5 41	21.2 46	28.3 47
1947 1947	1.50 38	1.57 36	1.83 30	2.43 28	6.68 39	8.80 24	18.4 45	20.0 43	24.4 40
1948 1948	2.50 53	2.53 48	2.80 40	3.12 32	7.47 43	18.4 50	25.4 53	28.9 54	34.9 53
1949 1949	.68 19	.68 13	.71 9	.78 6	.99 4	1.51 3	3.32 3	10.9 18	15.3 14
1950 1950	1.70 41	3.53 57	3.74 47	5.10 46	7.61 44	18.1 49	21.4 49	21.8 48	24.8 41

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1951 1951	90.0 59	88.0 45	71.4 62	54.8 66	45.6 65	33.5 68	27.7 68	27.0 67	26.2 66
1952 1952	90.0 60	85.0 59	85.0 39	80.9 30	70.5 38	61.6 33	55.6 30	50.7 28	49.4 25
1953 1953	88.0 66	87.0 51	84.4 40	76.7 41	73.4 32	63.0 31	50.5 36	40.2 47	32.2 57
1954 1954	93.0 43	89.7 35	86.4 33	81.7 29	75.8 26	69.0 22	58.8 24	57.4 21	49.7 24
1955 1955	93.0 44	87.0 52	85.1 38	78.5 35	73.9 30	59.5 36	57.3 26	51.3 26	50.3 22
1956 1956	93.0 45	93.0 17	90.0 14	88.3 16	79.3 21	73.3 20	71.6 14	62.6 17	54.8 15
1957 1957	93.0 46	88.0 46	81.4 47	68.9 52	58.2 51	48.6 54	38.0 59	30.0 64	30.1 59
1958 1958	93.0 47	91.3 26	88.6 27	79.1 33	74.6 28	66.4 25	56.2 28	49.4 30	33.0 53
1959 1959	96.0 28	90.7 27	82.7 45	69.9 51	63.5 49	53.9 45	41.7 53	35.1 57	33.1 51
1960 1960	89.0 62	89.0 39	81.1 48	78.1 38	72.0 35	56.2 39	50.2 37	49.3 31	47.1 28
1961 1961	89.0 63	87.7 47	86.7 32	74.7 43	56.8 54	42.3 63	35.1 62	31.9 62	29.0 61
1962 1962	95.0 33	85.7 55	64.4 68	57.1 65	42.2 67	34.6 66	29.0 66	23.8 69	24.5 69
1963 1963	104 17	88.7 42	79.9 52	71.6 47	66.3 44	49.4 53	40.6 55	40.9 45	36.1 46
1964 1964	114 2	92.3 19	87.3 29	65.3 54	54.7 60	44.0 61	39.6 57	38.6 51	34.2 50
1965 1965	114 3	111 1	102 1	99.9 1	84.4 16	64.8 26	48.5 42	42.0 42	39.1 39
1966 1966	105 12	82.0 65	61.9 69	44.6 69	37.7 69	32.5 69	26.6 69	23.9 68	24.9 67
1967 1967	92.0 49	85.3 56	79.7 53	62.8 56	50.7 62	45.0 60	34.4 63	30.6 63	28.0 63
1968 1968	110 5	89.0 40	79.0 54	78.3 37	67.6 42	52.4 47	46.8 46	39.4 50	32.2 58
1969 1969	99.0 25	85.0 60	80.3 51	77.9 39	75.5 27	61.7 32	50.0 39	46.2 36	48.0 27
1970 1970	106 10	97.0 9	80.7 50	80.0 31	69.2 40	55.3 41	43.7 51	44.0 41	42.2 33
1971 1971	106 11	87.7 48	80.9 49	72.4 46	65.7 46	53.8 46	46.3 47	40.1 48	32.9 54
1972 1972	94.0 38	86.3 53	59.7 70	45.3 68	41.7 68	34.0 67	28.6 67	28.7 65	28.0 64
1973 1973	108 6	98.7 7	86.0 34	74.5 44	71.2 36	60.7 34	54.9 33	49.2 32	39.5 38
1974 1974	105 13	85.3 57	73.4 60	57.3 64	48.3 64	38.5 64	33.6 64	32.8 59	29.0 62
1975 1975	103 19	83.7 63	75.4 56	61.3 58	55.8 57	50.9 50	49.9 40	45.5 37	41.6 34
1976 1976	90.0 61	84.0 62	74.1 59	70.9 48	64.3 47	57.2 37	47.0 44	42.0 43	34.8 48
1977 1977	111 4	107 2	86.9 31	77.5 40	72.9 34	63.9 28	55.6 31	44.9 39	40.7 36
1978 1978	100 23	83.7 64	72.1 61	60.1 62	56.4 55	50.8 51	48.9 41	44.3 40	41.0 35
1979 1979	104 18	90.3 31	83.4 43	65.8 53	61.4 50	50.6 52	38.3 58	32.2 61	27.0 65
1980 1980	96.0 29	92.0 21	88.7 25	64.8 55	57.2 52	51.8 49	50.1 38	46.8 34	37.5 42
1981 1981	107 9	101 4	66.6 67	42.7 70	32.2 70	26.8 70	20.9 70	17.9 70	17.9 70
1982 1982	108 7	95.3 13	84.4 41	75.1 42	69.1 41	64.6 27	59.9 22	50.9 27	37.3 43
1983 1983	93.0 48	87.3 49	84.3 42	70.0 50	55.0 59	46.8 58	40.0 56	37.4 55	32.7 55
1984 1984	108 8	84.7 61	75.4 57	60.3 61	57.2 53	47.8 56	36.9 60	34.3 58	32.3 56
1985 1985	101 22	90.3 32	78.0 55	70.1 49	63.8 48	51.9 48	48.1 43	41.5 44	36.5 45

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1911 1911	101 21	98.7 6	96.9 3	95.8 2	94.0 1	91.5 1	87.7 2	85.3 3	83.0 2
1912 1912	95.0 30	90.3 28	89.1 20	88.7 12	85.9 11	78.3 13	76.3 11	72.7 11	69.9 11
1913 1913	95.0 31	91.7 22	91.3 9	90.7 6	87.1 7	84.5 7	84.5 6	80.0 5	74.2 7
1914 1914	95.0 32	93.0 16	91.3 10	90.4 7	90.2 4	88.7 4	85.9 4	82.6 4	80.2 3
1915 1915	93.0 39	90.0 33	89.4 18	88.3 14	86.6 8	83.4 9	82.7 8	77.7 7	75.2 5
1916 1916	93.0 40	92.0 20	91.4 8	91.2 5	90.9 3	90.1 2	89.9 1	89.8 1	83.5 1
1917 1917	94.0 34	91.7 23	90.3 12	88.3 15	84.7 14	83.7 8	75.5 13	72.0 12	63.8 13
1918 1918	93.0 41	91.3 24	90.1 13	89.8 10	89.1 5	89.1 3	87.7 3	86.5 2	80.1 4
1919 1919	91.0 50	88.0 43	87.1 30	86.9 20	86.4 9	82.0 10	76.9 10	77.0 8	74.6 6
1920 1920	94.0 35	89.7 34	88.7 22	87.7 18	86.1 10	71.2 21	59.2 23	54.3 25	54.2 16
1921 1921	91.0 51	90.3 29	88.7 23	88.1 17	85.3 12	85.1 6	83.3 7	79.0 6	72.5 9
1922 1922	116 1	95.3 12	89.7 16	86.8 21	81.7 19	80.6 11	76.2 12	73.8 10	71.6 10
1923 1923	88.0 64	86.0 54	85.7 35	85.1 25	83.4 17	79.5 12	77.0 9	74.1 9	73.7 8
1924 1924	99.0 24	96.3 10	93.1 6	90.3 8	85.1 13	78.0 14	71.5 15	63.2 16	49.7 23
1925 1925	96.0 27	94.7 14	94.3 5	93.4 4	91.9 2	88.6 5	85.0 5	71.0 13	53.1 17
1926 1926	74.0 71	57.3 71	44.0 71	35.4 71	24.2 71	17.5 71	14.7 71	13.0 71	10.8 71
1931 1931	104 14	99.0 5	95.0 4	89.9 9	78.4 24	76.2 15	66.8 18	55.9 22	45.6 30
1932 1932	104 15	94.7 15	89.3 19	82.3 28	74.0 29	63.3 30	55.9 29	57.9 19	52.0 20
1933 1933	90.0 53	80.0 67	68.7 65	60.4 60	48.8 63	45.5 59	42.7 52	40.4 46	33.0 52
1934 1934	104 16	101 3	99.0 2	94.3 3	88.7 6	74.1 18	68.8 17	65.5 15	51.9 21
1935 1935	94.0 36	92.7 18	91.1 11	86.0 24	66.6 43	55.6 40	54.9 32	45.3 38	44.8 31
1936 1936	93.0 42	91.3 25	89.9 15	87.5 19	82.5 18	68.9 23	65.6 20	57.5 20	58.4 14
1937 1937	102 20	98.3 8	91.7 7	88.9 11	84.6 15	76.0 16	71.2 16	67.9 14	64.0 12
1938 1938	97.0 26	95.7 11	88.6 26	86.5 22	77.7 25	67.1 24	64.6 21	61.8 18	52.6 18
1939 1939	90.0 54	88.0 44	87.4 28	78.3 36	69.7 39	60.2 35	57.4 25	54.7 24	52.1 19
1940 1940	90.0 55	89.0 36	89.1 21	86.5 23	73.2 33	54.8 42	45.1 49	36.6 56	34.4 49
1941 1941	90.0 56	89.0 37	85.3 37	78.9 34	66.1 45	54.0 43	52.8 35	50.1 29	48.8 26
1942 1942	94.0 37	90.3 30	89.6 17	88.5 13	78.9 22	73.8 19	66.0 19	55.4 23	46.2 29
1943 1943	91.0 52	88.7 41	82.3 46	73.4 45	70.9 37	54.0 44	44.5 50	37.9 52	35.8 47
1944 1944	87.0 67	80.0 68	68.7 66	50.9 67	42.9 66	36.6 65	31.9 65	32.6 60	29.9 60
1945 1945	90.0 57	87.0 50	85.6 36	79.4 32	73.7 31	56.3 38	46.8 45	37.5 54	39.0 40
1946 1946	90.0 58	89.0 38	88.7 24	84.9 26	80.2 20	75.0 17	56.2 27	46.4 35	40.5 37
1947 1947	84.0 69	81.7 66	70.6 63	62.7 57	53.6 61	47.7 57	46.1 48	39.9 49	37.6 41
1948 1948	85.0 68	85.0 58	82.9 44	82.4 27	78.7 23	63.4 29	54.1 34	47.4 33	42.9 32
1949 1949	79.0 70	76.0 69	74.3 58	60.0 63	56.0 56	48.4 55	36.8 61	28.1 66	24.6 68
1950 1950	88.0 65	74.0 70	68.9 64	61.1 59	55.4 58	43.2 62	41.2 54	37.6 53	37.0 44

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)			MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)		
WATER YEAR RANGE			WATER YEAR RANGE		
1956 1956	35.4	47	1956 1956	35.4	25
1957 1957	28.2	27	1957 1957	28.2	45
1958 1958	26.3	23	1958 1958	26.3	49
1959 1959	29.3	33	1959 1959	29.3	39
1960 1960	34.0	45	1960 1960	34.0	27
1961 1961	23.4	12	1961 1961	23.4	60
1962 1962	20.5	3	1962 1962	20.5	69
1963 1963	25.0	20	1963 1963	25.0	52
1964 1964	30.9	38	1964 1964	30.9	34
1965 1965	31.4	41	1965 1965	31.4	31
1966 1966	21.3	7	1966 1966	21.3	65
1967 1967	24.2	15	1967 1967	24.2	57
1968 1968	25.4	21	1968 1968	25.4	51
1969 1969	29.1	30	1969 1969	29.1	42
1970 1970	31.0	39	1970 1970	31.0	33
1971 1971	24.7	17	1971 1971	24.7	55
1972 1972	22.1	8	1972 1972	22.1	64
1973 1973	23.5	13	1973 1973	23.5	59
1974 1974	20.9	5	1974 1974	20.9	67
1975 1975	27.3	24	1975 1975	27.3	48
1976 1976	24.8	19	1976 1976	24.8	53
1977 1977	28.5	28	1977 1977	28.5	44
1978 1978	29.8	36	1978 1978	29.8	36
1979 1979	24.8	18	1979 1979	24.8	54
1980 1980	29.4	34	1980 1980	29.4	38
1981 1981	15.8	2	1981 1981	15.8	70
1982 1982	30.7	37	1982 1982	30.7	35
1983 1983	25.5	22	1983 1983	25.5	50
1984 1984	23.6	14	1984 1984	23.6	58
1985 1985	22.8	11	1985 1985	22.8	61

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16592000
Lowrie Ditch at Honopou Gulch near Huelo, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP)			MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP)		
WATER YEAR RANGE			WATER YEAR RANGE		
1911 1911	79.8	71	1911 1911	79.8	1
1912 1912	64.9	62	1912 1912	64.9	10
1913 1913	67.9	64	1913 1913	67.9	8
1914 1914	72.7	70	1914 1914	72.7	2
1915 1915	72.1	69	1915 1915	72.1	3
1916 1916	70.2	68	1916 1916	70.2	4
1917 1917	59.4	60	1917 1917	59.4	12
1918 1918	66.7	63	1918 1918	66.7	9
1919 1919	69.3	67	1919 1919	69.3	5
1920 1920	47.7	58	1920 1920	47.7	14
1921 1921	69.1	66	1921 1921	69.1	6
1922 1922	61.7	61	1922 1922	61.7	11
1923 1923	68.2	65	1923 1923	68.2	7
1924 1924	38.8	50	1924 1924	38.8	22
1925 1925	32.3	43	1925 1925	32.3	29
1926 1926	8.88	1	1926 1926	8.88	71
1931 1931	28.2	26	1931 1931	28.2	46
1932 1932	45.5	57	1932 1932	45.5	15
1933 1933	21.2	6	1933 1933	21.2	66
1934 1934	32.1	42	1934 1934	32.1	30
1935 1935	35.9	49	1935 1935	35.9	23
1936 1936	40.5	53	1936 1936	40.5	19
1937 1937	55.2	59	1937 1937	55.2	13
1938 1938	43.4	55	1938 1938	43.4	17
1939 1939	44.9	56	1939 1939	44.9	16
1940 1940	31.3	40	1940 1940	31.3	32
1941 1941	39.2	52	1941 1941	39.2	20
1942 1942	41.4	54	1942 1942	41.4	18
1943 1943	27.4	25	1943 1943	27.4	47
1944 1944	20.6	4	1944 1944	20.6	68
1945 1945	29.3	31	1945 1945	29.3	41
1946 1946	29.3	32	1946 1946	29.3	40
1947 1947	29.5	35	1947 1947	29.5	37
1948 1948	34.9	46	1948 1948	34.9	26
1949 1949	22.5	10	1949 1949	22.5	62
1950 1950	29.0	29	1950 1950	29.0	43
1951 1951	22.2	9	1951 1951	22.2	63
1952 1952	38.9	51	1952 1952	38.9	21
1953 1953	24.4	16	1953 1953	24.4	56
1954 1954	35.7	48	1954 1954	35.7	24
1955 1955	33.7	44	1955 1955	33.7	28

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1950 1950						5	5	1	1	15	6	10	13	16	35	27	28	22	26	17	12	14	3	6	9	8	13	12	11	17	33				
1951 1951				4	2	17	13	8	5	21	19	36	34	26	22	34	20	21	9	8	6	4	3	10	2	6	7	10	9	5	4				
1952 1952				2		8	2	3		5	8	2	11	13	30	34	39	28	24	18	13	9	6	11	12	10	9	16	20	15	18				
1953 1953	2	4		6	6	22	3	2	3	13	26	54	47	25	21	23	7	11	5	9	9	7	6	2	8	3	5	5	6	10	15				
1954 1954	15	3	6	6	7	11	3	3	4	23	25	17	17	23	19	12	20	9	13	7	8	4	5	10	4	6	16	15	19	12	23				
1955 1955							12	21	17	31	29	23	19	17	18	9	16	11	8	11	6	6	12	8	8	9	11	11	14	21	16	1			
1956 1956						3	18	20	22	37	13	13	12	9	11	23	17	14	14	7	6	9	6	7	8	10	14	9	17	13	34				
1957 1957								27	5	27	14	22	22	21	20	30	31	21	12	6	7	12	10	6	8	4	11	13	12	7	17				
1958 1958				1	1	8	17	10	9	4	21	10	12	15	14	14	9	9	6	8	21	15	9	19	26	14	18	13	21	23	18				
1959 1959						5	10	10	13	15	20	14	18	14	10	15	11	15	19	21	16	13	8	18	15	9	19	14	10	10	23				
1960 1960						7						1	4	3	21	43	54	42	35	32	11	6	6	5	13	9	16	18	18	12	10				
1961 1961										2	10	26	44	13	16	32	58	34	24	10	10	6	6	9	10	9	9	8	10	13	6				
1962 1962										3	6	5	7	46	45	34	49	25	22	17	9	9	8	5	13	10	16	11	12	7	6				
1963 1963					1	13	18	18	8	10	5	9	20	16	25	26	34	25	16	10	8	1	6	9	7	9	12	10	20	17	12				
1964 1964											1	14	15	19	20	26	29	39	28	18	18	16	10	15	9	11	15	12	28	13	10				
1965 1965					1	1	2	11	9	12	5	8	7	15	21	25	41	25	28	20	14	12	3	19	12	9	11	7	23	7	17				
1966 1966								3	11	22	6	10	28	32	31	27	24	23	5	7	7	15	6	13	11	10	17	15	22	12	8				
1967 1967													1	20	22	37	53	42	16	19	17	13	9	13	14	11	14	17	17	18	12				
1968 1968				1					1	1	3	2	23	46	49	23	19	19	15	12	10	14	6	13	13	12	12	13	14	16	29				
1969 1969							5	17	29	23	10	22	26	9	17	17	12	9	5	28	16	7	4	15	11	6	13	17	14	21	12				
1970 1970			1	4	2		7	18	4	3	2	4	2	10	33	64	34	28	31	15	3	4	7	7	14	13	8	7	18	16	6				
1971 1971								6	5	16		12	23	35	29	36	49	20	9	8	8	10	3	13	11	6	13	12	9	16	16				
1972 1972												24	10	42	58	55	37	28	19	23	12	4	4	7	8	5	4	7	7	7	5				
1973 1973							2	2			1	2	12	47	17	31	42	16	7	22	15	7	14	25	12	14	16	13	20	16	12				
1974 1974						2	4	4		1	6	13	43	33	46	31	23	28	25	28	12	11	5	3	5	5	7	7	7	5	11				
1975 1975										8	6	32	11	36	25	30	31	36	26	25	13	12	6	7	10	5	9	18	9	6	4				
1976 1976								2	7	14	22	25	25	31	21	18	37	29	22	12	7	6	10	9	4	11	8	14	17	10	5				
1977 1977		1				1	1	2	1	23	20	19	32	18	39	44	38	14	16	17	6	4	1	3	5	1	4	10	12	17	16				
1978 1978											9	26	37	20	28	35	37	38	22	12	8	11	3	4	14	5	10	15	5	16	10				
1979 1979							4	7	7	8	7	15	35	29	25	10	41	35	22	17	12	13	4	6	2	4	14	11	14	13	10				
1980 1980									2	3	14	8	14	9	4	15	32	46	41	21	6	12	3	5	5	9	12	16	29	39	21				
1981 1981									3	8	21	80	73	43	25	21	38	14	3	3		1	3	1	4	3	3	4	6	2	6				
1982 1982					2	5	3	6	10	12	4	3	16	7	8	14	15	29	25	15	14	8	8	12	18	12	16	22	24	38	19				
1983 1983						2		1	2	2	2	1	12	38	49	64	59	30	29	6	2	3	1	3	7	7	7	10	11	9	8				
1984 1984										4	16	21	17	18	9	57	58	40	26	10	8	3	4	7	10	4	17	9	11	13	4				

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES
FOR PERIOD OCT TO SEP

NUMBER OF DAYS IN CLASS

CLASS / WATER YEAR RANGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1911 1911	1					3			1				1		1		5		7	15	6	7	6	14	17	13	19	19	25	196	9				
1914 1914																	3	14	17	12	7	7	6	3	10	4	12	18	16	199	37				
1916 1916																			3	11	10	6	3	8	9	7	25	24	32	45	133	50			
1917 1917															20	45	50	23	14	8	8	11	9	10	14	12	17	29	24	25	30	16			
1918 1918														6	42	3	3	4	2	3	7	14	11	11	23	16	26	29	38	27	37	63			
1919 1919																	1	36	28	28	46	7	10	19	11	10	21	17	25	41	34	31			
1920 1920												1		1		8	74	56	64	26	17	10	10	9	7	6	9	8	10	15	15	20			
1921 1921																1	6	46	16	23	16	15	7	11	16	17	23	21	17	28	48	54			
1922 1922																	1	2	11	15	27	12	13	26	14	9	14	20	28	36	67	69	1		
1923 1923																				1	6	3	23	22	28	9	33	20	30	41	41	108			
1924 1924																			2	7	21	39	21	20	27	21	27	29	42	24	31	53	2		
1925 1925																					1	3	13	36	42	22	42	40	38	37	40	41	10		
1926 1926																		4	7	29	40	38	26	42	43	42	35	21	15	4	15	4			
1927 1927																					7	20	17	28	33	33	57	39	33	28	38	30	2		
1928 1928																					5	11	28	30	17	42	63	37	54	24	31	17	7		
1931 1931	6									1				3	11	18	21	25	22	8	12	24	18	23	23	32	24	21	21	16	23	13			
1932 1932														2	16	6	25	25	25	49	42	28	9	8	12	14	13	12	25	18	23	14			
1933 1933										15		32	38	59	24	15	29	23	14	15	30	9	4	4	9	6	8	9	13	8		1			
1934 1934	9							2		66		18	13	27	21	19	27	17	16	12	15	7	7	4	2	6	7	9	7	16	13	15	10		
1935 1935												4	11	2	20	23	44	55	29	23	15	20	10	14	9	7	6	8	10	10	11	19	8	7	
1936 1936										2	16	20	32	24	22	31	22	14	15	12	12	13	7	11	6	6	10	10	14	13	18	29	7		
1937 1937													1	10	17	15	19	26	22	20	12	16	9	10	14	5	16	18	22	12	30	45	25	1	
1938 1938												1		13	26	27	30	37	28	14	14	14	8	11	10	9	14	8	16	16	30	26	12	1	
1939 1939								1				3	5	19	40	31	34	31	17	6	17	11	4	14	15	12	16	20	20	22	16	9	2		
1940 1940									1			4	21	47	28	38	30	27	21	16	21	21	5	8	7	11	10	7	10	11	11	11			
1941 1941												12	11	12	10	15	45	40	41	27	15	17	3	11	10	8	13	13	13	17	23	9			
1942 1942													4	14	12	31	55	30	23	19	22	15	6	8	14	9	11	15	10	10	38	19			
1943 1943													2	14	16	20	32	18	32	24	17	22	30	26	18	17	14	9	23	11	16	4			
1944 1944												1	28	8	15	46	53	48	36	30	22	15	6	8	11	3	4	5	8	9	9	1			
1945 1945									3	7	12	16	9	35	31	24	43	26	18	20	18	14	6	3	12	6	8	8	10	14	17	5			
1946 1946											42	30	30	25	15	27	30	30	16	13	8	9	3	2	13	4	9	12	7	7	33				
1947 1947										2	33	4	16	21	22	25	31	27	28	18	15	12	9	11	13	11	12	16	9	12	18				
1948 1948							9	6	2	3	3	7	7	11	15	16	48	46	36	15	15	10	11	7	7	10	10	6	13	16	37				
1949 1949										11	27	34	25	35	28	36	27	19	18	17	15	8	2	5	7	10	5	8	11	7	10				

DURATION CURVE STATISTICAL CHARACTERISTICS FOR ...
STATION ID: 16594000 Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE = 00060
STATISTIC CODE - 00003 MEAN

DURATION DATA VALUES ARE INTERPOLATED FROM DURATION TABLE:
DATA ARE NOT ANALYTICALLY FITTED TO A PARTICULAR STATISTICAL DISTRIBUTION,
AND THE USER IS RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION.

ADDITIONAL CONDITIONS FOR THIS RUN ARE:
STATISTICS ARE BASED ON LOGARITHMS (BASE 10).
NUMBER OF VALUES IS REDUCED FOR EACH NEAR-ZERO OR ZERO VALUE.

NUMBER OF VALUES = 19 (NUMBER OF NEAR-ZERO VALUES = 0)
LISTING OF DATA FOLLOWS:

PERCENT OF TIME VALUE EQUALED OR EXCEEDED	DATA VALUE	
95.0	0.33	(LOG = -0.47598)
90.0	0.57	(LOG = -0.24713)
85.0	0.80	(LOG = -0.09743)
80.0	1.07	(LOG = 0.02834)
75.0	1.36	(LOG = 0.13214)
70.0	1.68	(LOG = 0.22465)
65.0	2.06	(LOG = 0.31481)
60.0	2.52	(LOG = 0.40095)
55.0	3.11	(LOG = 0.49310)
50.0	4.16	(LOG = 0.61880)
45.0	5.93	(LOG = 0.77313)
40.0	9.03	(LOG = 0.95546)
35.0	15.0	(LOG = 1.17745)
30.0	23.8	(LOG = 1.37576)
25.0	35.3	(LOG = 1.54717)
20.0	49.7	(LOG = 1.69634)
15.0	66.5	(LOG = 1.82285)
10.0	84.0	(LOG = 1.92436)
5.0	107.2	(LOG = 2.03037)

MEAN OF LOGS = 0.77343

STANDARD DEVIATION OF LOGS = 0.78512 (VARIABILITY INDEX - SEE USGS WSP 1542-A)

COEFFICIENT OF VARIATION = 1.01512

COEFFICIENT OF SKEW = 0.19446

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

DURATION TABLE OF DAILY VALUES

NUMBER OF DAYS IN CLASS

CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
WATER YEAR 1985 1985									9	33	42	21	23	7	29	33	27	19	14	12	6	8	2	3	6	9	5	11	11	26	9				

CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT	CLASS	VALUE	TOTAL	ACCUM	PERCT
1	0.00	33	25568	100.00	13	0.57	1019	22989	89.91	25	16.00	871	8757	34.25
2	0.02	8	25535	99.87	14	0.75	1209	21970	85.93	26	22.00	737	7886	30.84
3	0.03	7	25527	99.84	15	1.00	1364	20761	81.20	27	28.00	1044	7149	27.96
4	0.05	24	25520	99.81	16	1.30	1589	19397	75.86	28	38.00	1017	6105	23.88
5	0.06	22	25496	99.72	17	1.70	1957	17808	69.65	29	50.00	1216	5088	19.90
6	0.08	113	25474	99.63	18	2.30	1643	15851	62.00	30	66.00	1533	3872	15.14
7	0.11	138	25361	99.19	19	3.00	1295	14208	55.57	31	87.00	1467	2339	9.15
8	0.14	211	25223	98.65	20	4.00	1067	12913	50.50	32	115.00	777	872	3.41
9	0.19	194	25012	97.83	21	5.30	917	11846	46.33	33	152.00	86	95	0.37
10	0.25	506	24818	97.07	22	7.00	797	10929	42.74	34	201.00	9	9	0.04
11	0.33	532	24312	95.09	23	9.30	570	10132	39.63	35	0.00	0	0	0.00
12	0.43	791	23780	93.01	24	12.00	805	9562	37.40					

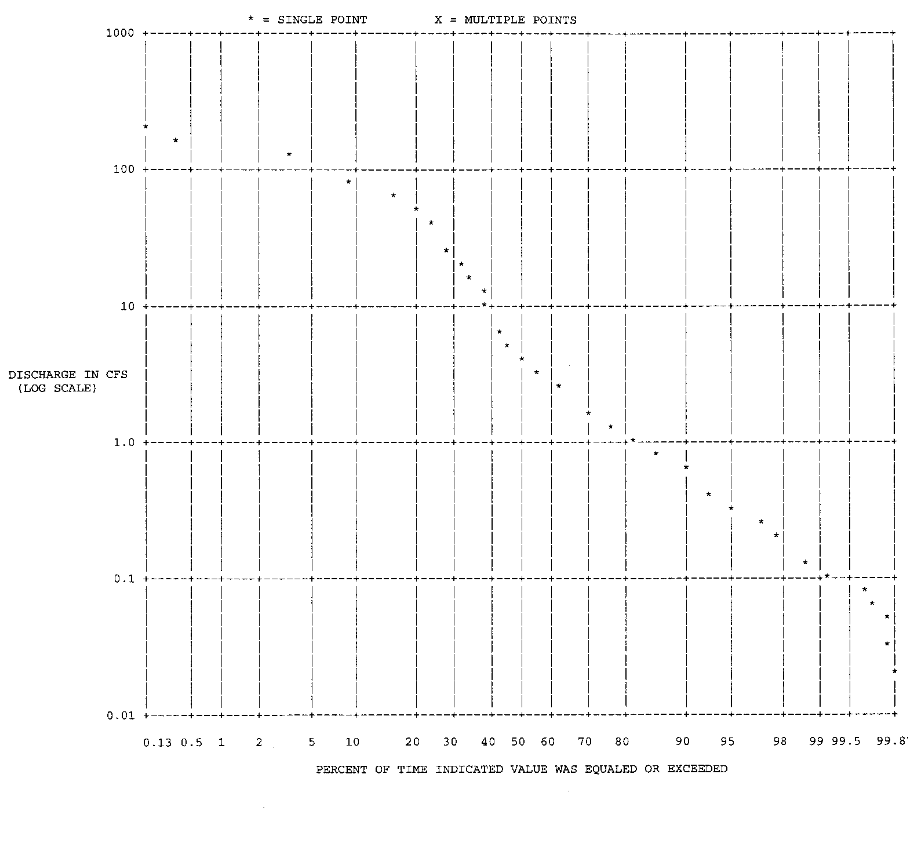
DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1911 1911	.0000 1	.067 8	.30 29	4.58 64	14.0 66	30.9 68	42.6 69	49.2 69	44.4 67
1914 1914	1.90 61	2.13 61	2.30 60	2.69 61	8.79 63	18.7 64	34.2 67	37.2 66	43.9 66
1916 1916	3.40 65	3.77 65	4.21 65	8.94 69	20.0 69	32.3 69	38.2 68	46.1 68	54.0 69
1917 1917	1.20 59	1.20 59	1.20 58	1.20 53	1.31 42	1.72 21	2.96 20	13.7 52	24.3 55
1918 1918	.93 57	.93 56	.97 55	1.10 48	1.11 40	10.5 59	16.4 58	20.8 58	38.4 61
1919 1919	2.20 63	2.27 63	2.33 61	2.52 60	3.01 54	9.18 56	22.3 62	25.7 61	34.3 59
1920 1920	.46 51	1.10 58	1.67 59	1.69 56	1.77 47	3.03 32	5.27 35	8.28 40	20.0 52
1921 1921	1.60 60	1.90 60	2.34 62	2.38 59	2.54 52	10.4 57	20.1 60	24.0 60	36.4 60
1922 1922	1.90 62	2.23 62	3.54 64	4.33 63	5.20 60	7.96 55	18.2 59	22.3 59	40.1 63
1923 1923	5.00 67	6.77 69	7.31 69	7.69 66	16.6 68	42.9 70	46.2 70	49.2 70	68.4 70
1924 1924	3.60 66	4.03 66	4.21 66	5.14 65	8.77 62	19.7 65	31.7 64	27.7 62	43.3 65
1925 1925	5.70 68	8.53 70	9.40 70	11.0 70	22.8 70	25.2 66	29.0 63	37.7 67	45.5 68
1926 1926	2.30 64	2.93 64	3.37 63	4.31 62	5.07 59	12.3 60	12.2 54	13.6 51	14.6 39
1927 1927	5.70 69	5.87 67	6.51 67	7.86 68	12.4 65	16.6 62	20.3 61	30.4 63	33.0 58
1928 1928	6.20 70	6.40 68	6.73 68	7.71 67	14.0 67	27.7 67	32.3 65	35.7 64	41.6 64
1931 1931	.0000 2	.0000 1	.044 4	2.17 58	5.03 58	10.4 58	16.0 56	18.5 56	21.5 54
1932 1932	.93 58	1.04 57	1.10 57	1.59 55	2.51 50	6.45 52	16.3 57	14.8 54	25.3 56
1933 1933	.31 40	.31 34	.33 34	.34 27	.43 19	1.05 9	1.62 6	2.86 12	3.71 1
1934 1934	.0000 3	.0000 2	.0000 1	.31 25	.31 8	3.26 33	3.78 26	3.84 18	6.80 16
1935 1935	.43 47	.46 47	.59 45	1.19 52	3.32 56	5.98 50	7.48 46	9.02 42	18.8 50
1936 1936	.28 36	.33 41	.37 38	.38 32	.87 32	3.57 37	3.56 24	6.34 33	12.9 35
1937 1937	.74 55	.76 52	.81 51	1.15 51	9.04 64	18.4 63	34.0 66	36.9 65	39.0 62
1938 1938	.43 48	.77 54	.87 53	1.72 57	4.98 57	7.39 54	10.5 51	16.7 55	32.9 57
1939 1939	.17 30	.49 48	.90 54	1.13 50	8.00 61	12.9 61	15.1 55	18.6 57	20.1 53
1940 1940	.22 34	.53 49	.63 48	.89 47	1.66 45	3.89 42	5.19 34	6.38 34	7.77 23
1941 1941	.43 49	.43 45	.52 44	.61 40	2.40 49	3.59 38	6.41 42	7.52 39	14.2 38
1942 1942	.57 53	.68 51	.83 52	1.32 54	1.66 46	3.26 34	9.07 49	11.3 46	19.8 51
1943 1943	.74 56	.79 55	.98 56	1.12 49	3.23 55	5.82 49	6.96 45	7.32 37	12.9 36
1944 1944	.53 52	.56 50	.62 47	.65 41	.81 27	3.96 43	5.95 38	6.98 36	7.87 25
1945 1945	.19 31	.22 29	.23 26	.29 21	.60 24	1.44 17	2.14 13	4.42 21	9.37 27
1946 1946	.34 44	.37 42	.38 39	.39 33	.86 31	2.03 23	6.19 41	8.75 41	16.6 46
1947 1947	.31 41	.32 39	.33 35	.34 28	.42 17	5.36 48	10.6 52	11.9 49	15.1 42
1948 1948	.11 21	.11 19	.11 14	.13 8	1.87 48	6.09 51	10.2 50	11.4 47	18.7 49
1949 1949	.31 42	.31 35	.31 31	.35 29	.45 20	1.52 18	1.97 11	4.20 20	6.54 12
1950 1950	.090 18	.090 15	.10 11	.18 13	.34 11	3.68 40	6.50 43	9.31 43	12.6 33

LOG-NORMAL DURATION PLOT FOR PERIOD OCT TO SEP (YEARS 1910 - 1986)
STATION ID: 16594000 Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN



DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1911 1911	91.0 70	88.0 60	87.1 40	85.8 28	78.2 21	74.8 13	73.9 10	65.2 10	61.1 11
1914 1914	101 61	96.3 49	92.1 33	90.0 25	85.1 18	84.3 9	82.1 7	82.3 5	77.7 5
1916 1916	136 19	127 21	121 17	114 13	111 6	107 4	103 3	101 2	86.3 3
1917 1917	131 21	128 19	113 20	102 17	93.2 13	82.4 11	69.3 13	55.5 15	37.1 19
1918 1918	151 12	146 8	144 6	134 2	128 1	118 1	102 4	93.2 4	80.8 4
1919 1919	137 17	134 17	129 15	111 14	92.1 14	65.2 19	56.3 18	57.0 14	51.3 14
1920 1920	137 18	137 15	136 13	132 4	104 11	57.6 24	39.7 28	35.5 28	31.2 27
1921 1921	139 14	139 13	137 10	130 5	113 4	105 5	94.8 5	81.2 7	73.0 7
1922 1922	158 8	139 12	138 9	129 7	116 3	108 3	108 1	105 1	93.6 1
1923 1923	139 15	139 14	137 11	132 3	126 2	112 2	107 2	100 3	86.7 2
1924 1924	158 9	145 9	132 14	126 10	112 5	96.4 6	80.7 8	66.4 9	63.5 10
1925 1925	156 10	155 6	153 5	120 12	110 7	87.8 7	76.1 9	70.4 8	73.4 6
1926 1926	139 16	118 23	97.6 29	87.1 27	61.8 32	46.1 30	36.4 34	32.0 36	26.8 36
1927 1927	155 11	144 11	136 12	128 8	107 8	82.8 10	70.0 12	62.9 11	63.8 9
1928 1928	179 4	152 7	126 16	101 18	83.6 19	79.3 12	71.5 11	59.6 12	54.7 12
1931 1931	127 23	118 24	104 23	70.9 39	61.1 33	48.5 28	42.2 25	33.8 32	31.4 26
1932 1932	136 20	136 16	103 27	69.5 43	60.2 35	46.6 29	38.7 31	41.8 22	33.3 23
1933 1933	121 28	84.0 66	53.1 67	39.0 64	30.9 64	23.2 64	20.6 61	19.1 60	14.7 64
1934 1934	179 5	179 3	167 2	127 9	101 12	67.3 16	58.8 16	51.2 16	37.6 17
1935 1935	209 1	209 1	162 3	104 16	66.0 28	55.8 25	46.3 24	44.7 19	42.2 16
1936 1936	170 6	170 4	155 4	129 6	107 9	69.1 15	61.4 15	50.9 17	47.4 15
1937 1937	201 3	190 2	172 1	136 1	106 10	87.2 8	88.1 6	81.9 6	69.1 8
1938 1938	209 2	156 5	144 7	125 11	88.4 17	67.1 17	67.0 14	58.7 13	52.0 13
1939 1939	167 7	144 10	138 8	91.2 24	67.5 26	45.4 32	39.7 29	36.2 26	32.9 24
1940 1940	142 13	130 18	118 18	96.7 23	65.1 29	38.3 42	29.0 48	22.6 52	19.5 53
1941 1941	127 24	119 22	90.4 35	66.2 49	49.8 49	37.5 44	34.3 36	33.6 33	31.2 28
1942 1942	130 22	128 20	118 19	108 15	90.6 15	72.3 14	58.1 17	46.3 18	34.8 21
1943 1943	118 29	107 29	83.1 47	71.0 38	54.9 43	49.5 27	41.6 26	35.8 27	30.9 29
1944 1944	122 25	93.3 54	61.8 62	35.1 68	27.3 65	22.8 65	17.7 65	18.2 63	14.1 67
1945 1945	122 26	110 25	101 28	77.3 34	58.1 38	37.1 46	27.7 50	21.2 57	23.6 43
1946 1946	114 30	110 26	104 22	85.8 29	71.5 23	58.0 23	41.1 27	33.3 34	26.4 37
1947 1947	110 38	97.3 44	58.9 64	45.1 60	32.9 62	27.0 59	25.3 56	21.3 56	21.1 49
1948 1948	114 31	108 27	103 26	100 20	89.6 16	59.6 21	47.1 23	37.6 24	29.8 32
1949 1949	110 39	100 38	77.1 52	43.5 62	32.3 63	28.1 58	20.5 62	15.5 67	15.1 62
1950 1950	107 47	105 32	103 24	101 19	82.7 20	66.7 18	51.6 19	40.8 23	30.8 30

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

LOWEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	14	30	60	90	120	183
1951 1951	.050 8	.050 6	.057 5	.069 3	.50 21	.66 6	2.13 12	2.74 11	5.17 8
1952 1952	.050 9	.080 12	.096 10	.15 10	2.72 53	7.19 53	11.6 53	14.3 53	16.7 47
1953 1953	.0000 4	.007 4	.020 3	.050 2	.17 3	1.06 10	2.71 18	2.54 7	4.46 4
1954 1954	.0000 5	.0000 3	.0000 2	.0000 1	.34 10	2.03 24	3.66 25	4.81 22	8.29 26
1955 1955	.12 25	.12 20	.12 16	.13 9	.82 29	2.61 28	5.17 33	6.15 30	10.5 29
1956 1956	.090 19	.10 18	.11 12	.12 7	.26 6	1.87 22	1.56 5	2.28 5	6.66 14
1957 1957	.14 26	.14 24	.14 20	.15 11	.17 2	.38 2	5.08 32	6.24 32	7.83 24
1958 1958	.050 10	.063 7	.077 6	.094 4	.85 30	4.06 44	6.04 39	11.4 48	14.9 41
1959 1959	.080 15	.087 14	.11 13	.24 17	1.34 43	3.86 41	6.73 44	6.38 35	14.7 40
1960 1960	.080 16	.080 13	.083 8	.67 42	.90 34	4.64 46	5.65 37	7.33 38	13.8 37
1961 1961	.31 43	.32 40	.35 36	.39 34	.50 22	2.84 29	2.67 17	5.09 24	7.00 17
1962 1962	.28 37	.31 36	.37 37	.80 45	.88 33	2.16 25	3.42 21	4.18 19	5.06 7
1963 1963	.060 12	.073 10	.091 9	.095 5	.10 1	1.28 12	3.50 22	3.71 17	4.83 6
1964 1964	.40 45	.42 44	.44 43	.46 37	1.10 39	4.48 45	4.92 30	5.86 27	11.3 30
1965 1965	.060 13	.097 16	.14 19	.19 14	.40 14	3.52 36	4.41 28	6.23 31	11.3 31
1966 1966	.15 28	.16 25	.19 23	.29 22	.39 13	2.96 31	3.97 27	5.16 25	7.38 22
1967 1967	.65 54	.76 53	.79 50	.87 46	1.06 38	4.98 47	7.97 47	12.0 50	16.2 44
1968 1968	.050 11	.31 37	.69 49	.71 43	.90 35	2.54 27	3.50 23	3.54 16	17.5 48
1969 1969	.11 22	.12 21	.14 18	.16 12	.22 4	2.88 30	2.23 15	3.11 13	5.22 9
1970 1970	.030 7	.043 5	.081 7	.11 6	.23 5	.51 4	1.85 9	3.42 15	5.26 10
1971 1971	.14 27	.16 26	.21 25	.24 18	.41 16	1.43 16	1.78 8	1.94 3	9.69 28
1972 1972	.43 50	.44 46	.44 42	.59 39	1.18 41	1.63 20	4.60 29	6.06 28	7.22 19
1973 1973	.11 23	.23 30	.61 46	.78 44	.81 28	.90 7	1.25 4	1.35 1	5.66 11
1974 1974	.090 20	.10 17	.12 15	.26 20	1.03 37	1.30 13	2.77 19	2.72 10	7.30 20
1975 1975	.28 38	.29 33	.31 32	.33 26	.58 23	1.34 14	1.72 7	3.41 14	4.70 5
1976 1976	.15 29	.18 27	.20 24	.25 19	.36 12	1.54 19	2.17 14	2.08 4	7.00 18
1977 1977	.020 6	.073 11	.18 21	.23 16	.27 7	.36 1	1.02 2	5.01 23	12.8 34
1978 1978	.40 46	.40 43	.41 41	.45 36	.69 26	1.03 8	5.51 36	5.20 26	7.31 21
1979 1979	.11 24	.12 22	.19 22	.30 24	.69 25	3.66 39	6.12 40	6.13 29	6.69 15
1980 1980	.22 35	.29 32	.39 40	.41 35	1.36 44	2.42 26	4.94 31	10.4 44	16.2 45
1981 1981	.19 32	.28 31	.31 30	.37 31	.40 15	.49 3	.93 1	2.64 8	3.82 2
1982 1982	.060 14	.067 9	.13 17	.21 15	2.53 51	3.37 35	8.73 48	10.6 45	15.3 43
1983 1983	.080 17	.12 23	.26 28	.51 38	.90 36	1.11 11	1.21 3	2.39 6	3.82 3
1984 1984	.29 39	.31 38	.33 33	.36 30	.42 18	1.34 15	1.86 10	1.85 2	6.59 13
1985 1985	.21 33	.21 28	.25 27	.29 23	.33 9	.65 5	2.61 16	2.64 9	11.6 32

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN LOW-VALUE ANALYSIS (OCT-SEP) WATER YEAR RANGE			MEAN VALUE AND RANKING FOR PERIOD INCLUDED IN HIGH-VALUE ANALYSIS (OCT-SEP) WATER YEAR RANGE		
1911 1911	55.0	65	1911 1911	55.0	6
1914 1914	60.9	67	1914 1914	60.9	4
1916 1916	75.9	70	1916 1916	75.9	1
1917 1917	31.2	56	1917 1917	31.2	15
1918 1918	53.9	64	1918 1918	53.9	7
1919 1919	40.3	58	1919 1919	40.3	13
1920 1920	21.3	45	1920 1920	21.3	26
1921 1921	49.3	62	1921 1921	49.3	9
1922 1922	62.8	68	1922 1922	62.8	3
1923 1923	72.9	69	1923 1923	72.9	2
1924 1924	51.0	63	1924 1924	51.0	8
1925 1925	57.4	66	1925 1925	57.4	5
1926 1926	23.4	47	1926 1926	23.4	24
1927 1927	48.2	60	1927 1927	48.2	11
1928 1928	46.9	59	1928 1928	46.9	12
1931 1931	27.9	54	1931 1931	27.9	17
1932 1932	25.8	51	1932 1932	25.8	20
1933 1933	8.45	4	1933 1933	8.45	67
1934 1934	21.6	46	1934 1934	21.6	25
1935 1935	26.4	52	1935 1935	26.4	19
1936 1936	28.5	55	1936 1936	28.5	16
1937 1937	49.1	61	1937 1937	49.1	10
1938 1938	35.0	57	1938 1938	35.0	14
1939 1939	23.5	48	1939 1939	23.5	23
1940 1940	15.9	28	1940 1940	15.9	43
1941 1941	21.2	44	1941 1941	21.2	27
1942 1942	27.2	53	1942 1942	27.2	18
1943 1943	19.7	41	1943 1943	19.7	30
1944 1944	10.4	10	1944 1944	10.4	61
1945 1945	15.8	27	1945 1945	15.8	44
1946 1946	16.6	32	1946 1946	16.6	39
1947 1947	15.5	26	1947 1947	15.5	45
1948 1948	20.5	43	1948 1948	20.5	28
1949 1949	10.0	8	1949 1949	10.0	63
1950 1950	19.6	40	1950 1950	19.6	31
1951 1951	7.39	2	1951 1951	7.39	69
1952 1952	17.2	37	1952 1952	17.2	34
1953 1953	9.89	7	1953 1953	9.89	64
1954 1954	16.9	36	1954 1954	16.9	35
1955 1955	16.2	30	1955 1955	16.2	41
1956 1956	18.9	38	1956 1956	18.9	33

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

HIGHEST MEAN VALUE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS
FOR PERIOD OCT TO SEP

WATER YEAR RANGE	1	3	7	15	30	60	90	120	183
1951 1951	108 42	95.7 53	57.1 66	38.6 66	24.5 68	15.5 68	11.4 69	10.5 69	9.97 69
1952 1952	104 50	104 33	86.3 42	67.0 47	40.1 55	28.3 56	27.3 52	26.4 43	22.4 46
1953 1953	108 43	97.7 43	79.9 50	66.5 48	59.4 36	38.2 43	27.7 51	21.0 58	15.3 61
1954 1954	113 33	98.7 42	86.6 41	70.5 40	52.1 47	42.3 36	34.9 35	34.4 30	27.7 34
1955 1955	122 27	103 37	88.0 37	62.9 51	47.6 50	33.6 53	29.1 46	27.2 41	25.6 38
1956 1956	108 44	97.0 46	88.0 38	83.3 30	57.8 39	53.7 26	50.0 20	42.4 21	34.9 20
1957 1957	113 34	104 34	103 25	99.7 22	63.1 31	35.9 48	25.5 55	21.7 54	17.9 55
1958 1958	104 51	104 35	93.0 32	69.0 44	60.5 34	42.6 35	32.6 38	32.9 35	30.3 31
1959 1959	108 45	104 36	80.1 48	61.1 52	43.7 53	36.6 47	29.5 45	25.6 45	23.7 41
1960 1960	103 53	88.0 61	74.7 55	69.8 41	54.9 44	39.7 39	31.8 40	27.0 42	22.9 44
1961 1961	92.0 69	86.3 63	80.0 49	60.7 53	38.9 57	25.9 61	19.1 64	19.6 59	15.9 60
1962 1962	101 62	99.0 40	67.1 60	55.0 55	41.5 54	32.1 55	23.4 59	18.3 62	17.7 56
1963 1963	101 63	96.7 47	83.9 45	68.3 46	57.3 41	44.8 33	38.1 32	34.3 31	25.3 39
1964 1964	102 57	80.0 67	60.0 63	47.2 57	34.5 61	28.2 57	27.2 53	25.0 46	22.1 48
1965 1965	107 48	106 30	106 21	99.9 21	68.1 25	42.3 37	29.8 43	24.1 50	20.2 52
1966 1966	102 58	86.7 62	77.0 53	68.4 45	44.5 52	33.4 54	30.9 42	29.1 39	22.4 47
1967 1967	100 65	96.0 51	95.1 31	79.0 32	57.7 40	35.0 50	29.6 44	27.8 40	22.7 45
1968 1968	101 64	99.7 39	97.3 30	89.1 26	72.9 22	62.6 20	47.2 22	36.7 25	32.4 25
1969 1969	102 59	97.3 45	84.7 44	79.9 31	66.8 27	46.1 31	33.1 37	29.9 38	27.7 35
1970 1970	103 54	89.0 59	71.0 58	69.8 42	55.4 42	35.5 49	25.3 57	24.5 48	20.4 51
1971 1971	114 32	108 28	88.7 36	64.4 50	53.2 45	37.5 45	29.1 47	23.3 51	23.7 42
1972 1972	102 60	84.3 65	42.9 70	33.0 69	21.3 69	12.0 69	13.7 68	11.1 68	10.6 68
1973 1973	111 37	105 31	83.9 46	72.2 36	52.2 46	38.7 41	31.6 41	26.0 44	28.2 33
1974 1974	113 35	96.0 52	71.3 57	38.8 65	26.8 66	17.2 67	15.9 67	15.9 66	14.7 65
1975 1975	99.0 66	71.7 70	48.0 68	35.5 67	25.7 67	22.1 66	21.6 60	19.0 61	16.4 59
1976 1976	104 52	77.0 69	57.6 65	45.8 59	40.1 56	34.0 52	28.7 49	24.8 47	18.3 54
1977 1977	109 41	92.7 55	78.1 51	53.3 56	51.2 48	41.8 38	32.0 39	24.4 49	21.1 50
1978 1978	108 46	78.7 68	68.1 59	42.6 63	35.2 60	26.6 60	23.5 58	21.6 55	17.6 57
1979 1979	112 36	92.7 56	66.7 61	47.0 58	45.7 51	34.5 51	26.7 54	22.2 53	16.5 58
1980 1980	103 55	99.0 41	85.3 43	78.4 33	71.5 24	58.8 22	49.4 21	43.0 20	37.3 18
1981 1981	105 49	90.0 58	43.9 69	21.6 70	12.6 70	8.77 70	8.09 70	6.57 70	5.93 70
1982 1982	110 40	96.3 50	87.4 39	73.4 35	64.9 30	43.4 34	37.5 33	35.4 29	33.8 22
1983 1983	99.0 67	96.7 48	91.6 34	60.1 54	37.1 59	25.6 62	19.5 63	16.3 65	14.2 66
1984 1984	98.0 68	84.7 64	75.0 54	44.9 61	37.4 58	24.2 63	17.3 66	16.7 64	14.9 63
1985 1985	103 56	92.3 57	72.4 56	71.6 37	58.2 37	38.8 40	38.9 30	30.4 37	24.4 40

DVSTAT - DAILY VALUES STATISTICAL PROGRAM

STATION ID - 16594000
Haiku Ditch at Honopou Gulch near Kailua, Maui, HI
PARAMETER CODE - 00060 DISCHARGE
STATISTIC CODE - 00003 MEAN

ANNUAL AND/OR SEMI-ANNUAL VALUES

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN LOW-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE			
1957	1957	13.0	18
1958	1958	20.4	42
1959	1959	16.7	34
1960	1960	14.9	24
1961	1961	10.6	11
1962	1962	11.1	14
1963	1963	14.5	23
1964	1964	16.2	31
1965	1965	15.3	25
1966	1966	14.2	21
1967	1967	16.7	33
1968	1968	19.1	39
1969	1969	15.9	29
1970	1970	12.6	17
1971	1971	14.5	22
1972	1972	7.72	3
1973	1973	16.8	35
1974	1974	9.28	5
1975	1975	9.74	6
1976	1976	11.1	13
1977	1977	13.1	19
1978	1978	12.2	15
1979	1979	12.5	16
1980	1980	23.6	49
1981	1981	5.13	1
1982	1982	24.3	50
1983	1983	10.1	9
1984	1984	10.7	12
1985	1985	13.4	20

MEAN VALUE AND RANKING FOR
PERIOD INCLUDED IN HIGH-VALUE ANALYSIS
(OCT-SEP)

WATER YEAR RANGE			
1957	1957	13.0	53
1958	1958	20.4	29
1959	1959	16.7	37
1960	1960	14.9	47
1961	1961	10.6	60
1962	1962	11.1	57
1963	1963	14.5	48
1964	1964	16.2	40
1965	1965	15.3	46
1966	1966	14.2	50
1967	1967	16.7	38
1968	1968	19.1	32
1969	1969	15.9	42
1970	1970	12.6	54
1971	1971	14.5	49
1972	1972	7.72	68
1973	1973	16.8	36
1974	1974	9.28	66
1975	1975	9.74	65
1976	1976	11.1	58
1977	1977	13.1	52
1978	1978	12.2	56
1979	1979	12.5	55
1980	1980	23.6	22
1981	1981	5.13	70
1982	1982	24.3	21
1983	1983	10.1	62
1984	1984	10.7	59
1985	1985	13.4	51