WAI'ANAE WATERSHED MANAGEMENT PLAN

PREPARED FOR:
HONOLULU BOARD OF WATER SUPPLY

PREPARED BY:
TOWNSCAPE, INC.
AUGUST 2009

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GLOSSARY

Aquifer

A geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses.[1]

Aquifer Sector Area

A large region with hydrogeological similarities. "Sectors reflect broad hydrogeological similarities yet maintain traditional hydrographic, topographic and historical boundaries where possible."[2]

Aquifer System Area

An area within a sector showing ground water hydraulic continuity.[3]

Continuous Stream

A type of perennial stream that flows to the sea year-round under normal conditions, including streams with diversions.[4]

Criteria

Measures or standards for judging or selecting among choices.[5]

Domestic Use

"any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, noncommercial gardening and sanitation."[6]

Ground Water

"any water found beneath the surface of the earth, whether or not in perched, dike-confined or basal supply; in underground channels or streams; in standing, percolating or flowing condition; or under artesian pressure."[7]

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[1] USGS, Water Science Glossary of Terms, http://ga.water.usgs.gov/edu/dictionary.html#A
[2] Wilson Okamoto & Associates, Inc., March 1990, *Oahu Water Management Plan Technical Reference Document*, Department of General Planning City and County of Honolulu, p. 21.
[3] Wilson Okamoto & Associates, Inc., March 1990, *Oahu Water Management Plan Technical Reference Document*, Department of General Planning City and County of Honolulu, p. 21.
[4] *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*, 1990, p. 9.
[5] American Planning Association Hawaii Chapter, 1999, *From the Ground Up: A Handbook for Community-Based Land Use Planning*, p. 97.
[6] Revised Ordinances of Honolulu Chapter 30: Water Management, §30-1.2 Definitions
[7] Revised Ordinances of Honolulu Chapter 30: Water Management, §30-1.2 Definitions

Instream Flow Standard

"a quantity or 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."[8]

The amount of water required to protect instream uses such as to protect fish and wildlife habitat, aesthetic values, or traditional Hawaiian uses.[9]

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."[10]

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."[11]

Intermittent Streams

Streams that are normally dry during part of the year.[12]

Interrupted Streams

A type of perennial stream that flows year-round in the upper portions and intermittently at lower elevations under normal conditions. The interruption may be natural or man-made.[13]

Median Stream Flow

The flow at the gaging station that is exceeded 50% of the time.

Metered Consumption

The amount of water consumed by a specific user or system as measured by a water meter or aggregation of meters. Not all water infrastructure has a water meter, therefore making it difficult to determine the amount of water that is conveyed by that system.

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[8] HRS §174 C-3, State Water Code.
[9] *Oahu Water Management Plan*. 1992. p.11
[10] HAR §13-167-2.
[11] HRS §174 C-3, State Water Code.
[12] *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*, 1990, p. 9.
[13] *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*, 1990, p. 9.

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."[14]

Non-instream 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."[15]

Palustrine Wetland

Shallow non-tidal freshwater areas that lack flowing water and are dominated by trees and shrubs.

Perennial Streams

Streams that normally have surface flow year-round, in all or part of their course, as opposed to intermittent streams.[16]

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."[17]

Streams are considered separate entities when they have a separate mouth to the sea.[18]

Stream Channelization

Stream channelization is the realignment or lining of a natural stream channel for the purposes of flood or erosion control.

Stream Diversion

"the act of removing water from a stream into a channel, pipeline, or other conduit."[19]

[14] HRS §174 C-3, State Water Code.
[15] HRS §174 C-3, State Water Code.
[16] *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*, 1990, p. 9.
[17] HAR §13-167-2.
[18] *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*, 1990, p. 9.
[19] HRS §174 C-3, State Water Code.

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, and reservoirs) and diffused surface water (that is, water occurring upon the surface of the ground other than in contained waterbodies). Water from natural springs is surface water when it exits from the spring into the earth's surface."[20]

Sustainable Yield

"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."[21]

Forced withdrawal rate of ground water that could be sustained indefinitely from an aquifer without affecting either the quality of the pumped water or the volume rate of pumping. Meant to be a guide for planning.[22]

Total Maximum Daily Loads

Calculations of the maximum amount of each pollutant that can enter a given water body without violating state water quality standards

Water or Waters of the State

"any and all water on or beneath the surface of the ground, including natural or artificial watercourses, lakes, ponds, or diffused surface water and water percolating, standing, or flowing beneath the surface of the ground."[23]

Water Management Area

"a geographic area which has been designated pursuant to chapter 13-171 as requiring management of the ground or surface water resource, or both."[24]

Designated by the Commission when it is determined that water resources in the area may be threatened by existing or proposed withdrawals or diversions of water.[25]

Water Pumpage

The volume of water pumped from a ground water source.

[20] HAR §13-167-2.
[21] HAR §13-167-2.
[22] *Oahu Water Management Plan*. 1992. p.3
[23] HAR §13-167-2.
[24] HAR §13-167-2.
[25] *Oahu Water Management Plan*. 1992. p.7

Water Source

"a place within or from which water is or may be developed, including but not limited to: (1) generally, an area such as a watershed defined by topographic boundaries, or a definitive ground water body; and (2) specifically, a particular stream, other surface water body, spring, tunnel, or well or related combination thereof."[26]

Water Withdrawal

The volume of water withdrawn from a ground or surface water source.

Wetlands

Areas that are regularly wet or flooded throughout most of the year and are often characterized by specific plant associations and soil types.

ACRONYMS

AAG	*Ahupuaʻa* Advisory Group
ALISH	Agricultural Lands of Importance to the State of Hawaiʻi
AWUDP	Agricultural Water Use and Development Plan
AWWA	American Water Works Association
BMP	Best Management Practice
BOR	U.S. Department of the Interior Bureau of Reclamation
BWS	Honolulu Board of Water Supply
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFS	Cubic Feet per Second
CIP	Capital Improvement Program
CLGP	Certified Local Government Program
CNO	Chief of Naval Operations
CWA	Clean Water Act
CTAHR	University of Hawaiʻi College of Tropical Agriculture and Human Resources
CWB	Clean Water Branch

[26] HAR §13-167-2.

CWRM	State of Hawaii Commission on Water Resource Management
CY	Calendar Year
CZM	Hawai'i Coastal Zone Management Program
DAR	Division of Aquatic Resources
DFM	Department of Facility Maintenance
DHHL	Department of Hawaiian Home Lands
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOFAW	Division of Forestry and Wildlife
DOH	State of Hawai'i Department of Health
DP	Development Plan
DPW	U.S. Army Hawai'i. Directorate of Public Works
ENV	Department of Environmental Services, City and County of Honolulu
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GP	General Plan
GPCD	Gallons Per Capita per Day
GPD	Gallons Per Day
HFBF	Hawai'i Farm Bureau Federation
HWP	Hawai'i Water Plan
HRS	Hawaii Revised Statutes
HSA	Hawaii Stream Assessment
IFS	Instream Flow Standard
IIFS	Interim Instream Flow Standard
IRP	Integrated Resource Planning
MA'O	Mala 'Ai 'Ōpio
MAPS	Multi-Attribute Prioritization of Streams

MCL	Maximum Contaminant Level
MG	Million gallons
MGD	Millions of gallons per day
MSL	Mean Sea Level
NARS	Nature Area Reserves System
NAVMAG	Naval Magazine
NCTAMS	Naval Computer and Telecommunications Area Master Station
NELHA	Natural Energy Laboratory of Hawaiʻi Authority
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
OTEC	Ocean Thermal Energy Conversion
OWMP	Oʻahu Water Management Plan
PCA	Potential Contaminating Activity
PUC	Primary Urban Center
RAM	Robust Analytical Model
ROH	Revised Ordinances of Honolulu
RTF	Radio Transmitter Facility
SAP	Special Area Plans
SCHHA	State Council of Hawaiian Homestead Associations
SCP	Sustainable Communities Plan
SDWA	Safe Drinking Water Act
SDWB	Safe Drinking Water Branch
SMA	Special Management Area
SMZ	Streamside Management Zones
SWAP	Source Water Assessment Program
SWPP	State Water Projects Plan
SWQP	State Water Quality Plan
SY	Sustainable Yield

TMDL	Total Maximum Daily Load
TNCH	The Nature Conservancy Hawaiʻi
UH NREM	University of Hawaiʻi Department of Natural Resources and Environmental Management
UIC	Underground Injection Control
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCCHC	Waiʻanae Coast Comprehensive Health Center
WEC	Waiʻanae Ecological Characterization Project
WMA	Water Management Area
WMP	Watershed Management Plan
WOSWCD	West Oʻahu Soil and Water Conservation District
WQLS	Water Quality Limited Segment
WQP	Water Quality Plan
WRPP	Water Resources Protection Plan
WRRC	Water Resources Research Center
WSCP	Waiʻanae Sustainable Communities Plan
WWMP	Waiʻanae Watershed Management Plan
WWTP	Waiʻanae Waste Water Treatment Plant
WUDP	Water Use and Development Plan
WUZ	Water Use Zone

OV O'AHU WATER MANAGEMENT PLAN OVERVIEW

OV.1 AUTHORITY AND PURPOSE

The Watershed Management Plans (WMPs) have been prepared in accordance with the requirements of the State Water Code and Ordinance 90-62 of the City and County of Honolulu, which established the "O'ahu Water Management Plan." The State Water Code, Chapter 174-C protects, controls and regulates the use of the State's water resources for the benefit of its people and the environment. Under the Code, the City is responsible for preparing the county water use and development plan for the City and County of Honolulu. In response, City Ordinance 90-62, Water Management, established the O'ahu Water Management Plan (OWMP), which has evolved into a framework of regional WMPs by City development plan district to plan for the management of all water resources within each watershed (Appendices A and B).

The WMPs are prepared by the Honolulu Board of Water Supply (BWS) and BWS consultants, in collaboration with the City's Department of Planning and Permitting (DPP) and the Commission on Water Resource Management (CWRM). The plan will be submitted to the Board of Water Supply, the City Council and the CWRM for review and approval.

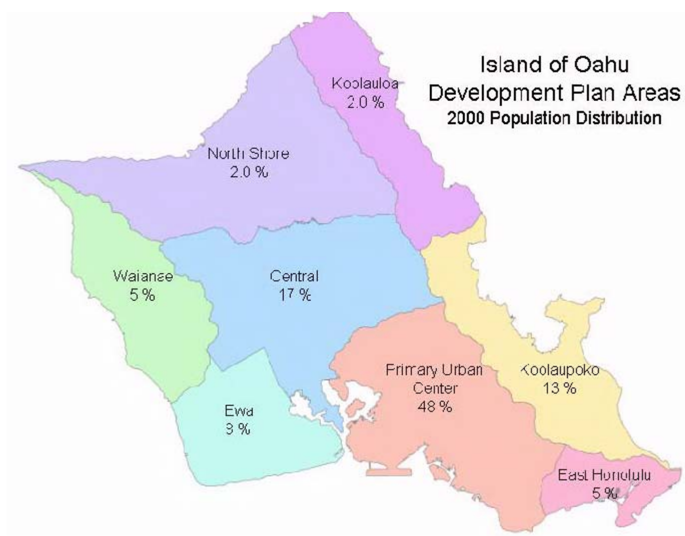

FIGURE OV-1
O'AHU DEVELOPMENT PLAN AREAS

Each of the eight WMPs together will constitute the OWMP. The land use districts are shown in Figure OV-1.

The OWMP consists of policies and strategies that will guide the City and County of Honolulu and will also provide advice to CWRM regarding the management, conservation, development, and allocation of Oʻahu's surface water and ground water resources for the next 25 years to 2030.

The OWMP shall be consistent with relevant Federal, State, and City laws and policy documents, including:

- Federal Clean Water Act and Safe Drinking Water Act
- Hawaiʻi State Water Plan
- State Water Code
- Statewide Framework for Updating the Hawaiʻi Water Plan
- Hawaiʻi Supreme Court Decisions on the Waiāhole Ditch and the Waiʻola O Molokaʻi contested cases
- City and County of Honolulu Ordinance 90-62 establishing the OWMP
- General Plan for the City and County of Honolulu
- City and County of Honolulu Development Plans and Sustainable Communities Plans
- BWS Sustainability Mission of "Water for Life, Ka Wai Ola"

OV.2 BWS MISSION

The Water for Life mission expanded the BWS' focus from water systems and services to the broader mission of meeting the needs of the community, the economy, and the environment. Thus, in fulfilling this mission, BWS seeks to ensure the sustainability of the island's water resources and to enhance the quality of life for the people of Oʻahu by providing world-class water services in a manner that:

- Protects the environment, including ground water, watersheds, streams, and shoreline areas.
- Supports Oʻahu's economy while working to achieve sustainable water supplies for future generations.

The BWS' mission is
"Water for Life – Ka Wai Ola."

OV.3 O'AHU WATER MANAGEMENT PLAN FRAMEWORK

The first OWMP was adopted in 1990. An update to the 1990 OWMP was completed in 1992, but was not adopted. Thereafter, the Technical Reference Document of the OWMP was updated several times between 1994 and 1998, but these updates were not adopted due to rapid changes to the water resources situation on O'ahu with the closing of the sugar plantations and the resulting Waiāhole Ditch Contested Case.

In 1999, BWS initiated an "Integrated Resource Planning" (IRP) process to update the OWMP as recommended by the CWRM. The IRP objective was to fulfill the water use and development plan mandate using advanced decision-making tools to resolve O'ahu's complex water issues. In August 2000, the Hawai'i Supreme Court announced their landmark decision that changed the way Hawai'i's water laws were interpreted. The court identified three public trust uses of water that have priority over other water uses: 1) maintenance of waters in their natural state; 2) domestic water use and 3) the exercise of Native Hawaiian and traditional and customary rights. The Supreme Court later in their Wai'ola O Moloka'i contested case hearing established reservations of water for Hawaiian Home Lands as a fourth public trust use. In response to the 2000 decision, BWS decided to expand the water planning principles to account for all the resources in the watershed, in addition to water use and development. Consistent with the BWS "Water for Life" mission, a holistic watershed approach modeled after the Hawaiian concept of *ahupua'a* was established. Elements of the IRP process were still used to develop the sections relating to the water use and development plan. The resulting WMPs are built on the following key planning principles:

- Community-based
- Environmentally holistic
- Based on *ahupua'a* management principles
- Action-oriented
- In alignment with State and County water and land use policies.

The following graphic (Figure OV-2) illustrates the planning framework for the OWMP. The framework identifies the various legal and planning documents that guide the plan. Each of the eight WMPs by O'ahu General Plan land use districts will be organized within this framework as a consolidating mechanism to place each of the regions into an island-wide perspective.

The framework is meant to establish and guide the watershed management objectives and strategies specific to each region. The eight WMPs tie directly into the eight land use plans through common boundaries, vision and policies. A key denominator integrating land use and water planning is the maintenance of a **healthy watershed**. Land use plans and water use and development plans that support growth and existing communities on O'ahu must ensure that watersheds remain healthy through sustainable planning practices, watershed

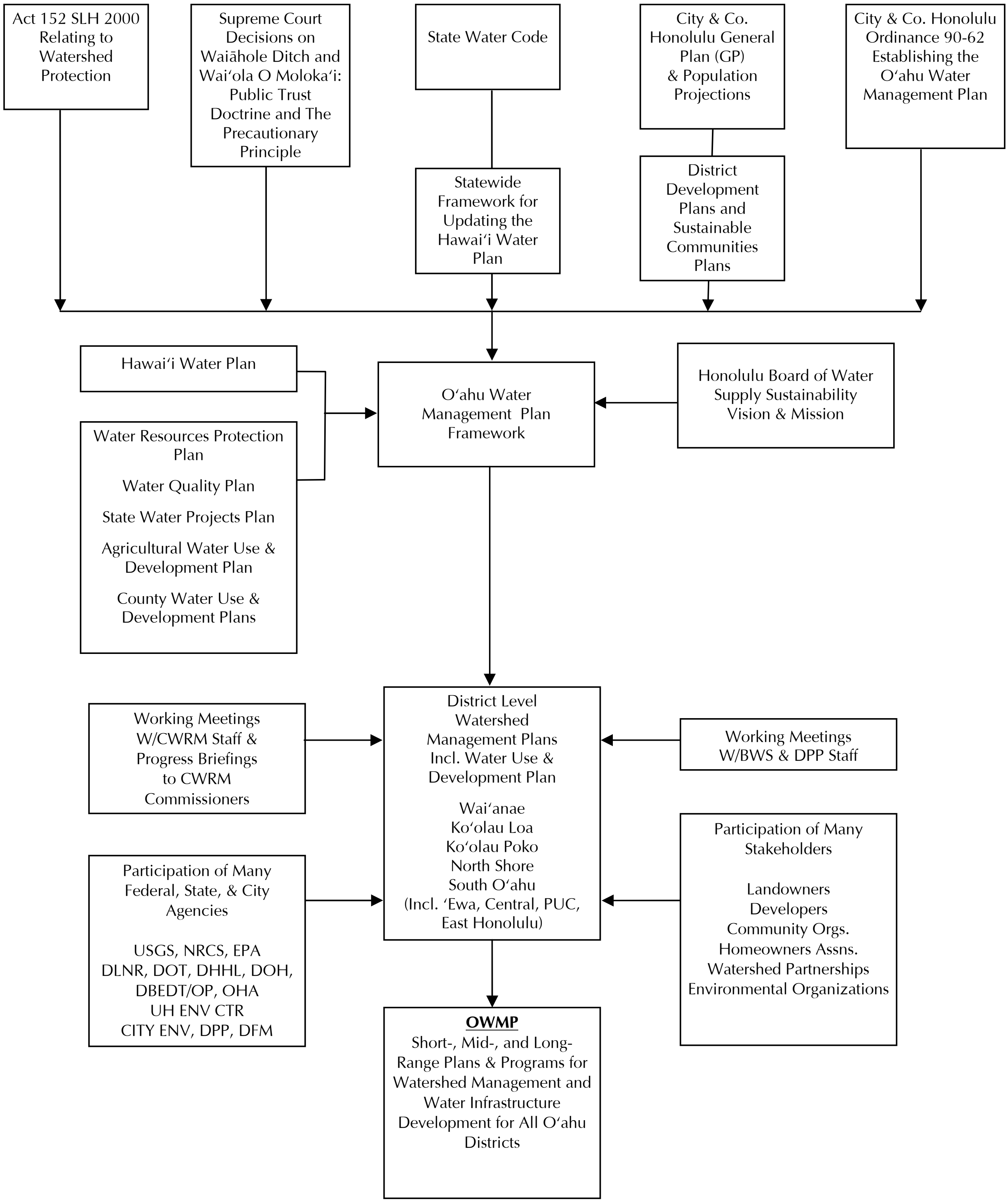

FIGURE OV-2

WATERSHED MANAGEMENT PLANS FOR O‘AHU STATE AND COUNTY LEVEL PLANNING FRAMEWORK DIAGRAM

protection projects and best management practices that minimize impacts.

Given these expressed inter-relationships, it is proposed that the WMPs undergo the same 5-year update cycle of the City's land use plans, so that with each iteration, land use and water planning become increasingly integrated to achieve a sustainable future.

Based on the planning principles and through a consultation process with community leaders, community groups, public agencies, land owners, and other stakeholders in the watershed management planning process, BWS then developed an overall statement of Goals and Objectives for the OWMP, as follows:

GOAL

To formulate an environmentally holistic, community-based, and economically viable WMP that will provide a balance between: (1) the protection, preservation and management of O'ahu's watersheds, and (2) sustainable ground water and surface water use and development to serve present users and future generations.

OBJECTIVES

1. Promote sustainable watersheds.
2. Protect and enhance water quality and quantity.
3. Protect Native Hawaiian rights and traditional and customary practices.
4. Facilitate public participation, education, and project implementation.
5. Meet future water demands at reasonable costs.

The WMP objectives were derived from an extensive stakeholder consultation process and reflect their values and thinking about water resources. These values and thinking were then consolidated into broad goals and objectives that apply island-wide thus providing the overall guidance and consistency for each of the eight district level WMPs. Each WMP will identify specific strategies and projects unique to each region to achieve these objectives. Each of the eight plans will define more specific sub-objectives, strategies and actions that reflect specific district conditions, issues, and needs.

Objective 1. Promote sustainable watersheds

Sustainable watersheds are bio-diverse, renewable, and resource productive land and water ecosystems extending from the mountains to the coral reefs, that meet present needs without compromising those of future generations. In a sustainable watershed, there is a holistic inter-relationship among watershed resources including geologic structures, soil characteristics, forest communities, endemic and indigenous animals, introduced species, ground water aquifers, streams and wetlands, reefs and near-shore waters, traditional and cultural practices, land use and land development. Healthy, sustainable watersheds should be the foundation for both land use and water resources management planning.

Sustainable watersheds can be achieved through the implementation of a comprehensive WMP that promotes a healthy watershed by emphasizing habitat and native species preservation, active forestry management practices, invasive species and pollution controls, resource conservation and demand-side management programs, low-impact development concepts and recycling.

Objective 2. Protect and enhance water quality and quantity

Water is essential to human life and to the health of the environment. As a valuable natural resource, it comprises marine, estuarine, wetlands, freshwater streams and ground water environments, across coastal and inland areas. Water has two dimensions that are closely linked - quality and quantity. Water quality relates to the composition of water as affected by natural processes and human activities. It depends not only on water's chemical condition, but also its biological, physical and radiological condition. Water quantity relates to the amount of renewable ground water supply or base stream flow existing on a sustainable basis in perpetuity. In a healthy environment, water quality and quantity supports a rich and varied community of organisms and protects public health. Water quality and quantity influence the way in which communities use the water for activities such as drinking, swimming, fishing, farming, gathering, or commercial purposes.

Drinking water systems are regularly tested for compliance with EPA Safe Drinking Water Standards and BWS criteria for system operations and resource monitoring. Watershed protection projects and programs will ensure that aquifers and streams are healthy and sustainable. Source water protection programs and the monitoring of hydrologic indicators of rainfall, stream and spring flows, and aquifer water levels will ensure consistently high source water quality. BWS ensures the health of the ground water aquifers by monitoring the island-wide index and deep monitor wells for water levels and chlorides at the top and mid-point of the freshwater-seawater transition zone. Source water quality can be affected by seawater intrusion or upconing brackish water especially during extended drought. Monitoring also ensures sufficient aquifer recovery during post-drought periods.

In conjunction with CWRM, University of Hawai‘i Water Resources Research Center (WRRC) and U.S. Geological Survey (USGS), BWS is advancing analytical methods and modeling tools to increase understanding of recharge and ground water aquifers and streams. The agencies will work together to fund, construct and utilize 3-dimensional solute transport ground water modeling calibrated with new deep monitor wells in basal aquifers to:

- Evaluate individual source yields to prevent upconing and saltwater intrusion during normal rainfall and drought events.

- Optimize existing source pumpages to meet water system demands and avoid detrimental impacts to the aquifer's utility (quality and quantity); ensure adequate aquifer recovery after long drought periods.
- Evaluate aquifer sustainable yields as allocations and pumpage approach sustainable yield limits to ensure new sources are sustainable.
- Site and size new wells to develop remaining ground water and minimize impacts to adjacent and down-gradient sources and surface waters.

Objective 3. Protect Native Hawaiian rights and traditional and customary practices

Native Hawaiian water rights are set forth in the State Constitution, Section 221 of the Hawaiian Homes Commission Act and Section 174C-101 of the State Water Code, providing for: a) Department of Hawaiian Home Lands water; b) traditional and customary gathering rights; and c) appurtenant water rights of *kuleana* and *kalo* lands. Native Hawaiian water uses also include cultural uses for spiritual/religious practices, *kalo* and other traditional agriculture, as well as adequate flows of freshwater into the nearshore water ecosystem.

The Hawaiʻi Supreme Court established the exercise of Native Hawaiian and traditional and customary practices as a public trust purpose, along with the maintenance of waters in their natural state and domestic water use, in Water Use Permit Applications, 94 Hawaiʻi 97, 136-37, 9 P.3d 409, 448-49.

Some of the objectives proposed for implementing the public trust purposes include the provision of adequate stream flows, riparian restoration, and control of alien species. These WMP objectives strive to ensure there are healthy and plentiful water resources available.

Protecting Native Hawaiian rights and traditional and customary practices must be done in conjunction with the setting of measurable instream flow standards (IFS), for all perennial streams and stream segments, balancing in-stream uses, domestic uses, and Native Hawaiian and traditional and customary uses with off-stream reasonable and beneficial uses. In developing those standards a precautionary order, consisting of instream studies such as stream hydrology and bio-assessments for habitat and gathering, is proposed. Studies of non-instream uses, domestic uses, and Native Hawaiian rights and traditional and customary uses of the stream water are also needed. Only after completing an evaluation of the instream uses, domestic uses, and Native Hawaiian rights and traditional and customary uses of stream water can a determination of availability of surface water for additional agricultural uses and urban nonpotable uses be accomplished.

Where practical, the WMP will identify the conversion of existing off-stream surface water uses to recycled water and implement conservation measures to create an opportunity for stream restoration. BWS will continue to develop new ground water sources that do not impact surface waters. However, if instream flow standards are established and surface water becomes available, ground water development that may reduce surface water within the allowances granted by the measurable IFS may be pursued.

Objective 4. Facilitate public participation, education, and project implementation

Planning and managing our island's water and related resources involves a variety of stakeholders from end users, landowners, public and private water purveyors and government agencies. A collaborative process can result in innovative planning and implementation that incorporates local knowledge and directly involves area residents. Public education involving water resource issues can support collaboration with informed stakeholders. Directed water resource curriculum for schools will ensure knowledge and respect for water resources will extend to future generations. Ultimately public participation will result in benefits to the water resources, water users and the related ecosystems.

Several watershed partnerships have been established in both conservation and urban areas with community groups, agencies and organizations with similar objectives. These partnerships pool funding, resources and initiatives toward common objectives of watershed health, education and project funding and implementation.

Objective 5. Meet water demands at reasonable costs

Water is essential to all life. O‘ahu’s population relies on an abundant and reliable water supply for drinking, irrigation, commercial and industrial use and fire protection. O‘ahu’s residents are educated in watershed management practices; water conservation is not just a message, but a way of life. Efficient water systems promote public health and safety and deliver water to meet current and future demands at reasonable costs. Reasonable costs encompass a balancing of the other plan objectives and are not necessarily the lowest economic costs. Capital improvements and operations and maintenance costs should not place an unreasonable burden on water rate payers. Water systems are flexible yet secure to account for uncertainties, and are expanded concurrent with land use plans and growth forecasts. Withdrawal rates are within established sustainable yields, which protect the long-term viability of the water resource and do not impact cultural uses and natural environments.

The allocation of water to land use matches water quality with appropriate use. Thus, high quality water is used for drinking and lower quality water, such as recycled water, is used for irrigation and industrial processes. New technology allows cost effective, diversified, drought proof water systems that develop ground water, surface water, recycled and seawater resources that meet water demands while balancing the other plan objectives.

The following categories describe the primary water planning elements of this objective:

Water Conservation

- Improving distribution system efficiencies will reduce Operations and Maintenance (O&M) costs and reduce water loss. Infrastructure water loss and efficiency measures include leak detection and repair of existing pipelines and the renewal and replacement of water system facilities (pipelines, pump stations, reservoirs and treatment systems). Advanced corrosion protection systems will maximize the life of existing and new pipelines.
- Promoting demand-side management programs provides hardware and behavioral modifications on customer water use. Water conservation tips, public service announcements and specific programs tailored to distinct user categories will effectively reduce water use and defer development of new water sources.
- Educational programs promote conservation as a way of life that effects a generational change in thinking that starts with the education of our children. BWS has been promoting water conservation best practices in schools for over 30 years.

Efficient Water Use and New Sources of Supply

- New source development can be deferred with increases in system efficiency, which is more cost effective. New source options must balance economic costs with environmental, cultural and social values.

Growth Projections

- Improving water demand forecasting methodologies will ensure that new sources become available at the appropriate time. The level of accuracy will improve as the calibration of leading indicators and trends improve.

Drought Mitigation

- A diversified and sustainable water system can mitigate drought impacts. The State and O‘ahu County Drought Plans have identified mitigation strategies and projects for water supply, agriculture and wildland fire prevention, to reduce the detrimental impacts of drought on water uses, the economy and the environment.

Operational Flexibility

- An integrated island-wide water system provides operational flexibility, water service reliability, and hydraulic efficiency. A flexible water system maintains level of service standards while allowing planned repair and maintenance. An important element of optimization integrates the operations of the existing water systems with sustainable aquifer pumpage levels.

Water System Reliability

- A diversified water supply system consisting of a combination of ground water, surface water, recycled water, desalinated water and seawater resources maximizes system reliability especially during periods of drought, high growth spurts and impacts from ground water contamination. The municipal water system is expanded and operated as an integrated island-wide water system to enhance system reliability.

- Water systems are constantly improved to meet BWS Water System Standards providing standby pump capacity, infrastructure redundancy, enhanced security systems and disaster response.
- Reliable water systems are energy efficient, have emergency power generation and are supplied with an increasing proportion of renewable energy supplies reducing reliance on imported oil. Elements of this objective include:
  - Reducing water system energy use per mgd produced.
  - Energy efficiency measures in pumping facilities include lighting, heating, ventilation and use of photovoltaics.
  - Peak power load reduction using reservoirs and diesel generators to meet peak hour water demand results in lower electric bills.
  - Researching and supporting renewable energy systems such as H-Power, wind, solar, biofuels, OTEC and wave energy will help reduce water pumping power consumption from imported oil, mitigating some of the global energy uncertainties.

Planning for Uncertainty

- Maximize the ability to effectively plan and respond to uncertainties in water supply, forecasting and climate change.

OV.4 O'AHU WATER USE AND DEVELOPMENT

Water use and development on O'ahu is guided by the City's General Plan and the Development Plans and Sustainable Community Plans for the eight land use districts. These community-based land use plans describe each community's vision of their future and provide land use and infrastructure policies and guidelines. An important aspect of the City's land use plans is the establishment of urban growth and sustainable community boundaries that separate urban, agricultural and conservation lands. These boundaries provide adequate area for urban and rural development, protect important agricultural and conservation lands and facilitate infrastructure master planning.

An essential component of the WMP is the development of regional specific watershed protection projects that enhance ground water and surface water supplies, improve land management with respect to water, protect traditional and cultural practices and facilitate plan implementation. Each regional WMP will consist of about 30 to 40 watershed protection projects derived from the strategic plans and capital improvement programs of various Federal, State and City agencies, organizations, communities and watershed partnerships. These projects meet the five WMP objectives of balancing the protection of natural resources and the sustainable use of O'ahu's water supplies.

The following summary of O'ahu's water use and development provides the island-wide context to review and understand the various regional WMPs. Together, the proposed eight regional watershed management plans create the OWMP as designed in the OWMP Framework.

As part of the process of initiating the update of the OWMP, and consistent with the guidelines set forth in the Statewide Framework for Updating the Hawai'i Water Plan, BWS has compiled information on existing and projected water demands and sources of supply for the municipal system and prime agricultural lands. In summary, BWS has evaluated the adequacy of the supply to meet future potable and non-potable water needs and through a combination of conservation, diversified water supply development and watershed protection strategies, BWS can meet water demands through the 2030 planning period.

OV.4.1 POPULATION FORECASTS AND MUNICIPAL WATER DEMAND

Table OV-1 shows the DPP population forecast from 2000 to 2030 by land use district accounting for residents, visitors, military and private water systems. Water use and census population in 2000 defines a per capita demand by development plan area that is used to forecast 2030 water demand for the population served by BWS.

In 2005, DPP forecasted an increase in O'ahu's resident population from about 870,000 in 2000 to about 1.1 million residents in 2030. Based on the City's growth forecast evaluating population, visitors, housing and employment factors, BWS forecasts an increase in municipal potable water demand for O'ahu averaging 154.7 mgd in 2000 to 206 mgd in 2030. The BWS served population, which includes visitors, is forecasted to increase by approximately 277,156 people resulting in an increase of approximately 52 mgd. Most of the forecasted growth will occur in 'Ewa, PUC, Central O'ahu, Wai'anae and East Honolulu. Military and private water use is expected to increase by 1.3 mgd in the same time period.

Conservation has reduced the per capita demand by 6% in 2000 from 1990 levels. Per capita demand ranges from a low of 142 gallons per capita per day (gpcd) in Ko'olau Loa to 224 gpcd in Wai'anae due to a drier climate and larger agriculture water use from the municipal system. Note that with all long-range forecasts, a range of variation will occur due to uncertainties such as economics, zoning, population distribution and conservation. However, this possible future is within the range of historical linear projections of municipal water demand growth.

TABLE OV-1
O‘AHU POPULATION AND WATER DEMAND

2000, By Development/Sustainable Communities Plan Area

DP Area	Resident Population	% Resident Population	Residents Absent	Visitors Present	Defacto Population	Private/ Military	Population Served	DP area Demand (mgd)	Per Capita Demand (gpcd)
Wai‘anae	42,259	4.80%	1,718	1,190	41,731	0	41,731	9.34	223.79
‘Ewa	68,696	7.80%	2,793	916	66,819	5,159	61,660	15.30	223.58 *
East Honolulu	46,735	5.30%	1,900	867	45,702	0	45,702	10.11	221.3
PUC	419,422	47.90%	17,053	79,882	482,251	35,137	447,114	76.45	170.98
Central O‘ahu	148,208	16.90%	6,026	484	142,667	18,213	124,455	19.41	155.96
Ko‘olau Poko	117,910	13.50%	4,794	140	113,256	0	113,256	19.84	175.14
Ko‘olau Loa	14,546	1.70%	591	1,391	15,346	4,936	10,409	1.48	142.47
North Shore	18,380	2.10%	747	40	17,672	3,234	14,438	2.82	194.97
Total	876,156	100.00%	35,623	84,911	925,444	66,680	858,766	154.75	

2030, By Development/Sustainable Communities Plan Area

DP Area	Resident Population	% Resident Population	Residents Absent	Visitors Present	Defacto Population	Private/ Military	Population Served	DP Area Demand (mgd)	Per Capita Demand (GPCD)
Wai‘anae	50,616	4.50%	2,044	3,701	52,273	62	52,211	11.68	223.79
‘Ewa	184,612	16.50%	7,455	22,257	199,415	9316	190,099	42.50	223.58
East Honolulu	51,059	4.60%	2,062	2,152	51,150	0	51,150	11.32	221.3
PUC	489,389	43.80%	19,761	93,139	562,767	36188	526,579	90.04	170.98
Central O‘ahu	189,599	17.00%	7,656	1,756	183,699	18048	165,651	25.83	155.96
Ko‘olau Poko	115,357	10.30%	4,658	1,349	112,048	0	112,048	19.62	175.14
Ko‘olau Loa	16,725	1.50%	675	4,814	20,863	6494	14,369	2.05	142.47
North Shore	19,945	1.80%	805	1,246	20,386	3212	17,174	3.35	194.97
Total	1,117,302	100.00%	45,116	130,414	1,202,600	73,320	1,129,280	206.40	

* The ‘Ewa District per capita demand reflects a 1.516 mgd adjustment to account for demineralized recycled water use for industrial process water, which reduced potable water use after 2000.

O‘AHU POPULATION AND WATER DEMAND SUMMARY

Development Plan Area	2000 BWS Population Served	2030 BWS Population Served	Estimated Population Increase in 2030	Additional Water Demand in 2030 (mgd)
Wai‘anae	41,731	52,211	10,480	2.34
‘Ewa	61,660	190,099	128,439	27.20
East Honolulu	45,702	51,150	5,448	1.21
PUC	447,114	526,579	79,465	13.59
Central O‘ahu	124,455	165,651	41,196	6.42
Ko‘olau Poko	113,256	112,048	-1,208	-0.22
Ko‘olau Loa	10,409	14,369	3,960	0.57
North Shore	14,438	17,174	2,736	0.53
Total	858,766	1,129,280	270,514	51.65

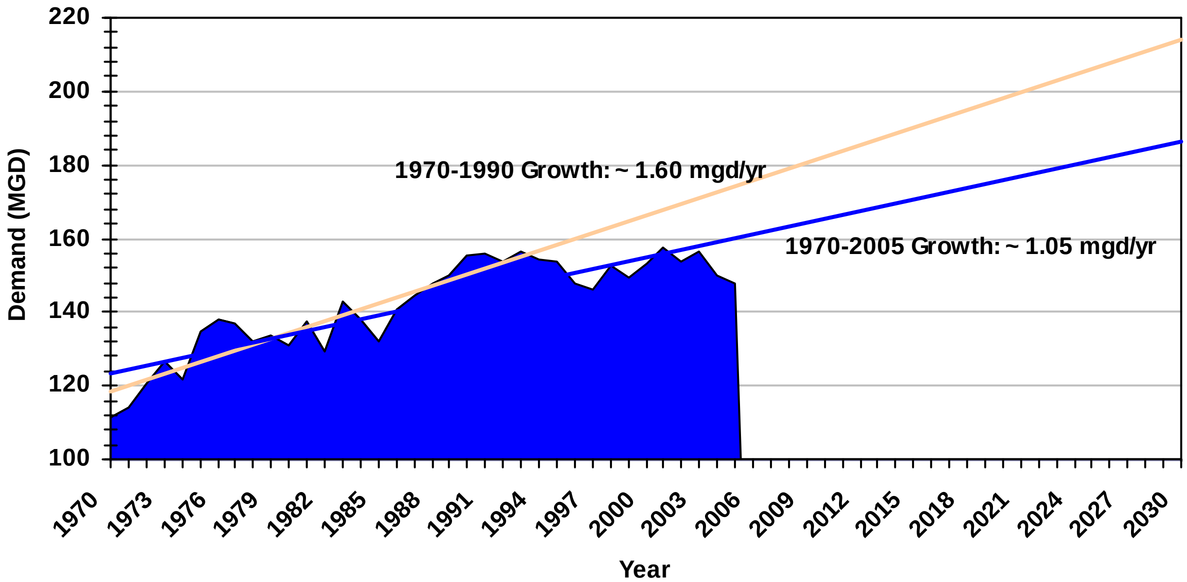

FIGURE OV-3

BWS WATER SYSTEM DEMAND PROJECTIONS: ACTUAL 1970 – 2005 AND LINEAR PROJECTION TO 2030

Conservation efforts and recycled water have had a significant role in keeping island-wide potable water use at 1990 levels through 2005. Figure OV-3 shows BWS water system historical water demand growth rates from 1970 to 2005. The growth rates are linearly projected to 2030 along two slopes ranging from 1.05 mgd/year to 1.60 mgd/year, with 2030 demands of 185 mgd to 215 mgd respectively and represent the range in water demand expectations over time. The lower slope represents the benefit that conservation and economic factors have on leveling water demand growth.

Table OV-2 shows O'ahu's ground water use as of July 2005. Municipal ground water use constitutes 80.5% of the total, with military, agriculture and irrigation and other uses taking up the remainder. Agriculture ground water use has significantly decreased post-plantation owing to the availability and use of surface water and the slow rate of diversified agriculture growth.

TABLE OV-2
O'AHU'S GROUND WATER USE JULY 2005

Use	Water Used (mgd) July 2005	Percentage of Total Water Use
Municipal	151.3	80.5%
Military	26.8	14.2%
Agriculture	6.0	3.2%
Irrigation	3.4	1.8%
Domestic	0.3	0.2%
Industrial	0.1	0.1%
Total	187.9	100%

Table OV-3 summarizes Appendix C by listing O'ahu's largest permitted uses of ground water by user including Waiāhole Ditch water uses but excluding saltwater and caprock water uses.

TABLE OV-3
O'AHU'S TOP GROUND WATER USERS BY PERMITTED USE JULY 2005

Owner	Permitted Use (mgd)	Owner	Permitted Use (mgd)
1. Honolulu BWS	183.08	9. HRI/Lā'ie Water Co	3.72
2. Waialua Sugar	33.48	10. Robinson Kunia	2.59
3. US Navy	28.56	11. Serenity Park	2.21
4. D.R. Horton	7.97	12. Dole/Castle&Cooke	2.13
5. US Army	7.29	13. Agribusiness Dev.	2.00
6. Campbell Estate	5.53	14. Galbraith Estate	2.00
7. Del Monte	5.03	15. Bishop Estate	1.86
8. Dillingham Ranch	4.10	16. Kahuku Land LLC	1.67

OV.4.2 AGRICULTURAL WATER DEMAND

The State and City have adopted objectives and policies for the preservation of agricultural lands and for the long-term support of a viable agriculture industry on O'ahu. City land use plans have been adopted with urban growth and sustainable community boundaries in part to protect prime agricultural lands.

The agricultural industry's needs are uncertain yet important for water use planning because of the substantial quantities consumed for irrigation. Future water demand for agricultural crops depends on the type of crops cultivated, the climate and the number of acres in cultivation. The State Agricultural Water Use and Development Plan, (AWUDP) December 2004[1], focuses on maintaining existing diversified agriculture systems and on transforming plantation water systems to serve diversified agriculture. "With available farm lands and adequate irrigation water, a significant expansion of diversified agriculture is an attainable and economically worthwhile goal which can be achieved largely by: 1) replacing much of Hawai'i's imported produce with locally grown produce, 2) pursuing niche and off-season markets of fruits and vegetables for export, 3) growing new or Asian-based specialty crops for export, and 4) meeting increased demand from the tourism and cruise ship industries for fresh fruits and vegetables." The two irrigations systems studied on O'ahu are the Waiāhole Ditch and Waimānalo irrigation systems. The Kaukonahua ditch system in Central O'ahu was not included in the State AWUDP. Based on water metered data from the Lālāmilo system (South Kohala, Hawai'i Island), dry and wet season water use per acre varied between 2,500 gpd/acre to 4,600 gpd/acre. According to the AWUDP, an

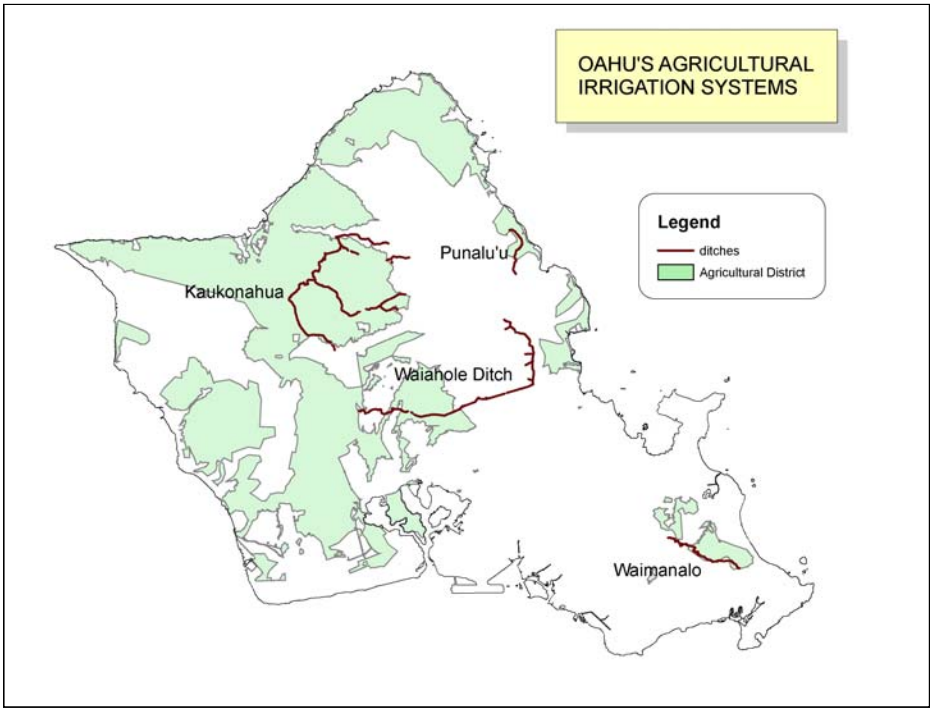

FIGURE OV-4
AGRICULTURAL ZONED LANDS ON OʻAHU

average of 3,400 gpd/acre is considered the best available estimate and a reliable value for use in planning and forecasting irrigation water demand for Hawaiʻi's diversified agriculture industry.

Figure OV-4 shows the agricultural zoned lands on Oʻahu with the four major irrigation systems: Waiāhole Ditch, Kaukonahua, Waimānalo and Punaluʻu. Existing stream diversions should be inventoried, leaks and evaporation losses reduced to 10% or less and water use verified. Diversion works should include control gates to maintain diverted flows at reasonable and beneficial use plus losses. The practice of diverting maximum stream flow and then releasing unused diverted water into downstream drainage systems or into different streams should be minimized. No new surface water diversions are recommended in the WMP until measurable IFS are established.

Large tracts of agricultural lands exist in the ʻEwa, Central Oʻahu, North Shore and Koʻolau Loa districts. Table OV-4 lists prime agricultural lands as identified in the City's land use plans with an average water use per acre proposed in the State AWUDP.

TABLE OV-4
PRIME AGRICULTURAL LANDS ON OʻAHU

City Land Use District	Prime Agricultural Land Area (acres)	Water Use per Acre (gal/acre-day) (State AWUDP)	Nonpotable Water Demand (mgd)
North Shore	20,000	3,400	68
Central Oʻahu	10,350	3,400	35
ʻEwa	3,000	3,400	10
Koʻolau Loa	3,000	3,400	10
Total	36,350		124

The total of prime agricultural lands in these districts could have an average potential agricultural water demand of 124 mgd and could range from a low of 90 mgd at 2,500 gallons per acre day (gpad) to 167 mgd at 4,600 gpad during wet and dry seasons. The Waiāhole Ditch contested case has allocated an average of 2,500 gallons per cultivated acre for Kunia farms. Existing systems like the Waiāhole Ditch, Kaukonahua Stream/Wahiawā Reservoir and the ʻEwa Caprock aquifer system area already provide a portion of this total. Additional potable ground water supplies in Waialua, Kawailoa, Wahiawā and Waipahu-Waiawa could provide supplemental agricultural water supply. Ground water development is more costly for agriculture than gravity and surface water sources and may compete with urban uses.

Diversified agriculture and traditional *loʻi kalo* occur in the other districts as well. Koʻolau Poko has about 2,300 acres of prime agricultural lands served primarily with existing stream diversions. However, due to the area's high rainfall, water demand will be less than what the State AWUDP recommends, which will be addressed in the Koʻolau Poko WMP. Agricultural water demands in Waiʻanae, PUC and East Honolulu are largely incorporated into the municipal demand forecasts. These farms tend to be smaller, and their water supply will be addressed in each of the regional watershed management plans.

Recent discussion regarding biofuels and ethanol as renewable energy sources have become prominent with the law requiring 10% ethanol additives to gasoline and HECO's announcement that their proposed Campbell power plant will be able to accept 100% biofuels. An evaluation of available agricultural lands and water supplies in the North Shore indicate that a biofuel or ethanol industry could be accommodated up to the sustainable limits of the Waialua, Mokulēʻia and Kawailoa aquifer system areas and from the Wahiawā reservoir. According to the State DOA, sugar cane using drip irrigation will require 5,600 gals/acre-day, depending on elevation and climate. Biodiesel crops range in water use, with the most oil efficient crop being oil palm using only 760 gals/acre-day yielding over 5,300 gals of oil/acre[2].

Other crops being studied by the Hawai'i Agriculture Research Center are kukui, avocado, coconut and jatropha. Algae are also being researched as a bio-fuel source and will require water use to produce.

OV.4.3 GROUND WATER AVAILABILITY

The table of Sustainable Yield and Ground water Use by Aquifer System Area was provided by the CWRM for 2005 (Table OV-5). The table shows the 7 aquifer sector areas and 26 aquifer system areas on O'ahu with their associated sustainable yields adopted by CWRM, water use permits, water use in 2005 and the unallocated sustainable yields. The table footnotes attempt to qualify the table and additional information on sustainable yields is included in *Chapter 1, Overview of O'ahu's Hydrogeology*. A complete listing of the 2006 O'ahu Water Use Permit Index is provided in *Appendix C* and the 2000 Well Use Data is provided in *Appendix D.*

Overall, there is available water on O'ahu. A significant portion of the remaining untapped supplies exist in remote areas of the island where growth is limited, infrastructure does not exist or pumping may affect stream flows and will be subject to future measurable IFS. 2005 was a high rainfall year, in which water use was below normal for both agriculture and urban sources. In general, the Honolulu sector is fully allocated to the adopted sustainable yield. The Pearl Harbor, Wahiawā and North Shore sectors have a significant amount of unallocated sustainable yield, unused or released by the sugar plantations. The Windward sector's unused sustainable yields (Waimānalo, Ko'olau Poko and Kahana) may interact with streams due to dike influences and therefore, availability may be subject to amendments of the interim IFS. Wai'anae's remaining water is small, in remote areas and also subject to interim IFS in dike areas. Due to these land, economic, operational and environmental reasons, BWS has identified the concept of recoverable yield for its own municipal planning purposes. Recoverable yield is an estimate of the amount of ground water that could feasibly be developed for an aquifer system area and is less than the CWRM adopted sustainable yield. BWS has identified Waimānalo, Ko'olau Poko, Kahana, Kawailoa, Mokulē'ia, Kea'au, Lualualei and Nānākuli aquifer system areas where recoverable yields are less than or equal to sustainable yields. The concept of recoverable yield allows BWS to plan and respond to uncertainties.

TABLE OV-5
SUSTAINABLE YIELD AND GROUND WATER USE BY AQUIFER SYSTEM AREA (MGD)

Aquifer Sector	Aquifer System		Sustainable Yield (SY)	Water Use Permits Issued 2005	Unallocated Sustainable Yield	Existing Water Use 12 MAV July 2005	SY minus water use
Honolulu	Wai'alae-East		2	0.790	1.210	0.193	1.807
	Wai'alae-West		4	2.797	1.203	0.385	3.615
	Pālolo		5	5.646	-0.646	4.431	0.569
	Nu'uanu	6	14	15.270	-1.270	13.293	0.707
	Kalihi		9	8.761	0.239	8.507	0.493
	Moanalua	6	16	19.960	-3.960	17.340	-1.340
Total Honolulu			50	53.224	-3.224	44.149	5.851
Pearl Harbor	Waimalu		45	46.951	-1.951	39.011	5.989
	Waipahu-Waiawa	1	104	83.892	20.108	53.354	50.646
	'Ewa-Kunia	1	16	15.457	0.543	11.071	4.929
	Makaīwa		0	0.000	0.000	0.000	0.000
Total Pearl Harbor			165	146.300	18.700	103.436	61.564
Central	Wahiawā		23	20.386	2.614	9.245	13.755
Total Central			23	20.386	2.614	9.245	13.755
Wai'anae	Nanakuli	2,4,6	2	0.000	2.000	0.000	2.000
	Lualualei	2,4,6	4	0.000	4.000	0.264	3.736
	Wai'anae	2	3	0.000	3.000	2.515	0.485
	Makaha	2,6	3	0.000	3.000	1.767	1.233
	Kea'au	2,4	4	0.000	4.000	0.000	4.000
Total Wai'anae			16	0.000	16.000	4.546	11.454
North	Mokulē'ia	4,6	8	8.301	-0.301	0.303	7.697
	Waialua	6	25	30.311	-5.311	3.020	21.980
	Kawailoa	4,6	29	1.549	27.451	0.682	28.318
Total North			62	40.161	21.839	4.005	57.995
Windward	Ko'olau Loa	6	36	21.508	14.492	9.738	26.262
	Kahana	4,6	15	1.101	13.899	0.085	14.915
	Ko'olau Poko	3,4,6	30	10.312	19.688	12.828	17.172
	Waimānalo	4,6	10	1.656	8.344	0.629	9.371
Total Windward			91	34.577	56.423	23.280	67.720
Grand Total			407	294.648	112.352	188.661	218.339
'Ewa Caprock	Malakole	5	1,000 mg/l	5.928		5.800	
	Kapolei	5	1,000 mg/l	2.033		0.471	
	Pu'uloa	5	1,000 mg/l	14.817		2.417	
Total 'Ewa Caprock				22.778		8.688	

2004-2005 Recorded 125% of normal rainfall reducing island-wide pumpage below permitted use. Permanent instream flow standards may reduce available sustainable yield. Withdrawals affecting streams require instream flow standards amendments.

1 Sustainable yields reduced by CWRM due to recharge reduction from sugar plantation closure & land use changes.
2 Wai'anae is not a designated water management area, therefore, there is no permitted use.
3 Waihe'e Tunnel + Waihe'e Inclined Wells are not included under 2005 Permitted Uses, but are included under Existing Water Use.
4 BWS Recoverable Yield expected to be lower due to economics, land constraints, small yields, etc. & regulatory actions involving instream flow standards.
5 Brackish Water. Managed by chloride limit of 1,000 mg/l.
6 2008 Water Resource Protection Plan updates on sustainable yield included.

Source: CWRM Data. BWS footnotes.

Query date 5/31/06. Based on reported pumpage to CWRM as of 7/31/05.

Excludes caprock and salt water wells, except for 'Ewa Caprock Sector Area. Excludes Waiāhole Ditch.

CWRM has adopted sustainable yields to protect ground water resources and regulate water use by water use permits. The following Table OV-6 summarizes the available ground water by aquifer sector area accounting for the uncertainties of ground water-surface water interaction in dike formations in Windward and BWS operational experience in Wai‘anae.

TABLE OV-6
SUMMARY OF AVAILABLE GROUND WATER BY AQUIFER SECTOR AREA

Aquifer Sector	Sustainable Yield	Water Use Permits Issued July 2005	Unallocated Sustainable Yield (mgd)	Water Use 2005	SY minus Water Use
Honolulu	50	53	-3	44	6
Pearl Harbor	165	146	19	103	62
Central	23	20	3	9	14
Wai‘anae	16	---	16	5	1*
North	62	40	22	4	58
Windward	91	35	56	23	26**
Total	**407**	**294**	**113**	**187**	**167**

* Adjusted: Based on pumping operations and BWS assessed recoverable yields.
** Adjusted: Ko‘olau Loa only, (36 mgd SY – 10 mgd use). Excludes the Waiāhole Ditch and the Kahana, Ko‘olau Poko & Waimanalo sectors due to possible surface water interactions in dike formations.
***All footnotes in Table OV.3 apply.

On O‘ahu in 2005, an above normal rainfall year, about one-third or 107 mgd (294-187) of permitted use was unused. An estimate of available ground water on O‘ahu is approximately 167 mgd, based on CWRM adopted sustainable yields for O‘ahu minus water use in 2005, excluding the Kea‘au, Lualualei, Nanakuli, Kahana, Ko‘olau Poko and Waimānalo aquifer systems and Waiāhole Ditch.

OV.4.4 SURFACE WATER AVAILABILITY

IFS are similar to sustainable yields for ground water, in that their establishment provides a management system that protects instream and cultural uses while allowing for possible non-instream water use. CWRM is tasked with setting IFS for Hawai‘i’s streams in accordance with the State Water Code.

The hydrogeology chapter describes the complexity of setting measurable IFS balancing hydrology with instream and non-instream uses. It is difficult to plan for additional non-instream uses of surface water without measurable IFS, because non-instream uses of surface water are an essential IFS component. Realistically, surface water is not available for planning purposes, especially for non-domestic water use, due to the high cost of stream related studies required to amend the interim IFS. Punalu‘u Stream and irrigation system studies have cost over $500,000 and therefore, new diversions are not cost effective unless a simpler methodology for setting measurable IFS is proposed. The planning approach to surface water availability then, is to plan within the diverted amounts existing when the status quo interim IFS were adopted, or as subsequently amended by CWRM.

Additional surface water can be provided for non-instream uses through improvements in distribution system efficiency, leakage reduction, crop selection and through efficient irrigation techniques. Table OV-7 lists some of Oʻahu's largest perennial streams.

TABLE OV-7
OʻAHU'S LARGEST STREAMS AND MEAN FLOWS 2004

Stream Name	USGS Stream Gage No.	Mean Flow 2004 (CFS)	Mean Flow 2004 (MGD)
Punaluʻu	16303000	21.3	13.8
Kahana	16296500	53.5	34.6
Waikāne	16294900	19.1	12.3
Waiāhole	16294100	55.0	35.6
Waiheʻe	16284200	9.21	6.0
Kamoʻaliʻi - Kāneʻohe	16272200	17.5	11.3
Makawao – Kailua	16254000	7.21	4.7
Mānoa	16240500	5.89	3.8
Kalihi	16229000	9.24	6.0
Waiawa	16216000	50.0	32.3
Waikele	16213000	53.7	34.7
N. Kaukonahua	16200000	19.2	12.4
S. Kaukonahua	16208000	29.6	19.1
Ōpaeʻula	16345000	18.8	12.2
Kamananui - Waimea	16330000	24.7	16.0
Total		**393.95**	**254.7**

Source: USGS Data

OV.4.5 PLANNED SOURCE DEVELOPMENT

New sources recently completed or in various stages of construction that will provide for future water demands are listed in Table OV-8. Alternative potable and provide for future water demands are listed in Table OV-8. Alternative potable and nonpotable sources such as recycled water and desalination are listed in Table OV-9.

TABLE OV-8
POTENTIAL GROUND WATER RESOURCES OF POTABLE WATER

	New Ground water Sources	Estimated Yield (mgd)	Additional Permitted Use Required (mgd)	CWRM Water Management Area	Potential Development Plan Area(s) Served
1.	Mālaekahana	1.0	1.0	Koʻolauloa	Koʻolauloa
2.	ʻŌpana Wells	1.0	1.0	Koʻolauloa	Koʻolauloa
3.	Kaipapaʻu Well (1)	1.0		Koʻolauloa	Koʻolaupoko
4.	Kaluanui Wells * (1)	1.5		Koʻolauloa	Koʻolaupoko
5.	Maʻakua Wells * (1)	1.0		Koʻolauloa	Koʻolaupoko
6.	Kūʻou Well III *	0.5		Koʻolaupoko	Koʻolaupoko
7.	Waimānalo Well III *	0.5	0.3	Waimānalo	Koʻolaupoko
8.	ʻĀina Koa Well II *	0.7		Waialae-West	East Honolulu
9.	Waiʻalae Nui Well *	0.7		Waialae-West	East Honolulu
10.	Wahiawā Well III	3.0	3.0	Wahiawā	Central
11.	Waipiʻo Heights Wells II and III	2.5	0.65	Waipahu-Waiawa	Central/PUC
12	Mililani Wells IV *	3.0	1.0	Waipahu-Waiawa	Central
13.	Waiawa Wells I-IV (2)	6.0	6.0	Waipahu-Waiawa	Central
14	Manana Well *	1.0	0.9	Waipahu-Waiawa	PUC
15	Kunia Wells III *	3.0		Waipahu-Waiawa	ʻEwa, Waiʻanae
16	Waipahu Wells II *	3.0	1.0	Waipahu-Waiawa	Central
17	Waipahu Wells III *#	3.0		Waipahu-Waiawa	PUC
18	Waipahu Wells IV *	3.0		Waipahu-Waiawa	ʻEwa, Waiʻanae
19.	ʻEwa Shaft *	10.0	3.0	Waipahu-Waiawa	ʻEwa
20.	Koa Ridge Makai Wells	2.0	2.0	Waipahu-Waiawa	Central
	Total Potable Resources	**47.4**	**19.85 ****		

Notes:
1) Potential transfer of existing permitted use from Punaluʻu Wells to optimize pumpage
2) Waiawa Water Master Plan, Revised Dec 14, 2004.
* Source already has an existing permitted use equal to or a portion of the estimated yield.
** Total does not include transfers of existing permitted use.
# Includes 0.5 mgd water reservation for Department of Hawaiian Home Lands (DHHL)
0.124 mgd water reservation exists for DHHL in the Waimānalo WMA

Table OV-9
POTENTIAL ALTERNATIVE POTABLE AND NONPOTABLE WATER

Resource		Minimum Estimate	Maximum Estimate	Development Plan Area(s) Served
Desalination (potable)				
1.	Kapolei Brackish Desalination Plant	0.2	0.5	'Ewa, Wai'anae
2.	Kalaeloa Seawater Desalination Plant	5.0	15.0	'Ewa, Wai'anae
Recycled Water				
4.	Wahiawā Recycled Water (1)	2.0	4.0	Central
5.	Honouliuli Recycled Water	12.0	20.0	'Ewa
6.	Wai'anae Recycled Water (2)	2.0	3.0	Wai'anae
7.	Kahuku, Turtle Bay, Lā'ie Recycled Water	0.8	2.6	Ko'olau Loa
Nonpotable Water				
8.	Waiāhole Ditch (3)	12.57	15.0	'Ewa, Central
9.	Wahiawā Reservoir (4)	8.5	22.0	North Shore, Central
10.	Kalauao Spring	0.5	3.3	PUC
11.	'Ewa Brackish Basal Wells (5)	4.0	5.0	'Ewa
12.	Ko'olau Loa Agricultural Wells (6)	6.3	12.6	Ko'olau Loa
13.	Punalu'u Stream Irrigation System (7)	2.0	7.0	Ko'olau Loa
	Total Alternative Resources	**55.87**	**110.0**	

Notes:
1) Wahiawā WWTP avg flow = 2 mgd, Schofield (Army) Avg flow = 2 mgd.
2) Wai'anae WWTP effluent chlorides at 800-900 mg/l may constrain full expansion.
3) Waiāhole Ditch Min = 2006 CWRM permitted use. 2.43 mgd remains unpermitted.
4) Kaukonahua Streams minimum average month = 8.5 mgd, 2002 annual average = 22 mgd. Wahiawā Reservoir storage capacity = 9,200 ac-ft or 3,066 mg.
5) Revised 'Ewa Development Plan. EP2 (1 mgd), EP5&6 (2 mgd), EP10 (1-2 mgd).
6) Sustainable yield exists, but well sites have not been identified.
7) Effects of Surface Water Diversion and Groundwater Withdrawal on Streamflow and Habitat, USGS Report 2006-5153.

The following table summarizes Tables OV-8 and OV-9 of planned potable ground water sources and alternative potable and nonpotable sources.

Resource	Quantity (mgd)
Ground water – Potable	47
Desalination – Potable (minimum estimate)	5
Recycled Water (minimum estimate)	17
Ground water – Nonpotable *	26
Surface water – Nonpotable	32
Total	**127**

* includes Waiāhole Ditch permits for Leeward uses

Increases in potable and nonpotable demand are offset by water conservation, released agricultural ground water from the close of the sugar plantations, seawater desalination and the development of brackish and recycled irrigation water systems. Surface water is not planned for municipal use until measurable IFS are set and water availability is determined.

Ground water supplies will be constructed utilizing available sustainable yield including released agricultural water for agricultural lands rezoned to urban use. Ground water supply evaluations will be conducted to refine available ground water estimates especially as permitted use approaches sustainable yields. New sources of supply will be developed in locations that do not impact streams or other sources.

Recycled water facilities in 'Ewa and Central O'ahu are planned for expansion to continue to off-set additional ground water development.

- In 2000, BWS acquired and now operates the 12 mgd Honouliuli Water Recycling Facility supplying irrigation and industrial process water for 'Ewa. The recycled water distribution system is supplemented with brackish water.
- BWS is working with the City Department of Environmental Services to design and construct a R-1 recycled water distribution system to utilize approximately 2.0 mgd of Wahiawā recycled water in Central O'ahu. The system could possibly be integrated with the Army's Schofield recycled water system to add additional supply.

In the mid term, seawater and brackish water desalination plants will be constructed to provide for future demand and off-set additional ground water development and provide a cost competitive alternative to increasing inter-district transfers.

- The Kalaeloa Seawater Desalination Plant is currently planned for construction in the 2018-2020 timeframe and will bring an additional 5.0 mgd of potable water supply to the 'Ewa and Wai'anae districts. The plant will be capable of further expansion as needed.
- BWS acquired the State's demonstration brackish water desalination plant facilities in Kapolei Business Park, which could be renovated at relatively low cost, to produce approximately 0.5 mgd of potable water supply for Kapolei.

Research will continue to develop more economical methods of cold seawater development for municipal purposes using a multiple product approach of distillation, energy production using ocean thermal energy conversion, district cooling and aquaculture.

OV.4.6 SUMMARY OF SUPPLY, DEMAND AND POPULATION DISTRIBUTION

The 167 mgd of unused ground water available on O'ahu in 2005 (Table OV-6) is able to meet most of the projected 2030 municipal demand of 52 mgd and the total of 124 mgd for prime agricultural lands in North Shore, Central, 'Ewa and Ko'olau Loa. In addition, existing diversions of surface water from Kaukonahua/Wahiawā Reservoir (22 mgd), Waimānalo Ditch (0.4 mgd) and Punalu'u Stream (7.0 mgd) and the Waiāhole Ditch (15 mgd) increase the available supply for prime agriculture by about 45 mgd.

Existing stream diversions will continue to provide for agricultural uses reducing the need for potable ground water, although supplemental wells are recommended as a drought mitigation strategy. No new stream diversions are planned for non-instream uses until interim IFS are amended to protect and support appurtenant rights, traditional and customary rights in the stream, estuary and nearshore water environments.

Recycled water is planned to supply a minimum of 17 mgd for urban irrigation. Future seawater desalination could supply 5 to 15 mgd of potable water for 'Ewa and Wai'anae.

The City's General Plan directs the majority of future growth to 'Ewa and the Primary Urban Center, the two development plan areas where plans and infrastructure investment will support growth. The sustainable communities of Central O'ahu, Wai'anae and East Honolulu are relatively stable regions and will realize a lesser amount of expansion. In these five districts, natural and alternative water supplies, such as ground water, recycled water and seawater desalination will be fully integrated. The sustainable communities of North Shore, Ko'olau Loa and Ko'olau Poko will have little change in water demand throughout the planning period. The existing sources and infrastructure in these areas are adequate to provide potable water service through the planning horizon and therefore, additional integration of water supplies between these regions will be limited.

A summary graphic of O'ahu's estimated population distribution based on the 2000 census, BWS potable water demand in calendar year 2000 and water distribution is provided for the eight land use districts (Figure OV-5). This is essentially the base case of existing water demand and distribution in the BWS system that will be referenced in establishing future watershed management plan scenarios.

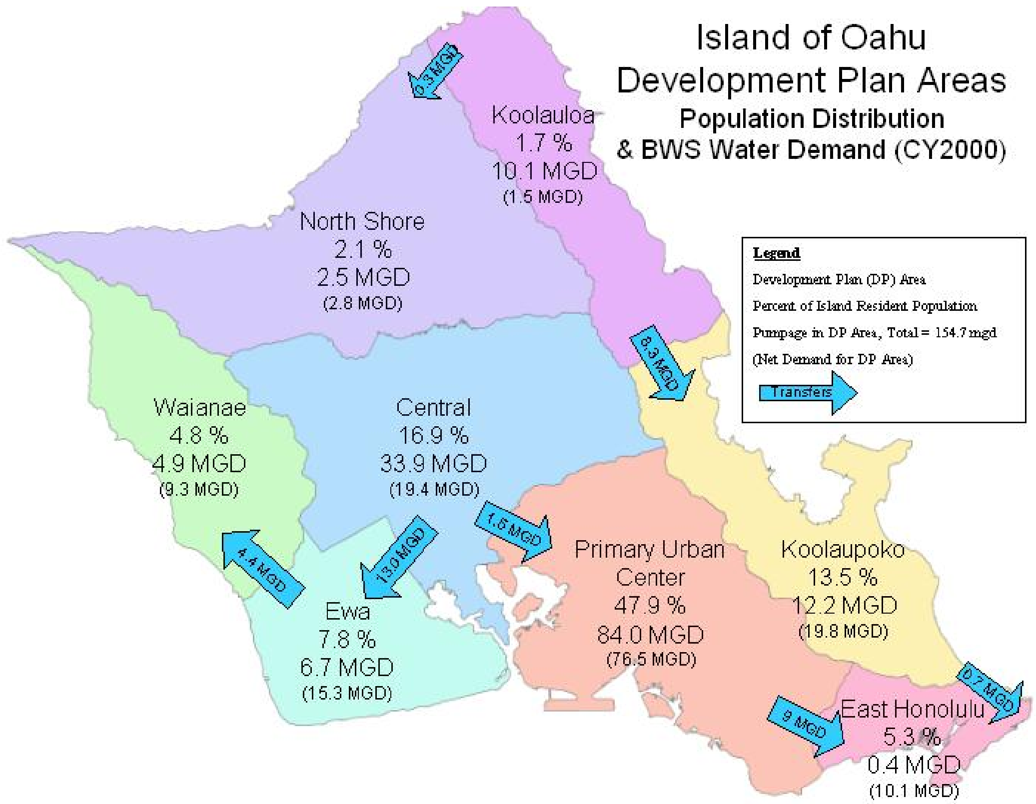

FIGURE OV-5
POPULATION AND POTABLE WATER DEMAND DISTRIBUTION 2000

A second summary graphic (Figure OV-6) of O'ahu's estimated population distribution based on DPP's 2030 forecast, BWS potable water demand and water distribution in 2030 is also provided for the eight land use regions. Desalination is included in the 'Ewa district. This graphic represents a likely future scenario at this time.

The following findings summarize Figures OV-5 and OV-6 Population Distribution and Potable Water Demand 2000 and 2030 and represent the most likely future scenario at this time.

- The O'ahu General Plan directs growth to the PUC and Ewa development plan areas allowing Wai'anae, Central O'ahu, North Shore, Windward and East Honolulu to be rural areas with limited growth.
- Projected increase in water demand in 'Ewa, Central O'ahu, PUC and East Honolulu of about 48.4 mgd can be met through a diversified combination of conservation, ground water, existing stream diversions, recycled water and desalination. New potable ground water sources will be developed utilizing released agricultural ground water in the Pearl Harbor aquifer. Brackish 'Ewa Plantation wells will continue to be converted for urban irrigation in 'Ewa to supplement potable ground water. New

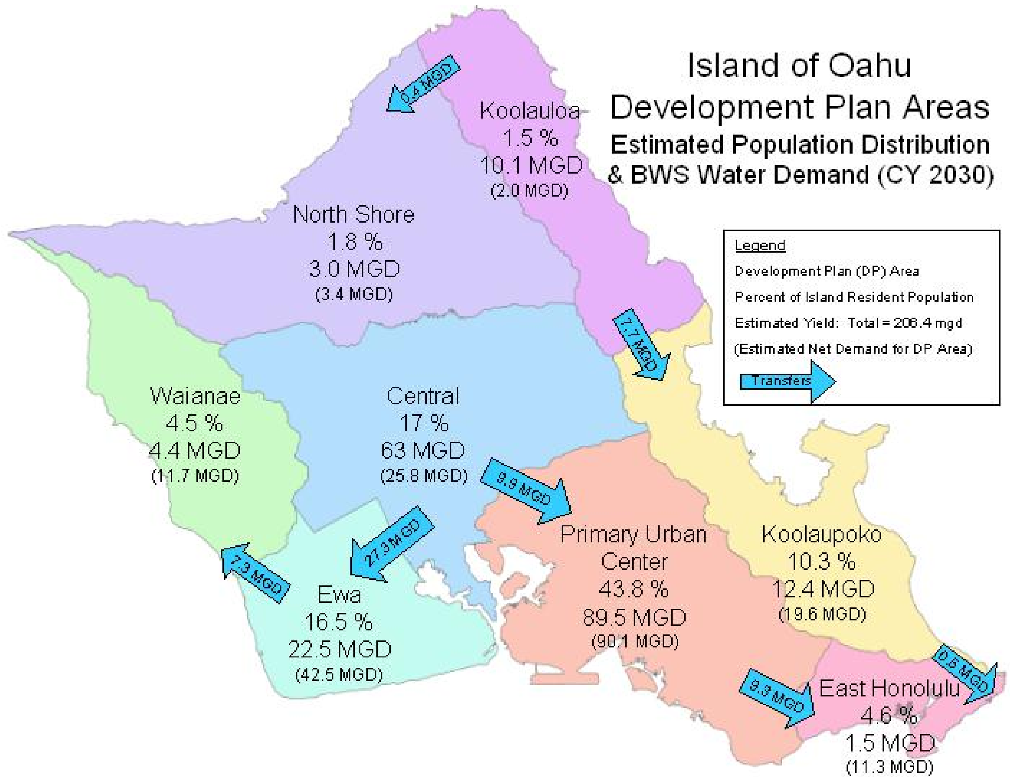

FIGURE OV-6
ESTIMATED POPULATION AND POTABLE WATER DEMAND DISTRIBUTION 2030

recycled water system expansions are planned.

- Projected water demand in Wai'anae of about 2.4 mgd will be met with transfers from the Pearl Harbor aquifer. To sustain the existing watersheds and streams in Makaha and Wai'anae valleys, source production will be kept at sustainable levels based on long-term operational experience and stream gaging. Over the long term, advanced conservation and recycled water in Wai'anae may reduce Pearl Harbor transfers, increasing the availability of ground water in 'Ewa
- Projected water demand in Ko'olau Loa of 0.5 mgd can be met with conservation, existing and planned ground water sources and recycled water within the district.
  - o Ground water transfers from Ko'olau Loa to Ko'olau Poko are expected to reduce slightly over time due to the forecasted reduction in Ko'olau Poko's population by approximately 1,200 people.
  - o Ground water transfers from Ko'olau Poko to East Honolulu, because of geology and drought susceptibility, are expected to remain between 0.5 and 0.7 mgd over time as 0.3 mgd of additional Pearl Harbor aquifer water is directed to East Honolulu.

- The North Shore currently has the largest unused supplies of ground water and existing surface water diversions on O'ahu. Because South O'ahu's water demands will be met with resources within South O'ahu, the North Shore's large water supplies will be available to support diversified agriculture including the potential bio-fuels industry.

This likely scenario of population and potable water distribution in 2030 is based on the best available estimates of supply and demand plus a significant commitment to advanced water conservation and alternative water development. New aquifer studies will continue to refine estimates of sustainable yield and pumpage optimization plans will be adapted to avoid salinity and other water quality impacts.

The most conservative estimates of available remaining ground water sustainable yields, a reasonable accounting of uncertainties, planned ground water source projects, advanced water conservation programs and alternative water source projects, such as recycled water and desalination, will be utilized to accommodate future demands.

OV.4.7 UNCERTAINTIES AND CONTINGENCIES

Planning efforts have uncertainties due to assumptions made about existing conditions and future scenarios. Identifying these uncertainties provides an opportunity to plan for a practical range of contingencies. This section highlights the major uncertainties and contingencies of this watershed management plan. Many of the watershed protection projects and water supply options discussed in *Chapter 5: Watershed and Water Supply Projects* and *Chapter 6: Implementation* are contingencies designed to plan for uncertainties in supply and demand.

1.4.7.1 Ground water Supply Uncertainties

<u>Estimating Sustainable Yield</u>

Sustainable yields for all aquifer system areas have been adopted as part of the State Water Code's Water Resources Protection Plan and are used for resource management, protection and development. The current sustainable yields are based on the best available information of hydrologic factors but have acknowledged limitations in estimating rainfall distribution, vegetative transpiration, overland runoff, aquifer leakage to the ocean and to the brackish transition zone and recharge to the various dike, basal, perched and caprock aquifers.

<u>Recoverability of Sustainable Yield</u>

Recoverability is the ability to feasibly extract ground water through wells or tunnels, up to the adopted sustainable yield. Recoverability is a major uncertainty due to surface and ground water interactions, presence of separate hydro-geological formations within an aquifer system area, extended drought, and well location and spacing constraints. There are also regulatory, political, financial and public acceptance uncertainties surrounding additional ground water development and regional transport of water with respect to environmental impacts, local water needs and available supply.

Climate Change

Climate change is expected to cause more severe droughts and floods and as global temperatures increase, seawater levels are expected to rise affecting coastal environments, aquifers and streams. The uncertainties introduced by climate change emphasize the importance of incorporating flexibility, conservation and alternative supplies in the range of planning options. "Although most scientists worldwide agree that our planet's climate is warming, they recognize the uncertainty inherent in assessing climate change impacts. Uncertainties in projected greenhouse gas emissions, limitations of climate models, information loss when climate projections are downscaled to watershed resolution, and imperfections in hydrological models all contribute the uncertainty."[3]

Ground water Contamination

Contaminants infiltrating into ground water and spreading through the aquifers places uncertainty in the amount of available water supply. Contamination from agricultural and urban activities has previously occurred in central O'ahu, Waialua and Honolulu. Contamination could also result from purposeful human activities. The contamination can be mitigated, but treatment is very expensive and time consuming. If treatment is too costly, the well will be shut down and pump capacity will be permanently reduced. Replacement wells are also expensive. Therefore, prevention is the most cost effective measure against ground water contamination.

1.4.7.2 Recommended Contingency Plans for Ground water Supply Uncertainties

Ground water sustainable yield estimates provide for resource management and protection but contain uncertainties in water budget, recoverability, climate change and impacts from contamination. The following planning strategies will mitigate the effect of ground water supply uncertainties:

Contingency for Estimating Sustainable Yield

- Periodically update information on rainfall, evapo-transpiration, runoff, leakage and recharge to reflect current hydrologic trends due to climate change.
- Evaluate and account for aquifer boundary conditions recognizing separate geological formations such as dike, basal, alluvial and caprock aquifers within each aquifer system area.
- Construct deep monitor wells in important basal aquifers to provide the ability to monitor water levels, freshwater lens and transition zone thickness and trends in response to pumping.
- Develop advanced numerical ground water models to improve sustainable yield estimates. CWRM with BWS, USGS and the Navy participating, has created the Pearl Harbor Ground water Monitoring Working Group to monitor key indicators such as head, salinity, and transition zone trends, and also to reaffirm the adopted sustainable yields through a milestone framework and optimize pumpage in the Pearl Harbor aquifer sector area. The group is working toward a 3-dimensional solute transport

ground water model calibrated to the new deep monitor wells. The work of this group could be a viable model applied to other aquifer sector areas statewide.

Contingency for Recoverability of Sustainable Yield

- Until interim IFS are amended, seek new ground water wells that do not impact surface waters. Develop long-term monitoring plans of stream and watershed indicators.
- Optimize well spacing and pump sizing on an aquifer system area basis to increase recoverability and avoid lens shrinkage, upconing and seawater intrusion. Align water system infrastructure capital plans to more readily accommodate smaller wells spaced throughout the water system when practical.
- During severe, long-term droughts usually greater than 3 years, the full sustainable yield may not be recoverable. Dike source yields will likely drop below permitted use. BWS operational experience accounts for source yields in normal rainfall and drought years. The difference, approximately 14 mgd, is supplemented by the following drought mitigation strategies that will improve the water system's resilience to climate variability:
  - In non-drought years, ensure pumping does not exceed normal rainfall level estimates to preserve sufficient aquifer storage to meet maximum day demands during drought.
  - During drought years, reduce pumping to drought level estimates to protect the freshwater lens. Reducing pumping is difficult, as water demands will increase during drought, therefore:
    - Implement the BWS low ground water plan and other progressively increasing conservation measures to reduce water demands.
    - Develop additional ground water wells to supplement reductions in source yields due to severe drought.
    - Develop alternative, drought-proof water supplies such as recycled water, brackish and seawater desalination facilities.
    - Mandate dual water systems for new large developments to maximize nonpotable water use to conserve the potable water supply.
  - Ensure sufficient aquifer recovery during post-drought periods by reducing pumpage and implementing the applicable watershed protection projects for the most important and/or impacted watersheds.
- Regulatory, political, financial and public acceptance uncertainties can be addressed by environmental disclosure, cost benefit analysis, public outreach, education, alternative source analyses, and holistic watershed management and integrated resource planning.

Contingency for Rising Sea Levels due to Climate Change

Rising sea levels is a global issue which may have long-term impacts for Hawai'i. A precautionary approach to mitigating impacts of rising sea levels is to identify the water system's most critical vulnerabilities, then to suggest how climate variability and extremes might aggravate those vulnerabilities, and finally to design a range of solutions covering the climate uncertainty.[3] The following contingencies could be evaluated:

- Partially backfilling deep wells to account for rising sea levels. Well capacity may decrease and may have to be supplemented with other wells.
- In areas of thin caprock, such as in Pearl Harbor, constructed hydraulic barriers could prevent rising sea levels from intruding over the caprock into the freshwater aquifers. This solution is similar to Orange County California's Water Factory 21, recycled water hydraulic barrier injection system.
- Private brackish caprock wells near the coast may become more brackish or unusable and may need to be replaced with alternative supplies, such as recycled water
- Recycled water and seawater desalination could replace capacities lost to rising sea levels.

Contingency for Impacts from Ground water Contamination

- EPA and DOH provide extensive regulatory guidelines to address contamination of drinking water. EPA has developed a list of Best Available Technologies (BAT) to remove various contaminants in drinking water and restore the drinking water source for public consumption.
- Conduct regular water quality samples and track trends of contaminants. If trends are rising toward the maximum contaminant level (MCL), initiate planning and engineering of the recommended BAT so that the treatment system is in place before the MCL is reached.
- Apply DOH Source Water Protection program guidelines to water systems such as conducting sanitary surveys, protecting source water delineation/capture zones above wells and best management practices for potential contaminating activities. Conditions for source water protection should be placed on land use plan approvals.
- Implement the water system vulnerability assessment recommendations and other security measures for well stations and other facilities.
- Seal old, unused wells with cement grout to prevent direct contamination to the aquifer and leakage from the aquifer. Well sealing could be regulated through the building permit application process.

1.4.7.3 Surface Water Supply Uncertainties

Amending Interim Instream Flow Standards

The most significant uncertainty related to the availability of surface water is the lack of measurable IFS for the majority of streams on

Oʻahu and a standardized methodology for amending the interim IFS to measurable IFS. Other uncertainties relate to the complexity of stream studies (scientific, cultural, economic and environmental) and their potential cost. These uncertainties realistically mean that additional surface water is not available now or for the foreseeable future. The following is a range of possible outcomes:

- If there is additional water available after instream uses are met, water will be available for agricultural use.
- If no additional water is available, status quo instream and non-instream uses will be maintained.
- If there is insufficient water in the stream to meet the measurable IFS, water from existing non-instream uses will need to be returned to the stream, and alternative water sources for agriculture and urban uses may be needed.

Quantifying Stream Flows, Diversions and Use

There is a level of uncertainty in the amount of surface water flowing in Oʻahu's streams and stream segments (low, mean, median and peak variations of flows), the number of diversions and the diverted flows and their associated use and non-use. On Oʻahu there are 87 surface water hydrologic units containing approximately 232 stream diversions. In order to adequately protect streams and manage surface water use, streams need to be gaged, diversions structures must be inventoried and surface water use reported on a regular basis. As with ground water use, non-instream water use must be reasonable and beneficial, conserved or returned to the stream.

Drought Impacts on Surface Water

Drought impacts instream uses and the availability of surface water, and is another uncertainty. Surface water is supplied by rainfall and ground water leakage as base flow, and is impacted more readily during drought than ground water. Extended drought can have dire implications, especially for agriculture, much of which relies solely on surface water for irrigation.

1.4.7.4 Recommended Contingency Plans for Surface Water Supply Uncertainties

Surface water measurable IFS provide for resource management and protection but contain uncertainties because of the complexity in setting measurable IFS, the need for updating inventories of flows, diversions and use, and impacts from drought. The following planning strategies account for surface water supply uncertainties:

Contingency for amending interim IFS

- CWRM has established a prioritized listing of high natural quality streams to amend interim IFS using best available information.
- CWRM will be acting on the pending petitions for amending interim IFS and will develop a standardized measurable IFS methodology emphasizing practicality and consistency.

- Until measurable IFS are established, new stream diversions are not recommended in this plan. Surface water users should work within the existing diverted flows, applying conservation and water loss prevention strategies to increase system efficiencies.

Contingency for inventories of stream flow, diversion and use

- Cooperative partnerships such as with USGS, will be expanded to jointly fund the gaging of important perennial streams.
- The 2006 Legislature appropriated $650,000 to conduct statewide field investigations to verify and inventory surface water uses and stream diversions and update existing surface water information.
- The stream permitting process is being revised to improve the acquisition of pertinent information, and a surface water use reporting system will be established.

Contingency for Drought Impacts on Surface Water

- Alternative sources such as ground water and recycled water should be developed to mitigate drought impacts on agriculture. Barriers to recycled water especially for edible vegetable crops will need to be addressed.
- Water loss strategies will extend existing diverted flows. Agricultural crops could also be modified to use less water, markets permitting.
- Watershed forestation and protection projects will focus on critical watersheds to increase base flows and natural storage supplying streams.

A significant limitation to using surface water is its variability and lack of reliability especially during dry periods and drought. By increasing water storage, or by supplementing surface water with ground water, which is called conjunctive use, additional agricultural lands may be irrigated year-round cost effectively with minimal impact. Figure OV-7 (Seasonal Agricultural Water Use Supplementing Surface Water with Ground water) shows the seasonal relationship between surface water in conjunction with ground water for agricultural irrigation. During dry seasons and drought, when demand increases and limited stream water is available, ground water can supplement surface water, protecting instream uses. Surface water, which is more abundant during the wet season, can be economically used, allowing time for the ground water source to be replenished.

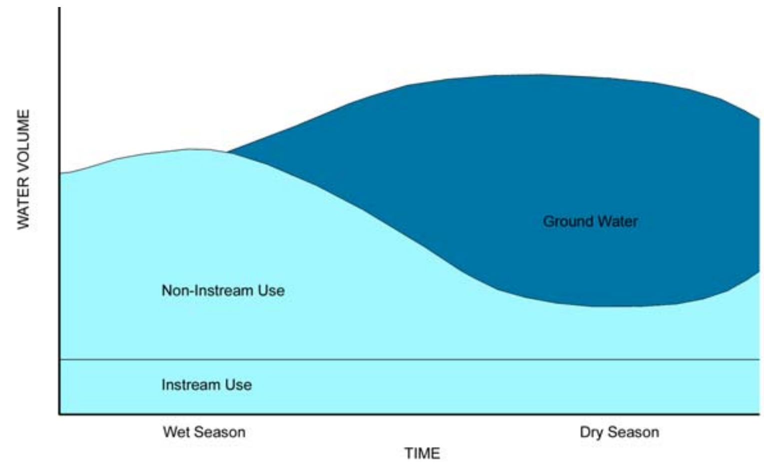

FIGURE OV-7
SEASONAL AGRICULTURAL WATER USE SUPPLEMENTING SURFACE WATER WITH GROUND WATER

1.4.7.5 Demand Projection Uncertainties

Agricultural Water Demands

Predicting agricultural water demands is challenging because of two categories of information – the agricultural products market and regional crop water demand numbers. While Hawai'i's diversified agricultural production has increased in recent years, the amount of agricultural activity has not yet come close to the former sugar plantation days. Much of the land with agricultural zoning is not in agricultural production. Potential bio-fuel production could put more acreage into active cultivation and increase crop water demands.

Regional crop water demand uncertainties are related to crop types, operational variables for each crop type such as fallow periods and frequency of harvest, and local climatic conditions. Crop water demands are challenging because of the diversity of crops and of the relatively few crop numbers that are geographically specific or agreed upon.

Urban Water Demands

Predicting population growth depends on public policies in the Development and Sustainable Communities Plans, the enforcement of more plans and the overall economy. While the urban growth and rural community boundaries are established, within the boundaries there is much area for future residential growth. With a strong economy, the growth within it could happen at a faster than predicted pace – but with a slow economy, growth could occur at a slower than predicted pace. Also, the amount of water that may be conserved and maintained over time is difficult to predict.

1.4.7.6 Recommended Contingency Plans for Demand Projection Uncertainties

The following strategies can mitigate the uncertainties in demand forecasting:

- Demand forecasts provide a range of possible future demands (low, mid and high) with associated water supplies. Adjusting the timing of water supply projects will accommodate changes in the rate of demand growth. If growth is slower or faster than predicted, projects can be deferred until needed or developed in a shorter timeframe. Regular updates of this plan will allow course corrections.
- Improved conservation measures and economic forces have slowed both urban and agricultural water demand growth extending existing supplies.
- With the diversified water supply approach of advanced conservation, sustainable ground water and surface water supplies, and new technologies in recycled water and desalination, there should be sufficient water supply to accommodate variability in domestic and agricultural water demand growth.

OV.5 PLAN IMPLEMENTATION

The implementation of the watershed management plans will be accomplished by:

1. Guiding public investment in infrastructure through agency functional and facility plans, which are consistent with the sustainable communities and development plans and the WMPs of the City.
2. Including watershed and water supply projects in agency capital improvement programs for short, mid and long-term horizons that balance the five WMP objectives.
3. Incorporating major watershed management strategies and projects through the City's land use planning processes such as the Development Plans, Sustainable Communities Plans, special area plans, land use permitting process for private and public development, and through the Public Infrastructure Map.
4. Creating watershed partnerships of Federal, State and City agencies, landowners, organizations and communities who can pool resources toward common objectives, and creating groups that choose to assume the responsibility or obtain authorization to implement specific watershed projects.
5. Securing sufficient funding sources to support watershed and water supply projects through a combination of appropriations, grants, fees and dedicated funds. Each project is subject to annual budget approval and available funding.
6. Recommending approval, approval with conditions or denial of developments seeking water based on the adequacy and timing of planned water system infrastructure.

Water Allocation and System Development

The OWMP sets forth the allocation of water to land use by identifying new water supplies for the planned urban developments and agricultural lands as designated in O'ahu's sustainable communities and development plans. The land use plans and watershed management plans will be used as a guide for the review and approval of CWRM water use permit applications and water commitments and land use approvals by the BWS and DPP. CWRM review of Stream Diversion Works Permits and Stream Channel Alteration Permits for new diversions of surface water can also use the plans for guidance. Water use permits are not required for domestic consumption of water by individual users (Chap. 174C-48(a) HRS). Regular updates of the regional land use plans and watershed plans will integrate land use and water planning and with iteration, will improve consistency and ultimately achieve healthy watersheds.

Adequate Facilities Requirement

All land use actions for developments requiring water, including domestic service, irrigation and fire protection from the BWS water systems are reviewed for adequacy of supply and level of service in compliance with *BWS Rules and Regulations, Chapter 1, Water and Water System Requirements for Developments and BWS Water System Standards.*

BWS issues water commitments based on an assessment of the adequacy of water supply and water system capacity. There are three categories of available water of which Category 2 currently applies island-wide:

1. Areas with Adequate Water Supply. BWS may issue advance water commitments to proposed developments in areas where the water system has adequate supplies to assume new or additional services.
2. Areas with Limited Additional Water Supply. BWS may restrict the issuance of advance water commitments to proposed developments in areas where the water system has limited additional supplies to assume new or additional services.
3. Areas with No Additional Water Supply. BWS shall not issue water commitments to proposed developments in areas where the water system has no additional supplies to assume new or additional services. The only exceptions shall be the issuance of a single 5/8-inch meter to proposed developments on existing single vacant lots.

BWS assists CWRM with permit reviews for new development. New water sources both public and private, must comply with the State Water Code, Chapter 174C-51, Application for a Permit. Water Use Permits are required for sources of supply in designated water management areas. All areas except Wai'anae are designated water management areas. Chapter 174C-49 Conditions for a Permit, establishes that the proposed use of water:

1. Can be accommodated with the available water source;
2. Is a reasonable-beneficial use as defined in Section 174C-3;

3. Will not interfere with any existing legal use of water;
4. Is consistent with the public interest;
5. Is consistent with state and county general plans and land use designations;
6. Is consistent with county land use plans and policies; and
7. Will not interfere with the rights of the Department of Hawaiian Home Lands.

Review of zoning and other development applications

Before zoning is approved for new residential, commercial and industrial development, the BWS will indicate to DPP that adequate potable and nonpotable water is available or recommend conditions that should be included as part of the zone change approval in order to assure adequacy.

Large developments requiring major new water system infrastructure

BWS requires new large developments to submit potable and nonpotable water master plans for review and approval, showing the necessary infrastructure to accommodate the development. The master plan should provide land use, site layout, phasing, water demands, and infrastructure including proposed source, storage, transmission and treatment facilities with hydraulic analysis. The master plan then guides the review and approval of construction plans, and the installation of infrastructure to be dedicated to BWS in compliance with BWS Water System Standards. Applications for Water Service are contingent upon the fulfillment of these conditions.

Existing lot developments and small subdivisions

BWS capital program expands the water system to accommodate planned growth. Each application for water service is evaluated for system adequacy to provide domestic and fire protection services. Water System Facilities Charges, the BWS impact fees, are applied to all new developments requiring new or additional water service. If water system infrastructure is not adequate, the development can be denied or conditions to ensure adequacy are placed on the development before water service is approved.

BWS Capital Program

The OWMP is the long-range strategic water resource plan for the City and drives the BWS long-range capital program plan of source, storage, transmission, treatment and infrastructure renewal and replacement projects. The capital projects plan is an integral part of the BWS responsibility, authorized by City Charter as the public water system purveyor and water resource manager. The capital projects program is integrated with the BWS long-term financial plan and water rate structure. BWS is authorized by City Charter to set water rates to provide water supply for O'ahu. The capital program accommodates water system expansion and infrastructure renewal and replacement as guided specifically by the strategies in Objective #5 meet demands at reasonable costs while balancing the other plan objectives.

ENDNOTES

[1] State Agricultural Water Use and Development Plan, Revised 2004, State Department of Agriculture

[2] Hawai'i Agricultural Research Center Report, Bio-diesel Crop Implementation in Hawai'i, Sept. 2006

[3] Climate Change and Water Resources: A Primer for Municipal Water Providers by Kathleen Miller and David Yates National Center for Atmospheric Research, American Waterworks Assoc. Research Foundation Publication

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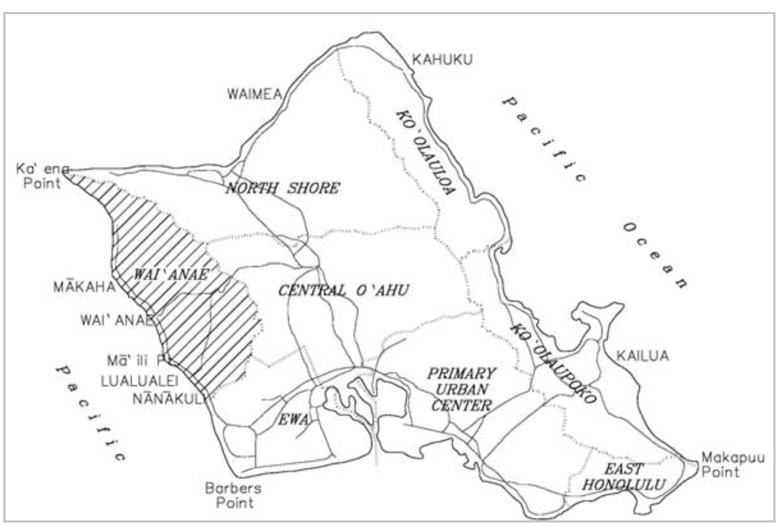
ES EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Wai‘anae Watershed Management Plan (WWMP) provides a long-range plan to the year 2030 for the protection, preservation, restoration, and balanced management of ground water, surface water, and related watershed resources in the Wai‘anae District, island of O‘ahu. The WWMP has been prepared in accordance with the State Water Code and the City’s ordinances on land use and water use planning. It is one of eight plans that will together form the “O‘ahu Water Management Plan.”

FIGURE ES-1



The eight districts of the O‘ahu Water Management Plan.

The Honolulu Board of Water Supply (BWS) has developed the WWMP in collaboration with the City and County of Honolulu Department of Planning and Permitting (DPP) and the State's Commission on Water Resource Management (CWRM). The planning process included extensive and intensive consultation with the Waiʻanae community, major land owners, and public agencies that play a role in land and water planning and use. BWS began the WWMP process in August 2004 and published a "Public Review Draft" of the Plan in June 2006.

A "PDF" format copy of the Public Review Draft was posted on the BWS website at www.hbws.org. Hard copies of the document were mailed to community members who participated on the project "Working Group," and CDs were mailed to public agencies. Based on the comments received, the WWMP was revised to develop a Preliminary-Final ("Pre-Final") version of the Plan. The Pre-final WWMP was submitted to the Honolulu City Council for adoption, and to the Commission on Water Resource Management for approval.

This Executive Summary provides a brief synopsis of the major findings and recommendations of the WWMP. The WWMP is presented in six chapters and six appendices:

Chapter 1	Overview of Oʻahu Hydrogeology
Chapter 2	Waiʻanae Watershed Profile
Chapter 3	Water Use and Projected Demand
Chapter 4	Objectives, Sub-Objectives, and Strategies
Chapter 5	Watershed Management Projects and Programs
Chapter 6	Implementation
Appendix A	Approval of Watershed Management Plan Scope and Approach
Appendix B	Plans, Policies, Guidelines, and Controls
Appendix C	Oʻahu Water Use Permit Inventory (2008)
Appendix D	Waiʻanae Water Sources
Appendix E	Water Use and Demand
Appendix F	BWS Waiʻanae Capital Program
Appendix G	Waiʻanae Neighborhood Board Support

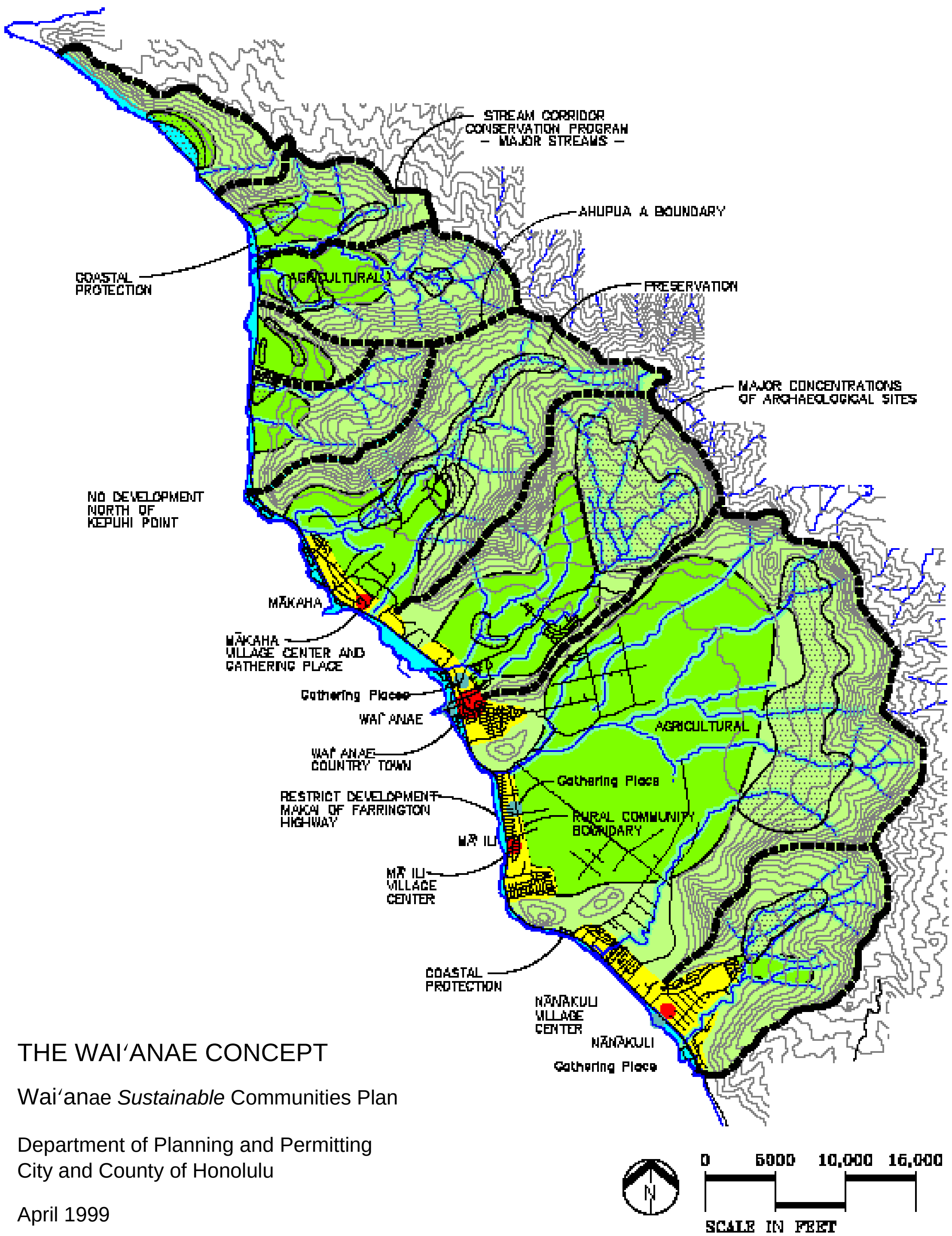
ES.2 THE WWMP AND THE WAIʻANAE SUSTAINABLE COMMUNITIES PLAN

The State Water Code requires that the County Water Use and Development Plans be developed in alignment with the County land use plans. Throughout the planning process for the WWMP, BWS has been mindful of the policies and guidelines of the "Waiʻanae Sustainable Communities Plan" (WSCP), which was completed and enacted in 2000.

The **VISION STATEMENT** articulated in the WSCP has been an overall guide for the WWMP as well:

"THE VISION FOR THE FUTURE OF WAI'ANAE IS A VISION OF A COMMUNITY living by values and customs that are firmly embedded in the rural landscape, the coastal shore lands, the ocean waters, the forested mountains, the diversity of cultures, the warmth of family and friends, and the Wai'anae traditions of independence, country living, and aloha."

FIGURE ES-2



THE WAI'ANAE CONCEPT

Wai'anae *Sustainable* Communities Plan

Department of Planning and Permitting
City and County of Honolulu

April 1999

ES.3 THE PLANNING PROCESS

At the outset of the planning process, BWS established several key guiding principles for the WWMP. BWS directed that the Plan be:

- Community-based
- Environmentally holistic
- Reflective of the ahupuaʻa management principles of the Waiʻanae community
- Action-oriented
- In alignment with State and City water and land use policies

In accordance with these overall guidelines, the planning process for the WWMP emphasized the importance of two complementary sets of studies and actions:

(1) Research work involving data collection and analysis and review of relevant plans and programs, maps, charts, graphs, and statistical projections;

(2) Meetings, interviews, and other consultation with key stakeholders, including Waiʻanae community leaders, community groups and organizations, land owners, developers, and public agency representatives.

Thus, the planning process was both technical and community-based in nature and the conclusions and recommendations that emerged from the planning process were based on both objective analysis and the values and ideas of the many stakeholders.

The accompanying flow chart (Figure ES-3) diagrams the overall planning process for the WWMP.

ES.4 WAIʻANAE WATERSHED – KEY FACTS AND FINDINGS

The term "Waiʻanae Watershed" is used in this Plan to describe the geographic area encompassed by the City's "Waiʻanae District" boundaries. The watershed is also roughly coterminous with the traditional boundaries of the "Waiʻanae Moku," except where that Hawaiian land division extended to Kaʻena Point to the north and across the Waiʻanae Mountains through a portion of Central Oʻahu and up to the ridgeline of the Koʻolau Mountains – "Waiʻanae Uka" on the old maps of the *moku*.

Physical and ecological characteristics of the Waiʻanae watershed may be summarized as follows:

- **Land Area:**

  38,089 acres, or about 59.5 square miles = 10% of Oahu's land area.

- **9 ahupuaʻa:**

  Nānākuli, Lualualei, Waiʻanae, Mākaha, Keaʻau, ʻŌhikilolo, Mākua, Kahanahāiki, Keawaʻula.

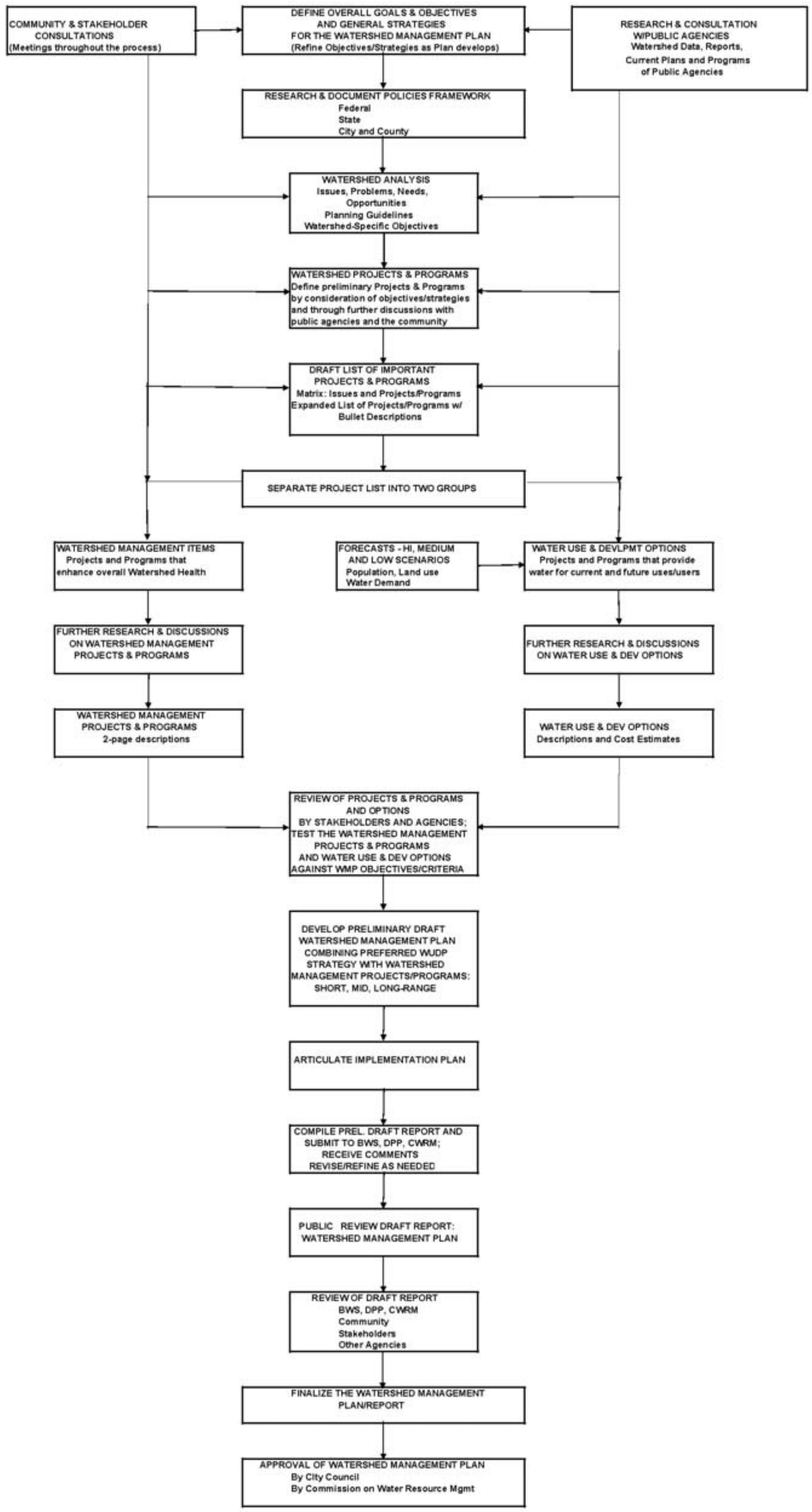
- **6 major streams:**

  Nānākuli, Ulehawa, Māʻiliʻili, Kaupuni, Mākaha, Mākua.

- **5 Hydrologic Aquifer System Areas:**

  Nānākuli, Lualualei, Waiʻanae, Mākaha, Keaʻau.

FIGURE ES-3
DIAGRAM OF THE WATERSHED MANAGEMENT PLANNING PROCESS



- **Nearshore Waters:**

  Ocean recreational uses are increasing, resources are declining.

- **Coastal Areas:**

  Urban/suburban development up to Kepuhi Point.

- **Valley Areas:**

  Rural residential, small farms, military use.

- **Mountain Areas:**

  Introduced plants and animals dominate; remnant native plants and animals in isolated enclaves. Remnant native populations are threatened by feral ungulates and wildfires.

General Assessment based on discussions with public agencies and community members: The land and water resources and ecology of the Waiʻanae Watershed have been highly impacted by human settlement and activities over the past 200 years, causing their health and quality to be poor and declining. Strong resource management programs are needed if a measure of natural health and ecosystem integrity is to be restored to this watershed.

Population and Water Use characteristics of the Waiʻanae Watershed are summarized as follows:

- **Population:**

  Estimated at 4,000 to 6,000 during pre-contact period

  1855: only about 800 people remained

  1940: 3,000

  1960: 16,452

  2000: 42,000 = 4.82% of 876,156 Oʻahu total population.

- **Ethnicity:**

  One of the most ethnically diverse districts in the State, with about 40% Hawaiian or part-Hawaiian people, and a large number of Filipinos, Japanese, Pacific Islanders, Vietnamese, Caucasians, and others.

- **Future Population: (by year 2030)**

  DPP "Policy Projections": 50,616 = 4.5% of Oʻahu total

  DPP "Trend Projections": 52,236 = 4.7% of Oʻahu total

  "High Growth" Projections: 60,259 = 5.4% of Oʻahu total.

- **Projected Water Use: (BWS System)**

  Year 2000: 6.62 mgd potable water, 3.00 mgd non-potable

  Year 2005: 6.97 mgd potable water, 2.85 mgd non-potable

  Yr 2030 "Policy Projections": 8.63 mgd potable, 3.25 mgd non-potable

  Yr 2030 "Trends Projections": 9.09 mgd potable, 3.16 mgd non-potable

  Yr 2030 "High Growth Projections": 10.37 mgd potable, 5.01 mgd non-potable.

- **Water Sources: (BWS system)**

  For 2000, BWS supplied about 9.47 mgd of potable and non-potable water to Waiʻanae, approximately 5.46 mgd from in-District sources, including non-potable water, and 4.45 mgd from the Pearl Harbor Aquifer.

Important water resource management issue: BWS produces 4 to 5 mgd from BWS water wells, shafts, and tunnels within the Wai'anae District. The District's water needs from the BWS system are currently about 9.62 mgd and growing. By 2030, an additional 2.01 mgd (or more) of potable water and an additional 0.27 mgd (or more) of non-potable water will be needed over year 2000 demands.

Table ES-1 below shows the range of additional potable and non-potable water that the Wai'anae community may need by the year 2030. Adding the numbers for potable and non-potable water, the total additional water that may be needed by 2030 is projected to be at least 2.29 mgd– about a 20% increase over 2000 use levels – and a high of 6.01 mgd, which would be a 55% increase over year 2000 use levels.

TABLE ES-1: 2000 TO 2030 INCREASE IN WATER DEMANDS IN MGD
"END-USE INVENTORY METHOD"
LOW (POLICY) AND HIGH GROWTH NUMBERS

	Potable Water (mgd)	Non-Potable Water (mgd)	**TOTAL (mgd)**
BWS System	2.01 to 3.75	0.25 to 2.01	**2.26 to 5.76**
Non-BWS System	0.00 to 0.00	0.03 to 0.25	**0.03 to 0.25**
TOTAL	**2.01 to 3.75**	**0.28 to 2.26**	**2.29 to 6.01**

ES.5 STAKEHOLDER CONSULATIONS

The project team devoted over 2,000 person hours to "one-on-one" meetings, small group meetings, agency meetings, community "working group" meetings, and other forms of consultations – with community leaders, community groups and organizations, land owners, and public agencies.

Some important "guiding principles" for watershed management emerged from the community interviews and meetings. These guiding principles are summarized as follows:

- Access to watersheds requires a sense of kuleana.
- Watershed management involves everyone!
- Take what you need and don't waste!
- Self-sufficiency, dignity and good health for our community are important.
- Sensitivity to species and habitats from mauka to makai is important.
- "Water justice" is a major concern - the *just* use of water and respect of water rights.
- Recycle, reuse, and conserve water.
- Appropriate application of new water development technology.
- Maintain the rural and agricultural landscape.
- Controlled and balanced community growth.
- Expand educational and intergenerational learning about watershed.

Representatives of stakeholder agencies generally concurred with most, if not all, of these guiding principles. However, agencies also voiced cautions and concerns about the lack of adequate resources to implement needed watershed restoration and water resource management projects and programs.

Consultation with community group/organization.

ES.6 GOALS AND OBJECTIVES OF THE WWMP

The Goals and Objectives for the Wai'anae Watershed Management Plan were developed within the overall context of relevant Federal, State, and City laws and policies, and through extensive discussions and consultations with the Wai'anae community, public agencies, major land owners, and stakeholder groups, and organizations.

Mākaha Stream.

GOAL OF THE WAI'ANAE WATERSHED MANAGEMENT PLAN:

To formulate an environmentally holistic, community-based, and economically viable watershed management plan that will provide a balance between: (1) the preservation and restoration of Oahu's watersheds, and (2) sustainable ground water and surface water use and development to serve present users and future generations.

MAJOR OBJECTIVES AND SUB-OBJECTIVES OF THE WWMP:

1. **PROMOTE SUSTAINABLE WATERSHEDS. Plan and take action towards a more sustainable future for the Wai'anae watershed and community.**

- Strive to enhance and protect natural resources including land, stream, and near shore ecosystems.
- Strive for regional self-sufficiency, where practical.
- Protect the community from natural and human-induced hazards

2. **PROTECTAND ENHANCE WATER QUALITY AND QUANTITY. Protect and restore the quantity and quality of ground water and surface water in the Wai'anae District.**

- Maintain and improve sustainable quantities of ground water.
- Protect the quality of ground, surface, and near shore waters for potable, recreational, and habitat needs.

3. **PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES. Understand and respect Native Hawaiian rights and traditional cultural practices that depend on healthy and sustainable land and water resources.**

- Develop a working relationship with Waianae's Native Hawaiian Community for the sustainable management of the District's water resources.
- Incorporate traditional Hawaiian values, cultural practices, and water rights into the modern context

4. FACILITATE PUBLIC PARTICIPATION, EDUCATION, AND PROJECT IMPLEMENTATION. Develop the WWMP and related plans and programs through an ongoing collaborative process with the Waiʻanae community.

- Partner with the community to promote a sense of kuleana, and to balance access to resources with management responsibility.
- Partner with agencies at multiple levels to improve efficiency and potential for project implementation

5. MEET FUTURE WATER DEMANDS AT REASONABLE COSTS. Provide for present and future potable and non-potable water needs of the Waiʻanae community in a cost-effective manner.

- Provide water at a reasonable cost to the community.
- Efficiently meet potable water demands.
- Improve and maintain BWS water system reliability.

These goals and objectives form the overall framework and foundation for the WWMP.

BWS Mākaha Well II.

ES.7 ELEMENTS OF THE WAIʻANAE WATERSHED MANAGEMENT PLAN

The planning studies and stakeholder consultations led to the identification of two sets of potential elements for the WWMP:

- Options for water use and development.
- Projects and Programs for watershed management.

These two sets of WWMP elements are inter-related in many ways, and they are thus described in detail together in Chapter 5 of this Plan. However, while all actions are presented using a similar format, the water use options are described in a format that will provide the specific information necessary to evaluate those types of actions. The titles of all of these elements are provided below.

Ten Water Supply Options were identified:

- Additional potable water imports from the Pearl Harbor Aquifer
- Develop additional Waiʻanae Aquifer Sector ground water – potable water
- Develop additional Waiʻanae Aquifer Sector ground water – brackish water
- Develop surface water sources
- Storm water capture
- Recycled water: Waiʻanae Wastewater Treatment Plant
- Recycled water: MBRs for single users
- Desalinated water – from BWS Kalaeloa Desal Plant
- Desalinated water – from new Waiʻanae Desal Plant
- BWS water conservation

Twenty-two Watershed Management Projects and Programs were identified:

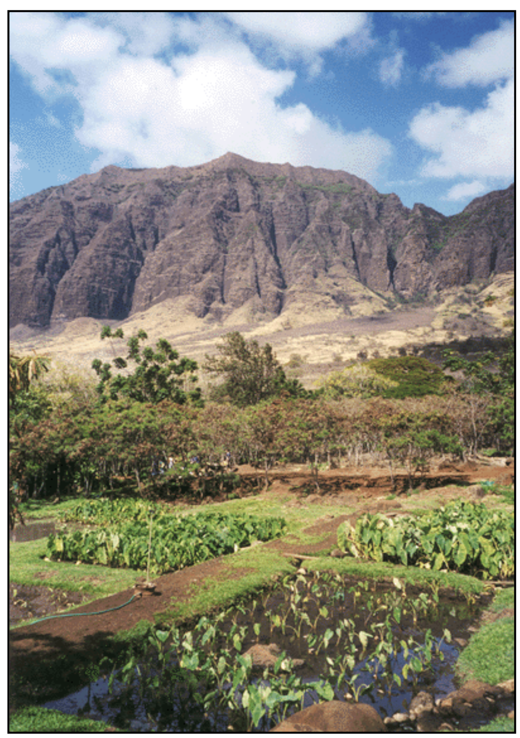
Ground Water Projects and Programs
- Waiʻanae Hydrogeology Study.
- Waiʻanae Source Water Protection Plan.
- Drought Mitigation Strategies

Surface Water Projects and Programs
- Measurable Instream Flow Standards.
- Stream Conservation Corridor Project.
- Wetlands Restoration and Protection.
- Concrete Flood Channel Redesign.
- Stream Biological Assessments.
- Water Quality Testing and Monitoring.
- Stream Dumping Prevention and Clean Up.
- Surface Water Inventory.
- Surface Water Quality Improvement.

Land Management
- Forest Restoration Program.
- Wildfire Management Plan.
- *Loʻi Kalo* Expansion Program.
- Mākaha Research Watershed.
- Agricultural Support Program.
- Flood Mitigation Program.
- Mākaha Special Area Plan.

Cultural/Educational Support
- Waiʻanae Watershed Partnership.
- Cultural Learning Centers.
- Community Watershed Education Program.
- Waiʻanae Rural Landscape Study.

Channel litter in Waiʻanae.



Cultural Learning Center at Kaʻala in Waiʻanae. (c) 2001 Environment Hawaiʻi, Inc.

ES.8 IMPLEMENTATION OF THE WWMP

Implementation of the WWMP is described in Chapter 6 of this document. This is a long-range plan, with a planning horizon of the Year 2030. The Implementation Plan is organized under the five major island-wide planning objectives discussed earlier. Each objective of the plan is further detailed by Waiʻanae-specific sub-objectives. Strategies to fulfill each sub-objective include a number of watershed management projects and programs as well as more specific water supply actions. **The blending of larger scale watershed management elements with specific water supply actions is a key element of this Plan.**

In keeping with the overall BWS themes of "Water for Life," "sustainability of water resources," and "holistic watershed planning," it is important that the WWMP and other District watershed management plans present integrated recommendations and implementation plans for both overall watershed management and water supply projects.

The watershed protection projects are applicable throughout the region. Phasing for the projects is based on watershed needs and organizational feasibility.

From a water supply perspective, Mākaha and Waiʻanae are the most critical watersheds in the Waiʻanae District and many of the watershed projects are focused here. These watersheds have the most ground water and surface water use, available agricultural lands, important cultural significance, and perennial stream segments in the upper valleys. Active community, landowner, and agency partnerships, such as Mohala I Ka Wai and the Waiʻanae-Kai Community Forest Project, are already implementing many of the watershed projects and strategies.

The Waiʻanae District's projected water demands by the year 2030, which could range from an increase of 2.3 mgd to 6.0 mgd of additional water, will be primarily met through increased imports from BWS sources in the ʻEwa and Central Oʻahu Districts. These increased imports may be supplemented to some extent by:

- Relatively small volumes of non-potable brackish water from existing wells that could be brought back on line, including wells in Nānākuli and Lualualei;
- The design and construction of MBR units for some of the large water users in Mākaha Valley;
- The design and implementation of more effective water conservation programs – by BWS as well as by other entities, including the Department of Education for Waiʻanae public schools and the Department of Hawaiian Home Lands for Hawaiian Homestead communities in Nānākuli, Lualualei, and Waiʻanae Valleys.

BWS will continue to use in-District potable water wells at sustainable levels, and will continue its plan of reduced pumpage of Mākaha and Waiʻanae Valley sources in order to account for drought mitigation and allow increased natural flows in Mākaha and Kaupuni Streams.

The accompanying color graphic summarizes the key elements of the WWMP.


WAI‘ANAE WATERSHED MANAGEMENT PLAN
“ELEMENTS OF THE PLAN”
SHORT-RANGE PROJECTS
(2006-2010)
Project No. 01 Additional Water Imports from the Pearl Harbor Aquifer
Project No. 10 Water Conservation Programs
Project No. 11 Wai‘anae Hydrogeology Study
Project No. 13 Drought Mitigation Strategies
Project No. 14 Measurable Instream Flow Standards
Project No. 15 Stream Conservation Corridor Project
Project No. 18 Stream Biological Assessments
Project No. 19 Water Quality Testing and Monitoring
Project No. 20 Stream Dumping Prevention and Clean Up
Project No. 22 Surface Water Quality Improvement Program
Project No. 23 Forest Restoration Program
Project No. 24 Wildfire Management Plan
Project No. 29 Mākaha Special Area Plan
Project No. 31 Cultural Learning Centers
Project No. 32 Community Watershed Education Program
MID-RANGE PROJECTS
(2011-2020)
Project No. 07 Recycled Water: MBRs for Single Users
Project No. 08 Desalinated Water from BWS Kalaeloa Desal Plant
Project No. 21 Surface Water Inventory and Registration Project
Project No. 25 Lo‘i Kalo Expansion Program
Project No. 26 Mākaha Research Watershed
Project No. 27 Agricultural Support Program
Project No. 28 Flood Mitigation Program
Project No. 30 Wai‘anae Watershed Partnership
Project No. 33 Wai‘anae Rural Landscape Study
LONG-RANGE PROJECTS
(2021-2030)
Project No. 16 Wetlands Restoration and Protection Program
Project No. 17 Concrete Flood Channel Redesign Project
NOTE: A selection of the “Short-Range Projects” is shown on the map. The selected projects are not intended to be all inclusive or site-specific.
LEGEND
Cultural Learning Center
Recycled Water Project
Stream Biological Assessments and Water Quality Monitoring
Reforestation Areas
Mākaha Special Area Plan
0 3,000 6,000 9,000
SCALE IN FEET
Ka‘ena Point
Mount Ka‘ala
Mākua Stream
Mākaha Stream
Kaupuni Stream
Mā‘ili‘ili Stream
Ulehawa Stream
Nānākuli Stream
Proj. #30 Cultural Centers
Proj. #22 Forest Restoration
Proj. #23 Wildfire Management
Proj. #28 Makaha SAP
Proj. #07 MBR's
Proj. #13 & 14 Stream Corridor & Flow Restoration
Proj. #21 Water Quality Improvement
Proj. #19 Stream Cleanup
Proj. #08 Desal Water from Kalaeloa
Proj. #01 – Additional potable water from Pearl Harbor Aquifer Sector
WAI‘ANAE
CENTRAL O‘AHU
‘EWA

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ES.9 CONCLUSIONS

The Honolulu Board of Water Supply will be the principal implementing agency for meeting future water demands in the Waiʻanae District. However, many other entities and individuals will need to be involved in the WWMP implementation process, including Federal, State, and City agencies, and community organizations like Mohala I Ka Wai and Kaʻala Farm.

Project-specific partnerships need to be established for priority watershed management actions. A broader "Waiʻanae Watershed Partnership" organization may evolve from these project-specific partnering activities. In the long run, an integrated organizational approach involving many public and private entities will be needed to implement this holistic watershed management plan.

Hoaʻaina O Mākaha Educational Farm.

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1 OVERVIEW OF O‘AHU HYDROGEOLOGY

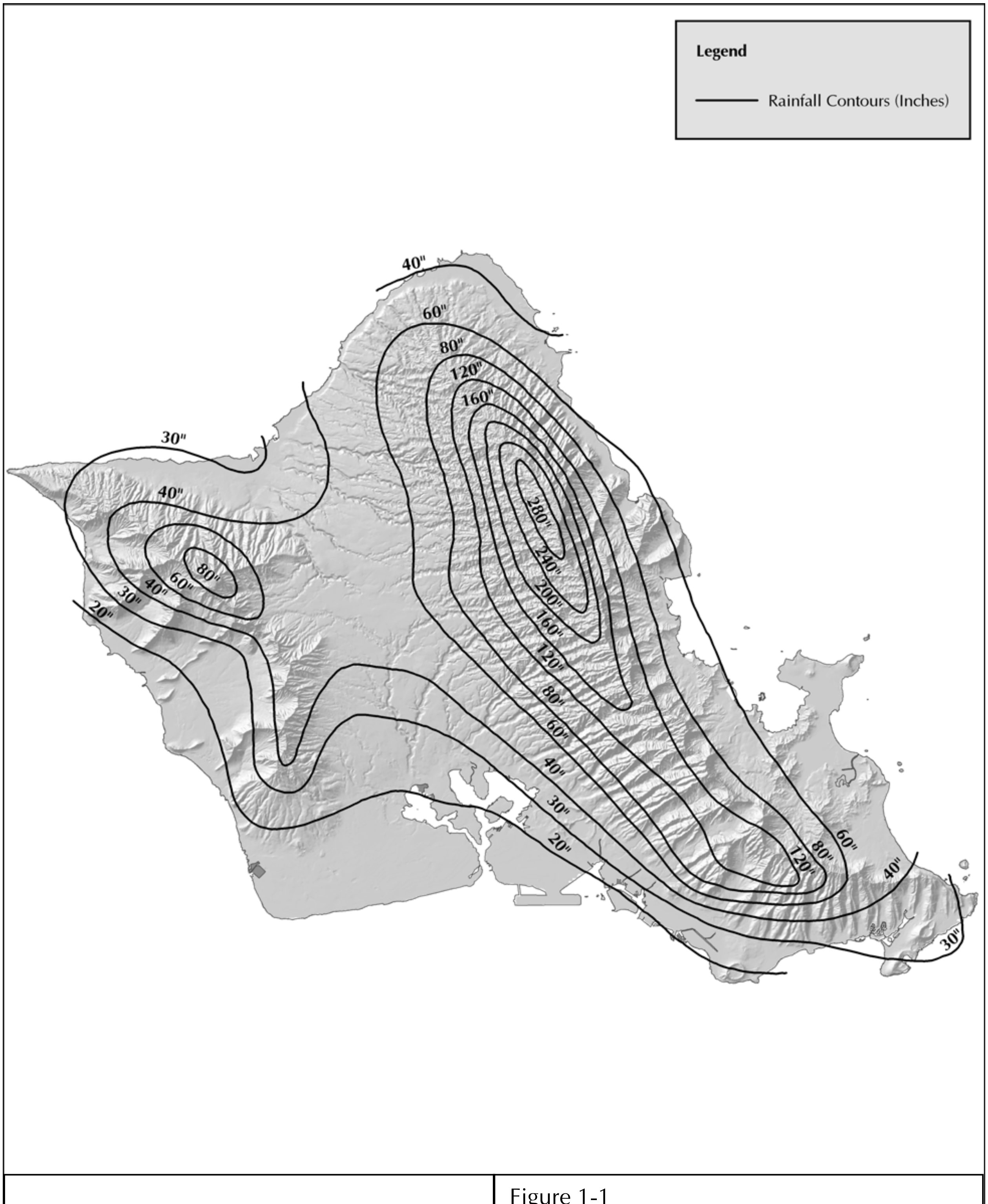
1.1 SETTING

The island of O‘ahu is approximately 600 square miles in size.[1] With less than ten percent of the land area of the State of Hawai‘i, O‘ahu's importance is not based upon its size, but upon its relationship to the economic and political activity of the state. As the center of business and government, O‘ahu is the State's economic mainstay, supporting tourism, military, agriculture, manufacturing, and research and development. Although the City and County of Honolulu and Kaua‘i are the smallest counties of the four counties in geographical size, the City and County of Honolulu alone has nearly three-fourths of the State's population with an estimated resident population of 876,000 in 2000.[2]

1.2 CLIMATE

O‘ahu's climate is mild throughout the year due to the island's location on the northern fringe of the tropics within the belt of cooling northeasterly trade winds. The two seasons in Hawai‘i are the warmer and drier period from May to October and the cooler, cloudier, wet weather from October to April. The coldest month, January, averages 72 degrees Fahrenheit and the warmest, August, 78.5 degrees Fahrenheit. Maximum temperatures rarely exceed 90 degrees Fahrenheit, and minimum temperatures hover around 50 degrees Fahrenheit. The average temperature in the lowlands is 75 degrees Fahrenheit, decreasing 4 degrees Fahrenheit with each 1,000 feet increase in elevation. Humidity of the area is generally within the 60 to 80 percent range.[3]

The contrast between O‘ahu's lush green mountains and the arid lowland plains reflects extremely wide rainfall variations. Annual average rainfall on O‘ahu ranges from less than 20 inches on the leeward coast to almost 300 inches near the central crest of the Ko‘olau Range (Figure 1-1). Such



Source: Rainfall Atlas of Hawai'i Report R76,
State of Hawai'i Department of Land and Natural Resources, 1986.

Figure 1-1
O'AHU ANNUAL AVERAGE RAINFALL
Wai'anae Watershed Management Plan

a marked difference over a distance of less than 15 miles has a significant effect upon water resources.

The sea surrounding O'ahu receives no more than 30 inches of rain each year, far too little to sustain vigorous plant growth in the tropics. However, because the rugged, steep Ko'olau Mountains intercept prevailing trade winds, the moisture carried by these winds is lifted, cooled, and thereby condensed into rain. Rainfall is heaviest high in the mountains and decreases in the leeward direction. The Wai'anae Range is a less effective rainmaker since it lies to the lee of the Ko'olau Range.

Another significant contributor to precipitation is fogdrip. Fogdrip is cloud vapor that clings to vegetation and then drips to the ground. This generally occurs between 2,000 and 6,000 feet above sea level.[4]

Trade winds prevail throughout the year, but are least continuous from October through April, Hawai'i's winter season. During these months, tropical storms occasionally bring heavy rains, which account for practically all the rainfall on the leeward plains. Flooding is more likely during the wet winter weather, and during the dry period, stream flow decreases and the supply of irrigation waters dependent on this source can be an issue.[5]

Climate Change and Rising Sea Levels

Climate variability affects the availability and quality of ground water and surface waters. The following summarizes the key points on climate change identified in the 2006 American Water Works Association (AWWA) Publication *Climate Change and Water Resources: A Primer for Municipal Water Providers.*[6]

- Global average temperatures have increased approximately 0.6 degrees Celsius over the past century and warming is expected to accelerate over the next century. The arctic areas have warmed more rapidly than other areas increasing glacial melt.
- Air pollution has changed the composition of the atmosphere.
- Global warming will change atmospheric and oceanic circulation and the hydrologic cycle leading to altered patterns of precipitation and runoff.
- Global average precipitation and evaporation will increase with warming because a warmer atmosphere can hold more moisture. However, this does not mean that it will get wetter everywhere and in all seasons. Some say average precipitation will tend to be less frequent but more intense. This implies unanticipated extremes, such as unprecedented droughts and floods.
- Climate variability affects the availability and quality of water resources. Long-term climatic trends could trigger vegetation changes that would alter a watershed's water balance. Changes in the quantity of water percolating to ground water will result in changes to aquifer levels, in base flows entering streams and in seepage losses from streams to ground water.

- While artic areas are warming and glaciers are melting more rapidly, current climate models suggest that arctic and equatorial regions may have a tendency to become wetter and that subtropical regions may experience drying. Hawai'i is within the tropical region defined as those areas between the Tropics of Cancer and Capricorn.
- Rising sea levels will introduce new stresses on physical and ecological systems, including aquifers, streams, forests and riparian zones as well as coastal and freshwater aquatic systems. Rising sea levels impact coastal environments in the following ways:
  - Lowland inundation and wetland displacement
  - Altered tidal range in rivers and bays
  - Changes in stream sedimentation patterns
  - Severe storm surge flooding
  - Saltwater intrusion into estuaries and freshwater aquifers
  - Increased wind and rainfall damage in regions prone to hurricanes

Sea level on O'ahu has risen 10 inches over the last century and is expected to rise another 3 feet during this century[7]. The rise is due in large part to the effects of climate change and in small part to O'ahu's slow but steady sinking into the ocean. Greenhouse gases, such as carbon dioxide and methane in the atmosphere hold global heat, melt ice at the polar caps, and coupled with thermal expansion of the oceans, causes the sea levels to rise.

BWS hydrologist-geologists comment that as long as mean sea level (msl), does not rise above the caprock, which are tens of feet above msl, basal aquifers will not be detrimentally impacted. Aquifers are susceptible where caprock above msl is thin, such as in Pearl Harbor. Brackish caprock sources will be impacted first. Due to density differences, the basal freshwater levels will rise accordingly above rising seawater and the aquifers will tend to migrate inland. Deep wells may be impacted as the brackish transition zone rises to a new equilibrium head, and wells may have to be partially backfilled. Climate change indicators will have to be monitored closely and mitigative measures initiated incrementally to minimize costs and detrimental impacts.

1.3 WATER CYCLE

A continuous cycle of water can be easily traced on small oceanic islands like Hawai'i. As noted most **precipitation or rainfall** begins as moist trade wind air that rises up the mountain side, cools and condenses and falls as rain or fog drip. However, in the winter months (November to April) extra-tropical storms approach from the north, covering the entire island during times when low pressure occurs in the northern Pacific. Sub-tropical "Kona" storms are important for recharging the drier leeward area of O'ahu.

The water cycle is illustrated in Figure 1-2. The three main elements of the water cycle are precipitation, runoff and evapotranspiration and can be summarized by the equation

$$R=P-RO-ET$$

where R = recharge, P=precipitation, RO = runoff and ET = evapotranspiration.

Rainfall varies greatly around the island and is measured by a limited network of rain gages. The rainfall data is then extrapolated to represent actual rainfall distribution. Trade wind rainfall in particular can be very localized. Rainfall distribution is based on averages and there are significant variations from wet and dry years. Maintaining existing rain gages are essential and more are needed, especially in critical aquifer systems.

When precipitation occurs faster than it can infiltrate the ground, it becomes **runoff**. Runoff flows over land surfaces into streams and drainage systems and eventually into the ocean. Ground water may supply stream base flows. *Runoff* is measured by stream gages but additional water flows in streams as underflow beneath and around the streams perched upon alluvium and is not measured in stream gages. Storm water flowing overland, through intermittent stream channels and storm drains are difficult to accurately estimate and account for in water budgets.

Evapotranspiration is the loss of water from

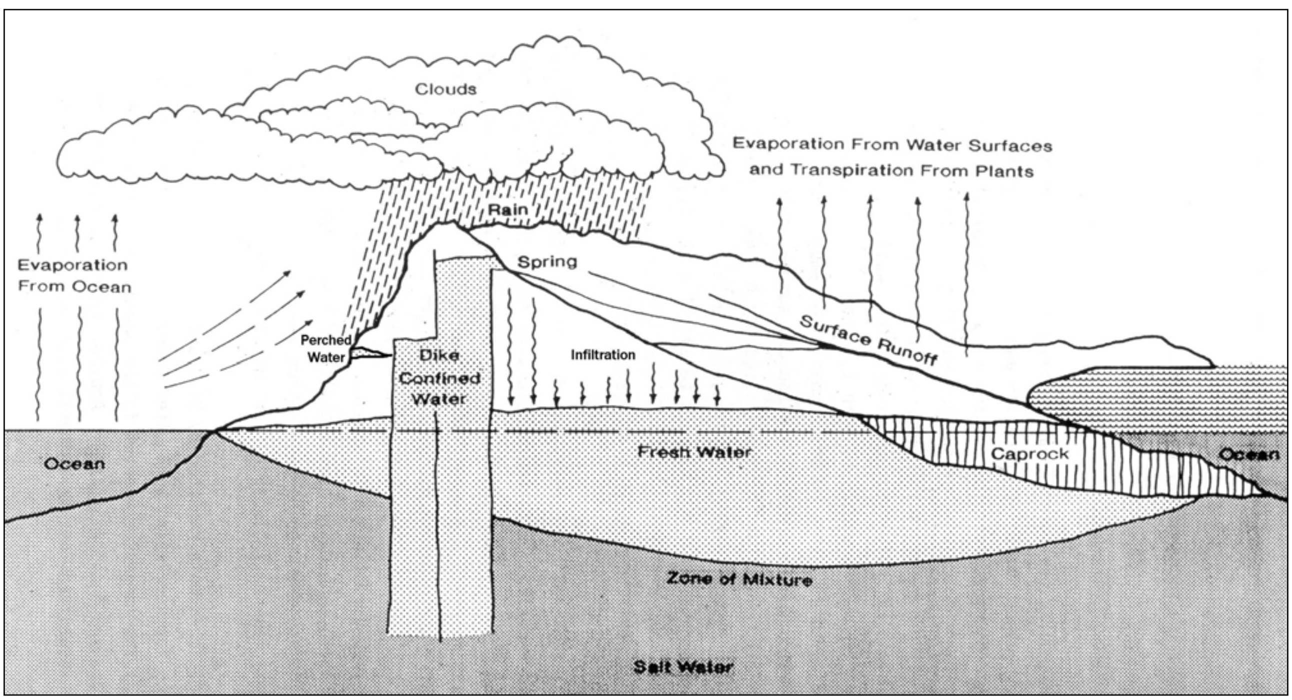


FIGURE 1-2
HYDROLOGIC CYCLE
(O'ahu Water Management Plan, 1990)

the soil by evaporation and by plant uptake of water as it lives and grows. Evaporation is the change of liquid water to a vapor. As the water heats, vaporization occurs. Warm moist air rises up into the atmosphere and becomes the vapor involved in condensation. There are also evaporation losses from water bodies above the ground and from water that lands on plants and other exposed surfaces. Evapotranspiration is based on pan evaporation data and an assumed vegetative transpiration quantity. Global warming will increase evaporation. Transpiration data is limited to few plant species, yet the vegetative cover is varied and changing over time with different land uses and changing ecosystems, which requires more study.

Percolation or infiltration occurs when precipitation sinks into the ground and becomes ground water. Some factors that affect the rate of infiltration are ground slope, vegetative thickness and soil permeability. Permeability is the measure of how easily a fluid flows through soil and rock. The more permeable, the more quickly precipitation seeps into the ground.

Recharge is water infiltrating into the aquifer. Recharge is not directly measured and is the calculated remainder of rainfall minus runoff and evapotranspiration, in a water budget.

Leakage is the seaward flow of ground water to nearshore waters in the form of springs, seeps and underflow. Leakage is not easily quantifiable and varies in aquifers due to the amount of caprock or lack of sedimentary caprock. There are also freshwater losses to the aquifer transition zone or zone of mixture between freshwater and seawater. Human activities can alter the components of the water cycle. For example, global warming and forest degradation can change evapotranspiration rates; agricultural and urban development can affect runoff patterns.

1.4 GEOLOGY

The islands of the Hawaiian Archipelago are emerged volcanoes on a great submarine ridge that extends northwesterly and southeasterly for 1,600 miles in the central Pacific Ocean. The creation of the Hawaiian Islands chain is thought to result from a fixed "hot spot" and moving plate tectonics.[8] The ridge and resulting islands are created with the movement of the Pacific plate northwest across the hot spot. The ridge, rising from ocean depths of 20,000 feet, was formed from immense quantities of lava, flow upon flow, spewing forth.

The sequential formation of the archipelago is indicated by the occurrence of submerged older islands in the northwest portion of the chain and by the youngest island at its southeast end, where volcanic activity continues. Eight of the islands are of sufficient elevation to intercept trade wind moisture and large enough to permit settlement.

Comparatively rapid weathering and erosion of their volcanic rock structure has reduced the size and altered the form of the islands. O'ahu is comprised of the remnants of two elongate shield volcanoes, the Ko'olau and Wai'anae volcanic ranges, joined by a broad convex plateau.

The giant Nu'uanu landslide took out much of the seaward flank of the Ko'olau volcano. The eroded Ko'olau volcanic shield, stretching nearly straight northwest southeast for 37 miles from Kahuku to Makapu'u, is O'ahu's principal mountain range. The older Wai'anae volcano, an arcing mountain range 20 miles long from Ka'ena Point to the 'Ewa Plains, makes up the western bulwark of the island.

The peaks of the Ko'olau Range average about 2,500 feet in elevation. The highest point, Kōnāhuanui, overlooking Nu'uanu and Mānoa Valleys in Honolulu, rises to 3,150 feet. The Wai'anae Range peaks are somewhat higher, averaging nearly 3,000 feet. The highest point on the island is Mount Ka'ala in the Wai'anae Range, at 4,025 feet elevation.

The Wai'anae shield volcano emerged first and was partially eroded before the Ko'olau volcano emerged to the east, sending lava flows westward to overlap against the Wai'anae flank. The shield building lavas of the Wai'anae and Ko'olau volcanoes are known as the Wai'anae Volcanics and Ko'olau Volcanics, respectively.

During later periods, erosional and depositional platforms of marine and terrestrial sediments interbedded with lava flows were created around O'ahu. This was very important in determining O'ahu's water resources. These formations formed what is called the caprock and prevent the freshwater lens of ground water from flowing into the ocean. Under the caprock the freshwater lens thickens and is under pressure, a characteristic referred to as artesian.

1.5 HYDROGEOLOGY

O'ahu's geology, climate and the water cycle all influence the storage and movement of ground water. The most important feature of the volcanic formations making up the aquifers is that they were emitted on land and not as submarine flows. Under their subaerial environment, degassing and physical emplacement of the lava allowed the physical feature important to permeability to develop. The volcanic rock and their residual soils have a very great capacity to absorb and percolate water, and consequently, the amount of rainfall that recharges the ground water is greater than the amount of rainfall that runs over the surface to the sea. This infiltration and confinement in areas confined by the caprock creates the large ground water bodies on which O'ahu depends for its water supply. It should be noted that while infilitration into the ground water is great, much water is released into the atmosphere through evapotranspiration.

1.5.1 GROUND WATER

There are several types of general ground water bodies on O'ahu. The most important and most extensive is the "basal freshwater lens" that floats on seawater under much of the southern and northern portions of the island. Less widespread, but of singular importance in some areas, is ground water restrained between impermeable nearly vertical rock structures called "dikes" in the rugged core of the mountains. Dikes form from chilled magma in the fissures that feed lava flows. The third type, of minor significance on O'ahu, is ground water held up, or "perched," on horizontal impermeable beds such as volcanic ash (Figure 1-2). And, finally there is caprock water, water within the caprock, which is typically brackish water and is perched over the basal water.

1.5.1.1 Basal Water

The immense basal water bodies, which are artesian where they underlie the coastal plain, exist because of the difference in density between freshwater and seawater. Freshwater floats on the heavier seawater, both of which permeate the subsurface rock. This relationship is known as the Ghyben-Herzberg principle. The density ratio between freshwater and salt water is such that, theoretically, for each foot that the freshwater lens stands above sea level (i.e. for each foot of "head"), the lens extends 40 feet below sea level to a midpoint where salinity is half seawater. A zone of mixture ("transition zone") grades upward to freshwater and downward to seawater. For example, if the freshwater head was found to be 20 feet above sea level, it can be reasonably estimated that the depth to the midpoint of the transition zone would be approximately 800 feet below sea level (Figure 1-2).

On O'ahu, the Leeward basal aquifer is much larger than the Windward basal aquifer. On the Windward side of the island, the dike complex makes this a much smaller or truncated lens (Figure 1-2).

Basal waters can be either confined or unconfined. Since confined aquifers underlie the coastal plains, O'ahu's aquifers are mostly unconfined. Unconfined aquifers are where the upper surface of the saturated aquifer is not bounded. Confined aquifers are bounded by impermeable or poorly permeable formations.

In some coastal areas there is a relatively impermeable sediment sequence commonly called "caprock." This caprock barrier tends to restrict the seaward flow of freshwater and causes the thickness of the freshwater lens to be greater than if the caprock were absent. Depending upon the effectiveness of the caprock, the resulting lens could range from local thickening of a relatively thin lens of a hundred feet to over 1800 feet. The amount of water stored in basal lens is significant. Water can be and is withdrawn from the basal aquifer for various uses but mainly for the island's municipal water supply.

Where fresh and salt water merge, a brackish zone of the mixture forms. The movement of this transition zone, both horizontally inland from the seacoast and vertically upward, presents a constant potential danger of saline contamination to the freshwater portion of the system.

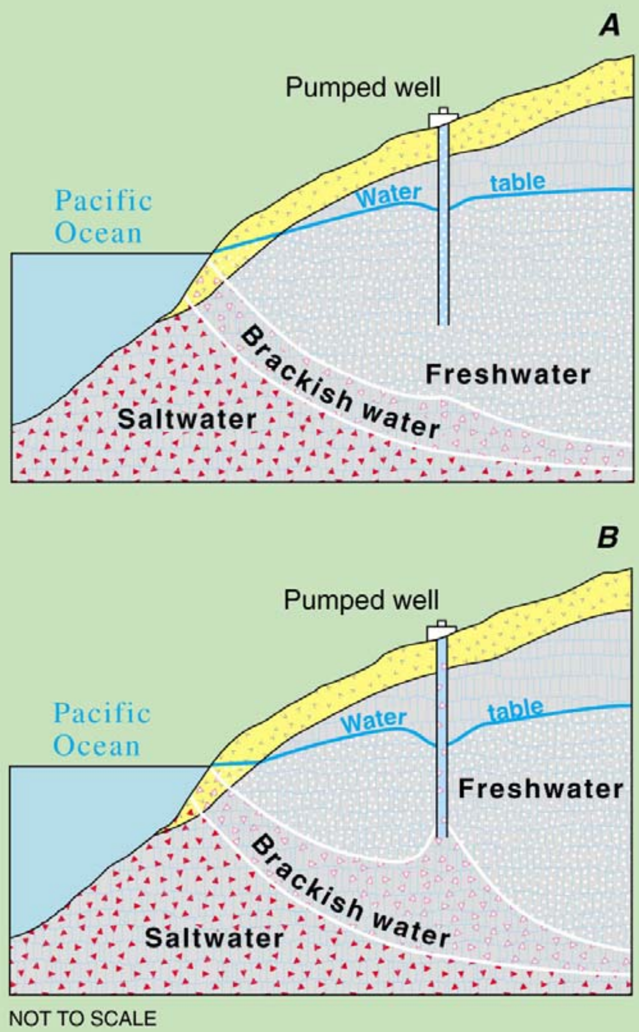
Utilization of brackish water sources for municipal supplies requires reduction of chlorides by blending and/or demineralization. Water containing more than 250 ppm of chloride ion is considered undesirable for drinking.[9] Although BWS prefers to distribute water containing less than 160 ppm, it will consider a higher level of salinity where appropriate to enhance opportunities for blending fresh and brackish water (Figure 1-3).

1.5.1.2 Dike Water

Water impounded behind impermeable dikes in the mountains is called "dike water," or "high-level water." Dikes are formed when molten magma intrudes and solidifies in conduits within the volcano's rift zone. These conduits may feed eruptions on the surface or may stay beneath the surface. Typically, they consist of nearly vertical slabs of dense, massive rock, generally a few feet thick, that can extend for considerable distances and cut across existing older lava flows. High level water impounded in permeable lavas occurring between dikes in the interior portions of O'ahu is of excellent quality and is generally hydrologically distinct from the basal water found in dike-free areas.

The dike water is not subject to saline contamination because of the high head of the water trapped between the dikes, distance from the sea, and the low permeability of the dikes which inhibits the lateral flow of seawater. However, water leaking through the dikes or overflowing, supplies the basal lens. The Waiāhole Tunnel complex relies on dike water.

Dike-impounded water may discharge at the ground surface where stream erosion has breached dike compartments. Once breached to the water table, the percentage of overall contribution to total stream flow depends on the head of the stored water, how deep the stream has cut into the high level reservoir, the permeability of the lavas



*Saltwater intrusion is a potential problem near the coast. (**A**) Diagram of a well completed in a volcanic-rock aquifer in which withdrawal is small. Only limited saltwater intrusion has taken place. (**B**) Diagram of the same well under conditions of large ground-water withdrawal. Pumping has lowered the water table and caused the freshwater lens to thin. Brackish water has reached the well.*

FIGURE 1-3
SALT WATER INTRUSION
Source: USGS Ground water in Hawai'i

between dikes, the size of the compartments as well as connections to other compartments, and the amount of recharge into the compartment that is breached.

In the northern portion of the Wai'anae region and on the windward side of the Ko'olau Range, dikes are exposed at or near sea level. Due to proximity to the ocean and lower head, freshwater within the dikes is in balance with underlying salt water and is classified as dike basal water. Dike basal water is commonly found in windward O'ahu.

1.5.1.3 Perched Water

O'ahu has only minor perched water, but in a few small areas it has met minor supply demands. This type of water is "perched" on top of layers of impermeable material such as dense volcanic rock, weathered and solidified ash, or clay-bearing sediments. Discharge of perched water sometimes occurs as springs where the water table has been breached by erosion. Perched water supplies can be developed by tunnels or by constructing masonry chambers around spring orifices to collect flow and to prevent surface contamination. This type of water is of excellent mineral quality, and like most dike water, is free from seawater encroachment.

Another type of perched water is alluvial water, which is in limited quantities. Alluvial water is found in the more recent alluvial layers and remains perched because of older compacted alluvial layers below. Sometimes small wells can be productive in this area but generally the alluvium provides small amounts of water for O'ahu.

1.5.1.4 Caprock Water

The limestone in the caprock generally contains ground water. Caprock water is mostly brackish to saline. It is recharged from sparse local rainfall, return irrigation water and leakage of basal water bodies. Caprock water occurs around the island with the sizeable 'Ewa Caprock having the most appreciable amount of brackish water that is pumped and utilized. Caprock withdrawals are not counted against basal sustainable yields.

1.5.1.5 Brackish Water

Water occurring in the caprock, the basal water transition zone, and some basal springs comprises a large resource that is presently unused for municipal supplies due to excessive chlorides (salt) content. Chlorides range from just above recommended drinking water limits to that nearly of seawater.

1.5.1.6 Salt Water

Salt water exists in basal and caprock formations underlying the fresh and brackish aquifers. Salt water can be extracted with wells and used for aquaculture and to assist in building cooling systems. Salt water replaces the use of potable water for cooling towers in chilled water air conditioning systems.

1.5.2 SURFACE WATER

Streamflow from O'ahu's perennial and intermittent streams is significant to

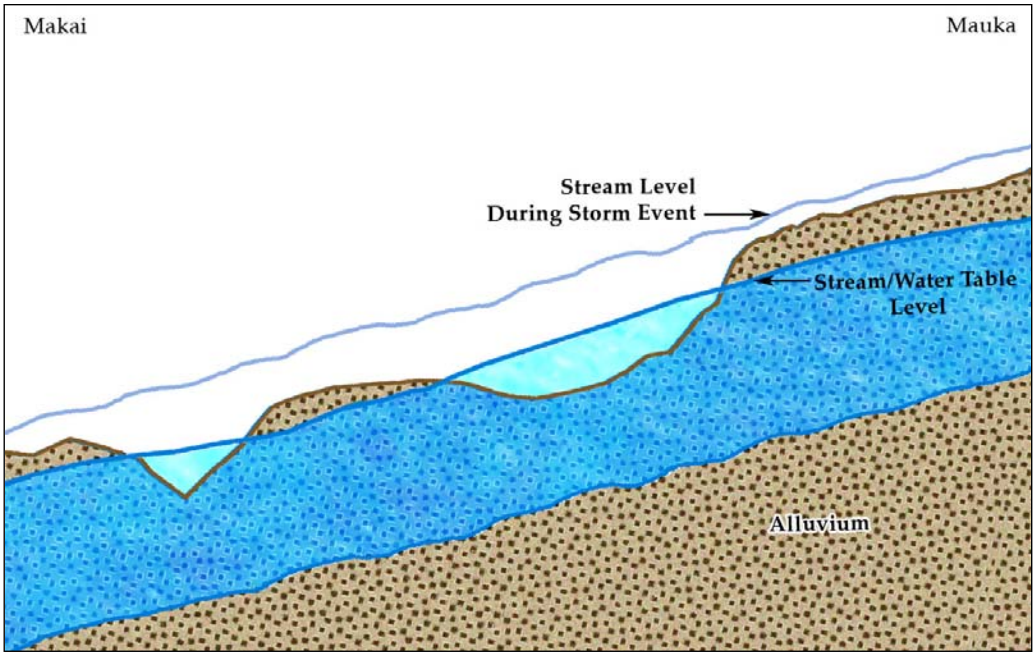


FIGURE 1-4
INTERMITTENT STREAMS DURING WET AND DRY PERIODS

agricultural pursuits and environmental and cultural values, especially on the windward side. Although the island is deeply incised by many stream valleys, the amount of perennial streamflow reaching the sea is comparatively low. Storm flows may be very heavy, but because of their short duration stream recharge may be slight.

On the leeward side of the island, streams are perennial in their headwaters because of high rainfall but intermittent in their lower reaches due to diversions, riparian vegetation, and porous ground conditions. Outflow of basal ground water as springs, especially in the Pearl Harbor area, maintains perennial streamflow near the shoreline. Figure 1-4 shows how areas with porous ground can make streams appear and disappear from the surface, but may be still be flowing beneath the surface.

Perennial streams by definition flow all year round. On O'ahu, they occur within the Ko'olau Mountain watersheds. These streams are sustained by high rainfall and leakage from high-level dike compartments. In addition, low permeability of the dike complex and small easily saturated compartments mean insignificant infiltration losses.

1.5.3 THE RELATIONSHIP BETWEEN GROUND AND SURFACE WATER

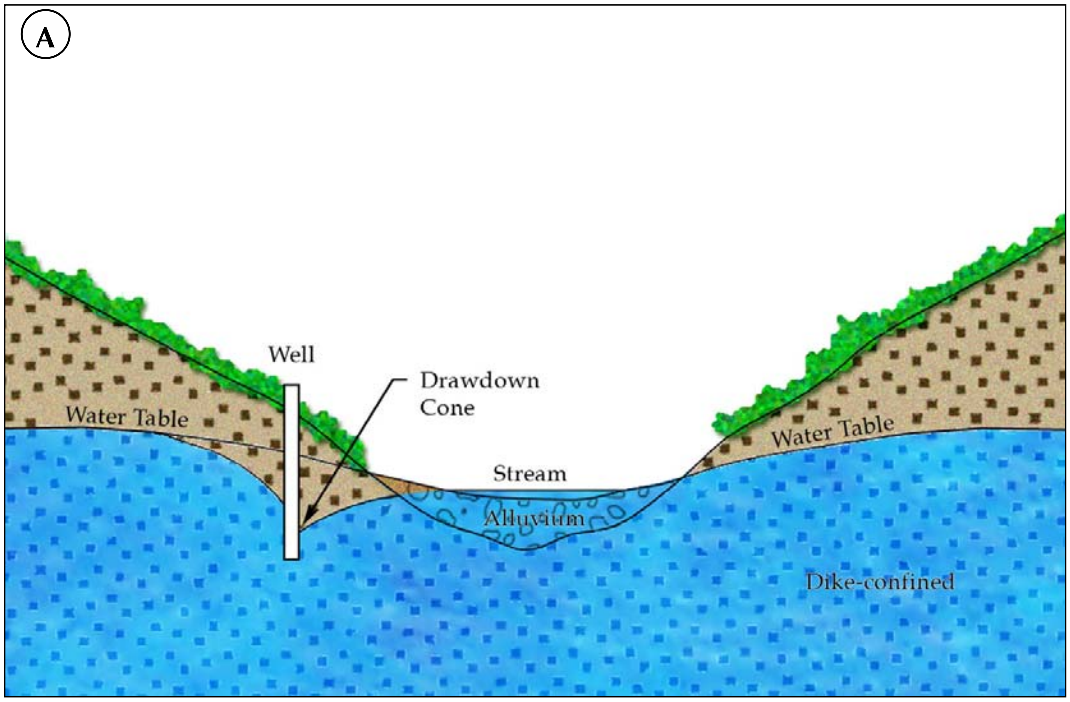
The aquifer systems in Windward O'ahu consist of basal aquifers, high level dike aquifers and dike basal aquifers, which are a combination of the first two. Three of the windward aquifer system areas – Waimānalo, Ko'olau Poko and Kahana – are generally considered to have a direct relationship between surface and ground water conditions. In Ko'olau Loa, the upper elevations of these dike areas intersect with streams. At lower elevations, surface water may be hydraulically separated from the basal and dike basal aquifers by layers of thick sediments.[10] Case by case test pumping is needed to verify localized site conditions.

The interactions between ground and surface water depend upon the location within a valley. Figure 1-5 shows two locations in a windward valley. Location A is high in the back of the valley and Location B is in the lower reaches of the valley.

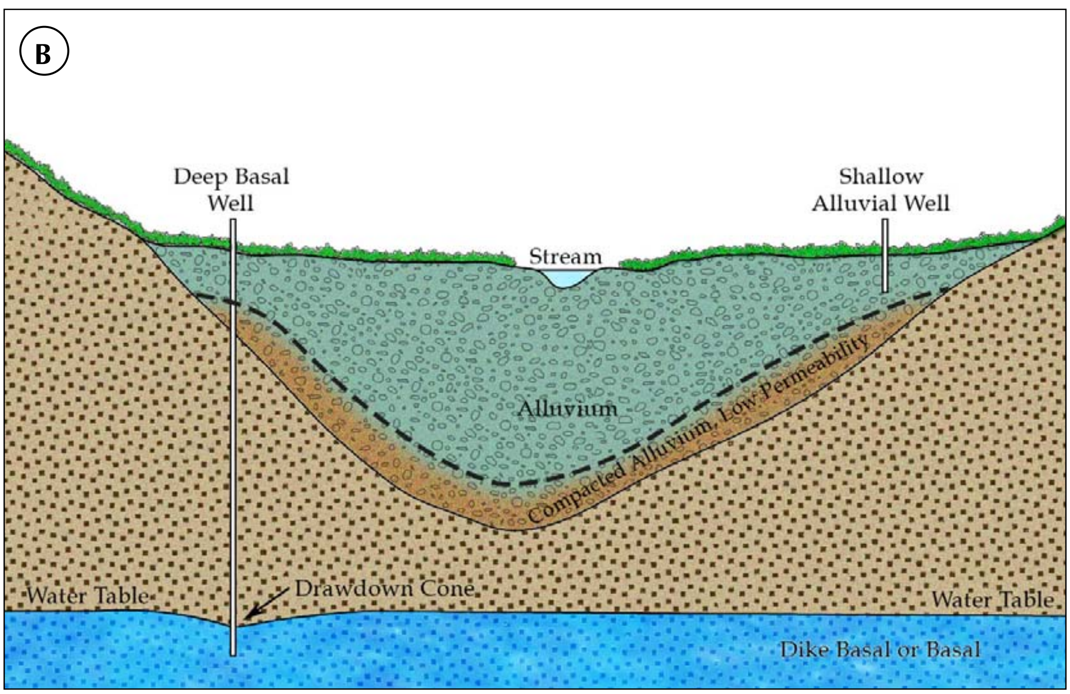
At Location A, there is a relationship between ground and surface water as illustrated in Figure 1-6, (Location A). This is a gaining stream reach, where the dike water supplies water to the stream, and therefore ground water withdrawals affect streamflow. Also, where tunnels tap dikes for water supply, streams can be affected because dike water levels have been lowered.

At Location B (Figure 1-6), the stream water and ground water are not hydraulically connected. This is a losing stream reach where streamflow is not directly supplied by the basal ground water which occurs far below it. While shallow alluvial wells at this location may affect streamflow, basal well withdrawals of ground water will not. This is the case for the mouth of the valley in Windward O'ahu and for most locations in Leeward O'ahu (Figure 1-7). The ground water and surface water relationship in the Ko'olau Poko Aquifer System Area will vary between different streams based on long-term well production experience and therefore, significant effects of ground water withdrawal on surface water should be evaluated on a case-by-case basis.

FIGURE 1-5
TYPICAL WINDWARD VALLEY WITH UPPER (A) AND LOWER (B) ELEVATION STREAM LOCATIONS



Well Affecting Stream Flow



Basal Well **Not** Affecting Stream Flow
Alluvial Well Potentially Affecting Stream Flow

FIGURE 1-6
WELL/GROUND WATER RELATIONSHIP

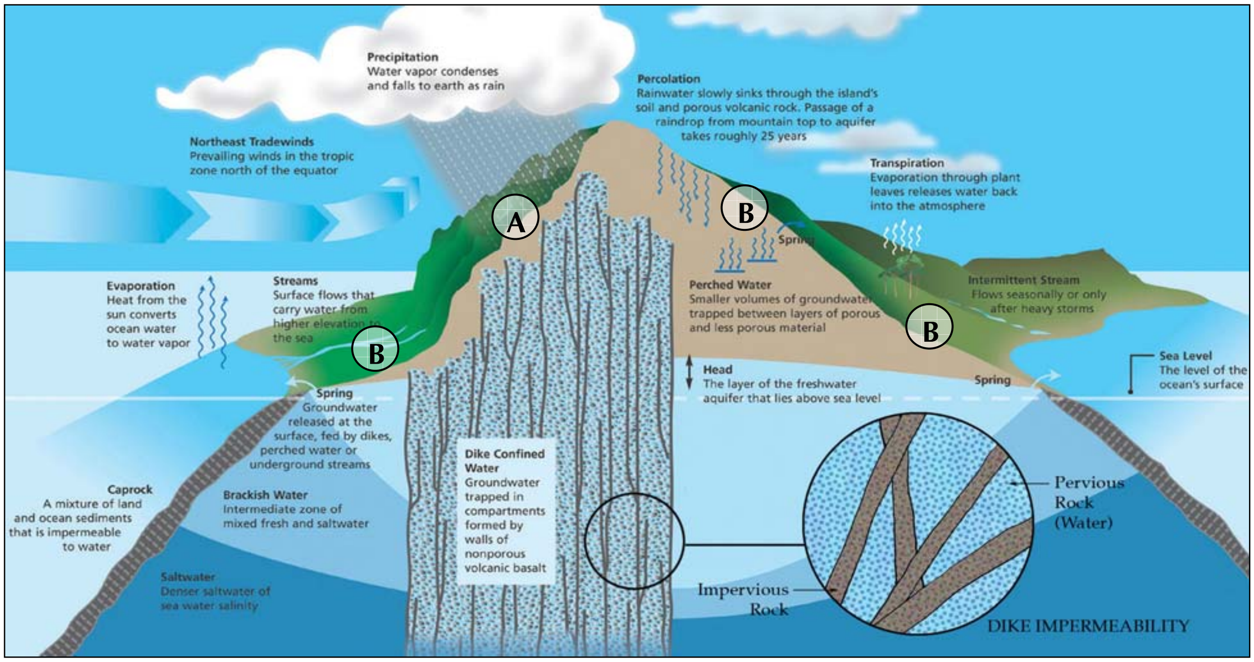


FIGURE 1-7
ISLAND CROSS SECTION WITH STREAM TYPE AND ELEVATION LOCATIONS

1.6 SUSTAINABLE YIELD

Sustainable yields for all aquifer system areas have been adopted as part of the State Water Code's Water Resources Protection Plan (WRPP) and are used for resource management and protection. Sustainable yield is defined by the Hawai'i Administrative Rules as *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.*[11] The island is divided up into Aquifer Sector and System Areas which are management tools that do not imply non-communication or separate independent aquifer bodies. Aquifer Sector Areas generally define large geological boundaries such as rift zones, unconformities or differences in water levels. Aquifer Sector Areas reflect broad hydrogeological similarities and are generally bounded geologic structures, which incorporate topographic divides, such as Honolulu and Pearl Harbor aquifer sectors. Aquifer System Areas such as Waipahu-Waiawa and Waimalu are more specifically defined by ground water hydraulic continuity.

Figure 1-8 shows the sustainable yields for the island of O'ahu for each Aquifer System Area. The sustainable yield numbers determined by CWRM are the maximum levels of withdrawal permissable for each Aquifer System Area. *Note: withdrawals affecting streams require amendments to the interim instream flow standards.*

The WRPP recommends that a periodic review of sustainable yields and pertinent

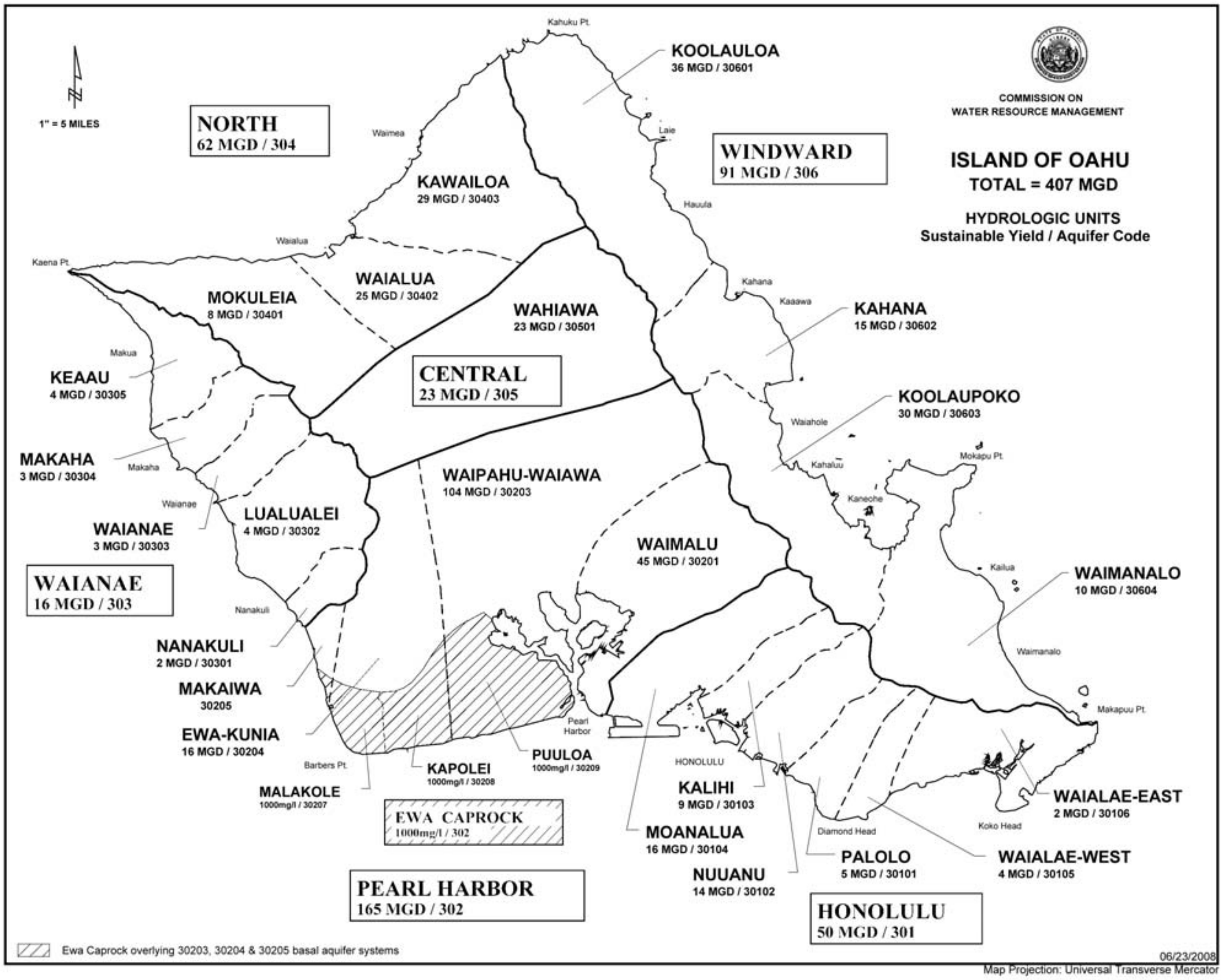


FIGURE 1-8
AQUIFER SECTOR AND AQUIFER SYSTEM AREAS

hydrologic data and water quality parameters be done at least every five years (p. I-4). CWRM has periodically reviewed and modified sustainable yields for certain aquifer system areas based upon new information (1991 ‘Ewa-Kunia, 1993 Wahiawā and Pearl Harbor, 1997 ‘Ewa Caprock, and 2000 Waipahu-Waiawa and ‘Ewa-Kunia).

The sustainable yields have been calculated with the water budget method using the widely accepted Robust Analytical Model (RAM). In August 2003 the CWRM updated the sustainable yields throughout the State using a modified RAM model calibrated to deep monitor well data where applicable. New 3-dimensional numerical ground water models calibrated with deep monitor well data may refine future estimates, but are costly and are only recommended as pumpage and permitted uses approach the adopted sustainable yield.

1.6.1 RECOVERABILITY OF SUSTAINABLE YIELD

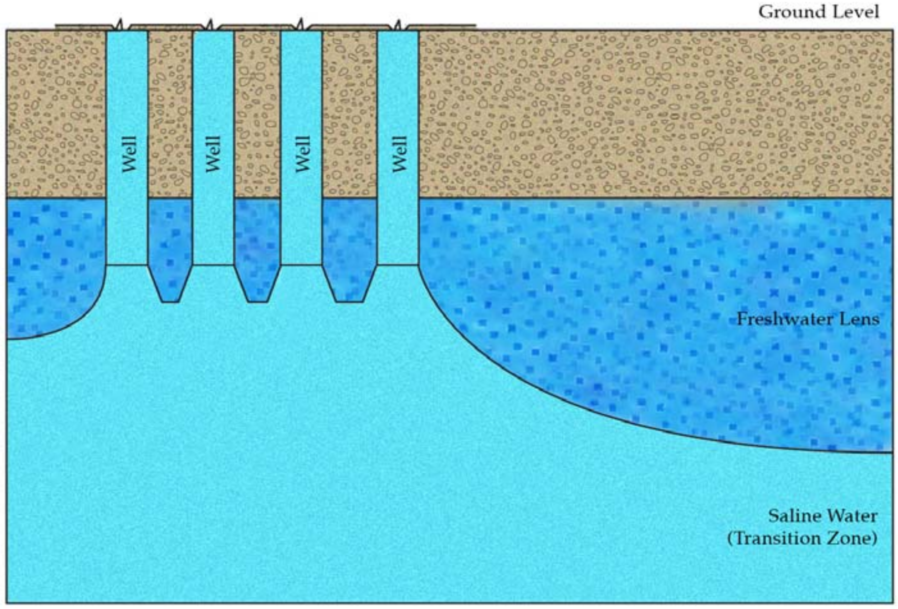
Recoverability is the ability to feasibly extract ground water through wells or tunnels, up to the adopted sustainable yield. The recoverable amount of water is usually less than (or equal to) the CWRM sustainable yield estimate and is used to plan for uncertainty. Various factors affect the full recoverability of the adopted sustainable yield:

1. ***Well spacing and pump size optimization:*** In general, a higher level of recoverability can be achieved with many smaller wells spaced evenly throughout the aquifer system area, than fewer larger wells concentrated in a few locations. When pumping ground water, wells have an upconing effect where the saline water is drawn up toward the well (Figure 1-3). Even in areas where well pumpage is within the sustainable yield, this may occur because of factors such as total station pumpage and the vertical permeability of the rock. The upconing may progress to a point where salt water begins to come up into wells instead of freshwater. This localized upconing effect can be more pronounced when wells are clustered as show in Figure 1-9. To avoid the upconing of saline water, wells can be more evenly distributed over the aquifer area as shown in Figure 1-9.

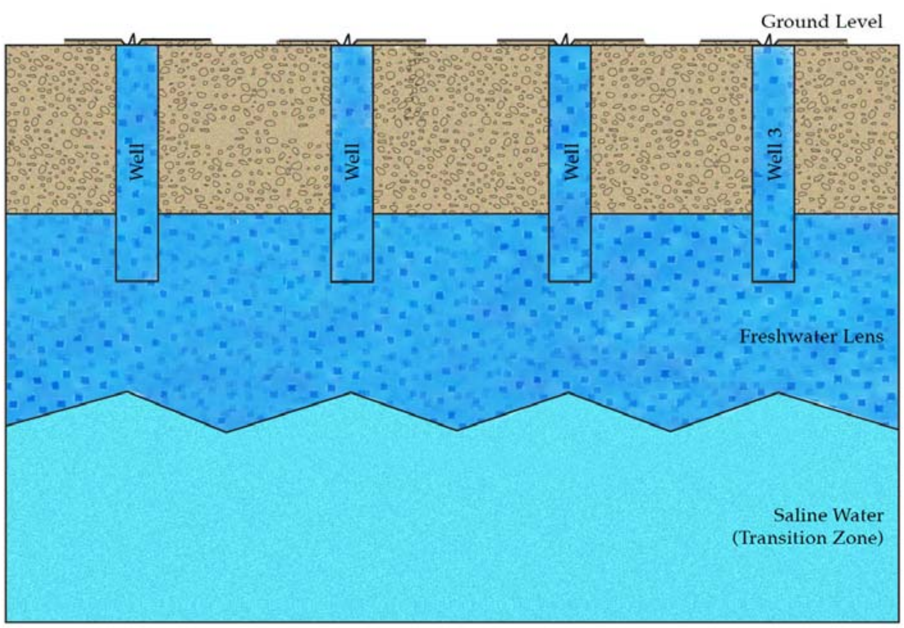
2. ***Surface and ground water interactions:*** Full recoverability is affected if a portion of the sustainable yield impacts surface water. Kahana and Ko'olau Loa have dike formations (dike complex and marginal dike zones) near the crest and basal aquifers near the coast. Surface and ground water interactions are more likely in dike formations. Ground water development in the basal formations usually does not have an effect on stream flows. Stream impacts from ground water development are evaluated on a case-by-case basis. Interim instream flow standards as well as appurtenant rights, riparian rights, and existing instream uses directly affect the availability of the portion of ground water interacting with surface water and require the approval of the CWRM.

3. ***Separate hydro-geological formations:*** The adopted sustainable yields provide a gross estimate for the entire aquifer system area assuming a single homogeneous geologic formation, and do not specifically account for the yields of each of the separate hydro-geological formations within the aquifer system, such as dike, basal, alluvial or caprock formations. CWRM does not count caprock withdrawals against sustainable yields, but does count alluvial withdrawals. In the sustainable yield calculations, residual rainfall is assumed to

recharge the underlying dike and basal aquifers. However, water infiltrating into the ground especially along the valley floors is intercepted by smaller perched aquifers lying above the basal aquifer formed by alluvium and other geologic formations. Perched aquifers divert



Clustered Well with Saline "Upconing"



Distributed Wells: **No** Significant Saline "Upconing"

FIGURE 1-9
CLUSTERED VERSUS DISTRIBUTED AQUIFER PUMPAGE

recharge from the underlying basal aquifer with the result that sustainable yields are lower from some areas. The hydraulic interaction between these geologic formations is not fully understood, estimated or readily measurable and affect recoverability.

4. ***Extended Drought:*** Extended drought impacts all water resources and affects recoverability. O'ahu experienced an extended, multi-year drought from 1998-2003 where rainfall averaged between 60% and 80% of normal levels and several source yields eventually dropped below permitted use. Dike sources declined first due to smaller storage volume compared to basal sources. These six straight years of drought were unprecedented in over 100 years of rainfall record. Sustainable yield and permitted use are based on averages, and BWS basal ground water sources can usually sustain permitted use levels through 3-4 years of drought depending on severity and max day demand.

5. ***Municipal Infrastructure Cost:*** The cost of infrastructure continues to rise and can affect recoverability in the following ways:

    a. ***Cost*** considerations limit the number of wells and length of connecting pipelines. Exploratory wells in dike and alluvial formations are risky due to potentially low yields and potential affects to IIFS.

    b. ***Land constraints*** such as steep terrain or urbanization can make potential well development infeasible due to high costs.

    c. In general, the higher the uncertainty from the factors noted above, the higher the **financial risk** and the less likely full recoverability will be achieved. However, water may be feasibly extracted through small on-site wells for private water systems.

1.6.2 WAIĀHOLE MANAGEMENT AREA

The approximately 25-mile long ditch stretching from Kahana Valley to Kunia was constructed to transport water from windward streams and springs to irrigate sugar cane fields on the drier leeward side (Figure 1-10). Initial construction on the Waiāhole Ditch and Tunnel System (Waiāhole Ditch) took place between February 1913 and December 1915. During construction, large amounts of dike-impounded ground water were encountered at the high elevations (between approximately 700 to 800 feet elevation) at which the transmission tunnels were being bored, and subsequent extensions of the tunnel system during 1925 to 1933 and again in 1964, have resulted in a system that currently collects mostly dike-impounded ground water. Development of these dike-impounded waters that previously fed Waiāhole (and its tributary Waianu), Waikāne and Kahana Streams through springs and seeps resulted in diminished flows in these streams.

The State CWRM has determined that the Waiāhole Ditch develops an average of 27 mgd, consisting of 23.3 mgd measured at the North Portal, which is directly underneath the crest of the Ko'olau Mountains, and an additional 3.7 mgd is developed on the leeward side measured at Adit 8, where the Waiāhole Ditch surfaces in Waiawa.

The development tunnels of the Waiāhole Ditch system include the Kahana Tunnel (1.1 mgd after bulkheading), Waikāne #1 Tunnel (4.2 mgd), Waikāne #2 Tunnel (1.1 mgd), Uwau Tunnel (13.5 mgd) and the Main Bore from the North Portal to Adit 8 (3.7 mgd). The remaining flows are captured in the ditch between Kahana and the North Portal averaging 3.4 mgd for a total of approximately 27 mgd.

As of 2006, CWRM has authorized a total of 15 mgd available for non-instream uses through water use permits, of which a total of 12.57 mgd has been allocated for leeward uses. 12 mgd of water was added to the Kahana, Waikāne, Waianu and Waiāhole Streams.[12]

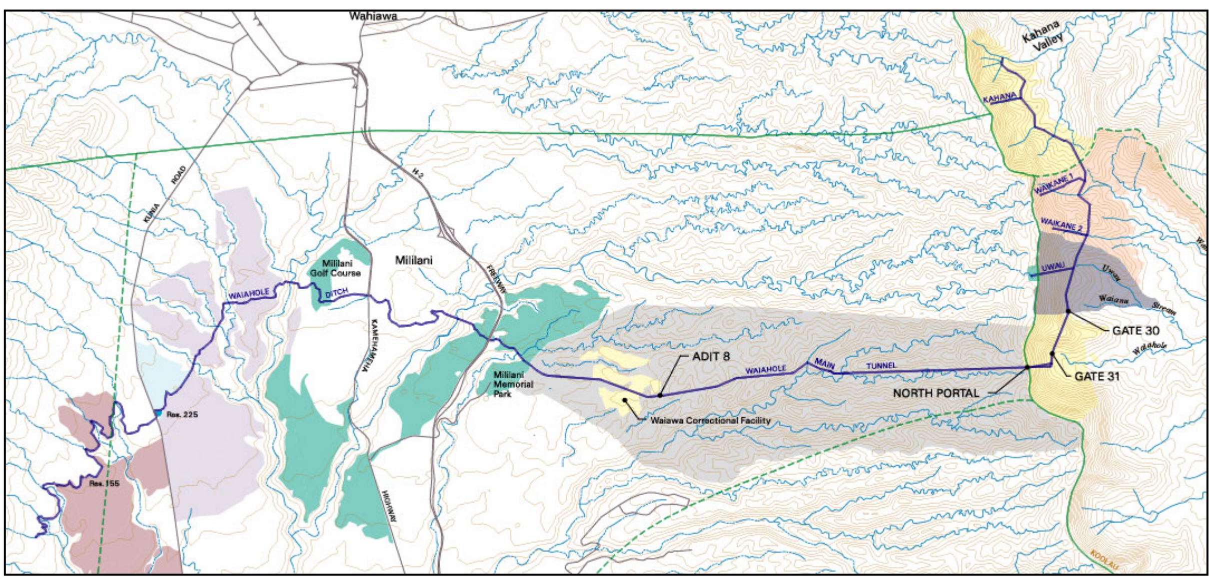


FIGURE 1-10
WAIĀHOLE DITCH SYSTEM
Source: CWRM

1.7 INSTREAM FLOW STANDARDS

Instream flow standards (IFS) are similar to sustainable yields for ground water, in that their establishment provides a management system that protects the resource and cultural uses while allowing for possible non-instream water use. The State Water Code defines instream flow standards as *"the quantity or 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."*[13] The instream flow standards need to consider the best available information in assessing the range of present or potential instream and non-instream uses. The Hawai'i Administrative Rules lists instream and non-instream uses to be considered (Figure 1-11). The figure shows the complexity involved in assessing instream and non-instream water uses and there are 87 surface water hydrologic units on O'ahu. The CWRM is working to develop a methodology for amending instream flow standards.

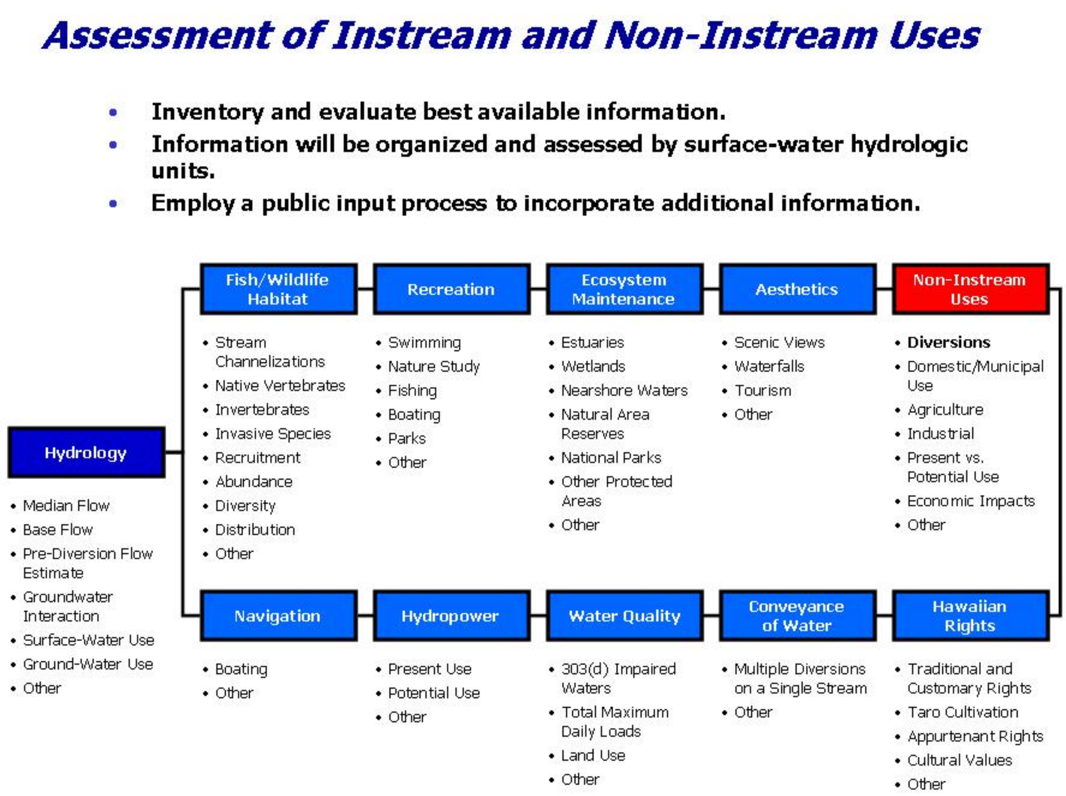


FIGURE 1-11
INFORMATION TO CONSIDER IN SETTING MEASURABLE INTERIM INSTREAM FLOW STANDARDS
Source: CWRM Presentation to Water Commission, June 2006

The current instream flow standards for O'ahu streams are called interim IFS and are based on the "amount of water flowing in each stream on the effective date of the standard without further amounts of water being diverted off-stream through new or expanded diversions". The effective dates are December 10, 1988 for Leeward O'ahu and May 4, 1992 for Windward O'ahu.[14] In the Waiāhole Contested Case Hearing, the CWRM recognized that "retaining the status quo (through the adoption of the previous interim standards) helped to prevent any future harm to streams while the scientific basis for determining appropriate measurable instream flow standards is developed and an overall stream protection program put into place."[15] The stream flows and diversions were not quantified in the standard, however users of surface water and ground water were required to register their uses with CWRM.

In an effort to approximate current water usage, and in accordance with the State Water Code and Chapter 13-168-31, HAR, the CWRM initiated the Registration of Stream Diversion Works and Declarations of Water Use (Registration) process in 1989. This process required the owner or operator of any stream diversion works to register with the CWRM. In September 1992, the Commission released a final report summarizing the findings of the Registration process for both ground and surface water. These reports are referred to as the Declaration of Water Use, Volume I (Declarations Summarized by File Reference) and Volume II (Location Data Sorted by Tax Map Key). The Declarations of Water Use provide a qualitative description of water use, but also includes a number of declarations comprised of claims for water rights, proposed future uses of water, and instream uses.[16]

TABLE 1-1
AMENDED O'AHU INTERIM INSTREAM FLOW STANDARDS

Stream	1960s Streamflow	Amended Interim Instream Flow Standard	Percent Increase
Waiāhole	3.9 mgd	8.7 mgd	124%
Waianu	0.5 mgd	3.5 mgd	600%
Waikāne	1.4 mgd	3.5 mgd	150%
Kahana	11.2 mgd	13.3 mgd	19%

The CWRM amended the interim instream flow standards for four windward streams - Waiāhole, Waianu, Waikāne and Kahana have been established via the *Findings of Fact, Conclusions of Law, and Decision and Order on Second Remand in the matter of water use permit applications, petitions for interim instream flow standard amendments, and petitions for water reservations for the Waiāhole Ditch Combined Contested Case Hearing (CCH-OA95-1) on July 13, 2006*. (Table 1-1).

The 1989 Registration process provided a baseline of current surface water diversions at that time. However, any new diversions constructed or existing diversions altered after the effective dates of the standards are subject to the Commission's regulatory permitting requirements. In essence, surface water diversions that were registered as part of the CWRM's Registration process and currently remain in use can continue to be utilized. Any person wishing to construct a new stream diversion or alter an existing diversion structure is required to obtain a Stream Diversion Works Permit from CWRM. As a result, construction or alteration of structures constitutes an alteration to the stream channel. Therefore, a Stream Channel Alteration Permit is also required (Chapter 13-169-50, HAR). In addition, any change to the instream flow that may result from the constructed or altered diversion requires a Petition to Amend the Interim Instream Flow Standard (Chapter 13-169-40, HAR). Owners of stream diversion works wishing to abandon or remove their diversion structures are also required to obtain a permit from CWRM (Chapter 13-168-35, HAR).

ENDNOTES

[1] Atlas of Hawai'i, 1983

[2] US Census, 2000

[3] O'ahu Water Management Plan Technical Reference Document, March 1990

[4] Groundwater in Hawai'i. USGS, FS 126-00

[5] State of Hawai'i Agricultural Water Use and Development Plan, December 2003

[6] Climate Change and Water Resources: A Primer for Municipal Water Providers by Kathleen Miller and David Yates National Center for Atmospheric Research, American Waterworks Assoc. Research Foundation Publication

[7] Rising Sea Levels, Sunny Lewis, Hawai'i Public Radio, July 19, 2006

[8] Atlas of Hawai'i, Third Edition, 1998

[9] Groundwater in Hawai'i. USGS, FS 126-00

[10] Report on the Hydrologic Investigation of Groundwater and Surface Water Conditions in the Windward O'ahu Water Management Area, 1990

[11] Water Resources Protection Plan, CWRM, June 1990.

[12] Waiāhole Ditch Contested Case

[13] State Water Code Section 174-C 3

[14] HAR Section 13-169-49 and 49.1

[15] Waiāhole Ditch Contested Case

[16] Declarations of Water Use, September 1992, State Commission on Water Resource Management

2 WAI‘ANAE WATERSHED PROFILE

2.1 INTRODUCTION

The Wai‘anae District encompasses 38,089 acres and generally includes those lands that lie between Ka‘ena Point to the North and Kahe Point to the South, and is bounded by the ridgeline of the Wai‘anae mountain range to the east and the Pacific Ocean to the west. Wai‘anae is a traditionally rural area that grew through agricultural development in the valleys. While much of the District’s population now commutes out of the district to work, many residents still maintain their rural lifestyles. Wai‘anae continues to be a tight-knit community that strives to protect their natural resources, strengthen their social and cultural identity, and maintain their rural way of life.

2.1.1 WATERSHED APPROACH

The Wai‘anae Watershed Management Plan (WWMP) is part of a comprehensive program of the Honolulu Board of Water Supply (BWS) to plan for future water resource needs of the county, as mandated by the State Water Code.

Over the years, BWS has recognized the importance of focusing on resource protection, conservation, and restoration, in addition to water use and development. A watershed approach was developed for these plans to understand the inter-relationships among the physical, biological, and human environments. Thus, in order to understand the resources and provide a context for water resource management, this plan includes an overview of the terrestrial, land use, socio-economic, and water systems resources present in Wai‘anae. This chapter provides a summary of the data that were collected and analyzed.

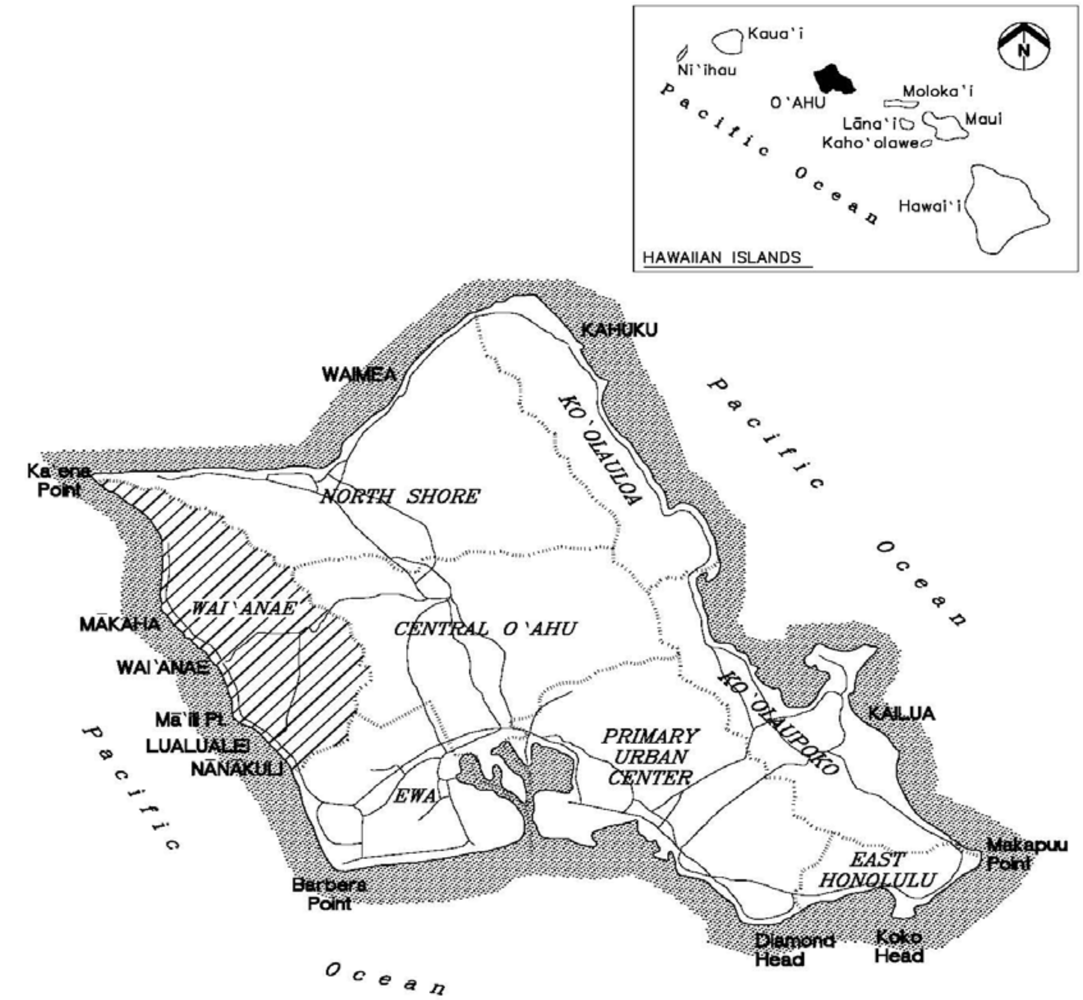
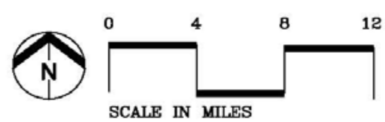


FIGURE 2-1
WAI'ANAE LOCATION MAP
Wai'anae Watershed Management Plan



2.1.2 METHODOLOGY

This process involved data collection; issues and needs identification, including the identification of data gaps; and identification of potential water resource management opportunities. The primary sources of data were previously conducted studies, plans, and reports done by various agencies, organizations, and academics. These documents provided information on specific topics within Wai'anae and on watershed issues in general. Various individuals, agencies and organizations were then contacted to provide either follow-up details or updated information, and to identify natural resource values, issues, and needs as perceived by Wai'anae residents. A description of the stakeholder consultation process may be found in Section 2.9.

The data was analyzed to develop an overall assessment of Waianae's natural resources and to identify issues and needs. Many of the problems and issues were discussed in the literature, while others were raised through discussions with agencies and stakeholders and by matching various interrelated data. Based on the data and the issues and needs identified, water resource management opportunities were identified.

2.2 PHYSICAL SETTING

2.2.1 OVERVIEW OF THE WAI'ANAE MOKU

Moku are historic land divisions, generally comparable in geography to County Development Plan and Sustainable Communities Plan districts. The Wai'anae *moku* is located on the western shore of the island of O'ahu between Ka'ena Point to the north, and Kahe Point to the south. Encompassing 38,089 acres (59.5 square miles), Wai'anae makes up approximately 10 percent of Oahu's 385,280-acre land mass. Known for its white sand beaches that line the coast, Wai'anae also has nine large valleys that extend between three and five miles inland. The Wai'anae Mountains are deeply eroded, forming steep walls at the back of the valleys. Mount Ka'ala, located at the apex of the ridges that form Mākaha and Wai'anae Valleys, is the highest peak on O'ahu at an elevation of 4,025 feet.

Moku were subdivided into *ahupua'a*, traditional Hawaiian land divisions within *moku* that generally extended from the mountain tops to the sea and varied in size and shape. *Ahupua'a* were delineated to allow their inhabitants access to a full range of resources; therefore some *ahupua'a* did not include the mountain tops or even the sea. Exchange between *ma uka* and *ma kai* resources allowed most *ahupua'a* to remain fairly self-sufficient.

Wai'anae has nine *ahupua'a* that generally coincide with each of the nine watersheds: Nānākuli, Lualualei, Wai'anae, Mākaha, Kea'au, 'Ōhikilolo, Mākua, Kahanahāiki, and Keawa'ula. Most of the district's residents live in the four major *ahupua'a* of Nānākuli, Lualualei, Wai'anae, and Mākaha. Of these, Lualualei is the largest, accounting for approximately 14,000 acres, or 37 percent of the district's land area. By comparison, 'Ōhikilolo is the district's smallest *ahupua'a* and only accounts for 700 acres, or two percent of the district.

In the land division system prior to the 1848 Māhele, the Waiʻanae *ahupuaʻa* extended over the ridgeline of the Waiʻanae mountains into the Central plain of the Koʻolau Mountains. The area *ma kai* of the Waiʻanae mountain ridgeline was called Waiʻanae Kai while the area east of the Waiʻanae ridgeline to the area currently occupied by Schofield Barracks was called Waiʻanae Uka.[1] Waiʻanae Uka is not included in the WWMP area in order to facilitate water planning, as the BWS Waiʻanae water use district, County Waiʻanae Sustainable Communities Plan area, and State Commission on Water Resources Management Waiʻanae Hydrologic Unit boundaries all end at the Waiʻanae mountain ridgeline.

2.2.2 CLIMATE

General climate conditions for Oʻahu are described in Chapter 1. Waiʻanae is typically hot and dry in the lower elevations, with coastal low temperatures ranging from 62° F in the winter and 70° F in the summer and highs ranging between 80° F in the winter to 88° F in the summer.[2] Upper elevations experience cooler and wetter conditions.

Precipitation generally results from the northeasterly trade winds that are forced up the eastern flank of the Waiʻanae mountain range. As the winds rise, they cool, thereby inducing rain as the air mass is pushed over the tops of the mountain ridges. Trade winds are weaker during the winter months, but westerly wind patterns bring storms that provide much of the District's precipitation. Average rainfall varies from 20 inches along the coast to more than 75 inches a year near the summit of Mount Kaʻala.[3]

Clouds build up on the eastern flank of the Waiʻanae Mountains and create rain in the upper elevations.

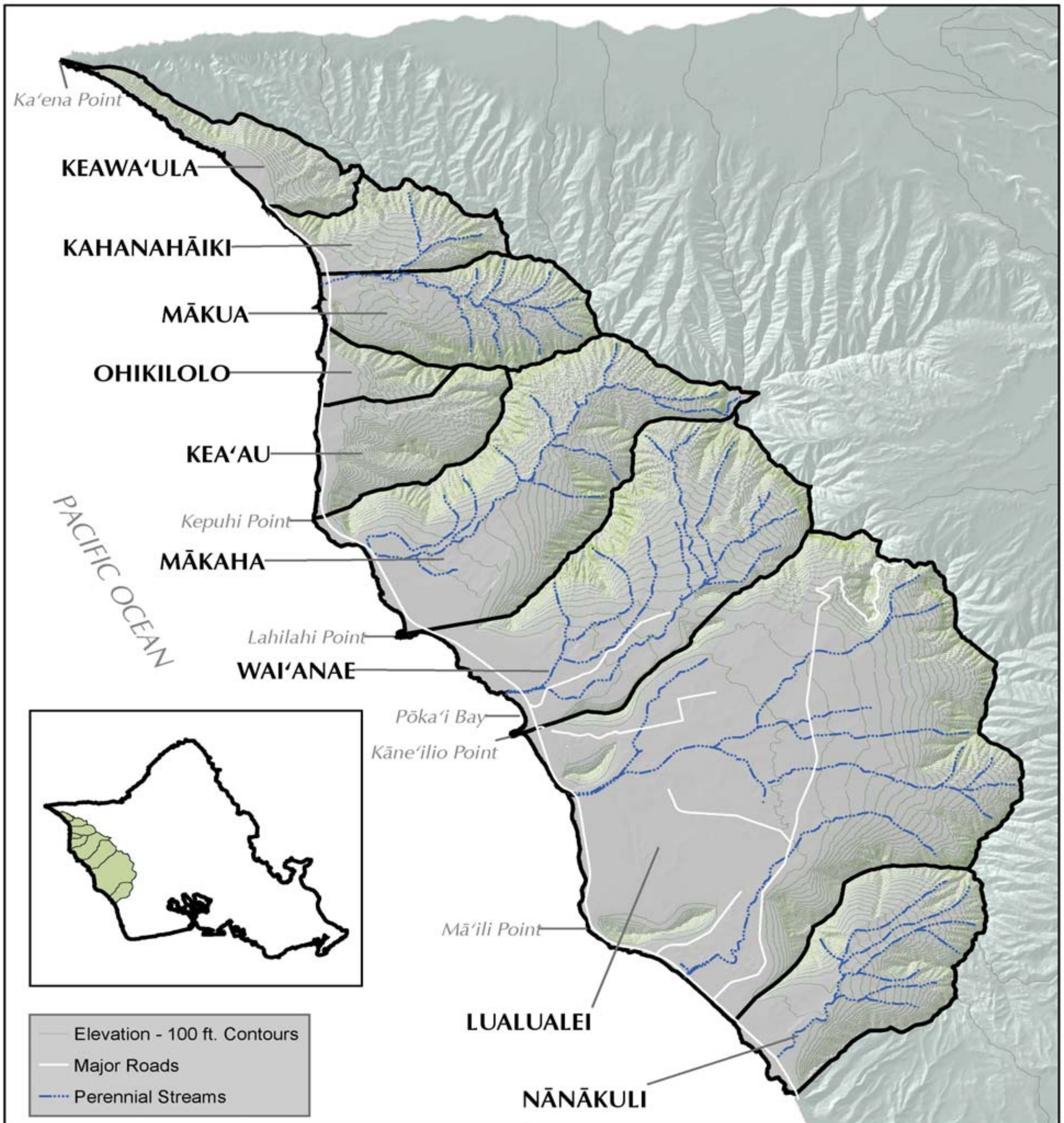


FIGURE 2-2
WAI'ANAE AHUPUA'A
Wai'anae Watershed Management Plan

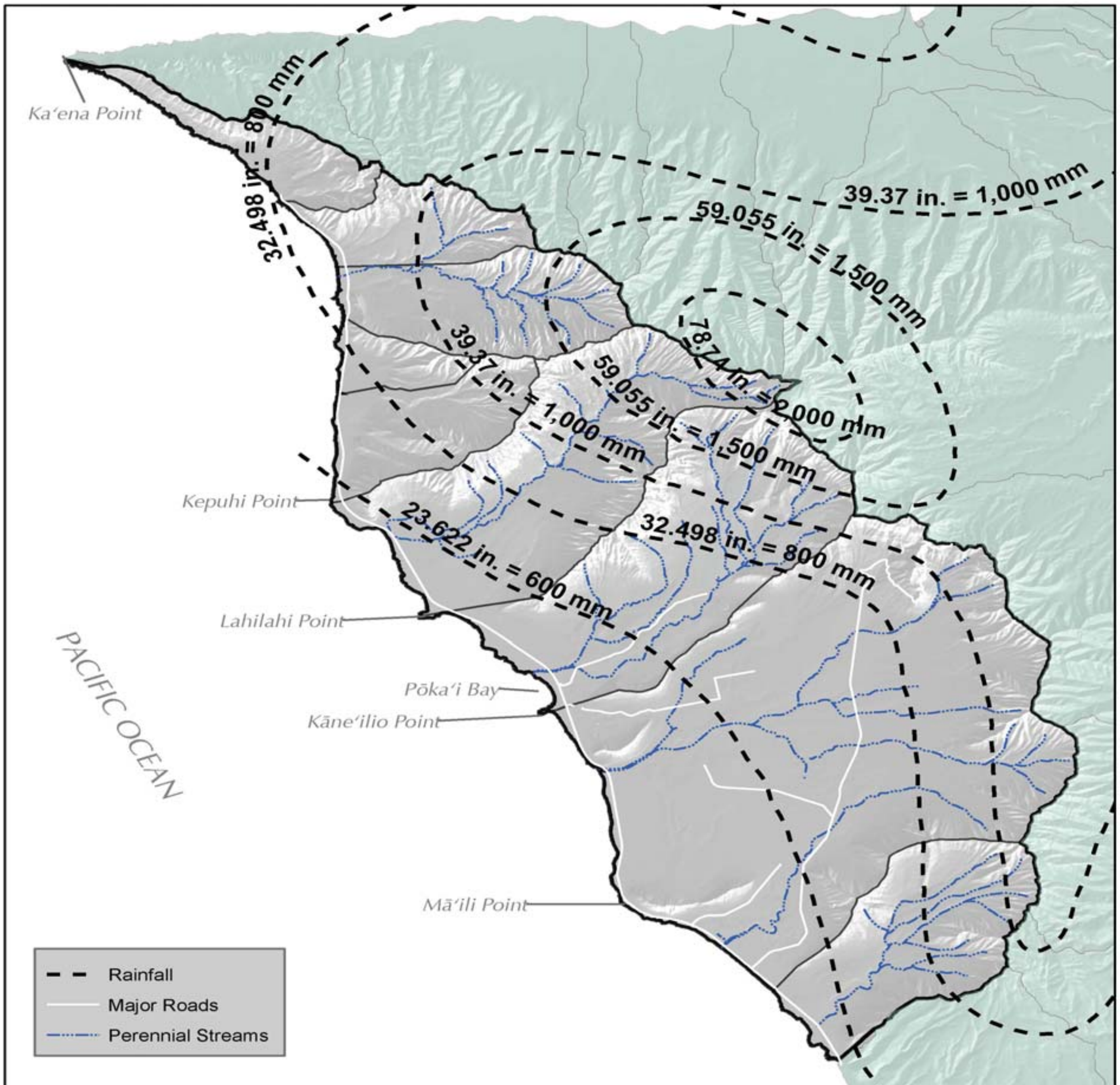


FIGURE 2-3
WAI'ANAE AVERAGE ANNUAL RAINFALL
Wai'anae Watershed Management Plan

Solar radiation is often used as an indicator of an area's agricultural productivity, as most plants grown for commercial gain rely on high levels of sunshine. Solar radiation in Waiʻanae is relatively high, with some areas receiving 500 or more solar calories per square centimeter per day.[4]

2.2.3 GEOLOGY AND SOILS

The Waiʻanae Mountain Range was created over three million years ago by volcanic eruptions. *Puʻu*, or hills, are very prominent features in Waiʻanae and often serve as landmarks. Significant *puʻu* include Mount Kaʻala, Puʻu Heleakalā, Palikea, Puʻu Kānehoa, Puʻu Hāpapa, Puʻu Kaua, and Kalena. Additionally, four significant coastal formations are Puʻu o Hulu Kai and Puʻu o Hulu Uka in Lualualei, Puʻu Māʻiliʻili in Lualualei, and Puʻu Pāheʻeheʻe in Waiʻanae.

The nine Waiʻanae valleys were created by several million years of erosion from storm water runoff. Additionally, wave action during times of higher sea levels contributed to shaping the valleys.[5] These processes led to steep mountain cliffs and relatively level or gently sloping coastal plains.

There are two soil associations in Waiʻanae. The rock land-stony steep land association is found in the steep, mountainous areas and is well-drained, rocky, and stony. Lualualei-fill land-Ewa association is found in the level to moderately sloping valley and coastal areas of Waiʻanae and is identified by well-drained soils with fine-textured underlying material and areas of fill land.[6]

Three soil orders are found in Waiʻanae: Mollisols, Vertisols, and Entisols, all of which are relatively young soils that vary in agricultural and construction value. Mollisols are deep, well-drained soils making them suitable for cultivation. Entisols are extremely young soils that have developed very little from their parent material. Some of the most productive soils are Entisols created by fluvial deposition. Vertisols are sticky and plastic, and have a high shrink-swell potential, making them difficult to build on and cultivate.[7]

2.3 WATER RESOURCES

2.3.1 REGIONAL HYDROLOGY

Fresh water in Waiʻanae comes primarily from precipitation in the upper valleys and from fog drip above the 2,000-foot elevation. Kaʻala Bog, at the 4,025-foot elevation, is an excellent example of a cloud forest fresh water bog where fog drip occurs. Infiltration of rainfall and fog drip recharges the dike and dike-basal aquifers in the upper portions of the valleys. Compacted older alluvium lines the sides and bottom of the valleys, restricting surface water in mid to lower valley areas from percolating through to the underlying dike-basal aquifer.

Instead, surface water only percolates into the younger, more permeable upper alluvium, contributing to the surficial aquifer. The water in this surface layer is exposed when streams erode the upper alluvium, resulting in visible stream flow in the lower reaches. Dams, weirs, and diversions were previously constructed on streams to manipulate surface water for agriculture and other purposes, but most of these structures are no longer used because they were either damaged, like the Mākaha weir, or there is no longer a need for them.

BWS is collaborating with the community and the University of Hawaiʻi to investigate the effects of well pumpage on stream flow in Mākaha Valley. Pumpage of Mākaha Wells II and III has been reduced since February 2002 to only accommodate peak demands. It is hoped that the results from the study will help in understanding the impacts of well pumping in Mākaha Valley. Results are not yet available, but preliminary examination of the data indicates that reduced rainfall in recent years may have at least some role in the reduced stream flow observed by community members.

2.3.2 GROUND WATER RESOURCES

The State Commission on Water Resources Management (CWRM) has assigned hydrologic units, or Aquifer Sector Areas, across Oʻahu generally based on regional geology, which describes its natural movement and how water is held. These Aquifer Sector Areas also serve as management boundaries for the regulation and allocation of ground water resources. CWRM identifies six hydrologic sector areas on Oʻahu. The Waiʻanae Aquifer Sector Area boundaries generally coincide with the Waiʻanae SCP and WMP boundaries.

Aquifer Sector Areas are subdivided into Aquifer System Areas, which are based on hydrogeology, but are mainly for descriptive ease, as there may be movement of water between systems. Within the Waiʻanae Aquifer Sector Area are five Aquifer System Areas: Nānākuli, Lualualei, Waiʻanae, Mākaha, and Keaʻau (Figure 2-4).

2.3.2.1 Ground Water Quantity

In the state of Hawaii, potable water is generally supplied by ground water sources. Waiʻanae ground water is defined as high level dike water in the upper elevations of the Waiʻanae Mountain Range and dike basal in the lower elevations. The sustainable yield (SY) of ground water is defined by the State Water Code as "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."[8] The CWRM estimated SY for the Waiʻanae sector area is 16 mgd. Each of Waianae's hydrologic system areas is also assigned a sustainable yield.

TABLE 2-1

WAIʻANAE HYDROLOGIC SYSTEM AREA SUSTAINABLE YIELD (SY)

Hydrologic System Area	SY (mgd)
Nānākuli	2
Lualualei	4
Waiʻanae	3
Mākaha	3
Keaʻau	4
WAIʻANAE TOTAL	**16**

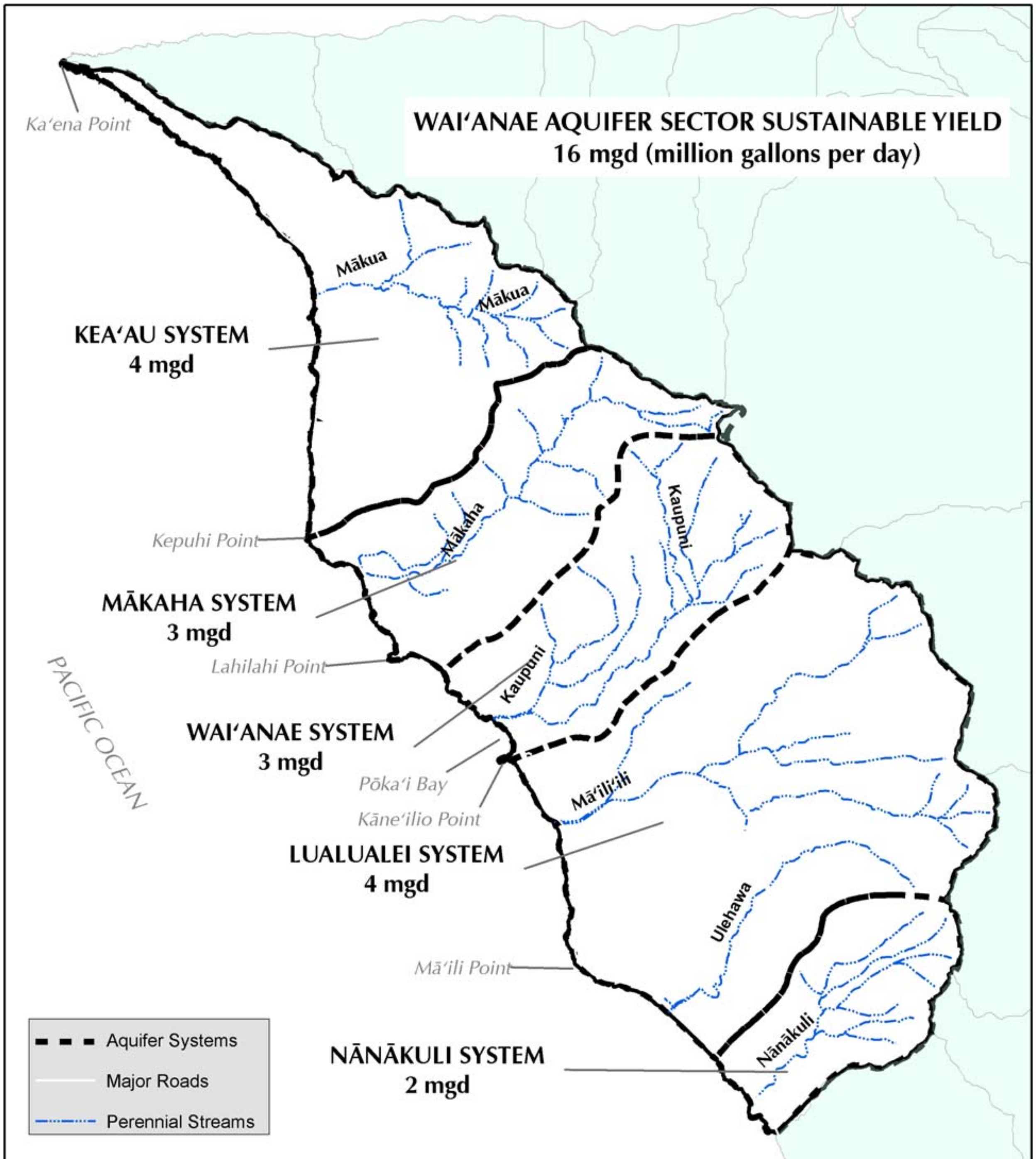


FIGURE 2-4
WAI‘ANAE HYDROLOGIC SYSTEM AREAS
Wai‘anae Watershed Management Plan

BWS has estimated the likely recoverable yield based on the portion of the CWRM sustainable yield amounts that might feasibly be developed. The likely recoverable yield for the Wai'anae and Mākaha Aquifer System Areas is approximately 4.3 mgd, based on the potential effect of ground water withdrawal on stream flows and limitations on infrastructure development.

A water management area (WMA) is defined by the State Water Code as "a geographic area which has been designated…as requiring management of the ground or surface water resource, or both." Under such designation, any "withdrawal, diversion, impoundment, or consumptive use of water,"[9] with the exception of domestic consumption of water by individual users and catchment systems, must first be permitted by CWRM. In order to obtain a water use permit, applicants must show that the proposed use of water "(1) Can be accommodated with the available water source; (2) Is a reasonable-beneficial use, (3) Will not interfere with any existing legal use of water; (4) Is consistent with the public interest; (5) Is consistent with the state and county general plans and land use designations; (6) Is consistent with county land use plans and policies, and (7) Will not interfere with the rights of the Dept. of Hawaiian Home Lands as provided in section 221 of the Hawaiian Home Commission Act."[10]

The State Water Code authorizes CWRM to designate water management areas, a process that may be initiated upon recommendation by the CWRM Chairperson or by written petition. The criteria for designation are set forth in HAR 13-171-7 and 13-171-8. To date, no recommendation or petition for designation has been made for the Wai'anae District.

In both designated and non-designated areas, CWRM regulates the construction, development, and abandonment of new ground and surface water sources through a permitting system. In addition, any proposal for a new or expanded diversion that will result in further amounts of water being diverted offstream must be supported by a successful petition to amend the interim instream flow standard for the affected stream(s). Permits are also required for the alteration of stream channels. CWRM sends a copy of all permit applications and petitions to numerous state and county agencies for review and comment. CWRM also publishes a bulletin of all new applications that is updated monthly on its website and sent to any interested party who requests to receive the monthly bulletin.

2.3.2.2 Ground Water Quality

Federal and State law requires the State DOH and BWS to regularly test O'ahu's drinking water for more than 100 different kinds of chemical "contaminants," which include naturally occurring minerals and other substances that do not necessarily indicate a health risk. BWS' 2005 Consumer Confidence Report found that all of the ground water that it provides to Wai'anae is fully compliant with Federal and State drinking water standards.

The City and State both take measures to protect ground water in Hawai'i. In addition to the Consumer Confidence Reports mentioned above, BWS also defined a "pass/no pass line" in the 1970s to regulate ground disposal of wastewater and other sources of contamination. The map indicates "pass" zones, where sedimentary caprock would be thick enough to prevent contaminants from leaching into the underlying basalt, and "no pass" zones, where waste disposal into the ground is not permitted.

The DOH also has Underground Injection Control (UIC) regulations that are intended to protect the quality of underground drinking water sources by restricting the injection of fluids to those areas where drinking water aquifers will not be affected. The UIC line identifies aquifers *ma kai* of the UIC line as exempt from "underground sources of drinking water" status. If aquifers are not *ma kai* of the UIC line, they are considered underground sources of drinking water.[11] Injection wells are generally restricted *ma uka* of the UIC line to protect underground sources of drinking water from chemical, physical, radioactive, and biological contamination.[12] The UIC line was drawn in the 1970s by committees of various Federal and State agencies, and generally follows the 500 ppm isochlor,[13] but in some places was drawn to follow a road or other significant landmark for regulatory convenience.

Despite the current high quality of ground water, there are potential threats in Wai'anae, typically from human activities. For example, abandoned drums of unknown oily substances were among Waianae's top notifications to the State Department of Health's (DOH) Hazard Evaluation and Emergency Response Office in 2003. Underground storage tanks belonging to gas stations, various corporation yards, and Lualualei Naval Magazine (NAVMAG) contain diesel, gasoline, and used oil and are potential threats to ground water.

The BWS has conducted an inventory of inactive landfills on O'ahu to evaluate the risks to human health as a result of ground water contamination. Six landfills were identified in the Wai'anae District: four in Lualualei, one in Wai'anae, and one in Keawa'ula. Of these, three landfills are located upgradient of the UIC line, two are *ma uka* of the pass/no pass line, and one is located within one mile of a BWS well. No landfills were designated as a Category 1 (highest potential to impact drinking water wells). Two wells were characterized as Category 2 (moderate potential to affect drinking water wells) and four were Category 3 (lowest potential to impact drinking water wells). One landfill, Nānākuli A in Lualualei, is located upgradient of brackish irrigation wells.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites are where hazardous waste sites, potential hazardous waste sites, and remedial activities are taking place. Since 1993, CERCLA sites in Wai'anae have been located at Maipalaoa Road, Mā'ili Kai Emergency Access Road Site, NAVMAG Lualualei, and the Mākua Military Reservation.

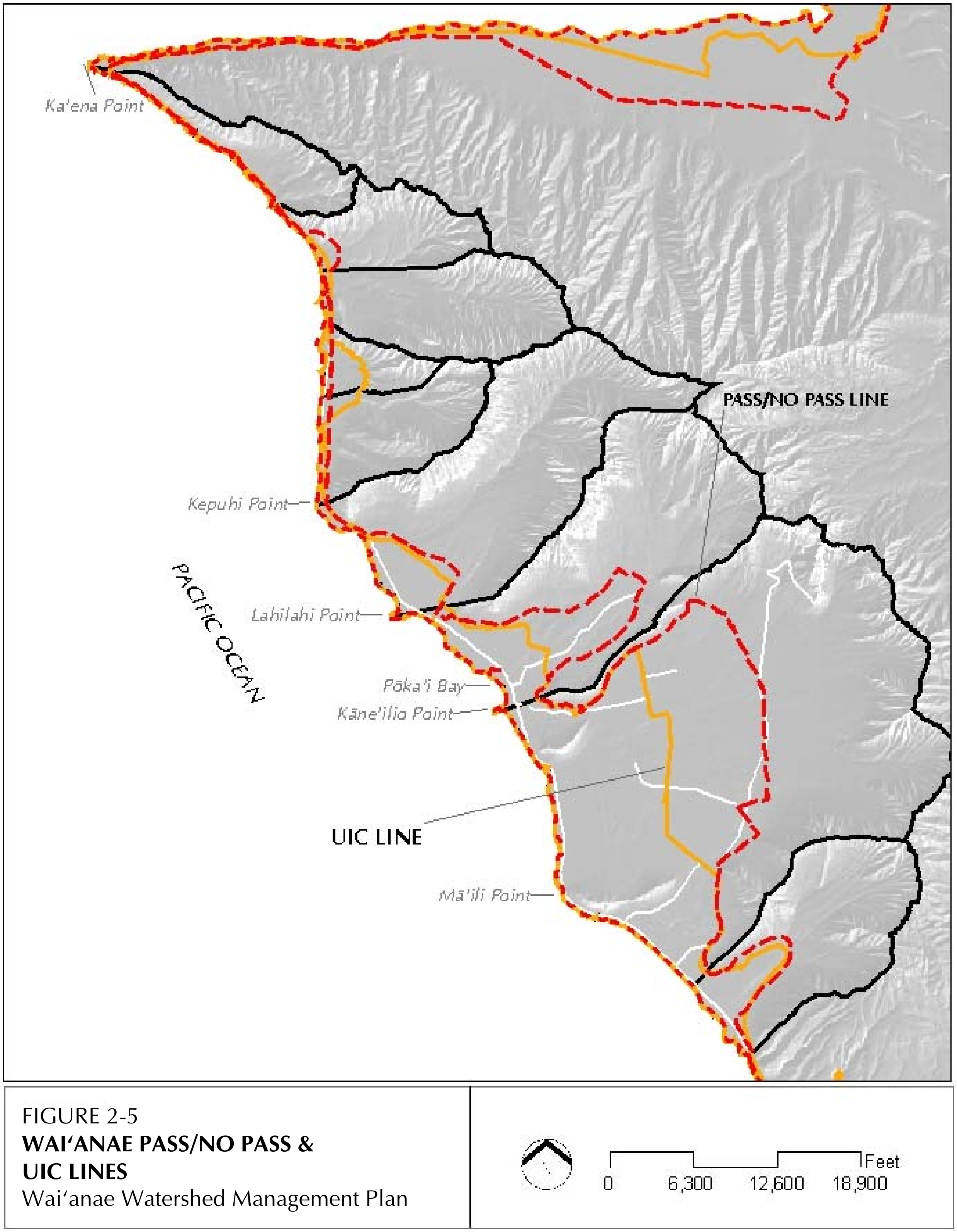


FIGURE 2-5
WAI‘ANAE PASS/NO PASS & UIC LINES
Wai‘anae Watershed Management Plan

Underground storage tanks containing diesel, gasoline, and used oil could also potentially affect ground water. However, BWS monitoring from their wells in Mākaha and Waiʻanae show that water quality remains high and treatment is not necessary to meet State and Federal standards

In 2004, the UH Water Resources Research Center (WRRC) completed the *Hawaii Source Water Assessment Program Report*, for the State DOH. This report was mandated by the 1996 reauthorization of the Safe Drinking Water Act, which required states to focus on protecting drinking water sources and provided funding for source water assessment programs (SWAP). Preliminary results from Hawaii's SWAP show that there is potential for contamination of drinking water tunnels and wells in the Waiʻanae District. Potential Contaminating Activities in Waiʻanae included Resource Conservation and Recovery Act sites, residential parcels, major roads, schools, septic tanks, sewer lines, utility stations, parks, fire stations, golf courses, agriculture, and underground storage tanks (non-leaking). Waiʻanae District sources with the highest susceptibility to contamination included Mākaha Shaft and those in Kamaile. The sources in Waiʻanae and some sources in Mākaha had the lowest susceptibility to contamination.

2.3.2.3 *Anchialine Ponds*

Anchialine ponds are located near the coast, and are fed by freshwater springs, but also have subterranean connections to the sea, thus making them brackish. Waiʻanae is home to several anchialine sinkholes that provide habitat to crustaceans that are candidates for listing as threatened or endangered species.

2.3.3 SURFACE WATER RESOURCES

Surface water is represented in Waiʻanae as springs, streams, and wetlands. Previously used for irrigation of both native Hawaiian and western plantations, stream flow is currently intermittent and no longer commonly used. The Waiʻanae community has shown a strong interest in restoring stream flow in order to provide for native aquatic species habitat, local small-scale farming and irrigation, and cultural practices.

2.3.3.1 Streams

In 1990, CWRM published the *Hawaii Stream Assessment* (HSA) as a "broad-based collection of existing information on Hawaii's rivers and streams." The Multi-Attribute Prioritization of Streams (MAPS) Project was initiated as a supplement to the HSA in an effort to prioritize streams for protection and management.

Perennial streams were grouped into six categories, based on five resource types: aquatic, riparian, cultural, recreational, and "special areas." Stream categories included potential heritage stream, non-diverted valuable stream, diverted valuable stream, other non-diverted stream, and remaining streams without aquatic resource data. [what was the overall assessment of the stream?]

Stream Flow

The HSA identified six perennial streams in Waiʻanae: Nānākuli, Ulehawa, Māʻiliʻili, Kaupuni, Mākaha, and Mākua, all of which are interrupted, meaning that they do not flow continuously to the sea, instead flowing year-round in upper portions and only intermittently at lower elevations under normal conditions. The interruption may be natural or man-made. MAPS identified Mākaha Stream as an "other non-diverted Stream," meaning it has no diversions, although it may be channelized, and has a total score of less than 50.0, which qualifies it as a "valuable" stream.

Waiʻanae streams are fed through surface water runoff and overflow from Kaʻala Bog into Mākaha and Waiʻanae Valleys. Dike-stored ground water at the back of the valleys may also contribute some flow as seeps and springs. Pervious alluvium in the upper strata of Waianae's valleys allows surface water flow to seep into the ground at lower elevations, leading to the streams' interrupted nature as water continues to move in subsurface flows to the sea.

While most of Waianae's perennial streams were gaged at some time, only two streams, Kaupuni and Mākaha, have median stream flow data, due to the intermittent nature of their lower reaches. Currently, there is only one continuously-recording USGS hydrologic data collection station operating in Waiʻanae. Funding for these rain and stream gages in Mākaha Valley was set to expire in September of 2006.

TABLE 2-2

WAIʻANAE PERENNIAL STREAMS[14]

Stream	Drainage Area (acres)	Median Streamflow (cfs)*	Tributaries	Diversions & Modifications
Nānākuli	2,547.2	---	none	Lined portion
Ulehawa	---	---	none	Lined portion
Māʻiliʻili	966.4	---	none	Lined portion
Kaupuni	2,291.2	0.3	nine	Dam or diversion weir, lined portion
Mākaha	1,478.4	0.5	none	Dam or diversion weir, lined portion
Mākua	2,739.2	---	none	None noted

*Median streamflow was only available for two of the streams. Time periods vary for USGS data collection.

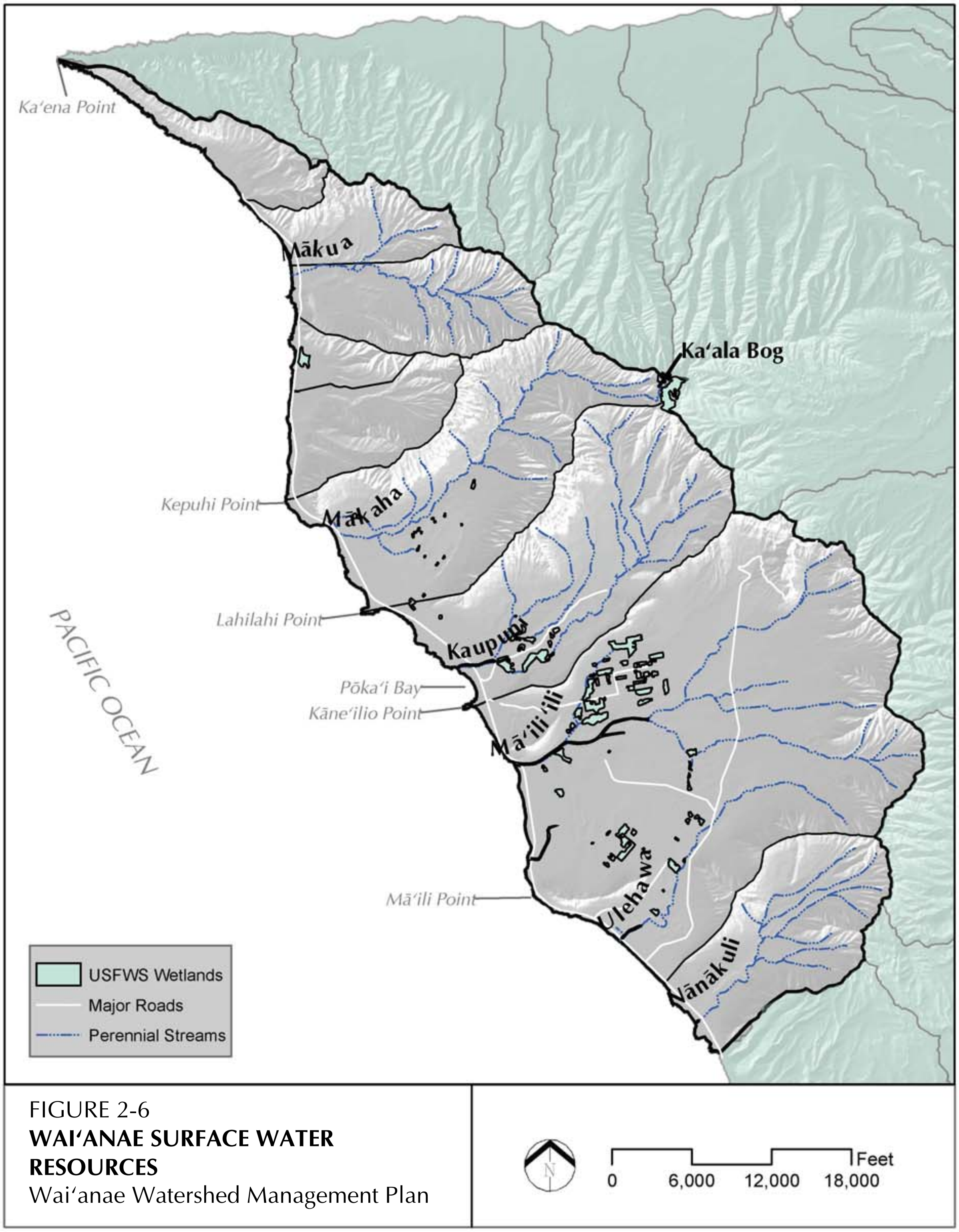


FIGURE 2-6
WAI'ANAE SURFACE WATER RESOURCES
Wai'anae Watershed Management Plan

Instream flow standards (IFS) are defined by the State Water Code as the "quantity or 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." As described in Chapter 1, the current IFS are interim and are based on "the amount of water flowing in each stream on the effective date of the standard without further amounts of water being diverted off-stream through new or expanded diversions." Measurable IFS have not yet been established for Waiʻanae. Streamflow is critical for the conservation of aquatic life and perpetuation of cultural and traditional practices, such as *loʻi kalo* restoration.

Stream Channel Alterations

Stream channel alterations in the Waiʻanae District include diversions, dams, and channelizations. There are six registered stream diversions, but only three in Waiʻanae Valley are listed as potentially being active in the CWRM database of declared water uses. The Waiʻanae District's only large stream diversion was Mākaha Dam, which was constructed to provide irrigation water for the plantations, but that structure is no longer diverting water.

The *ma kai* reaches of most streams in Waiʻanae were channelized with concrete from the late 1960s to early 1970s to provide flood control; of the major streams, only Mākaha and Mākua remain un-channelized. While flood control projects can help prevent property damage, they can also have negative effects on the aquatic environment, potentially altering hydrologic regimes, removing riparian vegetation, and eliminating or degrading native habitat.

Kaupuni Stream in its lower reaches.

Stream Biota

The *Hawaii Stream Assessment* identified 376 perennial streams in Hawaiʻi; of these, only 164 (44 percent) had some biological information. On a scale including the categories "Outstanding," "Substantial," "Moderate," "Limited," "Without," and "Unknown," Mākaha Stream ranked "Moderate" in terms of aquatic resources, meaning that at least one native species from the indicator species group was observed.[15] The other Waiʻanae perennial streams listed in the Assessment, Kaupuni, Nānākuli, Māʻiliʻili, Ulehawa, and Mākua, were listed as streams without aquatic data.[16] Forty-eight percent of the 376 perennial streams in Hawaiʻi have not been surveyed for aquatic organisms.

Native fresh water species require clear, well-oxygenated water and streambeds with boulders, cobbles, and gravel bottoms.

Additionally, all native stream species have a marine or estuarine component to their life cycles, therefore requiring at least intermittent stream flow from the headwaters to the sea. Streams throughout the County and the State have been facing increasing stress and degradation from alien species, non-point source pollution, trash and litter, loss of riparian habitat, and stream modifications. While it does not seem that Waiʻanae streams have reached a critical point in stream degradation, indicators, such as channelization, chronic dumping, and fewer observances of native stream biota, indicate that the health of Waiʻanae streams is in decline. Restoration efforts in other locations have shown that natural stream functions, properties, and biota can be reestablished, holding promise for future efforts.

In general, the riparian resources of Waiʻanae streams are relatively poor. The HSA noted the presence of a detrimental plant, hau (*Hibiscus tiliaceus*) at Māʻiliʻili, Kaupuni, and Mākaha Streams. Goats were located at Māʻiliʻili, Kaupuni, Mākaha and Mākua Streams, and pigs were found at all of the perennial streams. The streams all have little to no native riparian forest resources. Despite this, three threatened or endangered bird species were found at Mākaha Stream and two rare plants were found at Mākua.

2.3.3.2 Wetlands

Wetlands are areas that are regularly wet or flooded throughout most of the year, and are often characterized by specific plant associations and soil types. The State GIS database, based on US Fish and Wildlife

Wetland in Nānākuli.

Services (USFWS) National Wetlands Inventory data, identifies about 100 wetlands in the Waiʻanae District. The majority of wetlands is five acres or less and is concentrated in the Lualualei and Waiʻanae *ahupuaʻa*. Most of the wetlands in the Waiʻanae District are characterized as palustrine, shallow non-tidal fresh water areas that lack flowing water and are dominated by trees and shrubs.

Kaʻala Bog, found atop Mount Kaʻala, the highest peak in the Waiʻanae Mountains, is the largest wetland in Waiʻanae, measuring over 20 acres in size. Mount Kaʻala experiences an annual rainfall of 60 to 80 inches which, in combination with fog drip, created Kaʻala Bog. The Bog is a perched water body, and a significant water source that feeds Mākaha and Kaupuni Streams, as water overflows into both Mākaha and Waiʻanae Valleys. A part of the Mount Kaʻala Natural Area Reserve, the bog is managed by the State DLNR. This protected area is habitat to fourteen plant communities, ten of which are native plant dominated. Native fauna are also found in the Natural

Area Reserve, including federally listed forest birds and invertebrates.

Some wetlands are man-made, such as Lualualei Reservoir, the Niuliʻi Reservoirs, and the oxidation pond at Lualualei Naval Reservation, which serve as important waterbird habitat. These and other wetlands provide important ecological functions such as filtering pollutants from water, absorbing flood waters, providing habitat for native and endangered species, recharging ground water into alluvial aquifers, and providing for open space.

2.3.3.3 Surface Water Quality

There is very little water quality data available for Waiʻanae, and the intensity of sampling varies with each stream. Five samples for Kaupuni Stream were taken by the USGS between the years 1970 to 1973, while Mākaha has been studied more extensively with 130 samples taken between the years 1967 to 1986 and an additional four samples in 1997.

Threats to surface water quality include non-point sources of pollution from urban and agricultural lands including silt, herbicides, pesticides, farm animal wastes, oils, grease, cesspool effluent, paint products, and other harmful and toxic substances. Intermittent streams will most likely reflect poorer water quality than streams that are perennial because they tend to get their flow from runoff containing land-based pollutants, such as herbicides washing off vegetation and off roadways. A stream with a consistent base flow will generally reflect the makeup of the ground water seeping into it, but additional flow caused by runoff may be the major cause of pollutants of a temporary nature. Other impacts on streams come from grading operations for roads and houselots; trash; and debris including broken appliances, old cars, and tires, illegally dumped into stream channels.

The Federal Clean Water Act §303(d) mandates that each state submit a list of water bodies that are not expected to meet state water quality standards, even after action is taken to control non-point source pollution. The final *2004 List of Impaired Waters in Hawaii* includes Kaupuni Stream as a Water Quality Limited Segment due to excessive presence of nutrients, turbidity, and trash. Ground water in Waiʻanae is naturally high in nitrates, presumably from vegetation. It is possible that surface water fed by ground water has a similar tendency toward high levels of nitrates.

Total Maximum Daily Loads (TMDLs) are calculations of the maximum amount of each pollutant that can enter the given water body without violating state water quality standards. Prioritization depends upon the severity of the pollution, including the number of pollutants and degree to which standards are exceeded, the use of the waters, the type and location of the waterbody, the degree of public interest, and the vulnerability of particular waters. Kaupuni Stream is of medium priority to have TMDLs developed for its pollutants.[17] No other streams were identified for further monitoring that would aid in deciding whether or not designated uses are met.

2.3.3.4 Flood Mitigation Structures and Measures

Severe storms cause flood damage in the Wai‘anae District, prompting the concrete channelization of the lower reaches of Nānākuli, Kaupuni, Mā‘ili‘ili, Mā‘ili, and Ulehawa Streams from the late 1960s to early 1970s to improve water flow. Prior to this channelization, sand would accumulate in the dry stream mouths and block water runoff during heavy rains, creating flooding in coastal neighborhoods. Channelization has helped to reduce flooding in these areas.

Flooding is still a problem where *ma kai* areas are higher in elevation than those *ma uka* because of deposition of sediment, creating a damming effect. In some areas, Farrington Highway was built up higher than the adjacent *ma uka* areas and restricts seaward runoff, causing localized flooding. Most businesses along Farrington Highway were built at an elevation high enough to escape this type of flooding; however, some residential properties were not. Other localized flooding is caused by the lack of adequate drainage facilities in subdivisions, un-permitted property walls that divert storm water, the filling of natural drainage swales and ditches, and clogged storm drains. Increasing development continues to keep flooding a concern in Wai‘anae.

Flood control and mitigation is occurring at several levels. The City’s Capital Improvement Program calls for a variety of drainage improvements in Wai‘anae. The Farrington Highway Drainage Improvements work began June 21, 2004 to provide drainage along Farrington Highway, including curbs and gutters. Additionally, the Bayview Drainage Project, which is required before improvements to Pōka‘ī Bay Beach Park can occur, is awaiting budget approval.

A Flood Study for Lualualei was performed by the US Army Corps of Engineers (USACE) and US Department of Agriculture Natural Resources Conservation Service (NRCS) in 2001. Analysis of flooding in this area found insufficient drainage infrastructure. Sumps without drainage relief were also found to be prevalent in the area. Recommendations to alleviate local flooding include diverting water from ineffective sumps and directing runoff to existing drainage infrastructure. The Navy has secured some funding for development and design studies to implement a detention basin. Currently, various members of community; and the City, State, and Federal governments are meeting with congressional staff in order to secure funding for priority flood mitigation measures.

2.3.4 NEAR-SHORE WATERS

The 20-mile Wai‘anae coastline is a mix of rocky shoreline and white sand beaches, most with recreational facilities that are heavily used by both residents and visitors. Recreational activities include fishing, boating, surfing, snorkeling, diving, paddling, and beachside camping, among others. These activities may be impacted by chronic erosion occurring at Mā‘ili Beach, Mauna Lahilahi Beach Park, Mākaha Beach, and Keawa‘ula Bay. In addition to reducing coastal land area, erosion creates material that settles on coral, affecting food

Waianae's coastal areas and boat harbor provide many recreational venues.

production. In turn, as corals begin to die, marine life that rely on the coral for food and shelter are also affected.

In October of 2005, news reports brought to light information on chemical weapons disposed off of several coastal states in the 1940's, including Hawaiʻi. There are two known disposal sites off the coast of Oʻahu: one off of Pearl Harbor and one off of the Waiʻanae Coast. Subsequent to the news reports, Representative Neil Abercrombie requested the U.S. Army to provide more information regarding the timing, location, and nature of any chemical munitions; the current location and condition of the munitions in question; the potential health risks to the public posed by the dumped materials; and the potential environmental impact of the dumped materials. [18]

Items reportedly located off of Waiʻanae include: 1,000-pound hydrogen cyanide and cyanogen chloride bombs; nearly 15,000 mustard bombs; more than 30,000 four-inch mortar mustard shells; and more than 1,200 one-ton containers of both mustard agent and a blistering chemical called lewisite.[19] The Army reportedly stated that disposal occurred five miles from the coast in thousands of feet of water, however, divers and other coastal users say that ordnance may be found within one mile from shore in less than 100 feet of water.[20]

While Congress banned ocean disposal of chemical weapons in 1970, there has been no comprehensive clean up of dumped materials, and none is planned.[21]

The potential health threat of existing dumped materials is unknown. The Army was reported as saying that "marine life near the weapons could be at risk, and bombs that are accidentally brought to surface could be deadly." [22] Currents off of the Waiʻanae Coast may bring any leaking materials toward shore, although the Army Chemical Weapons Material Agency in Washington was reported as saying that "seepage from eroded or damaged shells would likely neutralize before reaching the surface and washing ashore."[23]

2.3.4.1 Estuaries

Estuaries are those areas where fresh water systems meet and mix with the ocean. They are often important breeding and feeding grounds for juvenile aquatic fauna, as waters tend to be rich in nutrients. The name Waiʻanae literally means "mullet water," perhaps from mullet in the *muliwai*, or brackish-water pools and estuaries, that were once common in the backshore of many Waiʻanae beaches. Today, many estuaries have either been degraded or modified by channelization of stream mouths.

2.3.4.2 Marine Ecosystem

Coral cover in Waiʻanae is typically low because of the shallow, flat, low-relief bottoms offshore; coral reefs cover only one to two percent of the area. These reefs are dominated by cauliflower coral (*Pocillopora meandrina)* and lobe coral (*Porites lobata)*.[24] Coral studies are ongoing through several monitoring programs including the Coral Reef Assessment and Monitoring Program and the Coral Reef Initiative. Additionally, the City Department of Environmental Services monitors coral and fish populations near their wastewater treatment plant outfall approximately 1.1 miles offshore. Study results have shown no significant deleterious effect on coral and fish populations near the City outfall.[25]

The flat reef, or *papa*, is known for its *heʻe* (octopus); menpachi or *ʻūʻū* (*Myripristis berndti*); *mamo* (*Abudefduf abdominalus*); and *kūmū* (*Upeneus porphyreus*), among other species. Several artificial reefs contribute to the near-shore ecosystems in Waiʻanae: Pōkaʻī Bay Artificial Shoal, the Mahi shipwreck, and a seaplane wreck.[26]

The waters of Waiʻanae are spawning and feeding grounds for many near-shore and pelagic fish such as *ʻamaʻama* (*Mugil cephalus*), *akule* (*Selar crumenophthalmus*), *ōpelu* (*Scomber japonicus*), and *ʻahi* (*Thunnus albacares*). Mākua is noted for its spinner dolphins, or *naiʻa* (*Stenella longirostris*), and is also an important Kona crab fishery area because of the offshore sand. False killer whales and Hawaiian monk seals are also occasionally observed in Waiʻanae waters.

2.3.4.3 Fisheries

Early settlers in Waiʻanae were drawn by the area's productive fisheries. It is still noted today by local fishermen that "When Oʻahu goes to fish, it comes to Waiʻanae." According to the DLNR Division of Aquatic Resources, 982,734 pounds of fish were landed in the area between Barbers Point and Kaʻena Point for the calendar year 2001. Of this amount, 912,310 pounds of fish were sold at a value of $1,433,787. This was approximately 10 percent of the $14,542,586 fish market value for the main Hawaiian Islands for that year.[27]

There are two restricted fishing areas in the Waiʻanae area: a bottomfish-restricted fishing area located at from 100 to 500 fathoms near Kaʻena Point to Mākua and the Pōkaʻī Bay Regulated Fishing Area, generally between Kāneʻīlio Point and Waiʻanae High School.

Local fishermen have reported that increasing commercial ocean recreation tours along the coast pose a potential threat to both fish and fishermen by disrupting the spawning and schooling grounds of *akule*. Other threats to near-shore fisheries could include over-fishing and carnivorous non-native fishes eating local juveniles.

2.3.4.4 Near-Shore Water Quality

The near-shore waters of the Waiʻanae Coast are designated as "Class A" under DOH water quality standards, with the exception of the near-shore waters off the coast of the Keawaʻula *ahupuaʻa*, which are designated as "Class AA." Class AA designations require that the water be left in its "natural pristine state," while the "A" classification allows limited discharge of approved effluents.[28]

Pōkaʻī Bay was listed as a 2004 Impaired Water Body; pollutants include total nitrogen and chlorophyll-a, at both the oceanic and open coastal water quality testing stations.[29] Mākaha Beach was listed for total nitrogen, chlorophyll-a, and turbidity. Both areas were assigned a low priority in the development of TMDLs.[30]

Māʻiliʻili Beach was listed as a water body needing future monitoring in order to determine whether or not any designated uses are met. Currently, there are no lab or field samples for this beach, which is one of the reasons it was considered one of the 70 dirtiest beaches in America by the Natural Resources Defense Council in 2002.[31] Natural Resources Defense Council criteria for listing that year included no monitoring or program to regularly notify the public when health standards are exceeded, no use of EPA recommended criteria, and the presence of known source(s) of pollution in the vicinity of the beach or that might affect the beach.[32]

2.4 TERRESTRIAL ECOSYSTEMS

Before human contact, the two most dominant natural communities in Waiʻanae were the lowland dry forest, which encompassed approximately 50 percent of the land area, primarily in the valleys, and lowland dry shrubland and grassland, totaling approximately 20 percent of the land area and occurring primarily on the coastal plains. The upper elevations were dominated by dry cliff and mesic forest, but

The forests serve many ecological and cultural functions.

they encompassed a relative small percentage of the ecosystem vegetation types.[33] Research is still ongoing regarding the optimal mix of native versus non-native plants for watershed benefits, but native plant associations are thought to provide greater ground water recharge than alien-dominated forests.

The landscape has since been greatly transformed by human activity, which has converted the native landscape into one that is now up to 96 percent non-native. Non-native communities cover areas from the coast through the valleys and uplands, restricting native plant communities to those lands that are generally inaccessible due to private land ownership or rough, steep terrain.[34] Lowland dry forests now account for only 0.06 percent of the vegetation and lowland dry shrubland and grassland account for only 0.14 percent.[35] Native vegetation cover is illustrated by Figure 2-7, which was developed using data from the Hawaii Natural Heritage Program (2003).

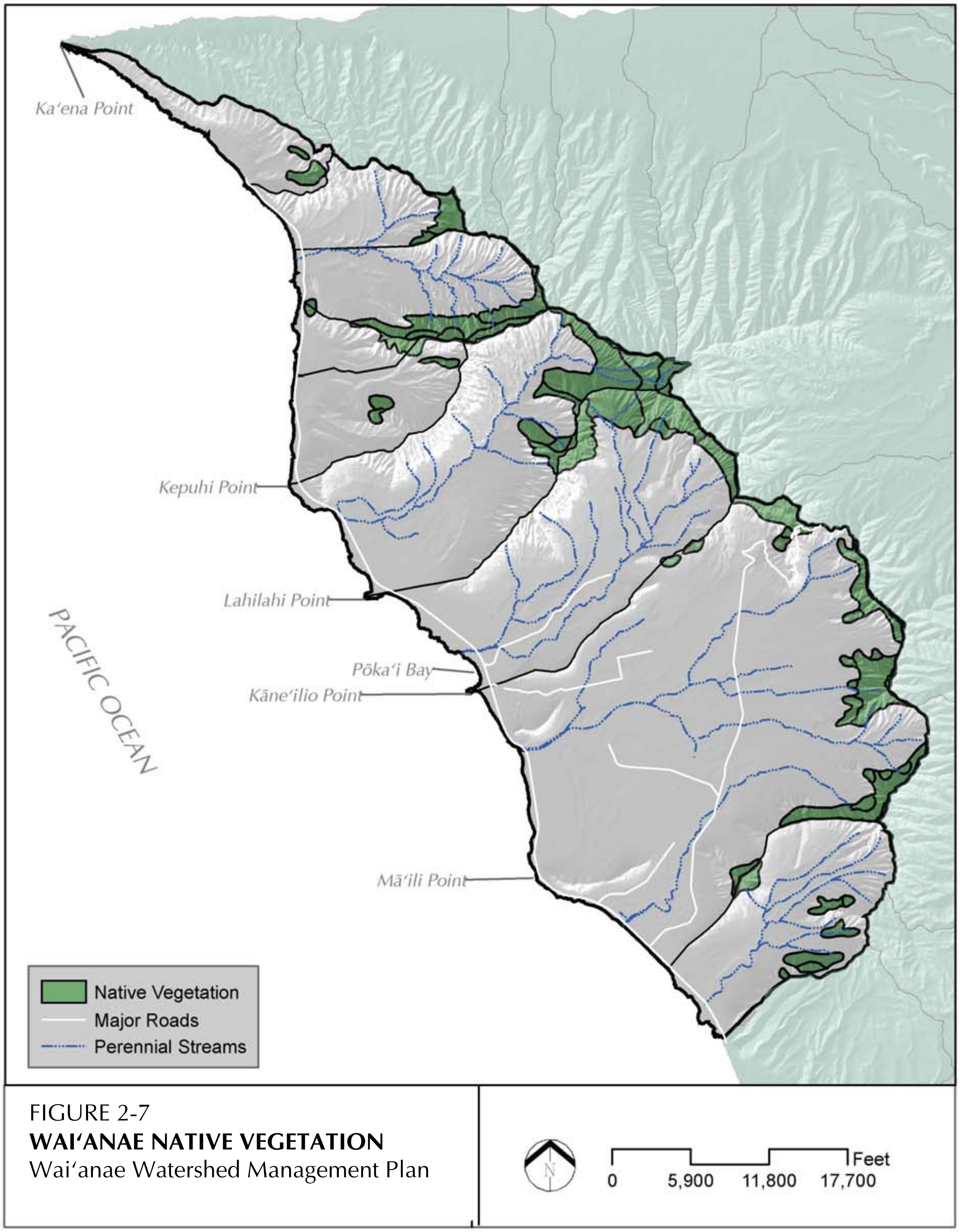


FIGURE 2-7
WAIʻANAE NATIVE VEGETATION
Waiʻanae Watershed Management Plan

TABLE 2-3

FEDERALLY LISTED ANIMAL SPECIES

Type	Hawaiian Name	Common Name	Scientific Name
Mammal	ʻOpeʻapeʻa	Hawaiian Hoary Bat	*Lasiurus cinereus semotus*
Invertebrate	---	Oʻahu Tree Snails	*Achatinella spp.*
Birds	ʻElepaio	Oʻahu Elepaio	*Chasiempis sandwichensis ibidis*
	---	Oʻahu Creeper	*Paroreomyza maculate*
	ʻŌʻū	Honeycreeper	*Psittirostra psittacea*
	---	Shearwater spp.	*Puffinus spp.*
	---	Laysan Albatross	*Phoebastria immutabilis*

Despite this alteration, the Waiʻanae area still accommodates over 100 endemic plant and animal species.[36] Fifty-eight of these species are listed on the USFWS list of Endangered or Threatened Wildlife and Plants: one mammal, one invertebrate, five birds, and fifty-one plants.[37] Threats to the Waiʻanae ecological community include alien invasive plant species, feral ungulates, introduced predators, loss of habitat, injurious insects and disease, wildfire, off-road vehicles, and illegal dumping.

Alien invasive plants compete with native species for light and other resources, and do not provide the habitat necessary to support native fauna. Feral ungulates consume and destroy native plants, spread invasive plants throughout the forest, and cause erosion. Additionally, pig wallows create breeding grounds for mosquitoes that may carry and transmit avian disease, such as malaria. Introduced predators such as rats and mice, prey upon native tree snails, eat the seeds of native plants, and carry bacterial diseases such as leptospirosis.

Wildfires have been a prevalent threat to Waiʻanae forests and communities. Although they often start in urban areas, wildfires tend to spread into the conservation zone and have destroyed hundreds of acres of forest land and have threatened several native and endangered species. While wildfires provide some benefit, such as clearing plant litter and returning nutrients to the soil, burned areas have a higher risk of erosion, and due to the presence of alien species, invasive species encroachment.

Human activities, such as off-road vehicle use in the Kaʻena area, have destroyed or degraded sensitive native ecological communities. Wildfires threaten to destroy native vegetation and illegal dumping introduces pollutants to the environment.

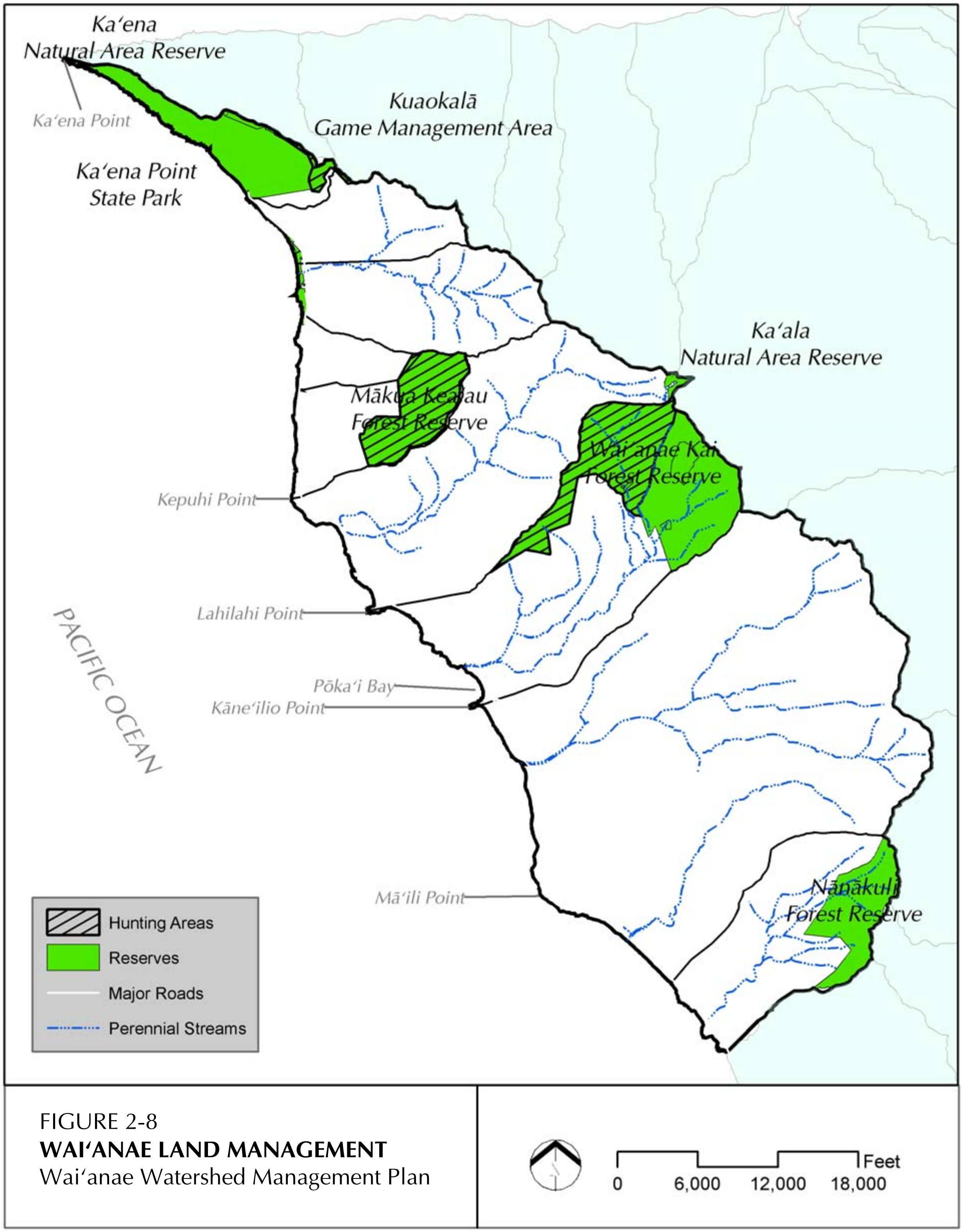


FIGURE 2-8
WAI'ANAE LAND MANAGEMENT
Wai'anae Watershed Management Plan

TABLE 2-4

CONSERVATION EFFORTS IN WAIʻANAE

Type	Reserve/Project Name	Sponsor	Acres
Forest Reserves	Nānākuli Forest Reserve	DLNR	*34,427
	Waiʻanae Forest Reserve	DLNR	
	Kuaokalā Forest Reserve	DLNR	
	Mākua Forest Reserve	DLNR	
Natural Area Reserves	Kaʻena Natural Area Reserve	DLNR	34
	Kaʻala Bog Natural Area Reserve	DLNR	*11,000
Game Management Areas	Kuaokalā Game Management Area	DLNR	
Hunting Areas	A: within the Kuaokalā Game Management Area	DLNR	
	D: within the Waiʻanae Kai Forest Reserve	DLNR	
	G: within the Mākua-Keaʻau Forest Reserve	DLNR	
Critical Habitat	ʻElepaio Critical Habitat	USFWS	*16,990
	Critical Habitat for 99 Plant Species on Oʻahu	USFWS	*55,040
Partnerships	Waiʻanae Kai Watershed Project	Five partners	5,795
	Waiʻanae Mountains Watershed Partnership	TNCH	TDB
	Mākaha Watershed Protection Project	US Army	100
Research	Mākaha Valley	CTAHR-NREM	
Education/Outreach	Waiʻanae Ecological Characterization	CZM	N/A
		Mohala I ka Wai	N/A
		UHM Ethnobotany	N/A
		Waiʻanae HS	N/A
	Kaʻala Learning Center	Kaʻala Farm, Inc.	

*Reserve boundaries extend beyond the Waianae District boundaries.

Several actions are currently underway to help protect remaining federally listed and native species and the natural communities they require. Among the many conservation efforts are four forest reserves; two Natural Area Reserves; one game management area; three designated hunting areas; one designated critical habitat; and various institutional, public agency, and community partnerships, programs, and projects.

Additionally, the Mākua Military Reservation encompasses approximately 4,190 acres in Kahanahāiki and Mākua. This reservation is managed by the Army and protects 33 endangered species in Mākua: 30 plants, one bird, one snail, and one bat.[38]

The Army oversees eight Management Units in Mākua:39

- Kahanahāiki Management Unit
- ʻŌhikilolo Management Unit
- Lower ʻŌhikilolo
- Kaluakauila Management Unit
- Lower Mākua Management Unit
- C-Ridge Management Unit
- East Rim Ungulate Control Area
- Koʻiahi Ungulate Control Area

2.5 CULTURAL RESOURCES AND TRADITIONAL PRACTICES

"Without the existence of a resource upon which to practice there can be no practice."

This section outlines, in general, the traditional and customary practices among the *kamaʻāina* of Waiʻanae in order to understand the broad scope of what is meant by cultural, historical, and natural practices, customs, and traditions.

2.5.1 ORIGINS

Hawaiʻi nui a Kea
Loaʻa Oʻahu, he wohi
He wohi na Ahukinialaʻa
Na Laamealaakona, he wahine

Oʻahu begotten of wohi rank
A chief of Ahu kini a Laʻa
Of Laʻamealaʻakona, a woman

This genealogical account of the chiefly birth of Oʻahu communicates not only the godly creative forces that gave birth to the Hawaiian archipelago but more importantly, describes the familial relationship shared between the Hawaiian people and their beloved lands.

The birth of the Hawaiian archipelago is credited to Papa and Wākea. Wākea, the upper province of the sky, is symbolic of the region from which descends sunshine and rain to fertilize the earth. Papa, the warm upper layer of earth, is where fertilized seeds await maturity to spring into life. Papa and Wākea are also credited as being the first parents of human life on earth. Through the birth of Hāloa, born from Wākea's own daughter, the first living child was named for "the long stalk" (*hā loa*), manifest as the original *kalo* that grew from the place where an earlier stillborn child, Hāloanakalaukapalili, was buried beside their house.

Thus, Papa and Wākea are the first parents of human life on earth as well as the plant life and animal life that they feed upon. These origins define the responsibility that rests with the younger generation to care for the elder Oʻahu, born of chiefly parents.

2.5.2 HAWAIIAN CUSTOMS AND PRACTICES

Hawaiian customs and practices include traditional, subsistence, cultural, and religious activities that Hawaiian families have engaged in for centuries. These customs and practices distinguish Hawaiians as a people and their continued existence in an island environment.

Major aspects of Hawaiian lifestyle are embodied in customs and practices including community life, family, human well-being and spirituality, stewardship, and the use of natural and cultural resources, rights and economics.[40] Thus, to the Hawaiian mind, the natural elements, land, and ocean form the basis of subsistence, cultural and religious beliefs, customs, and practices.

Basic principles of Hawaiian stewardship and the use of natural and cultural resources recognize the *ahupuaʻa* as the most common unit of resource management. There is an interdependency and interconnectedness among the natural elements of land, air, water, and ocean. Notably, of all these natural elements, water is afforded a greater importance for its life-giving force.

ʻOhana living, or the presence of multiple generations in the extended family, ensured that ancestral knowledge of practices, customs, and traditions were passed down from generation to generation. Legends and chants that record the names of winds, rains, and prominent environmental features are sources of ancestral knowledge.

Culturally prescribed behavior such as *aloha ʻāina*, and its companion expression of conservation through *mālama ʻāina*, ensures the sustainability of resources for present and future uses.

The activities that are central to traditional and customary practices are dependent upon having access to and being able to care for and use natural and cultural resources of the land, ocean, air, and water. While this discussion is not meant to be exhaustive, it does discuss some of those elements necessary for traditional and customary practices.

2.5.3 *WAHI PANA*

Wahi pana, are presented as sacred sites or significant places such as *heiau*, shrines, churches, prominent *pōhaku* or stones, burial caves, geographic features, and natural features and phenomena associated with deities or significant events.

In Waiʻanae, *wahi pana* are present from Nānākuli to Kaʻena Point as *heiau*, shrines, *koʻa*, and associated fishing grounds in the ocean. There are named landscape features, sacred *pōhaku*, and geographic features associated with *kino lau* (body forms) of deities, including natural phenomena and traditional and contemporary *ilina* (graves and cemeteries).

2.5.4 STREAMS, SPRINGS AND PONDS

Streams, springs, and ponds provide habitat for native species of marine and plant life, which supply the necessary resources for domestic use, cultural and spiritual practices and customs, and recreation. In Waiʻanae, intermittent streams are present in all nine *ahupuaʻa*. Springs and ponds may be found in Māʻiliʻili, Mākaha, and Mākua. Wetlands or *muliwai* can be found in Lualualei, Waiʻanae, Mākaha, ʻŌhikilolo, and Mākua.

2.5.5 SHORELINES, REEFS, FISHPONDS, NEAR-SHORE AND OFFSHORE OCEAN

Near-shore and offshore ocean resources are gathered for food and medicine, key to conducting cultural and spiritual customs, and play a role in recreation. The Waiʻanae District coastal resources are present from Nānākuli to Kaʻena Point.

2.5.6 FORESTS

Forests serve as hunting areas for pigs and other animals; gathering plants used for medicine, food, hula/ceremonial adornments, offerings; and conducting cultural and spiritual customs. The Waiʻanae District *ma uka* areas contain forest resources from Nānākuli to Kaʻena Point.

2.5.7 DOMAINS OF *ʻAUMAKUA* OR ANCESTRAL DEITIES

The Waiʻanae District contains natural and cultural areas significant for *hoʻailona* (natural signs) and natural phenomena important as domains of ancestral deities central to revitalizing ties and spiritual renewal from Nānākuli to Kaʻena Point.

2.5.8 EMBODIMENTS OF HAWAIIAN DEITIES

In the Waiʻanae District, forms of Hawaiian deities as natural resources (*kinolau*) and climatic phenomena are present in ocean, coast, and land from Nānākuli to Kaʻena Point.

2.5.9 ARCHAEOLOGICAL AND HISTORIC SITES

These human-made structures are found from Nānākuli to Kaʻena Point and may include temples, shrines, agricultural sites, and sites of food production, such as *loʻi*, terraced slopes, *ʻauwai*, and fish ponds; including special function sites such as trails, salt pans, *hōlua* slides, quarries, petroglyphs, gaming sites, and canoe landings.

2.5.10 AREAS OF TARO CULTIVATION AND OTHER AREAS OF CULTIVATION

Taro cultivation involves a system of interrelated elements such as fields, streams, and *ʻauwai*. Other cultivation areas may include plants used for food, medicine, adornment, ornament, implements, cooking, fuel, mulching, and ceremony.

In Nānākuli, it is estimated that a coastal and inland population of at least 200 to 300 people occupied the area in the late 1700s. Notably, large sweet potato (*ʻuala*) field systems and other dry land agriculture fields are present in the archaeological record.[41]

The Waiʻanae Kai and Waiʻanae Uka areas, comprised of various *ʻili*, contained house sites, irrigated *kalo* lands, land for dry land crops, and *heiau*. *Ma uka* areas had irrigated taro fields, houses, *heiau*, and dry land fields.

It is estimated that Lualualei had a population of 800 in the 1700s. The remains of dry agricultural fields, found all around upper valley house sites, probably contained *kalo* and *ʻuala*. Māhele records indicate *wauke* patches and other crops at Pūhāwai. Irrigated *loʻi* were found at two locations, near Kolekole and Pūhāwai. Māhele records identified 163 *loʻi* fields in six (6) *kuleana* awards.

Along the Leeward coast, Mākaha is the most abundant source of water. A large population of about 840 people lived near the upper and middle portions of this valley. Large numbers of permanent house sites have been located. Vegetable food came from two main areas. The upper valley stream flats are nearly all covered with small sets of irrigated *kalo* fields. Areas from the lower valley to the near-shore are full of remains of dry land agriculture fields that once grew *ʻuala*, gourds, *wauke*, and other crops.

The *ahupuaʻa* of Keaʻau and ʻŌhikilolo share the same valley. More people appear to have settled at the shore and lower valley. In the *ma uka* areas, agriculture appears to have been entirely dry land fields, with sweet potato as the dominant crop.

Similar to neighboring Keaʻau and ʻŌhikilolo, the bulk of the permanent housing in Mākua and Kahanahāiki was located along the shore and in the areas immediately adjacent to the lower valley. The farms of Mākua were dry land agriculture fields with *ʻuala* as the dominant crop. Kahanahāiki contains small irregular terraces, clearings, and mounds along the lower part of its slopes.

2.5.11 CIRCULATION NETWORKS

On land, circulation networks include trails and roads for lateral access, as well as for *ma uka* and *ma kai* access. Trails also provided around the island mobility. Along the shoreline, these networks include landings, harbors, and piers. In the Waiʻanae District, trail and road networks are present from Nānākuli to Kaʻena Point.

2.6 SETTLEMENT HISTORY

Best estimates indicate that there may have been a significant population of about 4,000 to 6,000 inhabitants in the Waiʻanae area at the time of first European contact. It appears that continual use of Waiʻanae coastal areas dates as early as the 1100s A.D. At that point in time, one can imagine moving through the valleys of the Waiʻanae *moku*, beginning at a shoreline rich with marine life, moving across sandy beaches until reaching gently sloping lands that were well suited for farming, and progressing upwards to steep mountains and forested areas.

Waiʻanae was not spared the tragic population loss experienced across the rest of the Hawaiian archipelago in the post-European contact period. Population records show that while Waiʻanae was sparsely settled, with about 1,600 residents in 1835, the population had dwindled to less than 800 by 1855, due in large part to the introduction of disease and the attraction of Honolulu.

By the second half of the 19^{th} century, the landscape was characterized by large ranches in Lualualei, Wai'anae, Mākaha, and Mākua Valleys. The sugar cane industry made its entry into Wai'anae in the late 19^{th} century, ushering in a wave of population growth of mostly Japanese and Chinese plantation workers in Lualualei and Wai'anae Valleys. Residential and agricultural landscapes developed around the plantation lifestyle. By 1940, at the peak of the sugar industry, the district population had increased to 3,000 people.

In 1946, when the Wai'anae Plantation closed its operations, some 9,150 acres were available for public purchase. Chinn Ho purchased the entire acreage for $1,250,000 and offered subdivided lots for sale. For the first time, a great number of building lots were available for purchase in the District. In Mākaha, for example, beach front lots were sold for $2,500 each. By 1950, and in large part due to Chinn Ho's development program, the coastal population had grown to 7,000 people.

Population increases in the 1950s were accompanied by a succession of public facility developments including a breakwater at Pōka'ī Bay, Pililā'au Park, a new high school, and improvements to the public water system. By 1960, Census counts indicated 16,452 people in Wai'anae, an increase of 9,452 people from the 1950s, marking a significant increase for this "rural" community.

Large scale residential and other associated development continued. In contrast to an earlier small scale homestead initiative in 1929, the State Department of Hawaiian Home Lands in 1962 began construction of streets and water lines for a Native Hawaiian community in Nānākuli Valley. By the close of the 1960s, over 500 families had built or purchased homes in Nānākuli Valley. Chinn Ho broke ground for the Mākaha Resort Hotel in 1967. A new municipal sewage treatment plant was completed in 1968.

With a population of about 24,000 people, Waianae's modern development pattern was well established by 1970. The District's landscape was now dotted with more homes, schools, and commercial centers. By 1980, and a few years prior to the enactment of the first City "Development Plan," the population had grown to over 31,000. The 1980s would be characterized as a period of continued growth for Wai'anae.

In the 1990s, larger state-wide trends would impact Waianae's development. The State experienced a slowing of its rapid post-Statehood growth and Hawai'i experienced its first extended recession. In 1996, the Sheraton Mākaha Resort closed, along with the Coronet store in Mākaha. Following suit, in 1997, the Woolworth store at Wai'anae Mall closed. In contrast to the area's commercial downturns, new housing projects continued to be developed. The Princess Kahanu project, with 226 homes, was completed in 1996 representing a major new subdivision in the area. Despite considerable community opposition, the Mā'ili Kai residential project received City zoning and approval, and by 1997, about 300 new homes had been constructed there. By 1997, the estimated population in Waiʻanae reached over 40,000 people.

The 2000 U.S. Census indicated continued growth, albeit moderate, with a resident population of 42,000 people. The State's agricultural industry shrank significantly during the 1980 to 2004 period, as diversified agriculture grew in the Pearl Harbor area, as sugar plantations were phased out, and as cheaper imported foods replaced locally grown products. This trend has impacted Waianae's agricultural landscape with the recent closure of family owned chicken farms in Nānākuli. The number of Waiʻanae dairies has declined as well. In contrast, truck farms seem to be a stable, if not a growing, agricultural sector on the coast, largely due to labor intensive farms run by immigrant families.

2.7 DEMOGRAPHIC CHARACTERISTICS

The Waiʻanae Coast is a traditionally rural agricultural community that has recently experienced the growth patterns of a rapidly suburbanizing district. Between 1990 and 2000, Waianae's population grew by 13 percent, compared to a 4.8 percent increase for Oʻahu as a whole for the same time period. In 2000, Waiʻanae accounted for 4.82 percent of Oahu's total population, an increase from 4.47 percent in 1990. The City and County of Honolulu Department of Planning and Permitting uses population projections from the State Department of Business, Economic Development, and Tourism and the land use policies established in each of Honolulu's Development/ Sustainable Communities Plan areas to project future population distribution. This projection shows Waianae's share of Oahu's population shrinking back down to 4.5 percent by 2025, suggesting that Waianae's population growth will be slower than the rest of Oʻahu.

TABLE 2-5

POPULATION TRENDS VS. GENERAL PLAN POLICY[42]

	Actual Population			General Plan Projected Population		
	1980	1990	2000	2010	2020	2025
Oʻahu	762,565	836,231	876,156	929,200	999,400	1,029,800
Waiʻanae	31,487	37,411	42,259	44,600	45,700	46,400
% of Oʻahu	4.10%	4.50%	4.80%	4.80%	4.60%	4.50%

TABLE 2-6

WAIʻANAE POPULATION AND HOUSING, YEAR 2000[43]

Ahupuaʻa	Population	Housing Units	Persons per Household	Available Housing Vacancy Rate
Nānākuli	11,866	2,745	4.64	4.30%
Māʻili	5,943	1,502	4.22	4.80%
Lualualei	2,616	789	3.83	6.80%
Waiʻanae	13,605	3,986	3.87	10.00%
Mākaha/Kaʻena	8,229	3,334	3.30	15.40%
TOTAL	**42,259**	**12,356**	**3.97**	**9.20%**
Oʻahu Totals	876,156	315,988	2.95	4.90%
% of Oʻahu	4.82%	3.91%	N/A	N/A

The average household size is larger in Waiʻanae (3.97 persons per household) than for Oʻahu as a whole (2.95 persons per household).[44] In the 2000 Census, 62.2 percent of Waianae's population identified themselves as Native Hawaiian or other Pacific Islander, either alone or in combination with other races, as compared to only 21.6 percent of the total Oʻahu population, demonstrating the large Native Hawaiian population residing on the Waiʻanae Coast.

2.8 LAND USE

State land use is differentiated into four broad categories: Urban, Rural, Agriculture, and Conservation (Table 2-7). Much of the land in Waiʻanae is designated Conservation (47 percent), which primarily encompasses the steep, mountainous ridges and upper valleys of the Waiʻanae Range. Agricultural lands make up almost as much acreage (40 percent) as Conservation lands, and are generally found on the more gently sloping valley floors. Urban lands only account for 13 percent of the land area and are generally found in a relatively narrow strip along the coast. There are no "Rural" lands in Waiʻanae.

TABLE 2-7

STATE LAND USE DESIGNATIONS[45]

Land Use	Acres	% of Total
Urban	4,787	12.6%
Agriculture	15,431	40.5%
Conservation	17,871	46.9%
TOTAL	**38,089**	**100.0%**

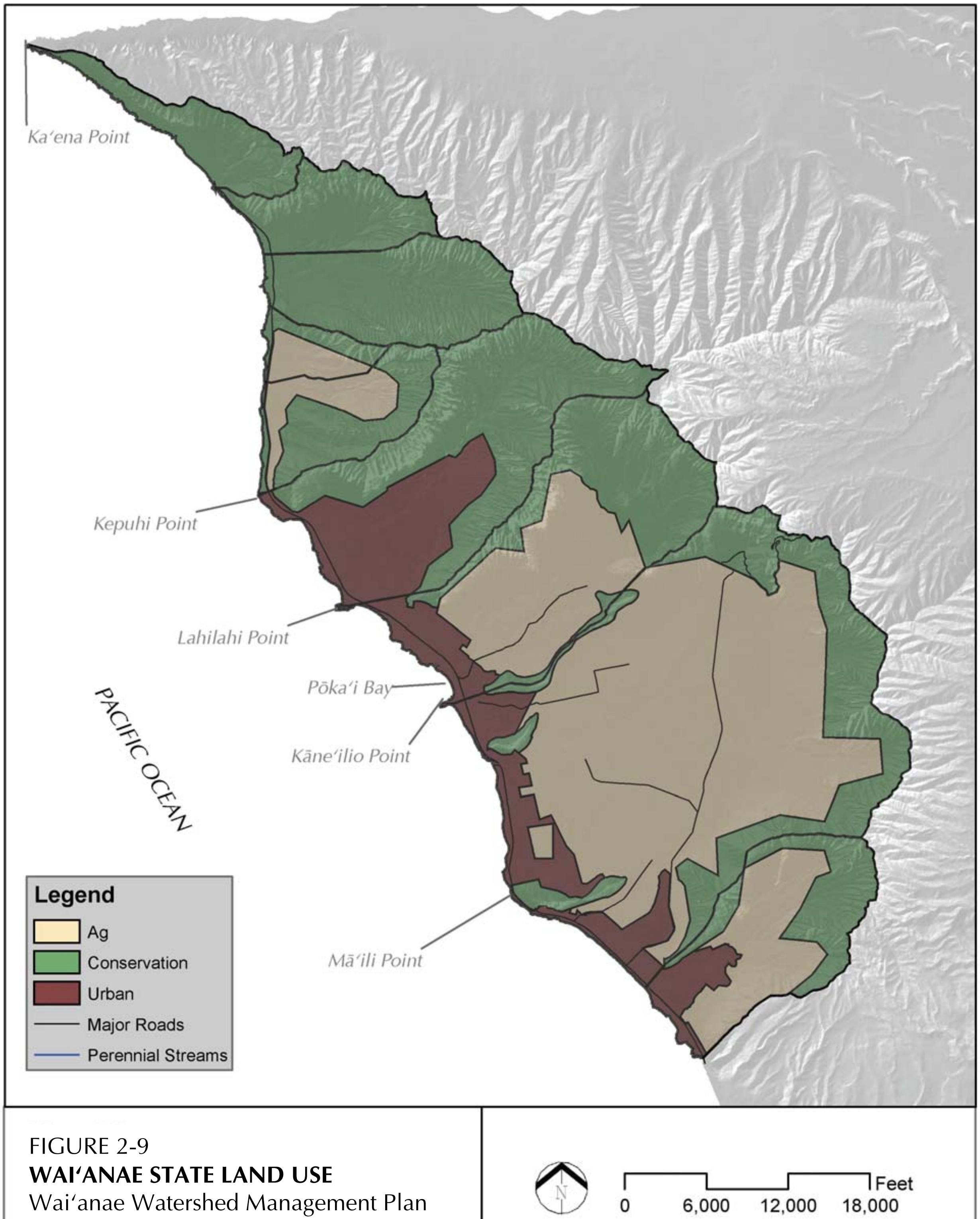


FIGURE 2-9
WAI‘ANAE STATE LAND USE
Wai‘anae Watershed Management Plan

At the City level, the three largest zoning districts in Wai'anae are Preservation, 50.1 percent of the land area; Agriculture, 22.7 percent; and Military/Federal, 18.3 percent. Residential zoning accounts for 5.8 percent of the land in Wai'anae, and commercially zoned lands account for only 0.3 percent.

TABLE 2-8

COUNTY ZONING[46]

Zoned Use	Acres	% of Total
Preservation	19,597.74	50.1%
Agriculture	8,872.86	22.7%
Military/Federal	7,147.46	18.3%
Residential	2,273.14	5.8%
Country	840.10	2.1%
Commercial	108.86	0.3%
Resort	97.03	0.2%
Industrial	79.39	0.2%
Apartment	77.98	0.2%
TOTAL	**39,094.56**	**100.0%**

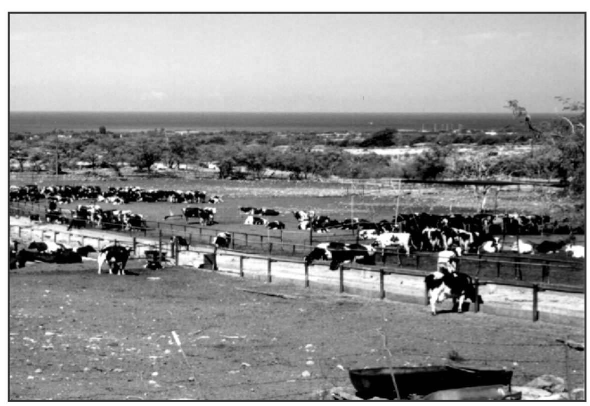
2.8.1 LAND OWNERSHIP

There are four landowners that own more than 2,000 acres each: State of Hawai'i (12,000 acres), United States of America (8,500 acres), City and County of Honolulu (4,498 acres), and Hawaiian Home Lands (2,880 acres).[47] Together, these four landowners own approximately 73 percent of the land in Wai'anae. Not including these four, there are an additional 20 landowners who own over 50 acres of land for a total of 11 percent of the total land in Wai'anae. Small parcels make up the rest of the acreage.[48]

2.8.2 AGRICULTURE

Of the 15,431 acres of land designated as State "Agriculture," approximately 4,800 acres are considered "Prime" and 2,700 acres are considered "Other," in the Agricultural Lands of Importance to the State of Hawai'i (ALISH) Soil Ratings adopted by the State Board of Agriculture in 1977. A 1997 Wai'anae-specific agricultural resources study indicated that most of Waianae's approximately 4,800 acres of "prime" agricultural land is located in the Lualualei *ahupua'a*, although much of it is owned by the Federal government and is therefore inaccessible to farmers.[49] The State Department of Agriculture operates a 150-acre Agricultural Park in Wai'anae Valley with 17 lots, all of which are currently leased.[50]

Agricultural lands not under control of the Federal government are generally owned by small farmers and other small landowners in Lualualei and Wai'anae Valleys. Fruit, vegetable, and herb farming occurs mostly in Lualualei. These farms are typically commercial operations, although some



Waianae's dairies are slowly shutting down.

"recreational farming" also occurs. Over two dozen flower and nursery farms were recorded, primarily in Lualualei, although smaller concentrations also exist in Wai'anae and Mākaha.

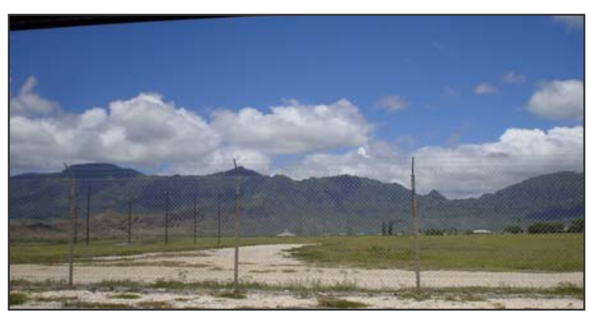
At the time of the1997 study, Wai'anae was the center of Hawaii's livestock operations, producing most of the State's milk, pork, eggs, boiler-chicken, and pullet. Since this study, several livestock operations have closed, including several chicken farms and dairies. However, as of January 2004, Wai'anae was still the largest and most productive center for livestock production in the State with three of the eight major commercial dairies (producing approximately half of the State's milk), 40 of the State's 230 piggery operations, (producing 45% of the State's total hog inventory), poultry operations that produced the majority of the State's eggs, broiler/fryer chickens and pullets, and various cattle, sheep, and goat farms.[51]

Additionally, there are many small farms that grow fruits, vegetables, and herbs that are sold in Honolulu markets. Many of these farms are part-time, family-run farms that are used for subsistence or recreation. There are an estimated 200 one- to two-acre parcels where some form of farming is practiced.[52] The general consensus from the Farm Service Bureau and some local farmers is that the flower and truck farm industries are relatively stable here, but that animal operations will continue to decline in the future, largely due to urbanization and competition from larger, more efficient mainland operations.

2.8.3 MILITARY

Among the eight O'ahu planning districts, Wai'anae has the largest percentage of military-occupied lands, and also has the second largest acreage of military land (13,510 acres) next to Central O'ahu (15,865 acres).[53] Three branches of the military are represented in Wai'anae: Army, Navy, and Air Force. The Navy owns 9,227 acres (approximately 66 percent of the total land area in Lualualei Valley), 7,498 acres of which are used for its "Naval Magazine Lualualei Headquarters Branch," and 1,729 acres for its "NCTAMS EASTPAC, RTF Lualualei" facilities.[54] Navy communication operations are expected to continue at its NCTAMS EASTPAC, RTF Lualualei facility. The Navy has long-range plans to phase out the use of NAVMAG Lualualei.

The Army engages in live fire training on 4,130 acres in Mākua Valley, most of which is leased from the State of Hawai'i.[55] The Army also runs the Wai'anae Army Recreational Center, located at Pōka'ī Bay. The Army's lease in Mākua expires in 2029, although recent Stryker Brigade plans indicate a need for the Valley for the foreseeable future.



Naval Communications Facility in Lualualei.

The Air Force operates the Kaʻala Air Force Station, a seven-acre facility that provides 24-hour radar air surveillance information to the Hawaiʻi Air Defense Control Center, and the Kaʻena Point Satellite Tracking Station, a 153-acre site in Keawaʻula. The Air Force facilities on Mount Kaʻala and in Keawaʻula are also expected to remain.

2.8.4 RESIDENTIAL

The 2000 Census reported 12,356 housing units in Waiʻanae, an increase of 13.6 percent from 1990. In comparison, Oʻahu as a whole only increased its housing stock by 10 percent for the same time period. Waiʻanae also increased its share of the County's population from 4.47 percent in 1990 to 4.82 percent in 2000, despite General Plan policies to maintain the percentage at or near 4.0 percent.

Numerous public and private housing projects are planned for Waiʻanae, totaling approximately 4,170 housing units. While the implementation schedule is unknown for many of these projects, the large number of housing units planned suggests a significant level of growth in the district. Trends in State Land Use indicate that while Conservation lands remain relatively stable on Oʻahu, agricultural lands are increasingly being converted to residential use.

The Waiʻanae Sustainable Communities Plan articulates policies to protect agricultural lands from encroachment. The Rural Communities Boundary recognized by the SCP "*is established to define, protect, and contain communities in areas which the General Plan designates 'rural' and which exhibit the physical characteristics of rural*

Residential development is growing in Waiʻanae.

TABLE 2-9

PLANNED HOUSING PROJECTS IN WAIʻANAE[56]

Name of Project	Project at Full Buildout	
	Total units	Year of Completion
LARGE PRIVATE HOUSING PROJECTS*	**2,544**	
Māʻili Kai, Phase II	1,000	?
Mākaha Valley Estates	240	?
Mākaha Valley Retirement Community	600	?
Nānākuli Self-Help Homes (N. Acres)	144	2005
Nānākuli Property (Willy's Enterprises)	57	?
Village Pōkaʻī Bay	503	2006
PUBLIC AND SMALL HOUSING PROJECTS**	**1,626**	
Ohana Ola O Kahumana, Phase II	34	
Nanaikeola Adult Day Care Facility	55	
Village Pōkaʻī Bay (formerly under DHHL)	127	2005-2010
HAWAIIAN HOME LANDS	**1,537**	
Kaupuni Village (formerly Consuelo Alger)	21	2005-2010
Lualualei, Voice of America site	400	No plans within the next 10 years
Nānākuli	800	No plans within the next 10 years
Jim Jones site	100	No plans within the next 10 years
TOTAL UNITS	**4,170**	

*Large Housing Projects: Five or more acres and 25 or more units

**Small Housing Projects: 25 or more units, but on less than 5 acres for private projects

lifestyles. The purpose of this boundary is to provide adequate lands for facilities needed to support established communities, to protect such communities from more intense land uses and patterns of development associated with more urban areas and to protect areas outside the boundary for agriculture or other resource or open space values.” Additionally, the agricultural boundary protects “*important agricultural lands for their economic and open space values, and for their value in helping to give the region its identifiable character.*”[57] However, the need for housing may place significant pressure on decision-makers to extend the rural communities boundary *ma uka* to allow for more development in the future.

The Department of Hawaiian Home Lands (DHHL) has the mission of managing the Hawaiian Home Lands Trust and developing and delivering lands to native Hawaiians. It owns almost 4,000 acres of land in Waiʻanae, 1,356 of which are utilized by the U.S. Navy in Lualualei. DHHL intends to develop approximately 50 additional units in Lualualei-Waiʻanae, and has an agreement to exchange these lands with the Federal government for lands in Kalaeloa. If this agreement is not executed, DHHL could choose to develop its lands for housing in the future.

2.8.5 INDUSTRIAL AND COMMERCIAL USE

Industrial and commercial lands account for only about 0.6 percent of the zoned land in Waiʻanae. Commercial operations are generally in the form of small businesses that service the local resident population, and industrial activities include a smattering of unassociated activities, as opposed to large industrial parks. The Waiʻanae Sustainable Communities Plan (WSCP) encourages local commercial businesses and light industry, but opposes heavy industry and does not foresee a significant growth in commercial or industrial lands.

There are six inactive landfills in Waiʻanae with four of them located in Lualualei. In terms of their potential effect on ground water quality, one landfill in Waiʻanae is located within one mile of a municipal well, and a landfill in Lualualei is located upgradient from brackish irrigation wells. Two landfills are located *ma uka* of the BWS Pass/No Pass line and three are located *ma uka* of the DOH UIC line. The landfills were used primarily for municipal and construction wastes, and preliminary risk modeling assessments indicate that none of the landfills exceed the EPA Cancer Risk Hazard Index. No further calculation of risk or precautionary investigations were determined to be necessary at this time for any of the landfills in Waiʻanae.[58]

The City and County of Honolulu recently completed a process for selecting a new landfill site to replace the Waimānalo Gulch Sanitary Landfill, which is almost at capacity. Sites that were evaluated in Waiʻanae included Māʻili and Nānākuli B. Each of these potential landfill sites would have a 15- to 16-year capacity and if selected as a City landfill, would need to be designed to minimize impacts to ground and surface waters, as well as impacts on the rest of the community. As of December 1, 2004, the City Council had decided to expand the Waimānalo Gulch landfill.

2.9 STAKEHOLDER CONSULTATION

2.9.1 GOALS AND OBJECTIVES OF THE STAKEHOLDER CONSULTATION PROCESS

The Stakeholder Consultation process emphasizes a community-based approach through extensive discussion and consultations with residents, community leaders, community organizations, *ahupua‘a* councils, land owners, business owners, public agencies and elected officials.

Interested and active public and private stakeholders provided valuable insight during the course of the planning process regarding:

- Defining key issues, problems, and needs
- Formulating principles to guide the plan
- Developing actions and strategies in response to issues
- Evaluating proposed actions

Wai‘anae Christmas Craft Fair, December 2004.

The stakeholder consultation process to date has involved numerous one-on-one interviews, small group meetings, *Ahupuaʻa* Advisory Group (AAG) meetings, Working Group meetings, and an Inter-Agency meeting. Further, project updates were made to the Waiʻanae Coast Neighborhood Board. BWS and its Waiʻanae Watershed Management Plan consultants also regularly attended Mohala i ka Wai meetings.[1]

While government agency representatives were invited to participate in community Working Group meetings, separate interagency meetings were held for Federal, State, and City agencies that have an interest in watershed management in Waiʻanae.

Monthly "Coordination Meetings" were held with the Board of Water Supply (BWS), Department of Planning and Permitting (DPP), the staff of the Commission on Water Resource Management (CWRM), and the consultant.[2] These monthly meetings ensured open and direct communication with the principal government agencies whose policy objectives constitute the planning framework for the Watershed Management Plans.

Lastly, planning staff coordinated other activities in an effort to encourage broad community involvement in the development of the Watershed Management Plan. These activities included: development of water fact sheets; participation at the Waiʻanae Christmas Fair and Parade; publication of articles in the local area newspaper; and coordination of a "community walk" in Mākaha Valley. The BWS also hosted a Watershed Management Plan web page that included information on both the Waiʻanae and Koʻolau Loa Watershed Management Plan projects.

2.9.2 STAKEHOLDER IDENTIFICATION

Stakeholders represented a range of community members, organizations, and public agencies that are interested in, are affected by, or could affect activities related to the development of the Waiʻanae Watershed Management Plan. Three resources were used to identify potential stakeholders; 1) Waiʻanae Sustainable Communities Plan (WSCP) stakeholder database; 2) references from local community contacts; and 3) government agencies. A "Master Participant" database identified area residents, community-based organizations, Neighborhood Board members, area families knowledgeable in local issues, community leaders, large land owners, farmers, and businesses located on the Waiʻanae Coast.

[1] Mohala i ka Wai is a community organization dedicated to water issues on the Waiʻanae Coast.

[2] The Board of Water Supply initiated two watershed management plans concurrently in the communities of Waiʻanae and Koʻolau Loa. Monthly coordination meetings were held with both consultant planning companies to ensure consistent methodology and work product.

2.9.3 CONSULTATION PROCESS

2.9.3.1 One-On-One Dialogues

The preliminary consultation strategy involved initial one-on-one dialogues and telephone interviews with respected *kūpuna*, community leaders, and community organizations. The purpose of these dialogues was to ask for community permission, guidance, and patience during this planning process. Preliminary consultations with Waiʻanae-based community organizations and City and State agencies helped to define and evaluate the goals, objectives, and planning process for the project. More importantly perhaps, these dialogues provided a venue for community issues and needs to surface. Agency meetings and telephone interviews were conducted concurrently during this phase of the stakeholder consultation process.

Between the months of October and December 2004, a total of 20 "dialogues" were held with 32 individuals who represented community-based organizations, Hawaiian Homestead Associations, *Ahupuaʻa* Councils, the Waiʻanae Neighborhood Board, businesses and large land owners, farmers, long-time residents, and Hawaiian cultural practitioners. These individuals and organization representatives were invited to participate in their respective *Ahupuaʻa* Advisory Groups (AAG).

TABLE 2-10

STAKEHOLDERS CONSULTED

Ai Pohaku
City Council
Consuelo Alger Foundation
Hoaʻaina o Mākaha
Koa Mana
Lualualei *Ahupuaʻa* Council
Mākaha Resort and Golf Club
Mālama Mākua
Ma'o Farms
Mohala i ka Wai
Neighborhood Board
Office of Hawaiian Affairs Trustee (Former)
Queen Liliuʻokalani Trust
Schuler Homes
State House of Representatives
State Senate
The Resort Group
Waiʻanae *Ahupuaʻa* Council
Waiʻanae Homestead Association Board
Waiʻanae Kai Hawaiian Homestead Association Board
West County Farm Bureau
Various Residents: Farmers, Kumu Hula, Kupuna, Educators, Former District Legislator, LCC lecturer, Physician, Ranchers Soil Specialist

Waiʻanae Ahupuaʻa Group Meeting, February 2005.

2.9.3.2 *Ahupuaʻa* Advisory Groups

Four *Ahupuaʻa* Advisory Group meetings were held in February 2005 in Nānākuli, Lualualei/Māʻili, Waiʻanae, and Mākaha. These AAG meetings provided another opportunity to explain the project goals and objectives, to define community issues and needs, and to begin discussions on ways to address them. The AAGs were originally intended to function as the primary working groups for the development of the WWMP. AAG meetings were open to the public and utilized public participation guidelines during the meetings. Based on feedback from these meetings, it was recommended that one "Working Group" serve as the vehicle for the community to participate in the development of the WWMP.

2.9.3.3 Youth Focus Group

A focus group was organized to get the thoughts and ideas of the Waiʻanae youth. The meeting was held in April of 2005 at Waiʻanae Intermediate School garden, with the group including several students and their parents. After a brief introduction to the plan and process, the discussion focused mainly on the importance of water to the community and on ideas on how to improve water resources and use water wisely.

Youth Focus Group, April 2005.

2.9.3.4 Working Group Meetings

Three WWMP Working Group meetings were held in April, July, and October of 2005. The purpose the Working Group meetings was to elicit input from active and interested community members on issues, strategies, water use, and development approaches for the Wai‘anae Coast, including review of the Draft WWMP.

Thirty-eight community and agency staff attended the April 2005 meeting. The purpose of the meeting was to create linkages between identified issues and action strategies. Spirited discussion in small and large group sessions resulted in a preliminary list of community projects and programs that addressed Wai‘anae watershed issues and needs. The list provided guidance to the Planning Team with regard to further development of projects and programs to be included in the WWMP.

The July 2005 meeting was attended by 24 community and agency staff. The purpose of this meeting was to introduce the Water Use and Development Plan element of the WWMP. Comments from participants resulted in a list of objectives that would shape development of the WWMP elements.

The October 2005 meeting was attended by 21 community members and BWS staff. The purpose of this meeting was to review and prioritize watershed projects and programs, and discuss water use options with regard to demand projections, water use, development options, and strategy themes.

Working Group participants help give the planning team direction on projects.

2.9.3.5 Inter-Agency Meetings and Additional Consultations

Two inter-agency meetings, co-hosted by the Waiʻanae and Koʻolau Loa WMPs, were held: one in March 2005 and one in November 2006. A total of 23 Federal, State, and City government agencies with responsibilities to water, and particularly to Waiʻanae, were consulted as to their existing and future water use plans, policies, and water-based strategies. The first meeting provided an opportunity for the Planning Team to investigate agency-related issues and needs. Further, agencies were solicited as to their interest in taking the lead on specific projects and programs outlined in the WWMP. The second meeting sought feedback on the findings to date and how the agencies might use it in their planning efforts.

Additional consultations with agencies were conducted on an as-needed basis in order to request more detailed information. These consultations included meetings and/or correspondence with the Coastal Zone Management Program, U.S. Army, U.S. Navy, City and County of Honolulu Department of Environmental Services, the State Department of Land and Natural Resources, and the University of Hawaiʻi.

Inter-Agency Meeting, March 2005.

TABLE 2-11

AGENCY AND PRIVATE SECTOR PARTICIPANTS

Department of Design and Construction, City and County of Honolulu
Department of Environmental Services, City and County of Honolulu
Department of Planning and Permitting, City and County of Honolulu
Honolulu Board of Water Supply
State Department of Agriculture
State Department of Health
Division of Aquatic Resources, Department of Land and Natural Resources
Division of Forestry and Wildlife, Department of Land and Natural Resources
Engineering Division, Department of Land and Natural Resources
State Commission on Water Resource Management
State Office of Hawaiian Affairs
Hawaii Coastal Zone Management
College of Tropical Agriculture and Human Resources, University of Hawaiʻi
U.S. Geological Survey
U.S. Army, Department of Public Works
U.S. Navy, Environmental Resources
Koʻolau Mountain Watershed Partnership
Mapping Change
The Nature Conservancy
Hawaiian Electric Company
R.M. Towill Corporation

2.9.4 PROFILE OF SOME WAI`ANAE STAKEHOLDERS – COMMUNITY ORGANIZATIONS, LAND OWNERS AND PUBLIC AGENCIES AND OFFICIALS

2.9.4.1 Community-Based Organizations

Ahupuaʻa Councils

The *Ahupuaʻa* Councils were first organized in 1995-1996, and are locally organized community councils based on geographic location. There are four *Ahupuaʻa* Councils in the Waiʻanae District; Nānākuli, Waiʻanae, Lualualei, and Mākaha.

Hawaiian Homestead Associations

In 1987, the State Council of Hawaiian Homestead Associations (SCHHA) was established to provide a mechanism through which homesteaders could effectively voice their *manaʻo* on matters and issues of concern to all homesteaders. Since 1987, the SCHHA has grown and transitioned itself into a viable state-wide community-based organization consisting of 23 organizations representing over 30,000 Native Hawaiian homesteaders. There are four Homestead Associations in the Waiʻanae District:

- Nānākuli Homestead Association
- Waiʻanae Valley Hawaiian Homestead Community Association
- Princess Kahanu Estates Hawaiian Homes Association
- Waiʻanae Kai Hawaiian Homestead Association

MAʻO Organic Farm

In 2001 the non-profit Waiʻanae Community Redevelopment Corporation established Mala ʻAi ʻŌpio (MAʻO) Community Food Security Initiative. MAʻO has six elements in its youth-focused program: leadership training, a five-acre certified organic farm, a farmers market, Aloha ʻAina Café and Natural Foods, ʻAi Pohaku in-school curriculum, and an Agriculture Center (Leeward Community College partnership). MAʻO has a license agreement to farm five acres of a 10-acre site of which MAʻO is actively farming 2.5 acres.

Mohala i ka Wai

Mohala i ka Wai is a grass-roots organization whose members reflect the diversity of the Waiʻanae community. It was founded in 1999 in response to growing concerns regarding watersheds and water use issues in Waiʻanae. The group has initiated numerous community-based efforts to protect the watershed and participates in BWS partnership programs.

West County Farm Bureau

The Hawaii Farm Bureau Federation (HFBF) is a non-profit organization of farming families united for the purpose of analyzing problems and formulating actions to ensure the future of agriculture, thereby promoting the well-being of farming and the State's economy.

2.9.4.2 Major Private Land Owners

HRT, Ltd.

The HRT, Ltd. is one of several companies controlled by the Weinberg Foundation. HRT, Ltd. owns several land parcels in Mākaha Valley totaling 249 acres. The various parcels are zoned agriculture, residential, and apartment.

Mākaha Resort and Golf Club

Owned by Fairmont Resort Properties, Ltd., the Mākaha Resort Golf Club is a 300-acre property with 173 rooms, a golf course, pro shop, swimming pool, meeting rooms, banquet facility, restaurant, and lounge. Extensive renovations are currently underway. Future planned uses include timeshare units and an updated hotel concept.

The Resort Group

The Resort Group purchased the Mākaha Valley Country Club in 2003 from Nitto Hawaiʻi. The property consists of a Country Club and an 18-hole golf course (also known as the East Course), that sit on approximately 200 acres of land. While there are no immediate plans to develop, The Resort Group acknowledges that the property is developable and future use may include residential development.

2.9.4.3 Elected Officials

Elected officials were consulted during the one-on-one dialogue step of the stakeholder process. The purpose of these meetings was to introduce the project, inform officials of community comments received during the preliminary dialogues, and lastly, to receive their input on watershed management issues, needs and strategies. BWS representatives attended all meetings with elected officials:

- State Senator Colleen Hanabusa
- State Representative Maile Shimbukuro
- State Representative Mike Kahikina
- City Council Member Elect Todd Apo

2.9.4.4 Federal Agencies

U.S. Army

The U.S. Army uses 4,130 acres in Mākua Valley for live fire training. The Army's Mākua Military Reservation is located within the Conservation District and consists of a combination of fee simple (170 acres), leased ceded lands (3,237 acres), and other leased lands from the State of Hawaiʻi (782). Prior to live fire training, the area was used for various types of agriculture, cattle ranching and rural settlement.

There are complex issues surrounding the use of the Valley for Army purposes. Environmental issues include threats to endangered plants, birds, and tree snails. Community members, especially Native Hawaiians, feel the area is important for traditional religious, hunting, gathering, and fishing use. The Army views the area as a "mission essential" training facility.

The U.S. Army Hawaiʻi, Directorate of Public Works (DPW) oversees resource management on Army lands. The DPW is engaging in resource protection in Waiʻanae through their Mākaha Watershed Project, which includes weed and predator control, native species restoration, threatened and endangered species protection, and a proposed 100-acre pig exclosure. Additionally, the Mākua Military Reservation covers the valleys of Mākua and Kahanahāiki, and includes eight management units and two ungulate control areas, where the Army provides endangered species, wildfire, weed, and ungulate management.

U.S. Navy

The Naval Magazine (NAVMAG) Lualualei occupies approximately 7,498 acres of land in the Lualualei *ahupuaʻa*. The mission of NAVMAG Lualualei is to receive, renovate, maintain, store, and issue ammunition, explosives, expendable ordnance items and weapons, and technical ordnance material for the Navy, Air Force, Army, and other activities and units as designated by the Chief of Naval Operations (CNO). The Navy also operates their "NCTAMS EASTPAC, RTF Lualualei" facility on another 1,720 acres in Lualualei, which is used for high and low frequency radio signal transmissions for the navigation of Navy vessels throughout the Pacific Ocean.

U.S. Air Force

Kaʻena Point Satellite Tracking Station is part of a remote-sensing network controlled by the Air Force Satellite Control Network, based in Sunnyvale, California. The only structures in the area belong to the Air Force Station, which has 16 facilities at Kaʻena Point on 153 acres leased from the State. State-owned lands in the area include the Mokulēʻia and Kuaokalā Forest Reserves and a game preserve managed by the State Department of Land and Natural Resources. The area surrounding the Satellite Tracking Station is considered a prime area for bird and pig hunting. While wildfires are a constant concern in the area, the Tracking Station has fire breaks around the buildings and there are two water tanks at the site, each capable of holding 25,000 gallons of water.

Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture

The NRCS provides technical assistance to land owners in an effort to conserve soil, water, and other natural resources. The NRCS and the USACE completed the "Lualualei Flood Study" in September 2001 in response to severe flooding that occurred in 1996. The study found that while existing flood control projects were adequate to convey the flood waters, the flood controls did not provide an effective means of conveying runoff to the improved sections of Māʻiliʻili, Māʻili, and Ulehawa Streams. The estimated construction costs for recommended flood mitigation improvements for the Māʻiliʻili, Māʻili, and Ulehawa basins were $3.5 million, $18.9 million, and $13.0 million respectively. The NRCS, USACE, and Navy are collectively involved in seeking funding for the design of the recommended flood projects.

U.S. Army Corps of Engineers (USACE)

The USACE Civil Works program includes authorities and funding for flood control, navigation, infrastructure, and environmental stewardship. They assist states, local governments, and other non-Federal entities with plans for the development, utilization, and conservation of water and land related resources, and assisted with the September 2001 "Lualualei Flood Study."

United States Geological Survey (USGS), U.S. Department of Interior

The USGS monitors Hawai'i streams as indicators and predictors of climatic change, and assists with flood control and water resource and water quality management. The Wai'anae District has seven USGS stream gages located in Nānākuli, Wai'anae, Mākaha, and Mākua.

2.9.4.5 State Agencies

Coastal Zone Management Program, Office of Planning, Department of Business, Economic Development and Tourism

The Hawai'i Coastal Zone Management (CZM) Program was enacted in 1977, as Chapter 205A, HRS, in response to the Federal Coastal Zone Management Act of 1972. The program encompasses 10 broad programmatic areas and has a policy role in the Special Management Area (SMA), Shoreline Setback Area, and Marine and Coastal Affairs. A Federal Consistency provision requires that Federal activities, permits, and financial assistance be consistent with the Hawai'i CZM program.

The Hawai'i CZM program initiated the "Wai'anae Ecological Characterization Project" (WEC), which is a multidisciplinary information resource database that provides physical, biological, historical, and cultural data; information; and Geographic Information Systems-based tools. This information will be used in developing their Cumulative and Secondary Impacts Program and Wai'anae Moku Management Framework.

Commission on Water Resource Management (CWRM), Department of Land and Natural Resources

The Commission on Water Resource Management (CWRM) has jurisdiction over the State's surface and ground water resources. CWRM is the entity responsible for the administration of the State Water Code, which was enacted in 1987 by the Hawai'i State Legislature. The protection and management of these water resources is carried out through resource assessments, planning, and regulation. Generally, the Commission is responsible for addressing water quantity issues, while water quality issues are under the purview of the State Department of Health. The Wai'anae Watershed Management Plan must conform to the State Water Code and CWRM policies.

Division of Forestry and Wildlife (DOFAW), Department of Land and Natural Resources

DOFAW is responsible for the management of State-owned forests, natural area reserves, public hunting areas, and plant and wildlife sanctuaries. DOFAW program areas cover watershed and native resources protection, including unique ecosystems and endangered plant and animal species; outdoor recreation; and commercial forestry. This Division is also the entity charged with issuing hunting permits and managing hunting areas.

In the Wai'anae region, DOFAW manages two natural area reserves, four forest reserves, one game management area, and three hunting areas. Management activities include feral pig, predator, and weed control; monitoring; native plant restoration; threatened and endangered species protection; public involvement; and education. The DOFAW also participates in the Wai'anae Kai Watershed Project along with the Board of Water Supply, 'Īlio'ulaokalani and Mohala i ka Wai. The Partnership is currently developing a Fire Management Plan for the area.

Department of Health (DOH)

The State of Hawai'i Department of Health, Office of Environmental Management has under its direction the Clean Water Branch (CWB) and Safe Drinking Water Branch (SDWB). The CWB protects the public health of those who utilize Hawaii's coastal and inland water resources. The CWB also protects and restores inland and coastal waters for marine life and wildlife. This is accomplished through state-wide coastal water surveillance and watershed-based environmental management through a combination of permit issuance, monitoring programs, enforcement, sponsorship of polluted runoff control projects, and public education.

The mission of the SDWB of the DOH is to safeguard public health by protecting Hawaii's drinking water sources (surface and ground water) from contamination and to ensure that owners and operators of public water systems provide safe drinking water to the community. This mission is accomplished through the administration of the Safe Drinking Water Program, Underground Injection Control Program, Groundwater Protection Program, the Hawaii Source Water Protection Program (HISWAP), and the Drinking Water State Revolving Fund. DOH is also the local implementing agency for several EPA initiatives.

2.9.4.6 City Agencies

Department of Environmental Services (ENV), City and County of Honolulu

The ENV administers the Clean Water Program, which ensures that the City and County of Honolulu conforms to a set of Federal rules called the National Pollutant Discharge Elimination System (NPDES). These rules constitute a part of the Federal Clean Water Act, and are designed to protect ground and surface water.

The Wai'anae Waste Water Treatment Plant (WWTP) has a capacity of 5.2 million gallons per day and is operated by the Wastewater Division of ENV to serve the Wai'anae Coast.

Department of Planning and Permitting (DPP)

DPP is responsible for the administration and enforcement of ordinances and regulations governing the development and use of land, various codes pertaining to the construction of buildings, and City standards and regulations pertaining to infrastructure requirements. It is also responsible for the framework that coordinates planned population and land development with supportive infrastructure improvements.

The Interim Planning Division helps establish, promote, and implement long-range planning and community planning programs for Honolulu. It is responsible for maintaining and updating the O'ahu General Plan, regional Development/Sustainable Communities Plans, Development Plan Land Use Annual and Biennial Reports, and Special Area and Neighborhood Master Plans.

2.9.5 SUMMARY OF COMMUNITY VALUES RELATING TO WATERSHED RESOURCES

"Values are standards, behaviors or practices widely understood, aspired to, and encouraged as desirable and mutually beneficial."

The expression of community-based values serves the greatest good when there are difficult decisions and choices to make. The "Guiding Principles" provided at the end of this section were developed out of the values community members articulated during meetings, workshops and dialogues.

Emerging themes centered around the community's deep seated understanding of the social, economic and ecological conditions that exist on the Wai'anae Coast. Community values advocated for a cleaner and healthier environment; an improved quality of life for residents, especially regarding an equitable distribution of environmental burdens and benefits; and controlled growth and economic development. The sections that follow are summaries of the Wai'anae community values that were expressed during this process.

2.9.5.1 Watershed Management

Watershed management involves everyone. Education is a key to better understanding watershed functions and management. Intergenerational learning among families and community members fosters a sense of responsibility. Valid and reliable scientific data fosters better decision-making with regard to watershed management.

2.9.5.2 Water Supply Quantity: Natural Conveyance and Man-Made Facilities

There is a general sentiment that watersheds should be able to function naturally without harm being done by man-made facilities.

2.9.5.3 Water Quality

Understanding the range of natural resources from *ma uka* to *ma kai* requires a spiritual foundation. This holistic approach to watershed management includes being sensitive to species and habitats that run *ma uka* to *ma kai* (including near shore environments), restoring and protecting natural waterways and *muliwai*, and protecting surface and potable ground water sources from polluting activities above ground.

2.9.5.4 Rural Lifestyle and Agriculture Preservation

Water use should support a community rural lifestyle that involves balanced community development, i.e., residential, business, and agriculture. In order for farmers and agricultural practices to remain a part of the community fabric, affordable water delivery systems are needed.

2.9.5.5 "Water Justice"

The idea of "water justice" addresses the issue of water uses that benefit many rather than a few, and respecting water rights.

2.9.5.6 "ʻOhana Self-sufficiency, Dignity and Health"

Community members feel that healthy families constitute a healthy community, and healthy communities are better able to care for their natural resources. Similarly, community members recognize that "the land heals;" therefore, shared watershed management responsibilities support and reinforce community health and well-being.

2.9.5.7 Exercise of Traditional and Customary Rights

Respect traditional and customary rights. This means providing the necessary natural resources for the continued exercise of traditional and customary rights. Access and conservation of natural resources is intimately related to the exercise of traditional and customary rights. However, community members explain that access is intimately related to *kuleana* to care for *ma uka* and *ma kai* resources.

2.9.6 GUIDING PRINCIPLES VOICED BY COMMUNITY MEMBERS

- Access to watersheds requires a sense of *kuleana*.
- Watershed management involves everyone!
- Take what you need and don't waste!
- Self-sufficiency, dignity, and good health are essential to our community.
- Be sensitive to species and habitats from *ma uka* to *ma kai*.
- Subscribe to the concept of "water justice" - the just use of water and respect of water rights.
- Recycle, reuse, and conserve water.
- Apply new water development technology appropriately.
- Maintain the rural and agricultural landscape.
- Community growth should be controlled and balanced.
- Value educational and intergenerational learning about watersheds.

2.9.7 SUMMARY OF COMMUNITY ISSUES, PROBLEMS AND NEEDS

Stakeholder issues, problems, and needs are summarized below according to Community and Agency comments regarding: Watersheds, Community, and Management. Statements taken verbatim are indicated by quotes.

2.9.7.1 Community Issues

Environmental Justice

- The goal in the 1970s was to protect the potable water supply, so BWS/DOH developed a line around the island above which no cesspools or [injection] wells can be developed.
- A community leader asserts that the No Pass Line along the Wai'anae Coast was drawn too far into the valleys, and that this has led to the high number of landfills in the area. Mākua and 'Ōhikilolo are still "suitable" for landfills. This is an environmental justice issue.

Cross contamination between aquifers.

- Kea'au Aquifer: "Some people suspect contamination." Is Kea'au aquifer connected to Mākaha aquifer? Is there a possibility of cross contamination by unexploded ordnance? This is important if Mākaha is one of the main sources of water for the District.

Flooding and Concrete Channels:

- Restore natural function to concrete floodways without compromising flood protection.
- Many wetlands and estuaries were filled in for development so now there is no infiltration to the ground water supply, nowhere for floodwaters to flow, and no cleansing function on land prior to water flowing into near-shore waters.
- "[I] Remember Wai'anae just being more vegetated. There was more water. Ka'ala waterfall flowed all the time. The bridges beyond Mākaha during big rains always washed out. This just doesn't happen any more. Not too sure if what is being observed is related to cyclical weather patterns or is a man-made effect."

Forest Line:

- "It seems that the tree line is moving higher and higher along *ma uka* areas."

Illegal Dumping in Streambeds:

- "Outside corporations, local businesses, and even the local residents dump rubbish in the streams."
- When water starts to run in the streams, are we polluting our oceans because everybody dumps rubbish in the streams?

Monitor Near-Shore ecological functions:

- "Ocean water now too salty, reduced freshwater intrusion along coast line or through reef systems affects species and habitats, [e.g.] *limu*, bait fish."
- Recognize that "underflow still occurs but maybe there was more before compared to now and underflow coupled with leaching of contaminants is dangerous."

- There is a lack of near-shore water quality monitoring.
- The "redistribution of water for sugar, the filling of estuaries and the *limu* fields suffer too without freshwater reaching near-shore areas, not like before. Now the only water that makes it out to ocean comes from sewage outfall."
- Golf courses using potable water, not a wise use of a scarce resource.
- Freshwater supply on the coast has been understudied. You can't refute water interpretations. Use a "precautionary principle" when data is inconclusive.
- "Where does Pūhāwai water go? Does the Navy use this water?"

<u>Water Diversions:</u>

- Diversions affect stream ecological functions that are vital to overall watershed functions.
- "No more water in streams. Used to be able to catch *ʻōpae* and crayfish in Waiʻanae Stream."

<u>Water Quality:</u>

- Landfills pollute scarce ground water sources (i.e., non-potable water sources).
- There are a lot of dump sites along the coast that are not properly closed down, there are no records of these sites, and this could be a source of contamination of ground water. There is no monitoring of landfills, nor does there seem to be any regulation as to what goes into them.

<u>Water Quantity:</u>

- "Nānākuli no more water, but what can be done with brackish water? Can we use brackish water to grow anything? Taro? Watercress?"

<u>Wild Fires:</u>

- 20-30 years of fires destroys upland regions, alien species invade burn sites and are less healthy for the forest regions, especially in terms of water infiltration.
- The complex native forest reduced flooding and encouraged water recharge.

<u>Conservation, Recycling and Alternative Water Development:</u>

- Wastewater recycling is a good idea contingent upon the nutrient content of recycled water -- don't want algae blooms.
- "Conservation needs to be a grass-roots effort to be successful."
- Use plants that don't need a lot of water; golf courses can xeriscape.
- Mākaha West golf course "interested to use recycled water because of higher nutrient content, save on fertilizer."
- Re-use gray water in homes, use all water except "toilet" water.

Farming and Agriculture Activity:

- Truck crops and nurseries seem to be stable in the region, unlike dairies and chicken farms, which seem to be declining.
- Farmers are interested in using recycled water if it's cheap enough.
- Without farmers on the coast, you end up with a bedroom community - this doesn't provide jobs.
- The City charges a lot for water meters in order to discourage higher water usage, but farmers need it.
- "Fear of regulation" - regulation may mean going out of business - increase regulations and farmers can't afford to farm.
- Most farmers want to be more environmentally friendly, e.g. use less chemicals, but they might feel that there is a risk associated with change. For example, there is heavy competition from large, highly mechanized farms on the North Shore and cheaper California farm produce imported to islands.

Growth and Development:

- Water is the limiting factor to growth on the coast – more water is imported than is locally produced.
- Alternative water development can increase population and development - is this really what we want?
- Without growth we are stagnant - "Wai'anae is the biggest cul-de-sac on O'ahu."
- Residential water costs discriminate against the Wai'anae area - Wai'anae is dry and hot, so we have higher irrigation needs.

Traditional and Customary Uses and Availability of Resources:

- "There's not enough water to grow taro - but Wai'anae had taro, they got their water from the *'auwai*."
- Access issues are very important, but must be balanced by *kuleana*.
- Water belongs to Hawaiian people, especially lineal descendents.

Community-Based Learning

- There is a lack of education about watersheds and water cycles among all ages in the community.
- Encourage young people/scientists to look at real life solutions to water scarcity and problem solving.
- Develop college curriculum for water (*wai*). Focus on hydrology, culture and resource management, but the problem is finding experts and expertise to develop curriculum.

Military

- "Lualualei, the Mikilua area, sugar cane was the highest yield crop on very fertile land. Now used by the military! Proper use of land?" "What about community and their goals for uses or concerns for water use?"
- "If the Navy is downsizing, why do they need so much water?"
- Where does Pūhāwai water go? Does the Navy use this water?

Management

- Sustaining community-based initiatives - organizing, funding and capacity.
- Government must find the resolve to fund adequate budgets and do watershed activities and monitoring.
- Poor maintenance of BWS infrastructure.

2.9.7.2 SUMMARY OF AGENCY ISSUES

The issues outlined below were captured during the Inter-Agency meeting held in March 2005. A total of 18 government agencies, private entities, and utility companies participated in the meeting.

Watersheds

- Effective management, use, and monitoring of ground and surface water.
- Working to develop surface water hydrologic units and coding system.
- Surface water issues present challenges, e.g., interim in-stream flow standards.
- Land without water is not productive; you need forests to have water.
- Plans should focus on holistically protecting the forest resources and this will cost money.
- Wildfires can increase erosion; with a plan, erosion can be kept to less than one ton of soil loss per year.
- Need to maintain water quality.
- Water data collection budgets reduced due to lack of funding; state-wide problem with lack of data to observe changes over time.

Water Use and Conservation

- State agency water conservation – CWRM prepared a prototype water conservation plan for DLNR in February of 2005 and intends to expand the program to other State agencies.
- Non-potable water usage should be explored more, e.g., storm water capture.
- Sustainable Communities Plans are being scheduled for their 5-Year review. Mākaha has zoning in place for development, but there is no master plan for infrastructure.
- There is an agricultural park in Wai'anae that gets water from BWS, should consider using reclaimed water.
- UH CTAHR can do studies and research regarding water conservation.

- Need to focus on demand side of use, not so much on supply.
- Main issue for utilities is balancing supply and demand.
- Consider idea of "cross over programs," e.g., low-flow showerheads use less electricity and water.

Community

- The Drought Plan has been created and needs updating. There is a need for a mitigation plan so that preparations can be made to avoid emergencies.
- Partnerships may be formed as follow through to implementation.
- DOE may be another partner to develop public education and outreach in agriculture projects, including specific resources and aquaculture.
- Major users of water need to be involved, such as the military.

Management

- Planning efforts need to be coordinated and implemented, avoid duplication of efforts.
- Plans have potential to organize and secure funding for identified priorities among multiple agencies.
- Need to identify permanent funding sources for forestry management.
- Protection will involve agency partnerships.
- Public may not think that management is costly. Funding is essential – how to generate funds? A water tax was previously proposed. This would show the public the need to protect the source.

2.9.8 SUMMARY OF "ACTIONS AND STRATEGIES" SUGGESTED BY THE WAI‘ANAE COMMUNITY

2.9.8.1 Preliminary Actions and Strategies

Below is a summary of the various stakeholder actions and strategies that were suggested during the one-on-one consultation.

- In the olden days, everybody who used the water helped to clean the waterways - have programs and activities to keep water ways and streams clean.
- Establish dams, like the Ku Tree Dam at Schofield and catchments up *ma uka*, so that water that runs off can be captured and percolate back into the water table.
- Grazing animals keep dry shrubs under control and reduce forest fires.
- Networking partners - University of Hawai‘i research and extension services -- UH is a land grant college.
- Develop agricultural anchors in the community to support farmers testing sustainable agricultural techniques.
- Devise grass-roots conservation programs.

- Use plants that don't need a lot of water for landscaping - xeriscaping education - homes, hotels, golf courses, parks.
- Develop water curriculum for schools and colleges that focuses on hydrology, culture, and resource management.
- Monitor reef systems for fresh water intrusion.
- Redesign flood channels to allow migration of species and establish habitats without compromising flood capacity.
- Take samples of landfills to test composition.
- Apply technology to seal landfill sites and protect the water supply.
- Examine OZONE technology for water reclamation.
- Protect existing estuaries
  - Radio Area close to Māʻili Stream
  - Mākaha Beach park wetland restoration
  - Nānākuli Stream near St. Rita's Church – *ma kai* area with *akulikuli* grass
  - Mākua *muliwai*.
- Retool single family homes and multi-residential complexes to use "gray water" for landscaping and examine tax breaks.
- Examine the role of "education tourism" as a tool to teach island water cycles, cultural values and practices.

2.9.8.2 Community Prioritizing of Watershed Management Strategies

In the October 2005 Working Group Meeting, watershed projects and programs were evaluated against a list of six project objectives, which were condensed from a longer list of objectives discussed in earlier meetings. The following matrix illustrates this evaluation of projects and objectives. Note that in Chapter 4, the six objectives used in this exercise were later condensed to five by combining objectives four and six.

Meeting participants were asked to identify the projects and programs that were most important to them. This relative ranking of projects is identified in Table 2-12 and was factored into the development of the plan and the phasing of plan elements.

TABLE 2-12

WAI`ANAE WATERSHED MANAGEMENT PLAN - OBJECTIVES/PROJECTS MATRIX

DRAFT OF OCTOBER 31, 2005 BY: TOWNSCAPE, INC.

● : The project meets the particular objective

(dark shading) : Projects that meet 5 or 6 of the 6 Objectives

(light shading) : Projects that meet 3 or 4 of the 6 Objectives

(white) : Projects that meet 1 or 2 of the 6 Objectives

GROUNDWATER AND SURFACE WATER PROJECTS

	PLAN OBJECTIVES	(1) Waianae Hydrogeology Study	(2) Waianae Source Water Protection Plan	(11) Spring and Stream Flow Restoration Project	(12) Stream Conservation Corridor Project	(13) Wetlands Restoration & Protection Program	(14) Concrete Flood Channel Redesign Project	(15) Stream Biological Assessments	(16) Water Quality Testing and Monitoring	(17) Stream Dumping Prevention and Clean Up	(18) Surface Water Inventory and Registration Project	(19) Water Quality Improvement Program
1	PLAN A SUSTAINABLE FUTURE FOR THE WAI`ANAE WATERSHED	●	●	●	●	●	●	●	●	●	●	●
2	PROTECT/RESTORE WATER QUANTITY AND QUALITY	●	●	●	●	●	●	●	●	●	●	●
3	RESPECT TRADITIONAL CULTURAL PRACTICES			●								
4	COLLABORATE WITH THE WAI`ANAE COMMUNITY	●		●	●	●				●		●
5	PROVIDE FOR POTABLE AND NON-POTABLE WATER NEEDS		●	●								
6	PROVIDE OPPORTUNITIES FOR PARTNERSHIPS	●	●	●	●	●	●	●	●	●	●	●

LAND MANAGEMENT PROJECTS

	PLAN OBJECTIVES	(20) Forest Restoration Program	(21) Wildfire Management Plan & Protocol for Action	(22) Loi Kalo Expansion Program	(23) Research Watershed: Makaha	(24) Agricultural Support Program	(25) Flood Mitigation Plan	(26) Makaha Special Area Plan	(27) Waianae Watershed Partnership
1	PLAN A SUSTAINABLE FUTURE FOR THE WAI`ANAE WATERSHED	●	●	●	●	●	●	●	●
2	PROTECT/RESTORE WATER QUANTITY AND QUALITY	●	●	●	●				●
3	RESPECT TRADITIONAL CULTURAL PRACTICES	●		●		●		●	
4	COLLABORATE WITH THE WAI`ANAE COMMUNITY	●	●	●	●	●	●	●	●
5	PROVIDE FOR POTABLE AND NON-POTABLE WATER NEEDS			●					
6	PROVIDE OPPORTUNITIES FOR PARTNERSHIPS	●	●	●	●	●	●	●	●

CULTURAL/EDUCATIONAL SUPPORT

	PLAN OBJECTIVES	(28) Cultural Learning Centers	(29) Community Watershed Education Program	(30) Waianae Rural Landscape Study	(31) Watershed Resource Management Training	(32) Water Conservation Education and Awareness
1	PLAN A SUSTAINABLE FUTURE FOR THE WAI`ANAE WATERSHED	●	●	●	●	●
2	PROTECT/RESTORE WATER QUANTITY AND QUALITY	●	●		●	●
3	RESPECT TRADITIONAL CULTURAL PRACTICES	●	●	●	●	●
4	COLLABORATE WITH THE WAI`ANAE COMMUNITY	●	●	●	●	●
5	PROVIDE FOR POTABLE AND NON-POTABLE WATER NEEDS					
6	PROVIDE OPPORTUNITIES FOR PARTNERSHIPS	●	●	●	●	●

WATER USE & DEVELOPMENT OPTIONS

	PLAN OBJECTIVES	Option #1. Additional potable water imports from Pearl Harbor aquifer	Option #2. Develop additional potable groundwater sources	Option #3. Develop additional brackish groundwater sources	Option #4. Develop surface water sources	Option #5. Storm water capture	Option #6. Recycled Water: Waianae WWTP	Option #7. Recycled Water: MBR's for major users	Option #8. Desal water from BWS Kalaeloa Desal Plant	Option #9. Desal water from new Waianae Desal Facility
1	PLAN A SUSTAINABLE FUTURE FOR THE WAI`ANAE WATERSHED						●	●	●	●
2	PROTECT/RESTORE WATER QUANTITY AND QUALITY						●	●	●	●
3	RESPECT TRADITIONAL CULTURAL PRACTICES						●	●		
4	COLLABORATE WITH THE WAI`ANAE COMMUNITY						●	●		
5	PROVIDE FOR POTABLE AND NON-POTABLE WATER NEEDS	●	●	●	●	●	●	●	●	●
6	PROVIDE OPPORTUNITIES FOR PARTNERSHIPS						●	●		

TABLE 2-13

RESULTS OF COMMUNITY PRIORITIZING OF PROJECTS AND PROGRAMS

Priority	Project	Tally
1	Spring and Stream Flow Restoration	12
2	Forest Restoration Program	11
3	Cultural Learning Centers	11
4	Wetlands Restoration and Protection Program	8
5	*Loʻi Kalo* Expansion Program	6
6	Water Conservation Education and Awareness	6
7	Community Watershed Education Program	5
8	Concrete Flood Channel Redesign Project	3
9	Waiʻanae Source Water Protection Plan	3
10	Mākaha Special Area Plan	3
11	Watershed Resource Management Training	3
12	Recycled Wastewater Project	3
13	Wildfire Management Plan and Protocol for Action	2
14	Agricultural Support Program	2
15	Waiʻanae Watershed Partnership	2
16	Greywater Project	2
17	Waiʻanae Hydrogeology Study	1
18	Water Quality Testing and Monitoring	1
19	Stream Dumping Prevention and Cleanup	1
20	Water Quality Improvement Program	1
21	Research Watershed: Mākaha	1
22	Flood Mitigation Plan	1
23	Waiʻanae Rural Landscape Study	1

*Note: some of the project names were changed later in the process to reflect additional data on scope and purpose. Similarly, some projects were added, combined, or broken into two separate projects in order to define actions more accurately and accommodate additional information.

2.10 IMPLICATIONS FOR WATERSHED PLANNING

The following discusses the implications for watershed and water resource planning that have been identified through the watershed analysis and agency and stakeholder consultations. Recognition of scientific data, agency issues, and community concerns is critical in understanding fundamental needs and opportunities for Wai‘anae.

2.10.1 PHYSICAL SETTING

- **Water conservation is especially critical in Wai‘anae** due to the relatively dry conditions that predominate.

2.10.2 WATER RESOURCES

2.10.2.1 REGIONAL HYDROLOGY

- **Protection of ground water infiltration areas in the *ma uka* valleys is necessary to maintain ground water supplies**. Precipitation at the upper elevations over non-alluvial areas contributes to the recharge of ground water aquifers that provide potable water for human consumption. Rainfall over alluvial areas recharges the alluvial aquifer, which contributes to base stream flow.
- **The interaction between ground and surface water needs to be verified**. The impacts of ground water pumping on surface water needs to be monitored to ensure minimal impacts on stream flow.

2.10.2.2 GROUND WATER RESOURCES

Ground water issues dealt with two main aspects: quantity and quality. While a main concern was for ground water availability for potable consumption, quantity and quality concerns also encompassed impacts to natural ecosystems.

- **Waianae's shallow, brackish aquifers could be a source for non-potable water**. Compacted, older alluvium prevents surface water from percolating through to the deeper dike-basal aquifers. Previously dug wells indicate the potential for tapping this resource.
- **Potable ground water resources need to be protected from contamination by land use activities**. The HISWAP report identified some potential contaminating activities. Known CERCLA and other illegal dump sites cause concern for ground water quality.
- **The UIC and pass/no pass lines should be re-evaluated in Wai‘anae**. Although the existing lines may have been drawn conservatively, new data and improved modeling techniques should be used to evaluate these ground water protection measures, especially where they extend back into the valleys and near existing potable water supplies.

2.10.2.3 SURFACE WATER RESOURCES

Surface water concerns are related mostly to quality and quantity. Ecosystem needs, human health, and maintenance of traditional and customary practices were all major issues. Surface water was discussed in terms of streams, drainage and flooding, wetlands, and near-shore waters.

- **More information is needed on stream biota** so proper management can take place. Of the six perennial streams identified in the HSA, five were "without aquatic data," and Mākaha Stream was last surveyed in 1976.
- **Measurable IFS should be developed for Wai'anae streams**. Instream flow standards are needed to balance uses and ensure that proper management of the resource occurs.
- **Ka'ala Bog and geologic structures at valley heads need to be protected** to continue as sources of stream flow into Mākaha and Wai'anae valleys.
- **Concrete channels in the lower stream reaches should be redesigned** to be more sensitive to aquatic habitat and rural character, but still adequately accommodate flood control needs.
- **Restoration of stream habitat, including riparian areas, needs to occur**. There is no riparian buffer zone in the urban area, and possibly much of the agricultural area. This zone should be reestablished to protect the stream habitat.
- **Wetlands should be restored and protected** as important habitat for native species and as natural pollutant filters. Many wetlands have been degraded or destroyed due to development or ignorance. Management, including an inventory of wetland biota and function according to Federal, State, and County standards, is needed to provide protection for wetlands and the ecological functions they support.
- **Surface water quality monitoring should be ongoing** to protect environmental and human health. Monitoring allows for identification of potential threats and provides the ability to assess the effects of human activities on water quality.
- **Surface water quality needs to be improved** to protect environmental and human health. Kaupuni Stream was identified in the State's List of Impaired Water Bodies in Hawaii in 2004.
- **Drainage analysis and flood mitigation plans are needed** for flood-prone areas in the District. Localized flooding is a problem where *ma kai* areas are higher than adjacent *ma uka* lands.
- **Drainage systems, both man-made and natural, require continual maintenance** to ensure proper function. Blocked and broken drainage systems have reduced capacity during heavy storms.

2.10.2.4 Near-Shore Waters

- **Monitoring and regulation of ocean activities may be necessary** to ensure that user conflicts are minimized. Increases in various ocean activities, such as those associated with recreation and economic employment, may be conflicting with each other and with near-shore ecosystems.
- **Near shore water quality should be monitored** to protect human health and safety and related ecosystems. Monitoring would allow for the tracking of trends and provide indicators for

concern. Māʻiliʻili Beach was identified as needing future monitoring.

- **Near shore water quality should be improved** to protect human and ecosystem health and safety. Near shore waters are heavily used by the community for recreation and fishing, but Pōkaʻī Bay was identified as an "impaired water body in 2004. A chemical munitions dump offshore poses unknown risk to the environment, communities, and nearby fisheries. Coral reefs are sensitive to water quality changes.
- **Estuary health should be improved** to provide habitat to native aquatic fauna and the juvenile stages that often utilize the brackish area.

2.10.3 LAND USE ZONES

2.10.3.1 Conservation Zone

- **Native forest areas should be improved and protected** to provide for ground water recharge, provide native habitat, and allow for traditional and cultural practices. Waiʻanae forests provide plant associations thought to be conducive to ground water infiltration; native habitat for threatened and endangered species; and plants, animals, and venues used in the practice of Hawaiian customs.
- **Forests and communities need to be prepared to protect themselves from wildfires** and restore health and function if they are burned. Wildfires are common in Waiʻanae, especially during the dry summer months, and can devastate forests and associated natural and human communities and the functions they provide.

2.10.3.2 Agricultural Zone

- **Agricultural support should be developed** to preserve the rural character of Waiʻanae. As outlined in the WSCP, agriculture should remain a part of the local landscape. Development should respect the WSCP boundaries and government should enforce the stated growth policy to allow agricultural uses to remain.

2.10.3.3 Military Zone

- **Mitigation of the impacts resulting from military operations in Lualualei and Mākua is needed** to protect Waiʻanae forests and ground, surface, and near shore waters.

2.10.3.4 Urban Zone

- **Additional potable water will be needed** to supply the expected increase in housing units in the coming decades. There are roughly 4,000 housing units planned for Waiʻanae, 1,537 of which are planned by DHHL. This could lead to a large increase in water demand, especially because DHHL has a high priority in terms of water allocation.

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[10] HAR Ch. 13-171, Subch. 3, § 13-171-13(a).

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3 WATER USE AND PROJECTED DEMAND

In order to identify future water demand for the Wai'anae District, the availability and current use of water was researched and is described in this chapter. Various scenarios for water use were then projected to the year 2030 and a most likely scenario was selected for further planning.

3.1 WATER USE IN THE WAI'ANAE DISTRICT

Residential and agricultural uses consume the most water in Wai'anae. While early plantations used some surface water for irrigation, water is now primarily from ground water sources due to inconsistent stream flow and the availability of good quality ground water.

The Honolulu Board of Water Supply provides most of the water consumed in Wai'anae.[1] Various constraints have resulted in roughly half of the water supplying Wai'anae's needs coming from Wai'anae sources and the remaining half being imported from the Pearl Harbor aquifer.

Note: Year 2000 data from CWRM are used throughout this chapter and the Plan because they provide the most comprehensive compiled data set for the Wai'anae District and can be used with the 2000 U.S. Census data.

3.1.1 WATER AVAILABILITY

Ground water supplies most of Wai'anae's water needs. The sustainable yield for the Wai'anae Aquifer Sector Area is 16 mgd, including some brackish water. The main factors limiting ground water availability are the environmental conditions of the Wai'anae District, including difficult geological terrain, low rainfall, and climate. Coastal deposits are generally permeable, but water from these wells will tend to be brackish or salty. The valley alluvial deposits vary from low to high permeability, but these deposits do not yield large volumes of water. Dike-basal to high level dike-confined aquifers in the upper valleys are potentially the most productive in terms of potable water.

Some surface water is available for use, but the intermittent nature of the major streams in the lower elevations makes any large uses infeasible and unlikely. Diversions in the upper reaches may be possible, but median stream flow, available for only Kaupuni and Mākaha Streams, indicate only 0.3 cfs and 0.5 cfs, respectively. New or expanded stream diversions would require an amendment to the existing interim instream flow standards.

3.1.2 EXISTING WATER DEMAND

The Honolulu Board of Water Supply provides for most of the water needs in the Waiʻanae District. While several private water systems were previously constructed for irrigation of plantations and smaller farms, many of these facilities have since been abandoned or closed due to a reduction in need from the closing of plantations, a degradation of the water quality, or more reliable supply from BWS.

In the Waiʻanae District, residential land use consumes the most water, followed by agriculture. Total water demand for Waiʻanae in calendar year 2004, including water imported from the Pearl Harbor aquifer, was 11.0 mgd. This includes potable and non-potable water from all infrastructure owners: BWS, Federal, State, and private. See Table 3-1 for the breakdown of water consumption by water infrastructure owner. Most of the water demand (87 percent) in 2004 was supplied by the BWS system, followed by private infrastructure. Federal and State infrastructure provides relatively little water.

FIGURE 3-1

ESTIMATED WAIʻANAE WATER CONSUMPTION BY WATER INFRASTRUCTURE OWNER

(CY 2004)

Total = 11.0 mgd

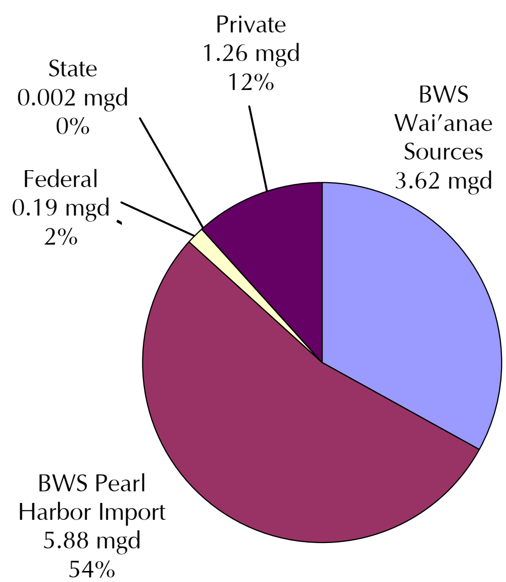


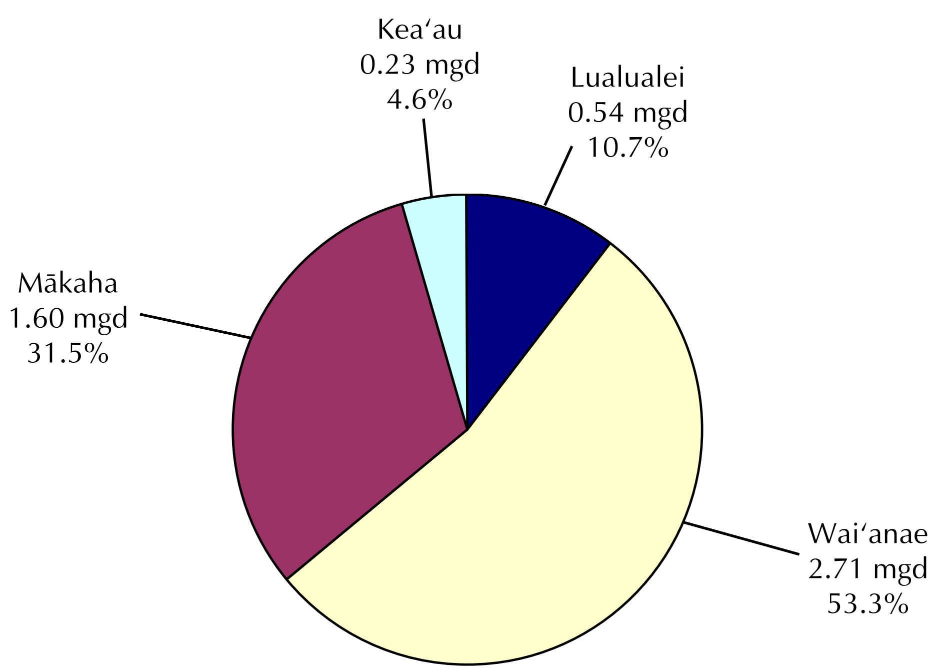
TABLE 3-1
WAI'ANAE ESTIMATED AVERAGE WITHDRAWAL*
BY AQUIFER SYSTEM AREA (CY2004)[2]

Aquifer System Area	BWS (mgd)	Federal (mgd)	State (mgd)	Private (mgd)	Total (mgd)	Sustainable Yield** (mgd)	Available Yield (mgd)
Nānākuli	0.00	0.00	0.000	0.000	0.00	2.00	2.00
Lualualei	0.00	0.19	0.000	0.349	0.54	4.00	3.46
Wai'anae	2.33	0.00	0.000	0.372	2.71	3.00	0.29
Mākaha	1.29	0.00	0.000	0.312	1.60	3.00	1.40
Keaau	0.00	0.00	0.002	0.230	0.23	4.00	3.77
TOTAL	**3.62**	**0.19**	**0.00**	**1.26**	**5.08**	**16.00**	**10.92**

*Withdrawal data was as close to the calendar year (CY) 2004 time period as possible, but varying availability caused some difference in reporting periods. State withdrawals are estimated from CY 2000. Federal and BWS data was obtained from CWRM for CY2004. Private withdrawals were obtained from CWRM for CY2004 or were estimated, where there was no reported use. BWS Withdrawal from Mākaha includes Glover Tunnel, which is non-potable.

**This table reflects the Sustainable Yields that were updated in 2008.

FIGURE 3-2
WAI'ANAE WATER WITHDRAWAL
BY AQUIFER SYSTEM AREA
(CY 2004)



3.1.3 BWS SYSTEM

The BWS operates, by far, the largest water system in Waiʻanae. Historically, the Waiʻanae Plantation / Capital Investment Corporation provided water to Mākaha and Waiʻanae, and the City and County Public Works Suburban Water System provided water to Nānākuli & Lualualei. BWS acquired the Suburban system in 1959 and acquired the Waiʻanae Plantation / Capital Investment Corporation system and Mākaha Watershed land in the early 1980s. These acquisitions led to extensive water system improvements and upgrades to source, reservoir storage, and pipeline capacities to modern national municipal standards that provide more reliable supply, efficient water systems, and added fire fighting capability.

The BWS water system is comprised of a low elevation service system from Nānākuli to Waiʻanae and high elevation service systems in Nānākuli, Waiʻanae, and Mākaha. The majority of water use in the region occurs in the low elevation service system, with a small amount of use in the high elevation service systems. Figure 3-3 diagrams BWS service areas in Waiʻanae.

3.1.3.1 Non-Potable Sources and Use

Most of the BWS non-potable water demand is currently supplied by potable water. BWS only provides non-potable water from Glover Tunnel in Mākaha, with water from this system directed into the Mauna Olu Non-Potable Open Reservoir, which stores irrigation water for the Mākaha Resort's West Golf Course and Kāneʻākī Heiau. This water is technically potable, until it comes into contact with the surface. Glover Tunnel is not metered at the source, but a meter is planned for installation to verify source production and measure any losses in the pipeline and from the open reservoir. Recycled water is not currently being used in Waiʻanae.

TABLE 3-2: BWS POTABLE VS. NON-POTABLE WATER USE IN WAIʻANAE IN CY 2000

POTABLE WATER USE	(mgd)
Residential Water Use	5.405
Commercial Water Use	0.531
Resort Water Use	0.032
Public School & Other State Water Use	0.383
Federal Government	0.058
Religious Facilities Water Use	0.061
Total Potable Water Use	**6.470**

NON-POTABLE WATER USE*	(mgd)
Agricultural Water Use	1.916
Industrial Water Use	0.005
Golf Course Water Use	0.511
Park & Other City Water Use	0.571
Total Non-Potable Water Use	**3.003**

*BWS's only source of non-potable water is Glover Tunnel, which goes toward golf course irrigation. All other non-potable uses in this table are currently being served by potable water.

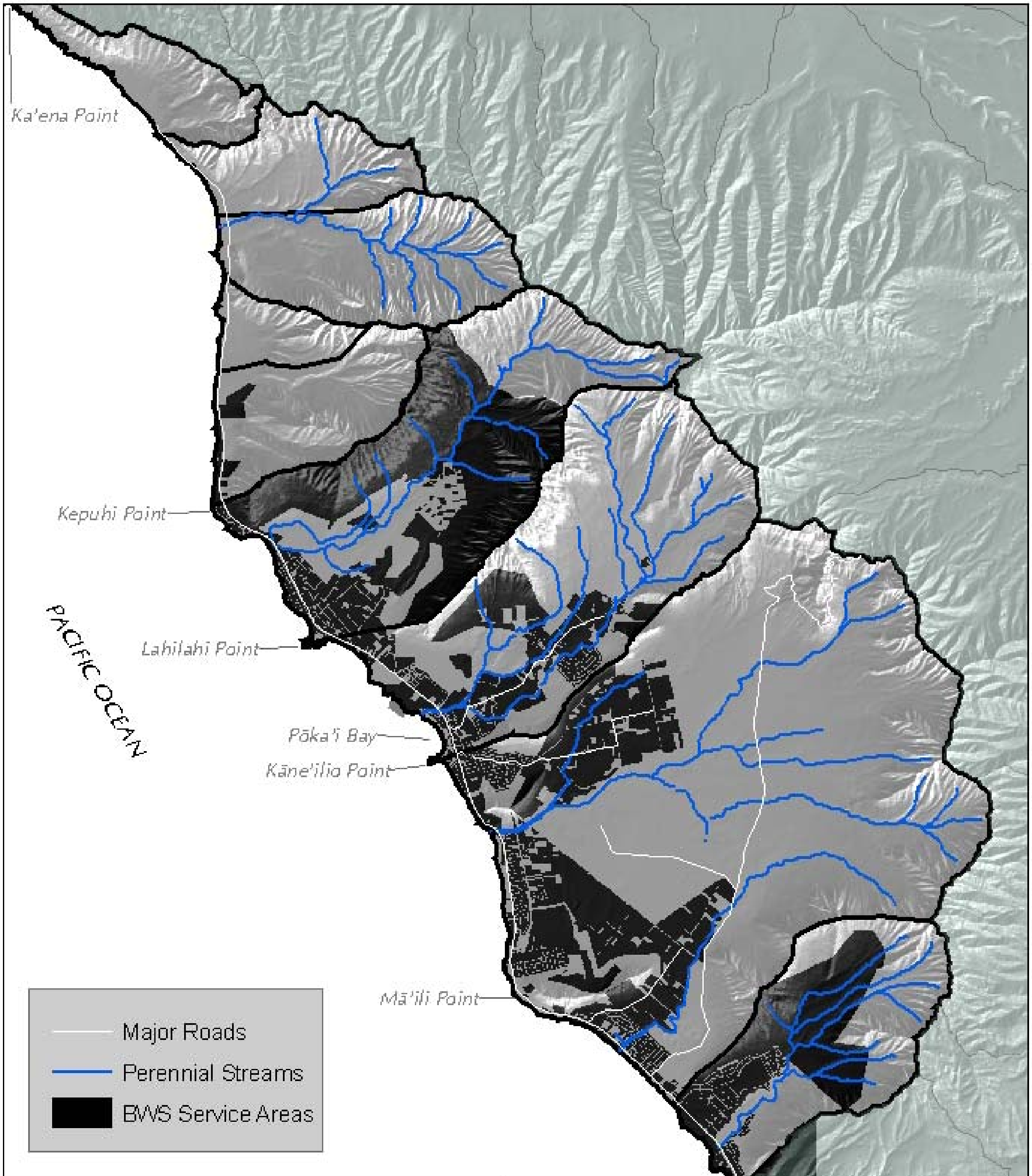


Figure 3-3
BWS SERVICE AREAS IN WAI'ANAE
Wai'anae Watershed Management Plan

Feet
0 5,300 10,600 15,900

TABLE 3-3

BWS TOP TEN LARGEST METERED WATER CONSUMERS IN WAIʻANAE (CY 2004)

	Water User	Average Daily Consumption (mgd)
1	Mākaha Hotel and Resort	0.38
2	Pacific Dairy	0.12
3	Mākaha Valley Tower	0.10
4	Waiʻanae District Park	0.09
5	Nānākuli Beach Park	0.09
6	Rainbow Hawaii	0.07
7	AO Mākaha Surfside	0.06
8	Mt. View Dairy	0.05
9	Private Individual	0.05
10	Nānākuli High & Intermediate School	0.05

3.1.3.2 Potable Water Use

In the year 2000, BWS potable water use in Waiʻanae totaled approximately 9.34 mgd (Table 3-4). Of the metered consumers in the Waiʻanae District, residential land uses consume the most water (5.4 mgd), followed by agriculture (2.3 mgd). City government is also a significant water user (0.571 mgd), presumably for park irrigation and the operation of the Waiʻanae Wastewater Treatment Plant.

While residential land uses consume the most water, the largest individual metered water users include resort, irrigation, and agricultural activities (Table 3-3). Schools also require a lot of water and rank among the top water users.

3.1.3.3 Potable Sources and Infrastructure

BWS provided 9.3 mgd, or about 90 percent of Wai'anae's potable water demand in the year 2000. A little more than half of the total water consumed is provided by in-district pumpage from its 10 wells, one shaft, and one tunnel. BWS also maintains 11 reservoirs in Waiʻanae. Most of the water withdrawn from the Waiʻanae Aquifer Sector Area comes from the Waiʻanae Aquifer System Area (Table 3-1 and Figure 3-2). Water drawn from within the Waiʻanae District generally supplies Mākaha and Waiʻanae *ahupuaʻa*. Other than in the Waiʻanae Aquifer System Area, withdrawal volumes are far less than the sustainable yield.

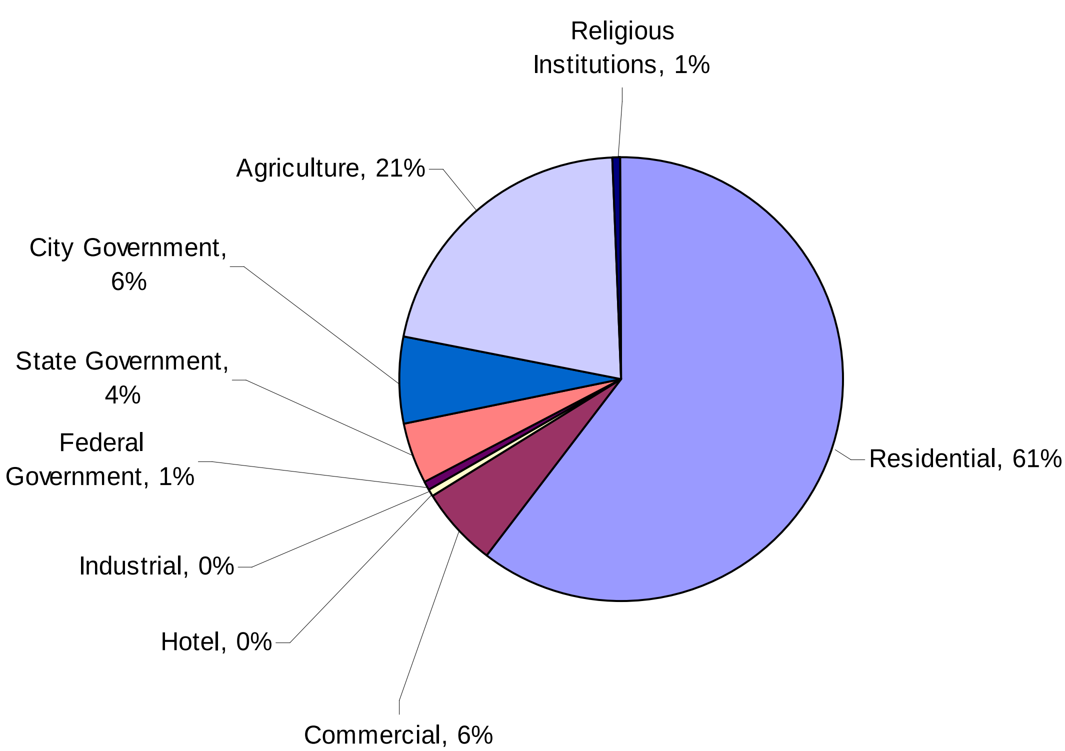
BWS Well II.

TABLE 3-4
BWS AVERAGE POTABLE WATER CONSUMPTION BY SECTOR (CY 2000)

Water Use by Sector (mgd)										
	Residential	**Commercial**	**Hotel**	**Industrial**	**Federal Government**	**State Government**	**City Government**	**Agriculture**	**Religious Institutions**	**TOTAL**
Mākaha/Kea'au	1.219	0.132	0.015	0.000	0.013	0.023	0.067	0.026	0.001	**1.496**
Wai'anae	0.976	0.135	0.000	0.000	0.000	0.190	0.158	0.580	0.048	**2.087**
Lualualei	2.570	0.259	0.017	0.005	0.045	0.034	0.295	1.310	0.011	**4.546**
Nānākuli	0.640	0.005	0.000	0.000	0.000	0.136	0.051	0.000	0.001	**0.833**
WAI'ANAE DISTRICT TOTAL	**5.405**	**0.531**	**0.032**	**0.005**	**0.058**	**0.383**	**0.571**	**1.916**	**0.061**	**8.962**

NOTE: BWS water use as shown in this table will not equal BWS water withdrawals as identified in Table 3-1 for various reasons, including (1) Table 3-1 reflects year 2004 data as opposed to year 2000 data in this table, (2) water use includes water imported from the Pearl Harbor Aquifer Sector Area and not just water withdrawn from the Wai'anae Aquifer Sector Area, and (3) this table includes 6.5% estimated water loss.

FIGURE 3-4
BWS POTABLE WATER CONSUMPTION BY SECTOR
(CY 2000)



Potable water not supplied by in-district sources are provided by the Pearl Harbor Aquifer. Previous estimates of the amount of ground water that Wai'anae sources could supply were significantly higher than amounts that could be economically extracted, leading to a common misconception that BWS exports water out of Wai'anae. Instead, a significant quantity of water has historically been supplied to the District from the Pearl Harbor Aquifer.

The Pearl Harbor Aquifer Sector Area is comprised of three major Aquifer System Areas: Waimalu, Waipahu-Waiawa, and 'Ewa-Kunia. The Waimalu Aquifer System Area mainly supplies the Primary Urban Center Development Plan area, while the Waipahu-Waiawa and 'Ewa-Kunia Aquifer System Areas supply the Central O'ahu, 'Ewa, and Wai'anae DP areas. Some Waipahu-Waiawa Aquifer sources supply water to the PUC as well.

Ground water from Pearl Harbor is drawn from the Hō'ae'ae Wells and Kunia Wells I and III in the 'Ewa-Kunia Aquifer System Area and is transported through a transmission main along Farrington Highway. The transmission main branches off at several places within the Wai'anae District, generally servicing the *ahupua'a* of Nānākuli and Lualualei.

The BWS only considers the Waipahu-Waiawa Aquifer System Area as being feasible for additional ground water development to meet future growth. The Waimalu Aquifer is not feasible for additional withdrawal because its permitted use is over-allocated by 1.95 mgd. The 'Ewa-Kunia Aquifer is not feasible for significant additional potable withdrawal because high chloride levels have been found in BWS sources at current withdrawal rates. The current CWRM estimates of sustainable yield and permitted use for the Pearl Harbor Aquifer Sector Area are shown in Table 3-5.

TABLE 3-5

PEARL HARBOR AQUIFER SECTOR AREA SUMMARY

Aquifer System Area	CWRM Sustainable Yield (mgd)	CWRM Permitted Use as of July 2005 (mgd)	CWRM Available Permitted Use (mgd)
Waimalu	45	46.95	-1.95
Waipahu-Waiawa	104	83.89	20.11
'Ewa-Kunia	16	15.46	0.54
Total Pearl Harbor	**165**	**146.30**	**18.70**

The Waipahu-Waiawa Aquifer System Area has 20.11 mgd of available permitted use, but not all of this water would be available for transport to Wai‘anae. As mentioned earlier, the Pearl Harbor Aquifer provides water to meet demands in the ‘Ewa, Central O‘ahu, and PUC areas, in addition to Wai‘anae. Thus, future growth in these areas will compete for developable, convenient, low cost water from the Pearl Harbor Aquifer and more specifically, from the Waipahu-Waiawa Aquifer System Area.

The combined projected increase in demand for those areas consuming Pearl Harbor water is approximately 50 mgd by the year 2030, much more than the approximately 20 mgd available in permitted use. Of the 84 mgd currently permitted in the Waipahu-Waiawa Aquifer System Area, an average of only 53 mgd was pumped over the 12 months ending in July of 2005 (see Table OV-5 in the O‘ahu Water Management Plan Overview), due to a normal rainfall year.

This would suggest that there could be up to 51 mgd of water available for future use (SY of 104 mgd minus 53 mgd pumped). However, this 51 mgd is not likely to be allocated all toward future growth. Competing uses include the replacement of certain permitted use that may be revoked to bring withdrawals from over-allocated aquifers to within SY estimates. There are also uncertainties related to drought and accelerated high growth that could reduce source yields and increase demands.

3.1.3.4 Historic Pumpage in Wai'anae

Historical records show that in-district pumpage volumes ranged from a high of 5.05 mgd in 2001 to a low of 3.10 mgd in 2004 (Figure 3-5). Ground water withdrawals were likely relatively high in the late 1990s through early 2000s due to the drought conditions that existed at that time. More recent declines in pumpage are attributed to various reasons, including the easing of drought conditions, conservation programs and pipe replacement projects that reduced the amount of water lost due to leaks, and the minimizing of pumpage from Mākaha Wells II and III in order to study potential impacts on watershed restoration.

Per Service Water Demand

The number of active BWS services has grown by 34,561 over the past 20 years, an increase of approximately 26.2 percent. The number of services in Wai'anae has increased by 2,572, or by 40.8 percent. It can be seen that over the years, the water demand per service has decreased by 9.1 percent between 1985 and 2005, and by 18.6 percent since 1991, when the per service water demand was the highest. This decrease is attributed to conservation measures implemented by the BWS. A description of the BWS conservation program is provided in the next section.

FIGURE 3-5
BWS HISTORIC POTABLE GROUND WATER WITHDRAWAL IN WAI'ANAE 1960-2004

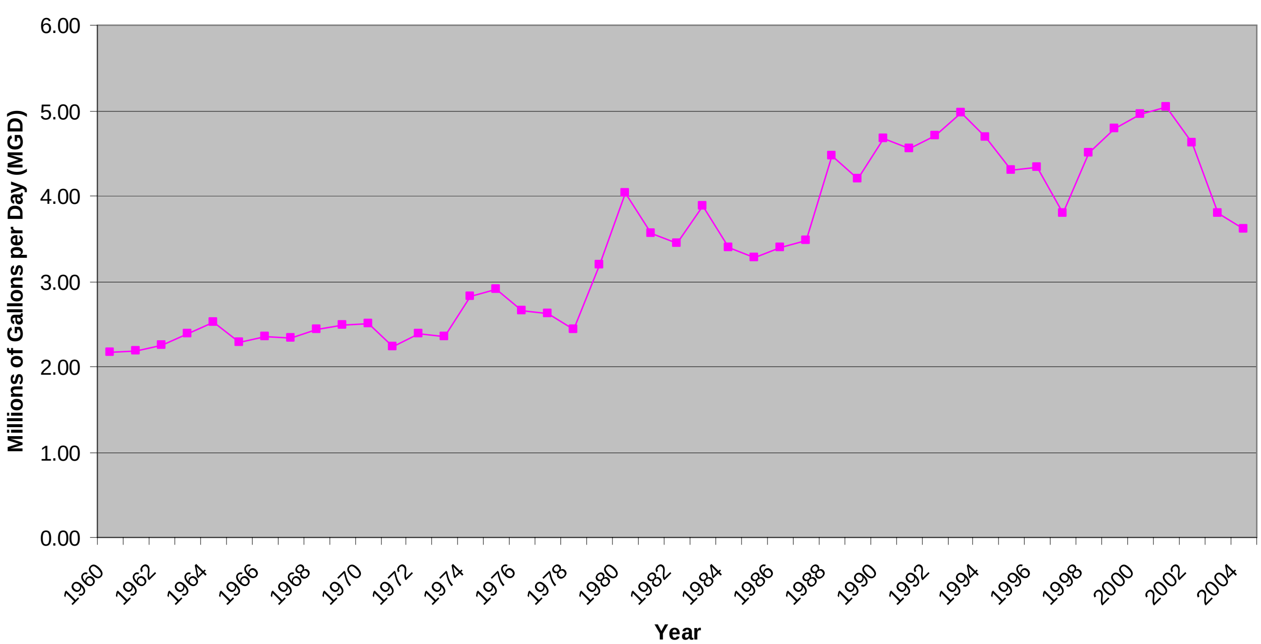
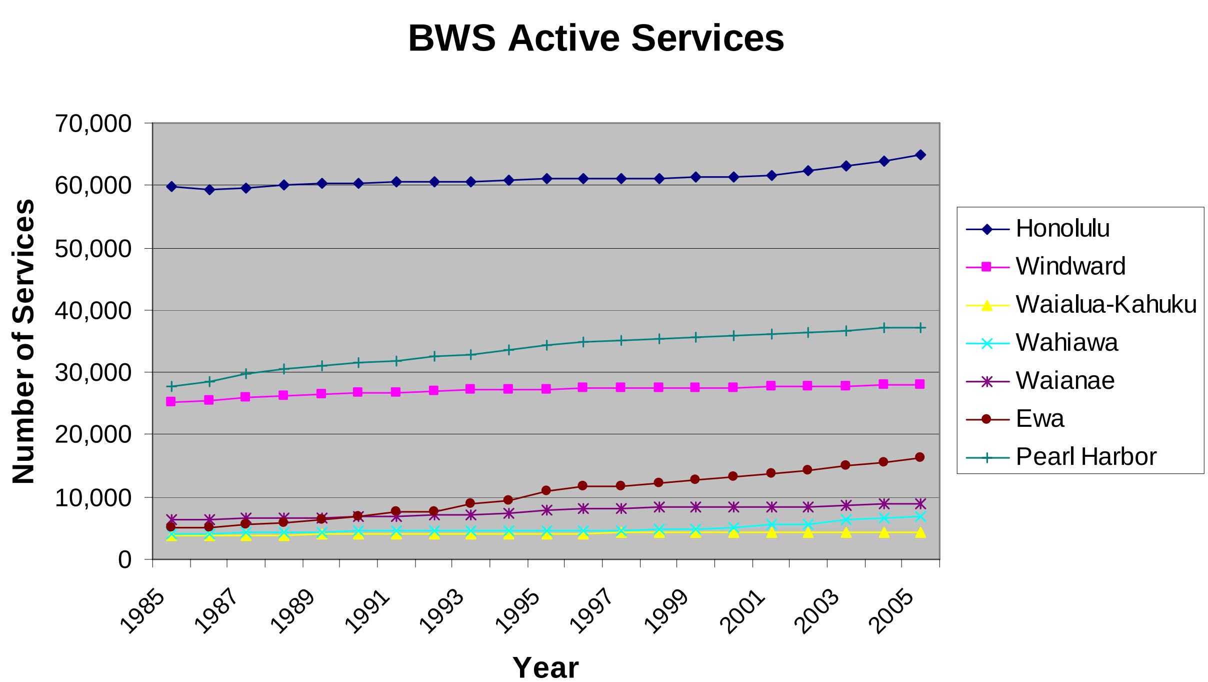


TABLE 3-6
BWS ACTIVE SERVICES, 1985-2005

FY	Honolulu	Windward	Waialua-Kahuku	Wahiawā	Wai'anae	'Ewa	Pearl Harbor	Total	Pumpage (mgd)	Demand per Service (gpd)
1985	59,801	25,129	3,735	4,162	6,302	5,041	27,714	131,884	129	978.13
1986	59,237	25,419	3,773	4,192	6,357	5,172	28,625	132,775	137.7	1,037.09
1987	59,590	25,891	3,848	4,240	6,495	5,680	29,674	135,418	141.3	1,043.44
1988	60,007	26,274	3,928	4,268	6,626	5,778	30,442	137,323	147.4	1,073.38
1989	60,249	26,473	4,056	4,439	6,702	6,289	30,936	139,144	149.6	1,075.15
1990	60,387	26,648	4,107	4,618	6,766	6,961	31,551	141,038	152.8	1,083.40
1991	60,489	26,835	4,131	4,669	6,823	7,632	31,821	142,400	155.6	1,092.70
1992	60,564	26,977	4,140	4,674	7,006	7,722	32,532	143,615	158.2	1,101.56
1993	60,691	27,154	4,151	4,685	7,217	8,879	32,849	145,626	155.6	1,068.49
1994	60,850	27,253	4,177	4,691	7,369	9,539	33,489	147,368	151.4	1,027.36
1995	61,025	27,342	4,190	4,678	7,858	10,869	34,285	150,247	155	1,031.63
1996	61,091	27,390	4,193	4,679	8,227	11,780	34,824	152,184	150.8	990.91
1997	61,180	27,418	4,206	4,680	8,268	11,799	35,141	152,692	145.7	954.21
1998	61,205	27,495	4,207	4,780	8,340	12,129	35,487	153,649	150.9	982.11
1999	61,261	27,531	4,223	4,955	8,346	12,648	35,618	154,576	150.79	975.51
2000	61,406	27,597	4,251	5,155	8,365	13,205	35,956	155,935	152.345	976.98
2001	61,630	27,663	4,265	5,565	8,415	13,707	36,184	157,429	155.256	986.20
2002	62,253	27,759	4,299	5,494	8,498	14,171	36,428	158,902	153.749	967.57
2003	63,115	27,836	4,326	6,421	8,676	15,017	36,737	162,128	156.516	965.39
2004	63,966	27,914	4,356	6,610	8,786	15,611	37,067	164,310	149.86	912.06
2005	64,815	27,997	4,380	6,974	8,874	16,250	37,155	166,445	148.042	889.43

FIGURE 3-6



3.1.3.5 BWS Conservation Programs

The BWS has actively promoted water conservation since its inception in 1929. The BWS Water Conservation Program is currently organized as follows:

- Public Education & Outreach
- Large Water Users Programs
- Leak Detection, Repair & Maintenance
- Regulation
- Alternative Source Development, Recycling, & Conservation Alternatives

The principal elements of these five program clusters are summarized in Table 3-7. Specific programs within each of these categories that have been major contributors to water conservation savings are detailed below.

Public Education & Outreach

The primary objective of the public education and outreach efforts is to influence water use habits of the individual consumer. A variety of programs including public service announcements, poster contests, features in the newspaper, water saving tips on the internet, xeriscape demonstrations, detect-a-leak week, educational booths, and a water waste hotline, target homes, schools and businesses.

Large Water Users Programs

Large water users programs target organizations and businesses with high consumption. These organizations often have the capacity to facilitate change internally. Existing agreements with City and State agencies target parks, schools, golf courses, roadway landscaping, and other governmental facilities to be more efficient in their water usage. Additionally, the State Department of Land and Natural Resources is conducting an audit of its usage to determine opportunities for saving water.

Leak Detection, Repair & Maintenance

Water loss accounting is a measure of water distribution efficiency that can indicate potential targets for specific water conservation measures. The Board of Water Supply recently began a targeted conservation program by identifying and fixing system water losses to reduce water lost between pumpage from the ground and delivery into homes. A portion of water loss is due to leakage; other causes of water loss can be from: pipe, reservoir, and hydrant flushing operations, illegal unmetered water taps, and meters requiring calibration.

On the mainland, water loss averages are between 10-15 percent, and the BWS goal for Oʻahu is to reduce losses to less than 10 percent. In 2005, the entire BWS system experienced 12.8 percent water loss. Waiʻanae District water loss is estimated to be 6.5 percent , and the completion of the Mākaha to Barber's Point Transmission Main will potentially result in further reduction in water losses.

TABLE 3-7: CURRENT BWS WATER CONSERVATION PROGRAMS

PUBLIC EDUCATION & OUTREACH	LEAK DETECTION, REPAIR & MAINTENANCE	LARGE WATER USER PROGRAMS	REGULATION	ALTERNATIVE SOURCE DEVELOPMENT, RECYCLING & CONSERVATION ALTERNATIVES
• **Schools** – Educational Material – Curriculum Development–Student Tours – Annual Poster Contest – Hawaii State Science Fair • **Tours** – Fred Ohrt Museum – Hālawa Xeriscape Garden – Nu'uanu Watershed – Water Reclamation Plant • **Water Conservation / Education Publications** • **Water Conservation Calendar** • **Video Library** • **Year Round Conservation Media Campaign** • **Speakers' Bureau** • **Water Conservation Information/Complaints** • **Communications** – News Releases / Advisories on Water Emergencies / High Water Usage / Community Concerns / Public Meetings / News Conferences • **Landscape Water Conservation Classes** • **Special Events** – Detect-A-Leak Week – Water Conservation Week – Trade Shows/Exhibitions – Hālawa Xeriscape Garden Open House& Plant Sale – Community Events	• **Leak Detection and Repair (within BWS distribution system and storage facilities)** • **Pipeline Corrosion Protection Program** • **Flow Transmitter Maintenance** • **Repair and / or Replacement** of valves, fire hydrants, water distribution mains and service line leaks and fractures • **Enforcement** of unauthorized use of water • **Meter Maintenance Program** • **Maintenance/Repair and Replacement** of aging service laterals and hydrants • **Meter-Reading / Water Bill Monitoring** (Identify high water use due to undetected leakage; report seepages, leaks, or other signs of possible water leaks) • **Water Audits** and development of internal water use efficiency practices and programs • **Cathodic Protection** Monitoring and Maintenance – flow transmitter maintenance – pipeline corrosion programs	• **Visitor Industry** – Conservation Education – Linen Reuse placard • **Government Agencies** – Conservation Partnership Projects • **Business/ Commercial** – Conservation Education – Low-Flow Fixture Incentives – Restaurant placard, water served only upon request • **Irrigation System Submetering and moisture controllers**	• **BWS Low Ground water (Drought) Plan** • **BWS Rules** – Governing wasteful water use practices (Empowering department to discontinue water service) – Use of non-potable water for irrigation of large landscaped areas, golf courses, parks, highways, school playgrounds – Restaurant water service, water served only upon request – Restricted irrigation program (Applicable to periods of low rainfall and high consumption) • **County legislation requiring low-flush toilets, and low-flow showerheads and faucet fixtures** • **Conservation Rate Structure (Inverted Block Rate)** • **New Construction Regulations (Future)** – Dual Water Systems – Low-Flow Fixtures	• **Nonpotable Water System Standards and Master Plans** • **Residential Toilet Rebate Program** • **Nonpotable Source Development** – Caprock – Brackish – Surface Springs • **Wastewater Reuse** – Honouliuli Water Recycling Facility – Wahiawa/ Central Oahu – Distributed Reuse using Membrane Bioreactors • **Desalination Plants** – Kalaeloa Seawater – Kapolei Brackish Water • **Seawater District Cooling** • **Future Studies** – Evapotranspira-tion Study – Evaluation of Water-Saving Fixtures – Rain Catchments for nonpotable irrigation – Rebates for water efficient appliances

BWS programs for leak detection, repair and maintenance are ongoing. As an example, under a BWS leak detection promotion program, Kahuku Villages repaired leaks to their water lines in 1997 reducing water losses by about 40 percent, or about 67,000 gallons per day thereby, saving $4,000 per month in water rate payments.

Regulation

Regulation related to water use and efficiency standards provide the legal basis for the implementation of water conservation measures. National standards and recommendations from the American Water Works Association provide a wide range of national utility best practices. The BWS Low Groundwater Plan established by BWS Rules and Regulations provides the hydrologic monitoring triggers for increasingly restrictive conservation measures that cut back consumer demand to protect water resources and maintain high water quality during drought.

The non-potable water requirement for large landscape irrigation places a higher burden on new developments to reduce new demands on potable water supplies. BWS requires new large developments to submit non-potable water master plans to ensure that dual water systems are installed, one for drinking and fire protection and the other for irrigation.

One of the highly successful BWS initiatives is the low flush toilet ordinance. City building codes were drafted to require the installation of low flow fixtures in all new developments.

Alternative Source Development, Recycling, & Conservation Alternatives

Realizing that O‘ahu‘s natural resources are limited, the BWS is diversifying its water supplies to develop alternative sources, including water recycling, brackish and seawater desalination and higher levels of water conservation. The following non-potable water systems are currently operating:

- Kalauao Springs Non-Potable system - 0.8 mgd of brackish water to users from ‘Aiea to the Airport.
- Barbers Point-West Beach Non-Potable system - 0.9 mgd of brackish water for users in the Ko ‘Ōlina resort area
- Honouliuli Recycled Water Facility – 9 mgd of recycled water to users in ‘Ewa-Kapolei
- District cooling in Kaka‘ako using cold seawater to cool buildings at University of Hawai‘i Medical School to conserve energy and potable water lost by evaporation in cooling towers.

The BWS is continuing to evaluate and plan for a seawater desalination plant in Kalaeloa, which would provide additional water supply, especially in times of drought.

Another conservation measure is the toilet rebate program which complements the low flow toilet ordinance. Toilet fixtures were targeted because they consume the largest percentage of indoor water usage. From 1995 to 2005 the BWS toilet rebate program has spent nearly $7 million in rebates for the exchange and replacement of 72,850 toilets for newer low flush toilets. Westlake Apartments, Hale Kāloapau Townhouses and Laulima Hawai'i Kai Subdivision all had pilot retrofits which indicated that the reduction of water use for new residential developments could range from 12 percent – 27 percent.

3.1.4 FEDERAL SYSTEM

The only Federal water system in Wai'anae is owned by the U.S. Navy at their facilities in Lualualei. The CWRM well database indicates that the Navy owns five wells, two of which the Navy reported pumping a combined volume of approximately 0.2 mgd in CY 2004, which the CWRM well database records identify as for domestic consumption.

3.1.5 STATE SYSTEM

The State owns and operates one water system for use at the Ka'ena Point State Park. This system consists of two non-potable wells that are operated by the DLNR Parks Division for irrigation purposes. Estimated consumption from this system in 2001 was approximately 0.001 mgd. DLNR has indicated water supply for future park water demands would be sought from BWS.[3]

The State Water Code provides that "the planning for, regulation, management, and conservation of water resources in the State shall, to the extent applicable and consistent with other legal requirements and authority, incorporate and protect adequate reserves of water for current and foreseeable development and use of Hawaiian home lands as set forth in section 221 of the Hawaiian Homes Commission Act."[4] In accordance with this provision, the Department of Hawaiian Home Lands may request water reservations to CWRM in support of their programs. DHHL has submitted a request to increase their existing 1.482 mgd water reservation by 2.318 mgd for a total of 3.8 mgd in order to serve their island-wide needs. Although DHHL is planning on developing lands in the Wai'anae District, the water reservation request is for the Waipahu-Waiawa and Waimānalo Ground Water Management Areas. Therefore, DHHL water needs in Wai'anae will be supplied by sources that are outside of the District.

The SWPP indicates that the Department of Hawaiian Home Lands owns a diversion off of Nānākuli Stream. CWRM records indicate two diversions off of Nānākuli Stream used for livestock watering. However, discussions with DHHL water resource personnel reported no known use of the diversion. Discrepancies related to these diversions will be addressed in the update of the State Water Project Plan, which is currently in progress.

3.1.6 PRIVATE SYSTEMS

Over 250 wells, tunnels, and shafts were dug in Wai'anae between the years 1884 and 1962, but most have been abandoned due to high salinity, the availability of piped potable water from BWS, or the current lack of need for these sources. For example, the Mākaha Stream weir and the six-inch transmission main to Glover Tunnel which were originally constructed to supply irrigation water for the plantation, have both not been operational since 1998, and there are no plans for their repair.

CWRM maintains a database of stream diversions that were in existence before enactment of the State Water Code. This database is based on declarations of water use mandated by HRS §174C-26 and published in 1992. The database includes some diversions that were abandoned at the time of the declarations, but were intended to be reopened in the future. Field verifications of existing diversions are incomplete due to funding constraints. Therefore, it is unlikely that CWRM has records of (1) abandoned diversions not intended for reuse or (2) diversions undeclared by owners. Since 1998, all new diversions are tracked through a permit system and are captured in a separate database.

CWRM also maintains a database of ground water sources, including wells, shafts, and tunnels, based on the wells registered pursuant to the State Water Code Administrative Rules (HAR Ch 13-168) in 1988. Since 1988, all new wells are tracked through the permit system also implemented by the State Water Code. CWRM requires monthly ground water use greater than 1,700 gpd to be reported.[5] The databases may not include all of the wells in existence before the 1988 permit requirements came into effect.

BWS also prepared a non-potable well database to address community concerns on potential contamination. This database (Appendix D) could be useful in identifying abandoned wells that should be sealed to prevent pollution of the alluvial aquifer and near shore waters. It was used to verify the active wells in the CWRM database, and also to identify potential supply options for brackish, non-potable water.

Based on the CWRM and BWS databases, three diversions and seven private wells are thought to still be in active use in Waiʻanae (See Appendix D). The diversions are all located in Waiʻanae Valley and are all thought to be small water withdrawers. The private wells are located in the Lualualei, Waiʻanae, Mākaha, and Keaʻau aquifer system areas.

There are no records for the amount of water used by the three known diversions in Waiʻanae. All three are believed to be used for agricultural activities in Waiʻanae Valley: manual water withdrawal by bucket, loʻi kalo cultivation, and watering cattle.

Of the seven privately-owned wells thought to be in use, four do not have pumpage volumes associated with them. BWS records show that two wells are used for building air conditioners, although CWRM records show the same wells as being used for domestic consumption. Non-potable water from two wells is used for golf course irrigation, two wells are used for industrial activities, and the remaining well is used for irrigation.

3.2 WATER DEMAND PROJECTIONS

In order to adequately plan for Wai'anae's future water needs, District water demand was projected through the year 2030. These projections not only suggest how much water might be needed, they also indicate when increased demands might require infrastructure improvements.

The Statewide Framework for Updating the Hawaii Water Plan (Statewide Framework) requires that the County Water Use and Development Plans "…shall also include forecasts of water requirements of federal and private sector purveyors." Therefore, water demand was forecast for Federal, State, and private uses, as well as municipal use.

This chapter contains summary level information regarding future water demands. Additional details and the step-by-step methodology behind this process may be found in Appendix E.

3.2.1 THREE FUTURE SCENARIOS

The Statewide Framework recommends including "a range of forecasts of the amount of water required over the planning horizon…Among the scenarios are the base case scenario…a high-growth scenario, and a low growth scenario." Forecasts are presented in each of the three scenarios in five-year increments through 2030.

The "Policy Scenario" reflects City DPP population, housing unit, and job forecasts based on each district's official land use plan. Wai'anae has a Sustainable Communities Plan (SCP), which advocates controlled population growth, therefore representing the

TABLE 3-8
WAI'ANAE DISTRICT POPULATION

	2000	2005	2010	2015	2020	2025	2030
Policy Scenario Population	42,259	44,004	45,465	47,295	48,619	49,682	50,616
% of Honolulu's Population	4.80%	4.80%	4.80%	4.80%	4.70%	4.60%	4.50%
Trend Scenario Population	42,259	44,004	46,708	49,408	50,790	51,666	52,236
% of Honolulu's Population	4.80%	4.80%	4.90%	5.00%	4.90%	4.80%	4.70%
High-Growth Scenario Population	42,259	45,259	48,259	51,259	54,259	57,259	60,259
% of Honolulu's Population	4.80%	5.00%	5.10%	5.10%	5.20%	5.30%	5.40%

"low growth scenario." This "Policy Scenario" is meant to fulfill the Statewide Framework's mandate that, "…demand forecasts shall be consistent with county land use plans, development plans and/or community plans."

The "Trend Scenario" uses DPP's forecasts based on past trends, and may represent the "base case," or the "scenario based on the most likely assumptions," as discussed in the Statewide Framework.

DPP does not produce a third set of projections, so the planning team developed a "High-Growth Scenario" independently, which may not conform to the SCP, but is still possible, based on past trends, current growth patterns, land use and zoning, and potential influences from the rest of O'ahu.

3.2.2 TWO METHODOLOGIES: *PER CAPITA* AND END USE INVENTORY

Two methodologies for projecting future water demands were used: "*Per Capita*" and "End Use Inventory." The *Per Capita* approach is widely used due to its simple, straight-forward process, and because it is the standard methodology used by BWS in their future demand forecasting. It estimates the *per capita* water use in the District, 224 gallons per day (gpd) for Wai'anae, and applies that *per capita* demand to future population projections. The following tables present the projected future water demand for each of the three scenarios, policy, trend, and high-growth, using the *per capita* methodology.

TABLE 3-9
WAI'ANAE DISTRICT PER CAPITA WATER DEMAND: POLICY (LOW GROWTH) SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	9.34	9.72	10.24	10.65	10.97	11.25	11.70
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.85**	**10.23**	**10.76**	**11.17**	**11.48**	**11.76**	**12.22**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non- Potable Demand (mgd)	1.27	1.28	1.29	1.29	1.29	1.29	1.29
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1.48**	**1.48**	**1.48**	**1.48**
TOTAL DEMAND (mgd)	**11.31**	**11.70**	**12.23**	**12.64**	**12.96**	**13.24**	**13.69**

TABLE 3-10
WAI'ANAE DISTRICT PER CAPITA WATER DEMAND:
TREND (MODERATE GROWTH) SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	9.34	9.72	10.51	11.11	11.44	11.68	12.05
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.85**	**10.23**	**11.02**	**11.62**	**11.95**	**12.19**	**12.56**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.29	1.29	1.29	1.29	1.29
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1.48**	**1.48**	**1.48**	**1.48**
TOTAL DEMAND (mgd)	**11.31**	**11.70**	**12.50**	**13.10**	**13.43**	**13.67**	**14.04**

TABLE 3-11
WAI'ANAE DISTRICT PER CAPITA WATER DEMAND:
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	9.34	9.99	10.84	11.51	12.18	12.88	13.78
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.85**	**10.50**	**11.36**	**12.02**	**12.70**	**13.39**	**14.29**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.29	1.49	1.49	1.99	1.99
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1.68**	**1.68**	**2.18**	**2.18**
TOTAL DEMAND (mgd)	**11.31**	**11.97**	**12.83**	**13.70**	**14.37**	**15.57**	**16.47**

A second approach was employed to verify demand figures calculated using the *Per Capita* method, and to provide a range of demand figures for water providers to work within. This second approach, the End Use Inventory, is a unit-use method where future water demand is estimated by assigning water use coefficients to each type of water use. In most cases, that change in acres or jobs attributed to each type of water use is projected based on either trends or the local land use plan. Water use coefficients are then applied to the projected acreages or number of jobs.

The following tables present the projected future water demand for each of the three scenarios, policy, trend, and high-growth, using the end use inventory methodology.

TABLE 3-12
WAI'ANAE DISTRICT END USE INVENTORY WATER DEMAND
POLICY (LOW GROWTH) SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	6.62	6.97	7.29	7.69	8.03	8.33	8.63
BWS Non-Potable Demand (mgd)	3.00	2.85	2.95	3.01	3.08	3.18	3.25
BWS Total Demand (mgd)	**9.62**	**9.82**	**10.24**	**10.70**	**11.11**	**11.51**	**11.88**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.30	1.30	1.30	1.30
Non-BWS Total Demand (mgd)	**1.46**	**1.48**	**1.49**	**1.49**	**1.49**	**1.49**	**1.49**
TOTAL DEMAND (mgd)	**11.08**	**11.29**	**11.73**	**12.19**	**12.60**	**13.00**	**13.37**

TABLE 3-13
WAI'ANAE DISTRICT END USE INVENTORY WATER DEMAND
TREND (MODERATE GROWTH) SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	6.62	6.97	7.53	8.12	8.51	8.82	9.09
BWS Non-Potable Demand (mgd)	3.00	2.84	2.92	2.97	3.02	3.10	3.16
BWS Total Demand (mgd)	**9.62**	**9.80**	**10.45**	**11.09**	**11.54**	**11.92**	**12.24**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.30	1.30	1.30	1.30
Non-BWS Total Demand (mgd)	**1.46**	**1.48**	**1.49**	**1.49**	**1.49**	**1.49**	**1.49**
TOTAL DEMAND (mgd)	**11.08**	**11.28**	**11.94**	**12.58**	**13.03**	**13.41**	**13.73**

TABLE 3-14
WAI'ANAE DISTRICT END USE INVENTORY WATER DEMAND
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	6.62	7.24	7.88	8.50	9.11	9.73	10.37
BWS Non-Potable Demand (mgd)	3.00	3.24	3.59	3.95	4.30	4.66	5.01
BWS Total Demand (mgd)	**9.62**	**10.48**	**11.48**	**12.45**	**13.42**	**14.39**	**15.38**
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.36	1.36	1.52	1.52
Non-BWS Total Demand (mgd)	**1.46**	**1.48**	**1.49**	**1.56**	**1.56**	**1.71**	**1.71**
TOTAL DEMAND (mgd)	**11.08**	**11.95**	**12.97**	**14.00**	**14.97**	**16.10**	**17.10**

3.2.3 TECHNICAL NOTES REGARDING PROJECTIONS

Base year (2000) water demand differs slightly between the *Per Capita* and End Use Inventory methodologies due to the types of data available. The *Per Capita* methodology used BWS metered consumption data, which is broken down into water uses based on City sewer class codes. However, in order to get a more accurate estimate of agricultural water demand for the End Use Inventory, agricultural water use was estimated based on consumption by those parcels with an agricultural water meter. This allowed for an estimation of per acre water use, which was used to calculate future water demands. Year 2000 agricultural water use differed by 0.377 mgd between the two methods, which was considered an acceptable difference.

Water demand for the year 2005 differs between the *Per Capita* and End Use Inventory methodologies. Although 2005 has already occurred, year 2005 demand is a projected increase based on year 2000 data, the year with the most complete water use and population data.

3.2.4 WATER DEMAND SUMMARY

Estimates of future water demands for Wai‘anae range from 13.7 mgd to 16.5 mgd using the *Per Capita* method of projecting water demands, and 13.4 mgd to 17.1 mgd using the End Use Inventory method. This translates into an increase of 2.3 mgd to 6.0 mgd, or approximately 21 percent to 54 percent by the year 2030.

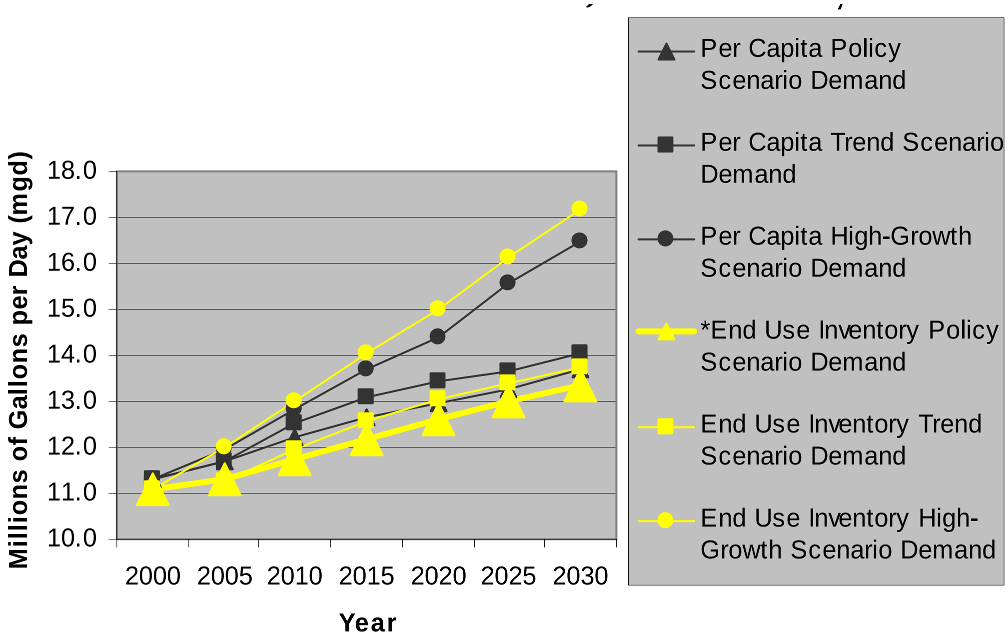
Some of BWS non-potable demand, including agricultural, industrial, and City park use, is currently served by potable water. Based on projections, 3.2 mgd to 5.0 mgd of non-potable water will be needed from BWS by 2030. Of that, only 0.5 mgd is already supplied by non-potable sources. Therefore, 2.7 mgd to 4.5 mgd of projected non-potable demand, which would otherwise be supplied by potable water, could potentially be served by additional non-potable sources, e.g., reclaimed water.

TABLE 3-15
WAI'ANAE TOTAL PROJECTED WATER DEMAND
PER CAPITA AND END USE INVENTORY METHODS

PER CAPITA	2000	2005	2010	2015	2020	2025	2030
Policy Scenario Demand (mgd)	11.31	11.70	12.23	12.64	12.96	13.24	13.69
Trend Scenario Demand (mgd)	11.31	11.70	12.50	13.10	13.43	13.67	14.04
High-Growth Scenario Demand (mgd)	11.31	11.97	12.83	13.70	14.37	15.57	16.47

END USE INVENTORY	2000	2005	2010	2015	2020	2025	2030
***Policy Scenario Demand (mgd)**	**11.08**	**11.29**	**11.73**	**12.19**	**12.60**	**13.00**	**13.37**
Trend Scenario Demand (mgd)	11.08	11.28	11.94	12.58	13.03	13.41	13.73
High-Growth Scenario Demand (mgd)	11.08	11.95	12.97	14.00	14.97	16.10	17.10

FIGURE 3-7
Wai'anae Water Projection Summary



***End Use Inventory Policy Scenario has been identified as "the most probable demand scenario."**

3.3 MOST PROBABLE DEMAND SCENARIO

Future water demand projections will be used to estimate how much water providers will need to plan for in the 25-year horizon. In order to efficiently develop water use options to meet future demand, one demand scenario was selected as the “base scenario.”

The End Use Inventory Method was selected over the *Per Capita* Method because specific water uses could be identified and their growth in demand tracked. The “Policy Scenario” was then chosen in order to comply with the State Water Code requirement that “Each water use and development plan…be consistent with the respective county land use plans and policies,” and the Statewide Framework, which requires that, “…demand forecasts shall be consistent with development plans and/or community plans.”[6] Additionally, Revised Ordinances of Honolulu §30-2.2 (c) (1), states that, “Facilities for the provision of water shall be based on the general plan population projections and the land use policies contained in the development plans.” The DPP’s “Policy Scenario” for future land use and population growth is the basis for each district’s official land use plan.

The Statewide Framework and ROH Chapter 30 also recommend water resource strategies and systems that are flexible enough to adequately supply demand, even if the selected demand scenario is not realized. Therefore, although a combination of water supply options will generally be planned to accommodate the policy scenario, additional water could be provided by expanding one or more options, or by implementing options sooner.

Various indicators can be used to identify which projection scenario Waiʻanae is on track for. As the inventory method is tied to land use, land use changes should be monitored and compared with projected increases. Large water use categories, such as residential, agriculture, and golf course use should have priority in monitoring. Water demand in the policy and trend scenarios only differs by 0.36 mgd by the year 2030. A move to the trend scenario is thus not likely to significantly change the timing and expansion of options.

3.4 IMPLICATIONS FOR WATER SUPPLY PLANNING

The following summary identifies the implications for water supply planning that have been identified through the analysis of current and future water use.

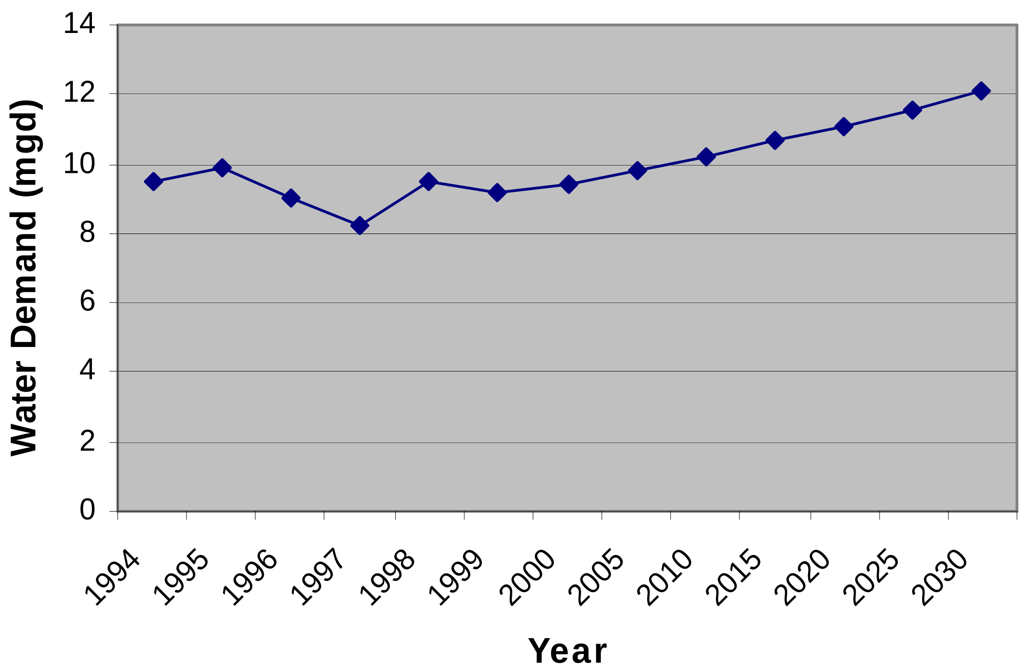
- Increases in potable water supplies will have to come from sources other than in-district ground water, which is already heavily developed. Ground water is limited and both brackish and additional fresh water are available only in small quantities, making significant in-district source development generally infeasible. Small scale brackish wells may be feasible.
- Surface water is unreliable and not available in large enough volumes to be

feasible for large-scale development. Small scale diversions for farming or cultural uses may be appropriate.

- Wai'anae will need to diversify its water supply sources. There will be competing demands for currently undeveloped water from the Pearl Harbor Aquifer Sector Area, and in-district ground water withdrawals are already heavily developed.
- There is a potential demand for non-potable water, if it were to become available. One of the largest consumers of BWS water is agriculture, which may be able to use non-potable water. Two Wai'anae parks are also among the top five individual water users on the BWS Wai'anae system.
- Water conservation programs may become increasingly important as water demands in Wai'anae continue to grow.
- Additional residential development will increase potable water demand. DHHL has a reservation with CWRM for future water allocations for their developments, including those in Wai'anae. Residential use is currently the top water use by BWS customers.

FIGURE 3-8

BWS ACTUAL AND PROJECTED WATER DEMAND FOR WAI'ANAE, 1994-2030



ENDNOTES

[1] Honolulu Board of Water Supply. December 2, 2004. *Wai'anae Consumption Survey*.

[2] Honolulu Board of Water Supply, Reserve Source Capacity table; Honolulu Board of Water Supply, Wai'anae Ground Water Well Index and Summary; Commission on Water Resources Management, 1992, Declarations of Water Use.

[3] Fukunaga & Associates, Inc., February 2003, *State Water Projects Plan: Hawai'i Water Plan Volume 5, SWPP for the Island of O'ahu*, Commission on Water Resources Management, Department of Land and Natural Resources State of Hawai'i, p.2-17 & Table 4.1.

[4] State of Hawai'i, Hawai'i Revised Statutes Chapter 174C, State Water Code, §174C-101(a).

[5] Memo re: "Data Requests Regarding Wai'anae Water Issues" dated October 19, 2004, from the Commission on Water Resources Management.

[6] State of Hawai'i Commission on Water Resource Management, *Statewide Framework for Updating the Hawai'i Water Plan*, 2000, p. 3-23.

4 OBJECTIVES, SUB-OBJECTIVES, AND STRATEGIES

All of the O'ahu Watershed Management Plans have the same goal and the same five major objectives to provide consistency. More detailed sub-objectives, derived from the consolidation of watershed issues and stakeholder values, obtained from the extensive public participation process, reflect the unique values, issues, and needs of each district.

The objectives and sub-objectives provide guidance for developing the Wai'anae Watershed Management Plan. A series of Wai'anae-specific strategies is designed to achieve each planning objective and sub-objective. Possible actions that support each strategy are then suggested, and are further detailed in Chapter 5. The implementation plan, presented in Chapter 6, is a consolidated, prioritized presentation of those projects and programs that are determined to be the most feasible and consistent with all of the five planning objectives.

The proposed strategies and actions within this Watershed Management Plan are the compilation of a comprehensive watershed analysis and stakeholder consultation process. The implementation and funding of these strategies and actions are not the sole responsibility of the BWS, City and County of Honolulu, or State of Hawai'i. Implementation of the WWMP will depend on budgetary priorities, grant availability and partnering efforts over the long term.

The overall goal of the O'ahu Water Management Plan is:
"To formulate an environmentally holistic, community-based, and economically viable watershed management plan that will provide a balance between: (1) the preservation and management of Oahu's watersheds, and (2) sustainable ground water and surface water use and development to serve present users and future generations."

4.1 OBJECTIVE 1: PROMOTE SUSTAINABLE WATERSHEDS

Sustainable watersheds are biologically diverse, renewable, and resource productive land and water ecosystems, from the mountains to the coral reefs, that meet present needs without compromising those of future generations. In a sustainable watershed, there is a holistic interrelationship among watershed resources and dynamics – including geologic structures, soil characteristics, forest communities, endemic and indigenous animals, introduced species, streams and wetlands, ground water aquifers, reefs and near-shore waters, traditional and cultural practices, land use, and land development. Healthy, sustainable watersheds should be the foundation for both land use and water resources management planning.

Native forest on Mt. Ka'ala, Wai'anae
Photo: Donna Shanefelter
www.malamahawaii.org.

SUB-OBJECTIVE 1.1 Strive to enhance and protect natural resources including land, stream, and near shore ecosystems.

The people of Wai'anae understand the interrelationships among natural resources from mauka to makai and therefore subscribe to a holistic approach to watershed management. Part of caring for the environment includes careful management of human activities and impacts.

<u>Strategy 1.1.1 Restore natural watershed structure and functions through the implementation of incremental, long-term ecosystem restoration programs.</u>

Healthy watersheds provide many services, some of which include holding soil and minimizing erosion; absorbing precipitation and replenishing the aquifer, thus providing high-quality drinking water; providing habitat for plants and animals, some of which provide us with food or materials for use; and providing recreational opportunities for enjoyment and spiritual fulfillment. Wai'anae's watersheds show signs of degradation and are in need of restorative actions to enable them to function at optimal levels.

Of particular interest are the forested watershed areas of Mākaha and Wai'anae valleys, as they are the most intact, publicly accessible areas in Wai'anae. Additionally, the majority of Wai'anae's ground water supply and flowing stream segments occur in these valleys, making them priority watershed management areas.

Actions such as forest restoration and wildfire management would help to maintain watershed functions and enhance the benefits they provide. An inventory of surface water resources could identify a starting point for surface water restoration efforts. Research on ecosystem dynamics could provide additional information and insight in how to better manage and protect these watersheds. Partnerships among agencies, the private sector, and community members could ensure that these watersheds will be maintained and restored.

Strategy 1.1.2 Preserve species and habitat biodiversity by assessing and restoring critical water-related habitats.

Current information on Wai'anae's native biota is lacking, but community members observed that native species and their habitat

Endangered tree snails, Mākaha.
Photo: HBWS

'Elepaio – endemic but rare in the forests on O'ahu.
Photo: Hawai'i Audubon Society.

have been declining in forests, streams, and near shore waters. Management, including an updated inventory and assessment of biota and habitat, is needed to provide protection of native species. Habitat restoration activities, in streams, wetlands, and forests, would help to reestablish native populations.

SUB-OBJECTIVE 1.2 Strive for regional self-sufficiency, where practical.

The Wai'anae community has expressed the desire to be as self-sufficient as possible; still, it is understood that not all of a district's needs may be met internally. Knowing this, Wai'anae will continue to strive for self-sufficiency where it can, thus lessening its dependence on neighboring regions.

Strategy 1.2.1 Implement resource conservation and demand-side management programs that conserve ground water and surface water resources.

Water conservation supports restoration efforts and the maintenance of watershed health, especially during periods of drought. Efforts by both water purveyors and consumers will reduce reliance on supplemental water imports.

Strategy 1.2.2 Stabilize water imports from the Pearl Harbor Aquifer by providing alternative sources for both potable and non-potable water.

Over time and where practical, Wai'anae should stabilize its water imports from the Pearl Harbor Aquifer by developing sustainable in-district water sources while also minimizing impacts on surface water and watershed health. Options to consider include ground water and surface water development, storm water capture, recycled wastewater for irrigation needs, and desalinated water for potable consumption.

All options should be considered for feasibility.

Strategy 1.2.3 Implement a "slow growth" policy in alignment with the rural character envisioned in the "Waiʻanae Sustainable Communities Plan."

The vision articulated in the Waiʻanae Sustainable Communities Plan was that of a rural district that embraced its agricultural traditions. In order to sustain that vision, the tenets of the Waiʻanae Sustainable Communities Plan should be adhered to. Additional support may be achieved through agricultural and loʻi kalo support programs; a Special Area Plan for Mākaha Valley, which has high potential for expanded growth; and a rural landscape study, which could investigate the rural history of Waiʻanae for use and integration into future planning.

SUB-OBJECTIVE 1.3 Protect the community from natural and human-induced hazards.

Waiʻanae, as with other districts, is vulnerable to natural hazards, some of whose impacts have been exacerbated by man-made structures or land management practices. Protecting life and property is of utmost importance to the community.

Strategy 1.3.1 Implement flood reduction actions and maintain flood protection when modifying or implementing other projects.

There are specific coastal and *ma uka* areas in Waiʻanae that are subject to frequent flooding. Mitigative actions should be implemented to protect flood prone areas from damage. Additionally, if previous flood control projects, such as the channelized stream mouths, are modified to provide better stream habitats, care should be taken to maintain the level of protection afforded the community by the existing channels.

Flood control drainage canal.

4.2 OBJECTIVE 2: PROTECT AND ENHANCE WATER QUALITY AND QUANTITY

Water is essential to human life and to the health of the environment. This valuable natural resource is comprised of marine, estuarine, freshwater, and ground water environments across coastal and inland areas. Water has two dimensions that are closely linked - quality and quantity. A healthy environment is one in which the water quality and quantity supports a rich and varied community of organisms and supports public health. Water quality and quantity influence the way in which communities use water for activities such as drinking, swimming, fishing, farming, gathering, or commercial purposes.[1]

ENDNOTES

1 http://ohioline.osu.edu/b873/b873_8.html and http://www.ncdot.org/environment/stormwater/awareness/education/vocabulary.html

SUB-OBJECTIVE 2.1 Maintain and improve sustainable quantities of ground water.

Ground water quantity relates to the amount of renewable ground water that may be extracted on a sustainable basis. Withdrawal rates should remain within established administrative sustainable yields set by CWRM, which protect the long-term viability of the water resource and do not impact natural and cultural environments. Half of Wai'anae's drinking water comes from municipal wells and tunnels located in Waiʻanae and Mākaha Valleys. It is therefore important to maintain the integrity of the aquifer by optimizing pumping levels and by allowing nature to replenish the ground water resources.

Dependable surface water quantity relates to the amount of base stream flow existing on a regular basis. This flow provides many functions, including native species habitat; water for agriculture, cultural practices, and recreation; and fresh water inputs to the near shore ecosystem. Ground and surface water are inextricably linked and should be managed with consideration for both systems.

Mākaha Valley from Mt. Kaʻala.
Photo: Pauline Sato

<u>Strategy 2.1.1 Protect ground water infiltration areas in Mākaha and Waiʻanae Valleys through pro-active land management programs.</u>

The upper forested watersheds of Waiʻanae and Mākaha Valleys are the main ground water infiltration areas in Waiʻanae. These lands are owned by the DLNR and BWS respectively, which provide opportunities to improve, maintain, and protect natural infiltration areas through forest restoration and watershed partnerships.

Additionally, storm water capture should be investigated as a possible way to enhance infiltration. Waiʻanae is typically a dry area, but it often receives storm events in the winter months. Finding a way to capture runoff for use or infiltration could enhance natural ground water stores.

<u>Strategy 2.1.2 Make efficient use of existing ground water supplies in Waiʻanae</u>.

Because Waiʻanae ground water resources are limited, conservation, both by BWS and consumers, is necessary to eliminate waste and avoid overuse of the resource. In addition to conservation, research is needed to establish a water production level for existing ground water wells and tunnels in Mākaha and Waiʻanae that is sustainable during normal rainfall and drought periods. This would also allow for the optimization of existing source production levels by spreading production among several sources at lower pumping levels rather than concentrating pumping to a few sources.

SUB-OBJECTIVE 2.2 Protect the quality of ground and surface water for potable, recreational, and habitat needs.

Water quality is defined by its physical, chemical, and biological characteristics and can be affected by natural processes as well as human activities. Threats to water quality should be minimized for the protection of human health and the environment.

Strategy 2.2.1 Identify sources of contamination, trends, and possible mitigative actions by collecting and analyzing water quality data.

Water quality information for Wai'anae's streams is limited and out-of-date. Updating water quality information would provide for an assessment of the effects of human activities on ground, surface, and near shore waters and provide insights on how to improve and maintain water quality.

Strategy 2.2.2 Reduce the potential for ground water contamination from land-based activities by establishing appropriate land use regulations and controls.

All of Wai'anae's potable water comes from ground water, with about half of it coming from within the district. Regular monitoring, testing, and treatment of potable water supplies is conducted in order to ensure continued high-quality drinking water in support of public health and safety and in compliance with the Safe Drinking Water Standards of the State Department of Health. In addition to these actions, preventive measures should be implemented to reduce conflicts between ground water supplies and potentially contaminating local land uses.

Strategy 2.2.3 Reduce erosion, sedimentation, and contaminated storm water runoff from upland areas, farms, and urban neighborhoods through the implementation of synergistic conservation, restoration, and public education programs.

A water quality improvement program would investigate various surface water contaminant sources and identify and implement ways to reduce them. Actions could include forest restoration and wildfire management to reduce erosion and sedimentation, stream conservation corridors to filter sediments and other contaminants from runoff, education and training to improve environmental behavior, and partnerships to develop solutions and actions to further improve water quality.

Wai'anae Kai-Mākaha Fire, September 2003.
Source: HBWS.

Strategy 2.2.4 Reduce streamside littering and dumping through a combination of public education and enforcement of anti-dumping laws.

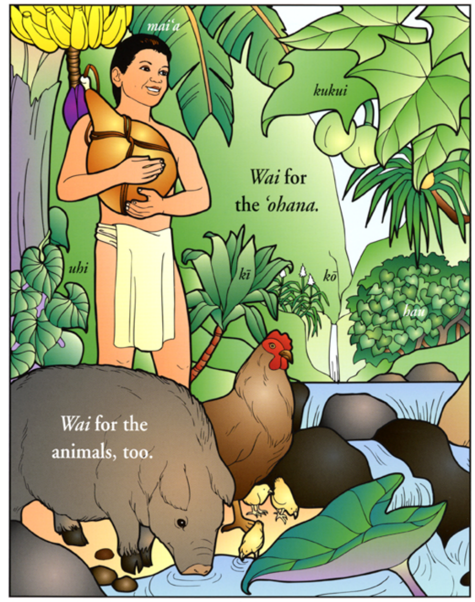
Illegal dumping in the stream beds negatively impacts the dump site and downstream areas as well. Education, preventive measures, enforcement of existing rules and laws, and clean-up actions are needed.

Strategy 2.2.5 Improve the quality of near shore waters from Kahe to Ka'ena Point through a combination of public education and BMPs for storm water management and ocean pollution control.

Pōka'ī Bay is a designated impaired water body that is used extensively for a variety of purposes, such as fishing and swimming. Efforts to ensure maximum health, safety, and ecosystem function should be undertaken, including education on how to improve water quality.

4.3 OBJECTIVE 3: PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES

Native Hawaiian water rights are guaranteed by Article XII, Section 7 of the Hawai'i State Constitution and Section 174C-101 of the State Water Code. In brief, the Code provides for: a) Department of Hawaiian Home Lands water, b) traditional and customary gathering rights, and c) appurtenant water rights of *kuleana* and taro lands. Implementing these rights will mean the provision of adequate stream flows, riparian restoration, control of alien species, and other actions, so that not only are there native stream species present, but that they are in sufficient quantity to allow for gathering and use. Native Hawaiian water uses also include cultural uses for spiritual/religious practices, *kalo* and other traditional agriculture, as well as adequate flows of fresh water into the near shore water ecosystem. While this objective focuses specifically on Native Hawaiian water rights, other plan objectives play a supporting role to assure that there are healthy water resources available for exercising these rights.



Wai'anae: Where I Live
Kamehameha Schools Press.

SUB-OBJECTIVE 3.1 Develop a working relationship with Wai'anae's Native Hawaiian Community for the sustainable management of the District's water resources.

Government agencies have a responsibility to carry out a particular mission, whether it be to provide natural resource management, protection of health and safety, or providing water supplies. In the fulfillment of these missions, agencies may sometimes negatively impact one or more sectors of the community. While such impacts cannot always be avoided, efforts should be made by agencies to understand the needs and desires of the communities being served and to then use that understanding to perform those functions they are tasked to do in the most sensitive manner, and to mitigate impacts as much as possible.

Strategy 3.1.1 Consult with Waiʻanae's Native Hawaiian community through an on-going process to better understand Native Hawaiian rights, values, and cultural practices, and to improve sensitivity to cultural issues.

The BWS is developing its relationship with the Native Hawaiian community, and the Waiʻanae community at large, in order to perform those functions it is tasked to do with sensitivity. Examples of this include consulting with the Hawaiian community prior to constructing pipeline projects in culturally sensitive areas of Waiʻanae; hiring appropriate, qualified cultural monitors; and incorporation of Native Hawaiian concerns and considerations into specific projects, such as the Mākaha Special Area Plan and Cultural Learning Centers.

SUB-OBJECTIVE 3.2 Incorporate traditional Hawaiian values and cultural practices into the modern context.

Traditional values and practices reflect the understanding and close relationship Hawaiian communities had with interrelationships and functions of the natural world. Modern practices and knowledge have developed new ways of understanding and interacting with the natural environment. Identifying relevant traditional Hawaiian natural resource stewardship models and integrating them with current Western management strategies can be an effective way of promoting environmental policies and practices that address biological sustainability and human well-being.

Strategy 3.2.1 Protect and restore watershed structure and functions in order to encourage the interconnectedness and interdependence between the ahupuaʻa of Waiʻanae and community health and well-being.

Many in the Waiʻanae community describe a relationship between environmental and community health, with one being dependent upon the other. Therefore, in order to maintain a viable community, it is essential to protect the natural environment through such actions as forest restoration; watershed education; and resource management training.

Graphical depiction of the ahupuaʻa concept.
Source: CZM Hawaiʻi.

Strategy 3.2.2 Provide technical and funding support for projects and activities that express traditional Hawaiian values and practices.

Traditional Hawaiian values and practices may be viewed as a way to maintain the viability of ecosystem and community health. This can be promoted by investigating and sharing concepts of Wai'anae's history and how it evolved, supporting the community's efforts to continue traditional practices such as taro farming, and supporting watershed grants and educational programs on traditional and customary practices, such as cultural learning centers.

Strategy 3.2.3 Provide better public access to natural resources through the development of paths and trails in the Conservation District.

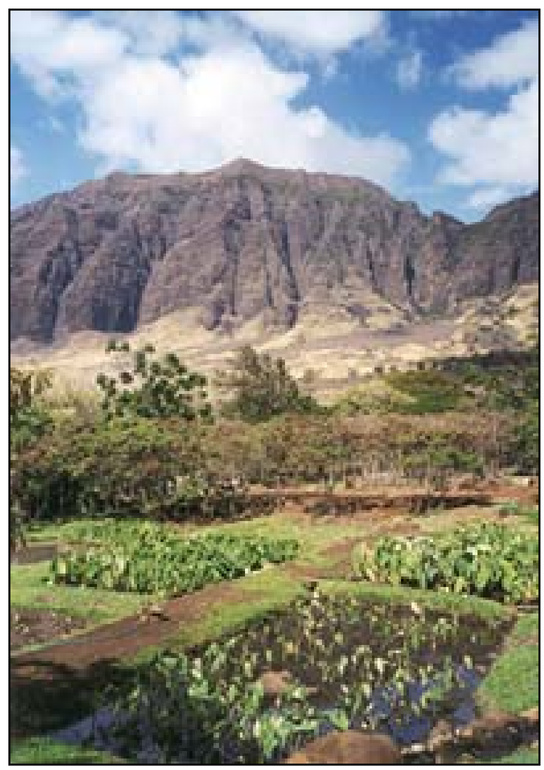
Practice of traditional customs and values relies on the ability of practitioners to access natural resources for both use and management. This access is already provided in part via the existing Wai'anae Kai Community Watershed Partnership and can be reinforced and expanded with additional partnerships between landowners, managers, and practitioners.

Access to resources could also provide educational opportunities to Wai'anae and Nānākuli High Schools and various middle and elementary schools. Outdoor classes in the mauka watersheds could integrate students in watershed management projects and provide field experience and continual learning opportunities in watershed studies, projects, and programs.

Strategy 3.2.4 Protect surface water resources as an integral component in the way that the Native Hawaiian community practices their culture.

The Native Hawaiian community relies on surface water resources in order to continue to exercise traditional and customary practices. In addition to their use for traditional farming methods, streams are also used to gather aquatic flora and fauna and for religious practices.

Protection of surface water resources may be achieved through spring, streamflow, and wetland restoration. Additionally, surface water use should be limited to fulfilling water



Lo'i Kalo at Ka'ala Farm Cultural Learning Center.
Source: Photo by Catherine Black used with permission of Environment Hawai'i, Inc.

rights and restoration of *loʻi kalo*. The development of ground water in Waiʻanae should be limited to those currently existing withdrawals that do not affect base flow or are deemed necessary and irreplaceable. Further ground water development should be pursued only if future adopted instream flow standards identify available surface water.

4.4 OBJECTIVE 4: FACILITATE PUBLIC PARTICIPATION, EDUCATION, AND PROJECT IMPLEMENTATION

Planning and managing our island's water and related resources involves a variety of stakeholders, including end users, landowners, public and private water distributors, and government agencies. A collaborative process can result in innovative planning and implementation that incorporates local knowledge and directly involves area residents. Education of the public on water resource issues can support collaboration with informed stakeholders. Directed water resource curricula for schools will ensure knowledge, and respect for water resources will extend to future generations. Ultimately, public participation will result in benefits to the water resources, water users and the related ecosystems.

SUB-OBJECTIVE 4.1 Partner with the community to promote a sense of *kuleana*, and to balance access to resources with management responsibility.

It is essential to the health of the environment that community members take responsibility for their watersheds. Access to natural resources must be balanced by careful management and education of the various users in order to prevent degradation.

<u>Strategy 4.1.1 Develop programs that promote the intergenerational education of Waiʻanae community members on watershed issues and water conservation measures</u>.

It is important to develop natural resource stewardship models that respect the rights of native Hawaiians and local communities but that also re-establish the responsibilities attached to those rights in a culturally appropriate way. Intergenerational learning among families and community members fosters a sense of responsibility and has been an effective method of passing along information and behavior. This should be developed as a tool to teach watershed education, resource management, and conservation.

<u>Strategy 4.1.2 Form partnerships with Waiʻanae community groups in order to implement specific projects and programs</u>.

Watershed management involves many stakeholders. Partnerships between agencies and communities would tap a wealth of human capital and knowledge that can be used to not only develop better programs, but to also provide support for funding requests and manpower for implementation. There are several existing government agency and community partnerships that have been implementing projects and programs such as forest restoration, stream maintenance, wildfire management, loʻi kalo expansion, and rural landscape studies.

Strategy 4.1.3 Facilitate project implementation by supporting watershed partnerships and non-profit organizations with funding resources and technical assistance when available.

Community groups and organizations often have wonderful vision for watershed management but often require additional technical assistance and expertise to be able to implement their concepts. Where possible, opportunities for grants, appropriations, and other funding should be sought and provided.

SUB-OBJECTIVE 4.2 Partner with agencies at multiple levels to improve efficiency and potential for project implementation.

Agencies and organizations often have similar watershed management objectives in both conservation and urban areas. Partnerships pool funding, resources, and initiatives toward common watershed objectives, resulting in directed watershed projects and programs.

Strategy 4.2.1 Form partnerships with/among Federal, State, and City agencies to implement specific projects and programs.

Partnerships among agencies would help to identify where the overlaps or gaps occur in watershed management and provide for a maximization of efforts. Partnerships are critical for solving water needs due to the interrelatedness of water resource issues. Specific actions that could benefit from agency partnerships include wetland restoration; stream corridor protection; flood mitigation; biological assessments; watershed and water quality research, testing, monitoring, and improvement; surface water inventories; and Special Area Plans.

4.5 OBJECTIVE 5: MEET FUTURE WATER DEMANDS AT REASONABLE COSTS

Water is essential for life, all life. Oahu's people need an abundant and reliable water supply for drinking, irrigation, commercial and industrial use, and fire protection. While a critical component of everyday life, water provision should also be balanced with quality of life, which is reflected by balancing the previous four objectives of this plan. Water demand projections should thus be consistent with the City's "General Plan" and "Sustainable Communities Plan" and should guide the process of selecting the water supply options that will meet projected demands.

Inter-Agency Meeting.

Meeting with the Community.

Cost refers to not only economic costs, but environmental, cultural, and social costs as well. All of these factors must be considered and balanced when identifying appropriate strategies for meeting future demand. Thus, water demands should be met while also balancing the other objectives of the Plan.

SUB-OBJECTIVE 5.1 Provide water at a reasonable cost to the community.

The development and provision of water comes at a substantial economic cost. In providing water supply, costs of capital construction, operations, and maintenance should not place an unreasonable burden on rate-payers.

<u>Strategy 5.1.1 Make the best use of existing sources before developing new water sources</u>.

The development of new water sources requires substantial capital expenditures; therefore, it is more efficient to optimize use of existing supplies, which can then defer the development of new sources. Continued monitoring of Mākaha and Waiʻanae Valley hydrogeology would help to ensure that the pumping of existing wells efficiently meets demands while maintaining withdrawal rates within established sustainable yields, protecting the long-term viability of the ground water source and limiting impacts to natural and cultural environments.

The Pearl Harbor Aquifer currently supplements Wai'anae's in-district ground water supply. In the short to mid-term, existing facilities and infrastructure make continued and increased imports from Pearl Harbor the most cost-efficient method of providing for projected increases in water demand.

<u>Strategy 5.1.2 When new sources are needed, balance least-cost options with environmentally, culturally, and socially acceptable options.</u>

Efficient water systems promote public health and safety and deliver water to meet current and future demands at reasonable costs. The community may welcome the concept of using new technologies, such as recycled or desalinated water, but these options may be cost prohibitive, especially when new complementary infrastructure, such as transmission lines, must be built.

Inexpensive new water supply alternatives, such as additional potable and non-potable well development in Waiʻanae, are necessary for the community to continue to maintain a reasonable standard of living in Waiʻanae and to meet the objective of regional self-sufficiency. However, even these relatively lower cost options need to take into account ancillary infrastructure. For example, while Keaʻau has untapped, small, brackish, ground water sources that could be used to supplement existing supply, the expense of constructing a new well or wells, probable low yields, and the necessary pipelines and pumps, would make this a very costly venture for the little volume it would supply.

Additional potable water imports from Pearl Harbor would also be among the most cost-effective options to meeting increasing demand because transmission lines already exist to transport water from new wells into Wai‘anae. However, similar to ground water extraction in Wai‘anae, consideration must be given to the sustainable yields of the Pearl Harbor Aquifer, and to the growing water demands of ‘Ewa, Central O‘ahu, and the PUC.

When evaluating each option, it is also important to remember that the development of new sources includes more than just economic costs. Impacts of each resource option on the social, cultural, and natural environment need to be considered and balanced so that sustainable yields are not exceeded and surface water flows are maintained for habitat and ecosystem needs.

SUB-OBJECTIVE 5.2 Efficiently meet potable water demands.

Potable water is the highest quality water produced, and is the only kind of water that can be used for drinking and bathing, therefore making it a precious resource. Currently, the only naturally occurring source for potable water is ground water aquifers, which have finite sustainable yields. With the population on O‘ahu and throughout the State growing, every effort should be made to make the best use of potable water supplies, thereby providing for domestic needs and maintaining affordability.

<u>Strategy 5.2.1 Match water quality to appropriate uses and balance water use with potable and non-potable water availability</u>.

As a rural community, Wai‘anae has a large agricultural base and extensive open spaces. Currently, agriculture and landscape irrigation account for approximately 26 percent of Wai’anae’s total water demand, with potable water being used to serve a large portion of this non-potable demand. The quality of the water supply should correspond to the use such that high-quality water is used for drinking and lower quality, non-potable water is used for irrigation and industrial processes.

If non-potable water resources can be affordably developed, existing irrigation uses can be converted from high-quality potable water to non-potable water, thereby freeing up ground water for domestic purposes. This is important not only to continue to provide water for Wai’anae’s growth, but also to account for the ‘Ewa District’s growing needs as well. Possible non-potable water sources in Wai‘anae include the development of new or re-use of existing brackish ground water wells in the lower valley areas, storm water capture, and recycled water, both on the municipal scale and on the individual user scale. Surface water flows are limited, and should therefore provide for instream and traditional uses rather than for municipal purposes.

Strategy 5.2.2 Continue with BWS' ongoing proactive leak detection and repair program and other infrastructure water conservation measures.

Minimizing leaks in transmission systems will reduce operating costs and the amount of water wasted. The BWS will continue its proactive leak detection and repair program and implement the renewal and replacement program for BWS water system facilities, pipelines, pump stations, reservoirs and treatment systems. BWS will also promote advanced corrosion protection programs to maximize the life of existing and new pipelines.

BWS workers repairing water main on Farrington Highway.
Source: Star-Bulletin

Strategy 5.2.3 Develop programs to implement "grass roots" water conservation.

Water conservation is not just the responsibility of water purveyors; it is also the responsibility of consumers as well. Demand-side management of water resources includes education and outreach to promote water-saving behavior and the promotion of water-efficient fixtures as well, thereby making water conservation not just a message for Oahu's residents, but a way of life. Maintaining and expanding advanced water conservation programs will protect existing resources and defer development of new water sources.

SUB-OBJECTIVE 5.3 Improve and maintain BWS water system reliability.

Reliable water systems ensure that high-quality water is consistently provided where needed. Reliability can be achieved through diversification of sources and improvements to and maintenance of transmission and other facilities. A reliable system can minimize the frequency, magnitude, and duration of water shortages, and ensure a consistent supply of high-quality water to customers.

BWS 2006 Water Conservation Calendar.

Reliability of water supply can be obtained in various ways. A secure system can ensure a safe and un-interrupted water supply. Infrastructure must be periodically upgraded, including back-up sources, in-district reservoir storage, and emergency generators. The effectiveness of these measures will be transparent to users who depend on reliable water delivery and expect the reliability to be provided at a reasonable cost. Also, Objective #2, "Protect and Enhance Water Quality and Quantity," contains strategies that support BWS system reliability by protecting ground water sources and aquifer quality and integrity.

Strategy 5.3.1 Continue to provide high quality drinking water that meets or exceeds Safe Drinking Water Standards.

Disinfection and treatment protocols are used by BWS to meet existing Safe Drinking Water Standards, which are continuously monitored in order to anticipate changes. Water sources are continuously tested for regulatory and operational compliance. Various ongoing BWS initiatives and actions implement this strategy. Additionally, source waters should be protected to prevent contamination from land-based activities, thereby relieving the need for treatment.

Strategy 5.3.2 Continue with BWS' ongoing main replacement program, and other system upgrades.

In order to achieve water system reliability, it is important to upgrade the water system infrastructure to meet BWS water system standards, thereby providing sufficient standby capacity and system integration. A series of evaluations were conducted to assess the condition of the water system including: hydraulic efficiency, system capacity, regulatory compliance, and aesthetic quality of the water. The BWS program of infrastructure improvements includes treatment plants, pipeline renewals, pump stations, storage capacity, fire flows, service pressures, and transmission system redundancy. Plant operational strategies for the transmission and distribution systems from Pearl Harbor to Wai'anae will meet the range of water demands while optimizing ground water source pumpage, power consumption, and infrastructure improvements.

Future growth in Wai'anae will require upgrades to the existing line booster stations importing Pearl Harbor water into Wai'anae and a new reservoir to meet the maximum daily demand. The target rate of water main renewal and replacement for 2,000 miles of pipeline on O'ahu should be about 29 miles per year based on a 70-year life span, however, funding availability and competing priorities will influence the capital improvement program schedule.

The BWS capital program identified an average of approximately $35 million dollars per year in island-wide improvements to be undertaken over the next 6-year period, 2006-2011. With the significant capital investment in parallel pipeline infrastructure along Farrington Highway, Wai'anae's water system will be in good condition, with the remaining secondary infrastructure to be replaced during the upcoming decades.

Strategy 5.3.3 Optimize system operations.

The BWS system can be optimized to provide flexibility, reliability, and efficiency and potentially reduce operating costs. Ground water withdrawals are monitored and optimized. Leak detection programs, back-up supplies, standby generators, and preventive emergency maintenance procedures provide reliability to system operations. Optimizing the distribution of source pumpage described in Strategy 2.1.2 with efficient water system operations to meet demands is a continuing challenge.

Strategy 5.3.4 Implement security measures.

Preserving system reliability also means ensuring security of the water sources and reservoirs to prevent the risk of contamination and system failure. Security measures include hardening of facilities, operating the security system program and having emergency response plans in place. Various ongoing BWS initiatives and actions implement this strategy.

Strategy 5.3.5 Diversify water supply systems.

A water supply system diversified to include ground water, surface water, recycled water and desalinated water will maximize system flexibility and reliability especially during periods of drought and high growth spurts. For example, desalinated, recycled, and brackish water resources are not affected by drought conditions, and can provide added reliability to existing potable ground water supplies in meeting high demands and relieve the reduction of ground water levels during prolonged drought periods.

BWS is continuing to research the technology to improve the processing efficiency and cost effectiveness of recycled water and desalination. Research also continues on deep, cold ocean water applications—including production of electricity, desalination, district cooling systems, aquaculture, and agricultural irrigation. This research will provide opportunities for renewable resources and economic development. Recycled water could also replace potable water that is currently being used for irrigation, thus "releasing" potable water for domestic use.

Additionally, an integrated municipal water system will allow for an accounting of uncertainties such as droughts and an expansion that is concurrent with land use plans and growth forecasts.

Concepts identified in the development of the strategies were investigated and written up as projects or programs in Chapter 5. Some of these projects were determined to be infeasible. Explanation of these determinations is provided in the project write-ups.

Table 4-1 below provides a summary of the objectives, sub-objectives and strategies that are presented in this chapter.

TABLE 4-1
SUMMARY OF OBJECTIVES, SUB-OBJECTIVES, AND STRATEGIES

OBJECTIVE 1. PROMOTE SUSTAINABLE WATERSHEDS	
Sub-Objective 1.1 Strive to enhance and protect natural resources	Strategy 1.1.1 Restore natural watershed structure and functions through the implementation of incremental, long-term ecosystem restoration programs. Strategy 1.1.2 Preserve species and habitat biodiversity by assessing and restoring critical water-related habitats.
Sub-Objective 1.2 Strive for regional self-Sufficiency, where practical.	Strategy 1.2.1 Implement resource conservation and demand-side management programs that conserve ground water and surface water resources. Strategy 1.2.2 Stabilize water imports from the Pearl Harbor Aquifer by providing alternative sources for both potable and non-potable water. Strategy 1.2.3 Implement a "slow growth" policy in alignment with the rural character envisioned in the Wai'anae Sustainable Communities Plan."
Sub-Objective 1.3 Protect the community from natural and human-induced disasters.	Strategy 1.3.1 Implement flood reduction actions and maintain flood protection when modifying or implementing other projects.
OBJECTIVE 2. PROTECT AND ENHANCE WATER QUALITY AND QUANTITY	
Sub-Objective 2.1 Maintain and improve sustainable quantities of ground water.	Strategy 2.1.1 Protect ground water infiltration areas in Mākaha and Wai'anae Valleys through pro-active land management programs. Strategy 2.1.2 Make efficient use of existing ground water supplies in Wai'anae.
Sub-Objective 2.2 Protect the quality of ground and surface water for potable, recreational, and habitat needs.	Strategy 2.2.1 Identify sources of contamination, trends, and possible mitigative actions by collecting and analyzing water quality data. Strategy 2.2.2 Reduce the potential for ground water contamination from land-based activities by establishing appropriate land use regulations and controls. Strategy 2.2.3 Reduce erosion, sedimentation, and contaminated storm water runoff from upland areas, farms, and urban neighborhoods through the implementation of synergistic conservation, restoration, and public education programs. Strategy 2.2.4 Reduce stream side littering and dumping through a combination of public education and enforcement of anti-dumping laws. Strategy 2.2.5 Improve the quality of near shore waters from Kahe to Ka'ena Point through a combination of public education and BMPs for storm water management and ocean pollution control.

TABLE 4-1 (Continued)

OBJECTIVE 3. RESPECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES	
Sub-Objective 3.1 Develop a working relationship with the Wai'anae Native Hawaiian Community for the sustainable management of the District's water resources.	Strategy 3.1.1 Consult with Waianae's Native Hawaiian community through an on-going process to better understand Native Hawaiian rights, values, and cultural practices, and to improve sensitivity to cultural issues.
Sub-Objective 3.2 Incorporate traditional Hawaiian values and cultural practices into the modern context.	Strategy 3.2.1 Protect and restore watershed structure and functions in order to encourage the interconnectedness and interdependence between the ahupua'a of Wai'anae and community health and well-being. Strategy 3.2.2 Provide technical and funding support for projects and activities that express traditional Hawaiian values and practices. Strategy 3.2.3 Provide better public access to natural resources through the development of paths and trails in the Conservation District.
OBJECTIVE 4. FACILITATE PUBLIC PARTICIPATION, EDUCATION AND PROJECT IMPLEMENTATION	
Sub-Objective 4.1 Partner with the community to promote a sense of kuleana, and to balance access to resources with management responsibility.	Strategy 4.1.1 Develop programs that promote the intergenerational education of Wai'anae community members on watershed issues and water conservation measures. Strategy 4.1.2 Form partnerships with Wai'anae community groups in order to implement specific projects and programs. Strategy 4.1.3 Facilitate project implementation by supporting watershed partnerships and non-profit organizations with funding resources and technical assistance when available.
Sub-Objective 4.2 Partner with agencies at multiple levels to improve efficiency and potential for project implementation.	Strategy 4.2.1 Form partnerships with/among Federal, State, and City agencies to implement specific projects and programs.
OBJECTIVE 5. MEET FUTURE WATER DEMANDS AT REASONABLE COSTS	
Sub-Objective 5.1 Provide water at a reasonable cost to the community.	Strategy 5.1.1 Make the best use of existing sources before developing new water sources. Strategy 5.1.2 When new sources are needed, balance least-cost options with environmentally, culturally, and socially acceptable options.
Sub-Objective 5.2 Efficiently meet potable water demands.	Strategy 5.2.1 Match water quality to appropriate uses and balance water use with potable and non-potable water availability. Strategy 5.2.2 Continue with BWS' ongoing proactive leak detection and repair program and other infrastructure water conservation measures. Strategy 5.2.3 Develop programs to implement "grass roots" water conservation.
Sub-Objective 5.3 Improve and maintain BWS water system reliability.	Strategy 5.3.1 Continue to provide high quality drinking water that meets or exceeds Safe Drinking Water standards. Strategy 5.3.2 Continue with BWS' ongoing main replacement program, and other system upgrades. Strategy 5.3.3 Optimize system operations. Strategy 5.3.4 Implement security measures. Strategy 5.3.5 Diversify water supply systems.

5 WATERSHED MANAGEMENT PROJECTS AND PROGRAMS

Plan objectives, sub-objectives, and strategies were developed and articulated in Chapter 4. The strategies suggest potential actions that would address the watershed issues and problems identified through the Watershed Profile and Stakeholder Consultation described in Chapter 2. As potential actions were examined more closely, some were eliminated based on stakeholder input or because similar actions were already being implemented. Additional concepts were added by agencies, organizations, and the study team based on their expertise and observations made during the course of the analysis.

The list of potential actions was then further researched, evaluated for feasibility in Waiʻanae, and described in project write-ups found later in this chapter. During this process, several projects were eliminated from further consideration as a component in the final plan due to limited benefit, disproportionately high costs when compared to benefits, or other related factors.

5.1 WATERSHED PROJECTS AND PROGRAMS

On the following page is a list of the 32 potential actions that could be implemented to improve the health of the Waiʻanae watershed. Actions are grouped into one of five categories to provide some reference to the issue they address: (1) Water Supply Options, (2) Ground Water, (3) Surface Water, (4) Land Management, and (5) Cultural/Educational Support.

WAIʻANAE WATERSHED MANAGEMENT PROJECTS AND PROGRAMS

WATER SUPPLY OPTIONS

01 Additional Potable Water Imports From the Pearl Harbor Aquifer
02 Develop Additional Waiʻanae Aquifer Sector Ground Water Resources – Potable Water
03 Develop Additional Waiʻanae Aquifer Sector Ground Water Sources – Brackish Water
04 Develop Surface Water Sources
05 Storm Water Capture
06 Recycled Water: Waiʻanae Wastewater Treatment Plant
07 Recycled Water: Membrane Bioreactors (MBRs) for Single Users
08 Desalinated Water – From BWS Kalaeloa Desalination Plant
09 Desalinated Water – From New Waiʻanae Desalination Plant
10 BWS Water Conservation

GROUND WATER

11 Hydrogeology Study
12 Waiʻanae Source Water Protection Plan
13 Drought Mitigation Strategies

SURFACE WATER

14 Measurable Instream Flow Standards
15 Stream Conservation Corridor Project
16 Wetlands Restoration and Protection
17 Concrete Flood Channel Redesign
18 Stream Biological Assessments
19 Water Quality Testing and Monitoring
20 Stream Dumping Prevention and Clean Up
21 Surface Water Inventory
22 Surface Water Quality Improvement

LAND MANAGEMENT

23 Forest Restoration Program
24 Wildfire Management Plan
25 *Loʻi Kalo* Expansion Program
26 Mākaha Research Watershed
27 Agricultural Support Program
28 Flood Mitigation Program
29 Mākaha Special Area Plan

CULTURAL/EDUCATIONAL SUPPORT

30 Waiʻanae Watershed Partnership
31 Cultural Learning Centers
32 Community Watershed Education Program
33 Waiʻanae Rural Landscape Study

5.2 PROJECT DESCRIPTIONS

The following are descriptions of those projects that were identified as potential actions that could be implemented to improve watershed health and fulfill the objectives and sub-objectives described in Chapter 4. All but one of the project write-ups uses a two-page format to describe the general need for action, as well as what actions should be undertaken by the project. Project 10, Water Conservation Programs, has significant importance to warrant an extensive description.

Water Supply Options, projects 01 through 10, are described in terms of occurrence, current and potential future use, cost, development issues and limiting constraints, and conclusions: feasibility for Wai'anae. The remaining watershed projects are described in terms of a problem statement, general background, general actions and best management practices, the issues in Wai'anae, preliminary scope, potential participating entities, cost, and references.

The proposed strategies and projects within this plan are the result of a comprehensive watershed analysis and stakeholder consultation process. The projects may involve various governmental agencies and non-governmental organizations. The implementation and funding of these projects are not the sole responsibility of the Board of Water Supply, City and County of Honolulu, or State of Hawai'i. This Plan is intended to guide agencies and organizations in implementing the most important initiatives for Wai'anae watersheds and water resources; however, implementation will depend on budgetary priorities, the availability of grants, and partnering efforts over the long term.

PROJECT 01: ADDITIONAL POTABLE WATER IMPORTS FROM THE PEARL HARBOR AQUIFER (pg. 1 of 2)

Occurrence

The most significant ground water body that supplies Oahu's potable water needs is the Pearl Harbor Aquifer Sector Area, comprised of three major aquifer system areas: Waimalu, Waipahu-Waiawa, and ʻEwa-Kunia. The Waimalu Aquifer System Area mainly supplies the Primary Urban Center (PUC) and East Honolulu DP Areas, while the Waipahu-Waiawa Aquifer System Area supplies ʻEwa, Central Oʻahu, Waiʻanae, and an increasingly larger amount to the PUC. The ʻEwa-Kunia Aquifer System Area supplies the ʻEwa and Waiʻanae DP Areas.

The total adopted administrative sustainable yield for the Pearl Harbor Aquifer Sector Area is 165 mgd (See Table 3-5 – "PEARL HARBOR AQUIFER SECTOR AREA SUMMARY") based on ideal, optimal well locations. The current SY for Waipahu-Waiawa and ʻEwa-Kunia are based on a model that protects existing infrastructure in Pearl Harbor and Honolulu. CWRM's action in 2000 to adopt new SYs accounted for reduced irrigation return recharge resulting from the cessation of sugarcane agriculture.

Due to uncertainties regarding the new SY estimates for Waipahu-Waiawa and ʻEwa-Kunia, CWRM conditioned the adoption upon adherence to a set of milestones for pumpage and water use allocation. Deep monitor wells were drilled and additional ground water modeling calibrated to the monitor well data is ongoing. The model will help to refine SYs, site new wells and optimize pumpage to ensure the sustainability of the aquifer systems.

The Waimalu Aquifer System Area is over-allocated by about 2.0 mgd and ʻEwa-Kunia has only 0.54 mgd available for allocation, but operational experience indicates that the aquifer has brackish tendencies, requiring blending to potable levels, or non-potable use of new sources. The Waipahu-Waiawa Aquifer System Area is conditioned by the CWRM milestone framework and has allocatable SY available. To maintain the long-term integrity of the Waimalu Aquifer, BWS is planning to reduce current allocation and pumpage from specific wells and replace this with additional pumpage from existing and new sources in the Waipahu-Waiawa Aquifer System Area. The extent of this reduction will be dependent upon the results of the new calibrated ground water model.

Current and Potential Future Use

The Waiʻanae District's CY 2000 average potable water use was about 9.3 mgd, of which about 4.4 mgd was imported from the Pearl Harbor Aquifer via a transmission main that runs along Farrington Highway from BWS' Hōʻaeʻae, Kunia I, and Kunia III wells in Central Oʻahu. The water is pumped to the BWS Nānākuli, Lualualei, and Waiʻanae Reservoirs. The selected demand scenario projects that the Waiʻanae District will increase its water demand by approximately 2.7 mgd by the year 2030. Pearl Harbor Aquifer water import to Waiʻanae is expected to increase to 7.2 mgd by 2030.

Based on DPP 2030 population projections, the BWS-adjusted served population for the ʻEwa District will be 190,099 people– an increase of 128,439 people and 208 percent over the year 2000 population of 61,660 (see Table OV.1 in the Oʻahu Water Management Plan Overview). At a per capita water use of about 223.58 gallons per capita per day, per the recent BWS Rate Study, this additional ʻEwa population will require about 27.2 mgd more than the 2000 population.

PROJECT 01: ADDITIONAL POTABLE WATER IMPORTS FROM THE PEARL HARBOR AQUIFER (pg. 2 of 2)

The Central O'ahu District, although not projected to grow as rapidly as the 'Ewa District, is expected to require an additional 6.4 mgd by 2030. Additionally, the PUC is expected to require an additional 13.5 mgd by 2030. Thus, any increased import of water from the Pearl Harbor Aquifer Sector Area into Wai'anae to meet "High Growth" trends will become more uncertain. Seawater desalination or additional wells in Wahiawā and the North Shore will need to be brought on-line. Meanwhile, additional hydro-geologic studies will be conducted to confirm sustainable yields and siting of any additional ground water wells.

Cost

In order to increase system capacity and reliability, BWS is planning improvements at the existing Barbers Point and Lualualei Line Booster pumping stations so that additional Pearl Harbor water can be delivered to Wai'anae users. The estimated cost of the booster station is $3.79 million. The cost of developing new well stations with Granular Activated Carbon treatment systems is estimated at $3.38/gallon.

Development Issues and Limiting Constraints

Wai'anae relies on water imported from the 'Ewa District because its own water resources are limited. Continued and increased imports of Pearl Harbor Aquifer Sector Area water may be constrained by the competing water needs of the rapidly developing 'Ewa, Central O'ahu, and PUC Districts, as well as anticipated reductions in Waimalu and Honolulu Aquifer sources from pump optimization actions. There is also the uncertainty of future decisions on available SY as deep-monitor-well-calibrated 3D ground water models are developed. Prudent planning suggests using a conservative SY estimate and seriously planning for either seawater desalination or regional import from the North Shore, if water is available. BWS is planning for the construction of the Kalaeloa seawater desalination plant in its capital program.

Conclusions: Feasibility for Wai'anae

Increasing water imports from the Pearl Harbor Aquifer Sector Area is a relatively cost-effective solution to Waianae's short-term and possibly longer-term future water needs. However as demand grows in 'Ewa, Central Oahu and the PUC, and the Waipahu-Waiawa Aquifer Sector Area becomes fully allocated, other water supply options will need to be developed. While imports could continue to occur in the long-term, it is important that Wai'anae diversify its water supplies to include brackish and recycled water to offset any import shortfalls and to become more self-sufficient.

North Shore ground water import to Wai'anae: It should be noted that potable water could theoretically be imported directly into Wai'anae from the North Shore via Ka'ena Point or Wahiawa-'Ewa. Aquifers in the North Shore District have a large unused SY as compared to current use within the District. However, high capital costs would be incurred for new transmission infrastructure – pumps, water mains, etc. North Shore and Wai'anae community members will have issues with any proposed transport of North Shore water to Wai'anae without first identifying and planning for North Shore's agricultural needs and addressing potential growth issues along the route of the new transmission main.

PROJECT 02: DEVELOP ADDITIONAL WAIʻANAE AQUIFER SECTOR GROUND WATER RESOURCES – POTABLE WATER (pg. 1 of 2)

Occurrence

The Waiʻanae and Mākaha Aquifer System Areas have developed a significant portion of their sustainable yields. Other aquifers in Waiʻanae have not been developed to a large extent because of infeasible development conditions. Mākaha and Waiʻanae Aquifer System Areas have deeper, thicker basal water lenses that are better suited to sustain large yield sources than the thinner lenses of other Waiʻanae aquifers that have marginal or very low source yield potential. Similarly, the alluvial lenses of Waiʻanae aquifers do not contain significant quantities of water for potable water development.

Current and Potential Future Use

FY 2005 was a wet year and BWS pumpage from the Mākaha and Waiʻanae aquifers was approximately 4 mgd. This potable water served the Mākaha-Waiʻanae end of the BWS system. Current use of the Navy's Lualualei Shaft, located in the Lualualei Aquifer System Area, is approximately 0.1 mgd.

Small potable ground water wells could be drilled into the dike formations of the Lualualei and Keaʻau Aquifer System Areas, but with possible impacts to perennial stream segments in the *ma uka* valleys and a high degree of uncertainty in finding cost effective yields. Water in the young alluvium also needs more exploration despite the lower potential yield per well.

Cost

Estimated costs for the development of small potable water wells in the Lualualei and Keaʻau Aquifer System Areas exceed $12.00 per gallon in capital costs, which are higher than desalination costs. The high costs are attributable to the low well yields of about 0.1 mgd per well and long transmission mains to develop wells, e.g., in the back of Kahanahāiki and Mākua Valleys.

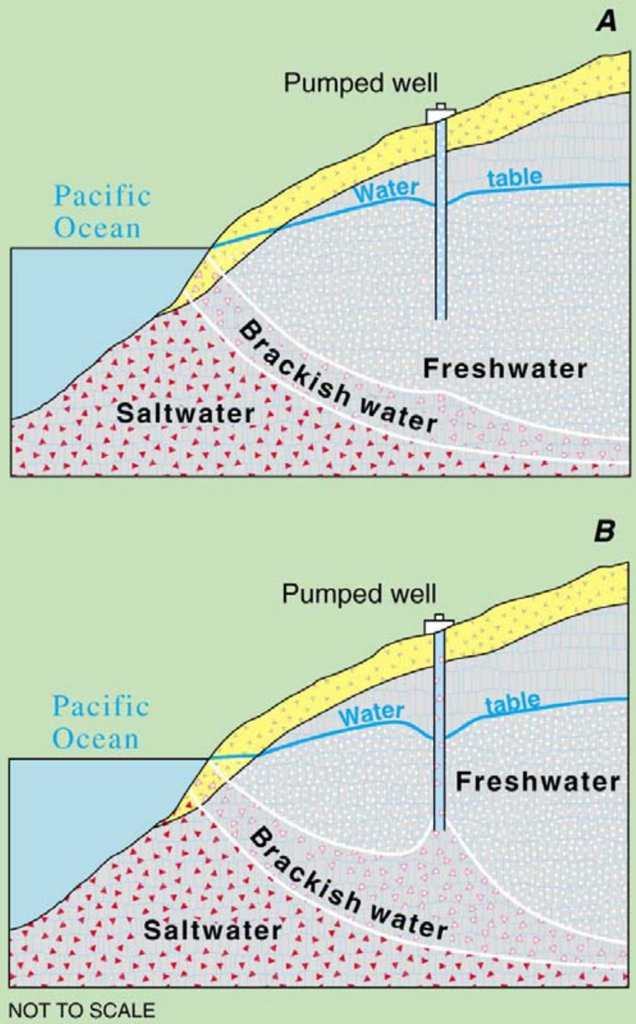
Development Issues and Limiting Constraints

Access is a major limiting constraint to well development in the Lualualei and Keaʻau aquifers due to extensive military land holdings and their associated activities. Extensive infrastructure costs and low well yields are equally limiting constraints. Many small wells would be needed to extract amounts close to the adopted sustainable yield. For example, the Nānākuli Well produced only 50,000 gpd. To extract the 1.0 mgd adopted sustainable yield, 20 wells would be required. This is not economically or realistically achievable.

Lastly, most of the developable water in these untapped aquifers is located in the dike formations in the *ma uka* valleys. Impacts to streams and forest health would need to be evaluated prior to well development. Amendments to the interim instream standards would be required if well withdrawals are found to impact stream flows. These limiting constraints are very significant and create a large degree of uncertainty.

PROJECT 02: DEVELOP ADDITIONAL WAI'ANAE AQUIFER SECTOR GROUND WATER RESOURCES – POTABLE WATER (pg. 2 of 2)

Conclusions: Feasibility for Wai'anae
The development of additional Wai'anae Aquifer Sector Area potable ground water wells is constrained by military land use, low yield and potential stream flow impacts if dike water is developed. New water would have high economic costs as well as potentially high social and environmental costs. Therefore, this alternative has a low feasibility rating.



*Saltwater intrusion is a potential problem near the coast. (**A**) Diagram of a well completed in a volcanic-rock aquifer in which withdrawal is small. Only limited saltwater intrusion has taken place. (**B**) Diagram of the same well under conditions of large ground-water withdrawal. Pumping has lowered the water table and caused the freshwater lens to thin. Brackish water has reached the well.*

USGS Groundwater in Hawai'i

PROJECT 03: DEVELOP ADDITIONAL WAIʻANAE AQUIFER SECTOR GROUND WATER RESOURCES – BRACKISH WATER (pg. 1 of 2)

Occurrence

The report "Nonpotable Water for the Leeward District," prepared for the BWS by George A.L. Yuen and Associates, Inc., and dated May 1996, includes a brief analysis of the potential for brackish, non-potable water wells in the Waiʻanae District. The report notes that:

"Nonpotable water development in the Waianae Sector will use drilled wells penetrating to the saturated zone in three aquifer types: Waianae basalt, valley limestone and valley alluvium. In all instances the opportunities to successfully develop a supply useful for irrigation are fraught with uncertainties. Risk of failure probably exceeds the likelihood of success, and cost of development for the amount of water obtained will be high. As a general rule, all drilling attempts would have to be considered exploratory in the sense that pumping a water supply suitable for irrigation on a long term basis would have to be proved by both pumping tests and operational experience. The regions of interest are limited to the lower reaches of valleys below an elevation of about 80 feet and the noses and sides of basalt ridges up to a mile inland below an elevation of 150 feet."

Current and Potential Future Use

During and after the plantation era in Waiʻanae, many shallow wells were dug to provide water, as there was no City service yet in the area. Most of these wells have been abandoned, although a few may still be in use by individual farmers. CWRM has approximately 230 wells on record in the Waiʻanae District. See "Well Inventory," Appendix C.

There are two existing unused brackish water sources that previously provided drinking water to the old suburban water supply company serving Nānākuli and Lualualei. These sources could be rehabilitated for brackish water irrigation.

- The Nānākuli Shaft (State Well No. 2308-01) produced about 0.05 mgd and is located along Nānākuli Stream about 4,000 feet *ma uka* from the coast. Water could be used in agricultural lands along Nānākuli Stream. *Loʻi kalo* could be restored and the resulting flow through could support wetlands in the estuary.
- The Lualualei Shaft (State Well No. 2508-02) produced about 0.25 mgd and is located near the *ma kai* fence line of the Lualualei Naval Magazine at the end of Hakimo Road. Water could be used for farms along Hakimo Road to offset potable water use. A 6-inch cast iron main still runs from the shaft to Hakimo Road and rehabilitation of this water main could reduce distribution costs. An exploratory well for a proposed golf course adjacent to the shaft defined the water body. It should be noted that this well is located near, but upgradient of, known landfills.

The Yuen report recommends developing shallow drilled wells, typically six inches in diameter, with a per well capacity of less than 100 gpm = 144,000 gallons in 24 hours. These small agricultural wells could be installed where needed but the expected elevated chloride levels will limit the types of crops grown. Conservatively, only about 10 to 20 of these small wells could prove to be productive for irrigation. Well development is likely to be diminished by a poor ratio of successful to unsuccessful wells and by excessive cost of development.

PROJECT 03: DEVELOP ADDITIONAL WAIʻANAE AQUIFER SECTOR GROUND WATER RESOURCES – BRACKISH WATER (pg. 2 of 2)

Cost
According to the Yuen report, typical cost for a six-inch well, including submersible pump, security fence, electrical service, and contingency, would be about $60,000 per well adjusted for inflation. If 10 to 20 small brackish water wells were developed at an estimated yield of 30,000 gpd per well, the cost would be in the range of $600,000 to $1,200,000. This cost does not include transmission, storage, operations, or maintenance costs.

A BWS planning level cost estimate for the rehabilitation of the two shafts for brackish irrigation water is estimated between $200,000 to $300,000 each, not including distribution system costs.

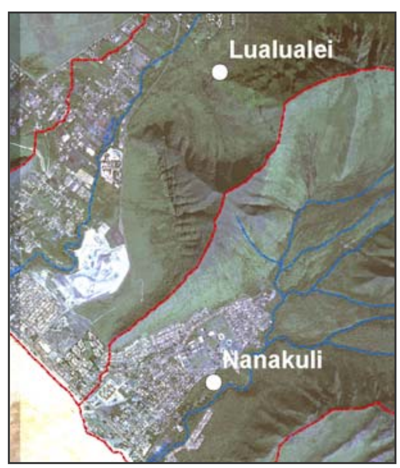
Development Issues and Limiting Constraints
As noted in the Yuen report, efforts to develop small brackish water wells in the Waiʻanae ahupuaʻa are likely to meet with many "dry holes." The primary constraint therefore is the lack of sufficient yield and poor water quality of Waianae's caprock and basalt resources below the 150′ elevation.

BWS experience has shown that water from brackish wells can experience significant fluctuations in chloride content. In addition, the brackish water lens in this area of Oʻahu is thin and subject to upconing and salt water intrusion. Blending brackish water with potable water is possible in those cases where the brackish water's salinity is too high for certain kinds of farm crops.

The development issues on the rehabilitation of the two existing shafts include landowner consent and cost of the pump, controls and distribution system to nearby farms. The shafts are proven, productive sources, reducing investment risk, but they should be test pumped to determine pumping levels that stabilize chlorides.

Conclusions: Feasibility for Waiʻanae
The development potential of new brackish ground water sources in Waiʻanae is low and not feasible except for a limited amount of small, low yield on-site wells. The rehabilitation of the two shafts show the most promise as proven water sources for agricultural lands immediately adjacent.

BWS provides subsidized irrigation water for farms in the District but as BWS operating costs increase, water rates will follow. If federal/state assistance can reduce the capital cost of rehabilitating the two shafts, the operating costs could remain affordable. Increases in competing water uses of the Pearl Harbor aquifer will decrease the availability of Pearl Harbor imports into Waiʻanae. Brackish water sources should be pursued to provide useable irrigation water and reduce Waianae's reliance on Pearl Harbor imports. This option although limited, has a moderate feasibility rating.



Potential non-potable well restoration sites at Lualualei and Nānākuli.

PROJECT 04: DEVELOP SURFACE WATER SOURCES (pg. 1 of 2)

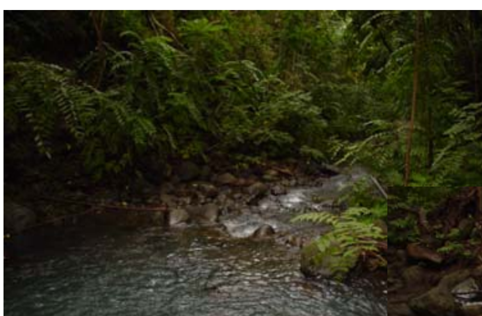
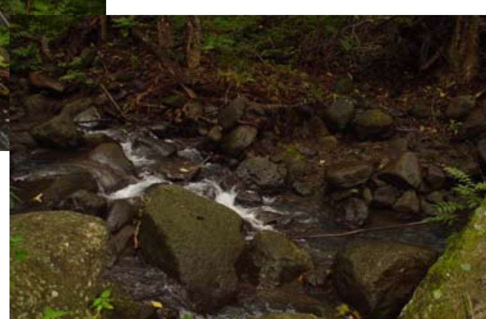
Occurrence

Surface water occurs in the two intermittent streams in the Waiʻanae District: Mākaha and Kaupuni Streams with perennial flows in their upper reaches and subsurface flow in their lower reaches. Other very low to intermittent surface water sources occur in the *ma uka* watersheds in the form of various springs and other stream segments throughout the District.

Current and Future Use

Use of surface water in Waiʻanae is limited to a very small amount of non-potable water use, mainly for agricultural irrigation and taro loʻi. There are small stream diversions on Nānākuli and Kaupuni streams.

There is significant existing and future non-potable agricultural water demand in Waiʻanae that could theoretically use surface water. However, additional off-stream use contradicts stream restoration efforts and therefore should be limited to the fulfillment of appurtenant rights and public trust water uses of instream and traditional and customary use.


Mākaha Stream – interrupted stream..

PROJECT 04: DEVELOP SURFACE WATER SOURCES (pg. 2 of 2)

Cost

Stream diversion systems to fulfill water rights and support lo'i kalo would be relatively low cost to develop, depending on the proximity of the use to the perennial stream segment, located in the ma uka watersheds.

Development Issues and Limiting Constraints

Stream flows in Wai'anae are relatively small and located in the *ma uka* watersheds in conservation districts. Access to lands appurtenant to flowing segments is limited. Restoration of stream diversions, *'auwai* and *lo'i kalo* may be possible in conjunction with watershed partnerships and cultural learning centers that could pool resources and leverage grant funding.

Conclusions: Feasibility for Wai'anae

There is insufficient surface water in Waianae's streams to support large-scale nonpotable uses. Additional stream diversions contradict stream restoration efforts and should be limited to fulfilling water rights and the restoration of *lo'i kalo*.

BWS is not planning any new potable dike sources in the *ma uka* watersheds of Wai'anae because of potential stream impacts and high economic costs. If in the future, when instream flow standards are adopted for Waianae's streams and in the unlikely event that surface water becomes available, BWS could pursue ground water sources that may reduce streamflow or other entities could pursue additional stream diversions for agriculture.

In the pre-contact era, the Native Hawaiians cultivated taro in the mid to upper areas of Wai'anae and Mākaha *ahupua'a*. For more information on *lo'i kalo* restoration, see the description of the "*Lo'i Kalo* Restoration Project."

Photo courtesy of Harry Ako.
(http://starbulletin.com/2002/07/news/story2.html)

PROJECT 05: STORM WATER CAPTURE (pg. 1 of 2)

Occurrence

Storm water runoff that occurs in valleys during a rainfall event can be retained and used as a water resource for direct use. Retained runoff water can also be used to increase recharge of aquifers and stream flow.

Types of structures that could be constructed to impound or retain runoff are Dams and Sedimentation Basins. Such structures could retain large volumes of water during storm events. The stored water would then percolate slowly down into the underlying rocks or alluvium.

Current and Potential Future Use

Examples of storm water capture on O'ahu are Nu'uanu reservoir and Ho'omaluhia reservoir for flood control and fisheries. Wahiawa reservoir is also used for agricultural irrigation.

A recent report prepared for the U.S. Department of the Interior, Bureau of Reclamation (BOR), entitled "Hawaii Storm Water Reclamation Appraisal Report" (July 2005) analyzes the feasibility of thirty-one "storm water reuse" opportunities in the Hawaiian islands, including a project for the Wai'anae Agricultural Park in Wai'anae Valley. This Ag Park is currently using BWS potable water for the irrigation of various crops.

The report presents the concept of constructing a storm water diversion ditch and detention reservoir on the slopes of Kamaileunu Ridge, just *ma uka* of the 150-acre Wai'anae Agricultural Park. Approximately 100-acres of the Ag Park are suitable for farming. The diversion ditch had already been planned by the state Department of Agriculture (DOA) as a flood mitigation project before the initiation of the BOR study.

The reservoir would be about 25 acre-feet (approximately eight MG) in size, and would capture storm water runoff during the wetter months of the year in sufficient quantities to irrigate approximately 10 acres of the Ag Park. The report estimates that the diversion ditch would capture and convey to the reservoir approximately 45 acre-feet of runoff over the course of a year = approximately 15 million gallons, or about 0.041 mgd of irrigation water (15 mg/365 days = 0.041 mgd).

This 0.041 mgd could replace BWS potable water. DOA water costs for Ag Park farmers using the Reservoir for irrigation water would be 1/2 of the BWS charges for agricultural users. However the proposed reservoir would only result in an average saving of about 41,000 gallons per day (i.e., 15 mg/365 days.) This amount is about 10% of the amount of water provided by BWS to the Ag Park: 0.456 mgd in calendar year 2004.

Nu'uanu Reservoir. Source: (http://www.lava.net/~nyuen/hiking/konahuanui/07-Lanihuli-2.JPG)

PROJECT 05: STORM WATER CAPTURE (pg. 2 of 2)

Cost

Larger scale storm water capture projects involving impoundments or infiltration pits would be fairly costly, especially for more remote *ma uka* areas. For example, an earth dam similar to the dam at Nuʻuanu Reservoir would cost in the range of $40-$50 million. Assuming no losses due to infiltration or evaporation, a series of infiltration pits capable of capturing two inches of rainfall runoff from a 5,000-acre watershed would require a volume of about 833 acre-feet = 271 MG or 0.74 mgd. Assuming that the excavated material is mostly rock, and including hauling away and disposal of the excavated material, costs might run $50 or more per cubic yard = $67 million or more or about $90/gallon capital costs.

The relatively small reservoir proposed in the BOR study was estimated to cost $1.54 million for 0.04 mgd = $39/gal, including excavation, piping, pump station, filter station, engineering, construction management, and contingencies.

There are also high maintenance costs associated with storm water retention structures.

Development Issues and Limiting Constraints

In addition to high capital and maintenance costs for relatively low volumes of water, the larger scale storm water capture techniques have health, safety, and environmental impact issues. Large impoundments on small Hawaiʻi streams disrupt the natural flow and ecology of the stream. Unless designed with care and appropriate materials, earth dams are also subject to failure when impacted by major flood flows, and a failed dam could result in extensive downstream property damage and even loss of life. Large infiltration pits would lack the natural forest floor layer of contaminant-filtering organic matter and soil, and so might allow contaminated runoff to percolate down into the ground water. Deep pits might also pose a hazard to unwary hikers and hunters.

Conclusions: Feasibility for Waiʻanae

Large impoundments and large infiltration pits do not seem to be appropriate for Waiʻanae. Storm water diversions and small reservoirs similar to the system proposed in the BOR study may be feasible to implement in other areas of the Waiʻanae District. However, when the cost of diversion ditches is added to the reservoir costs, and when additional maintenance costs are factored in, the cost/benefit ratios for these small reservoirs are low.

It may be more feasible to promote small rain catchment systems in residential, agricultural and commercial areas to collect storm water for nonpotable irrigation. Collectively, the beneficial effects maybe similar to a medium scale storm water impoundment.

Rainfall in Waiʻanae averages between 20″ to 40″ annually, and will only provide intermittent amounts of nonpotable water. However, the catchment systems can elevate the community's awareness of water conservation.

PROJECT 06: RECYCLED WATER: WAIʻANAE WASTEWATER TREATMENT PLANT (pg. 1 of 2)

Occurrence

The existing Waiʻanae WWTP has design capacity to accept an average of 5.2 mgd of wastewater, and a peak flow of 13.8 mgd. It is currently producing about 3.1 mgd of R-3 (un-disinfected secondary) effluent, which is disposed of via ocean outfall approximately 1.1 miles offshore. This R-3 wastewater could potentially be converted to R-2 (secondary disinfected) or R-1 (tertiary disinfected) quality water and made available for direct reuse.

Current and Potential Future Use

Use of recycled wastewater is guided by DOH's *Guidelines for the Treatment and Resuse of Recycled Water*. R-1 is the highest quality recycled water under DOH reuse regulations and is approved for a variety of irrigation uses and can be applied using spray irrigation. R-2 recycled water could be used used for some limited applications and is usually applied using drip irrigation. R-3 recycled water could be used for some limited industrial or agricultural uses under specific guidelines and controls.

Currently, BWS operates the Honouliuli Water Recycling Facility (WRF) at the City's Honouliuli WWTP. It produces 2.0 mgd of dimineralized recycled water using reverse osmosis membranes (R-O) for industrial process water for power plants and refineries and 10.0 mgd of R-1 water, for irrigation of golf courses and large landscaped areas in ʻEwa. Honouliuli R-1 effluent is slightly brackish, with chloride levels at less than 300 mg/l. However, there is currently no recycled water available for Waiʻanae water users from Honouliuli unless a transmission main is extended to Waiʻanae and additional treatment capacity is added.

If treatment were increased, 3.1 mgd of R-1 water from the Waiʻanae WWTP could be made available to farms, parks, and industrial operations in Waiʻanae, and Lualualei to reduce BWS potable use from Mākaha-Waiʻanae sources and imported water from Pearl Harbor sources. In the future, as population and sewage flows increase, even more R-1 quality water could be produced. It should be noted that the potential for recycled water application has the potential to affect ground water quality. Therefore, it would be ideal to focus recycled water use over areas that have the lowest potential for this type of impact.

A preliminary study by R.M. Towill Corporation (RMTC) sketched out a "Conceptual Layout of Waiʻanae Nonpotable Water System – Initial Phase" that would provide R-1 quality water from the Waiʻanae WWTP through a system of 12-inch and 8-inch PVC pipes to beach parks in the area and to farms in Lualualei Valley. The Lualualei *ahupuaʻa* has about 870 acres of agriculturally zoned land. Total estimated water use by agricultural users in Lualualei was approximately 3.7 mgd.

BWS deferred plans to conduct a feasibility study for the development of a water recycling facility at the Waiʻanae WWTP and a distribution system to potential users within a 2-mile vicinity of the WWTP. The timing for this study has not yet been determined.

Waiʻanae Wastewater Treatment Plant.

Cost

R.M. Towill, in a 2005 Oʻahu non-potable water master plan, estimated a cost of $34.5 M for a 3.0 mgd recycled water facility and distribution system at the Waiʻanae WWTP for non-potable water users in the vicinity.

Development Issues and Limiting Constraints

The principal constraint for developing recycled water facilities at the Waiʻanae WWTP is the high chloride content of the wastewater influent (890 to 970 mg/l), which is due to aging sewer mains that allow infiltration of seawater. This high chloride content will limit use of the recycled water to the irrigation of crops/plants that can tolerate high chloride levels. It will be very costly to either repair the sewer mains or desalinate the wastewater effluent. In order to increase the number of potential recycled water users, blending with potable water may be required to reduce chlorides, but this reduces the environmental and economic benefit. Another major constraint is the cost recovery of treatment plant upgrades and pipeline delivery system to a sufficient number of users that can be acquired.

There is also some concern for using recycled water over the potable aquifer, particularly because some pharmaceuticals and hormones are not removed from wastewater during conventional treatment. A Soil Aquifer Test conducted by BWS found that recycled water use over the potable aquifer is acceptable, if applied at appropriate rates based on geology and vegetation.

Related issues include: the possible resistance of some potential users to the concept of using recycled water for irrigation, especially for food crops, although permitted by DOH regulations; the additional cost of DOH recycled water application and reporting requirements; and the cost of installing physically separate on-site irrigation systems and backflow preventers.

Conclusions: Feasibility for Waiʻanae

Recycled water should be part of the overall long-range plan to conserve Mākaha-Waiʻanae water resources by matching water quality with appropriate use, to reduce potable water demands, and meet any shortfalls in the availability of imported water from Pearl Harbor. However, this option has a low feasibility rating until chloride levels can be reduced to acceptable levels.

The City meanwhile should determine which sewer line segments contribute the most seawater to the WWTP and then plan for the timely replacement of these mains. Disinfection equipment should then be installed to produce R-2 quality water, which would expand wastewater reuse opportunities, or to disinfection and filtration equipment to produce R-1 quality recycled water, which has even more permissible uses. All wastewater plans would need to conform to DOH Administrative Rules Chapter 11-62, “Wastewater Systems.”

There is also the uncertainty of how much recycled water would be used and at what cost to the users, given the long lengths of new non-potable water mains that would be required to distribute the recycled water. To reduce distribution costs, BWS could rehabilitate old unused water mains using new technologies. Many of the distribution mains around the Waiʻanae WWTP have been recently replaced and the unused pipes are still in the roadways.

PROJECT 07: RECYCLED WATER: MEMBRANE BIOREACTORS (MBRS) FOR SINGLE USERS (pg. 1 of 2)

Occurrence

Membrane Bioreactors (MBRs) is a relatively new technology that is attracting considerable attention in the water resources management community, especially for its potential application to make the best use of limited water supplies in developing regions of the world, as well as its potential use for remote or rural developments in developed countries to convert wastewater to recycled water. MBR units can extract water from sewer mains away from the WWTP and treat the wastewater to R-1 quality for nearby or on-site non-potable irrigation and industrial uses.

Generally, an MBR unit converts wastewater to recycled water by immersing micro-filtration membranes into an aerobic biological reactor that produces high quality recycled water. When compared with conventional wastewater treatment plants, MBR units have a number of significant advantages, including:

- Significantly smaller size and space requirements: these units can be constructed where the water is needed, such as at golf courses, eliminating expensive transmission pipelines;
- Removal of a very high percentage of organic material and inorganic nutrients;
- Removal of a very high percentage of pathogens, thereby reducing chemical disinfection requirements;
- A significantly higher level of automation, making them simpler to operate.
- Development of MBR units for nearby individual users can be more economical in lieu of developing large-scale treatment plants with a widespread distribution main system.
- Developing satellite recycling facilities can avoid salinity issues from aging sewer mains below mean sea level.
- Biosolids can be discharged back into the sewer main as long as minimum flow velocities are maintained, thereby eliminating a separate solids removal process and associated odors.

Current and Potential Future Use

The City Department of Environmental Services, the Honolulu Board of Water Supply, and the WateReuse Foundation have jointly sponsored a pilot study led by the University of Hawaiʻi Water Resources Research Center to test whether MBR technology is feasible as an alternative to conventional recycling treatment. The study compares five MBR units, running side-by-side at the Honouliuli Wastewater Treatment Plant, treating the same three waste streams: raw sewage, primary effluent, and a high-strength, colored centrate. The results have been favorable in that R-1 water was produced from all three waste streams. A related UH-WRRC study will also evaluate capital and O&M costs to help agencies determine the feasibility of specific applications.

Potential applications of MBR technology in Waiʻanae should focus on recycling water from points of high sewer main flows for on-site irrigation use on golf courses, large landscaped areas and farms.

PROJECT 07: RECYCLED WATER: MEMBRANE BIOREACTORS (MBRS) FOR SINGLE USERS (pg. 2 of 2)

For example, wastewater flows from Mākaha Towers condominiums (a total of 586 units = about 175,000 gallons of wastewater per day), and Mākaha Resort, with about 180 visitor units, restaurant, meeting rooms, and golf course clubhouse = perhaps 100,000+ gallons of wastewater per day, could be recycled for irrigation of the resort's landscaped areas and golf course. The planned expansion of the Mākaha Resort could result in an additional 100,000+ gpd of wastewater becoming available for recycling.

Parks, schools, and other landscaped areas within close proximity could also be potential providers and users of MBR recycled water.

Cost

From R.M. Towill, Islandwide Nonpotable Water Master Plan, a 0.6 mgd MBR unit could cost $4.2 M = $7/gal. This capital cost is one-half the cost of a centralized recycling facility at the Wai'anae WWTP and is not constrained by high chloride effluent. The estimated annual electrical power cost is $100,000 per year. These costs will be refined with the UH study.

Development Issues and Limiting Constraints

Limiting constraints include having sufficient low chloride sewer flows adjacent to large landscaped areas that would maximize economic feasibility. Once a suitable site is located, impacts are noise from the aerator blowers and odors from the aeration process. Enclosing the equipment within a building can mitigate both noise and odors but this increases the relative cost of the facility. Capital and O&M costs are less than a centralized recycling facility. Ownership issues are another development issue whether privately owned or dedicated to the City, cost recovery, liability and regulatory compliance responsibilities need to be addressed.

As is the case with larger recycled water facilities, MBRs may not remove certain pharmaceuticals and hormones from wastewater. Therefore, their use over the potable aquifer should be studied to ensure ground water protection.

Conclusions: Feasibility for Wai'anae

It may be feasible for developers to use MBR units to avoid high costs of sewer system improvements that would be required in areas that are at maximum capacity, such as in Mākaha. It would be highly beneficial to recycle wastewater to reduce potable water demands or provide new water supply to users that don't have convenient access to available water systems. Urban uses in Mākaha Valley are too far from the Wai'anae WWTP and its potential future recycled water facility to be economically served: the Resort is about 5 miles from the WWTP. MBR technology may be a feasible and attractive alternate to the transmission of recycled water from the WWTP.

If the Resort were to use MBR technology, the R-1 quality water could be used to irrigate landscaped areas and the golf course. This new technology could then allow the Resort to reduce use of Glover Tunnel water for the golf course. Glover Tunnel water could then be allocated to other uses, including, with some treatment, for potable water needs of new developments in the valley, or providing irrigation water to the proposed Mākaha Cultural Learning Center.

PROJECT 08: DESALINATED WATER – FROM BWS KALAELOA DESALINATION PLANT (pg. 1 of 2)

Occurrence

Desalination of seawater and brackish water exists in many areas around the world and desalination technology has advanced in recent years due to its critical need and widespread use. Various desalination methods, in order of occurrence, include reverse osmosis, distillation, ion exchange, electrodialysis, and freezing.

In the late 1980s, the State constructed and operated a demonstration brackish water desalination plant in Kapolei on Campbell Estate Land; it was recently acquired by BWS. The plant processed brackish caprock water into 0.25 mgd of potable water for research purposes to compare costs and operating requirements among Reverse Osmosis, electrodialysis and electrodialysis reversal. The plant provided water to the Campbell Industrial Park, but was closed in 1995. BWS has long-range plans to renovate this plant in the future, but because there are insufficient quantities of brackish water to sustain more than a few mgd of desalinated water, this plant will remain relatively small. Brackish water also came from the basal aquifer, therefore drawing against the CWRM sustainable yield.

The BWS has developed preliminary designs for a future seawater desalination plant at Kalaeloa on lands conveyed for public benefit from the federal government. The initial phase would produce 5 mgd, expandable to 15 mgd or more, to provide a portion of the 27.2 mgd projected high growth of the ʻEwa District by 2030. This facility will utilize Reverse Osmosis (RO) membrane filtration to filter high quality basal seawater from deep wells into fresh water. The brine concentrate will be injected into caprock wells below the benthic environment of the nearshore.

The final design and construction of the Kalaeloa seawater desalination plant has been deferred about 10 years after BWS conducted a major review of available groundwater resources, infrastructure capacity, capital program priorities, and the long-range financial plan.

Current and Potential Future Use

Most desalination facilities on Oʻahu are small and limited to demineralizing potable water for industrial boiler feed for power plants and refineries in Campbell Industrial Park. BWS uses RO membranes to desalinate recycled water at Honouliuli WWTP to replace the potable water used for these industrial uses. In 2006, 1.5 mgd of potable water was replaced with RO recycled water for industrial use.

Some local bottled water companies use RO membranes to further filter potable water for drinking and some home filtration systems employ RO membranes.

There are no large-scale desalination facilities on Oʻahu for drinking water, but brackish water desalination exists at some resorts on the Kohala coast of the Big Island and Maui is planning a facility in South Maui.

BWS has selected seawater desalination as a long-range sustainable water supply option to meet the large increase in demand in the ʻEwa District, as a drought mitigation strategy allowing groundwater sources to recover, and to reduce development pressures on groundwater resources in rural Oʻahu.

PROJECT 08: DESALINATED WATER – FROM BWS KALAELOA DESALINATION PLANT (pg. 2 of 2)

Cost

A BWS funded engineering feasibility study conducted by GMP & Assoc. in 2000, estimated a 5 mgd seawater RO desalination plant would cost about $40 M or $8/gallon in capital costs and $3/1,000 gallons in operating and maintenance costs, primarily in power and chemical costs. The plant will use 1,000 kilowatts per 1.0 mgd of processed water.

Desalination costs are now comparable to the costs for new groundwater development in Waialua and installing a new transmission system through Central Oʻahu to ʻEwa. Regulatory, environmental, social and cultural issues from further groundwater development add many layers of cost and complexity.

As new desalination technology advances, capital and O&M costs will decrease. RO membranes have already become less expensive and have greater efficiencies than 15 years ago when the demonstration desalination plant was constructed. Energy recovery technology has also advanced greatly.

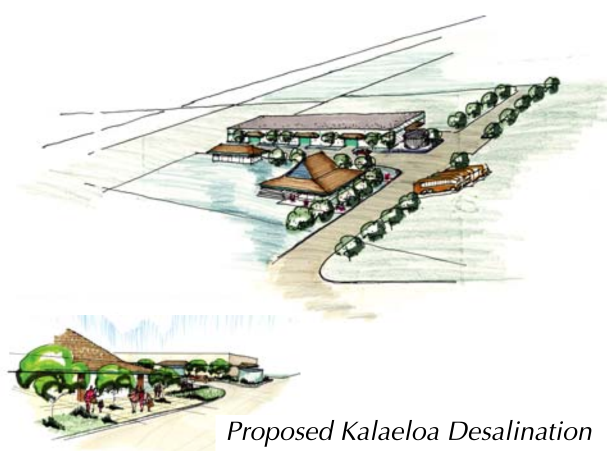
Development Issues and Limiting Constraints

The primary limiting constraint is funding the $40 million to construct the facility. The federal government has been very cooperative in conveying released navy lands for public benefit and Congress passed Bill S.960 authorizing a 25% Federal match for the design and construction costs. The Appropriation is pending and BWS will be issuing municipal bonds for the remaining project costs.

A development issue is that seawater desalination is an electrical power intensive process and increases reliance on imported oil for power. BWS is evaluating renewable energy and conservation systems such as deep well seawater building cooling and the use of solar lighting for the facility. The facility could also provide RO water for boiler feed and air emission scrubbers for the expansion of H-Power to establish a synergistic relationship between desalination and renewable energy facilities. Implementation should account for multiple-year lead times in development of required electrical infrastructure. Early coordination with electricity providers will be necessary to ensure timely, orderly, and cost-effective planning.

Conclusions: Feasibility for Waiʻanae

As available ground water in Pearl Harbor becomes fully allocated, the Kalaeloa seawater desalination facility will be constructed to meet the growing demands of ʻEwa and Waiʻanae. Desalination technology should thus be considered as part of the long-range plan for Waiʻanae water use and development.



Proposed Kalaeloa Desalination Plant. (BWS/Oceanit)

PROJECT 09: DESALINATED WATER – FROM A NEW WAIʻANAE DESALINATION PLANT (pg. 1 of 2)

Occurrence

A desalination plant using a different desalination technology than the proposed Kalaeloa RO desalination plant, could be developed along the Waiʻanae coast to provide a sustainable water supply for Waiʻanae. This technology utilizes cold deep seawater directly off the Waiʻanae coast, the only place on Oʻahu with close proximity to deep water. BWS has been conducting an engineering feasibility study of deep ocean water applications for using cold seawater pumped from an ocean pipeline similar to the Natural Energy Laboratory of Hawaiʻi Authority (NELHA) at Keāhole. Cold seawater could be used in multiple ways like producing potable water by distillation, energy using ocean thermal energy conversion (OTEC), district cooling, aquaculture industry and temperate agriculture.

Current and Potential Future Use

Construction of a desalination plant in Waiʻanae would remove the need to import Pearl Harbor Aquifer Sector Area ground water, and would make Waiʻanae more water self-sufficient. A cold seawater facility similar to the NELHA facility at Keāhole could be developed along the Waiʻanae coast using distillation to produce desalinated water. The distillation process could be more efficient if warmer water is used as the evaporative source, such as cooling seawater from the Kahe power plant. The process is described as follows:

> *In a vacuum, warm water is heated until it flashes into freshwater vapor, which drives a turbine generating electricity. The freshwater vapor is then condensed into distilled water using the cold seawater flowing through separate pipes.*

Private, on-site solar or wind-powered brackish water desalination package units could also be developed for small-scale use.

Cost

BWS does not have cost estimates at this time, but the ocean pipeline is the largest cost variable and could be in the range of $30 Million, depending on its size and length. Multi-effect distillation has a higher capital cost but lower operating and maintenance cost than reverse osmosis.

Capital and operating costs can be off-set by maximizing the use of the cold water by developing other uses and income streams, such as building cooling and aquaculture.

PROJECT 09: DESALINATED WATER – FROM A NEW WAIʻANAE DESALINATION PLANT (pg. 2 of 2)

Development Issues and Constraints

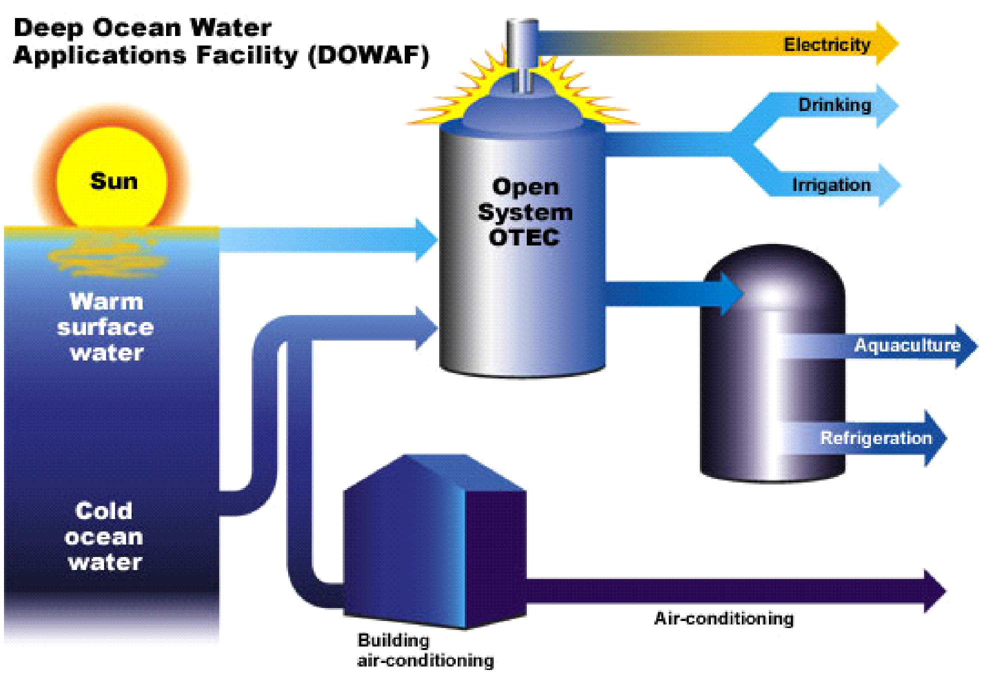
Like RO seawater desalination, the limiting constraint is project funding. Investing partners and Federal energy and water related grants would need to be pursued for a project of this magnitude.

The cost of energy due to imported oil continues to rise. Hawaiʻi has one of the highest per capita oil consumptions in the nation and is particularly vulnerable to future increases in oil prices and supply shortfalls. Lowering power consumption with renewable energy options will create a sustainable, reliable and affordable water supply.

Conclusions: Feasibility For Waiʻanae

Because costs would be much higher to build a new plant in Waiʻanae than to expand the proposed plant in Kalaeloa, BWS has no plans at this time to construct a distillation desalination plant along the Waiʻanae coast. However, some future combination of increased water demands, limited ground water sources, technological advances, and alternate energy systems may be such that a Waiʻanae distillation desalination plant becomes economically feasible.

Exploring OTEC & Deep Ocean Water



PROJECT 10: BWS WATER CONSERVATION (pg. 1 of 5)

Occurrence

Water is a precious resource on Oahu, and it is everyone's *kuleana* to use it wisely. Water conservation is the management of water resources so as to eliminate waste and/or maximize efficiency of use. This conservation ethic is applicable to those who deliver/supply water as well as the end-users. While this project is focused on the Board of Water Supply and its customers' conservation efforts, it could also be applied to other water purveyors and their customers.

Current and Potential Use

The BWS been actively promoted water conservation since its inception in 1929. The BWS "Water Conservation Program" is currently organized as such:

- Public Education & Outreach
- Leak Detection, Repair & Maintenance
- Large Water Users Programs
- Regulation
- Alternative Source Development, Recycling, & Conservation Alternatives

The principal elements of these five program clusters are described in detail in Chapter 3 under the description of the BWS system.

Expanding the conservation gains already made will require a renewed effort and systematic approach to increase water conservation opportunities. This can be accomplished through water efficiency planning, which is a resource management practice that incorporates analysis of costs and uses of water; specification of water-saving solutions; installation of water-saving measures; and verification of savings to maximize the cost-effective use of water resources.

The list below provides the proposed tasks to move conservation forward to the next level.

- *Assess the water efficiency of existing users and quantify opportunities for water savings and identify areas for improvement.*

  A solid conservation program needs to establish a baseline and solid understanding of how water is being used. The chart at right shows typical indoor usage for single family homes in the United States. In addition to identifying local indoor versus outdoor water use, it is important to understand the island's geographical and seasonal variations and their effects on water consumption. Questions to address may include: Is more water used inside or outside for residences, and in what sectors (residential, commercial, agricultural) are there large scale users? Is water use excessive (e.g. over watering of landscaping)? Can new technology reduce water consumption?

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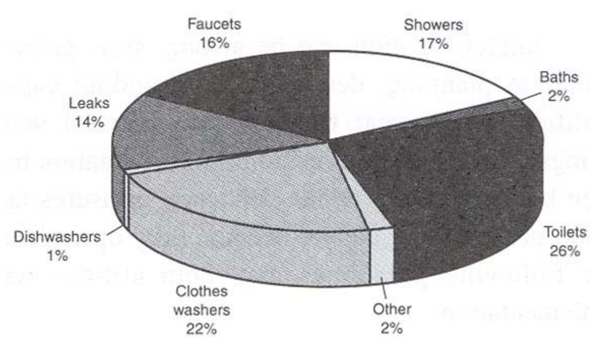


Source: Guide to Preparing Urban Water-Use Efficiency Plans, Water Resources Series No. 83, United Nations (2003)

PROJECT 10: BWS WATER CONSERVATION (pg. 2 of 5)

Develop a wide range of new conservation programs and measures tailored toward specific classes of users in each district.

Identifying water conservation opportunities for each type of user can provide a starting point for water savings. Residential and nonresidential water use constitutes about 55% and 45%, respectively, of the BWS water use. Effective water conservation programs for residential users would include public education and new construction regulations. Effective programs for nonresidential users would include directed programs such as on-site plumbing audits, partnerships, and economic incentives.

The Department of Education and the University of Hawaii are candidates for water conservation surveys and measures to be implemented with an educational component. Both hardware and behavior modification approaches can be successful in increasing water savings. Economic incentive programs will increase consumer participation highlighting the fact that conservation has environmental as well as economic benefits.

- *Research and implement new water conservation technologies for residential and non-residential users, where practical*

  Possible future conservation measures are listed in the figure on the next page. Industry best practices can help to provide successful program models. The selection of conservation programs should be based on the highest possible water conservation savings at the least cost. For larger non-residential users, identify opportunities for water savings. For residential users, typically education and regulation measures produce the most water conservation for dollar invested.

- *Research and expand alternative resources development for the use of recycled wastewater and brackish ground water where feasible.*

  Technologies for recycling water continue to evolve and are becoming increasingly cost effective. These alternatives to ground and surface water should be researched and expanded where feasible.

- *Expand partnerships with community organizations and agencies for promoting water conservation.*

  Many community organizations and agencies have missions that support water conservation. By partnering with them, greater gains can be made in promoting conservation messages and implementing water saving practices.

- *Continue and expand water conservation education and incentive programs.*

  Current programs have been effective, particularly for the residential sector, and should be continued. Programs have included Detect-a-Leak week, school education programs and the Hālawa Xeriscape Garden and the Unthirsty Plant Sale.

- *Reduce leakage in the system.*

  Reductions in system leakage can be accomplished through main failure analysis that includes the collection and investigation of main failures and the identification of the potential causes and solutions to premature pipeline failure

PROJECT 10: BWS WATER CONSERVATION (pg. 3 of 5)

Possible Future Water Conservation Measures

Residential

- Multifamily (apartments, townhouses, condos) Submetering
- Multifamily Property Manager Workshops
- High Efficiency Clothes Washer Regulations or Rebates
- Homeowner Water Use Audits

Landscaping

- Landscape Irrigation System Analysis
- Developer/Landscaper Irrigation And Landscape Workshops
- Evapotranspiration (ET) Controller Retrofit (for larger users)
- Submetering For Landscaped Areas Above 10,000 Square Feet
- Xeriscaping
- Rain Harvesting (Residential, Schools, Government)

Commercial/Government

- Water Use Audits
- Combined Campaigns (Water, Wastewater, Recycling And Energy)
- Commercial And Government Landscape Irrigation Reduction Programs
- Linen Change Programs
- High Efficiency Commercial Dishwasher Rebates
- High Efficiency Clothes Washer Regulations or Rebates
- Cooling Tower Audits

Agriculture (for KL move to ag water project)

- Drip Irrigation
- Evapotranspiration (ET) Controller Use (for large farms)
- Field Soil Moisture Monitoring for Irrigation Scheduling
- Water Reducing Farming Techniques (e.g. field leveling, mulching, furrow diking)

Other

- Tiered Water Pricing
- LEED (Leadership in Energy and Environmental Design) certification for government facilities

PROJECT 10: BWS WATER CONSERVATION (pg. 4 of 5)

Cost

The island-wide breakdown of estimated dollars spent on water conservation programs is as follows:

- $200,000 per year for Public Education & Outreach and Large Water Users Programs
- $500,000 per year for Leak Detection, Repair & Maintenance
- $7 million over 10 years for Toilet Rebates. After 2008 the BWS funding will switch to other programs.
- $15 million over the next six years for Alternative Source Development, Recycling & Conservation Alternatives
- $114 million over the next six years for Pipeline Replacement program – (This is proactive water conservation that reduces water losses in addition to providing system reliability.)

Typically in the United States, water utilities spend between $0.50 and $10 per account annually on water conservation programs. The Board of Water Supply spends an estimated $1.4 million each year (not including alternative source development, recycling, conservation alternatives or the pipeline replacement program) which equates to nearly $9.00 per account each year.

The primary value of these conservation expenditures are savings referred to as "cost avoidance". Water conservation provides savings through decreased costs for the following:

- Treatment costs (chemicals and testing)
- Distribution costs (BWS electricity)
- Note: Customers may also experience electricity cost savings because they use less water, particularly if less hot water.
- Wastewater treatment costs
- Potable water is conserved and that means less water needing waste water treatment.
- New development costs
- If enough water is saved, it may defer, prevent, or downsize new source development. At a general development cost of $6/gallon, for example, a savings of 0.5 to 1.0 mgd would translate to cost avoidance of about $3M to $6M.

Environmental benefits that are not economically quantifiable could also result from using less of the available water supply.

Development Issues and Constraints

While new technologies and changes in behavior can decrease water consumption, they do not eliminate a need for water. As conservation measures are implemented the savings that accompany water conserving measures tend to decrease over time.

PROJECT 10: BWS WATER CONSERVATION (pg. 5 of 5)

The types of conservation programs listed include both "hardware" changes such as leak detection and repair, low use fixtures, system and landscaping changes - and behavioral changes in the use of water. With hardware conservation programs, once the measure is implemented, water conservation savings will continue over the life of that fixture or technology. However, behavioral conservation measures may amount to saving levels over time depending on factors such as the frequency of the messages being sent out, existing drought or weather conditions that are declared, costs, etc. Other utilities, such as HECO, are interested in partnering with BWS on conservation and education initiatives where practical, thus increasing the potential for behavioral changes.

In order to utilize water conservation as a water supply option, strict evaluation of which programs to implement can be done using a cost per dollar invested analysis. Estimating anticipated conservation is difficult. Estimating past efforts can be equally challenging because of the many factors such as economy, weather, etc that effect water usage. Yet a prioritization and baseline for efforts beyond general conservation efforts are needed.

Conclusions: Feasibility For Wai'anae

Water conservation is often the most cost effective alternative which conserves resources, decreases operating costs, and defers source development. Using water wisely is everyone's responsibility. By looking for opportunities to conserve water for the lowest possible cost, more groundwater may be saved. Water conservation can be viewed as decreasing water demands or as freeing up water as an "additional" water supply. In this Plan, Chapter 6 on implementation presents water conservation as a supply source to meet some of the demand.

TABLE 5-1

RESOURCE OPTION SUMMARY TABLE

	Capital Cost ($/Gal)	Current Wai'anae Use (mgd)	Potential Future Use (mgd)	Development Feasibility Rating	Feasibility Notes
GROUND WATER RESOURCES					
Additional Pearl Harbor Aquifer Ground Water	$3.66	4.5	4.4+	high	Source readily available, low cost
North Shore Aquifer Ground Water	$8.00	0	4.4+	low	Environmental, social objections, high cost
Additional Kea'au Basal Ground Water	$12.00	0	1.5	low	High cost of development and transport, low yield
Additional Brackish Non-Potable Sources	$6.00	< 1	1.0	Low to moderate	High cost, low yield, more appropriate for onsite irrigation
SURFACE WATER RESOURCES					
Stream and Spring Water Sources	n/a	< 1	n/a	low	Source not readily available
Stormwater Capture Facilities	$39.00	0	stream restoration	not feasible	Source undependable, environmental, social objections, high cost
ALTERNATIVE WATER RESOURCES					
Wai'anae WWTP Recycled Water	$15.17	0	3.0	low	Users uncertain, high cost of production & distribution, high chlorides
Membrane Bioreactor Units Recycled Water	$7.00	0	1.0	moderate	Source limited in areas, moderate cost
Kalaeloa Desalination Plant - initial plant	$8.60	0	5.0	moderate	High cost but competitive with N. Shore import costs
Wai'anae Desalination Plant	$8.60	0	2.0	not feasible	2nd Leeward desal plant not feasible, develop only a single plant

PROJECT 11: HYDROGEOLOGY STUDY (pg. 1 of 2)

Problem Statement

Improved ground water modeling is needed to optimize use of the Waiʻanae and Pearl Harbor Aquifers

General Background

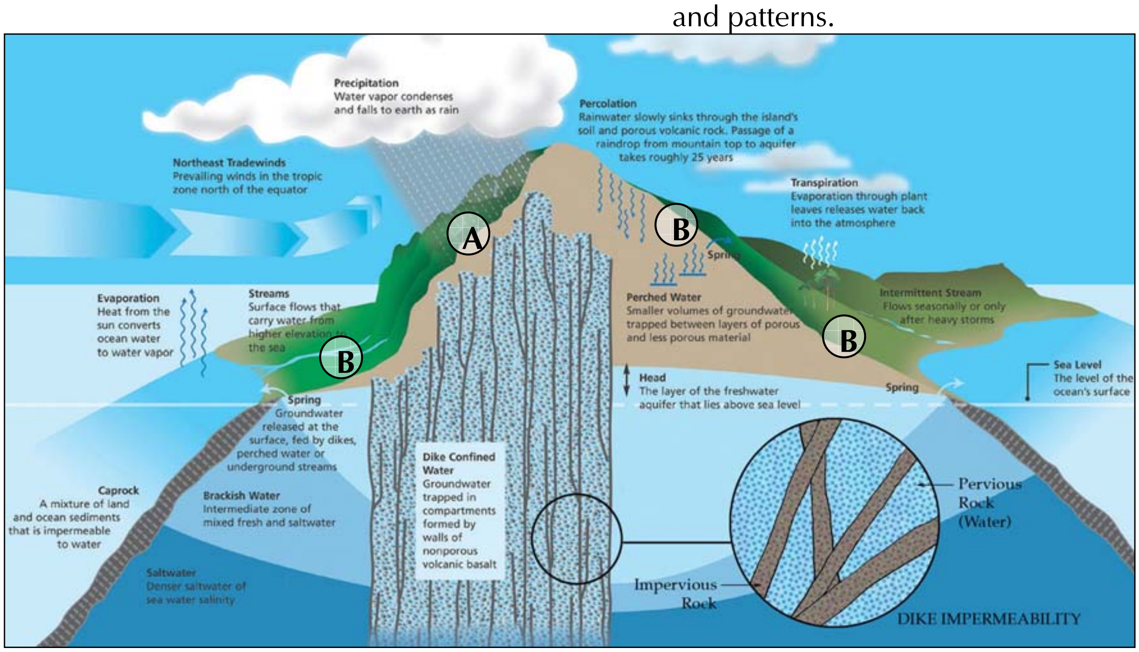
Hydrology is the study of the inter-relationships of precipitation, evaporation, transpiration, infiltration, and runoff. Additionally, man-made influences, such as development, land use, and infrastructure influence hydrology through increases in runoff and flood peaks and decreases in ground water recharge.

While much research has been done on hydrologic cycles, local hydrology cannot always be explained by models based on research from other locations. Therefore, research into Hawaiʻi-specific hydrologic processes is necessary. This specialized understanding could then be applied toward developing Hawaiʻi-specific actions that restore or protect our water resources and natural functions.

Generic Actions & BMPs:

Research conducted for a hydrology study will help to better understand the relationship between ground and surface water. Factors to consider include:

- ✓ Improve access to existing data collected by different agencies.
- ✓ Review existing hydrologic studies.
- ✓ Evaluate streams in terms of flow, infiltration, sediment transport, flooding patterns, natural drainage, and alterations.
- ✓ Understand effects of manmade influences, including water infrastructure and land use on the water cycles of specific areas.
    - Identify appropriate models and information needed.
    - Develop an optimization plan that provides for water withdrawals while protecting natural processes.
- ✓ Understand the effects of impervious surfaces on infiltration and surface flows.
- ✓ Construct a watershed (rainfall-runoff) model to simulate the hydrologic cycle.
- ✓ Develop recommendations on ways to improve or restore natural water cycles and patterns.



Island Cross-Section with groundwater types and elevations.

PROJECT 11: HYDROGEOLOGY STUDY (pg. 2 of 2)

The Issues in Wai'anae

Wai'anae Aquifer Sector Area ground water is limited, with BWS pumpage experience suggesting that potable water supplies are lower than the CWRM-recognized SY of 15 mgd. Some residents remember flowing streams, which today run dry. Hydrologists suggest that this is caused by the "drought" cycle that Hawai'i is currently experiencing, the geohydrologic makeup of the coast, and withdrawal by wells, tunnels, and stream diversions.

Community concern regarding stream flow has led to a partnership between BWS and Mohala i ka Wai, a community organization focused on water issues in Wai'anae. This partnership has resulted in a project where BWS has reduced pumping of two wells in Mākaha to identify the effect, if any, on stream flow. This five-year program is designed to allow BWS to optimize ground water pumping and minimize effects on surface water flow.

If in-district well pumpage cannot increase, Wai'anae will need additional water to meet both its current and future demands. Wai'anae already imports about half of its water from the Pearl Harbor Aquifer, with future demand to be met in the short term by additional imports. The Pearl Harbor Aquifer has 18.7 mgd of currently unpermitted use. While expected future demand for Wai'anae is up to an additional 6 mgd by 2030, there are competing uses for Pearl Harbor water, including in-district use, transfer to the PUC, and possible adjustment of the SY as land use changes and ground water models improve. Pearl Harbor ground water modeling is needed to provide confident estimates of SY and to optimize withdrawals in order to protect the resource. Improved models that take into account current land use changes will ensure that proper decisions are made regarding Oahu's largest aquifer.

Preliminary Scope

A Wai'anae hydrologic study should include the following actions:

- ❖ Model the Pearl Harbor Aquifer to improve SY estimates and produce better estimates of ground water availability for in-district use, as well as for transport to other districts such as Wai'anae.
  - Develop a process for stakeholder agencies to agree on an appropriate 3D model to estimate SY.
  - Develop an optimization plan for existing and future withdrawals.
- ❖ Continue to study the relationship between BWS wells and stream flow, particularly in Mākaha. Optimize pumping to minimize impacts on stream flow.
- ❖ Initiate a study to reduce current use of Glover Tunnel in order to accommodate other uses.
- ❖ Determine the movement of contaminants through ground water.

Potential Participating Entities

USGS, BWS, UH WRRC, CWRM, DOH, CZM.

Estimated Cost

$500,000 - $1,000,000.

References

Honolulu Board of Water Supply, (1978). *Waianae Water Development Study*.

Honolulu Board of Water Supply, (2002). Hydrogeology of the Watersheds of Makaha Valley and Waianae Valley.

Memorandum of Agreement Pearl Harbor Monitoring Working Group.

PROJECT 12: WAI‘ANAE SOURCE WATER PROTECTION PLAN (pg. 1 of 2)

Problem Statement

Wai‘anae has limited potable water resources; therefore, it is important to protect ground water sources from potential contamination.

General Background

There are approximately 465 drinking-water sources in the State of Hawai‘i. Microbiological and chemical contamination are potential threats to these sources throughout the state. In 1996, the reauthorization of the Safe Drinking Water Act required states to develop assessments of drinking water sources, including documentation and evaluation of existing conditions, potential problem locations, and local protection opportunities. Establishment of subsequent protection programs is under the discretion of local government.

As a part of the 1996 mandate, the University of Hawai‘i Water Resources Research Center concluded the Source Water Assessment Program (HISWAP) report for the state Department of Health in 2004. The four elements of the report included the delineation of the area around a drinking water source through which contaminants may travel to the drinking water supply; an inventory of activities that may lead to the release of microbiological or chemical contaminants within the delineated area; determination of the susceptibility of the drinking water source to become contaminated from the surrounding potential contaminating activities; and public disclosure and access to assessment information.

The HISWAP defined source water "susceptibility" as "the potential for a Public Water System to draw water contaminated by inventoried PCAs [potential contaminating activities] at concentrations that would pose concern."

Relative susceptibility was determined using a numerical scoring system. Local drinking water purveyors were provided the HISWAP report in order to help them in protecting their sources.

The U.S. Navy has moved further in protecting their potable water sources in Waiawa by developing what they call a Hydrologic Zone of Contribution. This zone delineates an area where land uses may affect the ground water supplying the source and restricts the type of development that is allowed to occur there. This might serve as a model for other water purveyors to protect their own sources.

Generic Actions & BMPs:

A source water protection program should take the HISWAP through the next phase of implementing protective measures that could include:

- ✓ Review HISWAP to aid in identifying priority wells to protect
- ✓ Establish "acceptable land uses" within the various capture zones
- ✓ Require new development to conform to acceptable land uses either through agreements or changes to the zoning code
- ✓ Work to remove PCAs from delineated capture zones
- ✓ Maintain records of existing and new PCAs to aid in siting new drinking water sources

PROJECT 12: WAIʻANAE SOURCE WATER PROTECTION PLAN (pg. 2 of 2)

The Issues in Waiʻanae

There are two potable water systems in Waiʻanae owned by BWS and the Navy. The Navy source is protected within Navy-owned property and likely needs little, if any, further protection. BWS potable water sources are located in Mākaha and Waiʻanae valleys. In the State SWAP report, susceptibility scores for ground water sources on Oʻahu ranged from 0-2119, with higher scores indicating greater susceptibility to contamination. By comparison, scores for Waiʻanae sources ranged from 0-120. On an island-wide scale, Waianae's sources have a relatively low potential for contamination because most sources are located within the *ma uka* State Conservation Districts.

Waiʻanae gets its water from both in-district and out-of-district sources, all of which need to be protected. Out of district sources include those at Hōʻaeʻae and Kunia, both of which have higher susceptibility scores (332-492) than for sources in Waiʻanae; however, these scores are still on the lower end of the island-wide scale.

While susceptibility scores for sources that serve Waianae's drinking water needs are low when compared island-wide, there is still some threat to drinking water quality. Treatment of contaminated wells is expensive and should be avoided if possible. Additionally, because potable water is a limited resource, particularly in Waiʻanae, every effort should be made to protect it.

Preliminary Scope

A Waiʻanae source water protection plan should:

- ❖ Include the Hōʻaeʻae and Kunia wells that also provide potable water to Waiʻanae.
- ❖ Conduct "on the ground" sanitary surveys of source capture zones, identify threats, and mitigate PCAs.
- ❖ Monitor susceptible sources more frequently for possible contaminants.
- ❖ Examine the overlap between delineated capture zones and land available for new development. Restrict or condition development around:
  - o Mākaha Shaft, where capture zones likely include zoned, undeveloped agricultural, residential, country, and resort land.
  - o Kamaile Wells, where capture zones likely include undeveloped, agriculturally zoned lands.
- ❖ Conform with and feed into an island-wide source water protection program.

Participating Agencies

DOH; BWS; DPP; Navy, CWRM.

Estimated Cost

$100,000 or more.

References

El-Kadi, Aly, et. al., November 2004, *Hawaii Source Water Assessment Program Report,* Water Resources Research Center University of Hawaiʻi at Mānoa, prepared for State of Hawaiʻi DOH Safe Drinking Water Branch.

State of Hawaii DOH, 1990, *Hawaii Ground Water Protection Strategy*.

Mākaha Well II.

PROJECT 13: DROUGHT MITIGATION STRATEGIES (pg. 1 of 2)

Problem Statement

Extended periods of little to no precipitation can decimate crops and livestock, damage terrestrial and aquatic wildlife habitat, contribute to wildfires, affect drinking water quality and supply, and result in hundreds of millions of dollars in damage. Rather than reacting to drought as a temporary emergency, it is more effective to reduce the impacts of drought before they occur.

General Background

Drought is defined by USGS as "*…a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and man over a sizable area.*" Taking a proactive approach to drought preparedness requires continuous monitoring of indicators that signal the onset of drought. Drought monitoring serves to lessen the element of surprise and allows time for planning and implementing drought mitigation strategies.

The State CWRM has provided a statewide plan for drought entitled the Hawaiʻi Drought Plan and led the effort to develop the Oʻahu County Drought Mitigation Strategies Report of November 2004. The plans can be viewed at the following link to CWRM Hawaiʻi Drought Monitor: http://www.state.hi.us/dlnr/cwrm/drought.

Drought mitigation can be defined as actions or activities that reduce the degree of long-term risk and consequently the costs of responding to drought. Drought mitigation comprises a broad range of proactive measures. A coordinated drought preparedness program is key to reducing the impacts of drought on farmers, communities, and the environment. An effective drought mitigation plan includes:

- An analysis of past, current, and projected water demand, instream flow needs for appropriate ecosystem protection, water availability, and potential water shortages;
- A description of how shortages would be met, by increased supply, leak detection, water use efficiency, demand management, and associated cost estimates;
- A description of interagency coordination and public participation; and
- Consideration of social and economic factors.

Generic Actions & BMPs:

State Drought Plan lists the following drought mitigation strategies:

- ✓ Statewide Water Resources Monitoring and Impact Assessments
- ✓ Development of New or Alternative Water Sources
- ✓ Water Conservation Practices
- ✓ Public Education Awareness and Outreach
- ✓ Watershed Protection Partnerships
- ✓ Legislation
- ✓ Land Use Planning

The BWS Rules and Regulations Sections 3-318 to 3-322 establish low groundwater conditions and procedures to monitor and reduce water use to protect groundwater sources. There are ten index stations throughout Oʻahu that are monitored for water and chloride levels. The BWS low ground water plan is activated if three or more index stations meet the prescribed low groundwater conditions.

The Issues in Waiʻanae

Waiʻanae is typically hot and dry in the lower elevations, being on the leeward side of the island, and shielded from rainclouds by the Waiʻanae Mountain Range. Rainfall averages only 20 inches a year along the coast.

In addition to being a generally dry area, the current 50-year period has recorded 30 percent less rainfall than the previous 50 years, and in the five years spanning 1998-2003, Mākaha gages recorded rainfall 17% below normal levels.

With this in mind, BWS set their recoverable yield for their sources in Mākaha and Waiʻanae Valleys at about 4.3 mgd combined, well below the adopted Sustainable Yield of 6 mgd identified. This lower level of pumping is anticipated to build up the aquifers in anticipation of drought. The benefit is that by pumping less and letting water levels recover, stream flow may increase in certain stream segments.

The susceptibility of Waiʻanae to drought conditions is also a key reason to conserve and diversify supplies. Diversification ensures that water will still be available even when one source is impacted by drought, while conservation lowers the overall demand.

Preliminary Scope

The Waiʻanae drought mitigation strategies should include:

- **Monitoring**: Establish low groundwater conditions for the larger users of ground water wells and stream diversions. Evaluate and expand rain gages in Waiʻanae.
- **Alternative Sources**: See Projects 01 through 09.
- **Water Conservation Practices**: See Project 10 Water Conservation Program.
- **Public Education Awareness and Outreach**: See Project 32 Community Watershed Education Program.
- **Watershed Partnerships**: See Project 30 Waiʻanae Watershed Partnership.
- **Legislation**: Formally establish and authorize the Hawaiʻi Drought Council and its leadership structure to validate the recommendations of the Hawaiʻi Drought Plan. Provide funding. Drought mitigation projects listed in the State Hazard Mitigation Plan qualify for FEMA grant funding.
- **Land Use Planning**: Incorporate drought management principles in updates of the Waiʻanae Sustainable Communities Plan and zoning ordinances.

Participating Agencies

National Weather Service, USGS, NRCS, DLNR, CWRM, DOA, WOSWCD, BWS, DPP, HFD, Oʻahu Civil Defense, Hawaiʻi Reserves, Inc.

Estimated Cost

Please see the various watershed and water supply project cost estimates in this chapter.

References

Hawaiʻi Drought Plan Update 2005, State CWRM February 2005

City and County of Honolulu Drought Mitigation Strategies, Oʻahu Drought Committee and CWRM, 2004

BWS Low Groundwater Plan, BWS Rules and Regulations, Section 3-318 to 3-322

PROJECT 14: MEASURABLE INSTREAM FLOW STANDARDS (pg. 1 of 2)

Problem Statement

Waiʻanae streams do not run continuously to the sea, even though stories and anecdotal evidence suggest that they once did. Similarly, some springs, primarily in the lower valley areas, have gone dry.

General Background

Streams provide many functions, and are of most benefit when they run continuously from their source, often high in the mountains, to the ocean. For example, many native stream species are amphidromous, requiring continuous streams in order to complete their reproductive life cycles, which for some, requires traversing the entire length of a stream.

Another benefit of streams is the role they play in supporting traditional and cultural practices. Many *heiau* were associated with water features, and plants and animals were sometimes gathered from springs and streams. Additionally, a recent resurgence in *loʻi kalo* restoration has led to a desire for robust stream flow to support taro cultivation.

In order to ensure that the many benefits of stream flow continue to be provided, the State Water Code requires the establishment of instream flow standards (IFS). IFS are defined by the State Water Code as the "*quantity or 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.*"

Currently, interim IFS are based on the "amount of water flowing in each stream on the effective date of the standard (1988 for Leeward Oʻahu and 1992 for Windward Oʻahu) without further amounts of water being diverted off-stream through new or expanded diversions." Measurable IFS have not been set for most of Hawaii's streams, including those in Waiʻanae. The Waiʻanae Sustainable Communities Plan also supports establishment of measurable IFS.

It is the responsibility of CWRM to establish IFS. Standards should be expressed in terms of the variable flows of water necessary to protect instream uses. In formulating IFS, CWRM must also weigh the importance of the present or potential non-instream uses, including the economic impact of restricting such uses. When preserving, enhancing, or restoring instream values, CWRM must consider water exchanges, alternative sources, or any other solutions that may avoid or minimize impacts on existing uses.

Generic Actions & BMPs:

- ✓ Identify and collect the data needed to make appropriate decisions, including information regarding existing instream flow, non-instream uses and end uses, biological needs, and appurtenant rights.
- ✓ Engage in a collaborative process with input from interested parties and agencies
- ✓ Determine and weight present or potential instream values against present or potential non-instream uses.
- ✓ Protect the public interest and avoid or minimize the impact of existing uses.
- ✓ Close diversions and wells that are no longer in use.

Mākaha Stream

PROJECT 14: MEASURABLE INSTREAM FLOW STANDARDS (pg. 2 of 2)

The Issues in Waiʻanae

Priority for setting measurable IFS is given to perennial streams and those with diversions where there may be conflicts between instream uses versus non-instream uses. Waianae's streams are intermittent, with only some, such as Mākaha and Kaupuni Streams, having perennial flow in the *ma uka* regions. Despite this, long-time residents remember days when all the streams flowed year-round, driving the community's desire to restore at least one stream in each *ahupuaʻa*.

Many in the community suspect that undocumented diversions, capping, and pumping are reducing or diverting stream flows. Concern has been raised specifically at Pūhāwai Stream in Lualualei, which some say is not only diverted by the Navy, but is contaminated as well, and Kekoʻo Spring in Waiʻanae, where the old spring site is littered with debris and no surface water flows.

Additionally, the community believes that Glover Tunnel reduces the flow of Mākaha Stream. Even if stream flow will not increase if Glover Tunnel is closed, the water is currently used for golf course irrigation, which some say is an inappropriate use of precious resources. Instead, some in the community would like to put that water directly into the stream to support ecological, cultural, and educational functions.

Mākaha Stream is also thought by some to be affected by BWS pumping. While the connection between pumping and stream flow is not clear, BWS has agreed to minimize pumping at Mākaha Wells II and III, except during peak demand periods when additional capacity is needed. This action, coupled with stream and rainfall monitoring, is meant to identify the connection, if any, between BWS' wells and Mākaha Stream.

Preliminary Scope

The following actions should be taken to develop measurable IFS for Waiʻanae streams, with priority given to Mākaha and Kaupuni Streams:

- Determine characteristics of stream flow and macrofauna, through stream and biological assessments.
- Assess non-instream uses.
    - Verify known diversions and investigate suspected diversions, such as one on Pūhāwai Stream.
    - Characterize the need for and impacts of diversions and partial or full restoration.
- Survey cultural uses & appurtenant rights
- Develop management actions.
    - Clean up Kekoʻo Spring site.
    - Reduce Glover Tunnel use through conservation or alternative sources.
    - Continue the BWS-community partnership to optimize BWS pumping in Mākaha and minimize effects on stream flow.

Potential Participating Entities

BWS, CWRM, Koa Mana, Land owners, Mākaha Resort, Mohala i ka Wai, Na Wai o Waiʻanae, UH NREM, USGS, US Navy.

Estimated Cost

$465,000 per stream
 $350,000 stream flow and macrofauna
 $75,000 instream use
 $40,000 cultural and appurtenant use

References

Hawaii Cooperative Park Service Unit, 1990, *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*. State of Hawaii Commission on Water Resources Management, Honolulu, HI.

Hawaiʻi Revised Statutes Chapter 174C, State Water Code.

PROJECT 15: STREAM CONSERVATION CORRIDOR PROJECT (pg. 1 of 2)

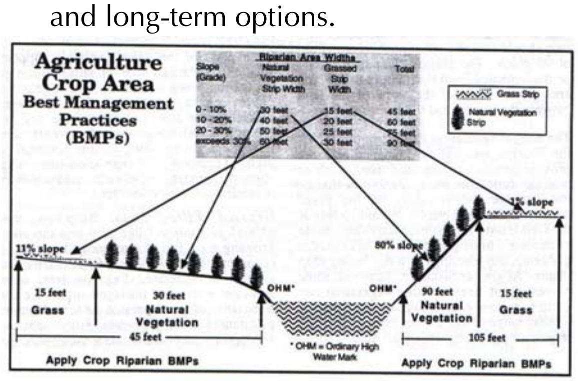
Problem Statement
There is no transition area to protect or buffer streams from the impacts of surrounding urban and agricultural land uses.

General Background
In addition to providing scenic and recreational benefits, streams provide habitat for native organisms, such as ʻoʻopu and ʻōpae. Unfortunately, streams in Hawaiʻi are being negatively impacted by adjacent land uses. Private land often abuts stream banks, or even includes the stream itself, leading to development right up to the stream edge, exacerbating flooding, erosion, and polluted runoff. Private ownership of streams and stream banks also leads to maintenance difficulties in terms of access and jurisdiction.

Hawaii's Coastal Nonpoint Pollution Control Program Management Plan (1996) recommends Streamside Management Zones (SMZs) consisting of the stream and adjacent areas where activities are closely managed. Widths are determined by the management activities necessary to mitigate adverse effects on water quality, fish, or other aquatic resources. SMZ vegetation buffers streams from polluted runoff, stabilizing stream banks, and providing shade, keeping stream waters cool for native aquatic species. Buffers may also promote surface water percolation into the ground, aquifer recharge, and reduced flooding.

Due to the built-out nature of many streamside properties, it may be necessary to consider maintenance easement options, as opposed to property acquisition measures or setbacks. Additionally, active coordination among multiple landowners will be essential, along with incentive programs.

Generic Actions & BMPs:
Stream corridor best management practices include:
- ✓ Identify land ownership within the stream corridor and involve owners in a partnership with agencies.
- ✓ Identify the width of appropriate stream corridors based on adjacent land uses, stream and site specifics, maintenance needs, and fish and wildlife considerations.
- ✓ Acquisition / agreement techniques and tools to investigate:
  - Land acquisition –full title purchase, easements, eminent domain.
  - Land use regulations – setback ordinances.
  - Landowner agreements – transferable development rights.
  - Incentives – reduction in real property tax, density transfers, variances.
- ✓ Clearly delineate Stream Conservation Corridors (or SMZs) on a map.
- ✓ Ensure consistency with existing comprehensive plans.
- ✓ Identify compatible uses within the corridor.
- ✓ Restore natural vegetation within stream floodplain areas.
- ✓ Develop alternatives for corridor preservation including short, medium, and long-term options.



Agricultural buffer design options. From: Riparian Nonpoint Pollution Control in Hawaii: Impacts and Policy Recommendations (1996)

PROJECT 15: STREAM CONSERVATION CORRIDOR PROJECT (pg. 2 of 2)

The Issues in Wai'anae

Waianae's major streams are important elements of the landscape and the natural ecology of the region. Some of these streams are perennial near their origins in the mountains, but all are intermittent as they flow through the lower reaches, where there are little or no riparian zones to buffer them from urban and agricultural land uses.

Runoff from Wai'anae agricultural lands may carry concentrations of silt, herbicides, pesticides, and farm animal wastes. Urban runoff can include herbicides, oils, grease, paint products and other toxic substances, and trash and debris. Kaupuni Stream has been listed by DOH as an impaired water body. Streams carry polluted runoff to near-shore waters where they may impact activities such as fishing, swimming, and surfing, and resources, such as fisheries and coral reefs. Pōka'ī Bay, fed by Kaupuni Stream, is also an impaired water body.

The 1999 Wai'anae SCP recommends the establishment of stream conservation corridors for all significant perennial and intermittent streams in the district. In addition to protecting waterways from polluted runoff and erosion, stream corridors could also allow for public access to the stream and as a *ma uka-ma kai* corridor, providing there is landowner agreement.

Preliminary Scope

The establishment of Stream Conservation Corridors in Wai'anae could include the following actions:

- ❖ Establish acceptable uses within the corridors. Possible uses may include public access for hiking or gathering.
- ❖ Accommodate flood flow capacity of the streams.
- ❖ Identify continuous, variable-width corridors from the conservation district to the mouths of the following:
  - o Nānākuli Stream
  - o Ulehawa Stream
  - o Mā'ili'ili Stream
  - o Kaupuni Stream
  - o Mākaha Stream
  - o Mākua Stream.
- ❖ Coordinate maintenance or land acquisition easements among streamside public and private land owners.
- ❖ Restore functioning vegetated buffer zones within the corridor, including
  - o Appropriate native vegetation.
  - o Stream bank stabilization.
  - o Native plant nursery.
  - o Water service to establish plants.

Potential Participating Entities

DPP, DFM, DLNR-DAR, BWS, private landowners, community groups.

Estimated Cost

Plan: $100,000 - $250,000
Implementation: $250,000 - $500,000

References

Bay Pacific Consulting, 1996. *Riparian Nonpoint Pollution Control in Hawaii: Impacts and Policy Recommendations*, Office of State Planning, State of Hawaii.

City and County of Honolulu Department of Planning and Permitting, 1999, *Waianae Sustainable Communities Plan*.

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PROJECT 16: WETLANDS RESTORATION AND PROTECTION (pg. 1 of 2)

Problem Statement

Wetlands provide a wide range of valuable natural functions, but many wetlands in Wai'anae have been degraded or destroyed.

General Background

Hawaii's wetlands "contain plants and animals requiring water at or near the soil surface all or part of the time…Wetlands may include tidal flats, muliwai or sand bars at the mouth of streams, some anchialine pools, marshes, riparian areas, lakes, ponds, bogs, and taro fields." Approximately 110,000 acres of wetlands exist in Hawai'i in a variety of locations from the coast to the mountain tops. Despite this, an estimated one-third of coastal wetlands have been destroyed in the past two hundred years.

Wetlands, both natural and man-made, provide many ecological functions, such as providing habitat for numerous native plants and animals. Other functions include infiltration and recharge of ground water supplies, settling basins for sediment, and flood control. Additionally, wetlands serve as natural filters, which contain plant species that take up some pollutants and nutrients, improving downstream, water quality and reducing the potential for algal blooms.

Ecologists have begun constructing wetlands to take advantage of these bioremediation functions. Similarly, wetlands have been incorporated into water recycling projects as a method of filtering nutrients from gray water. Water from these systems may then be re-used in toilets or as irrigation water for gardens or lawns.

Existing and constructed wetlands are also being used to absorb storm waters and prevent or reduce flooding of adjacent developed areas. Some developments have even incorporated "mini-wetlands" into their project designs for such purposes.

Existing wetlands have some measure of protection from EPA, USFWS, and USACE programs; however, each agency has their own definition of the term wetland, and protects them according to their own interest. These agencies also tend to be regulatory, generally requiring specific triggers in order to initiate management actions.

Issues associated with wetland creation, restoration, and protection include the need for large land areas and the potential liability associated with open bodies of water. Another concern is the potential to create "biological sinks," where wetland fauna, such as waterfowl, are attracted to a habitat that does not have the proper conditions for their survival. For example, a contaminated wetland could attract birds but make them sick. A wetland with a high concentration of predators could similarly attract birds to their death. Wetlands should therefore be designed to minimize such risks.

Generic Actions & BMPs:

Often seen as a best management practice itself, wetland restoration and preservation may benefit from the following actions:

- ✓ Inventory wetlands, biota, functions, and cultural and historic uses;
- ✓ Coordination among resource agencies, landowners, and community organizations;
- ✓ Vegetated buffers;
- ✓ Native plant restoration;
- ✓ Alien species removal;
- ✓ Interpretive signs/education;
- ✓ Fencing;
- ✓ Constructed wetlands for water recycling.

PROJECT 16: WETLANDS RESTORATION AND PROTECTION (pg. 2 of 2)

The Issues in Waiʻanae

The largest wetland in Waiʻanae is Kaʻala Bog, which provides for native habitat and infiltration of water into the ground, and also supplies a significant amount of surface water to Mākaha and Kaupuni Streams. A protected Natural Area Reserve, Kaʻala Bog still faces such threats as alien invasive species.

Lualualei and Niuliʻi Reservoirs provide habitat for various waterfowl, including native, migratory, and Federally listed threatened or endangered birds. However, Navy studies have found metals and pesticides in Niuliʻi Reservoir sediments, which could have a negative effect on wetland species frequenting the area.

Historically, some of the coastal wetlands in Waiʻanae may have functioned as fishponds or taro loʻi, but many have since been filled in or degraded by development. Some degraded coastal wetlands include muliwai in Nānākuli and Mākua. The Mākaha Beach Park parking lot and comfort station are situated adjacent to another coastal wetland and may create significant impacts, such as human disturbance and pollution from vehicles, on any restoration efforts.

Preliminary Scope

In addition to the BMPs listed previously, specific actions that could be undertaken to create, restore, and protect wetlands in Waiʻanae include:

- ❖ Monitor invasive species at Kaʻala Bog and conduct regular eradication efforts.
- ❖ Maintain perimeter fencing.
- ❖ Remediate Niuliʻi Reservoir using phytoremediation and other methods.
- ❖ Whenever feasible, restore cultural activities such as loʻi kalo or fishpond functions where they once occurred, for example, at Mākaha or Lualualei.
- ❖ Identify and restore coastal wetlands, possibly at Mākua, Mākaha, and Nānākuli.
  - o Restore native wetland vegetation for habitat and phytoremediation.
  - o Fence areas to protect water birds from feral cats and other predators.

Potential Participating Entities

USFWS, USACE, USGS, DLNR-DAR, UH, Mohala i ka Wai

Estimated Cost

$1,500 - $2,500 per acre.

References

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Nānākuli coastal wetland.

PROJECT 17: CONCRETE FLOOD CHANNEL REDESIGN (pg. 1 of 2)

Problem Statement

Concrete flood channels eliminate aquatic habitat for native species, prevent natural water exchange between stream flow and stream banks, and detract from natural aesthetics associated with streams and riparian areas.

General Background

In response to flooding, some streams have been channelized to convey storm waters more efficiently. While flood control projects can help prevent property damage, stream bank erosion, sedimentation, and floodway damage, they may also have negative effects on stream ecology. Many native aquatic species have amphidromous life cycles that require them to migrate between estuaries and various upstream locations. Most stream modifications, most notably channelization, inhibit the ability of native stream organisms to traverse the length of the stream and find suitable habitat.

Channel designs commonly include steep concrete banks with a wide, flat bottom. Concrete lining is impervious, therefore eliminating natural water flow between the stream and its banks. Typical concrete linings also eliminate the pools, runs, and riffles native fish and invertebrates prefer as habitat. Wide, flat bottoms reduce oxygen content in the water and spread stream flow out. The slow, shallow flows that are thus created during low flow periods favor alien species that out-compete or prey upon natives. Shallow flows also heat up to intolerable levels as the sun warms the concrete. Additionally, channelization often removes riparian vegetation that normally shades the stream, cools the waters during the day, and provides food.

Redesigning these concrete-lined reaches could recreate, restore, or improve destroyed habitat. Various structures, such as gabions and rock-lined reaches, can be added to these concrete channels to allow for pool, fall, and riffle features. Channel bottoms could also be redesigned to accommodate a natural bottom or a low flow channel so that stream flow is concentrated and depth is increased during low flow conditions. Trees and native plant restoration along the banks of the channels would provide shade to cool the waters, and increase detritus for nutrient enrichment. Bike trails and walkways along the channel banks would increase recreational attraction.

Generic Actions & BMPs:

While design standards for ideal native stream habitat have not been developed yet, local biologists and agencies suggest the following concepts be considered in channel reconstruction:

- ✓ Permeable linings;
- ✓ Natural bottoms;
- ✓ Vegetated stream banks;
- ✓ Low flow channels;
- ✓ Public access and safety;
- ✓ Ability to accommodate adequate flood capacity;
- ✓ Maintenance considerations – cost and access.

Māʻiliʻili Channel.

PROJECT 17: CONCRETE FLOOD CHANNEL REDESIGN (pg. 2 of 2)

The Issues in Waiʻanae

Severe flood damage in the Waiʻanae District led to the channelization of the lower reaches of Kaupuni, Māʻiliʻili, Māʻili, and Ulehawa Streams in the 1960s and 1970s. A 2001 flood study by the Army Corps of Engineers found that these improved sections of stream are adequate to convey flood waters, even if drainage improvements redirect additional runoff into these channels. Flood structures typically have a 50-year life span, suggesting that these structures may need to be re-examined in the near future.

The flood channels constructed are massive, concrete-lined and fenced structures, which are considered an eyesore to many. Not only do they restrict access to the stream, they may also look out of place in this rural community and do not provide for riparian habitat, eliminating the benefits of a natural riparian system. It should be noted that it may not be possible to design all flood channels in an ecologically sensitive way. Depending on available right of way and other considerations, trade-offs must often be made between flood protection and ecosystem protection.

Preliminary Scope

Reconstruction of the concrete channels in Waiʻanae should seek to incorporate the following:

- ❖ Develop a pilot project for one stream to test design concepts.
- ❖ Redesign Kaupuni, Māʻiliʻili, Māʻili, and Ulehawa channels as a part of their end-of-design-life evaluation and possible reconstruction.
- ❖ Meet City storm water design standards.
- ❖ Coordinate with an overall flood mitigation plan, such as Project 27.
- ❖ Integrate native species habitat into the design of reconstructed channels.
- ❖ Create “zones of passage for amphidromous native species, where feasible.
- ❖ Consider permeable or semi-permeable materials, like gabion mattresses, to allow for water exchange between stream and subsurface.
- ❖ Provide for community access to streams.
- ❖ Soften the concrete channels to fit in with the community around them.
- ❖ Provide for native riparian vegetation.

Potential Participating Entities

NRCS, USACE, USGS, DLNR, DDC, DFM

Estimated Cost

$2 million - $10 million or more per stream.

References

Horsley Witten Group, 2006, *Low Impact Development: A Practitioner’s Guide*, Hawaii Coastal Zone Management Program and the National Oceanic and Atmospheric Administration.

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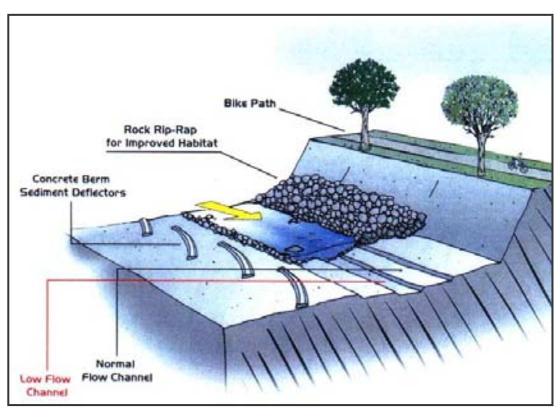

Possible channel redesign concept.

PROJECT 18: STREAM BIOLOGICAL ASSESSMENTS (pg. 1 of 2)

Problem Statement
There is limited information available on Wai'anae streams in terms of native species, habitat, ecosystem stability, and threats.

General Background
The Federal Water Pollution Control Act as amended in 2002, i.e., the Clean Water Act, sets forth as a national goal, "water quality which provides for the protection and propagation of fish, shellfish, and wildlife." Additionally, Hawaii's State Water Code mandates that "adequate provision shall be made for the…protection and procreation of fish and wildlife." Limited data makes it difficult to assess the health of streams, native biota, and stream habitats, in order to compare it with historical information, and to assess and plan for future needs.

The National Park Service and DLNR developed the "Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources" (HSA) in 1990. As a part of their resource inventory and assessment, aquatic resources for all perennial streams were evaluated in terms of their biological quality. All existing and available records were reviewed, but no additional surveys or studies were conducted. Therefore, some streams could not be adequately assessed due to a lack of current data.

There is little information on Hawaiian stream fauna and their habitat needs, including the significance of estuaries and embayments to their life cycles. However, it is generally agreed that most native stream species, such as 'o'opu, favor clear, well-oxygenated, fast-flowing water and stream beds with boulders, cobbles, and gravel bottoms. This is supported by the HSA's findings of a positive correlation between biological resources and larger streams that lack modifications.

Biological measurements taken during assessments help to evaluate the overall health of streams, and also help to complement the chemical and physical components in assessing water quality. Once overall health and water quality are properly assessed, information gathered from biological assessments can be used to restore and maintain a stream's biological integrity.

"Instream flow standards" (IFS) are defined by the State Water Code as the "quantity or 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." CWRM is currently in the process of developing quantifiable IFS. Biological assessments of the native organisms and the habitat they require could help in the IFS process.

Generic Actions & BMPs:
Stream biological assessments could:
- ✓ Establish a protocol for updating the HSA aquatic resource database and for setting quantifiable IFS.
- ✓ Develop a master plan for aquatic research that includes those interested in the study and management of aquatic resources.
- ✓ Develop recommendations for management actions, including aiding in setting TMDLs, IFSs, and habitat design guidelines.

PROJECT 18: STREAM BIOLOGICAL ASSESSMENTS (pg. 2 of 2)

The Issues in Waiʻanae
The HSA ranked Mākaha Stream as "Moderate" in terms of aquatic resources, meaning that at least one native species from the indicator species group was observed. However, the most recent survey was conducted in 1976, therefore giving no indication of current or recent biological health. The other Waiʻanae perennial streams listed in the HSA, Mākua, Kaupuni, Māʻiliʻili, and Nānākuli, did not have biological data to evaluate.

A 1997 survey of Mākaha Stream by AECOS, Inc. did not observe any fishes, but did record several invertebrates, particularly insects. A native worm and snail were found at an intermittent reach, and it was speculated that *ʻoʻopu*, *hapawai*, and/or *ʻōpae kalaʻole* were present in upstream perennial reaches. In 1998, alien fish, shrimp, and frogs were recorded in Kaupuni Stream, indicating an increasing presence of nonnative species.

Measurable IFS standards have not yet been established for Waiʻanae streams. The major Waiʻanae streams are perennial in their upper reaches, but intermittent in their lower reaches. The biological resources supported by the streams may help to develop appropriate measurable IFS for different stream reaches.

Preliminary Scope
The following actions are recommended:

- Develop an ongoing schedule and assess the perennial streams in Waiʻanae: Mākua, Mākaha, Kaupuni, Māʻiliʻili, and Nānākuli.
- Consider impacts of habitat threats, e.g., alien species, trash and litter, loss of riparian buffers, low stream flows, and channelization, on biological integrity.
- Utilize data from the biological assessments to develop management actions such as developing measurable IFSs, identifying appropriate riparian buffer widths, and redesigning flood channels.
- Identify opportunities for community and school involvement in regular assessments.

Potential Participating Entities
DLNR-DAR, UH, USGS, CWRM

Estimated Cost
$25,000 per stream.

References

Hawaii Cooperative Park Service Unit, 1990, *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources*. State of Hawaii Commission on Water Resources Management, Honolulu, HI

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Rapid biological assessment of an Oʻahu Stream.

PROJECT 19: WATER QUALITY TESTING AND MONITORING (pg. 1 of 2)

Problem Statement

There is little water quality information on which to base management decisions and evaluate projects, programs, and other actions in the watershed.

General Background

The State Department of Health (DOH) determines the level of impairment and assesses the overall status of water quality throughout the state, using "existing and readily available" data. Regular monitoring is needed in order to adequately assess water quality and determine if standards are being met, in order to protect the health of natural ecosystems, biota, and human users.

Monitoring could also provide data for determining the effects of land use on the environment and the effectiveness of different programs and projects. However, water quality monitoring is costly, therefore making it infeasible to collect large amounts of data. Monitoring should therefore be restricted to data that are necessary for evaluating the most important watershed questions. The monitoring of other parameters should be included in individual project design to determine the specific effects of that action.

Some typical water quality monitoring parameters include rainfall, stream flow, temperature, turbidity, dissolved oxygen content, salinity, and pH. These measures should be taken at strategic locations to minimize the number of monitoring locations, maintenance, and other costs.

Because monitoring data are so costly to obtain, what little data are collected should be readily available to eliminate repetition. Currently, different agencies, groups, and individuals collect various types of data, making it difficult to determine if desired information is available and which group holds a particular data set. Historical information is also difficult to access because it is stored at various locations. A centralized database would make research more accessible to decision-makers and others who wish to execute projects. Additionally, multiple agencies and entities often use different sampling methodologies, which may make it infeasible to compare data sets.

Generic Actions & BMPs:

Water quality testing and monitoring should include the following steps:

- ✓ Organize and analyze available baseline data.
- ✓ Identify agencies and organizations that are actively monitoring and have the capacity to monitor surface water quality.
- ✓ Identify the water quality parameters necessary to make useful assessments for specific water bodies.
- ✓ Design sampling methodology to account for specific water quality parameters, sampling entity level of expertise, consistency, and transferability.
- ✓ Conduct field surveys and laboratory sampling of the streams, estuaries, and near-shore waters.
- ✓ Where/when feasible, note other water body characteristics that may help in assessing the overall health of the water and watershed, including organisms, instream and riparian habitat, and illegal dumping sites.
- ✓ Present the results for management
    - Draw conclusions from the results of the assessment and translate them into management actions.
    - Make recommendations.
- ✓ Maintain a regular schedule for monitoring.

PROJECT 19: WATER QUALITY TESTING AND MONITORING (pg. 2 of 2)

The Issues in Wai‘anae

While most Wai‘anae streams are gaged, median stream flow is only available for Kaupuni and Mākaha Streams. A 1996 USGS report recommended adding gaging stations at Nānākuli and Mā‘ili‘ili Streams in order to address future issues, including surface water availability and perennial streams.

USGS currently operates two water quality stations at Mākaha and Kaupuni Streams and seven rain gages in Mākaha. There is little water quality data available for Wai‘anae and the intensity of sampling varies with each stream. USGS sampled Kaupuni Stream five times between the years 1970 to 1973, while Mākaha has been studied more extensively, with 130 water quality samples taken between the years 1967 to 1986, and an additional four samples in 1997.

DOH’s 2004 List of Impaired Waters in Hawaii includes Kaupuni Stream as a Water Quality Limited Segment (WQLS) due to excessive presence of nutrients, turbidity, and trash. Kaupuni Stream is of medium priority to have TMDLs developed. TMDLs are calculations of the maximum amount of each pollutant that can enter a given water body without violating state water quality standards. Pōka‘ī Bay was also listed as a low-priority WQLS due to excessive concentrations of chlorophyll-a and Total Nitrogen.

Preliminary Scope

This study will help to assess the condition of Wai‘anae surface water quality and monitor changes due to land use and other management projects and programs.

- ❖ Add surface water gaging stations for Nānākuli and Mā‘ili‘ili Streams.
- ❖ Focus monitoring on Kaupuni Stream and Pōka‘ī Bay in order to establish TMDLs.
- ❖ Input data into Wai‘anae watershed information clearinghouse for distribution and use.

Potential Participating Entities

USGS, DOH, UH, DOE, ENV, private landowners.

Estimated Cost

$50,000 - $100,000 per new station per year.

References

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Koch, L., J. Harrigan-Lum, and K. Henderson. (2004). *Final 2004 List of Impaired Waters in Hawaii: Prepared Under Clean Water Act 303(d).* Hawaii State DOH EPO.

Oki, D.S., and Brasher, A.M.D. (2003). Environmental Setting and the Effects of Natural and Human-Related Factors on Water Quality and Aquatic Biota, Oahu, Hawaii: USGS Water-Resources Investigations Report 03-4156.

Water quality testing.

PROJECT 20: STREAM DUMPING PREVENTION & CLEAN UP (pg. 1 of 2)

Problem Statement

Stream dumping pollutes surface water with trash, debris, and chemical contaminants that leach into the water, negatively impacting recreational activities, posing health threats, and degrading aquatic habitat both in the streams and in the near shore waters they feed into.

General Background

Oahu's storm water drainage system was designed to prevent flooding, not to dispose of waste or pollutants. Storm water flows from single-family residences, condominiums, roadways, and sidewalks into drains, directly to streams. Stream and ocean quality and the aquatic life they support can be compromised when pollutants enter the storm drainage system and flow out to nearshore waters.

The Federal Clean Water Act mandates cities with more than 250,000 residents to conform to the National Pollutant Discharge Elimination System (NPDES) regulations and keep their storm drain and sewer systems as pollutant-free as possible. Under these regulations, the City and County of Honolulu monitors storm water discharges, issues water pollution control guidelines, oversees private connections to the storm sewer systems through permits, and conducts educational campaigns. Additionally, municipal storm drains have catch basins that collect pollutants and waste debris from a variety of sources.

City ordinance section 29-4.4(a)(5) states that no person shall: "Throw or deposit litter in any fountain, pond, lake, stream, bay or any other body of water in a park or elsewhere within the city." Despite this, dumping has become a problem in many neighborhoods. It is especially problematic in flood plain areas where flood waters can carry debris into streams and drainages. Enforcement is difficult due to the large areas that must be policed and the unwillingness of many people to report dumping when they do observe it. In addition to

Generic Actions & BMPs:

Best Management Practices include the following:

- ✓ Keep sidewalks, curbs, gutters, and floodplains clean.
- ✓ Gather grass and tree cuttings and dispose as green waste or compost yard trimmings. Compost is a valuable soil conditioner.
- ✓ Education regarding the watershed.
    - Curriculum development and presentations on water, point and non-point source pollution, and storm water versus wastewater
    - Organize stream walks
    - Storm drain stenciling
- ✓ Data collection via visual assessments of drainage channels
    - Conduct onsite walks to collect data that identifies human and animal impacts on storm drains
    - Map and record details for assessment
- ✓ Identify target areas for clean-up.
    - Involve residents, community groups, and schools in conducting basic clean ups
    - City complete large, bulky or potentially hazardous materials removal or clean up.
    - Continue regular municipal curbside bulky item pickup
- ✓ Monitor storm drain, channels, and streams regularly; include yearly data collection.

PROJECT 20: STREAM DUMPING PREVENTION & CLEAN UP (pg. 2 of 2)

The Issues in Wai'anae

Streams and drainage channels along the Wai'anae Coast collect large amounts of debris and pollutants from storm water run-off or by directly dumping rubbish and debris into streams, storm drainage canals, and floodplains. In a coastal community such as Wai'anae, pollutants such as these can affect nearshore water quality and community health and safety in places where people fish, surf, and swim.

The City Storm Water Quality Branch is interested in developing a storm drain cleanup project in Nānākuli. The storm channel along Helelua Street was built in the 1960s and is experiencing a high rate of rubbish dumping allegedly from both residents and visitors. The City would like to bring greater awareness to the problem, and perhaps use Nānākuli as a demonstration project for eventual application in other areas. The objectives of the Nānākuli Channel project are to promote education and community awareness about drainage; collect data, target areas for clean up, and conduct monitoring activities. The outcomes of this project will be to decrease trash and increase community awareness.

Preliminary Scope

The scope of this project could be as follows:

- Involve local schools in watershed education and as participants in other project activities. Schools could adopt streams and drainageways in their watershed
- Conduct regular visual assessments and monitoring
- Increase awareness of the City's various hotlines:
  - Environmental Concern Line 692-5656
  - Household Hazardous Waste Disposal 692-5411
- Schedule regular community cleanups that target streams and drainage channels, or organize and promote the City's Adopt-A-Stream program.
  - Include safety training
  - Provide safety equipment
  - Provide for proper trash removal and disposal

Participating Agencies

ENV Storm Water Quality Branch, DHHL, Local Landowners, Industries and Businesses; Schools; Youth Groups and Service Groups: Boy Scouts, Girl Scouts, AmeriCorp, Boys and Girls Club, Nani o Wai'anae

Estimated Cost

$10,000 per stream per year.

References

Department of Environmental Services. City and County of Honolulu. Brochures: *Tips to Protect Our Waters ... For Life* and *Industry Can Help Protect Our Waters....For Life.*

Department of Environmental Services, City and County of Honolulu. *Honolulu's Clean Water Program.* http://www.cleanwaterhonolulu.com/

Nani o Wai'anae. Brochure: *Stop Illegal Dumping*

Litter collected in a storm drain catch basin in Wai'anae.

PROJECT 21: SURFACE WATER INVENTORY (pg. 1 of 2)

Problem Statement

The data record on Waiʻanae surface waters is incomplete, therefore making it difficult to plan for their restoration and appropriate use.

General Background

Surface water in Hawaiʻi is utilized in many ways. Stream water alone is recognized by the State Water Code as having multiple uses, including, but not limited to: maintenance of fish and wildlife habitat; outdoor recreational activities; maintenance of ecosystems such as estuaries, wetlands, and stream vegetation; aesthetic values such as waterfalls and scenic waterways; navigation; instream hydropower generation; maintenance of water quality; conveyance of irrigation and domestic water supplies to downstream points of diversion; and protection of traditional and customary Hawaiian rights. Because there are many demands on surface water, proper management and allocation of resources is necessary to ensure fair and sustainable use.

The State is currently in the process of developing instream flow standards to protect and allow for multiple uses. However, basic data on many streams is limited, as is data on the volume of water required to sustain some recognized instream uses, such as habitat and ecosystem maintenance. Additionally, information on existing human uses of surface water is incomplete.

The CWRM maintains a database of known surface water diversions in the state. However, this database was created through self-reported declarations and has not been fully verified for accuracy. Additionally, listed diversions often do not have uses and quantities associated with them because diversion owners do not have the knowledge or equipment to measure flow.

There may also be some diversions and other water uses that are not known to CWRM due to non-reporting. However, due to limited staff, CWRM is unable to verify all details of water declarations and do regular inspections to ensure the database is current and complete.

Generic Actions & BMPs:

- ✓ Verify locations of known diversions.
- ✓ Periodically conduct surface water surveys for undeclared diversions.
- ✓ Train diversion owners to measure volumes and educate them on the importance of reporting any changes.
- ✓ Update the information on listed diversions with new volumes, uses, and status.
- ✓ Maintain the database with new entries and updated information.

"Icy pond" in Mākaha.

PROJECT 21: SURFACE WATER INVENTORY (pg. 2 of 2)

The Issues in Waiʻanae

Waiʻanae is a dry area, with streams that are intermittent in their lower reaches and no natural lakes. Despite this, there are several known wetlands, some of which have been degraded or destroyed, and a few surface water diversions that have been and continue to be used for agricultural purposes. Remnants of *loʻi kalo*, particularly in Waiʻanae and Mākaha Valleys, indicate historic surface water use. There is currently a push to restore some of those *loʻi*, although stream flow has been "unreliable" in recent years.

There are only three stream diversions that are thought to be active, but none of the records have volumes associated with them. Additionally, community members believe there may be other diversions on private property, including a significant one within the Navy complex in Lualualei that are not registered with CWRM.

Wetlands in Waiʻanae provide habitat for native waterbirds and other organisms. Community members are interested in restoring and protecting wetlands for their habitat functions, as well as for the other functions they provide, such as flood water absorption and filtering. However, there is no list of historic wetlands for restoration, and wetland management is overseen by three separate agencies, DLNR, USFWS, and USACE, which maintain separate wetland databases.

Additionally, some historic accounts of surface water, particularly springs, are not easily identified today because names may have changed or the nature of the surface water body may be different from records. These water bodies should be recorded and their statuses updated.

Preliminary Scope

- Verify the locations, uses, and volumes of known stream diversions.
- Investigate suspected diversions.
- Investigate known wetlands, assess health and function, and prioritize for restoration and protection.
- Record historic accounts of surface water and use and identify the current status of these features.

Potential Participating Entities

DLNR, USACE, USFWS, CWRM.

Estimated Cost

$30,000 - $50,000.

References

Hawaii Cooperative Park Service Unit. (1990). *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources.* State of Hawaii Commission on Water Resources Management.

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Stream Protection and Management (SPAM) Task Force, April 1994*, Stream Protection and Management in Hawaii: Recommendations and Suggestions*, State of Hawaii Commission on Water Resource Management, Honolulu, HI.

PROJECT 22: SURFACE WATER QUALITY IMPROVEMENT (pg. 1 of 2)

Problem Statement
Some of Waianae's waters have been declared "impaired" by the State Department of Health (DOH) in terms of water quality.

General Background
The Federal Clean Water Act §303(d) mandates that each state submit a list of water bodies that are not expected to meet state water quality standards, even after action is taken to control non-point source pollution. This list, the 303(d) List of Impaired Waters in Hawaii (List), is developed by DOH every two years.

A total of 70 streams and 174 coastal stations were listed in 2004. This is an addition of 11 streams and 35 coastal stations since 2002. Data is collected through monitoring by various agencies, stream surveys, biological assessments, and other sources, such as scientific and university research. Additionally, information from environmental assessments and other related investigations could be used, but none were used for the 2004 listing.

Some possible water quality impairments include turbidity, nutrients, bacteria, and trash and debris. Listed water bodies are prioritized as high, medium, and low, based on the number of water quality parameters exceeded; the severity of the exceedance; the type, location, and use of the water body; the degree of public interest, and the vulnerability of those waters to pollution. High priority water bodies are first in line for the development of Total Maximum Daily Loads (TMDLs), which are calculations of the maximum amount of each pollutant that can enter the given water body without violating state water quality standards.

DOH is in the process of developing TMDLs for high priority water bodies. The TMDL process identifies activities that may help to reduce pollutant loads, improve water quality, and increase the ability of a waterbody to support its legally protected uses. TMDLs already approved include those for Kawa Stream, Waimānalo Stream, and the Ala Wai Canal. DOH is currently conducting a TMDL study for Waikele Stream.

Generic Actions & BMPs:
- ✓ Vegetated buffers;
- ✓ Storm drain filters;
- ✓ Sediment traps and basins;
- ✓ Stream cleanups;
- ✓ Develop, implement, and enforce TMDLs.


Trash in a Wai'anae drainage canal.

PROJECT 22: SURFACE WATER QUALITY IMPROVEMENT (pg. 2 of 2)

The Issues in Wai‘anae

Of the six major streams in Wai‘anae, Kaupuni Stream is a medium priority on the 2004 List of Impaired Waters in Hawaii. Pollutants include nutrients, turbidity, and trash, but the pollutant sources have not been determined and TMDLs have not been developed. Potential sources of nutrients include cesspools and agricultural fertilizers. The actual number of cesspools in Wai‘anae is not known; however, it is suspected that many homes in this rural area are not connected to sewer lines.

Some nutrients, like nitrogen, may naturally occur at high levels, possibly from vegetation in the watershed. High nitrate levels have been found in BWS Wai‘anae and Mākaha wells. Background levels of these types of pollutants should be determined to understand what man-made pollutant levels can be addressed.

Agricultural production in Wai‘anae Valley possibly contributes to some of Kaupuni Stream's nutrient loads, expecially where there are no buffers between farming operations and the stream or its tributaries. Other impacts may come from grading operations for roads and houselots, trash, and illegal dumping of debris, including broken appliances, old cars, and tires.

Pōka‘ī Bay is also in the 2004 303(d) List for total nitrogen and chlorophyll-a. While Pōka‘i Bay is of low priority on the List, it is also a popular fishing and recreational area in Wai‘anae. The high nitrogen levels may come from Kaupuni Stream, which feeds directly into the Bay, and excessive chlorophyll may be the result of high nutrient levels and poor circulation. As a low priority water body, studies to identify pollutant sources have not been done yet.

Of particular concern are the chemical weapons dumped off of Waianae’s coast after World War II. The extent of the risk posed to the public and the environment is currently unknown. Hundreds of tons of chemical weapons are believed to be located at offshore dumpsites in waters shallower than those required by Army rules.

Preliminary Scope

- Determine the naturally-occurring levels of nitrogen and other pollutants to provide realistic targets for water quality improvement.
- Improve storm water facilities to reduce agricultural wastes into streams.
- Implement silt basins.
- Develop incentives for conversion from cesspools to sewer.
- Organize stream cleanups.
- Create stream buffers.
- Maintain existing debris booms.
- Promote agricultural BMPs.
- Investigate the type and quantities of hazardous materials dumped off Waianae’s coast.
    - Survey of underwater dump sites
    - Monitor for release of harmful agents
    - Assess the risks to environmental and public health posed by the dumpsite
    - Estimate the cost and feasibility of cleanup operations.

Potential Participating Entities

DOH, ENV, CZM, Nani O Wai‘anae, Army.

Estimated Cost

$150,000 - $300,000.

References

Department of Health, 2004 303(d) List of Impaired Waters in Hawaii,

PROJECT 23: FORESTT RESTORATION PROGRAM (pg. 1 of 2)

Problem Statement

The overall health of the Waiʻanae forests is not really known, yet protection of these forests is needed to ensure the quality of surface water and ground water resources.

General Background

While there are approximately two million acres of forest land in Hawaiʻi, much of the state's original forest lands have been eliminated or degraded due to human influences. Approximately 96 percent of the ecological communities in Waiʻanae are non-native, largely due to settlement and development, agricultural activities, and the introduction of alien species.

One of the most important functions of a healthy forest is to recharge aquifers. The forest canopy "catches" precipitation and fog drip, allowing water to percolate into the ground and feed our drinking water supply. Another important function is the forest's ability to reduce erosion and sedimentation in streams and near-shore waters. A multi-storied canopy, common in native but not in alien species-dominated forests, provides layers of barriers that break the force of rain, thereby reducing its erosive capacity. The root structures of native forest plants are also thought to hold soil better than alien species, although research on this is ongoing.

Additional benefits of forests include providing habitat for native, threatened, and endangered species; hunting opportunities for recreation and subsistence; places for other recreational opportunities such as hiking; scenic beauty; educational opportunities; economic opportunities; and plants and other materials used for medicine, food, hula/ceremonial adornments, and offerings; and conducting cultural and spiritual customs.

Despite the many benefits of healthy forests, they face many threats, including alien invasive plant species, feral ungulates, introduced predators, loss of habitat, injurious insects and disease, wildfire, off-road vehicles, and illegal dumping.

Awareness of the value and importance of forests is increasing, but it is still not sufficient to produce adequate resource management. Some current governmental actions include protective zoning, fire protection fencing, removal/control of feral animals, and reforestation in selected areas.

Generic Actions & BMPs:

Common BMPs for forest restoration and preservation include:

- ✓ Coordination among resource agencies, landowners, and community organizations.
- ✓ Assessment and prioritization of issues.
- ✓ Prioritization and location of noxious weeds; subsequent removal.
- ✓ Research on appropriate vegetation types (native and non-native) for the maximization of ground water infiltration and water quality.
- ✓ Native plant restoration.
- ✓ Threatened/endangered species mapping.
- ✓ Fencing of priority resource areas.
- ✓ Interpretive signs/education.
- ✓ Research on most aggressive alien species, desired game species, especially sensitive native species, and habitats.
- ✓ Research and implementation of:
  - Methods of protecting native forests from feral ungulates.
  - Actions to control small predators, such as feral cats and rats.

PROJECT 23: FORESTRY RESTORATION PROGRAM (pg. 2 of 2)

The Issues in Waiʻanae
Waiʻanae forests are habitat to over 100 endemic plant and animal species, 58 of which are listed on the USFWS List of Threatened and Endangered Species: one mammal, one invertebrate, five birds, and 51 plants. Additionally, the forests contribute to stream flow; Kaʻala Bog is a major source of surface water for both Mākaha and Kaupuni Streams. Waiʻanae and Mākaha Valley forests also enhance ground water recharge, replenishing aquifers. These forests are also used by hunters, hikers, and cultural practitioners.

The most commonly identified threats to Waiʻanae forests are wildfire; invasive plant species, such as Christmasberry, thorny kiawe, and Himalayan blackberry; and feral pigs and goats. Current forest protection actions include the Mākua-Keaʻau, Nānākuli, Waiʻanae Kai, and Kuaokalā Forest Reserves; Kaʻena and Kaʻala Bog Natural Area Reserves; U.S. Army's Mākua Implementation Plan, Waiʻanae Kai Watershed Project, ʻelepaio critical habitat, and various programs and projects.

Restoration efforts should be focused on large, publicly owned tracts of forest that are important ground water recharge zones and are already actively managed. Examples include those areas encompassed by the Waiʻanae Kai Watershed Project, which includes the Waiʻanae Kai Forest Reserve and BWS land in upper Mākaha Valley, and the U.S. Army's restoration efforts in Mākua and Makaha's upper valleys.

Preliminary Scope
In addition to the BMPs listed previously, specific actions that can be undertaken to restore and protect Waiʻanae forests include:

- Invasive species survey, control, and monitoring in Mākaha and Waiʻanae.
- Continue to monitor and eradicate invasive species at Kaʻala Bog.
- Fence and control feral pigs and goats in Mākua, Mākaha, and Waiʻanae.
- Propagate and outplant native forest species using proper protocols.
- Fire management (see Project No. 24).
- Educate public on human impacts.
- Establish secure, clearly identified hunting areas.
- Implement policies supporting existing Waiʻanae research, projects, programs, and partnerships, such as the Hawaii Tropical Forest Recovery Action Plan and the Alien Species Action Plan.
- Implement a user fee in water charges for watershed management.

Potential Participating Entities
DLNR-DOFAW, TNCH, Waiʻanae Kai Watershed Project (WKWP), U.S. Army, USFWS, BWS, Mohala i ka Wai, UH.

Estimated Cost
$1 million per year.

References
Hawaii Tropical Forest Recovery Task Force, 1994, *Hawaii Tropical Forest Recovery Action Plan*, Honolulu, HI.
U.S. Army Garrison, Hawaii, 2004, *Oahu Training Areas Natural Resource Management, Final Report*, PCSU.

Mākaha forest.

PROJECT 24: WILDFIRE MANAGEMENT PLAN (pg. 1 of 2)

Problem Statement

Wildfires cause widespread damage to native ecosystems, increasing erosion and destroying native plants and animals and their habitat.

General Background

In 2004, O'ahu experienced 465 brush fires, and by September 2005, over 778 brushfires had already been reported. Brush fires are generally fought by Honolulu Fire Department personnel, although additional support may come from private land owners, such as the Military, State, and other private entities. Participation usually depends on the location of the fire and the resources threatened. The DLNR has primary responsibility over fires in forest and natural area reserves. Their fire protection program and contingency budgets for the current fiscal year have both been exhausted and officials are now seeking more funds to cover any additional fires that may occur.

In addition to structural damage, native species, including threatened and endangered species and their habitat, are destroyed when these fires reach upper forested areas. Forest burn sites are prone to soil erosion and colonization by weedy species and other alien plants.

Wildfires often start in the urban and agricultural zones that are accessible, and travel upslope to native forests. While some brushfires are caused by carelessness, accidents, or electrical malfunctions, many of them are believed to be intentionally set.

Generic Actions & BMPs:

Engineer fire management structures such as fuel breaks, dip ponds, fire caches, etc.

- ✓ Educate the public on the dangers of careless behavior and what they can do to reduce risks.
- ✓ Conduct firewise campaigns in high risk communities.
- ✓ Develop and/or update coordinated operational plans among land owners, managers, and agencies.
- ✓ Acquire needed equipment, training, and budget.
- ✓ Restore buffer between conservation and agriculture/urban zones for fire control.
- ✓ Wildfires – need education component; youth/others landowners participation; keep fuels low; cooperation to minimize threat to property.

Nānākuli fire smoldering in the upper valley, May 2005. Source: Honolulu Advertiser, 5-16-05

PROJECT 24: WILDFIRE MANAGEMENT PLAN (pg. 2 of 2)

The Issues in Waiʻanae

In 2004, the Honolulu Fire Department responded to 316 brushfires in Waiʻanae, or about 68% of the brushfires on Oʻahu that year. By September 2005, 521 brushfires had already been reported in Waiʻanae, the largest of which was located in Nānākuli and burned approximately 3,000 acres. The increase in wildfires was attributed to a large amount of brush due to an unusually wet winter, and, for the most part, to the deliberate setting of fires along the coast. The large Nānākuli brush fire was believed to have been started by an electrical arc from an electrical pole and/or line, but the exact cause was not confirmed.

Waianae's forests are home to many species of native plants and animals, including some threatened or endangered species. Fires have threatened such species as the native gardenia; three of the four known plants growing in the wild are located within the Nānākuli Forest Reserve. If no freshwater dipping ponds are available for use, helicopters often use ocean water. However, the sea water often damages the very plants that fire fighters are trying to protect. The dipping pond at Mauna Olu was damaged and is not currently in use. BWS has graded an area around one of its reservoirs for inflatable dipping pond use, to be filled by a fire hydrant connection, when the need arises. Similarly, reservoirs in Mākaha and Nānākuli may be retrofitted.

Brush fires in forested areas also affect ecosystem dynamics, as was seen in a burn at the Waiʻanae Kai Forest Reserve, which burned approximately 10 acres of koa forest. Restoration efforts have been implemented by partners in the Waiʻanae Kai Watershed Project, including erosion control measures and native species outplanting.

Preliminary Scope

Increase community awareness through known user groups: hunters, hikers, etc.
Identify and prepare dipping ponds for use during fires.
Preplan fire facilities and structures, such as fuel breaks, fire breaks, tools, and supplies.
Manage vegetation to reduce fuels.
Restore the buffer between the conservation and agriculture/urban zones.
Joint personnel training and mobilization.
Enhance existing fire suppression capabilities.
Integrate fire protection measures in all natural and cultural resource planning and management activities.
Improve capability to use prescribed fire as a management tool.

Potential Participating Entities

HFD, DLNR, Marine Corps, Army, Navy, FedFire, TNCH, Oʻahu Civil Defense, State Civil Defense, and BWS.

Estimated Cost

$75,000 - $100,000.

References

U.S Army, Hawaii and 25th Infantry Division (Light), January 2000, *Wildland Fire Management Plan, Pohakuloa & Oahu Training Areas*.

Wakida, Charles K., 1997, *Mauna Kea Ecosystem Wildland Fire Management Plan*, State of Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife.

Wilson Okamoto Corp., November 2004, ity and County of Honolulu Drought Mitigation Strategies, Oahu Drought Committee and State DLNR, CWRM.

PROJECT 25: LOʻI KALO EXPANSION PROGRAM (pg. 1 of 2)

Problem Statement

Only a few acres of land are used for taro cultivation in Waiʻanae despite demand and a history of taro cultivation in the area.

General Background

Taro (*Colocasia esculenta*), well-known throughout Polynesia, Asia, and Indonesia, is one of the oldest known cultivated crops in the world. Taro, or *kalo*, was, and continues to be, an integral part of the agricultural, nutritional, and spiritual traditions of Hawaiʻi. Hawaiians had developed a sophisticated system of terraced farming. These wetland agricultural systems consisted of irrigation channels and irrigated terraces that ranged from small plots that could be farmed by families, to large complex structures that required coordinated community efforts. While *loʻi* minimized water use by returning water back to streams and retained sediments, water in the *loʻi* was turbid and often heated, thus possibly affecting conditions downstream. Remnants of these agricultural systems may be found in the middle reaches of Waiʻanae *ahupuaʻa*.

Today, *poi* and *kalo* constitute an important cultural crop in Hawaiʻi. Fifty years ago, 14 million pounds of taro was grown on thousands of acres. *Poi* cost 13 cents a pound at the market in contrast to today, where *poi* can cost as much as $3.50 a pound. In 2004, it is estimated that 420 acres produced only 5 million pounds of taro, but it is difficult to establish how much taro is really grown since there is no accounting of the amount of taro grown by subsistence farmers.[1]

Wetland *kalo* farming is not without its obstacles. Disputes over water rights can result in years of legal battles. On the ground concerns by farmers include soil loss, invasive pests, taro pathogens, weed control, crop damage by feral ungulates, minimum stream flows, lack of water supply infrastructure, lack of land to meet production demands, farmland conversions to non-agricultural uses, high water temperatures that can cause taro rot, and potential increases in regulations on farms. Some observers note the "generational ebb and flow" of *kalo* farming. One generation continues the intense farming practice and the next chooses to move away from the farm. As that generation matures and values are recognized, efforts are renewed.

Generic Actions & BMPs:

Programs to expand *loʻi kalo* cultivation may need to do the following:

- ✓ Identify available and suitable lands for *loʻi* restoration, including access, ownership, and liability issues.
- ✓ Protect farmland.
- ✓ Clarify water rights, clearly outline regulations and streamline permitting.
- ✓ Identify stream impacts, such as erosion, turbidity, and increased temperatures, and implement mitigative actions.
- ✓ Implement invasive weed, pest, and pathogen control techniques.
- ✓ Provide water infrastructure support.
- ✓ Develop accurate water demand estimates.
- ✓ Identify and implement soil and water conservation measures.

Small-scale loʻi kalo operation.

PROJECT 25: LOʻI KALO EXPANSION PROGRAM (pg. 2 of 2)

The Issues in Waiʻanae

"Now, no more taro, no more water, but Waiʻanae had taro, they got their water from the *ʻauwai*" (Waiʻanae Resident, 2005).

Demand for taro far outpaces production. Families remember raising their own food for subsistence, but interested farmers may lack land ownership or access to existing taro fields. Interested farmers are unable to utilize functional agricultural systems such as *ʻauwai* and *loʻi* because there is no water. Disputes still remain among a handful of Hawaiian families regarding their water rights. Potential farmers may not have financial means to begin farming.

Certain areas show promise for the re-emergence of taro farming. Terraces have been located along Mākaha, Kaupuni, and Nānākuli Streams, and some community groups have shown interest in taro cultivation at these locations. A cultural landscape study could help to further identify previous areas of taro cultivation and thus suggest ideal locations for *loʻi* restoration.

The most promising impetus for taro recovery, restoration, and renewal in Waiʻanae is embedded in the cultural meaning upon which the practice is founded. Many practitioners have moved into the educational aspect of *kalo*, coupling labor with education and the art and technology of agriculture while teaching Hawaiian culture, adding diverse dimensions to taro cultivation.

Preliminary Scope

This project will support those interested in pursuing taro cultivation, i.e., wetland *kalo*, at a community scale.

- Conduct a "cultural landscape study" to identify historic *loʻi kalo* systems in Waiʻanae.
- Identify and prioritize those *loʻi* systems that can be restored for use. Likely those near perennial stream segments or brackish water wells, such as those in Nānākuli, Waiʻanae, and Mākaha.
- Rezone lands as "cultural agricultural districts" and establish "loʻi agricultural parks" (public loʻi parcels).
- Identify water demands and potential water sources for taro restoration.
- Develop cooperative agreements for the cleaning, maintenance, and management of irrigation systems by government and community.
- Examine the feasibility of establishing a "Taro *Hui*" in Waiʻanae (if one does not exist already) to manage restoration and operation of *loʻi* systems.
- Provide incentives for taro growing and community support.

Potential Participating Entities

NRCS, WOSWCD, DOA, Farm Bureau, UH CTAHR, BWS, local families, farmers, and community-based organizations.

Estimated Cost

$50,000 or more per year.

References

UH CTAHR website located at: http://www.ctahr.hawaii.edu/ctahr2001/

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WEC Project website located at: http://www3.csc.noaa.gov/waianae/

Hayworth, Phil, March 16, 2005, *No Mo' Poi?*, Midweek Magazine.

Gima Craig, *Demand Makes Poi Shortage Possible*,http://starbulletin.com/2004/05/16/news/story6.htm.

PROJECT 26: MĀKAHA RESEARCH WATERSHED (pg. 1 of 2)

Problem Statement
There are some watershed processes that need to be better understood in order to make appropriate management decisions.

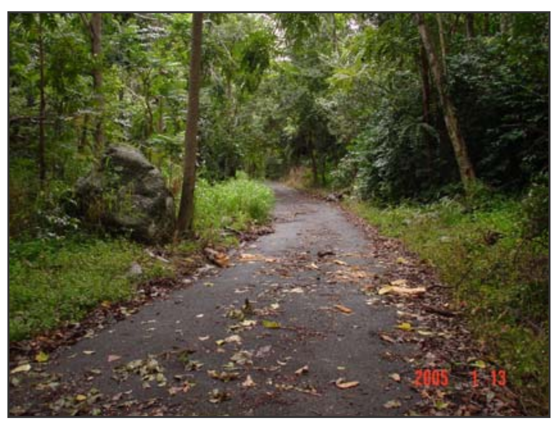
General Background
Watershed processes, ecosystem structure and function, forest condition and restoration, and global climate change are not well understood. These phenomena require permanent or at least long-term research efforts, but there are no officially designated experimental forests in Hawaiʻi at this time. Additionally, results from research conducted in other locations such as the U.S. Mainland may not be applicable in Hawaiʻi due to differences in climate, soils, watershed size, and other features.

Recommendation 17 of the Hawaii Tropical Forest Recovery Action Plan is to "Create a network of experimental forests with associated facilities to meet scientific and management objectives to restore deficient or degraded forests." Areas identified as good candidates for experimental forests include: NARS, TNC preserves, UH experiment stations, national parks, National Wildlife refuges. Under the Hawaii Tropical Forest Recovery Act, the Governor of Hawaiʻi and the U.S. Secretary of Agriculture share joint authority in establishing experimental forests.

Some research questions of interest in Hawaii watersheds include:
What are the differences in the ability of alien and native forest cover in watershed processes such as soil erosion, ground water infiltration, and habitat provision?
What are the optimal characteristics of stream habitat for native species?

Generic Actions & BMPs:
Research watersheds could be set up around a committee to organize participants, and coordinate studies and actions in order to maintain the integrity of each of the projects.

- ✓ Create a panel that will establish experimental forests or research watersheds, coordinate activities amongst areas, and report findings.
  - Identify potential locations for experimental forests and associated facilities
  - Present the list to the governor and U.S. Secretary of Agriculture for selection of a system of research watersheds that represent a broad range of forest communities, climates, soils, elevations, and forest qualities.
- ✓ Develop supporting facilities for day-to-day scientific and educational activities.
- ✓ Research is approved and should primarily focus on practical applications.
- ✓ Data is compiled in a continuing database that is open to the public.
  - Databases could be managed by existing and future watershed partnerships, where applicable.
  - Where no watershed partnership exists, databases could be housed by the State DLNR and updated as a mandatory component of approved research.



Access road into the Mākaha Valley portion of the Waiʻanae Kai Forest Reserve.

PROJECT 26: MĀKAHA RESEARCH WATERSHED (pg. 2 of 2)

The Issues in Wai'anae

There are many watershed questions that are specific to Wai'anae. Questions regarding the connection between surface and ground water, ground water movement, and the potential for contaminant migration have been concerns amongst the community for some time.

In Wai'anae, Mākaha is an ideal watershed because it has a variety of land uses, including residential, agriculture, resort, and forest; and because it has a conservation district that is primarily owned by one entity and is accessible via a maintenance road. Mākaha is already home to several research projects, even without official experimental forest status: Determining the Impacts of Water Pumping and Alien Species Invasion on Stream Flow for a Sustainable Water Resource Management in Mākaha Valley, Hawaii (UH NREM), Restoration of the Mākaha burn site (UH Ethnobotany and the Wai'anae HS Hawaiian studies program), and an after school explorations program ('Āi Pōhaku).

BWS has also recently entered their Mākaha forest lands into the Wai'anae Kai Watershed Project. The intent of the project is to "preserve Hawaii's unique natural and cultural inheritance for future generations…protect endangered tropical forest habitat and promote environmental policies and practices that address biological sustainability and human well-being…and…develop natural resource stewardship models that respect the rights of native Hawaiians and local communities but re-establishes the responsibilities attached to those rights in a culturally appropriate fashion."

Preliminary Scope

A research watershed would provide a venue for different agencies and organizations to undertake long-term watershed research projects, leading to a better understanding of watershed properties and processes in Wai'anae. A research watershed would need to :

- Define research watershed boundaries and managing body.
- Petition for research watershed designation by the USDA and governor.
- Establish facilities to support ongoing research.
- Assess the ability of native forest versus alien forest to promote ground water infiltration and reduce soil erosion.
- Measure the effects of forest restoration and protection measures such as fencing, reforestation, and alien species control.
- Understand the effect of fog drip on the hydrologic budget in Wai'anae.
- Ground truth infrared satellite imagery.
- Identify key indicators for monitoring and ranking watershed health.

Participating Agencies

USGS, BWS, NRCS, DLNR DOFAW, UH WRRC and NREM, and Wai'anae Kai Community Forest Partners.

Estimated Cost

$50,000 - $100,000.
*Organizational and coordination purposes only. Grants for research projects will likely be large and will need to be obtained separately.

References

Hawai'i Tropical Forest Recovery Task Force, July 1994, *Hawai'i Tropical Forest Recovery Action Plan*.

PROJECT 27: AGRICULTURAL SUPPORT PROGRAM (pg. 1 of 2)

Problem Statement
The Wai'anae community would like to maintain its rural, agricultural lifestyle, but is facing increasingly difficult challenges.

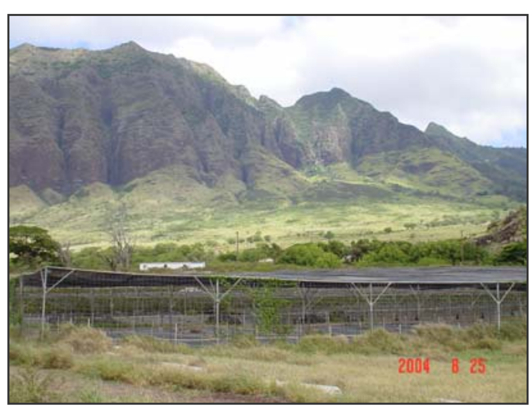
General Background
Hawaii's agricultural industry has declined since the sugar boom of the late 1800s to early 1900s, particularly due to increasing costs and competition. All of Oahu's sugar plantations have closed and been converted to other uses such as diversified agriculture and especially urban development, as growing populations increase pressure to convert agricultural lands to residential uses. Conflicts often arise as urban uses encroach upon traditionally agricultural areas.

Multiple users and claims on water have affected water sources for farmers. For example, increased urban uses compete for water with agricultural uses, and instream and native Hawaiian uses have been given higher status in terms of water rights, sometimes conflicting with agricultural application. New sources of agricultural irrigation water, primarily recycled water, are being developed, but there are strict limitations on use. The DOH has rules on the allowable uses for various recycled water types. However, despite DOH approval of recycled water use on certain crops and widespread use on the mainland, some farmers fear a negative stigma attached to crops treated with recycled water and the effect it would have on consumers.

While recycled water could replace some potable water for irrigation, the higher chlorides and costs of recycled water from the Wai'anae WWTP would be generally borne by the user, therefore creating a disincentive for use. Other cost concerns include the high infrastructure charges for adding or upgrading transmission lines and water meters needed in order to get agricultural water rates from the BWS. Unfortunately, Waianae's lack of water supplies leave few choices for affordable water, which makes it difficult to compete with large farms in 'Ewa, Kunia, the North Shore, and the mainland, which have large tracts of prime agricultural lands and access to abundant, inexpensive water.

Generic Actions & BMPs:
Agricultural support programs could include the following:

- ✓ Protect agricultural lands from development through:
  - Land banking.
  - Agricultural easements.
  - Agricultural use boundaries for areas with important agricultural lands.
- ✓ Mitigate land use conflicts between agriculture and urban land uses through:
  - Buffer zones to separate uses.
  - Eventual buyout of existing conflicting land uses in an area clearly designated for agriculture.
- ✓ Provide affordable water to farmers, possibly through:
  - Assistance from the Agribusiness Development Corporation to develop water facilities.
  - Use of recycled water.
  - Federal/State subsidies for fees related to new water meters and lines.



Wai'anae orchid farm

PROJECT 27: AGRICULTURAL SUPPORT PROGRAM (pg. 2 of 2)

The Issues in Wai'anae

As is occurring statewide, certain sectors of Wai'anae agriculture, such as livestock and dairy operations, are expected to decline, therefore opening lands up for possible conversion. The Wai'anae Sustainable Communities Plan (WSCP) detailed a land use policy to preserve agricultural lands by establishing a firm boundary for Important Agricultural Lands, defining uses that are compatible with agricultural use, and providing zoning and tax incentives for people to farm the land. The WSCP already established an agricultural boundary, within which the primary use should be agriculture. This boundary should be maintained in future WSCP updates.

Waianae's climate is very favorable for many types of agriculture but good agricultural soils are limited. Emphasis needs to be placed on agricultural methods that take advantage of the climate but do not rely on prime agricultural soils. The dry conditions on the leeward coast require Wai'anae farmers to rely on irrigation to support their crops. Streams are intermittent in their lower reaches where most of the agricultural lands are located, and ground water is limited. Affordable and available water are important issues.

Lack of long-term leases makes it difficult for farmers to invest in long-term improvements and obtain financing. The existing State-run agricultural park in Wai'anae is currently at capacity. Acquiring land and developing and operating an agricultural park may not be cost-prohibitive.

Preliminary Scope

In addition to measures addressing agricultural-urban land use conflicts, cost of irrigation water, and alternative water use, The following concepts should be explored in Wai'anae:

- Provide zoning and tax incentives to keep their properties in agriculture
- Determine the feasibility of creating another agricultural park to provide long-term leases
- Define uses that are compatible within the agricultural use boundary
- Develop an experimental agriculture program that focuses on cost-effective methods of conserving soil and water
- Identify farming niches that take advantage of Waianae's climate but rely less on high quality agricultural soils. Options include livestock operations, hydroponic crops, and aquaculture.
- Place agriculture lands in a long-term trust program that ensures their primary use as agriculture.
- Respect the WSCP boundaries protecting agricultural lands.

Participating Agencies

NRCS, Farm Bureau, USDA Farm Service, Agribusiness Development Corporation, DOA, DPP, BWS, Ka'ala Farm, Ma'o Farms, Hoa'aina o Mākaha.

Estimated Cost

$50,000 or more per year for technical assistance.

References

Hawai'i State Department of Health Wastewater Branch, 2002, *Guidelines for the Treatment and Use of Recycled Water*.

Decision Analysts Hawai'i, Inc., 1997, *Wai'anae Planning District, O'ahu: Agricultural Resources and Activities*.

Department of Planning and Permitting, City and County of Honolulu, 2000, *Wai'anae Sustainable Communities Plan*.

PROJECT 28: FLOOD MITIGATION PROGRAM (pg. 1 of 2)

Problem Statement

Localized flooding in Lualualei and Waiʻanae Valleys and along Farrington Highway continues to be a problem.

General Background

Some common types of flooding experienced in Hawaiʻi include (1) coastal flooding due to high waves; (2) river/stream flooding from overtopping of banks; (3) urban flooding, resulting from increased impervious surfaces that increases runoff; and (4) flash flooding, which results from intense, concentrated rainfall or dam or levee failures.

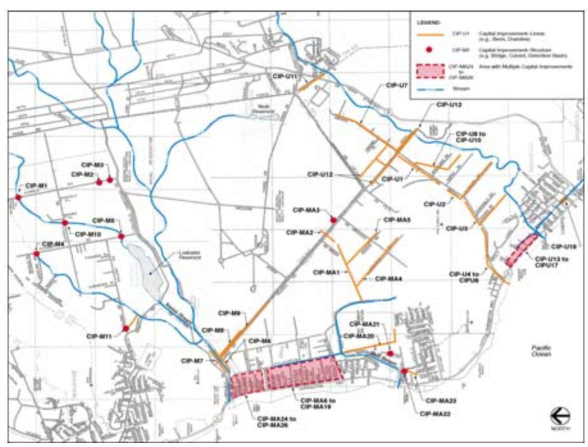
Floodplains should be viewed as multi-functional areas, and not only hazard zones. Designed correctly, floodplains can offer opportunities for recreation such as trails and bikeways, education, water quality improvement, ground water replenishment, sediment retention, limited risk agriculture, open space, greenbelts, as well as flood mitigation. Implementation of ecosystem- and community-friendly flood mitigation, such as wetland restoration, should be considered. Floodplains need to be controlled for community safety.

NRCS and USACE are the Federal agencies that work to develop and implement flood mitigation measures; USACE generally handles flood projects in urban areas and NRCS is responsible for projects in rural areas. USGS does not design and construct flood structures, but it assists other agencies by providing hydrologic and hydraulic data. The State DLNR coordinates Federal programs with City agencies. The City and County of Honolulu DDC constructs structures and DFM maintains them. Local civil defense agencies participate in flood hazard planning and in dealing with the impacts of flooding.

Generic Actions & BMPs:

A comprehensive flood mitigation plan should consider the following:

- ✓ Understand the history of past floods and the relationship of flood-prone areas to other functions of the watershed.
- ✓ If land area is available, consider multi-functional flood mitigation structures such as:
  - Wetlands/retention ponds
  - Floodplain preservation and utilization.
- ✓ Coordinate mitigation with other community needs, plans, and activities.
- ✓ Consider land acquisition as a means of reducing future damages.
- ✓ Address public safety concerns.
- ✓ Include emergency access routes.
- ✓ Rezone according to up-to-date local drainage and flooding hazards.
- ✓ Maintain drainage system regularly.
- ✓ Arrange periodic instruction on the latest flood mitigation techniques.



Drainage improvements recommended in the Lualualei Flood Study, 2001.

PROJECT 28: FLOOD MITIGATION PROGRAM (pg. 2 of 2)

The Issues in Waiʻanae

The 2001 Lualualei Flood Study found the cause of flooding in Lualualei to be a lack of drainage infrastructure and poorly maintained or undersized drainage structures. Sumps without drainage relief were also found to be prevalent in the area. Another problem is retaining walls that direct flood waters away from some properties but into others.

Recommendations to alleviate local flooding include diverting water from ineffective sumps and directing runoff to existing drainage infrastructure. The Navy has secured some funding for design studies to construct a detention basin. Currently, various members of community, City, State, and Federal governments are meeting to secure funding for priority measures.

The State Department of Agriculture also reports that localized flooding occurs within the Waiʻanae Agricultural Park. There is little information regarding the scope and severity of the flooding problem and there are currently no plans for mitigation.

Flooding is also a problem where Farrington Highway was built up higher than adjacent *ma uka* areas, restricting seaward runoff and causing localized flooding. Other localized flooding is caused by the lack of adequate drainage facilities in subdivisions, unpermitted property walls that divert storm water, filling in of natural drainage swales and ditches, and clogged storm drains. Increasing population continues to keep flooding a concern in Waiʻanae.

The City's Capital Improvement Program calls for a variety of drainage improvements for Waiʻanae.

Preliminary Scope

A Waiʻanae flood mitigation program should:

- ❖ Address the large-scale drainage problems in Lualualei.
- ❖ Remove illegal diversion walls after larger flood problems are addressed.
- ❖ Improve drainage systems along the *ma kai* portion of Farrington Highway.
- ❖ Define the scope, severity, and cause of flooding at the Waiʻanae Agricultural Park and develop and implement a mitigation plan.
- ❖ Implement non-structural solutions, where possible.
- ❖ Utilize natural drainage design principles, where applicable, and design for ease of maintenance..
- ❖ Document and map flooding locations, extent, and intervals.
- ❖ Update FEMA Flood Insurance Rate Maps based on flood mitigation improvements.

Potential Participating Entities

NRCS, USACE, Navy, DFM.

Estimated Cost

Over $34.5 million for construction of the Lualualei drainage improvements. Approximately $1,445,000 for the City's Bayview improvements.

References

West Oahu Soil Conservation District & City and County of Honolulu, 1960, *Watershed Work Plan: Waiʻanae Iki Watershed*.

West Oahu Soil Conservation District & City and County of Honolulu, 1960, *Watershed Work Plan: Waiʻanae Nui Watershed.*

U.S. Army Corps of Engineers and U.S. Department of Agriculture, Natural Resources Conservation Service, 2001, *Lualualei Flood Study*, Belt Collins, Hawaiʻi.

PROJECT 29: MĀKAHA SPECIAL AREA PLAN (pg. 1 of 2)

Problem Statement

Mākaha *ahupuaʻa* has distinct characteristics: the presence of important cultural resources in the Valley; valuable watershed functions that relate to ground and surface water supply and availability; developable lands under existing “urban” land use designation; new ownership of the Mākaha Resort and Mākaha Country Club. A “Special Area Plan” can be used to guide land use development and infrastructure investment.

General Background

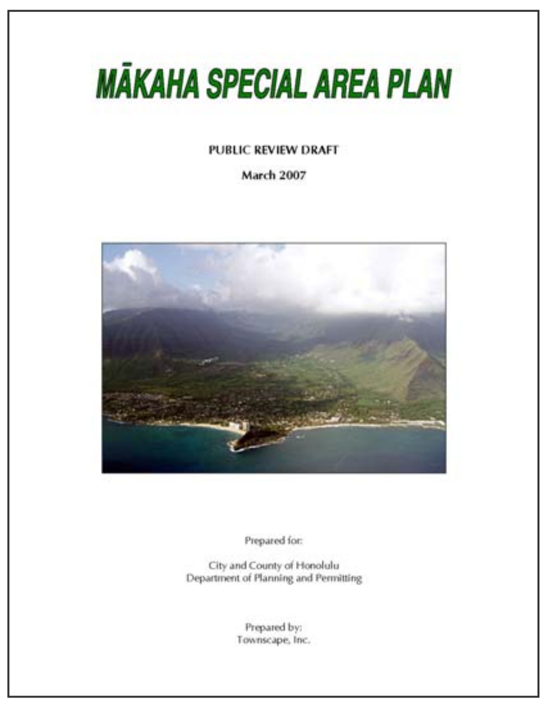
The Waiʻanae Sustainable Communities Plan (WSCP), prepared under the authority of the City Charter, is one of eight community-oriented plans that help guide public policy, investment and decision-making. Sustainable Community Plans are supplemented by other planning mechanisms such as, Special Area Plans (SAP).

Special Area Plans allow communities to “define the identity, function, organization, and character of their specific neighborhoods in accordance with the general planning framework provided by their area's Development or Sustainable Communities plan.” SAPs offer specific guidance for neighborhoods, communities, or specialized resources. One objective outlined in the WSCP, included the protection of established communities from more intense forms of development. The WSCP recommended that Mākaha be considered for Special Area Plan status. The objective of the Mākaha SAP is to ensure compatibility of developments and activities in Mākaha, where multiple land uses are present and additional developments are expected in the near future.

Generic Actions & BMPs:

Special Area Plans should include the following:

- ✓ Community-based process.
- ✓ Inventory of existing conditions including:
  - Cultural background and sites
  - Land use history
  - Natural resources
  - Threatened and endangered species
  - Infrastructure
  - Land uses and ownership
  - Resource preservation and restoration programs
  - Zoning, entitlements, and unilateral agreement requirements,
  - Plans for land development.
- ✓ Analysis of:
  - Infrastructure needs
  - Land development suitability
  - Important natural or cultural resources.
- ✓ Identification of issues, opportunities, constraints, and potential actions.



MĀKAHA SPECIAL AREA PLAN

PUBLIC REVIEW DRAFT

March 2007

Prepared for:

City and County of Honolulu
Department of Planning and Permitting

Prepared by:
Townscape, Inc.

PROJECT 29: MĀKAHA SPECIAL AREA PLAN (pg. 2 of 2)

The Issues in Waiʻanae

Mākaha *ahupuaʻa* is located approximately two miles from Waiʻanae High School to Keaʻau Beach Park to the north. Residential lots are scattered along the Farrington Highway corridor and larger farm lots are located in the lower part of the Valley. At the middle part of the Valley are the Mākaha Resort and Mākaha Country Club, two golf courses, the Mākaha Valley Plantations townhomes, Mākaha Towers, and the Mauna Olu Estate gated community. There is an elementary school and a few small commercial establishments in the area. Mākaha Valley contains one of the few flowing streams in the District. Several characteristics were deemed important to warrant SAP status:

- City ownership of approximately 4,000 acres of land in the upper valley and the steeper valley walls;
- Mākaha Valley is an important resource area in terms of water resources, rare and endangered plants and animals, and cultural sites. Water is limited and the valley is sewered, creating opportunity for recycled water development for non-potable irrigation in appropriate areas.
- A large portion of the Valley has been designated "urban" under the State Land Use system.
- In the year 2000, there were approximately 350 acres of undeveloped land in Mākaha Valley that were zoned for either Residential or Resort Uses.
- The Mākaha Resort and Golf Course and the Mākaha Valley Country Club have recently been purchased by new owners who may want to invest in development opportunities.

Preliminary Scope

A community-based Special Area Plan for Mākaha Valley will:

- ❖ Serve as a guide for future projects and other actions that will improve conditions and opportunities within the Valley.
- ❖ Provide a venue for on-going community/agency/land owner partnering and problem solving process.
- ❖ Secure, if feasible, a Memorandum of Agreement that would function as an important organizing document for implementation of the outcomes of the SAP.

Potential Participating Entities

DPP, community-based organizations, private landowners, commercial and business owners.

Estimated Cost

$100,000

References

Group 70, International, April 2005, *Waialua Town Master Plan*, City and County of Honolulu Department of Planning and Permitting.

Townscape Inc., July 2000. *Waiʻanae Sustainable Communities Plan*. City and County of Honolulu, Department of Planning and Permitting.

Wilson Okamoto & Associates, Inc. December 1995, *Waipahu Town Plan Report*, City and County of Honolulu Planning Department.

PROJECT 30: WAI'ANAE WATERSHED PARTNERSHIP (pg. 1 of 2)

Problem Statement

There is no single administrative organization that can comprehensively address watershed issues for the Wai'anae District.

General Background

Management and maintenance of Hawaii's watersheds is fragmented amongst various government agencies, private landowners, and community organizations. This makes stewardship activities difficult as jurisdictional responsibilities do not allow for holistic planning. The EPA suggests a watershed approach for water resource management that relies on three components: a geographic focus, continuous improvement based on sound science, and partnership/stakeholder involvement. It is recognized that watersheds transcend political and other socially constructed boundaries, therefore making it necessary to collaborate among all those with an interest.

Watershed partnerships in Hawai'i are "voluntary alliances of public and private landowners committed to the common value of protecting large areas of forested watersheds for water recharge and other values."[1] Currently, more than 750,000 acres of important watershed areas have been placed within the management areas of the 9 existing partnerships that belong to the Hawaii Association of Watershed Partnerships: East and West Maui, Ko'olau Mountains, Lāna'i Hale, East Moloka'i, Leeward Haleakalā, 'Ōla'a-Kilauea, Kauai, and Kohala Mountains.

Most of the partnerships coordinate actions among its members, who typically consist of Federal, State, and local agencies, and large landowners. For the most part, the existing partnership areas encompass only the upper forested Conservation District.

A management plan directs each partnership's focus, identifies priorities, and outlines actions and time frames for enactment. On the ground projects have focused on such issues as alien species control, native species out-planting, threatened and endangered species protection, and fencing projects.

Generic Actions & BMPs:

New watershed partnerships in Hawai'i have generally followed these processes:

- ✓ Determine feasibility of engaging the local community in establishing and participating in a partnership.
  - Determine geographic boundary.
  - Identify potential participants.
- ✓ Develop a vision and mission statement.
- ✓ Establish goals and objectives.
- ✓ Develop policies and procedures for deliberations and coordinated action.
- ✓ Identify and obtain funding.
- ✓ Develop and implement a management or action plan.
- ✓ Create a watershed-wide public awareness/involvement program.
- ✓ Serve as an information clearinghouse by developing and maintaining a "data bank" of historical and current information, including a listing of watershed-related agencies, programs, research, funding sources, and contacts.

Mohala I ka Wai volunteers, a partner of the Wai'anae Kai Community Forest partnership.

PROJECT 30: WAIʻANAE WATERSHED PARTNERSHIP (pg. 2 of 2)

The Issues in Waiʻanae

Several resource-oriented organizations and partnerships already exist in Waiʻanae, some of which include the *ahupuaʻa* councils, Waiʻanae Kai Watershed Project (WKWP), Kaʻala Farm, Mohala i Ka Wai, Waiʻanae Neighborhood Board, Homestead Associations, West Oahu Soil and Water Conservation District (WOSWCD), WCCHC, and various other civic clubs, *hula hālau*, canoe clubs, churches, and schools. Despite this multitude of interests, there is no overall cooperative body to provide long-range oversight and coordination of watershed management in a holistic manner.

The Waiʻanae community is a relatively strong and cohesive one that has expressed the sentiment that "the land heals," i.e., healthy environments are intrinsically linked to healthy families and communities. Therefore, the community must share in watershed management responsibilities. For optimal community involvement, management efforts need to be "grass-roots." Typical watershed partnership models have been landowner-based, which may be a good starting point, as long as a community-based partnership is the long-term goal.

Waiʻanae residents are strongly linked to the *ahupuaʻa* concept and to their particular *ahupuaʻa* as well. Additionally, the ocean is a large part of residents' daily lives, whether it be for recreation, spiritual fulfillment, or subsistence. Therefore, a Waiʻanae partnership would likely have a strong emphasis on the extension from the mountains through to the near-shore waters.

TNCH has completed a study on the feasibility of creating a Waiʻanae Mountains Watershed Partnership. The study concluded that a partnership is possible and needed.

Unique challenges regarding partnership structure, leadership, funding, and community and landowner interests will need to be overcome in the planning process.

Preliminary Scope

A Waiʻanae Watershed Partnership should:

- ❖ Cover an area that extends from the mountain tops to near-shore waters.
- ❖ Include agency, landowner, and community partners.
- ❖ Evaluate the pros and cons of having one large partnership or multiple smaller partnerships for Waiʻanae.
- ❖ Conduct initial organizational actions, such as develop a management plan, hire an administrator, etc.
- ❖ Identify a dedicated source of funding, possibly through a watershed fee.
- ❖ Maintain and update the Waiʻanae Ecological Characterization website.

Potential Participating Entities

DLNR, BWS, CZM, USFWS, Army, Navy, NRCS, USGS, WOSWCD, TNCH, landowners, Waiʻanae Neighborhood Board, Community Associations, Ahupuaʻa Associations, Mohala i ka Wai, ʻIlioʻulaokalani Coalition, Kaʻala Farm.

Estimated Cost

Establishment: $50,000; Coordination: $100,000 to $250,000 annually.

References

Koʻolau Mountains Watershed Partnership, 2002, Koʻolau Mountains Watershed Partnership Management Plan.

West Maui Mountains Watershed Partnership, 1999, *West Maui Mountains Watershed Management Plan*.

PROJECT 31: CULTURAL LEARNING CENTERS (pg. 1 of 2)

Problem Statement

There is a need for community gathering and learning centers in Wai'anae.

General Background

Today's natural, cultural, and social landscapes require protection and preservation. New technologies and an increasing variety of outside influences have caused many localities to lose their sense of community. Additionally, it has become increasingly difficult for native Hawaiian practitioners to practice and perpetuate traditional cultural practices and values.

"Cultural Centers" are gaining support as a way to offer access to cultural practices that can support cultural and natural restoration activities as well as individual development. These centers may vary in their service area and scope, depending on the needs of the community, although many are *ahupua'a*-based.

Cultural Learning Centers may be defined and managed to suit the needs of the communities they serve. Often times, culture, values, and practices are taught through hands-on educational programs, agricultural and environmental projects, cultural exchanges, and educational tours.

Generic Actions & BMPs:

"*Ahupua'a*-Based Cultural Centers" could:

- ✓ Promote physical health and well being among residents.
- ✓ Enhance community safety by providing a place for healthy physical and spiritual activities.
- ✓ Offer life-long learning experiences and skill development to residents.
- ✓ Understand and protect the area's natural resources.
- ✓ Develop economic opportunities that result from activities, work, education, and learning.
- ✓ Offer a *pu'uhonua* for *'ohana* to develop spiritually and emotionally.

Conceptual rendering of a cultural learning center.

PROJECT 31: CULTURAL LEARNING CENTERS (pg. 2 of 2)

The Issues in Waiʻanae

While the Waiʻanae District is blessed with a stunning natural environment, the District ranks behind the rest of Oʻahu and the State of Hawaiʻi in important economic areas, such as median household income, per capita income, and rates of employment. For example, the percentage of individuals living below the poverty level is more than double that of Oʻahu residents as a whole.

Many families supplement their income with fishing and subsistence farming. Familial and local networks also serve an important function in the sharing of resources. With a large percentage of Waianae's population composed of native Hawaiians, cultural centers could offer opportunities for residents to practice or reconnect with their traditions and history.

Waiʻanae residents already have strong connections with *ahupuaʻa* concepts and have established *ahupuaʻa* councils to help organize community voices. *Ahupuaʻa*-based cultural centers are thus a logical way to define community service areas and should be explored as possible organizing units.

Preliminary Scope

This program will locate cultural centers for environmental and cultural activities. Initial steps may include:

- ❖ Convene interested government agencies, private landowners, and cultural practitioners to determine level of interest in pursuing a "cultural center" in their area.
- ❖ Organize interested community residents and other stakeholders to participate in the development of a "Cultural Center" site plan concept.
- ❖ Determine costs and funding mechanisms for the development of the concept.
- ❖ Initiate dialogue with landowners as to their interest in participation.
- ❖ Create a community-based non-profit entity that will take the lead in developing the Cultural Center where and when feasible.
- ❖ Seek and obtain construction funding.
- ❖ Complete preliminary designs, obtain necessary permits, finalize designs and build.

Potential Participating Entities

Community-based organizations, private landowners, health and human services providers, Office of Hawaiian Affairs, Department of Hawaiian Home Lands, and Kamehameha Schools.

Estimated Cost

Initial Concept Design: $10,000;
Permits and Entitlements: $10,000 to 20,000;
Center Plans and Development: $100,000 to $300,000.

References

Hawaiʻi Coastal Zone Management Program and National Oceanic and Atmospheric Administration, Coastal Services Center 2004. *Waiʻanae Ecological Characterization: A State, Federal, and Community Partnership.* CD-rom.

Townscape, Inc., July 2000. *Waiʻanae Sustainable Communities Plan.* City and County of Honolulu, Department of Planning and Permitting.

PROJECT 32: COMMUNITY WATERSHED EDUCATION (pg. 1 of 2)

Problem Statement

Residents are not familiar with the natural environment around them and are no longer knowledgeable about how to care for the resources they utilize. Therefore, natural resources are overused, poorly managed, and un-replenished.

General Background

Community members indicate that there is a lack of understanding about watersheds and water cycles among all ages in the Waiʻanae community. Watershed education and resource management training can increase the pool of skilled resource managers who could identify issues, and apply necessary actions. Further, a trained individual could also offer assistance to landowners with watershed management, monitoring, and restoration activities promoting environmentally-based work in the region.

Training programs could utilize a Waiʻanae-based "outdoor classroom" to integrate science, math, and history with environmental function and Hawaiian culture. The program would develop geographically appropriate curriculum materials, on-site training modules, and demonstration projects. Training modules would cover watersheds and stream processes, soils, erosion and conservation; riparian area functions and management; stream assessment and restoration; and wetlands/ estuary evaluation and enhancement.

Generic Actions & BMPs:

Watershed Resource Training and Education programs in the U.S. have utilized the following practices:

- ✓ Extension Context: Cooperative Extension Systems develop and deliver natural resource curricula.
- ✓ Multidisciplinary Teams: Multidisciplinary teams comprised of forestry, agriculture, and sea grant programs led curriculum development and were responsible for creating, testing, and piloting programs.
- ✓ Advisory Councils: In certain instances, Councils were developed to build, guide, and promote programs among agencies and entities. This ensured long-term stability and funding, promoted partnerships, and delivered programs that met the intended target audience's needs.
- ✓ Program Learning Guides: Serve as resource texts that provide information to better understand the complexities of watersheds.
- ✓ Curricula: Modules are developed around watershed subject matter. Training books are used in the field and outline preparation, learning objectives and outcomes, key concepts and indoor presentation outlines, and other media and exercises.
- ✓ Training Program: Sessions provide practical watershed education to groups. A session, covering a module, may consist of 2 hours indoor class training and 4 hours field work.
- ✓ Evaluation: Consists of evaluation of trainers and program. Trainers are evaluated on indoor and outdoor work. Program content and material is peer reviewed.

Informational booth at the Waiʻanae Craft Fair.

PROJECT 32: COMMUNITY WATERSHED EDUCATION (pg. 2 of 2)

The Issues in Waiʻanae

In Waiʻanae, the forests provide a myriad of services to the community, such as providing visual assets, habitat for native plants and animals, and venues for cultural practices, recreational opportunities, materials for gathering, hunting, and spiritual healing and replenishing ground water stores. Similarly, coastal resources supply multiple needs, including recreational activities such as surfing, swimming, diving, boating, fishing, and scenic vistas, as well as providing subsistence materials, such as limu and salt.

Historically, people who lived on and worked the land in Waiʻanae had intimate knowledge and respect for the soils, seasons, plants, animals, and other aspects of the natural environment. As a part of this knowledge and respect, whenever a resource was used, a point was made to contribute to its restoration.

Despite a long history of connectedness with the natural environment, contemporary Waiʻanae residents seem to have lost touch with the resources that surround them. Some community members relate accounts of pollution, neglect, and overuse of shoreline resources, therefore depleting them or degrading them to the point of being unusable.

One recommendation from the Waiʻanae community was to develop a program that empowers local resource users to become resource managers. Knowledge of watershed resources and management education will help to restore degraded and depleted resources, ensuring their perpetuation within natural ecological cycles, as well as for human use and enjoyment.

Preliminary Scope

Actions to create, restore, and protect natural resources in Waiʻanae include:

- Utilize expertise across disciplines, and partner with agencies, to develop a Watershed Resource Training Program.
  - Target specific user groups, including hunters, cultural practitioners, and coastal zone users.
  - Provide equipment, additional education, and training.
- Inventory existing training courses and resources, and identify the need for additional educational opportunities.
- Develop a watershed management handbook available to the Waiʻanae community to include identification of:
  - Unique Waiʻanae resources;
  - Resource contacts;
  - Training opportunities;
  - Management techniques and tips;
  - Funding possibilities.
- Tap Searider Productions and ʻŌlelo to produce and air Waiʻanae-specific management tips.
- Support culturally-based watershed education opportunities.
- Conduct community watershed tours.

Potential Participating Entities

Army Natural Resources Staff; USGS; DLNR; DOE; UH; LCC; BWS; TNCH; Mohala i ka Wai; Kaʻala Farms; QLCC; Alu Like, Inc.; hunters; private property owners; and volunteer groups.

Estimated Cost

Initial: $25,000 - $50,000.
Annual: $15,000 - $20,000.

References

West Maui Mountains Watershed Partnership. *West Maui Watershed Owners Manual*

PROJECT 33: WAIʻANAE RURAL LANDSCAPE STUDY (pg. 1 of 2)

Problem Statement

Waiʻanae was known for taro cultivation. Surface remains of ancient irrigation ditches and taro terraces are present on the landscape. In a few areas, some wetland taro cultivation continues until today. There is interest in the Waiʻanae community to restore taro fields to productive use. Land use conflicts, conversion of agriculture lands to higher uses, and water availability are obstacles to restoration of *loʻi* fields.

General Background

Many rural communities across the Hawaiian archipelago have opened small manageable plots for agricultural, cultural, educational, spiritual, and social enrichment. Many taro farmers have moved into the educational aspect of their taro cultivation and farming practices -- coupling labor with education and the art and technology of agriculture, while teaching Hawaiian culture -- adding diverse dimensions to taro cultivation.

There are two broad objectives of the *Waiʻanae Loʻi Systems Rural Landscape Study*: 1) conduct work that is concerned with landscape understanding, and 2) conduct work that is related to landscape protection and management.

A Waiʻanae Rural Landscape study can systematically survey a rural landscape in order to identify landscape characteristics that have resulted from taro agricultural field systems. A "rural landscape study" of the Waiʻanae Valley can help to identify those systems that, for example, may be restored to productive use. Based on this information, restoration priorities may be set.

Generic Actions & BMPs:

The National Park Service Bulletin 30 suggests the following for completing a Rural Survey:

- ✓ Be comprehensive both in documentary research and site observations.
- ✓ Use the statement of historic context as a guide for identifying historic properties and judging what features require the greatest attention and contribute most to historic significance.
- ✓ Be well-equipped in terms of intellectual and physical preparation to enter the field to survey.
- ✓ Be sensitive to on-going activities as well as rights of property owners.
- ✓ Listen to people who know the landscape.
- ✓ Keep careful records.
- ✓ Look for the landscape of the past as you would expect to find it today -- landscapes change.
- ✓ Do not rely on a single source, i.e., check and countercheck any information.

This rural road, with no curb, gutter, or sidewalk and little development, is typical of Waiʻanae.

PROJECT 33: WAI'ANAE RURAL LANDSCAPE STUDY (pg. 2 of 2)

The Issues in Wai'anae

"In ancient times Waianae Valley had extensive systems of terraces along its various streams, in what is now forest and water reserve, and well down into the broad area now covered by sugar cane." (Sterling. Sites of Oahu. p.68).

For a variety of reasons, there are relatively few people in Wai'anae who cultivate dry or wetland taro. Archaeological studies and resident observations indicate the presence of numerous *lo'i* terraces and irrigation ditches throughout the District. Among those *lo'i* systems that have survived, access to these systems may be difficult due to private land ownership. Geology coupled with ground water withdrawal may contribute to the lack of available surface water in streams needed for wetland taro farming.

The restoration of *lo'i kalo* may contribute to greater economic, nutritional, social, and cultural self-sufficiency among residents.

Preliminary Scope

The following actions are recommended:

- Establish a "Landscape Study Coordinating Team."
- Design "Landscape Project" by Coordinating Team.
- Use design to solicit funds (see below).
- Recruit research team: Archaeologists, ethnographers, architects, and planners.
- Perform qualitative landscape assessment including recommendations for restoration, landowner.
- Conduct "charrettes" with stakeholders to outline a "Wai'anae *Lo'i* System Restoration Plan" to identify restoration areas with consideration offered to long-range goals of landowners and the Wai'anae community preferred *lo'i* system restoration outcomes.
- Explore potential funding sources:
  - Certified Local Government Program (CLGP);
  - Historic Preservation Fund Grants to Indian Tribes, Alaskan Natives, and Native Hawaiian Organizations.

Potential Participating Entities

Mohala i ka Wai; DLNR, Historic Preservation Division; DOA, DPP, Community Action Plans Branch; UH CTAHR Agricultural Extension; BWS; local families; farmers; and community-based organizations.

Estimated Cost

$100,000 to $200,000.

References

http://www.cr.nps.gov/helpyou.htm

National Park Service (NPS). National Register Bulletin. *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. Retrieved April 13, 2005 at http://www.cr.nps.gov/nr/publications/bulletins/nrb38.

ibid. National Register Bulletin. *Guidelines for Evaluating and Documenting Rural Historic Landscapes*. Retrieved April 13, 2005 at http://www.cr.nps.gov/nr/publications/bulletins/nrb30.

Cordy, Ross. 2002. *An Ancient History of Wai'anae*. Mutual Publishing.

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6 IMPLEMENTATION

This final chapter of the Wai'anae Watershed Management Plan (WWMP) presents narrative and numerical material that BWS and other public and private entities can use to move forward with the implementation of the objectives and strategies that have been presented in the first five chapters.

6.1 PROJECT PHASING BY OBJECTIVE

The purpose of this chapter is to guide the implementation of the goals and objectives of the WWMP by presenting strategies and projects that BWS and other agencies and community organizations can pursue to implement. Chapter 4 (Objectives and Strategies) discusses the relationship between the plan objectives, sub-objectives, strategies and individual projects to implement them. Chapter 5 (Watershed and Water Supply Projects) provides detailed descriptions of the projects. In this chapter, the phasing for project implementation is presented and organized according to the five major objectives of the WMPs:

1. Promote sustainable watersheds
2. Protect and enhance water quality and quantity
3. Protect Native Hawaiian rights and traditional and customary practices
4. Facilitate public participation, education, and project implementation
5. Meet future water demands at reasonable costs.

Phasing

While every project is considered important to the watershed and the water supply, they cannot all be accomplished at the same time. By phasing the projects into short term (0-5 years), mid term (6-14 years), and long term (15+ years), manageable groupings of projects can be programmed for implementation. The selection of watershed management project phasing is a subjective process based on four factors: importance of the project to implementing agencies, importance to the community, cost, and legal/institutional complexity. The phasing reflects the current thinking and condition of the watershed. These factors may change over time and the phasing will need to be updated with subsequent Plan revisions. The general rationale for the project phasing is listed below. Explanations of specific project phasing are detailed later in this section.

- **Short-term projects (0-5 years)** tend to be ongoing or currently have strong "champions" either in an agency or the community and/or have a funding source. A regulatory mandate may also place a project in the short-term category. Potential outcomes of these projects are immediate and important improvements to the watershed(s) and may involve areas critical to watershed health.
- **Mid-term projects (6-14 years)** may not yet have an agency or community champion but are important to the health of the watershed and the water supply. The depth of support for the project or funding may be limited at this time, but the project is likely to have more support and funding in the future. Additional time may be needed for interagency coordination or obtaining permits.
- **Long-term projects (15+ years)** are important but may be complex and challenging to implement or the benefits may occur over a longer time period. Extensive agency coordination, permits, or funding may be needed prior to project implementation to a greater degree than for mid-term projects.

The phasing is presented for each of the five Plan objectives. Project Phasing for Objective #5 Meet Water Demands at Reasonable Costs (Section 6.1.5) provides the analysis and phasing of the various water supply projects. A wide array of factors guides the phasing of this objective. This section on Objective #5 also functions as the Water Use and Development Plan for Wai'anae in terms of future water allocations.

Agency and Organization Participation

The implementation and funding of these strategies and projects are not the sole responsibility of the Board of Water Supply, City and County of Honolulu, or State of Hawai'i. Many governmental agencies and non-governmental organizations will need to be involved to implement the strategies and projects. While the Board of Water Supply is one of the involved and participating agencies, it alone does not have the resources or the authority to implement all of the projects. This plan is intended to guide agencies and organizations to focus on implementing the most important initiatives for healthy Wai'anae watersheds and water resources, and to identify opportunities for collaboration. While it is understood that the strategies and projects presented in this Plan will improve water resources and provide for the water needs of the City and County of Honolulu, implementation will depend on budgetary priorities, availability of grants, and partnering efforts over the long term.

The presentation of implementation actions for each of the five objectives begins with a tabular summary of sub-objectives and general strategies – basically a tabular summary of material that was presented in Chapter 4 of the Plan – and also includes the projects and programs that would support those strategies and sub-objectives. A consolidated table summarizing short, mid, and long-range projects is provided at the end of this "Implementation" section.

Critical Watersheds

From a water supply perspective, Mākaha and Wai‘anae are the most critical watersheds in the Wai‘anae District and many of the watershed projects are focused here. These watersheds have the most ground water and surface water use, available agricultural lands, important cultural significance, and perennial stream segments in the upper valleys. Active community, landowner, and agency partnerships, such as Mohala i Ka Wai and the Wai‘anae-Kai Community Forest Project, are already implementing many of the watershed projects and strategies.

TABLE 6-1
SUMMARY OF OBJECTIVE 1: Promote Sustainable Watersheds

Sub-Objectives / Strategies	Projects
SUB-OBJECTIVE 1.1 Strive to enhance and protect natural resources including land, stream, and near shore ecosystems.	
Strategy 1.1.1 Restore natural watershed structure and functions through the implementation of incremental, long-term ecosystem restoration programs.	• (13) Drought Mitigation Strategies • (14) Measurable Instream Flow Standards • (21) Surface Water Inventory • (23) Forest Restoration Program • (24) Wildfire Management Plan • (26) Mākaha Research Watershed
Strategy 1.1.2 Preserve species and habitat biodiversity by assessing and restoring critical water-related habitats.	• (15) Stream Conservation Corridor Project • (16) Wetlands Restoration and Protection • (17) Concrete Flood Channel Redesign • (18) Stream Biological Assessments • (23) Forest Restoration Program
SUB-OBJECTIVE 1.2 Strive for regional self-sufficiency, where practical.	
Strategy 1.2.1 Implement resource conservation and demand-side management programs that conserve ground water and surface water resources.	• (10) BWS Water Conservation • (13) Drought Mitigation Strategies
Strategy 1.2.2 Stabilize water imports from the Pearl Harbor Aquifer by providing alternative sources for both potable and non-potable water.	• (07) Recycled Water: MBRs for Single Users • (08) Desalinated Water: from BWS Kalaeloa Desal Plant
Strategy 1.2.3 Implement a "slow growth" policy in alignment with the rural character envisioned in the "Waiʻanae Sustainable Communities Plan."	• (25) *Loʻi Kalo* Expansion Program • (27) Agricultural Support Program • (29) Mākaha Special Area Plan • (33) Waiʻanae Rural Landscape Study
SUB-OBJECTIVE 1.3 Protect the community from natural and human-induced hazards.	
Strategy 1.3.1 Implement flood reduction actions and maintain flood protection when modifying or implementing other projects.	• (17) Concrete Flood Channel Redesign • (28) Flood Mitigation Program

6.1.1 OBJECTIVE 1. PROMOTE SUSTAINABLE WATERSHEDS

This objective has three sub-objectives, six related general planning strategies, and a total of 18 projects and programs that should be undertaken by various agencies and community organizations to implement the strategies.

SUB-OBJECTIVE 1.1 Strive to enhance and protect natural resources including land, stream, and near shore ecosystems.

<u>Strategy 1.1.1 Restore natural watershed structure and functions through the implementation of incremental, long-term ecosystem restoration programs.</u>

The restoration of natural watershed structure and functions – for Wai'anae as well as for most of the more or less degraded small watersheds throughout the State of Hawai'i – is an extremely important and unquestionably daunting objective.

For Wai'anae, only about 5 percent of the District's 38,089 acres – perhaps no more than 2,000 acres – can be considered to be close to their natural ecological structure and function. The balance of the Wai'anae watershed, from the steep mountain ridges to the urbanized coastal zone, has been impacted by human use and development and by a variety of introduced and sometimes highly invasive plant and animal species.

"Complete restoration" of natural watershed structure and functions here is not a realistic goal. It may be more appropriate to implement projects with an objective of "ecosystem rehabilitation" – i.e., the recreation of a semblance or approximation of natural watershed structure and function. Ecosystem rehabilitation would thus recognize the reality of urban and agricultural land uses and impacts, as well as the presence of many non-native plant and animal species. The emphasis would then be on projects that could restore some natural species and natural functions, while mitigating the more extreme impacts of urbanization and invasive species.

In any case, implementation of this strategy will be a long-term undertaking. The over-arching program will undoubtedly be **Project No. 23 – Forest Restoration Program.** The objective of this program is to incrementally rehabilitate or restore large areas of Waianae's forested mountain lands to a semblance of natural health.

To date, there have been some significant forest preservation and restoration actions taken, notably by the Wai'anae Kai Community Forest Project and the Environmental Division, Directorate of Public Works, U.S. Army Garrison, Hawai'i. However, these programs have only been able to affect some 500 acres of forest lands.

It should be remembered that five public entities own or control 73 percent of Wai'anae acreage: State of Hawai'i (12,000 acres), U.S. Army and Navy (13,036 acres), City and County of Honolulu, including BWS (4,498 acres), and the Department of Hawaiian Home Lands (2,880 acres). These five public entities need to partner with one another and with the community to design, fund, and carry out an ongoing, comprehensive forest rehabilitation and restoration program for Waiʻanae. This partnering process should begin in the near term.

The Wildfire Management Plan (Project No. 24) is strongly related to the Forest Restoration Program. During the summer of 2005, Waiʻanae experienced a record number of fires – some 30 fires in all – that charred an estimated 4,000 acres of the District. The fire management plan is urgently needed, and should be implemented in at least a preliminary form before the onset of dry summer weather. Without an effective Wildfire Management Plan and Protocol for Action, forest restoration programs may prove to be of little value.

Several other projects directly address this restoration strategy in more specific ways. **Project No. 14 – Measurable Instream Flow Standards** is considered to be a very high priority project by many community members. Community perception is that "the streams used to flow year-round, but now they've dried up." Community members ascribe this reduction in stream flow to a variety of causes, including the expansion of urban land uses, loss of forest lands, and pumping of ground water for potable water supplies. BWS hydrogeologists have also noted that the period 1960 through about 2003 was a relatively dry period for Hawai'i. In any case, it should be remembered that natural streams and springs were the only source of fresh water for Hawaiian people in the pre-contact era, and that *"wai"* for Native Hawaiians was considered sacred.

The overarching strategy is that BWS is limiting source production of its Mākaha and Waiʻanae sources (gravity and wells) to about 4.5 mgd, as a **Drought Mitigation Strategy** so that more recharge is stored as ground water in anticipation of drought. A direct benefit of this management strategy is that more ground water is available as leakage to streams, increasing natural stream flow.

In the mid- to long-term, Glover Tunnel flows could also be reallocated, if recycled water can be brought on-line at Mākaha Resort, which at present uses Glover Tunnel water for irrigation of its golf course. Recycled water is a drought-proof source of irrigation water supply. Released Glover Tunnel capacity could then be re-directed to restoring *loʻi kalo* below Kāneʻākī Heiau in support of the community's plan to establish the Mākaha Cultural Learning Center.

Project No. 26 – Mākaha Research Watershed is a mid-range project that would eventually provide valuable data and research findings that could be applied to the management, rehabilitation, and restoration of other small watersheds of Waiʻanae as well as other impacted watersheds on Oʻahu and the neighbor islands.

Project No. 21 – Surface Water Inventory is a mid-range project that would be implemented for the entire District. This project would provide important baseline surface water data for a variety of watershed rehabilitation and restoration projects and actions in Waiʻanae.

Strategy 1.1.2 Preserve species and habitat biodiversity by assessing and restoring critical water-related habitats.

The broad **Forest Restoration Program** discussed above would, among other benefits, improve both terrestrial and aquatic habitats. Strategy 1.1.2 more specifically focuses on improving water-related habitats.

The first step would be to fund and implement **Project No. 18 – Stream Biological Assessments** as a short-range project. There is very little data available for these Waiʻanae streams: Nānākuli, Ulehawa, Māʻiliʻili, Kaupuni, Mākaha, and Mākua. An inventory of existing stream habitats and biota is needed to provide baseline data for subsequent restoration work.

Stream habitats and biota cannot be restored without the protection and restoration of stream banks, floodplains, and riparian zones. **Project 15 – Stream Conservation Corridor Project** addresses this important need. The foundation for this project already exists in the *"Waiʻanae Sustainable Communities Plan."* Policy 3.5.2.1 of the WSCP is *"Establish Stream Conservation Corridors."* The lead agency for implementation of this policy should be the City's Department of Planning and Permitting.

Two other projects that relate to the restoration of aquatic habitats, **Project 16 – Wetlands Restoration and Protection Program, and Project 17 – Concrete Flood Channel Redesign,** are more likely to be mid-range or long-range projects as part of their end-of-design-life evaluation and possible reconstruction. Both of these projects will require fairly complex environmental analysis, engineering analysis, land acquisition, and permitting, as well as significant levels of funding.

SUB-OBJECTIVE 1.2 Strive for regional water supply self-sufficiency, where practical.

Strategy 1.2.1 Implement resource conservation and demand-side management programs that conserve ground water and surface water resources.

Waiʻanae already depends on imports of potable water from the Pearl Harbor Aquifer for more than half of its potable water needs, and there are no significant new ground water sources in the District that could be economically developed for potable water supply.

Theoretically, Waiʻanae could become "water self-sufficient" through a combination of in-District ground water use, recycled water where practicable, and desalination. However, recycled water and desalination facilities would be costly to build and operate. Thus, for the short term and beyond, the Waiʻanae community's best option for maintaining a measure of self-sufficiency would be to follow the guidelines presented in **Project 10 – BWS Water Conservation.**

Wai'anae is relatively dry when compared to other parts of the island. Therefore, extended periods of little to no rainfall can impact water resources quickly. **Project 13 - Drought Mitigation Strategies** will protect ground water resources during these periods and allow for quicker aquifer recovery post-drought.

<u>Strategy 1.2.2 Stabilize water imports from the Pearl Harbor Aquifer by providing alternative sources for both potable and non-potable water.</u>

In the short term, imports from the Pearl Harbor Aquifer will continue to increase as the District's population continues to grow. However, in the mid to long-term, a modest amount of recycled water may be made available through the application of MBRs (Membrane Bioreactor units) or other wastewater recycling technology by one or more large water users (**Project 7 – Recycled Water: MBRs for Single Users**). Also in the mid to long-term, **Project 8 – Desalinated Water: from BWS Kalaeloa Desalination Plant** may become an alternative to increased imports from the Pearl Harbor Aquifer. The details of these options are presented under "Objective 5 – Meet Future Water Demands at Reasonable Cost" later in this chapter.

<u>Strategy 1.2.3 Implement a "slow growth" policy for Wai'anae, in alignment with the rural character envisioned in the Wai'anae Sustainable Communities Plan."</u>

Project 29 – Mākaha Special Area Plan was completed in April 2009. The Plan provides guidelines for the mitigation of the impacts of development and preservation of the rural character of the Valley.

Several other projects will serve to support and preserve the rural character of the Wai'anae District. **Project 25 – *Lo'i Kalo* Expansion Program** will provide people opportunities to engage in traditional food-growing practices, and also restore former taro fields to productive use. **Project 27 – Agricultural Support Program** will provide technical assistance and some funding support for local farmers, many of whom are struggling to maintain viable farm businesses in the face of escalating costs and ever-increasing price competition from U.S. mainland and foreign food producers. **Project 33 – Wai'anae Rural Landscape Study** will provide research findings on Waianae's rural past that will help both community organizations and involved government agencies to develop appropriate policies, projects, and programs for the preservation of the District's rural qualities.

These three projects are important for Wai'anae. However, they will take some time to fund and organize, and should thus be considered as "mid-range" projects.

SUB-OBJECTIVE 1.3 Protect the community from natural and human-induced hazards.

<u>Strategy 1.3.1 Implement flood reduction actions and maintain flood protection when modifying or implementing other projects.</u>

Project 28 – Flood Mitigation Program addresses inland and coastal flooding in several specific areas of the District. Flood mitigation projects have significant permitting requirements and funding challenges, and should therefore be considered mid to long-range in nature.

The reference to "maintaining flood protection" in the Strategy relates to projects like **Project 17 – Concrete Flood Channel Redesign,** in which concrete channels are to be redesigned to provide more natural channel bottoms and/or channel sides, thereby creating habitats for aquatic species, including native stream species.

Redesign/reconstruction of concrete flood channels to restore natural habitats is an interesting concept, but care must be taken to maintain the flood flow capacity of the channels. Design, funding, and permitting requirements make this a long-range project.

6.1.2 OBJECTIVE 2. PROTECT AND ENHANCE WATER QUALITY AND QUANTITY

SUB-OBJECTIVE 2.1 Maintain and improve sustainable quantities of ground water.

<u>Strategy 2.1.1 Protect ground water infiltration areas in Mākaha and Waiʻanae Valleys through pro-active land management programs.</u>

The critical ground water infiltration areas of Mākaha and Waiʻanae Valleys are the forest lands that are already protected by their "Conservation" designation under the provisions of the State Land Use Law.

BWS owns the Mākaha Valley forest lands, and DLNR has management responsibility for State lands in Waiʻanae Valley. Both agencies are involved in management programs for their lands in Waiʻanae. Potentially, these management programs could be expanded and strengthened through the implementation of **Project 23 - Forest Restoration Program**, and **Project 30 – Waiʻanae Watershed Partnership**. The two programs could be linked together. Once formed, the Waiʻanae Watershed Partnership could take the lead in seeking funds for and implementing the Forest Management Program. The Partnership program, however, will take some time to develop, as many public and private entities could be involved. It should therefore be considered a mid-range project.

TABLE 6-2
SUMMARY OF OBJECTIVE 2: Protect and Enhance Water Quality and Quantity

Sub-Objectives / Strategies	Projects
SUB-OBJECTIVE 2.1 Maintain and improve sustainable quantities of ground water.	
Strategy 2.1.1 Protect ground water infiltration areas in Mākaha and Waiʻanae Valleys through pro-active land management programs.	• (23) Forest Restoration Program • (30) Waiʻanae Watershed Partnership
Strategy 2.1.2 Make efficient use of existing ground water supplies in Waiʻanae.	• (10) BWS Water Conservation • (11) Hydrogeology Study • (13) Drought Mitigation Strategies
SUB-OBJECTIVE 2.2 Protect the quality of ground, surface, and near shore waters for potable, recreational, and habitat needs.	
Strategy 2.2.1 Identify sources of contamination, trends, and possible mitigative actions by collecting and analyzing water quality data.	• (19) Water Quality Testing and Monitoring
Strategy 2.2.2 Reduce the potential for ground water contamination from land-based activities by establishing appropriate land use regulations and controls	• (12) Waiʻanae Source Water Protection Plan • Monitoring, testing, and treatment of water, as needed
Strategy 2.2.3 Reduce erosion, sedimentation, and contaminated storm water runoff from upland areas, farm lands, and urban neighborhoods through the implementation of synergistic conservation, restoration, and public education programs.	• (15) Stream Conservation Corridor Project • (22) Surface Water Quality Improvement • (23) Forest Restoration Program • (24) Wildfire Management Plan • (30) Waiʻanae Watershed Partnership • (32) Community Watershed Education Program
Strategy 2.2.4 Reduce streamside littering and dumping through a combination of public education and enforcement of anti-dumping laws.	• (20) Stream Dumping Prevention and Clean Up • (32) Community Watershed Education Program
Strategy 2.2.5 Improve the quality of near shore waters and maintain water quality standards from Kahe to Kaʻena Point through a combination of public education and BMPs for storm water management and ocean pollution control.	• (22) Surface Water Quality Improvement • (32) Community Watershed Education Program

Strategy 2.1.2 Make efficient use of existing ground water supplies in Wai'anae.

BWS will continue to monitor both the quantity and quality of ground water from BWS sources in Mākaha and Wai'anae Valleys. **Project No. 11 – Hydrogeology Study** would provide research and analysis findings for both the Wai'anae and Pearl Harbor Aquifer Sectors that would assist BWS in managing the District's ground water resources in the most efficient way possible. This study should thus be undertaken in the short-term. **Projects No. 10 – BWS Water Conservation and 14 – Drought Mitigation Strategies** would also contribute to the efficient use of existing in-District ground water supplies. These programs should be considered "on-going" for the foreseeable future.

SUB-OBJECTIVE 2.2 Protect the quality of ground, surface, and near shore waters for potable, recreational, and habitat needs.

Strategy 2.2.1 Identify sources of contamination, trends, and possible mitigative actions by collecting and analyzing water quality data.

This strategy should be implemented in the near future through **Project 19 – Water Quality Testing and Monitoring**. Without a good data base and evaluation of existing point and non-point sources of water contamination, effective water quality protection actions cannot be designed.

BWS already monitors the quality of the ground water from its Mākaha and Wai'anae Valley sources. Other agencies, including USGS, DLNR, and DOH will need to coordinate personnel and funding to perform testing and monitoring of the quality of streams and near shore ocean waters.

Strategy 2.2.2 Reduce the potential for ground water contamination from land-based activities by establishing appropriate land use regulations and controls.

This strategy can be implemented by **Project No. 12 – Wai'anae Source Water Protection Plan**. Most of BWS Wai'anae water sources are located in the Conservation Zone, and thus are not at risk from urban or agricultural contaminants. However, Kamaile Wells are in the Agricultural Zone, and some of the lands near the Mākaha Wells are in the Agricultural and Urban zones. A Source Water Protection Plan for BWS Wai'anae sources would probably be a part of an island-wide Protection Plan. However, an initial Source Water Protection Plan could be developed in the short range for Wai'anae. Related analysis work would include ground sanitary surveys of Kamaile and Mākaha wells.

Strategy 2.2.3 Reduce erosion, sedimentation, and contaminated storm water runoff from upland areas, farm lands, and urban neighborhoods through the implementation of synergistic conservation, restoration, and public education programs.

This general strategy is very ambitious: it will require the synergistic implementation of a number of important, inter-related projects and programs. In the short-term, completion and implementation of a **Wildfire**

Management Plan, as well as the initiation of the first phases of a **Forest Restoration Program** for Waiʻanae will provide an important beginning for the eventual significant reduction of erosion, sedimentation, and pollution of Waianae's streams and coastal waters. **Project 32 – Community Watershed Education Program** has already been begun by Mohala i Ka Wai. This program can be expanded and strengthened as the BWS, other involved governmental agencies, and community groups like Mohala i ka Wai proceed with the implementation of the WWMP.

Other short-range projects of importance include **Project 15 – Stream Conservation Corridor Project** and **Project 22 – Surface Water Quality Improvement. Project 30 – Waiʻanae Watershed Partnership**, a mid-range project, may result in other projects and programs that directly or indirectly address erosion, sedimentation, and contamination of important surface water bodies.

<u>Strategy 2.2.4 Reduce streamside littering and dumping through a combination of public education and enforcement of anti-dumping laws.</u>

Project No. 20 – Stream Dumping Prevention and Clean Up, which is already being initiated in Nānākuli, implements this strategy. The Nānākuli storm drain clean up project is a good example of a community-based clean up project that will benefit the local stream and near shore waters. **Project No. 32 – Community Watershed Education Program** also addresses dumping issues, though at a broader level. If community members become better informed about watershed and water dynamics, they may be less inclined to toss trash into streams and drainage ways.

<u>Strategy 2.2.5 Improve the quality of near shore waters and maintain water quality standards from Kahe to Kaʻena Point through a combination of public education and BMPs for storm water management and ocean pollution control.</u>

This is another ambitious strategy that will require the combined efforts of many agencies and organizations, as well as the combined effects of many actions. **Project 22 – Surface Water Quality Improvement**, which focuses on BMPs and improvements in the water quality of Waianae's streams, is one of the key programs that will be needed for the improvement of Waianae's coastal waters. This program should begin in the near term, and should be considered an important ongoing program. **Project 32 – Community Watershed Education Program** can be implemented in the near-term, and could have some positive effects on ocean water quality.

A related concern is adverse impacts on Waianae's near shore waters from sediments and pollutants that originate from activities in the neighboring ʻEwa District, and that are carried west and north by prevailing ocean currents. These ocean pollution problems will require inter-District discussions, planning, and cooperation.

TABLE 6-3:
SUMMARY OF OBJECTIVE 3:
Protect Native Hawaiian Rights and Traditional and Customary Practices

Sub-Objectives / Strategies	Projects
SUB-OBJECTIVE 3.1 Develop a working relationship with Waianae's Native Hawaiian Community for the sustainable management of the District's water resources.	
Strategy 3.1.1 Consult with Waiʻanae's Native Hawaiian community through an on-going process to better understand Native Hawaiian rights, values, and cultural practices, and to improve sensitivity to cultural issues.	• BWS consultation of the Native Hawaiian community regarding projects in culturally sensitive areas.
SUB-OBJECTIVE 3.2 Incorporate traditional Hawaiian values, cultural practices, and water rights into the modern context.	
Strategy 3.2.1 Protect and restore watershed structure and functions in order to encourage the interconnectedness and interdependence between the *ahupuaʻa* of Waiʻanae and community health and well-being.	• (14) Measurable Instream Flow Standards • (23) Forest Restoration Program • (32) Community Watershed Education Program
Strategy 3.2.2 Provide technical and funding support for projects and activities that express traditional Hawaiian values and practices.	• (25) *Loʻi Kalo* Expansion Program • (27) Agricultural Support Program • (31) Cultural Learning Centers • (33) Waiʻanae Rural Landscape Study
Strategy 3.2.3 Provide better public access to natural resources through the development of paths and trails in the Conservation District.	• (30) Waiʻanae Watershed Partnership • (32) Community Watershed Education Program
Strategy 3.2.4 Protect surface water resources as an integral component in the way that the Native Hawaiian community practices their culture.	• (4) Develop Surface Water Sources • (14) Measurable Instream Flow Standards • (16) Wetlands Restoration and Protection • (21) Surface Water Inventory

6.1.3 OBJECTIVE 3. PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES

SUB-OBJECTIVE 3.1 Develop a working relationship with Waianae's Native Hawaiian Community for the sustainable management of the District's water resources.

Strategy 3.1.1 Consult with Waianae's Native Hawaiian community through an ongoing process to better understand Native Hawaiian rights, values, and cultural practices, and to improve sensitivity to cultural issues.

BWS and other governmental agencies have made commitments to consult closely with the State Historic Preservation Division regarding infrastructure and other construction projects in culturally sensitive areas. This consultation process is ongoing, with both public agencies and community representatives still learning how to communicate their often very different perspectives to one another. Community organizations like Mohala i Ka Wai have provided BWS, DLNR, and other agencies opportunities to participate in community workshops and learn more about Native Hawaiian values and traditions.

SUB-OBJECTIVE 3.2 Incorporate traditional Hawaiian values, cultural practices, and water rights into the modern context.

Strategy 3.2.1 Protect and restore watershed structure and functions in order to encourage the interconnectedness and interdependence between the *ahupua'a* of Wai'anae and community health and well being.

Two of the most important projects for restoring watershed structure and functions in Wai'anae are **Project 14 – Measurable Instream Flow Standards** and **Project 23 – Forest Restoration Program.** Both of these projects are considered to be very high priority projects by the community, and, although they will take many years to implement fully, both projects should begin in the near-term. As has been discussed in other sections of this Plan, these two projects are strongly inter-related: the ecological health and integrity of the watershed's forest lands is essential for the quantity and quality of spring and stream flows. BWS is currently partnering with Mohala i Ka Wai on the Mākaha Stream restoration project.

Project 32 – **Community Watershed Education Program**, another of the community's higher priority actions, would also complement these two projects by connecting residents to the natural environment and by encouraging natural resource management.

Strategy 3.2.2 Provide technical and funding support for projects and activities that express traditional Hawaiian values and practices.

Although there are many Hawaiian cultural projects and activities that need public agency technical assistance and funding support, public resources are limited. However, BWS and other public agencies may be able to provide assistance with high priority projects like **Project 31 – Cultural Learning Centers.** As discussed earlier in this Plan, BWS has already provided some assistance to Mohala i Ka Wai through an existing Memorandum of Understanding in that community organization's preliminary planning work for an eventual Cultural Learning Center in the middle reaches of Mākaha Stream. With the continued assistance of BWS and other agencies and private foundations, Mohala i Ka Wai hopes to some day establish Cultural Learning Centers in all of the major *ahupua'a* of the Wai'anae Coast.

Other projects and programs that support and express Native Hawaiian values and culture are **Project 25 – *Lo'i Kalo* Expansion Program, Project 27 – Agricultural Support Program, and Project 33 – Wai'anae Rural Landscape Study**. Although these are important projects, they will require more time for organization and funding, and may thus be mid-range actions.

Strategy 3.2.3 Provide better public access to natural resources through the development of paths and trails in the Conservation District.

DLNR and BWS control most of the land in Waianae's Conservation District. Both agencies have voiced concern about increasing public access to Conservation District lands due to liability concerns and because the public is not always respectful of the land and its natural resources. However, access to the forests and the oceans and access to natural resources is a very strong, integral part of Native Hawaiian values and culture.

Through continued development of **Project 32 – Community Watershed Education Program**, as well as through initiatives that can be developed through an eventual **Project 30 – Waiʻanae Watershed Partnership**, BWS, DLNR, and other agencies can work with the community to provide more opportunities for controlled access to forest lands and ocean areas, and at the same time ensure the health and integrity of the resources.

Strategy 3.2.4 Protect surface water resources as an integral component in the way that the Native Hawaiian community practices their culture.

Surface water is important to the Native Hawaiian community, and is recognized by **Project 04 – Develop Surface Water Sources**, which identifies the limited nature of such resources in Waiʻanae and concludes that its use should be to fulfill water rights and restoration of *loʻi kalo*. Additionally, Project 04 recommends that ground water sources should be limited to those that do not affect stream flow unless adopted measurable instream flow standards show surface water availability. This would only apply to streams that have flow in excess of measurable instream flow standards.

These actions should complement **Project 14 – Measurable Instream Flow Standards** and **Project 16 – Wetlands Restoration and Protection** in restoring degraded surface water bodies. Additionally, **Project 21 – Surface Water Inventory**, will document surface water bodies, identify their uses, and provide better information in support of projects 14 and 16.

6.1.4 OBJECTIVE 4. FACILITATE PUBLIC PARTICIPATION, EDUCATION, AND PROJECT IMPLEMENTATION

SUB-OBJECTIVE 4.1 Partner with the community to promote a sense of *kuleana*, and to balance access to resources with management responsibility.

Strategy 4.1.1 Develop programs that promote the intergenerational education of Waiʻanae community members on watershed issues and water conservation measures.

BWS and other governmental agencies can partner with the community in the planning and development of education-oriented projects like **Project 31 – Cultural Learning Centers**. As previously noted, BWS is

TABLE 6-4:
SUMMARY OF OBJECTIVE 4:
Facilitate Public Participation, Education, and Project Implementation

Sub-Objectives / Strategies	Projects
SUB-OBJECTIVE 4.1 Partner with the community to promote a sense of *kuleana*, and to balance access to resources with management responsibility.	
Strategy 4.1.1 Develop programs that promote the intergenerational education of Waiʻanae community members on watershed issues and water conservation measures.	• (10) BWS Water Conservation • (30) Cultural Learning Centers • (31) Community Watershed Education Program
Strategy 4.1.2 Form partnerships with Waiʻanae community groups in order to implement specific projects and programs.	• (20) Stream Dumping Prevention and Clean Up • (23) Forest Restoration Program • (24) Wildfire Management Plan • (25) *Loʻi Kalo* Expansion Program • (30) Waiʻanae Watershed Partnership • (33) Waiʻanae Rural Landscape Study
Strategy 4.1.3 Facilitate project implementation by supporting watershed partnerships and non-profit organizations with funding resources and technical assistance when available.	• Find opportunities to provide grants, appropriations, and other funding sources when available
SUB-OBJECTIVE 4.2 Partner with agencies at multiple levels to improve efficiency and potential for project implementation.	
Strategy 4.2.1 Form partnerships with/among Federal, State, and City agencies to implement specific projects and programs	• (15) Stream Conservation Corridor Project • (16) Wetlands Restoration and Protection • (17) Concrete Flood Channel Redesign • (18) Stream Biological Assessments • (19) Water Quality Testing and Monitoring • (21) Surface Water Inventory • Surface (22) Water Quality Improvement • (23) Forest Restoration Program • (24) Wildfire Management Plan • (26) Mākaha Research Watershed • (28) Flood Mitigation Program • (29) Mākaha Special Area Plan • (30) Waiʻanae Watershed Partnership

already assisting Mohala i Ka Wai with preliminary planning for a Cultural Learning Center in Mākaha Valley.

BWS, Mohala i Ka Wai, and other entities can also work together to implement various elements of **Project 10 – BWS Water Conservation,** and **Project 32 – Community Watershed Education Program.**

<u>Strategy 4.1.2 Form partnerships with Waiʻanae community groups in order to implement specific projects and programs.</u>

The BWS partnership with the community organization Mohala i Ka Wai is a good model for agency/community cooperation. The WWMP provides many other opportunities for BWS and other agencies to partner with Waiʻanae community groups and organizations for the implementation of specific projects and programs, including **Project 20 – Stream Dumping Prevention and Clean Up, Project 23 – Forest Restoration Program, Project 24 – Wildfire Management Plan** in the short-term, and **Project 25 – *Loʻi Kalo* Expansion Program, Project 30 – Waiʻanae Watershed Partnership,** and **Project 33 – Waiʻanae Rural Landscape Study** in the mid-term timeframe, due to time that will be required to provide funding and/or to organize these projects.

<u>Strategy 4.1.3 Facilitate project implementation by supporting watershed partnerships and non-profit organizations with funding resources and technical assistance when available.</u>

BWS and other Federal, State, and City agencies are, of course, constrained by finite resources, both in terms of personnel and funding. Assistance from governmental agencies can be supplemented through grant applications to Federal programs and private foundations that are focused on environmental and resource management issues.

SUB-OBJECTIVE 4.2 Partner with agencies at multiple levels to improve efficiency and potential for project implementation.

<u>Strategy 4.2.1 Form partnerships with/among Federal, State, and City agencies to implement specific projects and programs.</u>

Most of the projects and programs that are presented in Chapter 5 of this Plan will require, or at the very least benefit from, partnering among a number of governmental entities. The partnering process can provide benefits in terms of leveraged resources, complementary technical expertise, and shared responsibility of the management and implementation of projects.

TABLE 6-5:
SUMMARY OF OBJECTIVE 5:
Meet Future Water Demands at Reasonable Costs

Sub-Objectives / Strategies	Projects
SUB-OBJECTIVE 5.1 Provide water at a reasonable cost to the community.	
Strategy 5.1.1 Make the best use of existing sources before developing new water sources.	• Optimize existing in-district pumping • Continue potable water imports from the Pearl Harbor Aquifer
Strategy 5.1.2 When new sources are needed, balance least-cost options with environmentally, culturally, and socially acceptable options.	• (01) Additional Potable Water Imports From the Pearl Harbor Aquifer • (11) Hydrogeology Study • Upgrade BWS water system infrastructure
SUB-OBJECTIVE 5.2 Efficiently meet potable water demands.	
Strategy 5.2.1 Match water quality to appropriate uses and balance water use with potable and non-potable water availability.	• (03) Develop Additional Waiʻanae Aquifer Sector Ground Water Sources - Brackish Water • (07) Recycled Water: MBRs for Single Users
Strategy 5.2.2 Continue with BWS' ongoing proactive leak detection and repair program and other internal water conservation measures.	• (10) BWS Water Conservation • BWS CPP
Strategy 5.2.3 Develop programs to implement "grass roots" water conservation.	• (10) BWS Water Conservation • (13) Drought Mitigation Strategies
SUB-OBJECTIVE 5.3 Improve and maintain BWS water system reliability.	
Strategy 5.3.1 Continue to provide high quality drinking water that meets or exceeds Safe Drinking Water Standards.	• (12) Waiʻanae Source Water Protection Plan • Various ongoing BWS initiatives, including regular monitoring and reporting
Strategy 5.3.2 Continue with BWS' ongoing main replacement program and other system upgrades.	• BWS CPP
Strategy 5.3.3 Optimize system operations.	• Various ongoing BWS system management measures
Strategy 5.3.4 Implement security measures.	• Various ongoing BWS facilities security upgrades
Strategy 5.3.5 Diversify water supply systems.	• (01) Additional Potable Water Imports From the Pearl Harbor Aquifer • (03) Develop Additional Waiʻanae Aquifer Sector Ground Water Sources - Brackish Water • (07) Recycled Water: MBRs for Single Users • (08) Desalinated Water – From BWS Kalaeloa Desal Plant

6.1.5 OBJECTIVE 5. MEET FUTURE WATER DEMANDS AT REASONABLE COSTS

The Board of Water Supply will meet future water demands for the Waiʻanae District primarily through: (1) sustainable use of in-District ground water, and (2) continued imports of potable water from the Pearl Harbor Aquifer Sector Area -- more specifically, from the Waipahu-Waiawa Aquifer System Area. In the mid to long-term, water imports may include some water from BWS desalination facilities located at Kalaeloa and Kapolei Business Park. One or more large water users may also produce recycled water that could be used for irrigating golf courses and landscape areas.

SUB-OBJECTIVE 5.1 Provide water at a reasonable cost to the community.

<u>Strategy 5.1.1 Make the best use of existing sources before developing new water sources</u>.

Increasing permitted use of existing ground water to sustainable levels is more economical than developing new sources, which would require capital cost for design and construction, in addition to the operating costs incurred by all sources. At this time, the source option with a high feasibility rating is the increased import of Pearl Harbor Aquifer water. Additional ground water from Pearl Harbor will cost about $3.66/gallon capital costs and $0.25/1,000 gallons operating costs.

BWS will implement this strategy through the sustainable use of ground water drawn from the Waiʻanae Aquifer Sector Area - specifically from BWS wells, shafts, and water tunnels in Waiʻanae and Mākaha Valleys. Continued monitoring and assessment will help to improve BWS current estimates of recoverable yield to ensure that natural processes are protected.

BWS will continue to pump wells in Waiʻanae Valley at the estimated recoverable yield – about 2.67 mgd. BWS will also continue to pump wells in Mākaha Valley, but at a reduced level of about 1.67 mgd, based on operational experience during drought years. This reduced use of Mākaha Valley ground water should be monitored to determine if it results in some restoration of natural stream flow in the middle reaches of Mākaha Stream.

BWS thus estimates that the long-term recoverable yield from BWS Waiʻanae Valley and Mākaha Valley wells will total approximately 4.34 mgd – not including Glover Tunnel and private sources. BWS in-District ground water sources are thus projected to provide approximately 4.34 mgd of high quality, potable water for the short, mid, and long-range future. BWS will continue to refine source yield estimates and adjust pumpage accordingly, and implement drought mitigation strategies to lessen impacts on ground water resources.

It is important to note that BWS has enough existing sources in both Waiʻanae and Mākaha Valleys to increase pumpage to the full sustainable yield of 3.0 mgd for each aquifer system area. Waiʻanae is not a designated "Water Management Area," so there is no system of CWRM-permitted use in place, but both aquifers are fully allocated to their sustainable yields with existing BWS and private sources.

In addition, the BWS-owned Glover Tunnel will continue to provide approximately 0.51 mgd of high quality non-potable water. At present, Glover Tunnel water is used by the Mākaha Resort for irrigation of the Resort's golf course. If recycled water becomes available for the golf course's use at some future time, it may be possible to re-allocate some of Glover Tunnel water to other uses, including irrigation needs of restored *loʻi* at the Mākaha Cultural Learning Center or potable use.

Current non-BWS use of Waiʻanae Aquifer Sector Area water has been estimated at 1.46 mgd. The non-BWS water systems include systems owned and operated by the U.S. Navy, DLNR, and several private entities. Research for the WWMP concluded that this level of non-BWS use is not likely to increase in the future, and may actually decrease. For planning purposes, however, it is assumed that non-BWS water systems will continue to draw 1.46 mgd for the foreseeable future.

<u>Strategy 5.1.2 When new sources are needed, balance least-cost options with environmentally, culturally, and socially acceptable options.</u>

BWS will meet short-range increases in water demand through relatively small increases in imports of Pearl Harbor Aquifer Sector water from the Waipahu-Waiawa Aquifer System **(Project 01)**. For the short term, this is the most cost effective option for meeting increased demand. Use of this source option will allow pumping from Waiʻanae sources to remain at sustainable levels.

In the year 2000, the Waiʻanae District imported an average of 4.4 mgd from the Pearl Harbor Aquifer. If no other new sources are brought on line for Waiʻanae, the imports from the Pearl Harbor Aquifer by 2030 would increase by an additional 2.3 mgd (Policy Scenario), and by as much as 6 mgd (High Growth Scenario). Hydrogeology studies of the Pearl Harbor Aquifer (**Project 11**) will provide improved information on the amount of ground water available and the impacts of pumping, thereby allowing for better decision-making on the allocation of withdrawals and the placement of new wells. This would allow for the maximization of ground water supply while protecting the sustainability of the resource.

Continued growth and development in the ʻEwa, Central, and PUC Districts will require ever increasing amounts of water from the Pearl Harbor Aquifer Sector. Projections based on DPP regional growth policies indicate that regional water demands and exports could reach the sustainable yield of the Pearl Harbor Aquifer Sector Area within the foreseeable future. In the mid to long-range planning period, the increases in Waianae's water needs may be met with a combination of imports from the Pearl Harbor Aquifer Sector Area and with seawater desalination. The level of desalination and ground water will depend on actual future demand, accounting for advanced conservation, the availability and allocation of Pearl Harbor aquifer water and other variables that affect water use and development.

BWS plans to develop alternative water sources, including desalination facilities, in order to have flexibility to meet regional demands and to respond to unforeseen circumstances or events, including accelerated growth rates, extended droughts, or natural disasters. New technologies in reverse osmosis membranes and energy recovery and renewable energy systems are reducing the cost of desalination.

BWS owns the Kapolei brackish water desalination site and the Kalaeloa seawater desalination site in ʻEwa. Source wells and desalination processes were successfully pilot tested at both sites and are feasible. When potable water demand approaches the sustainable yield of the Pearl Harbor aquifer, BWS will initiate facility design and construction.

SUB-OBJECTIVE 5.2 Efficiently meet potable water demands.

<u>Strategy 5.2.1 Match water quality to appropriate uses and balance water use with potable and non-potable water availability.</u>

Increasing the supply of non-potable water that could be used to irrigate farms and parks in Waiʻanae will "free up" potable water that is currently used for irrigation purposes. Of the 4 mgd of potable irrigation water, perhaps 1 mgd could eventually be replaced by various non-potable sources.

As of February 2006, there were 16 parcels of undeveloped land in Mākaha Valley totaling 533 acres that were designated State "Urban" and that had either City "R-10" or "Resort" zoning. The potential "build-out" of these parcels is about 1,800 units.

According to information received from the City's wastewater system engineers, the sewer main that conveys sewerage from Mākaha and Waiʻanae Valleys to the Waiʻanae WWTP is operating at capacity. Any significant new development north of the WWTP – including development of zoned lands in Mākaha Valley – will require installation of a new sewer main. The cost of a new sewer main has not been determined, but it can be assumed that the cost would be in the tens of millions of dollars. Any major new developments will be required to pay their "fair share" of these costs.

Membrane Bioreactor units (MBRs) would provide an alternative method of treating wastewater, and would also provide R-1 quality water that could be used for irrigating golf courses and landscaped areas. MBR technology would thus further BWS objectives relating to system flexibility. The MBRs would also be a cost-effective alternative to building a new sewer line.

MBR units might be especially suitable for Mākaha Valley, where most of the zoned, undeveloped land is owned by three large private companies. One or more of these companies could fund, design, and construct an MBR facility. An MBR facility could provide dual benefits: treating wastewater and producing R-1 quality water to irrigate landscaped areas. Use of R-1 recycled water for landscape irrigation provides a drought proof source of supply and extends potable water supplies for higher uses.

In addition, the use of R-1 water for golf course irrigation would also allow BWS to re-allocate some of the non-potable Glover Tunnel water to other uses, including *lo'i* irrigation and/or augmenting the flow of Mākaha Stream, or for potable use.

If several major land owners in Mākaha Valley contribute to a centralized MBR facility in lieu of contributing to the cost of a new sewer main, the MBR facility could produce 0.5 mgd or more of R-1 quality recycled water.

Developers of new residential and resort projects in Mākaha Valley will be required to investigate the feasibility of recycled water.

As noted earlier in Chapter 5 of the WWMP, recycled water from the Wai'anae WWTP is generally considered to have a low feasibility rating due to high levels of chlorides in the wastewater. Sewer collection systems need to be replaced to reduce seawater inflow before BWS would consider developing a recycled water facility here.

In line with this strategy, **Option 3 – Develop Additional Wai'anae Aquifer Sector Ground Water Sources - Brackish Water** could also be implemented. Relatively small-scale brackish water wells, such as the existing Nānākuli Well and the Lualualei Shaft, could be brought on line to provide agricultural irrigation water and free up potable water for domestic use.

<u>Strategy 5.2.2 Continue with BWS' ongoing proactive leak detection and repair program and other infrastructure water conservation measures</u>.

BWS will continue its water conservation programs, outlined in **Project 10 – Water Conservation Programs**, in the Wai'anae District and throughout its island-wide system. Water loss from BWS systems in Wai'anae is currently lower than the average 12.8 percent in water losses for the BWS system island-wide. Completion of the Mākaha to Barber's Point Transmission Main Replacement Project will reduce main breaks and associated water loss.

<u>Strategy 5.2.3 Develop programs to implement "grass roots" water conservation</u>.

Many of the conservation measures discussed in the material on **Project 10 – BWS Water Conservation** address water conservation at the community and household level. These measures include the installation of low flow toilets, showers, and sink fixtures; installation of gray water plumbing to use gray water for irrigating gardens and lawns; use of rain barrels and micro water infiltration systems; and xeriscape landscaping with native plants. **Project 13 – Drought Mitigation Strategies,** will include public awareness and outreach to reduce impacts to ground water resources during and after droughts.

BWS will continue its water conservation programs for the short, mid, and long-range periods, both island-wide and within the Wai'anae District. These programs could continue to reduce day-to-day demands for potable and non-potable water.

SUB-OBJECTIVE 5.3 Improve and maintain BWS water system reliability.

Strategy 5.3.1 Continue to provide high quality drinking water that meets or exceeds Safe Drinking Water Standards.

BWS will continue to ensure the quality of public water supplies through the sustainable use of Oahu's natural ground water aquifers, and also through its ongoing water quality testing program.

The quality of Oahu's ground water may become a critical issue as urban development continues to expand in the 'Ewa, Central O'ahu, and Primary Urban Center Districts. Waianae's small aquifers, located within the *mauka* Conservation District, are relatively safe from urban or agricultural land use impacts. However, lands overlaying the very important Pearl Harbor Aquifer sector, the largest aquifer on the island, are now Oahu's primary areas for both large-scale agriculture and expanding urban development. Contamination of this important aquifer would impact not only 'Ewa and Central O'ahu District water users, but the Wai'anae community as well. A **Source Water Protection Plan** and related **Regulations**, as appropriate, are needed to protect the Pearl Harbor Aquifer and other important O'ahu ground water resources.

Strategy 5.3.2 Continue with BWS' ongoing main replacement program and other system upgrades.

BWS planned CP projects for the Wai'anae District include the following:

- Storage: Wai'anae 242 Reservoir No. 2: construction is tentatively scheduled for FY 2015.
- Transmission: Lualualei Line Booster Improvements: construction for FY 2011 at an estimated cost of $3.790 M. Barber's Point Line Booster Improvements: construction for FY 2014, at an estimated $1.650 M.
- Water Main Replacement: Wai'anae District Farrington Highway water main replacement project. Estimated cost: $14.275 M.
- 8-Inch Mains Replacement – Puhawai Road, Kuwale Road, and Pu'uhulu Road: $2.4 M.

The new reservoir will improve reliability by increasing storage capacity for emergency situations and fire fighting capability.

The line boosters will increase transmission capacity from Pearl Harbor sources to meet Wai'anae demands.

Approximately 55,265 linear feet of water main replacement at an estimated design and construction cost of $17,455,000 have been identified in the District and will be beyond the 6-year planning horizon.

The majority of the programmed waterline replacement projects are within residential areas. The water mains in older areas in Waiʻanae have been in service since the 1930s and have reached the end of their service life as evidenced by the rising number of water main breaks.

A transmission main replacement project from Mākaha to Barber's Point is near completion along the heavily traveled Farrington Highway to replace a 24-inch main that has been in service since the 1960s and has experienced breaks due to the corrosive nature of the soils along the coastal area. These main replacements will reduce the occurrence of main breaks, reduce water loss, and increase system reliability.

Strategy 5.3.3 Optimize system operations.

Ongoing system management measures include operation and maintenance, capital planning, financing, water system analysis, modeling cost/benefit and life cycle costs, leak detection and repair technology, monitoring pumpage and water quality, pumping power management, source pumpage optimization, emergency preparedness, and research and development of new technologies and measures to increase efficiency and lower operating costs.

Strategy 5.3.4 Implement security measures.

BWS has implemented a comprehensive security system and security protocol for all of its facilities.

Strategy 5.3.5 Diversify water supply systems.

For the Waiʻanae District, current water sources are somewhat, but not highly diversified. The current sources consist of potable and non-potable ground water wells and tunnels in Waiʻanae and Mākaha Valleys, and water imported from the Pearl Harbor Aquifer. The WWMP includes the possibility of further diversification of water sources in the future – primarily through the use of some of the desalinated water that will be produced at the BWS Kalaeloa Desalination Plant, and also possibly through the production and use of recycled water by some of the District's large water users.

Further diversification of water sources for Waiʻanae will provide BWS with increased flexibility to meet future demands, and flexibility to respond to events such as extended droughts, major water main breaks, and other system disruptions.

TABLE 6-6
SUMMARY OF WATER SUPPLY OPTIONS

WATER SUPPLY OPTIONS	Capital Cost ($/Gal)	Current Use (mgd)	Potential Future Use (mgd)	Development Feasibility	Feasibility Notes
GROUND WATER RESOURCES					
Additional Pearl Harbor Aquifer Ground Water	$3.66	4.5	4,5+	High	Source readily available. Low cost.
North Shore Aquifer Ground Water	$8.00	0.0	4.4+	Low	Environmental, social objections. High cost.
Additional Kea'au Basal Ground Water	$12.00	0.0	1.5	Low	High cost of development and transport, low yield
Additional Brackish Non-Potable Sources	$6.00	>1.0	1.0	Low to Moderate	High cost, low yield. More appropriate for on-site irrigation.
SURFACE WATER RESOURCES					
Stream and Spring Water Sources	n/a	>1.0	n/a	Low	Source not readily available
Stormwater Capture Facilities	$11.50	0.0	n/a	Not Feasible	Source undependable. Environmental, social objections. High Cost.
ALTERNATIVE WATER RESOURCES					
Wai'anae WWTP Recycled Water	$15.58	0.0	3.0	Low	Users uncertain. High production & distribution cost. High chlorides.
Membrane Bioreactor Units Recycled Water	$7.00	0.0	1.0	Moderate	Source limited in areas. Moderate cost.
Kalaeloa Desalination Plant – initial plan	$8.60	0.0	2.0+	Moderate	High cost but competitive with N. Shore import costs.
Wai'anae Desalination Plant	$8.60	0.0	5.0	Not Feasible	Not feasible to develop a second Leeward desalination plant.
CONSERVATION					
Conservation and Drought Mitigation Strategies	Reduced demand	Difficult to quantify savings	0.2+	High	Highly feasible, although difficult to quantify.

6.2 WAIʻANAE WATER SUPPLY – 25-YEAR SUMMARY

Presented below are three sets of Tables and Bar Charts that summarize **Water Demand** and **Water Supply Sources** for Waiʻanae for the next 25 years. The Tables and Bar Charts represent water demand projections in five-year increments using the end-use inventory method, from 2000 to 2030, for the three growth scenarios: Policy, Trend, and High Growth, and are basically numerical summaries of the narrative material provided in section 6.1.5 above.

The numbers presented in the Tables provide separate estimates for Potable Water Demand and Non-Potable Water Demand. Separate numbers are also provided for water supplied from the Waiʻanae Aquifer Sector Area by BWS vs. non-BWS systems.

The total Waiʻanae district projected water demand by the year 2030 for the three scenarios is:

- Policy Scenario 13.37 mgd
- Trend Scenario 13.73 mgd
- High Growth Scenario 17.10 mgd

For each of the three scenarios, the planned water sources provide for more water than the estimated demand. Starting at 2010, this extra "buffer" is 0.38 mgd for the Policy Scenario, 0.44 mgd for the Trend Scenario, and 1.01 mgd for the High Growth Scenario. The general guideline for this "buffer" amount was an amount of water equal to three to five years of projected increase in demand. Five to seven years is needed to provide time for BWS to either plan for and construct, or accelerate already planned capital improvements, if demands are higher than expected. This buffer allows some time for BWS to adjust to higher than expected demand, should it occur.

Based on past experience, it was estimated that conservation will account for five percent of the total increase in water demand over the planning horizon. The five percent was then distributed equally amongst each five year increment.

The accompanying Bar Charts illustrate how demand for each five-year increment of the Plan will be met by the five types of water sources:

- Waiʻanae Aquifer Sector – BWS
- Glover Tunnel - BWS
- Waiʻanae Aquifer Sector non-BWS
- Water imports from the Pearl Harbor Aquifer, including desalinated water from the Kalaeloa desalination facility
- Water conservation measures.

The Bar Charts show the volume of water to be provided by each water source. Note that the numbers provided inside the Bar Charts show the total estimated potable water demand for each five-year increment, and the total non-potable water demand, both in mgd.

TABLE 6-7
WAI'ANAE PROJECTED WATER DEMAND AND SUPPLY OPTIONS
INVENTORY METHOD
POLICY SCENARIO

			Short	Mid	Mid	Long	Long
All units in mgd	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
BWS Potable Demand	6.62	6.97	7.29	7.69	8.03	8.33	8.63
Non-BWS Potable Demand	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Potable Demand	**6.81**	**7.16**	**7.49**	**7.88**	**8.22**	**8.52**	**8.82**
BWS Non-Potable Demand	3.00	2.85	2.95	3.01	3.08	3.18	3.25
Non-BWS Non-Potable Demand	1.27	1.28	1.30	1.30	1.30	1.30	1.30
Non-Potable Demand	**4.27**	**4.13**	**4.25**	**4.31**	**4.38**	**4.47**	**4.54**
Buffer	**0.35**	**0.38**	**0.38**	**0.38**	**0.38**	**0.38**	**0.38**
TOTAL DEMAND	**11.43**	**11.67**	**12.11**	**12.57**	**12.98**	**13.38**	**13.75**
Waianae Aquifer Sector Area - BWS (Potable)	4.96	4.50	4.34	4.34	4.34	4.34	4.34
Glover Tunnel - BWS (Non-Potable)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Waianae Aquifer Sector Area - Non-BWS	1.46	1.46	1.46	1.46	1.46	1.46	1.46
Pearl Harbor Import, including potential Desal from Kalaeloa	4.50	5.16	5.73	6.15	6.52	6.88	7.21
Conservation	0.00	0.04	0.08	0.11	0.15	0.19	0.23
TOTAL SUPPLY	**11.43**	**11.67**	**12.11**	**12.57**	**12.98**	**13.38**	**13.75**

FIGURE 6-1

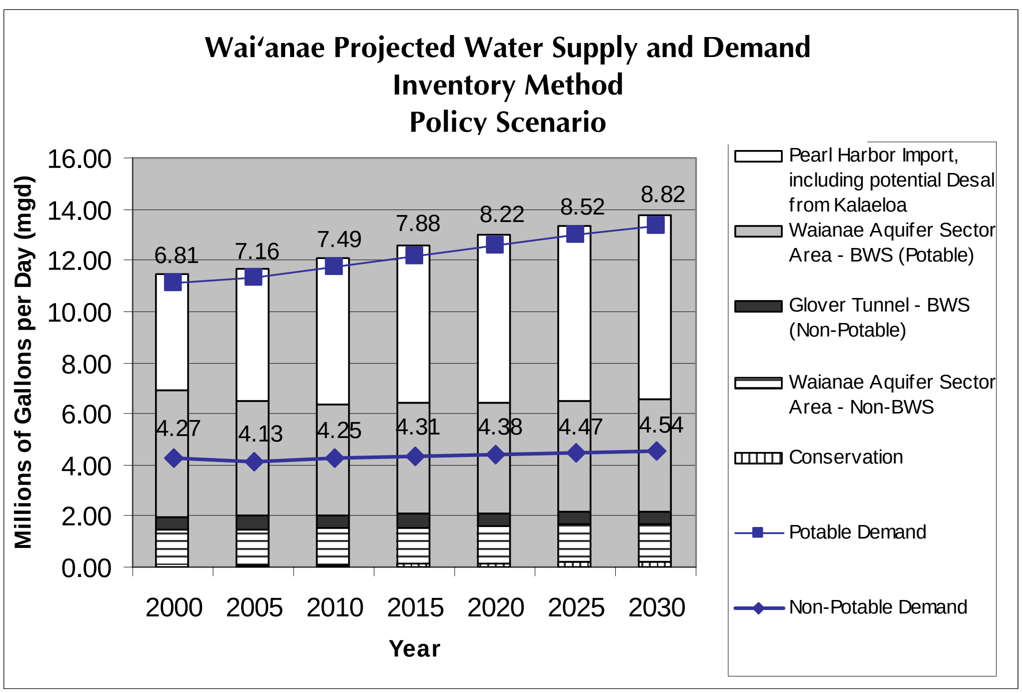


TABLE 6-8
WAI'ANAE PROJECTED WATER DEMAND AND SUPPLY OPTIONS
INVENTORY METHOD
TREND SCENARIO

			Short	Mid	Mid	Long	Long
All units in mgd	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
BWS Potable Demand	6.62	6.97	7.53	8.12	8.51	8.82	9.09
Non-BWS Potable Demand	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Potable Demand	**6.81**	**7.16**	**7.72**	**8.31**	**8.70**	**9.01**	**9.28**
BWS Non-Potable Demand	3.00	2.84	2.92	2.97	3.02	3.10	3.16
Non-BWS Non-Potable Demand	1.27	1.28	1.30	1.30	1.30	1.30	1.30
Non-Potable Demand	**4.27**	**4.12**	**4.22**	**4.27**	**4.32**	**4.40**	**4.46**
Buffer	**0.35**	**0.44**	**0.44**	**0.43**	**0.45**	**0.42**	**0.44**
TOTAL DEMAND	**11.43**	**11.72**	**12.38**	**13.01**	**13.47**	**13.83**	**14.18**
Waianae Aquifer Sector Area-BWS (Potable)	4.96	4.50	4.34	4.34	4.34	4.34	4.34
Glover Tunnel - BWS (Non-Potable)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Waianae Aquifer Sector Area-Non-BWS	1.46	1.46	1.46	1.46	1.46	1.46	1.46
Pearl Harbor Import, including potential Desal from Kalaeloa	4.50	5.21	5.98	6.57	6.98	7.30	7.60
Conservation	0.00	0.04	0.09	0.13	0.18	0.22	0.27
TOTAL SUPPLY	**11.43**	**11.72**	**12.38**	**13.01**	**13.47**	**13.83**	**14.18**

FIGURE 6-2

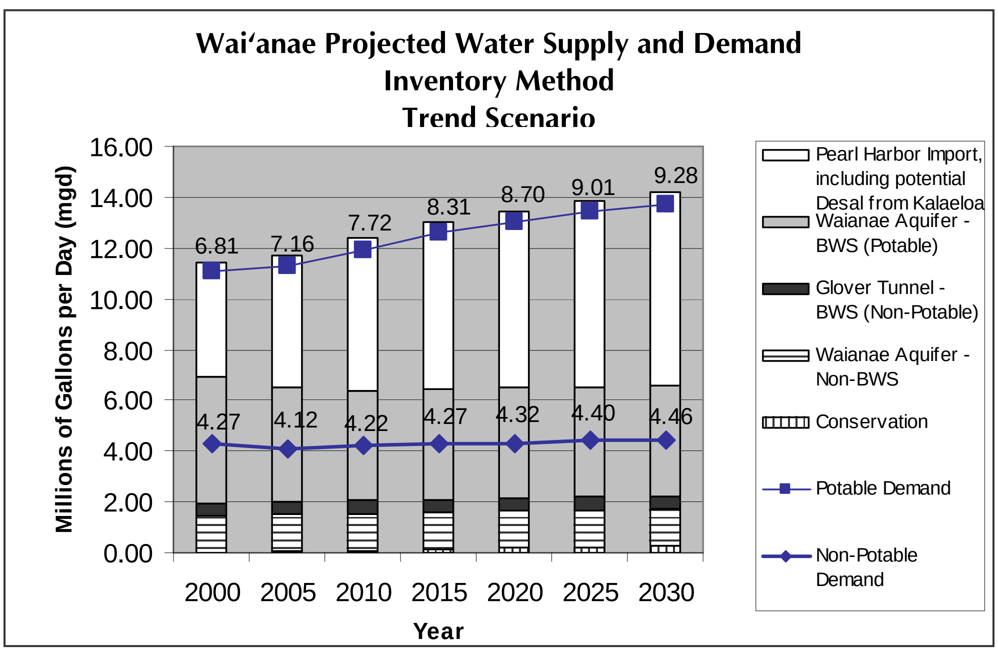
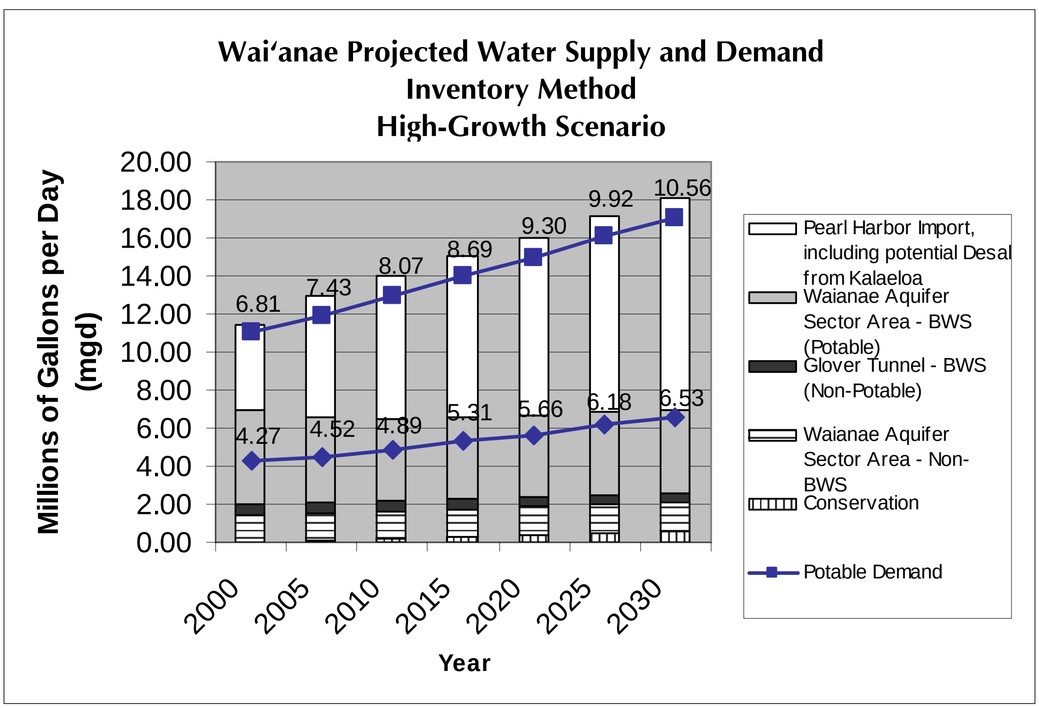


TABLE 6-9
WAI'ANAE PROJECTED WATER DEMAND AND SUPPLY OPTIONS
INVENTORY METHOD
HIGH-GROWTH SCENARIO

All units in mgd	2000	2005	Short 2010	Mid 2015	Mid 2020	Long 2025	Long 2030
BWS Potable Demand	6.62	7.24	7.88	8.50	9.11	9.73	10.37
Non-BWS Potable Demand	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Potable Demand	**6.81**	**7.43**	**8.07**	**8.69**	**9.30**	**9.92**	**10.56**
BWS Non-Potable Demand	3.00	3.24	3.59	3.95	4.30	4.66	5.01
Non-BWS Non-Potable Demand	1.27	1.28	1.30	1.36	1.36	1.52	1.52
Non-Potable Demand	**4.27**	**4.52**	**4.89**	**5.31**	**5.66**	**6.18**	**6.53**
Buffer	**0.35**	**1.01**	**1.02**	**1.01**	**1.02**	**1.01**	**1.02**
TOTAL DEMAND	**11.43**	**12.96**	**13.98**	**15.01**	**15.98**	**17.11**	**18.11**
Waianae Aquifer Sector Area - BWS (Potable)	4.96	4.50	4.34	4.34	4.34	4.34	4.34
Glover Tunnel - BWS (Non-Potable)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Waianae Aquifer Sector Area - Non-BWS	1.46	1.46	1.46	1.46	1.46	1.46	1.46
Pearl Harbor Import, including potential Desal from Kalaeloa	4.50	6.39	7.47	8.40	9.27	10.30	11.20
Conservation	0.00	0.10	0.20	0.30	0.40	0.50	0.60
TOTAL SUPPLY	**11.43**	**12.96**	**13.98**	**15.01**	**15.98**	**17.11**	**18.11**

FIGURE 6-3



6.3 SUMMARY OF ASSUMPTIONS

Any long-range plan will contain a number of key assumptions and uncertainties. This section of the Plan summarizes some of the key assumptions and uncertainties, both explicit and implicit, that users of the WWMP should be aware of.

6.3.1 DEMAND ASSUMPTIONS

6.3.1.1 Policy Scenario

DPP 2030 population projections for Wai'anae for the "Policy Scenario" assume that the policies and urban growth boundary line established by the July 2000 "Wai'anae Sustainable Communities Plan" will remain largely unchanged for the next 25 years. Thus, unlike the relatively large population growth that Wai'anae experienced during the period 1970 to 2000 – an average of about 6,000 people per decade, or 600 people per year – this "slow growth" scenario estimates an increase of only some 6,600 people for the period 2005 to 2030, or an average of about 264 people per year.

6.3.1.2 Trend Scenario

DPP 2030 population projections for Wai'anae for the "Trend Scenario" assume that "slow growth" will still be the norm, but that the development of DHHL lands will be a more significant factor. The Trend Scenario thus projects an increase of 8,232 people for the period 2005 to 2030, or an average of about 330 people per year.

6.3.1.3 High Growth Scenario

As previously noted, the "High Growth" Scenario was developed by the Townscape, Inc. planning team This scenario projects an increase of 15,000 people for the period 2005 to 2030, or an average of about 600 people per year – about the average annual population growth that Wai'anae experienced during the 30-year period 1970-2000. Although these numbers are significantly higher than either of the DPP scenario's numbers, Wai'anae may indeed see this kind of growth, given ever-increasing pressures to "open up" land on O'ahu for affordable housing.

6.3.1.4 Agricultural Water Demand

A significant increase in active agriculture would result in increased demand for irrigation water. However, active agriculture has been declining in Wai'anae. For the Policy and Trend Scenarios, the End-Use Inventory projection method assumed that agricultural acreage increased proportionally with the small increase in agricultural jobs as projected by the City. Agricultural acreage was doubled for the High-Growth Scenario. It was also assumed that the amount of water required to irrigate each acre of agricultural land remained constant. For additional background on the projection methodology, please refer to Appendix E.

Most agricultural water needs were assumed to be met by BWS, as there is limited ground and surface water to be developed in Wai'anae. Additionally, because agricultural operations n Wai'anae are relatively small, it is not likely that these farms would be able to afford the development of new sources.

6.3.2 WATER SOURCE ASSUMPTIONS

6.3.2.1 Sustainable Yield

CWRM estimated the sustainable yield of the Waiʻanae Aquifer Sector Area to be 16 mgd. The Mākaha and Waiʻanae Aquifer System Areas have SYs of 3 mgd each, and provide reliable sources of ground water. The remaining Aquifer System Areas: Nānākuli (2 mgd), Lualualei (4 mgd), and Keaʻau (4 mgd), have a combined sustainable yield of 10 mgd that BWS has judged to be impractical to develop for cost effective ground water wells. Thus, theoretical sustainable yield numbers do not necessarily translate into cost effective water sources.

6.3.2.2 Storm Water Capture

The Plan assumed that storm water capture would not be a cost effective strategy for Waiʻanae, but the Plan did not include feasibility concepts or order of magnitude cost estimates for this water source option.

6.3.2.3 Water Imports from the North Shore

The Plan also assumed that water imports from the North Shore would not be a cost effective or socially acceptable strategy; therefore the Plan did not investigate this option in any detail.

6.3.3 WATERSHED MANAGEMENT ASSUMPTIONS

The Waiʻanae Watershed Management Plan is grounded in a number of key beliefs on overall watershed dynamics that could be considered assumptions. These key beliefs or assumptions include the following:

All natural/ecological systems, structures, and functions are inter-related and interdependent: surface and ground water quantity and quality are therefore determined by the overall health of the watershed.

- A degraded watershed results in poor surface and ground water quantity and/or quality, increased flooding, soil erosion, stream siltation, and degraded quality of near shore waters and ocean biota.
- The Waiʻanae watershed has suffered significant degradation over the past 200+ years from a combination of human impacts and the proliferation of invasive, alien plants and animals.
- Public agencies, land owners, and Waiʻanae community groups need to work together to heal, rehabilitate, and restore the natural resources of the Moku, and return the watershed to health.

The Waiʻanae Watershed Management Plan provides data and guidance for this important mission.

6.4 SUMMARY, PHASING, AND IMPLEMENTATION

Water and watershed planning are important steps toward having healthy watersheds. Implementing this Plan's projects is part of achieving this goal. This section summarizes the findings of the plan and describes possible mechanisms for implementation.

6.4.1 SUMMARY AND PHASING

6.4.1.1 Water Supply

Water to meet the projected demand will come from a variety of sources, which are summarized below.

- ***Existing levels of Waiʻanae ground water withdrawals and imports from the Pearl Harbor Aquifer*** will continue to supply the Waiʻanae District.
- ***Imports from the Pearl Harbor Aquifer*** will be the primary source used to meet additional near-term water demands.
- ***Desalinated water from Kalaeloa*** will supplement mid- to long-term increases in water demand.
- ***No additional BWS ground water development in Waiʻanae*** is planned due to low recoverable yields.
- ***No new stream diversions*** are planned until there are measurable instream flow standards. Existing stream diversions should be as efficient as possible and return any unused water back to the stream.
- ***Water conservation and drought mitigation strategies*** will lessen the amount of water needed to meet future demands.

6.4.1.2 Project Phasing

A variety of projects will be required to ensure the health of watersheds in Waiʻanae. The current phasing is broken down into general timeframes of short, mid and long term. Table 6-7 is a summary of the projects proposed for improving the health of watersheds in Waiʻanae and for meeting the existing and future water demands. Phasing for projects is based on importance of the project to implementing agencies, importance to the community, cost, and legal/institutional complexity, as noted in Section 6.1

TABLE 6-10
SUMMARY OF SHORT, MID, AND LONG-RANGE PROJECTS

Project	Short-Term Projects (0-5 years)	Mid-Term Projects (6-15 years)	Long-Term Projects (16-25 years)
(01) Additional Potable Water Imports from the Pearl Harbor Aquifer	→	→	→
(03) Develop Additional Wai'anae Aquifer Sector Ground Water Sources – Brackish Water	→	→	→
(07) Recycled Water: MBRs for Single Users		→	→
(08) Desalinated Water – From BWS Kalaeloa Desal Plant		→	→
(10) BWS Water Conservation	→	→	→
(11) Wai'anae Hydrogeology Study	→	→	→
(12) Wai'anae Source Water Protection Plan	→		
(13) Drought Mitigation Strategies	→	→	→
(14) Measurable Instream Flow Standards	→	→	→
(15) Stream Conservation Corridor Project	→		
(16) Wetlands Restoration and Protection			→
(17) Concrete Flood Channel Redesign			→
(18) Stream Biological Assessments	→		
(19) Water Quality Testing and Monitoring	→	→	→
(20) Stream Dumping Prevention and Clean Up	→	→	→
(21) Surface Water Inventory		→	
(22) Surface Water Quality Improvement	→	→	→
(23) Forest Restoration Program	→	→	→
(24) Wildfire Management Plan and Protocol for Action	→		
(25) *Lo'i Kalo* Expansion Program		→	→
(26) Mākaha Research Watershed		→	→
(27) Agricultural Support Program		→	→
(28) Flood Mitigation Program		→	→
(29) Mākaha Special Area Plan	→		
(30) Wai'anae Watershed Partnership		→	→
(31) Cultural Learning Centers	→	→	
(32) Community Watershed Education Program	→	→	→
(33) Wai'anae Rural Landscape Study		→	→

6.4.2 IMPLEMENTATION MECHANISMS

This plan is intended to guide agencies and organizations in implementing the most important initiatives for Wai'anae watersheds and water resources. Various agencies and partnerships will need to collaborate for project and plan implementation. Funding, ongoing and one-time, is an essential element of project implementation. Watershed strategies and projects for the most critical watersheds will be implemented through watershed partnerships, joint agency projects, landowner and community initiatives over the long term as available funds allow

6.4.2.1 Agencies

BWS will implement the water supply projects in its Capital Program as funding becomes available.

For some of the proposed projects, programs are already in place to implement projects. For other projects, agency budgets and work plans will need to be realigned.

Agencies involved in watershed protection have a wide range of missions and responsibilities. Coordination among agencies is important because of the overlapping areas of missions and responsibilities. Agency coordination brings together diverse areas of expertise and resources in order to build better programs.

Interagency and organizational commitment needs to be coordinated given that most projects involve multiple agencies. The importance of the need for this coordination cannot be underestimated. One possible mechanism for coordination is to use legislation and resources to hold an Annual Watershed Health Forum to facilitate interdepartmental and interagency coordination.

6.4.2.2 Partnerships

Partnerships usually consist of various government and non-governmental organizations that come together around common objectives such as watershed improvement projects or setting instream flow standards. The mechanism for creating partnerships is a Memorandum of Understanding (MOU) that states the partnership's basic principles and is signed by representatives from the various organizations. Partnerships help to improve agency, landowner, organization and community collaboration. Partnership funding depends upon the ability of the various participants to contribute to the collective projects.

6.4.2.3 Funding

An estimated $22 - $30 million dollars (in 2006 dollars) is needed over the next 10 years to implement the watershed projects as described in this Plan. While some of the watershed projects have funding or partial funding through various agencies, many of the projects are not yet funded. Without a dedicated funding source, implementation will likely depend on budgetary priorities, grant availability and partnering efforts.

Dedicated ongoing funding for projects can come from various sources. Some of the more promising statewide sources examined by an Act 152 working group in 2001 are listed below:

- Conveyance Tax – This dedicated funding source is already in place. A portion of the conveyance tax is designated for watershed protection through the watershed partnerships. While this funding could address some of the projects, many others would remain unfunded, and it would be dependent upon the formation of a Wai‘anae Watershed Partnership.
- Percentage of Capital Improvement Projects (CIP) – The State Foundation on Culture and the Arts funds its Works of Art Special Fund through this source. 1% of all state funds for capital improvements go into a special fund. 2.5% would generate $5 million for watershed protection.
- Transient Accommodation Tax and Tourism Special Fund – money used might have to have a nexus to the tourist industry.
- Watershed Sustainability Fee – A fee added to water bills in Hawai‘i could generate watershed protection funds and reinforce the nexus relationship between water use and watershed protection. This funding source highlights the nexus between the tourist industry and the environment.
- Portion of Sales Tax – designating part of the State Excise for conservation. Arkansas and Missouri currently use this mechanism.

A dedicated source of funding will likely require a concerted lobbying effort by agencies and community partnerships to show legislators the widespread support.

Other “soft” or one-time funding sources would be needed to fill the gap between agency general funding and other dedicated funding sources. Grants are often useful for projects or portions of projects that are not ongoing.

Follow-up, coordination and funding commitments are needed for this plan to be implemented and for maintenance of a healthy watershed in Wai‘anae.

Oahu Water Management Plan Framework
And Scope of Work for Wai`anae and Ko`olauloa Watershed Management Plans

Submitted to the State Commission on Water Resource Management in Compliance with the Statewide Framework for Updating the Hawaii Water Plan, Oahu County Water Use and Development Plan.

Attachment to BWS Transmittal Letter to CWRM, Dated February 20, 2004.

Table of Contents:

OWMP Framework Summary

The OWMP consists of policies and strategies, which guide the activities of the City and County of Honolulu and advises the State Commission on Water Resource Management (CWRM) in the areas of planning, management, water development and use and allocation of Oahu's natural water resources. The OWMP framework proposes regional plans entitled "watershed management plans" and shall be consistent with the following:

1. State Water Resource Protection Plan, State Water Quality Plan, State Water Projects Plan, State Agricultural Water Use and Development Plan and Department of Hawaiian Home Lands water plans as listed in Chapter 174C-31, Hawaii Water Plan, State Water Code.
2. The Statewide Framework for Updating the Hawaii Water Plan (Statewide Framework)
3. The General Plan for the City and County of Honolulu. The General Plan is a comprehensive statement of objectives and policies, which sets forth the long range aspirations of Oahu's residents and the strategies of actions to achieve them. It is the focal point of a comprehensive planning process that addresses physical, social, economic and environmental concerns affecting Oahu. This planning process serves as the coordinative means by which the City provides for the future growth of the metropolitan area of Honolulu. http://www.honoluludpp.org/Planning/OahuGenPlan.asp
4. 8 Development Plan (DP) and Sustainable Community Plan (SCP) land use planning regions of Oahu. Each community oriented land use plan is intended to help guide public policy, investment, and decision making over the next 20 years. Each plan responds to specific conditions and community values of each region. Ewa and Primary Urban Center are "development plan" areas where growth and supporting facilities will be directed and be the policy guide for development decisions and actions needed to support that growth. The remaining 6 land use areas are "sustainable communities" plans, which are envisioned as relatively stable regions in which public programs will focus on supporting existing populations. The following table lists the 8 land use planning reports with links.

Oahu's Land Use Planning Regions	Web Page Links to the Plans
Waianae	http://www.honoluludpp.org/Planning/DevSust_Waianae.asp
Ko`olauloa	http://www.honoluludpp.org/Planning/DevSust_Koolauloa.asp
Ko`olaupoko	http://www.honoluludpp.org/Planning/DevSust_Koolaupoko.asp
North Shore	http://www.honoluludpp.org/Planning/DevSust_NorthShore.asp
Ewa	http://www.honoluludpp.org/Planning/DevSust_Ewa.asp
Central Oahu	http://www.honoluludpp.org/Planning/DevSust_CentralOahu.asp
East Honolulu	http://www.honoluludpp.org/Planning/DevSust_EastHonolulu.asp
Primary Urban Center	http://www.honoluludpp.org/Planning/DevSust_PrimaryUrbanCenter.asp

5. City and County of Honolulu Ordinance 90-62, Water Management establishing the Oahu Water Management Plan establishing water management policies and strategies "for water use and development within each development plan area."
6. Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152, SLH 2000, Relating to Watershed Protection. The annual report set forth the development of a watershed master plan, including identifying protected watersheds areas, enhancement projects and an implementation plan.
7. Supreme Court Decision on Waiahole Ditch Contested Case applying the Public Trust Doctrine and the Precautionary Principle to water resource management.
8. BWS Sustainability Vision and Mission of "Water for Life" to enhance the quality of life of our community by providing world-class water services. Protecting the environment and supporting Oahu's economy while involving the community achieve BWS goals of sustainable water supplies for future generations. BWS accomplishes these goals with our watershed protection and water conservation partnership programs and diversifying our water supplies, both natural and alternative technologies, such as recycled water, seawater desalination and ocean resource development.

Background:

The Commission in 1990 formally adopted the initial Hawaii Water Plan, prepared by various state and county agencies. Further updates in 1992 were deferred pending additional refinement of plan components. In 1994, the City and County of Honolulu began their initial revision to the Oahu Water Management Plan. The draft OWMP update was completed in January 1998 and is the most current reference document. However, it was not submitted for adoption because Oahu's water situation was in a state of flux, with major changes in the agriculture industry, including the closing of the Oahu Sugar Company and the Waialua Sugar Company.

In 1999, the Honolulu Board of Water Supply (BWS) initiated the integrated resource planning process to update the Oahu Water Management Plan, Oahu's County Water Use and Development Plan. The integrated islandwide water planning effort was met with significant opposition, which surfaced in our public participation process. After almost two years of effort, we did not move beyond the public participation process and so before we started the water planning stage, we decided to stop and re-evaluate our approach. We summarize the main lessons learned as follows:

1. It is important to have equal focus on resource protection, conservation and restoration as on water use and development. There needs to be a reassurance that our natural resources are protected and our water supplies are sustainable before planning on water use and development can successfully occur.
2. It is important to elevate the community's knowledge about water related issues so the interested community can actively participate in a community-based planning process. It is equally important that the planning document is written so that it is easily understood.
3. The islandwide integrated approach elevated community concerns on growth limits and regional water transport. The integrated approach is more complex on Oahu because approximately ¾'s of Oahu's water systems are interconnected. The communities needed assurance that there were sufficient water resources within their watersheds before islandwide regional water needs were discussed.

In February 2000, CWRM adopted a framework for updating the Hawaii Water Plan to provide focus and additional guidance to each agency responsible for updating specific plan components. CWRM recognized the complexities in addressing water resource planning and views the plans as "living documents which over several plan iterations will result in a truly comprehensive water plan" (Statewide Framework page 1-2)

In August 2000,the Hawaii Supreme Court's decision on the Waiahole Ditch Contested Case, and the remand hearings, provided additional guidance for water resources planning, like the precautionary principle. In addition, three public trust uses of water were identified; domestic use, instream use and water for traditional and cultural practices. Commercial and agricultural water uses are in a lower category.

In 2001, BWS broadened its mission to "Water for Life", which strives for sustainability of all water supplies and to enhance the quality of life of our community by providing world-class water services.

The 2000 Act 152 Watershed Protection required the development of a watershed protection master plan that identified priority watersheds and protection projects for implementation. Act 152 renewed BWS investment in watershed protection recognizing the importance of watersheds for the sustainability of our groundwater supplies and streams. To date, about $1 million has been invested by BWS into Oahu's watersheds and aquifers. Noteworthy watershed protection projects are as follows:

- Ka`ala Bog Fencing to prevent feral animals from destroying the Mt. Ka`ala native habitat.
- Grant to the Oahu Invasive Species Committee to control invasive plant species within the Ko`olau watersheds
- Ala Wai Mauka Restoration Project for the Ko`olau Mountain Watershed Partnership
- BWS and Kamehameha Schools funded a USGS study to assess the hydrological and biological features and also funded the Punalu`u Agricultural Lands and Irrigation System Assessment to help set the in-stream flow standard for Punalu`u Stream.
- Waihe`e Valley Make a Difference Day invasive species removal
- Malama O Manoa "Kuleana Project" to change the residential practices of the Manoa Ahupua`a to increase awareness of water conservation and polluted runoff control.
- Watershed protection studies in Ala Wai, West Honolulu and Central Oahu.
- Ka`ala Farms and Mohala I Ka Wai educational awareness program
- Makaha Valley Restoration project
- Wai`anae and Ko`olauloa Watershed Management Plans

From 2001 to the present, several mountain and urban watershed partnerships have been established among BWS, agencies, organizations and community groups. Together, these partnerships have identified watershed protection projects and plans have been developed and funded. The following partnerships have been developed:

- Ko`olau Mountain Watershed Partnership
- Mohala I Ka Wai in Wai`anae
- Punalu`u Watershed Partnership

- Waihe`e Ahupua`a Initiative
- Ahupua`a Restoration Council of He`eia
- Malama O Manoa
- Wai`anae Kai Watershed Partnership
- University of Hawaii Manoa / BWS Water Conservation Partnership
- Hawaiian Electric Co. / BWS Energy and Water Conservation Partnership

Watershed Planning Approach:

The OWMP Framework proposes individual planning documents referred to as regional watershed management plans, which collectively will be the Oahu Water Management Plan. The regional watershed management plans will address the water needs, both present and future, for the 8 land use districts on Oahu. Rather than an islandwide approach brought down to each watershed, the watershed planning approach will start from the basic planning unit, each watershed or "ahupua`a" and expand it to the region or "moku". It is important that this watershed management plan allow equal focus on resource protection, conservation and restoration as well as on water use and development. The watershed approach is supported by the following references:

- The planning regions will be consistent with and support each of the 8 DP/SCP land use planning regions established in the General Plan. The State Water Code, Chapter 174C-31(b)(2), requires that "Each water use and development plan shall be consistent with the respective county land use plans and policies, including general plan and zoning".
- The Statewide Framework for Updating the Hawaii Water Plan, Page 3-26, Need for Flexibility, recognizes the need for appropriate flexibility in the county plans due to institutional and /or funding constraints, to encourage innovation as well as to accommodate unique and county-specific concerns.
- The Statewide Framework Page 3-19 also requires the preparation of "**regional plans** for water development including recommended and alternative plans, costs, adequacy of plans and relationship to water resource protection and quality plan." (Emphasis added).

The watershed management plans will have the following key themes:

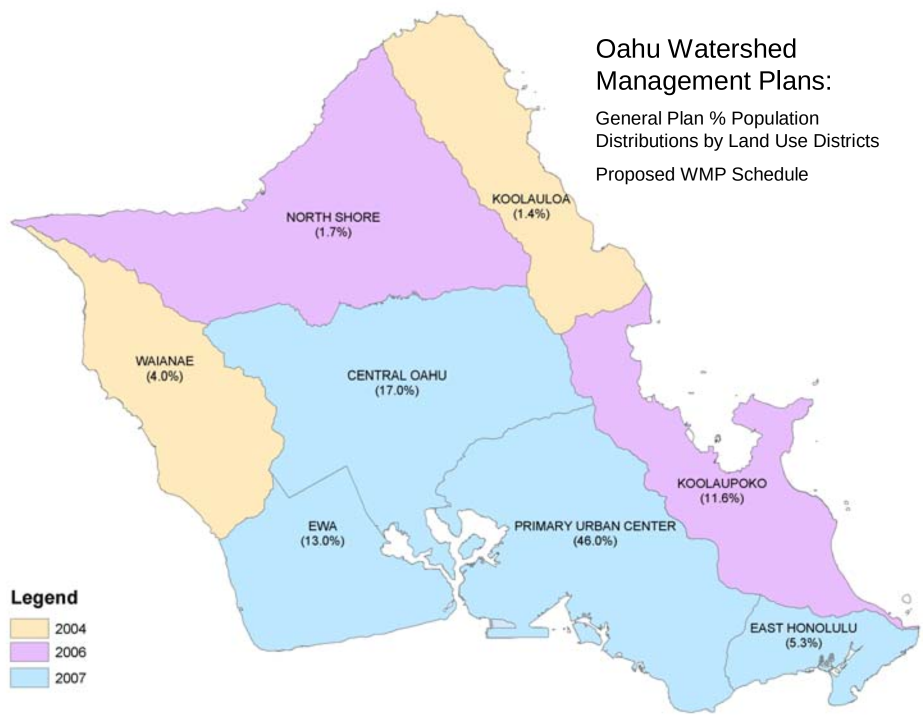
- Community-Based: In addition to public meetings, there will be many small group meetings with the community to educate, understand and apply the community's thinking and values about water resources. A wide-range of community meetings will be conducted including regional organizations such as Mohala I Ka Wai, Malama Ohana and the Neighborhood Boards, to local councils and associations, down to key individual meetings. The BWS watershed partnerships will be asked to provide representation for the community and key stakeholder groups.

- Environmentally Holistic: The watershed approach from mountains to the coral reefs recognizes the inter-dependence of water and land. The watershed management planning approach will not only address water use and development in the urban and agricultural zoned lands, but also describe protection strategies and enhancement projects for the forest reserves, conservation districts, streams and near-shore waters.

- Action-Oriented: The plan will describe specific watershed protection projects as well as natural and alternative water supply facilities that can be implemented by federal, state and city agencies and programs. The projects will be presented in a budgetary level format with information specific enough to support grant funding requests or an agency's capital improvement program.
- Alignment with State and County Water and Land Use Policies as stated above.
- Reflects Ahupua`a Management Principles: The watershed management plans will incorporate Ahupua`a principles in the plans. The community's help will be needed to identify their thinking and values about water. Living with Ahupua`a values and protocols is very important to culturally intact communities, like Wai`anae and Ko`olauloa. Ahupua`a principles are not major factors in all districts, such as the urban metropolitan districts, however, these principles can still be used to guide water resource planning.

Proposed Schedule of Funding and Plan Approval:

The Oahu graphic below, shows the 8 land use areas on Oahu and the proposed funding schedule for the watershed management plans.



The following table lists the proposed funding schedules and anticipated target dates for submittal to CWRM for plan approval. The approval dates are based on an 18-month planning time frame and are only estimates and therefore subject to change.

Watershed Planning Areas	BWS Funding Schedule Fiscal Year	Target Dates for Submittal to CWRM for Plan Approval
Wai`anae, Ko`olauloa	FY 2004	1st Qtr FY 2006
North Shore, Ko`olaupoko	FY 2006	2nd Qtr FY 2007
South Oahu: (Ewa, Central Oahu, Primary Urban Center, East Honolulu)	FY 2007	2nd Qtr FY 2008

* BWS Fiscal Year is July 1 to June 30.

The four-year funding schedule is proposed due to the following reasons:

1. The Statewide Framework recognizes that implementation of the requirements and recommendations will need to be phased over the next several years and possibly over successive iterations of the updating process for the Hawaii Water Plan. (Statewide Framework Implementation Plan, Page 4-1)
2. BWS budgetary and staffing constraints.
3. As this watershed approach is new and unique, we are proposing an 18-month planning process to develop a baseline format and obtain the necessary approvals.
4. Wai`anae, Ko`olauloa, North Shore and Ko`olaupoko are designated as low growth, sustainable communities in the General Plan. The water demand projections for these areas show only marginal water demand increases through the planning horizon, currently 2025.
5. BWS is participating in active watershed partnerships in the Wai`anae and Ko`olauloa areas among others and these partnerships could assist in the public participation process.
6. South Oahu will be funded after the 4 rural districts for the following reasons:
   - To allow time for progress on the Section IV Framework Implementation Plan; Phase I Framework Adoption and Initial Updates to Hawaii Water Plan components, Phase II Development and Funding of New Framework Initiatives and Phase III Component Integration Phase of the Statewide Framework.
   - To allow time to complete the on-going products of the CWRM led Pearl Harbor Monitoring Group as part of the Milestone Framework for the Revised Pearl Harbor Sustainable Yields. Since 1998, BWS has funded over $4 million for the construction of deep monitor wells throughout Oahu and have committed staffing resources for the monitoring of these wells on a quarterly basis. These wells will be essential in the groundwater monitoring and modeling efforts currently underway to increase our understanding of the groundwater supply in the Pearl Harbor and Honolulu aquifers.
   - To allow time to complete the Board of Water Supply's 3-dimensional groundwater model of the Honolulu aquifers.
   - To allow time to incorporate state projects water demands and agricultural water needs. We understand that the State Water Projects Plan was recently completed and the State Agricultural Water Use and Development plan is now underway.

- The watershed management plans for South Oahu will be funded in the same fiscal year and may be combined into a single plan to more easily address the integration of water resources.

In calendar year 2000, South Oahu consumed about 78% of the islandwide municipal source pumpage of 154.6 mgd. We anticipate that the South Oahu watershed management plan(s) will fully utilize the IRP decision tools as described in the Statewide Framework for Updating the Hawaii Water Plan. The scope of work contemplated for the South Oahu regional watershed plan(s) will provide for compiling and developing water demand projections for domestic, commercial, industrial, agricultural, and nonpotable uses of municipal, state, federal and private water systems. It will also include assessment of environmental factors as part of the project objectives and evaluation criteria to be developed for the purpose of evaluating resource options and water management strategies.

<u>Commitment for Agency Coordination:</u>

As each watershed management plan moves forward and in addition to the public participation process, we anticipate several staff meetings with CWRM, City Department of Planning & Permitting and BWS to update our planning progress and obtain feedback and guidance. At key milestones, as coordinated with CWRM staff, we will present updates to the CWRM, tentatively mid-way through the planning process, after the public review draft is available, during plan approval and as otherwise requested by the CWRM. A schedule will be developed.

Each watershed management plan will be submitted for approval as separate documents, closely supporting each respective DP/SCP land use plan. At the completion of the first iteration of all planning regions, there will be a consolidating process to provide an islandwide perspective and to resolve any remaining inter-regional issues.

<u>Proposed Scope of Work, Major Project Elements:</u>

As each planning region is funded, their scopes of work will be submitted to the CWRM for review and approval. The proposed scopes of work for the Wai`anae and Ko`olauloa sustainable community plan areas are being submitted for CWRM review and approval (see attached). The draft scopes and planning approach were discussed with some of the community leaders and organizations in Wai`anae and Ko`olaupoko, and their feedback incorporated. The major project elements for the FY 2004 watershed management plans for Wai`anae and Ko`olauloa are:

1. Project Organization
2. Preliminary Watershed Analysis
3. Preliminary Stakeholders Consultations
4. Preliminary Watershed Management Strategies
5. 5-year Watershed Action Plan
6. Water Use and Development Plan
7. Draft Report
8. Final Report

9. Watershed Management Plan Approval

Summary of Current Water Distribution:

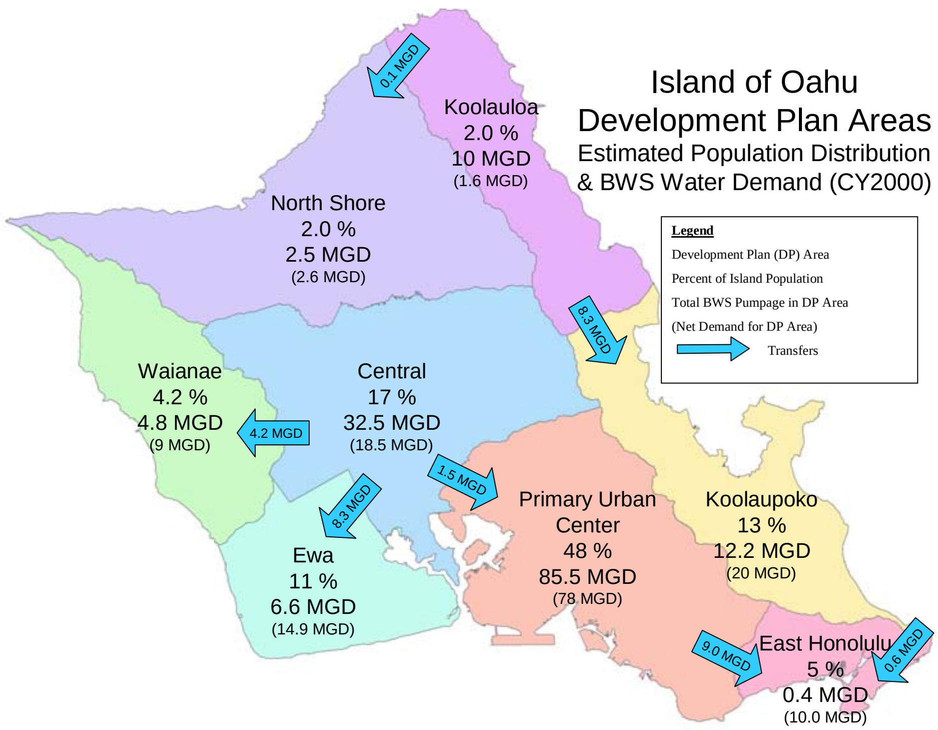
As part of the process of initiating the update of the OWMP and consistent with the guidelines set forth in the Statewide Framework for Updating the Hawaii Water Plan, we have compiled information on existing and projected water demands and sources of supply for the municipal system. BWS has evaluated the adequacy of the supply to meet the potable and nonpotable needs through ground water and recycled water sources. Water demand will be met with existing and funded source projects beyond the estimated 5-year planning period during the completion of all of the regional watershed management plans for Oahu.

The sustainable communities of Wai`anae, North Shore, Ko`olauloa and Ko`olaupoko have essentially the same water demand throughout the planning period. The existing sources and infrastructure in these areas are adequate to provide potable water service through the planning horizon and therefore, additional integration of water supplies between these regions will be limited.

In South Oahu, the water supplies, both natural and alternative, will be fully integrated and described in a future scope of work that once funded in FY 2007, will be submitted to CWRM for their review and approval. The following summarizes the main land use and water planning highlights in South Oahu.

- The City's General Plan directs the majority of the growth to South Oahu.
- Based on the City's growth forecast evaluating population, visitors, housing and employment factors, we forecast an increase in potable water demand for Oahu averaging about 1.1 million gallons per day per year, most of which will occur in South Oahu. In 5 years the BWS system demand is expected to increase by about 5.5 mgd, from 156 mgd in 2003 to 161.5 in 2008. New sources in the Waipahu-Waiawa Water Management Area, as identified in the City DP and SCP land use plans, will be able to provide adequate water supply.
- In addition, in that time period, recycled water facilities in Ewa and Central Oahu will be expanded to continue to off-set additional groundwater development.
    - In 2000, BWS acquired and now operates the 12 mgd Honouliuli Water Recycling Facility supplying irrigation and industrial process water for Ewa.
    - BWS has also funded the design of a delivery system to utilize approximately 3.0 mgd of Wahiawa recycled water in Central Oahu.
- The Kalaeloa seawater desalination plant is currently under design and will bring an additional 5.0 mgd of potable water supply to the second city of Kapolei.

For your information, a summary of Oahu's estimated population distribution based on the 2000 census, BWS potable water demand in calendar year 2000 and water distribution is provided among the 8 land use regions. The is essentially the base case of existing water demand and distribution in the BWS system, which will referenced in the watershed management plans.


Island of Oahu
Development Plan Areas
Estimated Population Distribution
& BWS Water Demand (CY2000)
Legend
Development Plan (DP) Area
Percent of Island Population
Total BWS Pumpage in DP Area
(Net Demand for DP Area)
Transfers
Koolauloa
2.0 %
10 MGD
(1.6 MGD)
North Shore
2.0 %
2.5 MGD
(2.6 MGD)
Waianae
4.2 %
4.8 MGD
(9 MGD)
Central
17 %
32.5 MGD
(18.5 MGD)
Ewa
11 %
6.6 MGD
(14.9 MGD)
Primary Urban
Center
48 %
85.5 MGD
(78 MGD)
Koolaupoko
13 %
12.2 MGD
(20 MGD)
East Honolulu
5 %
0.4 MGD
(10.0 MGD)
0.1 MGD
8.3 MGD
4.2 MGD
8.3 MGD
1.5 MGD
9.0 MGD
0.6 MGD

B PLANS, POLICIES, GUIDELINES, AND CONTROLS

B.1 OVERVIEW

The development of the Honolulu Board of Water Supply's Watershed Management Plans (WMPs) is guided by various Federal, State, and County statutes, ordinances, plans, and controls with specific policies regarding the use and management of water. The critical water policies have been outlined in this section to ensure compliance with and adherence to the broader context under which this plan falls. The framework for developing the WMPs is provided by:

- State Water Code
- Statewide Framework for Updating the Hawai'i Water Plan
- O'ahu Water Management Plan Framework
- Act 44: An Act to Provide for the Encouragement and Protection of Agriculture, Horticulture, and Forestry
- Act 152: Relating to Watershed Protection, 2000 and the Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152.

Additionally, the Oʻahu Watershed Management Plan strives for consistency with:

- Federal Clean Water Act and Safe Drinking Water Act
- All of the Hawaiʻi Water Plan components
- Department of Hawaiian Home Lands (DHHL) water plans as listed in the Hawaiʻi Revised Statutes (HRS) Chapter 174C-31
- Hawaiʻi State Plan
- General Plan for City and County of Honolulu
- County Development Plan/Sustainable Communities Plans
- City and County of Honolulu Ordinance Chapter 30: Water Management
- Supreme Court Decision on Waiāhole Ditch Contested Case applying the Public Trust Doctrine and Precautionary Principle
- BWS Sustainability Vision and Mission of "Water for Life."

This section is not meant to be a summary of these guidance documents, but a characterization of the major policy objectives that form the framework for the development of the WWMP. For more detailed information, the reader is directed to the original documents.

B.2 FEDERAL PLANS AND CONTROLS

Federal policy documents generally refer to the quality of recreational and drinking waters in order to protect the health and safety of users.

B.2.1 CLEAN WATER ACT (CWA) OF 1977, AMENDED 1987

The Clean Water Act (CWA) is the common name for the 1977 legislative amendment to the Federal Water Pollution Control Act Amendments of 1972. The objective of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" so they can support "the protection and propagation of fish, shellfish, and wildlife and…recreation in and on the water."[1] It provides the basic structure for regulating pollutant discharges to waters of the United States and sets water quality standards for all contaminants in surface waters. The CWA employs a variety of regulatory and non-regulatory tools to significantly reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff.

The CWA requires states to prepare and submit a 303(d) List of Impaired Waters every two years. This list includes waterbodies not expected to meet state water quality standards, even after application of technology-based effluent limitations to the U.S. Environmental Protection Agency (EPA). States are required to determine the level of impairment for that waterbody based on all existing and readily available surface water quality data and related information.[2]

B.2.2 SAFE DRINKING WATER ACT (SDWA) OF 1974, AMENDED 1996

Enacted in 1974, the purpose of the Safe Drinking Water Act (SDWA) is to protect public health by regulating the nation's public drinking water supply. Amended in 1996, the SDWA recognized the provisions of source water protection, operator training, funding for water system improvements, and public information as critical components to safe drinking water. The following are important programs as authorized by the SDWA:

- National standards for drinking water. Determined by EPA, these standards ensure consistent national water quality by setting enforceable maximum contaminant levels, which are the maximum permissible levels of a particular drinking water contaminant in a public water system.
- State source water assessment program. The Hawai'i Source Water Assessment Program (SWAP) is the first step in the development of a comprehensive drinking water source protection program. The SWAP requires delineation of the area around a drinking water source within which contaminants might filter through to that supply source. The SWAP requires an inventory of activities that might lead to the release of microbiological or chemical contaminants in the area. The Hawai'i SWAP report is currently under agency review.

B.3 STATE OF HAWAI'I PLANS AND CONTROLS

State water policy goals generally seek to protect, conserve, and manage the resource in such a way as to maintain its quality and availability for future generations.

B.3.1 CONSTITUTION OF THE STATE OF HAWAI'I

Article XI, Section 1 (Conservation, Control and Development of Resources) of the State Constitution mandates the State and its political subdivisions to conserve and protect its natural resources, including water. The State is to promote development and utilization of water in a manner that conserves and sustains the resource. As with all public resources, water is held in trust by the State for the benefit of the people.[3]

Article XI, Section 7 (Water Resources) expresses the State's obligation to "protect, control and regulate the use of Hawaii's water resources for the benefit of its people." It also mandates the establishment of a water resources agency that "shall set overall water conservation, quality and use policies; define beneficial and reasonable uses; protect ground and surface water resources, watersheds and natural stream environments; establish criteria for water use priorities while assuring appurtenant rights and existing correlative and riparian uses and establish procedures for regulating all uses of Hawaii's water resources."[4]

B.3.2 HAWAIʻI STATE PLAN

It is the goal of the State, under the Hawaiʻi State Planning Act (HRS, Chapter 226), to achieve: a) a strong and viable economy; b) a desired physical environment; and c) physical, social, and economic well-being for its people. The objectives and policies of the State Plan that are pertinent to the development of the Watershed Management Plans are discussed below:

B.3.2.1 Physical Environment: Land-Based, Shoreline, and Marine Resources

It is the objective of the State to make prudent use of Hawaii's land-based, shoreline, and marine resources and to protect unique and fragile environmental resources. It is the policy of the State to consider multiple uses in watersheds, provided such uses do not detrimentally affect water quality and recharge functions.[5]

B.3.2.2 Physical Environment: Land, Air, and Water Quality

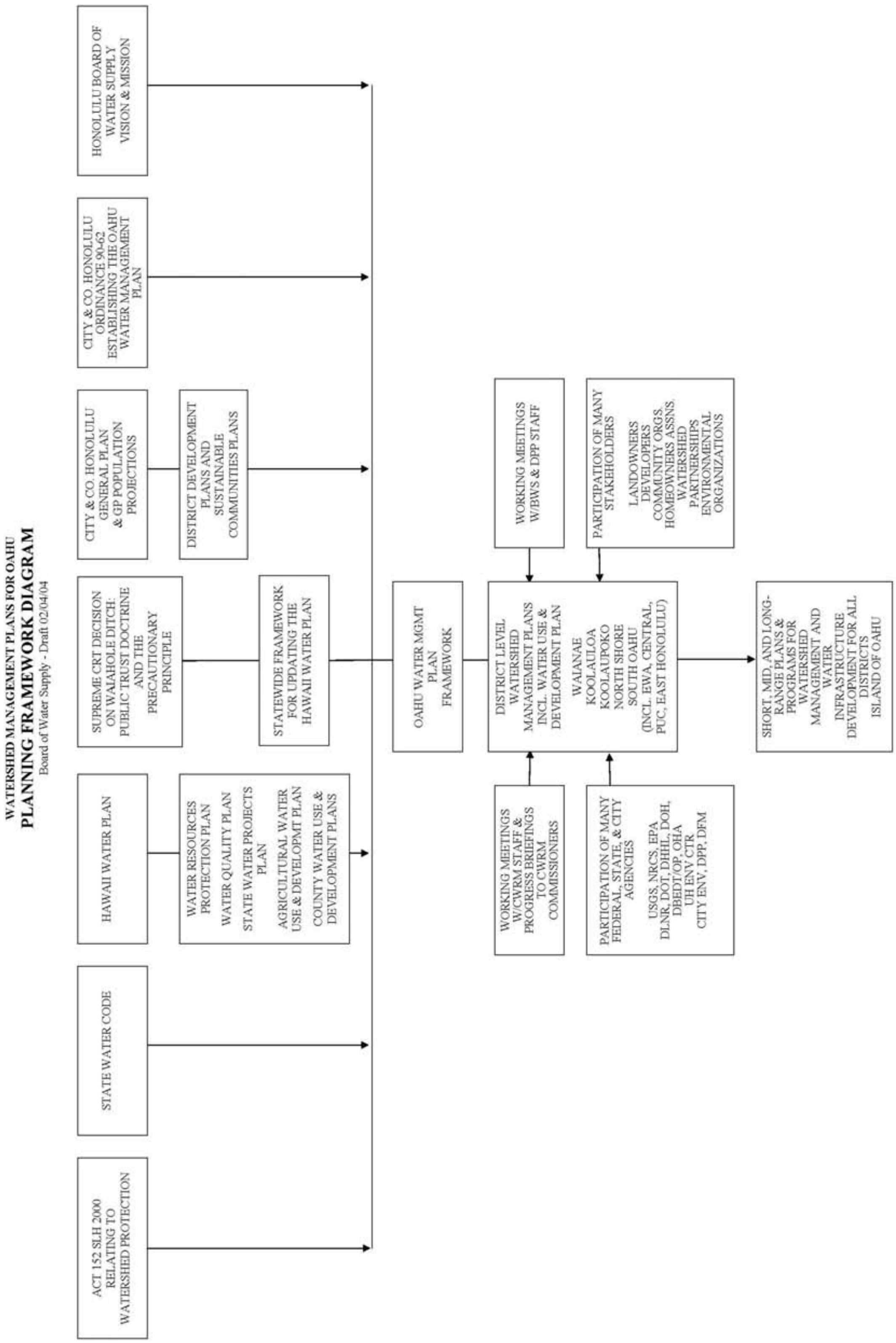
It is the objective of the State to maintain and pursue an improved quality of land, air, and water resources and to promote greater public awareness of Hawaii's environmental resources. In support of this, it is the policy of the State to:

- Promote the proper management of Hawaii's land and water resources
- Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters
- Foster recognition of the importance and value of land, air, and water resources to Hawaii's people, their culture, and visitors.[6]

B.3.2.3 Facility Systems: Water

It is the objective of the State to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities. It is the policy of the State to:

- Coordinate the development of land use activities with existing and potential water supply.
- Support research and development of alternative methods to meet future water requirements well in advance of anticipated needs.
- Reclaim and encourage the productive use of runoff water and water discharges.
- Assist in improving the quality, efficiency, service, and storage capabilities of water systems for domestic and agricultural use.
- Support water supply services to areas experiencing critical water problems.
- Promote water conservation programs or practices in government, private industry, and the general public to help ensure adequate water to meet long-term needs.[7]


WATERSHED MANAGEMENT PLANS FOR OAHU
PLANNING FRAMEWORK DIAGRAM
Board of Water Supply - Draft 02/04/04
HONOLULU BOARD OF WATER SUPPLY VISION & MISSION
CITY & CO. HONOLULU ORDINANCE 90-62 ESTABLISHING THE OAHU WATER MANAGEMENT PLAN
CITY & CO. HONOLULU GENERAL PLAN & GP POPULATION PROJECTIONS
DISTRICT DEVELOPMENT PLANS AND SUSTAINABLE COMMUNITIES PLANS
SUPREME CRT DECISION ON WAIAHOLE DITCH: PUBLIC TRUST DOCTRINE AND THE PRECAUTIONARY PRINCIPLE
STATEWIDE FRAMEWORK FOR UPDATING THE HAWAII WATER PLAN
HAWAII WATER PLAN
WATER RESOURCES PROTECTION PLAN
WATER QUALITY PLAN
STATE WATER PROJECTS PLAN
AGRICULTURAL WATER USE & DEVELOPMT PLAN
COUNTY WATER USE & DEVELOPMENT PLANS
STATE WATER CODE
ACT 152 SLH 2000 RELATING TO WATERSHED PROTECTION
OAHU WATER MGMT PLAN FRAMEWORK
WORKING MEETINGS W/BWS & DPP STAFF
PARTICIPATION OF MANY STAKEHOLDERS
LANDOWNERS
DEVELOPERS
COMMUNITY ORGS.
HOMEOWNERS ASSNS.
WATERSHED PARTNERSHIPS
ENVIRONMENTAL ORGANIZATIONS
DISTRICT LEVEL WATERSHED MANAGEMENT PLANS INCL. WATER USE & DEVELOPMENT PLAN
WAIANAE
KOOLAULOA
KOOLAUPOKO
NORTH SHORE
SOUTH OAHU
(INCL. EWA, CENTRAL, PUC, EAST HONOLULU)
WORKING MEETINGS W/CWRM STAFF & PROGRESS BRIEFINGS TO CWRM COMMISSIONERS
PARTICIPATION OF MANY FEDERAL, STATE, & CITY AGENCIES
USGS, NRCS, EPA
DLNR, DOT, DHHL, DOH, DBEDT/OP, OHA
UH ENV CTR
CITY ENV, DPP, DFM
SHORT, MID, AND LONG-RANGE PLANS & PROGRAMS FOR WATERSHED MANAGEMENT AND WATER INFRASTRUCTURE DEVELOPMENT FOR ALL DISTRICTS ISLAND OF OAHU

B.3.3

STATE WATER CODE

The State Water Code (Code) was enacted in 1987 as HRS Chapter 174C by the State Legislature to protect and manage Hawaii's surface and ground water resources. The Code recognizes five general policies regarding water:

- Waters of the State are held for the benefit of the citizens of the State, who have a right to have the waters protected for their use.
- The Hawai'i Water Plan is the guide for developing and implementing a program of comprehensive water resources planning to address the problems of supply and conservation of water.
- The Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic, aquaculture, irrigation and other agricultural, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of water of the State for municipal uses, public recreation, public water supply, agriculture, and navigation.
- The Code "shall be liberally interpreted to protect and improve the quality of waters of the State….The people of Hawaii have an absolute interest in the prevention, abatement, and control of both new and existing water pollution and in the maintenance of high standards of water quality."
- The State Water Code shall be liberally interpreted and applied to conform with the intentions and plans of the counties in terms of land use planning.[8]

The Commission on Water Resource Management (Commission) was created within the State Department of Land and Natural Resources to administer the State Water Code. The Commission is responsible for the protection and management of water resources through appropriate measures such as setting policies, defining uses, establishing priorities while assuring rights and uses, and establishing regulatory procedures. The Commission has jurisdiction over land-based surface water and ground water resources, but not coastal waters. The protection and management of these water resources is carried out through resource assessments, planning, and regulation. Generally, the Commission is responsible for addressing water quantity issues, while water quality issues are under the purview of the State Department of Health.[9]

B.3.4 HAWAIʻI WATER PLAN

The State Water Code also mandates the development of the Hawaiʻi Water Plan (HWP), whose process is to be guided by the Commission. The HWP objectives include: (1) obtaining maximum reasonable beneficial use of water; (2) proper conservation and development of the waters of the State; (3) control of the waters of the State for such public purposes as navigation, drainage, sanitation, and flood control; (4) attainment of adequate water quality as expressed in the water resource protection and water quality plans; and (5) implementation of the Code's water resource policies.

The Hawaiʻi Water Plan originally consisted of four parts: the Water Resource Protection Plan (WRPP), the Water Use and Development Plans (WUDP) for each county, the State Water Projects Plan (SWPP), and the Water Quality Plan (WQP). An Agricultural Water Use and Development Plan (AWUDP) was added through Act 101 by the 1998 State Legislature.

As of June 2009, the status of the HWP components was as reflected in the following table:

HAWAIʻI WATER PLAN COMPONENTS	OFFICIAL DOCUMENT	STATUS
Water Quality Plan (WQP)	June 1990	Update in progress
State Water Projects Plan (SWPP)	February 2003	Oʻahu update in progress
Water Resource Protection Plan (WRPP)	June 2008	Update completed
Agricultural Water Use and Development Plan (AWUDP)	December 2004	Update in progress
Hawaiʻi WUDP	1990	Update in progress
Kauaʻi WUDP	1990	Update in progress
Maui/Lānaʻi/Molokaʻi WUDP	1990	Update in progress
Oʻahu WUDP	1990	Update in progress

Specific requirements that the Code established for the county WUDPs include discussion of the status of water and related land development, future land uses and related water needs, and regional plans for water developments.[10] The WUDPs must also be consistent with the WRPP, WQP, county land use plans and policies (including General Plans and Zoning), and State land use classification and policies.[11]

B.3.5 STATEWIDE FRAMEWORK FOR UPDATING THE HAWAI'I WATER PLAN

The Code calls for coordination between the Commission and other State and County agencies to formulate an integrated and coordinated program to develop and update the Hawai'i Water Plan (HWP). To effectively implement these requirements, the Commission established a Statewide Framework in February 2000 to incorporate the techniques of Integrated Resources Planning.

The Statewide Framework established that the intent of the County WUDP was to ensure that future water needs of the County are met and to provide guidance to the Commission for decision-making on water uses and water reservation requests. Evaluation of the current HWP components, including the County WUDPs, noted several areas of improvement and planning complexities that need to be addressed. Implications of the Statewide Framework to the WUDPs are as follows:[12]

- Establish a focus that promotes the welfare of the resource, unrestricted by jurisdictional responsibility.
- Avoid unrealistic simplification of complex water availability and allocation scenarios.
- Address competing uses within the overall planning context.
- Address a range of future water demand projection scenarios, taking into account impact to the physical, environmental or other socioeconomic costs of the strategies, and plan for uncertainties.
- Integrated planning is needed to address competition for available resources.
- Greater sophistication is necessary in planning for future water resource development, especially for the uncertain agriculture, military, urban land development, and tourism industries.
- Public involvement and education is a necessary component of the plan process.
- Closer monitoring and implementation of management strategies to protect the aquifer from over-withdrawal are necessary.
- Management strategies should consider the full range of development options, including balancing various source developments with non-structural options and articulate decision-making criteria.
- Recognize and plan for water requirements for all legally protected water rights.

The Statewide Framework recommended plan elements that should be included in the WUDP updates. These elements are:[13]

- Submission of a County-Specific WUDP Project Description
- Coordination with the Commission
- Stakeholder and Public Involvement
- County Public Participation Process
- Objectives and Criteria
- Consistency with the WRPP
- Current and Future Demand Forecast
- Water System Profiles
- Resource and Facility Options
- Strategies Development and Evaluation
- Flexible Sequence of Supply, Infrastructure, Storage, and Conservation Program Additions Needed
- Uncertainties
- Final Strategy Selection
- Modeling Tools
- Implementation Plan
- Underlying Assumptions
- Flexibility
- County-Specific Project Descriptions
- Priorities and Objectives
- County IRP Scope
- WUDP Schedule

B.3.6 STATE WATERSHED PROTECTION AND MANAGEMENT PROGRAM, ACT 44 (1903) AND ACT 152 (2000)

During the expansion of the sugar and cattle industries in the late 1800s in Hawaiʻi, it was recognized that in order to ensure a steady supply of abundant water, legislation was needed to promote stronger conservation measures for Hawaii's forests. On April 25, 1903, Act 44, An Act to Provide for the Encouragement and Protection of Agriculture, Horticulture and Forestry, was passed by the Territorial Legislature, thereby creating Hawaii's forest reserve system and the basis for public-private partnerships to protect these resources.

Since the enactment of Act 44, "public and private investment in watershed protection and management has increasingly diminished and, once again, our forested watersheds are steadily degrading."[14] Act 152, Relating to Watershed Protection, passed in 2000, recognized that "Hawaii's forests function as critical watersheds and are the primary source of fresh water for the islands…have evolved into efficient ecosystems that capture and store appreciably more water than any other natural milieu…[and] are vital recharge areas for Hawaii's underground aquifers and a dependable source of clean water for its streams."[15] It therefore called for the development of a Watershed Protection Master Plan to provide for the protection, preservation, and enhancement of important watershed areas.

The Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152 was prepared by the watershed protection board created by Act 152. This annual report contains some policies that are specific to particular areas. Therefore, each Watershed Management Plan should refer back to this report to identify any policy or reference that specifically applies to the appropriate Development Plan or Sustainable Communities Plan area. Key points of the 2001 Annual Report that pertain specifically to Wai'anae and Ko'olau Loa include:

- A recommendation that forested watersheds that are important for recharge should be a priority as they affect the water sources for agricultural, industrial, and domestic use.[16]
- The Ko'olau forests are a primary water resource for the island of O'ahu with an estimated sustained yield of over 133 billion gallons of water each year and are a habitat for several thousand native species and natural communities.[17]
- The Ko'olau Mountains Watershed Partnership, consisting of major landowners within the watershed and associated non-landowner interests, is a valuable asset in the holistic, sustainable management of the watershed.[18]
- Wai'anae was recognized as a potential watershed partnership area valued for its agricultural and domestic water sources, as well as native species ecosystems, hunting, hiking, offshore waters, and cultural resources.[19]

B.4 WATER RIGHTS IN HAWAI'I

Water rights and uses in Hawai'i are governed by the State Water Code[20] and the common law. The Water Code preserved appurtenant rights but not correlative and riparian rights in designated water management areas. Thus, when a ground water management area is designated, existing correlative uses within that area can be issued water use permits under the existing use provisions of the Water Code, but unexercised correlative rights are extinguished. Similarly, when a surface water management area is designated, existing riparian uses within that area are eligible for water use permits as existing uses, but unexercised riparian rights are extinguished. Furthermore, the Hawaii Supreme Court has ruled that when there is an undisputed direct interrelationship between the surface and ground waters, designation of a ground water management area subjects both ground and surface water diversions from the designated area to the statutory permit requirement.[21] Presumably, permits would also be required for ground and surface water diversions when the interrelationship occurs in a surface water management area.

While water use permits are required only in designated water management areas and the common law on water rights and uses continue to apply in non-designated areas, other provisions of the Water Code apply throughout the state. Thus, for example, well construction and pump installation permits are required for any new or modified ground water use, and stream diversion and stream alteration permits are required for any new or modified surface water diversions. If the proposed stream diversion will affect the existing instream flow standard, a successful petition to amend the interim instream flow standard is also required.

B.4.1 CORRELATIVE RIGHTS

Under the common law, owners of land overlying a ground water source have the right to use that water on the overlying land as long as the use is reasonable and does not injure the rights of other overlying landholders.[22] When the amount of water is insufficient for all, each is limited to a reasonable share of the ground water. Overlying landowners who have not exercised their correlative rights cannot prevent other landowners from using the water on the theory that they are using more than their reasonable share. They must suffer actual, not potential, harm. Only when landowners try to exercise their correlative rights and the remaining water is insufficient to meet their needs, can they take action to require existing users to reduce their uses.

B.4.2 RIPARIAN RIGHTS

Riparian rights are rights of land adjoining natural watercourses and are the surface water equivalent of correlative rights to ground waters; i.e., the use has to be on the riparian lands, the use has to be reasonable, and the exercise of those rights cannot actually harm the reasonable use of those waters by other riparian landowners. The Court had originally stated that the right was to the natural flow of the stream without substantial diminution and in the shape and size given it by nature,[23] but later concluded that the right should evolve in accordance with changing needs and circumstances. Thus, in order to maintain an action against a diversion which diminishes the quantity or flow of a natural watercourse, riparian owners must demonstrate actual harm to their own reasonable use of those waters.[24]

B.4.3 APPURTENANT RIGHTS

Appurtenant water rights are rights to the use of surface water utilized by (non-riparian) parcels of land at the time of their original conversion into fee simple lands; i.e., when land allotted by the 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.[25] 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.[26] Once established, future uses are not limited to the cultivation of traditional products approximating those utilized at the time of the Mahele,[27] as long as those uses are reasonable, and if in a water management area, meets the Water Code's test of reasonable and 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"). As mentioned earlier, appurtenant rights are preserved under the 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.

B.4.4 EXTINGUISHING RIPARIAN OR APPURTENANT RIGHTS

Unlike appurtenant rights, which are based in the common law, the Court has interpreted riparian rights as originating in an 1850 statute.[28] This has led to a curious inconsistency in that, while unexercised appurtenant rights are preserved and unexercised riparian rights are extinguished in designated water management areas, actions by private individuals can extinguish appurtenant but not riparian rights. Both appurtenant and riparian rights cannot be severed from the lands they are attached to, and such rights pass with the title to the land whether or not the rights are expressly mentioned in the deed. If the transferor of the land attempts to reserve the riparian right in the deed, the reservation is not valid and the right nevertheless belongs to the transferee as the new owner of the land. The law with regards to appurtenant rights is not clear. The Court in Reppun held that where a landowner attempted to reserve an appurtenant right while selling the underlying land, the reservation is not valid and the attempt to reserve extinguishes the appurtenant right. In doing so, the Court reasoned that there is nothing to prevent a transferor from effectively providing that the benefit of the appurtenant right not be passed to the transferee.[29] This difference is due to the Court's interpretation that riparian rights had been created by the 1850 statute, so any attempt by the grantor to reserve riparian water rights in the deed when riparian lands are sold is invalid. Presumably, the inconsistency could be cured by legislation providing a statutory basis for appurtenant rights. In fact, the Court in the Waiāhole Ditch Contested Case cited to the Water Code's recognition of appurtenant rights and legislative comment to the effect that "Appurtenant rights may not be lost."[30] However, the Court did not explicitly discuss its prior Reppun decision, so it is unclear whether its Waiāhole decision overruled Reppun.

B.4.5 APPROPRIATED USES

Appropriated uses are uses of surface or ground waters on non-riparian or non-overlying lands. In the case of ground water, "(p)arties transporting water to distant lands are deemed mere 'appropriators,' subordinate in right to overlying landowners …(T)he correlative rights rule grants overlying landowners a right only to such water as necessary for reasonable use. Until overlying landowners develop an actual need to use ground water, non-overlying parties may use any available 'surplus' (citations omitted)."[31] For surface waters, "the effect of permitting riparian owners to enjoin diversions beneficial to others in the absence of a demonstration of actual harm may occasionally lead to wasteful or even absurd results…The continuing use of the waters of the stream by the wrongful diversion should be contingent upon a demonstration that such use will not harm the established rights of others."[32] Thus, appropriated uses are not based on water rights but are allowed as long as they are reasonable and do not actually impinge on correlative and riparian rights. Note that appurtenant uses would be a type of appropriated uses if they were not based on appurtenant rights, and that in fact, the history of appurtenant uses in the Kingdom of Hawai'i has led to their establishment as water rights superior to riparian rights. Also note that when a water management area is designated, appropriated uses become superior to unexercised water rights, because appropriated uses become existing uses and are eligible for water use permits, while unexercised correlative and riparian rights are extinguished.

B.4.6 OBSOLETE RIGHTS: PRESCRIPTIVE AND KONOHIKI RIGHTS

Until 1973, surface waters were treated as private property and could be owned. Prescriptive water rights were the water equivalent of "adverse possession" in land ownership, where open and hostile occupation of another's private property for a specified number of years entitled the occupier to take legal ownership, because it raised the legal presumption of a grant. Prescriptive rights to water were exercisable only against the ownership of other private parties and not against the government. Thus, under prescriptive rights, appropriated uses could ripen into a prescriptive right superior to riparian rights. (Some early Court cases viewed appurtenant rights as a type of prescriptive right.) In 1973, the Court voided private ownership of water resources and prescriptive rights because of public ownership of all surface waters.[33] As for ground water, two early cases (1884[34] and 1896[35]) reflected the then prevailing law on surface waters that water could be private property, but those cases also concluded that prescriptive rights cannot be exercised against subterranean waters that have no known or defined course; i.e., you could not adversely possess what you could not see. In 1929, the Court adopted the correlative rights rule,[36] in which the overlying landowners could not use the water as they pleased, because it was a shared resource.

Until 1973, "*konohiki* lands," or lands whose title had passed from persons documented as *konohiki*, owned the "normal daily surplus water" in excess of waters reserved by appurtenant and prescriptive rights. (Despite a number of earlier cases, in 1930 the Court had concluded that riparian rights had never been the law in Hawai'i.[37] The 1973 Court, instead of overturning that decision, found a statutory basis for riparian rights in the 1850 statute.) In 1973, in addition to voiding any private property interest in water, the Court ruled that there can be no "normal daily surplus water," because the recognition of riparian rights entitled owners of riparian lands to have the flow of the watercourse in the shape and state given it by nature.[38]

B.4.7 NATIVE HAWAIIAN WATER RIGHTS

The Water Code contains the following provisions on Native Hawaiian water rights (section 174C-101):

- Provisions of this chapter shall not be construed to amend or modify rights or entitlements to water as provided for by the Hawaiian Homes Commission Act, 1920, as amended, and by chapters 167 and 168, relating to the Molokai irrigation system. Decisions of the commission on water resource management relating to the planning for regulation, management, and conservation of water resources in the State shall, to the extent applicable and consistent with other legal requirements and authority, incorporate and protect adequate reserves of water for current and foreseeable development and use of Hawaiian home lands as set forth in section 221 of the Hawaiian Homes Commission Act.
- No provision of this chapter shall diminish or extinguish trust revenues derived from existing water licenses unless compensation is made.
- Traditional and customary rights of ahupuaʻa 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 hīhīwai, ʻōpae, ʻoʻopu, limu, thatch, ti leaf, aho cord, and medicinal plants for subsistence, cultural, and religious purposes.
- 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.

B.5 THE PUBLIC TRUST DOCTRINE AND THE PRECAUTIONARY PRINCIPLE

The Waiāhole Ditch Contested Case drew upon principles from the Public Trust Doctrine and Precautionary Principle in one of the landmark decisions in Hawaiʻi water law.

B.5.1 THE PUBLIC TRUST DOCTRINE

In its review of the Waiāhole Ditch Contested Case, the Hawaiʻi Supreme Court held that: 1) title to the water resources is held in trust by the state for the benefit of its people; 2) article XI, sections 1 and 7 of the Hawaiʻi Constitution adopted the public trust doctrine as a fundamental principle of constitutional law in Hawaiʻi; 3) the legislature incorporated public trust principles into the Water Code; and 4) nevertheless the Water Code did not supplant the protections of the public trust doctrine, which the Court would continue to use to inform the Court's interpretation of the Water Code, define its outer limits, and justify its existence.[39]

The Court has identified four trust purposes, three in the Waiāhole Ditch Contested Case, and a fourth in its 2004 decision, *In the Matter of the Contested Case Hearing on Water Use, Well Construction, and Pump Installation Permit Applications, Filed by Wai'ola o Moloka'i, Inc. and Moloka'i Ranch, Limited:*

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights;[1] and
- Reservations of water for Hawaiian home lands.

The Court also identified the following principles for the water resources trust:[2]

- The state has both the authority and duty to preserve the rights of present and future generations in the waters of the state;
- This authority empowers the state to revisit prior diversions and allocations, even those made with due consideration of their effect on the public trust;
- The state also bears the affirmative duty to take the public trust into account in the planning and allocation of water resources and to protect public trust uses whenever feasible;
- Competing public and private water uses must be weighed on a case-by-case basis, and any balancing between public and private purposes begin with a presumption in favor of public use, access, and enjoyment;

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[1] Although the Court has not ruled specifically on the issue, the exercise of an appurtenant right presumably would have to be done in a traditional and customary manner if it is to be considered a public trust purpose. Otherwise, commercial uses of appurtenant rights would be a protected public trust use. Note, however, that unexercised appurtenant rights cannot be extinguished, and this also applies to commercial uses of appurtenant rights as long as that use is reasonable and beneficial.

[2] While these principles are directed at surface water resources, they apply equally to ground water resources.

- There is a higher level of scrutiny for private commercial uses, with the burden ultimately lying with those seeking or approving such uses to justify them in light of the purposes protected by the trust; and
- Reason and necessity dictate that the public trust may have to accommodate uses inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values; offstream use is not precluded but requires that all uses, offstream or instream, public or private, promote the best economic and social interests of the people of the state.

B.5.2 THE PRECAUTIONARY PRINCIPLE

When scientific evidence is preliminary and not conclusive regarding the management of the water resources trust, it is prudent to adopt "precautionary principles." The Court's interpretation as explained in the Waiāhole Ditch Contested Case is as follows:

- As with any general principle, its meaning must vary according to the situation and can only develop over time. At a minimum, the absence of firm scientific proof should not tie the commission's hands in adopting reasonable measures designed to further the public interest.
- The precautionary principle simply restates the commission's duties under the Constitution and the Code. The lack of full scientific certainty does not extinguish the presumption in favor of public trust purposes or vitiates the commission's affirmative duty to protect such purposes wherever feasible. Nor does its present inability to fulfill the instream use protection framework render the statute's directives any less mandatory. In requiring the commission to establish instream flow standards at an early planning stage, the Water Code contemplates the designation of the standards based not only on scientifically proven facts, but also on future predictions, generalized assumptions, and policy judgments. Neither the Constitution nor the Water Code constrains the commission to wait for full scientific certainty in fulfilling its duty toward the public interest in minimum instream flows.

The Court's linking of the Public Trust Doctrine to the Precautionary Principle offers significant guidance to the Watershed Management Plans. The tenets of the Precautionary Principle state that:

- There is a duty to take anticipatory action to prevent harm to public resources;
- There is an obligation to examine the full range of alternatives before starting a new activity and in using new technologies, processes, and chemicals; and
- Decisions should be open, informed and democratic and include affected parties.

In this regard, “precautionary actions” may include:

- Anticipatory and preventive actions;
- Actions that increase rather than decrease options;
- Actions that can be monitored and reversed;
- Actions that increase resilience, health, and the integrity of the whole system; and
- Actions that enhance diversity.

The Public Trust Doctrine establishes a general duty to take precautionary actions and thus shifts the burden of proof to non-trust purposes and requires preventive action in the face of uncertainty.

B.6 CITY AND COUNTY OF HONOLULU PLANS AND CONTROLS

City and County of Honolulu water policies generally relate to water in regard to development goals, sustainability, and as a system that cannot be separated between its natural and human uses.

B.6.1 GENERAL PLAN (GP)

The General Plan is required by City Charter as a statement of (1) the long-range social, economic, environmental, and design objectives for the general welfare and prosperity of the people of Oʻahu and (2) the broad policies which facilitate the attainment of the objectives of the plan.[40] The 1992 GP, as amended, discusses eleven public policy areas that provide the framework from which the City and County of Honolulu derives public policies that address all aspects of health, safety, and welfare within its jurisdiction including: population, economic activity, the natural environment, housing, transportation and utilities, energy, physical development and urban design, public safety, health and education, culture and recreation, and government operations and fiscal management. The GP contains policies that are specific to particular areas. Therefore, each Watershed Management Plan should refer back to the original document to identify any policy or reference that specifically applies to the appropriate Development Plan or Sustainable Communities Plan area. The County WUDP, and specifically, the Koʻolau Loa and Waiʻanae Watershed Management Plans, need to consider:

<u>Population</u>

Control population growth to the extent possible to avoid social, economic, and environmental disruptions, plan for future population growth, and establish a pattern of population distribution that will allow the people of Oʻahu to live and work in harmony. The specific policy toward these objectives is to direct growth according to population policies set forth in the GP by providing land development capacity and needed infrastructure to distribute 1.4 percent of the island wide population to the Koʻolau Loa region and 4.0 percent to Waiʻanae by 2025.[41]

Economic Activity

Provide, encourage, and promote economic opportunities and maintain the viability of agriculture. Maintain agricultural land along the Windward, North Shore, and Waiʻanae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.[42]

Natural Environment

Provide, preserve, and enhance our natural environment by restoration, mitigation, and increasing public awareness and appreciation of our island resources. Policies to achieve these objectives include:

- Seek the restoration of environmentally damaged areas and natural resources.
- Retain the Island's streams as scenic, aquatic, and recreation resources.
- Design surface drainage and flood-control systems in a manner which will help preserve their natural settings.
- Protect the natural environment from damaging levels of air, water, and noise pollution.
- Protect plants, birds, and other animals that are unique to the State of Hawaiʻi and the Island of Oʻahu.
- Increase public awareness and appreciation of Oahu's land, air, and water resources.
- Protect the island's well-known resources: its mountains and craters; forests and watersheds areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.
- Provide opportunities for recreational and educational use and physical contact with Oahu's natural environment.[43]

Housing

Provide a choice of living environments which are adequately served by public utilities. Encourage residential development in areas where existing roads, utilities, and other community facilities are not being used to capacity and discourage development where the aforementioned cannot be provided at a reasonable cost.[44]

Transportation and Utilities

Develop and maintain an adequate water supply for the needs of residents, visitors, agriculture, and industry. Encourage the development of new technology that will reduce the cost of providing water and support the recycling of wastewater. Encourage a lowering of per-capita consumption of water. Maintain existing utility systems to avoid major breakdowns, provide improvements to reduce substandard conditions, plan for the timely and orderly expansion of utility systems, and increase efficiency by encouraging a mixture of uses with peak demand periods at different times of the day.[45]

Physical Development and Urban Design

Coordinate the construction of public facilities with location and timing of development. Policies that support this objective include:

- Plan for the construction of new public facilities and utilities in the various parts of the Island according to the following order of priority: first, in the primary urban center; second, in the secondary urban center at Kapolei; and third, in the urban-fringe and rural areas.
- Coordinate the location and timing of new development with the availability of adequate water supply, sewage treatment, and drainage.46

Health and Education

Coordinate county health codes and other regulations with State and Federal health codes to facilitate the enforcement of water pollution controls.[47]

Government Operations and Fiscal Management

Ensure that government attitudes, actions, and services are sensitive to community needs and concerns.[48]

B.6.2 WAIʻANAE SUSTAINABLE COMMUNITIES PLAN

The County Development Plans (DP) and Sustainable Communities Plans (SCP) were developed to guide public policy, investment, and decision-making for a planning horizon of 20 years. Each DP or SCP contains guidance that is specific to the district it addresses. Therefore, each Watershed Management Plan should refer back to the appropriate DP or SCP to identify any policy or reference that specifically applies to the area being studied. The Waiʻanae SCP recognizes this district as relatively stable, with a vision to sustain its unique character, current population, growing families, rural lifestyle, and economic livelihood. The following are land use policies and guidelines from the Waiʻanae SCP that have implications for the Waiʻanae Watershed Management Plan:

- Potable Water Systems
  - Determine safe yields of aquifers as related to stream flow
  - Wise use of potable water resources, including education and conservation to reduce demand and use of brackish and reclaimed water sources for irrigation and agriculture
  - Affordable water service for small farmers
- Wastewater Collection and Treatment Systems
- Investigate water reuse for irrigation
- Drainage Systems
  - Develop local drainage improvements plan and program
  - Sediment control program
- Solid Waste Handling and Disposal
  - Enforce anti-dumping laws
- Open Space
  - Protect open space character and dramatic visual beauty of Waianae's shorelands, valleys, and mountains
- Coastal Lands
  - No new coastal development, except those associated with the Waiʻanae Country Town
  - Shore armoring is not appropriate
- Mountain Forest Lands
  - Preserve and protect mountain forest lands in their natural state
  - Coordinate plans and programs toward the restoration of endemic and indigenous forest plants and animals
  - Do not grant land use permits to any uses of the District's forest lands that may degrade the natural ecology and scenic beauty
  - Protect rare and endangered species and habitat

    - Prevent the introduction of alien species, including aquatic species
- Streams and Floodplains
    - Establish stream conservation corridors where feasible
    - Establish conservation corridors for all significant perennial and intermittent streams, including Nānākuli, Ulehawa, Mā‘ili‘ili, Kaupuni, Kawiwi, Mākaha, and Mākua
    - Restrict uses within the stream conservation corridors to those compatible with natural resource use and programs
    - Establish minimum instream flow standards
- Historic and Cultural Resources
    - Protect and provide access to important cultural and historic sites on City-owned land, primarily in Mākaha Valley
    - Preserve and protect important sites and provide community access to sites on Federal, State, and private lands
- Agricultural Lands
    - Utilize zoning and tax assessments to support preservation of agricultural lands and uses
    - Develop water sources and provide affordable water rates and infrastructure
- Residential Lands
    - No increase in residential acreage

B.6.3 REVISED ORDINANCES OF HONOLULU, CHAPTER 30, AS AMENDED BY ORDINANCE NO. 90-62: WATER MANAGEMENT

Issued in 1990, the Revised Ordinances of Honolulu, Chapter 30, as amended by Ordinance No. 90-62 sets forth the policies for the Water Use and Development Plan to be prepared by the City and County of Honolulu. The intent of the Ordinance is to ensure (1) optimum utilization of the existing water supply in order to minimize the need for the development of additional potable ground water resources, (2) preservation of the aquifers for the benefit of future generations, in perpetuity, by proper management of Oahu's ground water sources, (3) timely development of additional potable ground water sources and alternative sources to provide for additional consumer demand, and (4) that growth in consumer demand will be compatible with available water supply.[49] The following policies recognize the vital role water plays in supporting land use activities and apply to all County agencies in their powers, duties, and functions and include the following:

- Facilities for the provision of water shall be based on the General Plan population projections and the land use policies contained in the DPs/SCPs and depicted on the DP and SCP Land Use Maps.

- System flexibility shall be maintained to facilitate the provision of an adequate supply of water consistent with planned land uses. The municipal water system shall be developed and operated substantially as an integrated island-wide water system.
- Close coordination shall be maintained between Federal, State, and County agencies involved in the provision or management of water to ensure optimal distribution of the available water supply.
- The quality and integrity of the water supply shall be maintained by providing for the monitoring and protection of the water supply in accordance with the requirements of the State Water Code.
- The development and use of non-potable water sources shall be maximized in a manner consistent with the protection of the ground water quality.
- Water conservation shall be strongly encouraged.
- Alternative water sources shall be developed wherever feasible to ensure an adequate supply of water for planned uses on O'ahu.[50]

B.6.4 O'AHU WATER MANAGEMENT PLAN (OWMP) FRAMEWORK

The Honolulu Board of Water Supply (BWS) prepared and submitted to the Commission the OWMP Framework and Scope of Work for Wai'anae and Ko'olau Loa Watershed Management Plans in compliance with the Statewide Framework for Updating the Hawai'i Water Plan. This project description is intended to be the basis for implementing the integrated resource planning process recommended by the State.

The initial O'ahu Water Management Plan was adopted in 1990; however, updates completed in 1992 were never adopted. Additionally, the City and County of Honolulu completed a revision of the Technical Reference Document of the Oahu Water Management Plan, Honolulu County's Water Use and Development Plan, in 1998, but it was never adopted because of the rapidly changing water situation. In 1999, BWS initiated an Integrated Resource Planning (IRP) process to update the OWMP. Differences of opinion for reliable sustainable yields and non-consensus of stakeholders in proceeding with a public planning process for an island-wide approach prompted the BWS to redirect the process as follows:

- It is important to have equal focus on resource protection, conservation, and restoration as well as water use and development.
- There needs to be assurance that our natural resources are protected and our water supplies are sustainable, before planning water use and development.
- General understanding of water related information allows active community participation. Equally important is the preparation of a clear and easily understood plan document.

- The island-wide integrated approach highlighted community concerns regarding growth limits and regional water transport. On Oʻahu, because approximately 75 percent of Oahu's water systems are interconnected, communities needed assurance that there are sufficient water resources within their watersheds before island-wide water needs are discussed.

Based on these lessons, the BWS established a goal to develop Watershed Management Plans that would be community-based, environmentally holistic, action-oriented, in alignment with State and County water and land use policies, and based on ahupuaʻa management principles. The major project milestones for each plan are:

- Project Organization
- Preliminary Watershed Analysis
- Preliminary Stakeholders Consultations
- Preliminary Watershed Management Strategies
- Five-Year Watershed Action Plan
- Water Use and Development Plan
- Draft Report
- Final Report
- Watershed Management Plan Approval[51]

B.6.5 HONOLULU BOARD OF WATER SUPPLY (BWS) MISSION

The BWS' new mission, established in 2001, is "Water for Life," which expanded the BWS' focus from water systems and services to meeting the needs of the community, economy, and environment. In fulfilling its mission, BWS seeks the sustainability of all water resources and the enhancement of the quality of life by providing world-class water services by:

- Protecting the environment, including ground water, watersheds, streams, and shoreline areas.
- Supporting Oahu's economy while working to achieve sustainable water supplies for future generations.

This is to be achieved through specific water resource activities that include:

- Internal and external conservation
- Watershed partnerships and management plans
- Recycled water
- District cooling with centralized seawater air conditioning
- Replacement of infrastructure

- Military water systems' operations and maintenance

B.7 PUBLIC/PRIVATE PARTNERSHIPS

The value of public/private partnerships has been increasingly recognized as an important tool in natural resource protection, restoration, and conservation. Various partnerships have been formed in each of the County's Development Plan/Sustainable Communities Plan areas. The following is a discussion of the goals of existing and potential partnerships in Koʻolau Loa and Waiʻanae.

B.7.1 WAIʻANAE KAI COMMUNITY FOREST PARTNERSHIP (WKCFP)

The WKCFP was created by members of City and State government, as well as local community groups, to manage the Waiʻanae-Kai Forest Reserve and the Mākaha Valley Forest Lands. Project goals are to "preserve the unique and cultural inheritance for future generations…protect endangered tropical forest habitat and promote environmental policies and practices that address biological sustainability and human well-being…[and] develop natural resource stewardship models that respect the rights of native Hawaiians and local communities but re-establishes the responsibilities attached to those rights in a culturally appropriate fashion."[52] Signatories to the MOU include:

- State of Hawaiʻi, Department of Land and Natural Resources, Division of Forestry and Wildlife
- Kaʻala Farm, Inc.
- ʻIlioʻulaokalani Coalition
- Honolulu Board of Water Supply
- Mohala i ka Wai

B.7.2 WAIʻANAE MOUNTAINS WATERSHED PARTNERSHIP

The Nature Conservancy of Hawaiʻi is currently researching the feasibility of creating a watershed partnership to manage the entire breadth of the Waiʻanae Mountains. Components of the feasibility study will include potential partners, size and scope of the partnership area, and possible management frameworks. The Waiʻanae Mountains were identified as a potential watershed partnership area by Act 152: Relating to Watershed Protection.

The Watershed Management Plans will use the framework set forth in these documents and policies to develop a plan that is consistent with Federal, State, and County plans and policies, cognizant of community values and visions, and useful to agencies, organizations, and individuals seeking to protect, conserve, and enhance water resources on Oʻahu.

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Well Owner	Well Name	Well No.	WUP	Use Description
Aina Nui Corporation	EP 10	2006-01 to 11	0.957	Diversified agriculture
Del Monte Fresh Produce	Kunia	2703-01, 02	1.075	Agriculture, irrigation for 2,595 acres pineapple; contaminant removal
Grace Pacific Corp.	Lower Makakilo	2104-01	0.044	Industrial washing and dust control
Grace Pacific, Inc.	Lower Makakilo	2104-01	0.124	Industrial washing and dust control
Honolulu BWS	Makakilo	2004-04	1.500	Municipal Use
Honolulu BWS	Barbers Point Nonpotable	2006-14, 15	1.000	Nonpotable irrigation for Ko Olina Resort
Honolulu BWS	Honouliuli I	2303-01, 02	2.240	Municipal Use
Honolulu BWS	Honouliuli II	2303-03 to 06	4.480	Municipal Use
Honolulu BWS	Ewa Desalt Plant	1905-04	0.500	Brackish basal water for Kapolei desalting plant
Ko Olina Co.	W. Beach Estates	2006-13	0.700	Golf course irrigation
State DLNR DOWALD	Ewa Desalt Plant	1905-04	0.500	Brackish basal water for Kapolei desalting plant
U.S. Navy	Barbers Point Shaft	2103-03	2.337	Military use
		Ewa-Kunia Total	**16**	
		Assigned	**15.457**	
		Available	**0.543**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kahana	3353-01, 02	0.600	Municipal Use
Kahana Valley State Park	Kahana Artesian	3352-01	0.008	Kahana Valley Park system serving 16 residences
Kualoa Ranch, Inc.	Yamamoto	3351-04	0.005	Irrigate one acre of papaya
Kualoa Ranch, Inc.	Tomasu	3251-01	0.288	Irrigation for 46 acres of pasture & 4 acres of aquaculture
Kualoa Ranch, Inc.	Saito	3251-03	0.200	Irrigation of 50 acres of pasture
		Kahana Total	**15**	
		Assigned	**1.101**	
		Available	**13.899**	

Well Owner	Well Name	Well No.	WUP	Use Description
Bishop Estate	Kamehameha A & B	2051-01, 02	0.229	Domestic use for Kamehameha Schools
Honolulu BWS	Kapalama	2052-13, 14	1.500	Municipal Use
Honolulu BWS	Kalihi Station	1952-06 to 08, 16 to 19, 22	6.948	Municipal Use
Oahu Country Club	OCC Irrigation	2050-01	0.060	Irrigation for 187-acre golf course
Palama Setlmt	Palama Setlmt	1952-15	0.024	
		Kalihi Total	**9**	
		Total	**8.761**	
		Available	**0.239**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kapolei Irr 1 & Irr 2	1905-08, 10	0.302	Irrigation of City of Kapolei common areas & Kapolei park
Kapolei People's, Inc.	Kapolei Golf Course A	2003-01, 02, 05	1.000	Kapolei Golf Course irrigation supply
State HCDCH	Kapolei Irr C-1, D	2003-07, 04	0.494	Kapolei Village Dust control; irrigation
State HCDCH	East Kapolei	2003-08	0.237	Landscape irrigation
		Kapolei Total		
		Total	**2.033**	*Managed by chloride limit of 1,000 mg/l*

Well Owner	Well Name	Well No.	WUP	Use Description
Attractions Hawaii	Waimea Falls 1	3803-01	0.100	800 acres of botanical gardens, nursery, landscape
Attractions Hawaii	Waimea Falls 2	3803-03	0.200	Waimea botanical gardens, nursery, landscape
Henry, Frank A.	Henry F.	4002-06	0.005	Use for 4 acres of pasture land
Honolulu BWS	Waialee I	4101-07	0.339	Municipal use
Honolulu BWS	Waialee II	4101-08	0.411	Municipal Use
Nakamura, Takemitsu	Nakamura T.	4002-09	0.001	Irrigation of 2 acres of banana and citrus
Paniolo Ranch	Meadow Gold Sh	3704-01	0.430	Livestock and irrigation of pasture land
UH Dept. of Animal Science	Waialee	4101-10	0.026	Dairy & piggery wash water
Sean Ginella	Kawela Mauka	4100-06	0.102	Irrigate 7.43 acres of fruits, trees
		Kawailoa Total	**29**	
		Total	**1.614**	
		Available	**27.386**	

Well Owner	Well Name	Well No.	WUP	Use Description
Caldeira, Raymond	Caldeira	3855-11		Irrigation for 1.2 acres of various crop & livestock
Campbell Estate	Sugar Mill Pump	4057-11	0.028	Domestic & Irrigation of 40 acres of various crops
Campbell Estate	Pump 15	4157-04	1.517	6 Military Offices, Irrigate 31 acres of prawns
Casey, Billy & Kanani	Waiono-Punaluu	3453-08		Supply 1 home irrigate 1acre banana, papaya
Diversified Ag Promotions LLC	Kahuku Air Base	4158-12, 13	0.300	Aquaculture, Agriculture, Pasture, Residential
E.L.C. Foundation	Hauula	3755-03	0.019	Nursery (2 acres) and landscape
Hanohano Enterprises, Inc.	Hanohano	3553-01	0.432	Aquaculture over 70 acres & domestic for 250 units
Hawaii Reserves Inc.	Truck Farm	3755-06	0.142	Irrigate 51 acres of grass
Hawaii Reserves Inc.	Welfare Farm	3855-04	0.091	Irrigate 39 acres bananas, papayas, grass
Hawaii Reserves Inc.	Quarry Well D	3856-04	0.036	Irrigation for 51 acres bananas, papayas, grass
Hawaii Reserves Inc.	Egg Farm	3956-05	0.001	Supply chicken and egg farm needs
Hawaii Reserves Inc.	Pump 12-A	4057-10	1.200	Aquaculture for 25 acres prawns
Hawaii Reserves Inc.	Kawananakoa	4056-01	0.576	Domestic & Irrigation for 135 acres of ranchland & cattle
Hawaii Reserves Inc.	Malaekahana (KP7)	3956-01	0.062	Domestic service to 33 homes, Malaekahana Park and ranch
Hawaii Reserves Inc.	Prawn Farm	3856-07	0.171	Agricultural irrigation over 60 acres
Hawaii Reserves Inc.	Laie Maloo	3755-04	0.039	Supply for livestock
Holt, Lemon	LW Holt	3654-02	0.002	Irrigation of 1 acre of coconut trees
Honolulu BWS	Hauula	3655-01	0.250	Municipal use
Honolulu BWS	Kahuku	4057-15, 16	0.600	Municipal use
Honolulu BWS	Maakua	3655-02	0.667	Various State projects
Honolulu BWS	Punaluu I	3553-02	0.360	Municipal Use
Honolulu BWS	Punaluu II	3553-03, 04, 06 to 08; 3554-03	4.618	Municipal Use
Honolulu BWS	Punaluu III	3453-06, 07	1.327	Municipal Use
Honolulu BWS	Kaluanui	3554-04 to 06	1.093	Municipal use
Kahuku Land, LLC	Pump 2, 2A	4159-01, 02	1.075	
Kahuku Land, LLC	Turtle Bay GC	4100-01	0.600	Golf Course Irrigation
Kaio, Jacob I. Sr.	Kaio Artesian	3956-07	0.017	Irrigate 3 acres of taro, on choi, other
Kapaka Farm	Kapaka Farm 1	3554-01	0.038	30 acres diversified fruits & vegetables
Kapaka Farm	Kapaka Farm 3	3654-03	0.190	30 acres diversified fruits & vegetables
Laie Water Co., Inc.	Quarry E and F	3856-05 and 06		Private system use backup
Laie Water Co., Inc.	Campus Well	3855-06	1.375	Private system use for residential, BYUH, Commercial, Laie School
Laie Water Co., Inc.	Ceramics Well	3855-07		Private system use
Laie Water Co., Inc.	Library Well	3855-08		Private system use
Ming Dynasty Fish Co.	Amor RCA Brackish	4258-04	0.010	Aquaculture
Nihipali, George N.	Nihipali	3855-12	0.009	Supply 1 home, irrigate 3.5 acre banana
Polynesian Cultural Center	PCC Lagoon Well	3855-09	0.568	Supply lagoon's aquatic life, provide circulation
Serenity Park LLC	Pump 3 and 3A	3957-01, 03	1.244	Agriculture irrigation & domestic; truck farm (40 ac.) & taro (20 ac.)
Serenity Park LLC	Pump 12	4057-07	0.300	Irrigation of ag parcel
State DOA	Pump 1	4057-01	0.307	Domestic & Irrigation of 215 acres of various crops
U.S. Fish and Wildlife Service	Kii Wildlife Refuge 1 to 4	4157-05 to 07 and 13	1.000	Habitat maintenance
		Koolauloa Total	**36**	
		Total	**20.264**	
		Available	**15.736**	

Well Owner	Well Name	Well No.	WUP	Use Description
Astori International Ltd.	RL Montgomery	2751-08	0.036	Supply 2 homes, livestock, 12 acres fruits, vegetables
Chang, Dudley W.A.	Kahaluu	2750-09	0.002	Irrigation of 6 acres for heliconias & ginger
Hawaii State Hospital	HI State Hosp/416	2448-01	0.088	Domestic consumption; nursery irrigation 2,280 sq. ft.
Honolulu BWS	Haiku Tunnel	2450-01	1.340	Municipal Use
Honolulu BWS	Haiku	2450-02	0.457	Municipal Use
Honolulu BWS	Iolekaa	2549-01	0.153	Municipal Use
Honolulu BWS	Kahaluu	2651-03	0.927	Municipal Use
Honolulu BWS	Kahaluu Tunnel	2651-01	2.128	Municipal Use
Honolulu BWS	Kuou I	2348-02, 03	2.969	Municipal Use
Honolulu BWS	Kuoul II	2348-05	0.010	Municipal Use
Honolulu BWS	Kuoul III	2348-06	0.196	Municipal Use
Honolulu BWS	Luluku Tunnel	2349-01	0.713	Municipal Use
Honolulu BWS	Luluku	2349-02	1.050	Municipal Use
Honolulu BWS	Waihee Inclined	2652-01 to 04		Municipal Use
Honolulu BWS	Waihee Tunnel	2652-02		Municipal Use
Koolau Golf Partners LLC.	Minami 1 and 2	2347-02, 03	0.150	100 Acres golf course, landscape, fire protection
State HFDC	Waiahole A and B	2853-04, 05	0.075	Serve 110 homes, 305 acres of bananas, papayas, etc.
Valley of the Temples	Heeia	2550-01	0.018	Irrigate 65 acres grass,Temple fish ponds, domestic
		Koolaupoko Total	**30**	
		Total	**10.312**	
		Available	**19.688**	

Well Owner	Well Name	Well No.	WUP	Use Description
State DLNR DOWALD	Ewa Caprock 1	1905-05	0.500	Brackish caprock water for Kapolei desalting plant
State DLNR DOWALD	Ewa Caprock 2	1905-07		Brackish caprock water for Kapolei desalting plant
State DLNR DOWALD	Ewa Caprock 3	1905-09		Brackish caprock water for Kapolei desalting plant
VIP Sanitation, Inc.	VIP Sanitation	1805-16	0.003	Irrigation, flush & clean portable toilets & trucks
		Malakole Total		
		Total	**0.503**	*Managed by chloride limit of 1,000 mg/l*
		Available		

Well Owner	Well Name	Well No.	WUP	Use Description
Damon Estate	Damon Estate	2153-02	0.021	Irrigate taro and fish pond, misc. uses
DPW, USAG-HI	Fort Shafter	2053-13		Military use. Replacement well for well 2053-10
Hon Int CC	Honolulu Int CC	2154-01	0.346	Irrigate golf course
Honolulu BWS	Kalihi Shaft	2052-08	9.500	Municipal use
Honolulu BWS	Moanalua Station	2153-10 to 12	3.790	Municipal use
U.S. Army	Fort Shafter	2053-11	1.035	Military Use
U.S. Army	Tripler	2153-07, 08	0.609	Military Use
U.S. Navy	Halawa Red Hill	2254-01	4.659	Military Use
		Moanalua Total	**16**	
		Total	**19.960**	
		Available	**-3.960**	

Well Owner	Well Name	Well No.	WUP	Use Description
D.O.T. AIRPORTS	Dillingham AFB	3412-02	0.055	Supply airfield, Camp Erdman, and some residents
Dillingham Ranch Aina LLC	Mokuleia Hmstds	3310-01	1.250	Agriculture and domestic
Dillingham Ranch Aina LLC	Mokuleia Hmstds	3310-02	0.850	Irrigation and domestic use
Dillingham Ranch Aina LLC	Mokuleia Hmstds	3410-03	1.500	Domestic & irrigation for Mokuleia Homesteads
Hawaii Fish Co.	Hawaii Fish Co. #1	3412-04	0.576	Fish hatchery & farm
Kaala Ranch	Mokuleia	3309-02	0.127	Cattle water, pasture & nursery irrigation
Mark Hamamoto	Hamamoto - 2006	3306-16	0.013	Domestic, 6-acre agriculture and domestic
Mokuleia Assoc.	Mokuleia Assoc.	3409-16	0.000	Well sealment planned
Mokuleia Hmstd	Mokuleia Hmstds	3410-05	0.000	Stock watering
North Shore Water Company LLC	Mokuleia Hmstds	3410-01	0.500	Domestic, irrigation of polo field, pasture
Stanhope Farms	Stanhope Farms	3308-02	0.056	Agriculture, Irrigation, domestic
State DLNR DOWALD	Kawaihapai	3309-01		Exploratory well
State DLNR DOWALD	Mokuleia	3309-02		Exploratory well
U.S. Air Force	USAF Kaena Pt.	3314-03	0.018	Military use
Waialua Sugar [02]	Pump 11	3409-13	0.530	Irrigate 133 acres of sugar, 75 gpm domestic
Waialua Sugar [02]	Pump 5	3411-04, 06 to 11, 13	2.550	Irrigate 315 acres of sugar cane
		Mokuleia Total	**8**	
		Total	**8.025**	
		Available	**-0.025**	

Well Owner	Well Name	Well No.	WUP	Use Description
Bishop Estate	Manoa Bishop Est.	1948-03		Exploratory Alluvial Well
Bus. Invest Ltd.	Shamrock Holding	1851-26	0.000	No use - application for well sealing & abandonment
Honolulu BWS	Wilder	1849-13 to 16	7.000	Municipal Use
Honolulu BWS	Manoa II	1948-01	0.700	Municipal Use
Honolulu BWS	Beretania Station	1851-12, 13, 31, 33 to 35, 67, 74, 75	7.000	Municipal Use
Kawaiahao Church	Kawaiahao Church	1851-73	0.030	Domestic consumption & irrigation
Pacific Club	Pacific Club	1851-07	0.040	Domestic and irrigation for private club
Punahou School	Punahou School	1849-10	0.158	Drinking, pool, irrigation
Queens Hospital	Queens Hospital	1851-54	0.237	Municipal use, air conditioning cooling, lawn
		Nuuanu Total	**14**	
		Total	**15.165**	
		Available	**-1.165**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kaimuki Station	1748-03 to 10	4.000	Municipal Use
Honolulu BWS	Palolo	1847-01, 02	1.310	Municipal Use
Kokusai Kogyo Co., Ltd.	Kokusai, K.	1749-19	0.336	Outrigger hotel, incl. drinking water
		Palolo Total	**5**	
		Total	**5.646**	
		Available	**-0.646**	

Well Owner	Well Name	Well No.	WUP	Use Description
Arbors Association	Arbors	2001-07	0.063	Irrigation for Arbors & Golf Villa 1, Area 3
C&C Dept. of Parks & Rec.	Geiger Park	2001-03	0.030	Irrigation of 10-acre Geiger Park
C&C DWWM	Honouliuli STP 1 and 2	1902-03, 04	0.500	WWTP in plant process water, emergency backup
Coral Creek Golf, Inc.	Coral Creek No. 2	2002-17	0.498	Water feature, backup golf course irrigation
Coral Creek Golf, Inc.	Coral Creek No. 4	2001-13	0.800	Water feature
Coral Creek Golf, Inc.	Coral Creek No. 10	2001-14, 2002-15 and 19	0.892	Backup golf course irrigation
Ewa by Gentry Comm. Assoc.	Soda Creek III	2001-05	0.066	13.23 acres of park lawn & Roadway landscaping
Gentry Development Co.	Gentry Area 26	2001-11		27.44 ac. of landscaped area and roadway landscape
Gentry Development Co.	Sunrise Apt.	2001-04	0.040	Irrigation for 13 acres of lawn and road landscape
Gentry Development Co.	Fort Weaver Apt.	2001-09	0.023	Irrigation of 7.8 acres of landscape and roadways
Gentry Development Corp.	Ewa Gentry	2001-02	0.080	Irrigation for 20 acres of Gentry Entry Park
Gentry Homes, Ltd.	Geiger Park	2001-03	0.000	Permit is for long term testing, not permanent use
Gentry Homes, Ltd.	Keaunui (Area 30)	2001-12	0.249	Irrigation (golf course, common area, park, roads)
Gentry Homes, Ltd.	Gentry Area 13	1901-05	0.056	Irrigation (common area & roadway)
Haseko (Ewa), Inc.	EP 27 Battery	1901-06; 1902-01, 09 to 11	3.300	Dust control; golf course, roadway, other irrigation
Hawaii Prince Golf Club	EP 22, Well 1 to 5	1900-02, 03, 17 to 20	0.301	Modification WUPA for Add'l 0.15 mgd (lake evaporation)
Hawaii Prince Golf Club	EP 22	1900-02, 03, 17 to 20	0.900	Golf course irrigation
Palm Court Association	Palm Court 3	2002-12	0.040	Irrigation for 22 acres of Palm Court 2&3, Area 1C
Palm Villa I Association	Palm Villa 1	2001-06	0.080	Irrigation for 15 acres fo Palm Villas 1, Area 1A
Palm Villa II Association	Palm Villa 2	2001-08	0.048	Irrigate 16 acres of Palm Villa 2, Area 4
Suncrest/Shores/Lombard/Avalon	Gentry Area 24	2001-10	0.022	Irrigation of 7.37 acres landscaped area and roadway
U.S. DOC/NOAA/NWS	Pacific Tsunami	1900-23	0.023	Irrigation (30 acres turf)
U.S. Fish & Wildlife	Honouliuli Unit	2101-14	0.216	Maintenance of 37 acre habitat for endangered water birds
U.S. Navy	EP 23	2001-01	5.890	Military/Agricultural use in blast zone
YHB EWA LLC	Puuloa Dug Well A and B	1959-08, 1900-22	0.600	Ewa Beach golf course
YHB EWA LLC	Puuloa GC Irr.	1900-21	0.100	Ewa Beach golf course
		Puuloa Total		
		Total	**14.817**	*Managed by chloride limit of 1,000 mg/l*
		Available		

Well Owner	Well Name	Well No.	WUP	Use Description
Del Monte Fresh Produce	Del Monte Well 3 and 4	2803-05, 07	3.960	Irrigate for 2480 acres pineapple; 150 residential @ Kunia Village
Galbraith Estate	Del Monte #5	3103-01	2.000	Pineapple agriculture
Honolulu BWS	Wahiawa I	2901-08, 09, 11	3.270	Municipal Use
Honolulu BWS	Wahiawa II	2902-01, 02	1.000	Municipal Use
Kelena Farms LLC	WSCo Pump 25	3203-01	1.442	Agriculture
Sandwich Isles Communications	SIC-01	2801-03	0.100	154.25 net acres for various irrigation, landscape irrigation
U.S. Army	Schofield Shaft	2901-02 to 04 and 10	5.648	Military use Schofield and Wheeler bases
U.S. Navy Public Works	Wahiawa Deep	3100-02	0.208	Military use NCTAMS
Waialua Sugar	Pump 24	3102-02	2.580	Irrigate 526 acres of sugar cane
Waialua Sugar	Pump 26	3203-02	1.720	Irrigate 506 acres sugar, 1803 acres pineapple
		Wahiawa Total	**23**	
		Total	**21.928**	
		Available	**1.072**	

Well Owner	Well Name	Well No.	WUP	Use Description
Agribusiness Dev. Corp.	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-01	2.030	System losses
Bishop Estate	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-02	0.170	Agricultural use for 150 acres
Dole/Castle & Cooke	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-08	2.130	Irrigation for 1,459 acres
Edmun C. Olson Trust No. 2	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-05	0.024	Irrigation
Hawaii Agricultural Research Center	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-03	0.260	Agriculture irrigation
Mililani Golf Club	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-09	0.250	Golf course use for 165 acres
Mililani Memorial Park	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-10	0.140	Cemetery use for 67 acres
Monsanto Company	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-06	2.636	Agriculture Irrigation, seed corn
Nihonkai	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-11	0.480	Agricultural use for 190 acres
Pioneer Hi-Bred Intl, Inc.	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-04	0.470	Agriculture Irrigation, seed corn
Puu Makakilo	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-12	0.750	Golf course use
Robinson Kunia Lands LLC	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-13	2.390	Agricultural use for 1,854 acres
State DLNR	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-14	0.150	Waiawa Correctional Facility domestic and irrigation (210 ac)
Syngenta Hawaii LLC	Waiawa, Waihole Main, Uwau, Waikane 1&2, Kahana Tunnels	2657-05, 2853-01, 2953-01 to 03, 3053-01, 3154-07	0.590	Agriculture Irrigation, seed corn
		Waiahole Ditch Total	**27**	
		Total	**12.470**	
		Available	**14.530**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kuliouou	1843-01	0.300	Municipal Use
Honolulu BWS	Waialae Iki	1746-02	0.190	Municipal Use
Honolulu BWS	Wailupe	1745-01	0.300	Municipal Use
		Waialae-East Total	**2**	
		Total	**0.790**	
		Available	**1.210**	

Well Owner	Well Name	Well No.	WUP	Use Description
Bishop Estate	Waialae C C	1646-01	0.460	Irrigation fo the Waialae Golf Course
Honolulu BWS	Aina Koa	1746-01	0.480	Municipal Use
Honolulu BWS	Waialae Nui	1747-03	0.700	Municipal Use
Honolulu BWS	Waialae Nui Ridge	1746-04	0.997	Municipal Use
Honolulu BWS	Waialae West	1747-05	0.160	Municipal Use
		Waialae-West Total	**4**	
		Total	**2.797**	
		Available	**1.203**	

Well Owner	Well Name	Well No.	WUP	Use Description
A.J. Lopez sone, Inc.	Lopez No. 1	3406-16	0.072	Irrigation of 13 acres truck farm crops
BG Farm	BG Farm	3506-10	0.003	Irrigation supply for 1 acre banana, papaya
Bishop Estate	Kawailoa	3505-24		Municipal use for Honolulu BWS Waialua/Haleiwa System
Gora, Dan	Gora	3406-08	0.144	Irrigation, aquaculture, on 7 acres
Honolulu BWS	Haleiwa	3405-03, 04	1.000	Municipal Use
Honolulu BWS	Waialua	3405-01, 02	1.730	Municipal Use
Kawamata, S.	Kawamata, S.	3406-03	0.100	Irrigate banana and watercress crops
Kunihiro, S.	Kunihiro, S.	3406-06; 3407-02	0.200	Irrigate lotus crop
Michael Jewett & Megan Ward	Pump 9	3406-02	0.160	Diversified agriculture
NHAC	Lopez	3407-02	0.200	Domestic; irrigate 4.5 acres various crops; aquaculture
Poamoho Venture, L.P.	Poamoho A	3205-02	0.600	Irrigation for 150 acres of diversified agriculture
Waialua Sugar	Pump 7	3407-11, 12	2.930	Irrigate 440 acres of sugar cane, 125 gpm domestic
Waialua Sugar	Pump 3	3505-01 to 20	1.552	Irrigate 362 acres of sugarcane, 75 gpm domestic
Waialua Sugar [02]	Pump 2	3307-01 to 06, 08 to 10	4.370	Irrigate 409 acres of sugar cane, some domestic
Waialua Sugar [02]	Pump 2A	3307-07	3.586	Irrigate 429 acres of sugar cane, 600 gpm domestic
Waialua Sugar [02]	Pump 2A	3307-11 to 14	0.864	
Waialua Sugar [02]	Pump 17	3404-01	8.630	Irrigate 990 acres of sugar cane, 300 gpm domestic
Waialua Sugar [02]	Pump 1	3407-04 to 06, 14, 15	2.330	Irrigate 367 acres of sugarcane
Waialua Sugar [02]	Pump 7	3407-18, 19	0.180	
Waialua Sugar [02]	Pump 8	3506-03, 04	1.660	Irrigate 136 acres of sugar cane, domestic
		Waialua Total	**25**	
		Total	**30.311**	
		Available	**-5.311**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Aiea	2355-06, 07	1.300	Municipal Use
Honolulu BWS	Aiea Gulch	2355-03, 05	0.980	Municipal Use
Honolulu BWS	Halawa Shaft	2354-01	11.320	Municipal Use
Honolulu BWS	Halawa Wells	2255-37 to 39	1.080	Municipal Use
Honolulu BWS	HECO Waiau G-11 & G-12	2357-11, 12	0.000	Municipal Use
Honolulu BWS	Kaahumanu I	2357-23, 24	1.110	Municipal Use
Honolulu BWS	Kaamilo	2356-58, 59	1.200	Municipal Use
Honolulu BWS	Kalauao Wells	2355-09 to 14	11.750	Municipal Use
Honolulu BWS	Kaonohi I	2356-55, 56	1.350	Municipal Use
Honolulu BWS	Newtown	2456-01 to 03	1.500	Municipal Use
Honolulu BWS	Punanani	2457-05, 06, 09 to 12	11.970	Municipal Use
Honolulu BWS	Waiau	2457-13 to 15	1.890	Municipal Use
Honolulu BWS	Waimalu Wells	2356-49, 50	0.080	Municipal Use
Lau Taro Farm	Kalauao	2356-70	0.100	Supply farm and a fish pond
Minami Farm	Minami Farm	2455-02	0.158	Agriculture
Pearl Country Club	Pearl Country Club	2356-54	0.330	Golf course irrigation (189 net acres)
State of Hawaii	Waimano Trng Sch	2557-01 and 02	0.136	State water system
U.S. Navy	Aiea Halawa Shaft	2255-32	0.697	Navy usage
		Waimalu Total	**45**	
		Total	**46.951**	
		Available	**-1.951**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Waimanalo Well II	1943-01	0.452	Municipal Use
Honolulu BWS	Waimanalo III	1942-01	0.200	Municipal Use
Honolulu BWS	Waimanalo Tunnel I-IV	2044-03, 04, 2045-03,05	0.700	Municipal Use
Royal Hawaiian CC	Royal Hawaiian 6, 1, 2, 4	2045-06, 2145-01, 02, 04	0.155	Irrigation for 176.4 acres fo Luana Hills Golf Course
State Department of Agriculture	Waimanalu Well I	2043-02		State Waimanalo agricultural irrigation system
State DHHL	Reservation		0.124	Reservation via 11/17/93 rule 13-171-63 via CWRM
		Waimanalo Total	**10**	
		Total	**1.631**	
		Available	**8.369**	

Well Owner	Well Name	Well No.	WUP	Use Description
Abe, Tadahiro	Honouliuli	2202-02	0.009	Irrigation supply for 1.5 acre roses
C&C West Loch Golf Course	EP 2	2201-03, 04, 07	0.000	Backup Irrigation
D.R. Horton - Schuler Homes, LLC	EP 18 Battery	2102-02, 04 to 15; 2202-03 to 14	7.969	Diversified Ag
Gary Takiguchi	Honouliuli	2201-02	0.019	Domestic and irrigation (4.8 acres) for six (6) houses
Waiawa Ridge Development LLC	Waiawa 575-ft 2	2659-04	0.300	Future Waiawa by Gentry, Phase I
Waiawa Ridge Development LLC	Waiawa 765	2658-05, 03	0.000	Future Waiawa by Gentry
Harris Rug CL	Harris Rug	2201-14	0.003	Industrial use for laundering or cleaning rugs
Hawaii Country Club	Hawaii Country Club	2603-01	0.400	Irrigation for Hawaii Country Club
Honolulu BWS	Ewa Shaft, EP 15, 16	2202-21	7.661	Municipal Use
Honolulu BWS	Hoaeae Wells 1-6	2301-34 to 39	6.610	Municipal Use
Honolulu BWS	Kunia I	2302-01 to 04	5.000	Municipal Use
Honolulu BWS	Kunia II	2402-01 to 03, 05	2.710	Municipal Use
Honolulu BWS	Kunia III	2401-04 to 06	3.050	Municipal Use
Honolulu BWS	Manana	2458-05	0.700	Municipal Use
Honolulu BWS	Mililani I	2800-01 to 04	2.670	Municipal Use
Honolulu BWS	Mililani II	2859-01 to 02	1.590	Municipal use
Honolulu BWS	Mililani III	2600-03, 04	1.250	Municipal use
Honolulu BWS	Mililani IV	2858-01 to 04	2.022	Municipal Use
Honolulu BWS	Pearl City I	2458-03, 04	1.150	Municipal Use
Honolulu BWS	Pearl City II	2457-01 to 03	1.500	Municipal use
Honolulu BWS	Pearl City III	2557-03	0.500	Municipal use
Honolulu BWS	Pearl City Shaft	2458-01	1.000	Municipal Use
Honolulu BWS	Waipahu I	2400-01 to 04	6.000	Municipal Use
Honolulu BWS	Waipahu II	2400-05, 06, 08, 14	2.100	Municipal Use
Honolulu BWS	Waipahu III	2400-09 to 13	3.029	Municipal use
Honolulu BWS	Waipahu IV	2301-44 to 47	3.000	Municipal Use
Honolulu BWS	Waipio Hts.	2459-19, 20	0.500	Municipal Use
Honolulu BWS	Waipio Hts. I	2459-23, 24	0.500	Municipal use
Honolulu BWS	Waipio Hts. II	2500-01, 02	1.000	Municipal use
Honolulu BWS	Waipio Hts. III	2659-02, 03	1.250	Municipal use
Kenneth Simon	Pearl City	2358-35, 44	0.040	Diversified agriculture
Kenneth Simon	Pearl City	2358-36	0.004	Domestic use for eight (8) residences
Kipapa Acres Assoc.of Owners	Kipapa Acres	2600-02	0.100	Supply residences, agricultural businesses, farm
Mark H. Ortiz	Ortiz	2202-01	0.003	Domestic supply for six (6) residences
Michael Watanabe	Watanabe, A.	2300-11	0.680	Irrigate watercress, onchoy, and taro farm
Michael Watanabe	Watanabe, A.	2300-20	0.400	Irrigate watercress, onchoy, and taro farm
Nazarene Church	Pearl City	2358-49	0.003	Supply Pastor's residence, church
Pearl City Community Church	Pearl City Comm Ch.	2359-10	0.005	Domestic for 10 residential units
Robinson Estate	Robinson 1 & 2	2602-01, 03		Irrigation of 1300 acres of diversified agriculture
Robinson Kunia Land, LLC	Robinson No. 1	2602-03	0.100	Agricultural food processing
Roman Catholic Church - Hawaii	Honouliuli	2101-01	0.110	Irrigation
Royal Kunia CC	Royal Kunia CC	2401-07	0.600	Irrigate 151 acre Royal Kunia CC Golf Course
State DHHL	Reservation		1.358	Reservation via 11/17/93 rule 13-171-63 via CWRM
State DLNR DOWALD	Waiawa 1 to 6	2758-01, 2658-06, 2657-03, 04, 2757-01, 02		Various State projects for Oahu
Taba Farm, Inc.	Taba Farm	2358-21, 22, 26, 29	0.864	Agriculture
Tadao Abe	Honouliuli	2201-02	0.002	Domestic
U.S. Fish & Wildlife	PHNWR No. 1	2359-19	0.180	Habitat maintenance
U.S. Navy	Waiawa Shaft	2558-10	14.977	Navy usage
Waiawa Development, LLC	Gentry Waiawa 1	2658-07	0.524	Irrigation of 181-acre golf course
Waiawa Development, LLC	Gentry Waiawa 2	2658-08	0.458	Irrigation of 149-acre golf course
Waikele Golf, LLC	WP 1	2301-01 to 10	0.950	Waikele Golf Course irrigation
Yoshimura, D.	Waipahu	2459-21	0.006	Irrigate farm
		Waipahu-Waiawa Total	**104**	
		Total	**84.856**	
		Available	**19.144**	

D WAI‘ANAE WATER SOURCES

Wai‘anae is not a Ground Water Management Area; therefore, its water sources are not represented on the Water Use Permit Inventory in Appendix C. Water sources currently in use in Wai‘anae were identified from the CWRM database of registered and reported uses, as well as through evaluation of BWS' non-potable well database (Table D-4). Most ground water withdrawals were obtained from the most recently available records of reported use from CWRM. Most of the private wells did not report use to CWRM for the calendar year 2004 but based on BWS' own database of wells, it is possible that some wells are still in operation. In order to have a conservative estimate of water withdrawals, those wells that were determined to have probable use were assigned an estimated withdrawal volume based on their pump capacities. The State well use was estimated based on volumes indicated in the 2003 State Water Projects Plan.

There are no reported volumes associated with the three known stream diversions in Wai‘anae. Based on the relatively small operations described by the water use declarations, an estimated combined use of 0.3 mgd was assigned to the diversions. Tables D-1 through D-3 list the existing water sources identified by this plan.

TABLE D-1
WATER SOURCES IN THE WAI‘ANAE DISTRICT (CY 2004)
BWS GROUND WATER SOURCES

Aquifer System Area	Well No.	Feature Name	Type of Feature	Use (mgd)	Type of Use (CWRM Categories)
Mākaha	3-2712-030	Kamaile 2	Well	0.270	MUNICIPAL
Mākaha	3-2812-001	Mākaha Shaft	Shaft	0.080	DOMESTIC
Mākaha	3-3011-003	Mākaha II	Well	0.000	MUNICIPAL
Mākaha	3-3010-011	Mākaha III	Well	0.630	MUNICIPAL
Mākaha	3-3010-012	Mākaha IV	Well	0.000	UNUSED
Mākaha	3-2811-002	Mākaha V	Well	0.120	MUNICIPAL
Mākaha	3-2911-004	Mākaha VI	Well	0.000	MUNICIPAL
Mākaha	3-2911-003	Mākaha I	Well	0.670	MUNICIPAL
Mākaha	3-2911-002	Glover Tunnel	Tunnel	0.511	IRRIGATION
Wai‘anae		Plantation Tunnels	Tunnel	0.560	
Wai‘anae	3-2809-006	Wai‘anae Tunnel	Tunnel	1.450	MUNICIPAL
Wai‘anae	3-2909-002	Wai‘anae I	Well	0.140	MUNICIPAL
Wai‘anae	3-2909-003	Wai‘anae II	Well	0.640	MUNICIPAL
Wai‘anae	3-2810-002	Wai‘anae III	Well	0.400	MUNICIPAL
TOTAL				**5.471**	

TABLE D-2
WATER SOURCES IN THE WAIʻANAE DISTRICT (CY 2004)
NON-BWS GROUND WATER SOURCES

Aquifer System Area	Owner/Operator	Well No.	Feature Name	Type of Feature	Use (mgd)	Type of Use (CWRM)
Lualualei	Navy Public Works Center	3-2808-001	Nānākuli	Well	0.098	DOMESTIC
Lualualei	U.S. Navy	3-2808-002	Lualualei Tunnel	Well	0.094	DOMESTIC
Lualualei	PVT Holdings	3-2308-002	Lualualei PVT1	Well	0.180	UNUSED
Lualualei	Sphere LLC	3-2509-007	Māʻili Quarry	Well	0.169	OTHER
Waiʻanae	Nitta, JY	3-2710-007	Nitta	Well	0.072	IRRIGATION
Mākaha	Makaha Valley CC	3-2811-003	MVCC Irr1	Well	0.163	IRRIGATION
Mākaha	Makaha Valley CC	3-2811-004	MVCC Irr2	Well	0.149	IRRIGATION
Keaʻau	AT&T	3-3314-001	AT&T1	Well	0.115	DOMESTIC
Keaʻau	AT&T	3-3314-002	AT&T2	Well	0.115	DOMESTIC
Keaʻau	State Parks	3-3314-004	Keawaʻula Bay	Well	0.002	DOMESTIC
	TOTAL Non-BWS				**1.157**	

TABLE D-3
WATER SOURCES IN THE WAIʻANAE DISTRICT (CY 2004)
SURFACE WATER DIVERSIONS

Aquifer System Area	Owner/Operator	TMK	Surface Water Source	Use (mgd)	Type of Use
Waiʻanae	Waianae Ranch	8-5-006:011	Punanaula Stream		Non-Potable
Waiʻanae	Manuel JM	8-5-005:032	Kunish Tunnel Runoff		Non-Potable
Waiʻanae	Kaʻala Farm		Honua Stream		Non-Potable
TOTAL Diversion Use				**0.300**	

BWS also developed a non-potable well database as a way to protect its own ground water sources. This database could be useful in identifying abandoned wells that should be sealed to prevent pollution of the alluvial aquifer and near shore waters. It was used to verify the active wells in the CWRM database, and also to identify potential supply options for brackish, non-potable water.

TABLE D-4
Well Inventory

WELL NUMBER	WELL NAME	USE
2208-01	KALANIANAOLE BCH	UNUSED
2307-01	NANAKULI	OBSERVATION
2308-01	NANAKULI	UNUSED
2308-02	LUALUALEI-PVT	UNUSED
2308-03	LUALUALEI-PVT	IRRIGATION
2407-01	NANAKULI	
2407-02	NANAKULI	
2408-01	LUALUALEI	UNUSED
2408-02	LUALUALEI	IRRIGATION
2408-03	LUALUALEI	IRRIGATION
2408-04	LUALUALEI	UNUSED
2408-05	LUALUALEI	OTHER
2408-06	LUALUALEI	INDUSTRIAL
2408-07	LUALUALEI	INDUSTRIAL
2408-08	MAILE IRR 1	SEALED
2408-09	MAILE IRR 2	UNUSED
2408-10	LUALUALEI G C 2	UNUSED
2409-01	MAILI	SEALED

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2409-02	ASATO FARM	UNUSED
2409-03	MAILI	UNUSED
2409-04	MAILI	UNUSED
2409-05	LUALUALEI	IRRIGATION
2409-06	LUALUALEI	UNUSED
2409-07	ADANIYA FARM	OTHER
2409-08	MAILI	UNUSED
2409-09	MAILI	IRRIGATION
2409-10	MAILI	IRRIGATION
2409-11	MAILI	IRRIGATION
2409-12	MAILI	IRRIGATION
2409-13	MAILI	OTHER
2409-14	MAILI	IRRIGATION
2409-15	MAILI	UNUSED
2409-16	MAILI-KAM	IRRIGATION
2409-17	MAILI	UNUSED
2409-18	MAILI	UNUSED
2409-19	MAILI	OTHER
2409-20	MAILI	OTHER
2409-21	MAILI	IRRIGATION
2409-22	MAILI	UNUSED
2409-23	MAILI-TOMITA	IRRIGATION

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2409-24	MAILI	IRRIGATION
2409-25	MAILI-UNO	UNUSED
2409-26	MAILI-PREGANA	UNUSED
2410-01	MAILI	UNUSED
2410-02	MAILI POINT	
2508-01	LUALUALEI	UNUSED
2508-02	LUALUALEI	UNUSED
2508-03	LUALUALEI	IRRIGATION
2508-04	LUALUALEI	UNUSED
2508-05	LUALUALEI	IRRIGATION
2508-06	LUALUALEI	UNUSED
2508-07	LUALUALEI	UNUSED
2508-08	LUALUALEI	UNUSED
2508-09	LUALUALEI-BRITOS	UNUSED
2508-10	LUALUALEI G C 1	SEALED
2508-11	LUALUALEI	SEALED
2508-12	LUALUALEI G C 3	UNUSED
2508-14	NIULII	OTHER
2509-01	MAILI	UNUSED
2509-02	MAILI	IRRIGATION
2509-03	MAILI	IRRIGATION
2509-04	MAILI	UNUSED

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2509-05	MAILI	DOMESTIC
2509-06	MAILI	IRRIGATION
2509-07	MAILI QUARRY	UNUSED
2509-08	LUALUALEI BACKUP	OTHER
2510-01	MAILI	UNUSED
2510-02	MAILI	UNUSED
2510-03	MAILI	
2510-04	MAILI	
2510-05	MAILI	
2607-01	LUALUALEI	OTHER
2608-01	LUALUALEI	IRRIGATION
2609-01	LUALUALEI	LOST
2609-02	LUALUALEI	LOST
2609-03	LUALUALEI HMSTDS	IRRIGATION
2609-04	LUALUALEI	UNUSED
2609-05	LUALUALEI	LOST
2609-06	LUALUALEI	IRRIGATION
2609-07	LUALUALEI	IRRIGATION
2609-08	LUALUALEI	UNUSED
2609-09	LUALUALEI	UNUSED
2609-10	LUALUALEI	UNUSED
2609-11	LUALUALEI	UNUSED

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2609-12	LUALUALEI	UNUSED
2609-13	LUALUALEI	SEALED
2609-14	LUALUALEI	UNUSED
2609-15	LUALUALEI	IRRIGATION
2609-16	LUALUALEI	IRRIGATION
2609-17	HOOHULI	UNUSED
2609-18	LUALUALEI	UNUSED
2610-01	LUALUALEI	UNUSED
2610-02	LUALUALEI	UNUSED
2610-03	LUALUALEI	UNUSED
2610-04	LUALUALEI	UNUSED
2610-05	LUALUALEI	UNUSED
2610-06	LUALUALEI	UNUSED
2610-07	LUALUALEI	
2611-01	WAIANAE	
2611-02	WAIANAE	
2611-03	WAIANAE	
2611-04	WAIANAE	
2709-01	LUALUALEI	UNUSED
2709-02	LUALUALEI	UNUSED
2709-03	LUALUALEI	UNUSED
2709-04	LUALUALEI	UNUSED

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2709-05	LUALUALEI	UNUSED
2709-06	LUALUALEI	UNUSED
2709-07	LUALUALEI	OTHER
2709-08	LUALUALEI	IRRIGATION
2709-09	LUALUALEI	UNUSED
2709-10	LUALUALEI	OTHER
2709-11	LUALUALEI	UNUSED
2709-12	LUALUALEI	UNUSED
2709-13	LUALUALEI	UNUSED
2709-14	LUALUALEI	UNUSED
2709-15	LUALUALEI	UNUSED
2709-16	LUALUALEI	UNUSED
2709-17	LUALUALEI	IRRIGATION
2709-18	LUALUALEI	UNUSED
2710-01	WAIANAE	UNUSED
2710-02	WAIANAE	IRRIGATION
2710-03	WAIANAE	UNUSED
2710-04	WAIANAE KAI II	UNUSED
2710-05	TOLEDO DAIRY	DOMESTIC
2710-06	DUG WELL #3	IRRIGATION
2710-07	NITTA	IRRIGATION
2711-01	WAIANAE	UNUSED

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2711-02	WAIANAE	UNUSED
2711-03	WAIANAE	OBSERVATION
2711-04	WAIANAE	OBSERVATION
2711-05	HAWAII BAPTIST	UNUSED
2711-07	WAIANAE KAI I	UNUSED
2711-08	DUG WELL #1	OTHER
2711-09	DUG WELL #6	UNUSED
2711-10	GAMULO	IRRIGATION
2712-01	WAIANAE	
2712-02	WAIANAE	
2712-03	WAIANAE	
2712-04	WAIANAE	
2712-05	WAIANAE	
2712-06	WAIANAE	
2712-07	WAIANAE	
2712-08	WAIANAE	
2712-09	WAIANAE	
2712-10	WAIANAE	
2712-11	WAIANAE	
2712-12	WAIANAE	
2712-13	WAIANAE	
2712-14	WAIANAE	

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2712-15	WAIANAE	
2712-16	WAIANAE	
2712-17	WAIANAE	
2712-18	WAIANAE	
2712-19	WAIANAE	
2712-20	WAIANAE	
2712-21	WAIANAE	
2712-22	WAIANAE	
2712-23	WAIANAE	
2712-24	WAIANAE	
2712-25	WAIANAE	
2712-26	WAIANAE	
2712-27	WAIANAE	
2712-28	WAIANAE	
2712-29	WAIANAE	DISPOSAL
2712-30	KAMAILE #2	MUNICIPAL
2712-31	KAMAILE #1	MUNICIPAL
2712-32	WAIANAE	OTHER
2712-33	RESPICIO-WILLS	UNUSED
2712-34	HOLOKAHI	IRRIGATION
2808-01	NANAKULI	DOMESTIC
2808-02	LUALUALEI TUNNEL	DOMESTIC

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2809-01	WAIANAE VALLEY	UNUSED
2809-02	WAIANAE VALLEY	OBSERVATION
2809-03	WAIANAE VALLEY	UNUSED
2809-04	WAIANAE VALLEY	UNUSED
2809-05	WAIANAE VALLEY	OTHER
2809-06	WAIANAE TUNNEL	MUNICIPAL
2810-01	WAIANAE VALLEY	UNUSED
2810-02	WAIANAE 1	MUNICIPAL
2810-03	WAIANAE 2	MUNICIPAL
2811-01	MAKAHA VALLEY	UNUSED
2811-02	MAKAHA WELL V	MUNICIPAL
2811-03	MVCC IRR 1	IRRIGATION
2811-04	MVCC IRR 2	IRRIGATION
2812-01	MAKAHA SHAFT	DOMESTIC
2812-02	MAKAHA VALLEY	UNUSED
2812-03	MAKAHA VALLEY	LOST
2812-04	MAKAHA-AKASE	IRRIGATION
2812-07	KAHALEOUMI	IRRIGATION
2812-08	MOLINA	IRRIGATION
2812-09	GARDEN	IRRIGATION
2813-01	MAKAHA BCH PARK	
2813-02	MAKAHA BCH PARK	
2813-03	MAKAHA-CAYER	DOMESTIC

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
2908-01	WAIANAE TUNNEL 1	UNUSED
2908-02	WAIANAE TUNNEL 2	UNUSED
2908-03	WAIANAE TUNNEL 6	IRRIGATION
2908-04	WAIANAE TUN 6A	UNUSED
2908-05	WAIANAE TUNNEL 7	UNUSED
2908-06	WAIANAE TUNNEL 8	UNUSED
2908-07	WAIANAE TUNNEL 9	UNUSED
2908-08	WAIANAE TUN 11	UNUSED
2908-09	WAIANAE TUN 14	UNUSED
2908-10	WAIANAE TUN 15	MUNICIPAL
2908-11	WAIANAE TUN 19	MUNICIPAL
2909-01	WAIANAE TUN 16	UNUSED
2909-02	WAIANAE I	MUNICIPAL
2909-03	WAIANAE II	MUNICIPAL
2911-01	MAKAHA VALLEY	DOMESTIC
2911-02	MAKAHA GLOVER	IRRIGATION
2911-03	MAKAHA I	MUNICIPAL
2911-04	MAKAHA VI	MUNICIPAL
2913-01	KEAAU BCH PARK	
2913-02	MAKAHA VALLEY	
2913-03	KEAAU-CHUNG HOON	UNUSED
3009-01	MAKAHA TUNNEL 10	IRRIGATION

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
3010-01	MAKAHA VALLEY	IRRIGATION
3010-02	MAKAHA VALLEY	IRRIGATION
3010-03	MAKAHA VALLEY	IRRIGATION
3010-04	MAKAHA VALLEY	IRRIGATION
3010-05	MAKAHA VALLEY	IRRIGATION
3010-06	MAKAHA TUNNEL 4	IRRIGATION
3010-07	MAKAHA TUNNEL 6	IRRIGATION
3010-08	MAKAHA TUNNEL 7	IRRIGATION
3010-09	MAKAHA TUNNEL 8	IRRIGATION
3010-10	MAKAHA TUNNEL 9	IRRIGATION
3010-11	MAKAHA III	MUNICIPAL
3010-12	MAKAHA IV	UNUSED
3011-01	MAKAHA VALLEY	
3011-02	MAKAHA TUNNEL 3A	IRRIGATION
3011-03	MAKAHA II	UNUSED
3013-01	OHIKILOLO	
3013-02	OHIKILOLO	
3013-03	OHIKILOLO	
3013-04	OHIKILOLO	
3013-05	OHIKILOLO	
3013-06	OHIKILOLO	
3013-07	KEAAU BEACH PARK	

TABLE D-4 (Continued)
Well Inventory

WELL NUMBER	WELL NAME	USE
3013-08	OHIKILOLO	
3013-09	OHIKILOLO	IRRIGATION
3013-10	OHIKILOLO-SILVA	DOMESTIC
3013-11	SILVA A DUG	UNUSED
3113-01	MAKUA	
3213-01	MAKUA	
3213-02	MAKUA	SEALED
3213-03	MAKUA	
3213-04	MAKUA	
3213-05	MAKUA	
3213-06	MAKUA	OTHER
3213-07	MAKUA	UNUSED
3314-01	AT & T # 1	DOMESTIC
3314-02	AT & T # 2	DOMESTIC
3314-04	KEAWAULA BAY	DOMESTIC

E WATER USE AND DEMAND

This appendix is intended to complement Chapter 3 of the Wai'anae Watershed Management Plan by providing supporting tables and detailed background information on how current water use volumes were determined and how future water demands were calculated.

E.1 PROJECTING FUTURE WATER DEMAND

In order to adequately plan for Waianae's future water needs, District water demand was projected through the year 2030. These projections not only suggest how much water might be needed over the next 25 years, they also indicate when increased demands might require infrastructure improvements.

Additionally, water demand was not only forecast for municipal use, but for Federal, State, and private uses as well. The Statewide Framework for Updating the Hawaii Water Plan (Statewide Framework) requires that the County Water Use and Development Plans (WUDP) "…shall also include forecasts of water requirements of federal and private sector purveyors."

E.2 THREE FUTURE SCENARIOS

The Statewide Framework recommends including "a range of forecasts of the amount of water required over the planning horizon…Among the scenarios are the base case scenario…a high-growth scenario, and a low growth scenario." Forecasts of population, jobs, and/or land use are presented in each of the three scenarios in five-year increments from the year 2000 through 2030.

TABLE E-1
WAIʻANAE DISTRICT POPULATION

	2000	2005	2010	2015	2020	2025	2030
Policy Scenario Population	42,259	44,004	45,465	47,295	48,619	49,682	50,616
% of Honolulu's Population	4.80%	4.80%	4.80%	4.80%	4.70%	4.60%	4.50%
Trend Scenario Population	42,259	44,004	46,708	49,408	50,790	51,666	52,236
% of Honolulu's Population	4.80%	4.80%	4.90%	5.00%	4.90%	4.80%	4.70%
High-Growth Scenario Population	42,259	45,259	48,259	51,259	54,259	57,259	60,259
% of Honolulu's Population	4.80%	5.00%	5.10%	5.10%	5.20%	5.30%	5.40%

E.2.1 POLICY SCENARIO

The "Policy Scenario" reflects the City Department of Planning and Permitting's (DPP) population, housing unit, and job forecast based on each district's official land use plan. Waianae's land use plan is a Sustainable Communities Plan (SCP), which advocates controlled population growth, therefore representing the "low growth scenario." It should be noted that the County General Plan guidelines for future growth attributes 3.8 percent to 4.2 percent of Oahu's population to Waiʻanae for the year 2010. However, population projections for the DPP "Policy Scenario" have Waiʻanae accounting for 4.5 percent of Honolulu's population by the year 2030. This "Policy Scenario" could be seen as fulfilling the Statewide Framework's mandate that, "…demand forecasts shall be consistent with county land use plans, development plans and/or community plans."

E.2.2 TREND SCENARIO

The "Trend Scenario" uses DPP's population, housing unit, and job forecasts based on past trends. According to this scenario, Waiʻanae will account for 4.7 percent of Honolulu's population by the year 2030. Therefore, this trend scenario may represent the "base case," or the "scenario based on the most likely assumptions," as discussed in the Statewide Framework.

E.2.3 HIGH-GROWTH SCENARIO

The City DPP does not produce a third set of projections; therefore, the planning team developed a "High-Growth" scenario independently. This scenario sketched out a future for Waiʻanae that may not conform to the existing Sustainable Communities Plan, yet is still possible, based on past trends, current growth patterns, existing land use and zoning, and potential influences from the rest of Oʻahu. For example, population figures from the year 1970 through 2000 show Waiʻanae growing by approximately 18,000 people in that 30-year period. The high-growth scenario assumed that Waiʻanae would continue to grow at a rate of about 18,000 people in 30 years, therefore accounting for approximately 5.4 percent of Honolulu's county-wide population by the year 2030. This growth, above that projected by DPP in their "trend" scenario, is thought to be possible because the current (and probable future) need for more affordable housing is anticipated to produce pressure on Waiʻanae to allow for more development.

TABLE E-2
WAIʻANAE DISTRICT POPULATION 1970 – 2030
HIGH-GROWTH SCENARIO

	1970	1980	1990	2000	2010	2020	2030
Population	24,077	31,487	37,411	42,259	48,259	54,259	60,259
Additional People		7,410	5,924	4,848	6,000	6,000	6,000

E.3 TWO METHODOLOGIES: *PER CAPITA* AND END USE INVENTORY

Two methodologies for projecting future water demands were used: "*Per Capita*" and "End Use Inventory." The *Per Capita* approach is widely used due to its simple, straight-forward process, and is the standard methodology used by BWS in their future demand forecasting.

A second approach was employed to verify demand figures calculated using the *Per Capita* method, and to provide a range of demand figures for water providers to work within. This second approach, the End Use Inventory, is a unit-use method where future water demand is estimated by assigning water use coefficients to each type of water use. In most cases, that change in acres or jobs attributed to each type of water use is projected based on either trends or the local land use plan. Water use coefficients are then applied to the projected acreages or number of jobs. Both the *Per Capita* and End Use Inventory methodologies were applied to the three scenarios of future water demand: policy, trend, and high-growth.

For each methodology, State water needs were taken directly from the 2003 State Water Projects Plan (SWPP); however, the SWPP only provided water use projections through the year 2020. Water demands through 2030 were kept the same as 2020, as the SWPP water demand numbers for Waiʻanae had stabilized by 2010. This fulfilled the Statewide Framework's mandate that "The WUDP shall incorporate the most recent SWPP and Agricultural Water Use and Development Plan (AWUDP) forecasts of water requirements within the county." No agricultural water demands were taken from the AWUDP because, although the State Department of Agriculture operates a State Agricultural Park in Waiʻanae, it does not operate its own water system. The Waiʻanae Agricultural Park is served by BWS.

Base year (2000) water demand differs slightly between the *Per Capita* and End Use Inventory due to the types of data available. The *Per Capita* methodology used BWS metered consumption data, which is broken down into water uses using City sewer class codes. However, in order to get a more accurate estimate of agricultural water demand for the End Use Inventory, agricultural water use was estimated based on consumption by those parcels with an agricultural water meter and paying the BWS's agricultural water rate. This allowed for an estimation of per acre water use, which was used to calculate future water demands. Year 2000 agricultural water use differed by 0.377 mgd[1] between the two methods, and was considered acceptable.

Additionally, BWS metered consumption data did not indicate any volume for the water use category "temporary" in the year 2000. In order to allow for some future water use, an estimated for the year 2000 was added to the base year water use in the End Use Inventory methodology.

E.3.1 *PER CAPITA* DEMAND METHODOLOGY

The *Per Capita* approach estimated future water demand based on the projected population of the service area (Waiʻanae District). The known Waiʻanae population was obtained from the U.S. Census 2000 through DPP and water use for that same year was obtained from a BWS water consumption survey with 6.5 percent water volume added to account for system water loss.[2] A *de facto* population was calculated by adjusting the population figures for residents absent[3] and

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[1] Year 2000 agricultural water demand for the *Per Capita* Method was 2.293 mgd and 1.916 mgd for the End Use Inventory Method. The agricultural water demand was therefore 0.377 mgd more for the *Per Capita* Method than for the End Use Inventory Method.

[2] BWS uses 6.5 percent as the typical amount of water lost from its Waiʻanae systems due to such things as leaks.

[3] The number of residents absent from Honolulu County was obtained by adding the number of visitors present to the total population and subtracting the *de facto* population. The county *de facto* population was retrieved from the State DBEDT report: *Population and Economic Projections for the State of Hawaiʻi to 2030*. The number of residents absent from Waiʻanae was determined by Waiʻanae's share of the county-wide population, i.e., if Waiʻanae accounted for 4.8 percent of Honolulu County's 2000 population, then the number of residents absent from Waiʻanae was 4.8 percent of the number of residents absent from Honolulu for that same year.

visitors present.[4] The number of residents served by private or other government water systems was then subtracted to give a BWS-served population. This BWS-served population was then used to calculate the year 2000 municipal *per capita* water use coefficient of 224 gallons per day (gpd). The following Table C-5 shows how the *per capita* water demand factor was calculated.

TABLE E-3
WAI'ANAE DISTRICT *PER CAPITA* WATER DEMAND CALCULATION

2000 Resident Pop-ulation	Residents Absent	Visitors Present	De Facto Pop-ulation[1]	Population on State/ Federal/ Private Water Systems[2]	BWS-Served Pop-ulation[3]	2000 Total Potable Water Demand (mgd)[4]	**2000 Per Capita Demand (gpd)[5]**
42,259	1,718	1,190	41,731	0	41,731	9.3	**224**

1/ De Facto Population = Resident Population - Residents Absent + Visitors Present

2/ Population relying on private or military systems for potable water service

3/ BWS-Served Population = (DeFacto Population) - (Population on Non-BWS Systems)

4/ Based on Board of Water Supply Average Daily Metered Consumption, including district imports and exports; includes residential, commercial, temporary, hotel, Federal government, State government, religious institutions, industrial, agriculture, City Government (NOT INCLUDED: Glover Tunnel). A water loss factor of 6.5% was applied to the water consumption data to get the total water demand.

5/ Per Capita Demand = (2000 Total Potable Water Demand/2000 DeFacto Population)*1,000,000 gallons

The *per capita* water use coefficient was then applied to DPP's projected service area population for the policy, trend, and high-growth scenarios to estimate future municipal potable water demands. Demands were calculated for each five-year increment through the year 2030. This method assumes that *per capita* water use will remain constant over the course of the planning horizon.

BWS also supplies some non-potable water to its customers. In Wai'anae, BWS's only non-potable water source is Glover Tunnel in Mākaha Valley, which supplies irrigation water for the Mākaha West Golf Course. Because this use is not directly tied to population, future demand projections were estimated based on likely use of Glover Tunnel water. The 2000 Wai'anae

[4] The number of visitors present in Honolulu County was obtained from the DBEDT *Average Daily Visitor Census to 2030* spreadsheet. The number of visitors present in Wai'anae was determined by Wai'anae's share of county-wide visitor units, i.e., if Wai'anae accounted for 2.3 percent of Honolulu County's year 2000 visitor units, then the number of visitors present in Wai'anae was 2.3 percent of the number of visitors present in Honolulu for that same year.

Sustainable Communities Plan advocates no new golf courses. Additionally, BWS has made efforts to work with the community to restore Mākaha Stream. Therefore, no additional uses were anticipated for Glover Tunnel water. Mākaha Resort golf course management reported that planned golf course improvements are not anticipated to require additional water from Glover Tunnel. Therefore, demand was kept constant through the planning period.

In addition to municipal water demand projections, Federal, State, and private potable and non-potable water demands were also estimated. The Navy owns the only non-BWS system that is known to convey potable water in Wai'anae at this time. The Navy was unable to indicate future water needs, so water demand was kept constant for the planning period. Due to the limited amount of ground water in the area and expected high cost of developing new sources, no additional potable water development is anticipated by non-BWS entities.

There are no Federally owned non-potable water systems in Wai'anae. Two non-potable wells owned by the State are used to irrigate its Ka'ena Point State Park. Projected water needs from this small system were taken directly from the 2003 SWPP and remained constant for each scenario.

As mentioned previously, private water systems data have not been verified. Water demand from wells for the year 2000 was estimated from last-reported withdrawal information and pump capacities. An additional 0.3 mgd was added as an estimate to account for the three registered diversions, which do not have any reported water demand volumes associated with them, and any other unreported well usage. Due to limited ground and surface water supply, the high cost of developing new sources, and the precautionary stance being promoted by the community and resource managers, no new private water use was anticipated, with the exception of a possible increase in the high scenario due to the development of additional golf course acreage. While new golf courses are discouraged in the Wai'anae SCP, there are existing properties that have previously been identified for new golf courses that are already zoned to accommodate such uses.

C.3.1.1 *PER CAPITA*: POLICY SCENARIO

Future Wai'anae *de facto* population estimates were used to calculate future potable water demand for the *per capita* method. The table below illustrates how the *de facto* population was calculated for the policy scenario and displays the numbers used in the calculations. The policy scenario shows a 2030 *de facto* population of 52,299 people, an increase of 10,568 people over the year 2000.

TABLE E-4
WAI'ANAE POLICY (LOW GROWTH) POPULATION PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
RESIDENT POPULATION [1]							
Wai'anae	42,259	44,004	45,465	47,295	48,619	49,682	50,616
O'ahu	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300
Wai'anae % of O'ahu	4.82%	4.82%	4.77%	4.75%	4.69%	4.61%	4.53%
RESIDENTS ABSENT [2]							
Wai'anae	1,718	1,775	1,835	1,908	1,962	2,004	2,044
O'ahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114
VISITOR UNITS							
Wai'anae VU	509	509	982	982	982	1,013	1,449
O'ahu VU	36,321	37,261	44,586	47,162	47,162	47,400	50,700
Wai'anae % of O'ahu	1.4%	1.4%	2.2%	2.1%	2.1%	2.1%	2.9%
VISITORS PRESENT [3]							
Wai'anae	1,190	1,214	2,145	2,222	2,376	2,607	3,727
O'ahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414
% Increase		4.7%	9.6%	9.6%	6.9%	6.9%	6.9%
DE FACTO POPULATION [4]							
Wai'anae	41,731	43,443	45,775	47,609	49,033	50,285	52,299
O'ahu	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600

1/ Population numbers based on population projections from DPP calculated from past trends.

2/ Total residents absent for Honolulu County from DBEDT. Waianae's percentage of Honolulu County population equals percentage of those residents absent from Honolulu County.

3/ Total visitors present for Honolulu County from DBEDT. Waianae's percentage of Honolulu County visitor units equals percentage of those visitors present in Honolulu County.

4/ De Facto Population = Resident Population + Visitors Present.

The population served by military and private potable water systems was subtracted from the *de facto* population calculated in the previous table to get the total population served by BWS systems. The *per capita* demand calculated in Table C-5 was then applied to get projected BWS potable water demands through the year 2030, when demands are expected to be 11.7 mgd, or an increase of 2.4 mgd over the year 2000 demands.

TABLE E-5
PROJECTED BWS POTABLE WATER DEMAND
POLICY (LOW GROWTH) SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
De Facto Population	41,731	43,443	45,775	47,609	49,033	50,285	52,299
Population on State/ Private/ Military Systems[1]	0	0	0	0	0	0	0
BWS-Served Population[2]	41,731	43,443	45,775	47,609	49,033	50,285	52,299
Per Capita Demand (gpd)[3]	224	224	224	224	224	224	224
Projected Water Demand (mgd)[4]	**9.34**	**9.72**	**10.24**	**10.65**	**10.97**	**11.25**	**11.70**

1/ No potable water use from State/Private/Military systems.
2/ BWS-Served Population = (*DeFacto* Population) - (Population on Non-BWS Systems).
3/ Assumes per capita demand does not change over time.
4/ Projected demand = (Projected BWS Served Population * Per Capita Demand)/1,000,000 gallons.

BWS non-potable water demand is expected to remain constant throughout the planning period, based on current water conservation activities and the lack of expansion plans of the sole customer. BWS does not intend on securing additional non-potable water customers in Waiʻanae.

TABLE E-6
PROJECTED BWS NON-POTABLE WATER DEMAND
POLICY (LOW GROWTH) SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Mākaha West Golf Course (mgd)[1]	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Projected 2005 Demand (mgd)	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**

1/ Mākaha West Golf Course irrigated with non-potable water from Glover Tunnel, operated by BWS.

The only other potable water system in Waiʻanae is owned by the Federal government. Federal potable water demand is expected to remain constant through the year 2030.

TABLE E-7
PROJECTED NON-BWS POTABLE WATER DEMAND
POLICY (LOW GROWTH) SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (gpd)[1]	0.2	0.2	0.2	0.2	0.2	0.2	0.2
State System Demand (gpd)[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Private System Demand (gpd)[3]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Non-BWS System Potable Water Demand (mgd)	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

1/ Water demand based on Navy reported use to CWRM for CY2004.
2/ No State demand noted.
3/ No private demand noted.

Non-BWS non-potable water demand is expected to remain relatively constant through 2030. There is no reported Federal use and due to the high cost of new source development and limited supplies, private development is not anticipated. According to the2003 State Water Projects Plan, State non-potable demand will increase by approximately 0.01 mgd over the planning period.

TABLE E-8
PROJECTED NON-BWS NON-POTABLE WATER DEMAND
POLICY (LOW GROWTH) SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (mgd)[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State System Demand (mgd)[2]	0.002	0.01	0.02	0.02	0.02	0.02	0.02
Private System Demand (mgd)[3]	1.26	1.26	1.26	1.26	1.26	1.26	1.26
Total Non-BWS System Non-Potable Water Demand (mgd)[4]	**1.27**	**1.28**	**1.29**	**1. 29**	**1. 29**	**1. 29**	**1. 29**

1/ No federal demand noted.
2/ Water demand based on SWPP, 2003; includes only projects to get water from State systems; does not include projects scheduled to get water from BWS.
3/ Water demand based on CWRM "Declarations of Water Use" database, GIS well database, and BWS well database. Includes estimations for unreported use of known ground water sources and surface water diversions.
4/ Sum of Federal, State, and Private Water System Use.

Table C-11 below summarizes the total water demands projected by the *per capita* method for the policy (low growth) scenario. Total BWS increase in demand is approximately 2.3 mgd from year 2000 demand and total other water demand is expected to remain relatively constant throughout the planning period. Total water demand is expected to be 13.7 mgd by 2030, an increase of 2.4 mgd since 2000.

TABLE E-9
WAI'ANAE DISTRICT *PER CAPITA* WATER DEMAND SUMMARY
POLICY (LOW GROWTH) SCENARIO

	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
BWS Potable Demand (mgd)	9.34	9.72	10.24	10.65	10.97	11.25	11.70
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.85**	**10.23**	**10.76**	**11.17**	**11.48**	**11.76**	**12.22**
Non-BWS Potable Demand (mgd)	0.19	0.19	0. 19	0. 19	0. 19	0. 19	0. 19
Non-BWS Non- Potable Demand (mgd)	1.27	1.28	1.29	1. 29	1. 29	1. 29	1. 29
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1. 48**	**1. 48**	**1. 48**	**1. 48**
TOTAL DEMAND (mgd)	**11.31**	**11.70**	**12.23**	**12.64**	**12.96**	**13.24**	**13.69**

C.3.1.2 *PER CAPITA*: TREND SCENARIO

The trend (moderate growth) scenario followed a similar methodology as the policy scenario described above. Future Wai'anae *de facto* population estimates were used to calculate future potable water demand. The table below illustrates how the *de facto* population was calculated for the trend scenario and displays the numbers used in the calculations. The trend scenario shows a 2030 *de facto* population of 53,854 people, an increase of 12,123 people over the year 2000.

TABLE E-10
WAI'ANAE TREND (MODERATE GROWTH) POPULATION PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
RESIDENT POPULATION[1]							
Wai'anae	42,259	44,004	46,708	49,408	50,790	51,666	52,236
O'ahu	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300
Wai'anae % of O'ahu	4.82%	4.82%	4.90%	4.96%	4.90%	4.79%	4.68%
RESIDENTS ABSENT[2]							
Wai'anae	1,718	1,775	1,885	1,994	2,049	2,084	2,109
O'ahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114
VISITOR UNITS							
Wai'anae VU	509	509	982	982	982	1,013	1,449
O'ahu VU	36,321	37,261	44,586	47,162	47,162	47,400	50,700
Wai'anae % of O'ahu	1.4%	1.4%	2.2%	2.1%	2.1%	2.1%	2.9%
VISITORS PRESENT[3]							
Wai'anae	1,190	1,214	2,145	2,222	2,376	2,607	3,727
O'ahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414
		4.7%	9.6%	9.6%	6.9%	6.9%	6.9%
DE FACTO POPULATION[4]							
Wai'anae	41,731	43,443	46,968	49,636	51,117	52,189	53,854
O'ahu	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600

1/ Population numbers based on population projections from DPP calculated from past trends.

2/ Total residents absent for Honolulu County from DBEDT. Waianae's percentage of Honolulu County population equals percentage of those residents absent from Honolulu County.

3/ Total visitors present for Honolulu County from DBEDT. Waianae's percentage of Honolulu County visitor units equals percentage of those visitors present in Honolulu County.

4/ De Facto Population = Resident Population + Visitors Present.

The *per capita* demand calculated in Table C-5 was applied to the BWS-served population to get projected water demands through the year 2030. BWS 2030 potable water demands are expected to be 12.1 mgd, or an increase of 2.8 mgd over year 2000 demands.

TABLE E-11
PROJECTED BWS POTABLE WATER DEMAND
TREND (MODERATE GROWTH) PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
De Facto Population	41,731	43,443	46,968	49,636	51,117	52,189	53,854
Population on State/ Private/ Military Systems[1]	0	0	0	0	0	0	0
BWS-Served Population[2]	41,731	43,443	46,968	49,636	51,117	52,189	53,854
Per Capita Demand (gpd)[3]	224	224	224	224	224	224	224
Projected 2005 Demand (mgd)[4]	**9.34**	**9.72**	**10.51**	**11.11**	**11.44**	**11.68**	**12.05**

1/ No potable water use from State/Private/Military systems.
2/ BWS-Served Population = (DeFacto Population) - (Population on Non-BWS Systems).
3/ Assumes per capita demand does not change over time.
4/ Projected demand = (Projected BWS-Served Population * Per Capita Demand)/1,000,000 gallons.

BWS non-potable water demand is expected to remain constant throughout the planning period, based on current water conservation activities and the lack of expansion plans of the sole customer. BWS does not intend on securing additional non-potable water customers in Waiʻanae

TABLE E-12
PROJECTED BWS NON-POTABLE WATER DEMAND
TREND (MODERATE GROWTH) PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Mākaha West Golf Course (mgd)[1]	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Projected 2005 Demand (mgd)	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**

1/ Mākaha West Golf Course irrigated with non-potable water from Glover Tunnel, operated by BWS.

The only other potable water system in Waiʻanae is owned by the Federal government. Federal potable water demand is expected to remain constant through the year 2030.

TABLE E-13
PROJECTED NON-BWS POTABLE WATER DEMAND
TREND (MODERATE GROWTH) PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (mgd)[1]	0.2	0.2	0.2	0.2	0.2	0.2	0.2
State System Demand (mgd)[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Private System Demand (mgd)[3]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Non-BWS System Potable Water Demand (mgd)	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

1/ Water demand based on Navy reported use to CWRM for CY2004.
2/ No State demand noted.
3/ No private demand noted.

Non-BWS non-potable water demand is expected to remain relatively constant through 2030. There is no reported Federal use and due to the high cost of new source development and limited supplies, private development is not anticipated. According to the2003 State Water Projects Plan, State non-potable demand will increase by approximately 0.01 mgd over the planning period.

TABLE E-14
PROJECTED NON-BWS NON-POTABLE WATER DEMAND
TREND (MODERATE GROWTH) PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (mgd)[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State System Demand (mgd)[2]	0.002	0.014	0.024	0.024	0.024	0.024	0.024
Private System Demand (mgd)[3]	1.26	1.26	1.26	1.26	1.26	1.26	1.26
Total Non-BWS System Non-Potable Water Demand (mgd)[4]	**1.27**	**1.28**	**1.29**	**1.29**	**1.29**	**1.29**	**1.29**

1/ No federal demand noted.

2/ Water demand based on SWPP, 2003; includes only projects to get water from State systems; does not include projects scheduled to get water from BWS.

3/ Water demand based on CWRM "Declarations of Water Use" database, GIS well database, and BWS well database. Includes estimations for unreported use of known ground water sources and surface water diversions.

4/ Sum of Federal, State, and Private Water System Use.

Table C-17 below summarizes the total water demands projected by the *per capita* method for the trend (moderate growth) scenario. Based on the methodology described above, the Trend Scenario resulted in a total water demand of 14.0 mgd by the year 2030, with 12.6 mgd from BWS systems, including 0.5 mgd in non-potable water demand. Potable water demand from non-BWS systems is expected to remain at 0.2 mgd, and 1.3 mgd of non-potable water is expected to be required of non-BWS systems by 2030.

TABLE E-15
WAI'ANAE DISTRICT *PER CAPITA* WATER DEMAND
TREND SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	9.34	9.72	10.51	11.11	11.44	11.68	12.05
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.85**	**10.23**	**11.02**	**11.62**	**11.95**	**12.19**	**12.56**
Non-BWS Potable Demand (mgd)	0.19	0. 19	0. 19	0. 19	0. 19	0. 19	0. 19
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.29	1.29	1.29	1.29	1.29
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1. 48**	**1. 48**	**1. 48**	**1. 48**
TOTAL DEMAND (mgd)	**11.31**	**11.70**	**12.50**	**13.10**	**13.43**	**13.67**	**14.04**

C.3.1.3 *PER CAPITA*: HIGH-GROWTH SCENARIO

The high growth scenario was developed by carrying population growth from the last 30 years through to the next 30 years. The table below illustrates how the *de facto* population was calculated for the high-growth scenario and displays the numbers used in the calculations. The high-growth scenario shows a 2030 *de facto* population of 61,553 people, an increase of 19,822 people over the year 2000

TABLE E-16
WAIʻANAE HIGH-GROWTH POPULATION PROJECTION
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
RESIDENT POPULATION[1]							
Waiʻanae	42,259	45,259	48,259	51,259	54,259	57,259	60,259
Oʻahu	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300
Waiʻanae % of Oʻahu	4.82%	4.96%	5.07%	5.15%	5.23%	5.31%	5.39%
RESIDENTS ABSENT[2]							
Waiʻanae	1,718	1,826	1,947	2,068	2,189	2,310	2,433
Oʻahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114
VISITOR UNITS							
Waiʻanae VU	509	509	982	982	982	1,013	1,449
Oʻahu VU	36,321	37,261	44,586	47,162	47,162	47,400	50,700
Waianae % of Oʻahu	1.4%	1.4%	2.2%	2.1%	2.1%	2.1%	2.9%
VISITORS PRESENT[3]							
Waiʻanae	1,190	1,214	2,145	2,222	2,376	2,607	3,727
Oʻahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414
% Increase		4.7%	9.6%	9.6%	6.9%	6.9%	6.9%
DE FACTO POPULATION[4]							
Waiʻanae	41,731	44,647	48,457	51,413	54,446	57,556	61,553
Oʻahu	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600

1/ Population numbers based on population projections from DPP calculated from past trends.

2/ Total residents absent for Honolulu County from DBEDT. Waianae's percentage of Honolulu County population equals percentage of those residents absent from Honolulu County.

3/ Total visitors present for Honolulu County from DBEDT. Waianae's percentage of Honolulu County visitor units equals percentage of those visitors present in Honolulu County.

4/ De Facto Population = Resident Population + Visitors Present.

TABLE E-17
PROJECTED BWS POTABLE WATER DEMAND
HIGH-GROWTH SCENARIO
PER CAPITA METHOD

	2000	2005	2010	2015	2020	2025	2030
De Facto Population	41,731	44,647	48,457	51,413	54,446	57,556	61,553
Population on State/ Private/ Military Systems[1]	0	0	0	0	0	0	0
BWS-Served Population[2]	41,731	44,647	48,457	51,413	54,446	57,556	61,553
Per Capita Demand (gpd)[3]	224	224	224	224	224	224	224
Projected 2005 Demand (mgd)[4]	**9.33**	**9.99**	**10.84**	**11.51**	**12.18**	**12.88**	**13.78**

1/ No potable water use from State/Private/Military systems.

2/ BWS-Served Population = (DeFacto Population) - (Population on Non-BWS Systems).

3/ Assumes per capita demand does not change over time.

4/ Projected demand = (Projected BWS-Served Population * Per Capita Demand)/1,000,000 gallons.

BWS non-potable water demand is expected to remain constant throughout the planning period, based on current water conservation activities and the lack of expansion plans of the sole customer. BWS does not intend on securing additional non-potable water customers in Waiʻanae

TABLE E-18
PROJECTED BWS NON-POTABLE WATER DEMAND
HIGH-GROWTH SCENARIO
PER CAPITA METHOD

	2000	2005	2010	2015	2020	2025	2030
Mākaha West Golf Course (mgd)[1]	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Projected 2005 Demand (mgd)	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**	**0.51**

1/ Mākaha West Golf Course irrigated with non-potable water from Glover Tunnel, operated by BWS.

The only other potable water system in Waiʻanae is owned by the Federal government. Federal potable water demand is expected to remain constant through the year 2030.

TABLE E-19
PROJECTED NON-BWS POTABLE WATER DEMAND
HIGH-GROWTH SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (gpd)[1]	0.2	0.2	0.2	0.2	0.2	0.2	0.2
State System Demand (mgd)[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Private System Demand (gpd)[3]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Non-BWS System Potable Water Demand (mgd)	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

1/ Water demand based on Navy reported use to CWRM for CY2004.

2/ No State demand noted.

3/ No private demand noted.

Non-BWS non-potable water demand is expected to remain relatively constant through 2030. There is no reported Federal use and according to the2003 State Water Projects Plan, State non-potable demand will increase by only 0.01 mgd over the planning period. Limited supplies and the high cost of new source development suggests little private development of new water sources however, there are existing properties that could be developed as golf courses. While the Wai'anae SCP discourages new golf courses, the high growth scenario anticipates their development, as they are already zoned to accommodate such uses. New private golf courses would need to develop their own water sources and are therefore reflected in an increased demand by private water systems.

TABLE E-20
PROJECTED NON-BWS NON-POTABLE WATER DEMAND
HIGH-GROWTH SCENARIO
***PER CAPITA* METHOD**

	2000	2005	2010	2015	2020	2025	2030
Federal System Demand (mgd)[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State System Demand (mgd)[2]	0.002	0.014	0.024	0.024	0.024	0.024	0.024
Private System Demand (mgd)[3]	1.26	1.26	1.26	1.46	1.46	1.96	1.96
Total Non-BWS System Non-Potable Water Demand (mgd)[4]	**1.26**	**1.27**	**1.28**	**1.48**	**1.48**	**1.98**	**1.98**

1/ No federal demand noted.

2/ Water demand based on SWPP, 2003; includes only projects to get water from State systems; does not include projects scheduled to get water from BWS.

3/ Water demand based on CWRM "Declarations of Water Use" database, GIS well database, and BWS well database. Includes estimations for unreported use of known ground water sources and surface water diversions. Assumed 9-hole expansion (85 acres) of Mākaha East course by 2015 and new 18-hole golf course (203 acres) in Lualualei by 2025.

4/ Sum of Federal, State, and Private Water System Use.

Table C-23 below summarizes the total water demands projected by the *per capita* method for the high- growth scenario. The high-growth scenario resulted in a total water demand of 16.5 mgd by the year 2030, with 14.3 mgd from BWS systems, including 0.5 mgd in non-potable water demand. Potable water demand from non-BWS systems is expected to remain at 0.2 mgd, and 2.2 mgd of non-potable water is expected to be required of non-BWS systems by 2030.

TABLE E-21
WAI'ANAE DISTRICT *PER CAPITA* WATER DEMAND
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030
BWS Potable Demand (mgd)	9.33	9.99	10.84	11.51	12.18	12.88	13.78
BWS Non-Potable Demand (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
BWS Total Demand (mgd)	**9.9**	**10.5**	**11.4**	**12.0**	**12.7**	**13.4**	**14.3**
Non-BWS Potable Demand (mgd)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Non-BWS Non-Potable Demand (mgd)	1.26	1.27	1.28	1.48	1.48	1.98	1.98
Non-BWS Total Demand (mgd)	**1.46**	**1.47**	**1.48**	**1.68**	**1.68**	**2.18**	**2.18**
TOTAL DEMAND (mgd)	**11.31**	**11.97**	**12.83**	**13.70**	**14.37**	**15.57**	**16.47**

E.4 END USE INVENTORY METHODOLOGY

The End Use Inventory method estimated future water demand by type of water use, which included residential, agricultural, commercial, industrial, resort, golf course, public school and other State uses, park and other City uses, military, U.S. non-military, religious facility, and temporary water uses. In general, unit-use coefficients were derived by dividing the demand from a particular water use for the year 2000 by the number of units projected to increase, i.e, housing units, jobs, or acres. Unit-use factors were then applied to each water use for each of the three scenarios: Policy, Trend, and High-Growth. It was assumed that average daily per unit demand would remain constant over the planning horizon.

Water demand was estimated for both BWS and non-BWS systems, as well as by potable versus non-potable water. Non-potable water use designations were applied to the agricultural, industrial, golf course, and park and other City water use water uses, regardless of whether or not they were currently using non-potable water.

Residential water demand was determined by applying an average daily demand of 437 gallons per housing unit per day[5] to the number of housing units projected for Wai'anae through the year 2030. Both the Policy and Trend scenarios applied DPP's projections for housing units. In the Per Capita method, the 2030 population for the High-Growth scenario was 15.4 percent higher than the 2030 projection for the Trend Scenario; therefore, housing units were increased by the same percentage using this methodology.

In Wai'anae, agricultural water is supplied by BWS, private wells, and stream diversions. BWS agricultural water demand was estimated by applying an average per acre consumption factor of 855 gallons per day[6] (gpd) to the agricultural acres projected through the year 2030.

[5] Average daily residential demand was derived by dividing the known residential demand for the year 2000 by the known number of housing units for the same year.
[6] The 855 gpd-consumption factor was determined by dividing the volume of BWS metered agricultural water use by the number of acres served by those same agricultural water meters.

TABLE E-22
WAI'ANAE DISTRICT NUMBER OF HOUSING UNITS
POLICY, TREND, AND HIGH-GROWTH SCENARIOS

	2000	2005	2010	2015	2020	2025	2030
Policy Scenario Housing Units	12,356	12,948	13,524	14,259	14,892	15,438	15,933
% of Oahu's Housing Units	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.7%
Trend Scenario Housing Units	12,356	12,948	13,971	15,076	15,801	16,350	16,774
% of Oahu's Housing Units	3.9%	3.9%	4.0%	4.1%	4.1%	4.0%	3.9%
High-Growth Scenario Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350
% of Oahu's Housing Units	3.9%	4.1%	4.2%	4.3%	4.4%	4.4%	4.5%
Total Oahu Housing Units	315,988	330,141	348,690	369,108	389,698	409,965	429,824

Agricultural acreage in the Policy and Trend scenarios were determined by the change in agricultural jobs projected by DPP, i.e., the percent change in agricultural jobs projected in each five-year increment equaled the percent change in agricultural acres for that same five-year increment. It was assumed that the volume of water provided by private wells would remain constant. Additional private wells were considered unlikely due to the limited amount of ground water available in Wai'anae, the small nature of agricultural operations, and the high cost of constructing new water systems. Any additional agricultural water needs are thus expected to be met by BWS.

Agricultural acreage was doubled between the years 2000 and 2030 in the High-Growth scenario. This growth was determined to be possible in that there are over 8,000 acres of land in Wai'anae that are zoned for agriculture, but only about 2,100 acres are currently in active agricultural use, as estimated from and evaluation of the parcels served by BWS agricultural water meters. Support for agricultural activities has been strongly voiced in the Wai'anae SCP and growth in this area was entertained as a possibility for planning purposes.

Commercial water demand for the Policy and Trend scenarios was based on the total number of commercial jobs[7] estimated by DPP. The percent increase in commercial jobs equaled the percent increase in commercial water demand. Growth in commercial jobs for the High-Growth scenario was assumed to be equal to the percent increase in housing units for the same period.

Industrial water demand was calculated by increasing the demand proportionately to the number of industrial jobs projected. All three scenarios showed no growth in industrial jobs through the year 2030 and consequently, industrial water use remained constant over the planning horizon.

Resort water use for the Policy and Trend scenarios was based on the total number of visitor units projected by DPP. The average daily visitor demand of 63 gallons per unit per day was derived by dividing the total resort demand in the year 2000 by the total number of visitor units accounted for by DPP for that same year. Visitor unit projections for the High-Growth scenario were the same as for DPP's Trend scenario, as those projections were not expected to be exceeded.

Golf course water use was calculated separately for golf courses served by BWS and golf courses served by private systems. An average daily demand of 2,008 gallons per acre, per day[8] was applied to the number of BWS-served irrigated golf course acres through the planning period. An average daily demand of 781 gallons per acre, per day was applied to privately served golf course acreage.

Both the Policy and Trend scenarios assumed no growth in golf course acreage. The High-Growth scenario assumed that two parcels in Mākaha (85 acres total) would be developed no earlier that 2015. This date is likely the earliest a golf course could be developed, considering the permitting and financing process that would need to be undertaken. It was also assumed that the three parcels in Lualualei (208 acres total), that was zoned "General Preservation" in 1996 for golf course use, will ultimately be converted into a golf course no earlier than 2025. This later date is due to community opposition and the need to find a new water source.

State water use was primarily attributed to public school use, although other smaller State uses were included. For example, the Wai'anae Boat Harbor uses an estimated 0.003 mgd; however, these uses were considered small by comparison. Therefore, future State water use was calculated

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[7] Included in the "commercial" job category were DPP's individual categories of service jobs; retail job; and finance, insurance, and real estate jobs.

[8] Golf course average daily demand was calculated by dividing the estimated golf course demand by the number of acres served. Two average daily demand factors were calculated in order to more easily estimate the amount of water required from BWS and private systems.

by estimating only public school use. This was done by increasing public school water use proportionately with the increase in population. Population projections for all three scenarios were the same as those used in the *Per Capita* approach.

City water use was primarily attributed to park use; therefore, future City demand was estimated by projecting future park demand. Other smaller City uses were included in the "Park and Other City Water Use" category, such as the Waiʻanae Wastewater Treatment Plant, which uses approximately 0.033 mgd.

Park water use is primarily served by BWS, although the State has its own system to serve Kaʻena Point State Park. Demand for Kaʻena Point State Park was taken directly from the 2003 SWPP. Although Kaʻena Point State Park is served by a State water system, it was included in the "Park and other City Water Use" in order to be able to group the non-potable demand. City park demand was calculated by applying an average daily demand of 1,830 gallons per acre, per day[9] to the city park acreage projected for Waiʻanae through the year 2030.

Future City park acreages differed for each of the three scenarios. The Policy scenario assumed that the eight neighborhood parks and one district park recommended in the 2000 Waiʻanae SCP would be developed incrementally by the year 2030, for an addition of approximately 66 acres. In the trend scenario, only 19.5 acres of district park improvements were assumed to be developed to accommodate the District's growing population. No additional neighborhood parks were expected because the City would need to purchase additional land in order to develop such parks. The High-Growth scenario assumed that park acreage would increase in proportion to the increase in housing units for that scenario.

Military water use was based on the number of military jobs projected through the year 2030. All three scenarios projected no increase in military jobs over the planning period. Based on discussions with the Army and Navy, little or no growth in military uses seems likely for Waiʻanae in the foreseeable future. Water use by U.S. non-military installations was kept constant over the planning period.

"Other" water use included that for religious institutions, temporary uses, and U.S. non-military installations. Religious institution water use was increased proportionately with the increase in housing units for each scenario.

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[9] The average daily county park demand of 1,830 gallons per acre per day was calculated by dividing City water use for the year 2000 by county park acreage. It was noted that City water demand may include uses other than parks, such as approximately 0.03 mgd for the Waiʻanae Wastewater Treatment Plant. However, because the amount attributable to other uses was considered relatively small, all of the City water use in BWS' water consumption survey was viewed as for park irrigation and related facilities.

Temporary water use includes water attributed to fire fighting, construction, and other such uses, and was zero since the year 1998, likely due to a reporting error. Therefore, an average of temporary water demand for the years 1994 to 1996 was used as the base demand for the year 2000. [10] This volume was increased in proportion to housing units over the planning period for all three scenarios.

The following table summarizes how the types of water uses were factored into water demand calculations.

TABLE E-23
Water Projection Scenario Summary

SECTOR	LOW (DPP Policy)	MID (DPP Trend)	HIGH
Residential	+ 8,357 people + 3,577 housing units	+ 9,977 people + 4,418 housing units	+ 18,000 people + 6,994housing units
Resort	+ 940 units	+ 940 units	+ 1,884 units
Agriculture (Ground Water)	13% increase (+ 275 acres)	13% increase (+ 275 acres)	100% increase (+ 2104 acres)
Agriculture (Surface Water)	No change*	No change*	No change*
Instream Uses (Surface Water)	No change*	No change*	No change*
Recycled Water	None	None	None

*Pending establishment of instream flow standards.

The following tables illustrate the process used to project water demand using the end use inventory methodology. Water uses included residential, agricultural, commercial, industrial, resort, golf course, public schools and other State water use, parks and other City water use, military, U.S. non-military, religious facilities, and temporary. Water demand for the policy scenario is depicted in Table C-26, for the trend scenario in Table C-27, and for the high-growth scenario in Table C-28.

[10] The year 1997 was not included in calculating the average temporary water use because the volume reported for this year was unusually high and was determined to likely be another reporting error.

TABLE E-24
END USE INVENTORY PROJECTIONS
POLICY SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RESIDENTIAL WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,524	14,259	14,892	15,438	15,933	Assume all DPP HU are on BWS system
Average Daily Demand (gallons per unit per day)	437	437	437	437	437	437	437	
Estimated BWS Consumption (mgd)	5.40	5.66	5.92	6.24	6.51	6.75	6.97	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use.
Total Residential Demand (mgd)	**5.40**	**5.66**	**5.92**	**6.24**	**6.51**	**6.75**	**6.97**	
AGRICULTURAL WATER USE								**Non-Potable**
DPP Projected Jobs	549	532	555	569	584	606	621	
Percent Increase in Jobs	-	-3%	4%	3%	3%	4%	2%	
Acres Served by BWS Agricultural Water Meters	2,104	2,038	2,127	2,180	2,238	2,322	2,379	Assume all new services supplied by BWS.
Per Acre Agricultural Water Consumption (gallons per acre per day)	855	855	855	855	855	855	855	
Estimated BWS Consumption (mgd)	1.92	1.74	1.82	1.86	1.91	1.99	2.03	Non-potable served by potable. Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	Assume no additional acres served by private systems.
Total Agricultural Demand (mgd)	**2.29**	**2.11**	**2.19**	**2.24**	**2.29**	**2.36**	**2.41**	
COMMERCIAL WATER USE								**Potable**
DPP Projected Jobs - Finance, Insurance, Real Estate, Services, Retai	5,138	5,707	5,902	6,238	6,576	6,929	7,250	Includes Finance, Insurance, Real Estate, Service, & Retail Jobs
Percent Increase in Jobs		11%	3%	6%	5%	5%	5%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.53	0.59	0.61	0.65	0.68	0.72	0.75	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	CWRM declarations show no use
Total Commercial Demand (mgd)	**0.76**	**0.82**	**0.84**	**0.88**	**0.91**	**0.95**	**0.98**	
INDUSTRIAL WATER USE								**Non-Potable**
DPP Projected Jobs	112	112	112	112	112	112	112	Policy suggests no growth
Percent Increase in Jobs		0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.349	0.349	0.349	0.349	0.349	0.349	0.349	CWRM declarations show no use
Total Industrial Demand (mgd)	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	
RESORT WATER USE								**Potable**
DPP Projected Visitor Units	509	509	982	982	982	1,013	1,449	
Average Daily Demand (gallons per unit per day)	63	63	63	63	63	63	63	
Estimated BWS Consumption (mgd)	0.03	0.03	0.06	0.06	0.06	0.06	0.09	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Resort Demand (mgd)	**0.03**	**0.03**	**0.06**	**0.06**	**0.06**	**0.06**	**0.09**	

TABLE E-24 (Continued)
END USE INVENTORY PROJECTIONS
POLICY SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
GOLF COURSE WATER USE								**Non-Potable**
Acres of Golf Course Served by BWS	255	255	255	255	255	255	255	TMKs: 84002053, 84002055
Average Daily Demand (gallons per acre per day)	2,008	2,008	2,008	2,008	2,008	2,008	2,008	
Acres of Golf Course Served by Non-BWS Systems	146	146	146	146	146	146	146	TMKs: 84002005
Average Daily Demand (gallons per acre per day)	2,143	2,143	2,143	2,143	2,143	2,143	2,143	
Estimated BWS Consumption (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51	Glover cons. Incr. to 0.5 mgd from 0.4 in previous vers.
Estimated Non-BWS Consumption (mgd)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	Makaha V East = two 0.288 gpd wells
Total Golf Course Demand (mgd)	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	
PUBLIC SCHOOL & OTHER STATE WATER USE*								**Potable**
DPP Projected Housing Units	12,356	12,948	13,524	14,259	14,892	15,438	15,933	
Percent Increase in Housing Units	-	5%	4%	5%	4%	4%	3%	Assume demand increases at same rate as population
Estimated BWS Consumption (mgd)	0.38	0.40	0.42	0.44	0.46	0.48	0.49	Assume all "State" use is for schools
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Public School Demand (mgd)	**0.38**	**0.40**	**0.42**	**0.44**	**0.46**	**0.48**	**0.49**	
PARK & OTHER CITY WATER USE**								**Non-Potable**
Acres of Parks Served by BWS	312	323	335	346	357	368	380	WSCP prop 66 prk ac=8 NBHpk @ 6ac + 1 Distrpk @ 19.5ac
Average Daily Demand (gallons per acre per day)	1,830	1,830	1,830	1,830	1,830	1,830	1,830	
Average Daily Potable Demand served by Non-BWS Systems (mgd)	0.001	0.006	0.011	0.011	0.011	0.011	0.011	Average daily demand from SWPP
Average Daily Non-Potable Demand served by Non-BWS Systems (mgd)	0.002	0.014	0.024	0.024	0.024	0.024	0.024	Quantities taken from SWPP
Estimated BWS Consumption (mgd)	0.57	0.59	0.61	0.63	0.65	0.67	0.70	Non-potable served by potable. Assume all "City" use is for parks
Estimated Non-BWS Consumption (mgd)	0.003	0.020	0.035	0.035	0.035	0.035	0.035	
Total Park Demand (mgd)	**0.57**	**0.61**	**0.65**	**0.67**	**0.69**	**0.71**	**0.73**	
MILITARY WATER USE								**Potable**
DPP Projected Jobs	47	47	47	47	47	47	47	
Percent Increase in Jobs	-	0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Estimated Non-BWS Consumption (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	12-MAV as of 8/2004 (CWRM)
Total Military Demand (mgd)	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	
U.S. NON-MILITARY INSTALLATIONS WATER USE								**Potable**
Estimated BWS Consumption (mgd)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	Assume no change in use.
Estimated Non-BWS Consumption (mgd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	CWRM declarations show no use
Total U.S. Non-Military Demand (mgd)	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	

TABLE E-24 (Continued)
END USE INVENTORY PROJECTIONS
POLICY SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RELIGIOUS FACILITIES WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,524	14,259	14,892	15,438	15,933	
Percent Increase in Housing Units	-	5%	4%	5%	4%	4%	3%	Assume demand increases at same rate as population
Estimated BWS Consumption (mgd)	0.06	0.06	0.07	0.07	0.07	0.08	0.08	
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Religious Facilities Demand (mgd)	**0.06**	**0.06**	**0.07**	**0.07**	**0.07**	**0.08**	**0.08**	
TEMPORARY WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,524	14,259	14,892	15,438	15,933	
Percent Increase in Housing Units	-	5%	4%	5%	4%	4%	3%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.15	0.16	0.16	0.17	0.18	0.19	0.19	Est. based on 1994-97 consumption.
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Temporary Demand (mgd)	**0.15**	**0.16**	**0.16**	**0.17**	**0.18**	**0.19**	**0.19**	
TOTAL WAIANAE WATER USE								
BWS Potable Demand (mgd)	6.62	6.97	7.29	7.69	8.03	8.33	8.63	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
BWS Non-Potable Demand (mgd)	3.00	2.85	2.95	3.01	3.08	3.18	3.25	Incl. Ag, Ind, Golf Course, Parks
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.30	1.30	1.30	1.30	Incl. Ag, Ind, Golf Course, Parks
Total Waianae Demand (mgd)	**11.08**	**11.29**	**11.73**	**12.19**	**12.60**	**13.00**	**13.37**	

GENERAL ASSUMPTIONS AND DATA SOURCES:

All DPP Projections from 2030 projections dated December 2004

Park demand from SWPP ends at 2025 projection. 2030 projection was an extension of the 2025 demand

All Estimated BWS consumption for 2000 from BWS consumption survey + 6.5% added for water lost, incl. Glover Tunne

-Exception: Agricultural BWS Water Consumption from Agricultural Water Meter Readings

-Exception 2: Temporary water use was zero for years 1998-2003. Estimated a temporary use based on metered consumption from 1994-1997

*State Water Use is primarily attributed to public school use, although other smaller uses, such as an estimated 0.003 mgd for the Waianae Boat Harbor, are includec

**City Water Use is primarily attributed to City park use, although other uses, such as an estimated 0.033 mgd for the Waianae Wastewater Treatment Plan

TABLE E-25
END USE INVENTORY PROJECTIONS
TREND SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RESIDENTIAL WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,971	15,076	15,801	16,350	16,774	Assume all DPP HU are on BWS system
Average Daily Demand (gallons per unit per day)	437	437	437	437	437	437	437	
Estimated BWS Consumption (mgd)	5.40	5.66	6.11	6.59	6.91	7.15	7.34	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use.
Total Residential Demand (mgd)	**5.40**	**5.66**	**6.11**	**6.59**	**6.91**	**7.15**	**7.34**	
AGRICULTURAL WATER USE								**Non-Potable**
DPP Projected Jobs	549	532	555	569	584	606	621	Trend and Policy same
Percent Increase in Jobs	-	-3%	4%	3%	3%	4%	2%	
Acres Served by BWS Agricultural Water Meters	2,104	2,038	2,127	2,180	2,238	2,322	2,379	Assume all new services supplied by BWS.
Per Acre Agricultural Water Consumption (gallons per acre per day)	855	855	855	855	855	855	855	
Estimated BWS Consumption (mgd)	1.92	1.74	1.82	1.86	1.91	1.99	2.03	Non-potable served by potable. Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	Assume no additional acres served by private systems.
Total Agricultural Demand (mgd)	**2.29**	**2.11**	**2.19**	**2.24**	**2.29**	**2.36**	**2.41**	
COMMERCIAL WATER USE								**Potable**
DPP Projected Jobs - Finance, Insurance, Real Estate, Services, Retail	5,138	5,707	6,059	6,559	6,975	7,364	7,675	Includes Finance, Insurance, Real Estate, Service, & Retail Jobs
Percent Increase in Jobs		11%	6%	8%	6%	6%	4%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.53	0.59	0.63	0.68	0.72	0.76	0.79	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	CWRM declarations show no use
Total Commercial Demand (mgd)	**0.76**	**0.82**	**0.86**	**0.91**	**0.95**	**0.99**	**1.02**	
INDUSTRIAL WATER USE								**Non-Potable**
DPP Projected Jobs	112	112	112	112	112	112	112	Trend suggests no growth
Percent Increase in Jobs		0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.349	0.349	0.349	0.349	0.349	0.349	0.349	CWRM declarations show no use
Total Industrial Demand (mgd)	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	
RESORT WATER USE								**Potable**
DPP Projected Visitor Units	509	509	982	982	982	1,013	1,449	
Average Daily Demand (gallons per unit per day)	63	63	63	63	63	63	63	
Estimated BWS Consumption (mgd)	0.03	0.03	0.06	0.06	0.06	0.06	0.09	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Resort Demand (mgd)	**0.03**	**0.03**	**0.06**	**0.06**	**0.06**	**0.06**	**0.09**	

TABLE E-25 (Continued)
END USE INVENTORY PROJECTIONS
TREND SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
GOLF COURSE WATER USE								**Non-Potable**
Acres of Golf Course Served by BWS	255	255	255	255	255	255	255	TMKs: 84002053, 84002055
Average Daily Demand (gallons per acre per day)	2,008	2,008	2,008	2,008	2,008	2,008	2,008	
Acres of Golf Course Served by Non-BWS Systems	146	146	146	146	146	146	146	TMKs: 84002005
Average Daily Demand (gallons per acre per day)	2,143	2,143	2,143	2,143	2,143	2,143	2,143	
Estimated BWS Consumption (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51	Glover cons. Incr. to 0.5 mgd from 0.4 in previous vers.
Estimated Non-BWS Consumption (mgd)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	Makaha V East = two 0.288 gpd wells
Total Golf Course Demand (mgd)	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	**0.82**	
PUBLIC SCHOOL & OTHER STATE WATER USE*								**Potable**
DPP Projected Housing Units	12,356	12,948	13,971	15,076	15,801	16,350	16,774	
Percent Increase in Housing Units	-	5%	8%	8%	5%	3%	3%	Assume demand increases at same rate as population
Estimated BWS Consumption (mgd)	0.38	0.40	0.43	0.47	0.49	0.51	0.52	Assume all "State" use is for schools
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Public School Demand (mgd)	**0.38**	**0.40**	**0.43**	**0.47**	**0.49**	**0.51**	**0.52**	
PARK & OTHER CITY WATER USE**								**Non-Potable**
Acres of Parks Served by BWS	312	315	319	322	325	328	332	Assume no increase in NBH Prks due to land acq. but 19.5 ac for District Pk
Average Daily Demand (gallons per acre per day)	1,830	1,830	1,830	1,830	1,830	1,830	1,830	
Average Daily Potable Demand served by Non-BWS Systems (mgd)	0.001	0.006	0.011	0.011	0.011	0.011	0.011	Average daily demand from SWPP
Average Daily Non-Potable Demand served by Non-BWS Systems (mgd)	0.002	0.014	0.024	0.024	0.024	0.024	0.024	Quantities taken from SWPP
Estimated BWS Consumption (mgd)	0.57	0.58	0.58	0.59	0.59	0.60	0.61	Non-potable served by potable. Assume all "City" use is for parks
Estimated Non-BWS Consumption (mgd)	0.003	0.020	0.035	0.035	0.035	0.035	0.035	
Total Park Demand (mgd)	**0.57**	**0.60**	**0.62**	**0.62**	**0.63**	**0.64**	**0.64**	
MILITARY WATER USE								**Potable**
DPP Projected Jobs	47	47	47	47	47	47	47	
Percent Increase in Jobs	-	0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Estimated Non-BWS Consumption (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	12-MAV as of 8/2004 (CWRM)
Total Military Demand (mgd)	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	
U.S. NON-MILITARY INSTALLATIONS WATER USE								**Potable**
Estimated BWS Consumption (mgd)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	Assume no change in use.
Estimated Non-BWS Consumption (mgd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	CWRM declarations show no use
Total U.S. Non-Military Demand (mgd)	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	

TABLE E-25 (Continued)
END USE INVENTORY PROJECTIONS
TREND SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RELIGIOUS FACILITIES WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,971	15,076	15,801	16,350	16,774	
Percent Increase in Housing Units	-	5%	8%	8%	5%	3%	3%	Assume demand increases at same rate as population
Estimated BWS Consumption (mgd)	0.06	0.06	0.07	0.07	0.08	0.08	0.08	
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Religious Facilities Demand (mgd)	**0.06**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.08**	

TEMPORARY WATER USE								**Potable**
DPP Projected Housing Units	12,356	12,948	13,971	15,076	15,801	16,350	16,774	
Percent Increase in Housing Units	-	5%	8%	8%	5%	3%	3%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.15	0.16	0.17	0.18	0.19	0.20	0.20	Est. based on 1994-97 consumption.
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Temporary Demand (mgd)	**0.15**	**0.16**	**0.17**	**0.18**	**0.19**	**0.20**	**0.20**	

TOTAL WAIANAE WATER USE								
BWS Potable Demand (mgd)	6.62	6.97	7.53	8.12	8.51	8.82	9.09	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
BWS Non-Potable Demand (mgd)	3.00	2.84	2.92	2.97	3.02	3.10	3.16	Incl. Ag, Ind, Golf Course, Parks
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.30	1.30	1.30	1.30	Incl. Ag, Ind, Golf Course, Parks
Total Waianae Demand (mgd)	**11.08**	**11.28**	**11.94**	**12.58**	**13.03**	**13.41**	**13.73**	

GENERAL ASSUMPTIONS AND DATA SOURCES:
All DPP Projections from 2030 projections dated December 2004
Park demand from SWPP ends at 2025 projection. 2030 projection was an extension of the 2025 demand.
All Estimated BWS consumption for 2000 from BWS consumption survey + 6.5% added for water lost, incl. Glover Tunnel
-Exception: Agricultural BWS Water Consumption from Agricultural Water Meter Readings
-Exception 2: Temporary water use was zero for years 1998-2003. Estimated a temporary use based on metered consumption from 1994-1997.
*State Water Use is primarily attributed to public school use, although other smaller uses, such as an estimated 0.003 mgd for the Waianae Boat Harbor, are included
**City Water Use is primarily attributed to City park use, although other uses, such as an estimated 0.033 mgd for the Waianae Wastewater Treatment Plant

TABLE E-26
END USE INVENTORY PROJECTIONS
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RESIDENTIAL WATER USE								**Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	Pop inc. btwn trend & high = 15.4% by 2030; Assume all DPP HU are on BW
Average Daily Demand (gallons per unit per day)	437	437	437	437	437	437	437	
Estimated BWS Consumption (mgd)	5.40	5.91	6.42	6.94	7.45	7.96	8.46	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use.
Total Residential Demand (mgd)	**5.40**	**5.91**	**6.42**	**6.94**	**7.45**	**7.96**	**8.46**	
AGRICULTURAL WATER USE								**Non-Potable**
Acres Served by BWS Agricultural Water Meters	2,104	2,455	2,806	3,157	3,508	3,858	4,208	Assume ac. Dbls due to small-ag support prgrms
Per Acre Agricultural Water Consumption (gallons per acre per day)	855	855	855	855	855	855	855	
Estimated BWS Consumption (mgd)	1.92	2.10	2.40	2.70	3.00	3.30	3.60	Non-potable served by potable. Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	Assume no additional acres served by private systems.
Total Agricultural Demand (mgd)	**2.29**	**2.47**	**2.77**	**3.07**	**3.37**	**3.67**	**3.97**	
COMMERCIAL WATER USE								**Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	
Percent Increase in Housing Units		9%	9%	8%	7%	7%	6%	Assume demand increases at same rate as housing
Estimated BWS Consumption (mgd)	0.53	0.58	0.63	0.68	0.73	0.78	0.83	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	CWRM declarations show no use
Total Commercial Demand (mgd)	**0.76**	**0.81**	**0.86**	**0.91**	**0.96**	**1.01**	**1.06**	
INDUSTRIAL WATER USE								**Non-Potable**
Projected Jobs	112	112	112	112	112	112	112	No growth anticipated
Percent Increase in Jobs		0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.349	0.349	0.349	0.349	0.349	0.349	0.349	CWRM declarations show no use
Total Industrial Demand (mgd)	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	**0.354**	
RESORT WATER USE								**Potable**
Projected Visitor Units	509	509	982	982	982	1,013	1,449	Do not expect more VU than DPP projected.
Average Daily Demand (gallons per unit per day)	63	63	63	63	63	63	63	
Estimated BWS Consumption (mgd)	0.03	0.03	0.06	0.06	0.06	0.06	0.09	Assume all new services supplied by BWS
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Resort Demand (mgd)	**0.03**	**0.03**	**0.06**	**0.06**	**0.06**	**0.06**	**0.09**	

TABLE E-26 (Continued)
END USE INVENTORY PROJECTIONS
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
GOLF COURSE WATER USE								**Non-Potable**
Acres of Golf Course Served by BWS	255	255	255	255	255	255	255	TMKs: 84002053, 84002055
Average Daily Demand (gallons per acre per day)	2,008	2,008	2,008	2,008	2,008	2,008	2,008	
Acres of Golf Course Served by Non-BWS Systems	400	400	400	485	485	688	688	TMKs: 84002005 + (84002056 & 84002057) + (87009007+ 87010006 + 870
Average Daily Demand (gallons per acre per day)	781	781	781	781	781	781	781	
Estimated BWS Consumption (mgd)	0.51	0.51	0.51	0.51	0.51	0.51	0.51	Glover cons. Incr. to 0.5 mgd from 0.4 in previous vers.
Estimated Non-BWS Consumption (mgd)	0.31	0.31	0.31	0.38	0.38	0.54	0.54	Makaha V East = two 0.288 gpd wells
Total Golf Course Demand (mgd)	**0.82**	**0.82**	**0.82**	**0.89**	**0.89**	**1.05**	**1.05**	
PUBLIC SCHOOL & OTHER STATE WATER USE*								**Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	
Percent Increase in Housing Units	-	9%	9%	8%	7%	7%	6%	Assume demand increases at same rate as housing units
Estimated BWS Consumption (mgd)	0.38	0.42	0.46	0.49	0.53	0.56	0.60	Assume all "State" use is for schools
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Public School Demand (mgd)	**0.38**	**0.42**	**0.46**	**0.49**	**0.53**	**0.56**	**0.60**	
PARK & OTHER CITY WATER USE**								**Non-Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	
Percent Increase in Housing Units	-	9%	9%	8%	7%	7%	6%	
Acres of Parks Served by BWS	312	341	371	400	430	459	489	Assume prk ac. Increases at same rate as housing units
Average Daily Demand (gallons per acre per day)	1,830	1,830	1,830	1,830	1,830	1,830	1,830	
Average Daily Potable Demand served by Non-BWS Systems (mgd)	0.001	0.006	0.011	0.011	0.011	0.011	0.011	Average daily demand from SWPP
Average Daily Non-Potable Demand served by Non-BWS Systems (mgd)	0.002	0.014	0.024	0.024	0.024	0.024	0.024	Quantities taken from SWPP
Estimated BWS Consumption (mgd)	0.57	0.62	0.68	0.73	0.79	0.84	0.89	Non-potable served by potable. Assume all "City" use is for parks
Estimated Non-BWS Consumption (mgd)	0.003	0.020	0.035	0.035	0.035	0.035	0.035	
Total Park Demand (mgd)	**0.57**	**0.64**	**0.71**	**0.77**	**0.82**	**0.88**	**0.93**	
MILITARY WATER USE								**Potable**
Projected Jobs	47	47	47	47	47	47	47	No growth anticipated
Percent Increase in Jobs	-	0%	0%	0%	0%	0%	0%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
Estimated Non-BWS Consumption (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	12-MAV as of 8/2004 (CWRM)
Total Military Demand (mgd)	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	
U.S. NON-MILITARY INSTALLATIONS WATER USE								**Potable**
Estimated BWS Consumption (mgd)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	Assume no change in use.
Estimated Non-BWS Consumption (mgd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	CWRM declarations show no use
Total U.S. Non-Military Demand (mgd)	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	

TABLE E-26 (Continued)
END USE INVENTORY PROJECTIONS
HIGH-GROWTH SCENARIO

	2000	2005	2010	2015	2020	2025	2030	NOTES
RELIGIOUS FACILITIES WATER USE								**Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	
Percent Increase in Housing Units	-	9%	9%	8%	7%	7%	6%	Assume demand increases at same rate as population
Estimated BWS Consumption (mgd)	0.06	0.07	0.07	0.08	0.08	0.09	0.10	
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Religious Facilities Demand (mgd)	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**	**0.09**	**0.10**	

	2000	2005	2010	2015	2020	2025	2030	NOTES
TEMPORARY WATER USE								**Potable**
Projected Housing Units	12,356	13,522	14,688	15,854	17,020	18,186	19,350	
Percent Increase in Housing Units	-	9%	9%	8%	7%	7%	6%	Assume demand increases at same rate as jobs
Estimated BWS Consumption (mgd)	0.15	0.16	0.18	0.19	0.21	0.22	0.23	Est. based on 1994-97 consumption.
Estimated Non-BWS Consumption (mgd)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CWRM declarations show no use
Total Temporary Demand (mgd)	**0.15**	**0.16**	**0.18**	**0.19**	**0.21**	**0.22**	**0.23**	

	2000	2005	2010	2015	2020	2025	2030	NOTES
TOTAL WAIANAE WATER USE								
BWS Potable Demand (mgd)	6.62	7.24	7.88	8.50	9.11	9.73	10.37	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
BWS Non-Potable Demand (mgd)	3.00	3.24	3.59	3.95	4.30	4.66	5.01	Incl. Ag, Ind, Golf Course, Parks
Non-BWS Potable Demand (mgd)	0.19	0.19	0.19	0.19	0.19	0.19	0.19	Incl. Res, Comm, Resort, Schools, Mil, Religious Fac., US Non-Mil, Temp.
Non-BWS Non-Potable Demand (mgd)	1.27	1.28	1.30	1.36	1.36	1.52	1.52	Incl. Ag, Ind, Golf Course, Parks
Total Waianae Demand (mgd)	**11.08**	**11.95**	**12.97**	**14.00**	**14.97**	**16.10**	**17.10**	

GENERAL ASSUMPTIONS AND DATA SOURCES:
Park demand from SWPP ends at 2025 projection. 2030 projection was an extension of the 2025 demand
All Estimated BWS consumption for 2000 from BWS consumption survey + 6.5% added for water lost, incl. Glover Tunne
-Exception: Agricultural BWS Water Consumption from Agricultural Water Meter Readings
-Exception 2: Temporary water use was zero for years 1998-2003. Estimated a temporary use based on metered consumption from 1994-1997
*State Water Use is primarily attributed to public school use, although other smaller uses, such as an estimated 0.003 mgd for the Waianae Boat Harbor, are includec
**City Water Use is primarily attributed to City park use, although other uses, such as an estimated 0.033 mgd for the Waianae Wastewater Treatment Plan

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F WAI‘ANAE BWS CAPITAL PROGRAM

PROJECT	TOTAL COST ($M)	FISCAL YEAR CONSTRUCTION
Farrington Highway 24-inch Main Part I	$14.275	2008
Lualualei Booster Improvements	$3.790	2011
Puhawai Road, Kuwale Road and Puuhulu Road 8-inch Mains	$2.400	2011
Barber’s Point Line Booster Improvements	$1.650	2014
Wai‘anae 242 Reservoir No. 2 (4.0 MG)	$28.020	2015
Total:	**$50.135 Million**	

Total Cost = cost for Design + Land + Construction

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G NEIGHBORHOOD BOARD SUPPORT

After the Wai‘anae Watershed Management Plan Public Draft was released for review and comments were accepted, the planning team asked Wai‘anae Neighborhood Board #24 for their support of the plan. At that time, the entire Wai‘anae District was represented by one Neighborhood Board. At their meeting held on August 1, 2006, the Neighborhood Board unanimously voted to support the plan. The minutes from that meeting are included in this appendix. The specific reference to the questions and discussion on the Wai‘anae Watershed Management Plan may be found on pages two and three.

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WAIANAE NEIGHBORHOOD BOARD NO. 24

c/o NEIGHBORHOOD COMMISSION • 530 SOUTH KING STREET ROOM 400 • HONOLULU, HAWAII, 96813
PHONE (808) 527-5749 • FAX (808) 527-5760 • INTERNET: http://www.honolulu.gov

REGULAR MEETING MINUTES
TUESDAY AUGUST 1, 2006
WAIANAE COMMUNITY CENTER

CALL TO ORDER: Chair Patty Teruya called the meeting to order at 7:00p.m. with a quorum present.

MEMBERS' PRESENT: Karen Awana, Alvin Awo, Black Hoohuli, Jo Jordan, Kimo Kelii, Suzanne Leonida, James Manaku, Kaipo Pomaikai, Cynthia Rezentes, Adrian Silva Jr., Albert H. Silva, Patty Teruya, Frank Slocum, Neddie Waiamau-Nunuha.

MEMBERS' ABSENT: Glen Kila

GUESTS: Bud Ebel, Kaiawe Makanani, Kini Kawelo-Polani, Alice U. Greenwood, Cdr. M.A. Sevilla (NMCDPH), Clara Batongbacal, Joan White (HCAP), Terrence Aratani (HCAP), Jose Villa (HCAP), Joy Barua (HCAP), Lou Chan (HCAP), Ryan Yamamoto (HCAP), Gerald Park (HCAP), Lei Furukawa (University of Phoenix), Rita K. Martin (Affordable Housing Alliance- Next Step), Maj. Mike Tamashiro (HPD), Maj. Ad Godinez (U.S. Army), Lt. Fabian Loo (HPD), William Steinke (HFD), Russell Youth (HFD), Mike O'Neill, George Kuo (BWS), Bruce Tsuchida (Townscape), Sybol Uelese (WCO), Laura Pitolo (WCO), Pat Lee (HHCTCP), Councilman Todd Apo (City Council), Faith Arakawa (Waianae Library), Mieko Shintani, Pat Patterson, Shuji Shintani, Clayton Brown (BWS), Scoot Ishikawa (State Department of Transportation), Johnnie Mae Perry, Jackie Ky, Ron Sullivan, Jacqueline Taylor-Lee, Samuel M. Kekumu, Randy Obata (Rep. Case' Office), Rep. Maile Shimabukuro, Ken Shimizu (Mayor's Rep), Marie Laderta (Governor's Rep), Kaulana Park (Governor's Homeless Solution team leader), Vanessa Matautia (Neighborhood Board Commission staff).

WELCOME/PULE/PLEDGE OF ALLEGIANCE/HAWAII PONO'I: Chair Teruya welcomed everyone to the meeting. Adrian Silva led the pledge of allegiance with Waiamau-Nunuha leading everyone in Hawaii Pono'i.

REPORTS PART ONE

Honolulu Fire Department (HFD) – Firefighter Russell Youth gave the following report:

1. For the month of June, the Waianae Fire Station reported to 5 structure, 31 brush, 7 rubbish and 6 vehicle fires, 53 medical and 18 medical emergencies, and no search and rescue.

2. There were two major incidents that occurred with the a) first incident being a brush fire happening July 12-13 involving 19 companies and encompassing 23 hours (2224-2104). b) The second incident was the bridge fire on Farrington and Kili Street on July 27.

3. Fire Safety Tip: Take the time to childproof your home, especially since keiki are on summer vacation. Check for potentially dangerous situations, i.e., electrical shock, accidental falls, or poisoning from medications, cleaning fluids, and houseplants. Keep matches and lighters in a safe place and out of the reach of small children.

Questions, comments and concerns:

> Albert H. Silva commented that during the time when the train traveled around Kaena Point, the area came to be known as "Yokahama Switch", in reference to the switchman Yokahama. After many years, the reference name was shortened to "Yokohama" but to many of the old Waianae residents, the area still goes by its Hawaiian name of Ke'awaula.

Emergency Services Department (EMS) - No representative was available for comment.

Honolulu Police Department (HPD) – Lt. Fabian Loo gave the following report:

1. Statistics for July were 5 robberies, 34 burglaries, 70 thefts, 19 auto thefts, 62 thefts from vehicles, 92 person thefts, 1 ID theft, 71 motor vehicle collisions, 4 DUIs, 36 CPDs, 2 drug calls with a total of 3629 calls.

2. Crime tip of the month included tips from the Department of Homeland Security on reporting suspicious behavior and activity. These tips included surveillance, being aware of suspicious persons or questioning, attempts to test security of key facilities, deploying assets or stockpiling of suspicious materials and acquiring supplies or dry runs. Call 911 for emergencies or call the Joint Terrorism task force at (808) 566-4300.

Questions, comments, concerns:

3. Slocum asked for a definitive answer to the standard for a citizen's arrest in Hawaii. Lt. Loo stated that in cases where law enforcement is on their way, private citizens may detain a suspect. He also stated that the HPD suggests against citizen's arrest since many suspects may be dangerous and will more than likely cause physical harm.

4. Kelii reported that he has documented a list of trucks with descriptions and license plate numbers that have modified their vehicles to create louder sounds by engine/stereo equipment and he asked what the correct protocol to turn in the list was. Lt. Loo stated that this should be reported to HPD because a noise complaint can be made as well as illegal modifications of the vehicle.

5. Alice Greenwood asked if there was a total count of tickets given out to homeless and Lt. Loo reported that this record would be accumulated at the Kapolei Police Station. Maj. Tamashiro also reported that approximately 1,000 tickets have been given out to the homeless for illegal camping over the last year and in the last three months, the number has declined considerably.

Board of Water Supply – Clayton Brown reported the following: There were two main breaks in the month of July. On July 7 at 86-136 Kakaiapola Street, a 6" fire hydrant later with no cause reported and there are no immediate plans to replace the main. On July 27 at 84-450 Farrington Highway an 8" main this may have been caused by the pressure surge in the main from the use by HFD fighting the bridge fire. It was replaced as part of the Farrington Highway Water Main Improvements.

Waianae Watershed Draft plan – Bruce Tsuchida, from Townscape, reported on the plan that will provide for the entire Waianae Coast, from the mountains to ocean. The Board of Water Supply is mandated by State law and began the plans by region with Waianae Coast as the first segment. The goal of the plan is to become City ordinance and receive funding for the programs needed in order to provide a viable water plan for the Waianae Coast's present and future water usage.

Questions, comments and concerns:

1. Pomaikai asked if there were options to use runoff water as a source of water. Tsuchida reported that this was done on Kauai and there were several options for that in the plan for the Waianae Coast.

2. Manaku asked if the watershed would include forest land, which is under the direction of the Department of Land and Natural Resources. Tsuchida believed that the BWS can only advise DLNR and may partner with them in order to provide better access to this area for residents.

3. Kelii commented a) regarding that since agriculture has declined in the Ewa area would it correlate to a decline in water demand. Tsuchida reported that increases in housing developments in Ewa will keep numbers at the same level if not higher. b) Kelii also questioned if it was still the case that golf courses on the leeward side would still need to find their own source of potable water. Tsuchida affirmed that this was still the case and the use of desalinated water plant was use at Ko Olina Resort. c) Kelii's last question was whether the plan was agriculturally friendly and Tsuchida pointed out several programs that would assist the agricultural community.

4. A resident asked whether water from Waianae was leaving the coast for other parts of the island. Tsuchida answered that there was no water that left the coast.

5. Resident questioned that due to more housing developments coming up in the Kapolei/Kalaeloa area, would there be less water available for the Waianae Coast. Tsuchida affirmed the residents' comment and reported that the Board has plans in the future for desalination plants to be used as a water source.

Motion to support the Waianae Watershed Draft plan by *Rezentes* and seconded by *Awana* was passed with unanimous consent of the Board.

The order of the agenda was deferred to allow for the State Department of Transportation (DOT) to give the following report regarding the Makaha Bridge.

Makaha Bridge Fire Update – Scott Ishikawa from the DOT reported that the Makaha Bridge was reopened at 7:00 p.m. today and will be contra flowed for the next several weeks until repairs could be done to repair the walkway on the mauka side. Ishikawa thanked the Board and the community for their patience.

The order of the agenda was resumed.

Monthly Reports, Part 1, continued:

U.S. Army 25th ID (Light) – Major Ad Godinez gave the following report:

1. There is an ongoing deployment of 7,000 soldiers from Schofield Barracks and Fort Shafter to Iraq over the summer months and will continue until September.

2. The Army Stryker Brigade will remain on the island and will not be deployed out to the Middle East. There are currently 20 vehicles on island and training will be contained at Schofield Barracks. Next year there will be 320 vehicles on island and most of them will be contained to government property.

3. The question from Board member Kelii regarding the donation of tents from the Army is being worked on at the moment. The Army is looking to consider the project and working out several legal issues.

Questions, comments, concerns:

1. Waiamau-Nunuha thanked the U.S. Army for bringing her grandson back home from deployment safe and sound.

2. Slocum asked Maj. Godinez if he had information regarding the dumping of ammunitions off of the Waianae Coast. Maj. Godinez reported that he had not seen any information of that nature and asked that Slocum provide him with information in order to update himself.

3. Manaku asked if there was resolution regarding roads at Schofield Barracks. Maj. Godinez reported that it is outside the jurisdiction and will report back next month.

U.S. Navy NavMag Pearl Harbor Commander- Cmdr. Sevilla gave the following report:

1. The Navy has changed the name of Pearl Harbor. It will be now known as Navy Munitions Detachment Pearl Harbor. This change will allow for a more focused job for the three installations. Capt. Staunch is the new commander of Pearl Harbor which is apart of the U.S. Navy's East Asia Division.

2. Normal status at the three installments of detachment Pearl Harbor.

3. There was a request from last month regarding rent paid by Bedminster LLC for land leased out by the Navy Regions HI and Cmdr. Sevilla reported that rent was being collected but the specific amount was not known.

Questions, comments and concerns:

1. Kelii commented that the change to “munitions” seemed to be a target for terrorists as it would display the stock up of ammunitions.

2. Alice Greenwood questioned the status of Lualualei Road and Cmdr. Sevilla reported that it was in the process of being turned over to the City.

Defer Approval of Regular Meeting Minutes for December 6, 2005 and February 7, 2006.
Defer Approval of Regular Meeting Minutes for June 6, 2006

Treasurer’s Report: No report.

Chair’s Appointment for Committee Chairs – Chair Teruya opened to the Board for calls of appointment.

1. **Transportation/OMPO, Public Health & Safety – Karen Awana**
2. **Planning & Zoning – Patty Teruya**
3. **Education – Kimo Kelii**
4. **Housing – James Manaku**
5. **Parks and Recreation/Parks Beautification – Jo Jordan**

Committee Reports

Transportation/OMPO-Ms. Awana

1. Several members of the transportation committee will be meeting with Department of Transportation Services regarding routing issues with at Makaha Marketplace tomorrow at 10:00 a.m.

2. Oahu Metropolitan Planning Organization’s next general meeting will be held on Friday August 16th at 4:00 p.m. in the Mayor’s Conference Room at Honolulu Hale.

3. Honolulu High-Capacity Transit corridor Project/Board to consider position on alternatives update

   Pat Lee updated the Board on project findings and provided a power point presentation that overviewed the four alternatives (no-build, an enhanced bus system, managed lanes, and fixed guideways), possible routes with stations, park and rides, the areas that would affected by the transit plans and a timeline in which is being followed. In December, the City Council will vote on what is the locally preferred plan. The increase for the general excise tax to fund the mass transit system begins in January 2007.

Questions, comments and concerns:

1. Pomaikai asked out of the alternatives, what was the alternative in which Lee preferred and Lee stated that he preferred option four (fixed guideways).

2. Jordan questioned if the fourth option were killed, would this also kill the GET surcharge. Lee reported that If the option picked is to not the Fixed Guideways then the GET surcharge will not be used for any other alternative due to the Federal mandate that matching funds must exist before federal funding is made available.

3. Adrian asked about the rail transit and why was it not mentioned in the list of alternatives. Lee reported that the fourth option – the Fixed Guideway, would basically be the rail transit. It was called the fixed Guideway because specific technology whether it be rail, monorail, or maglev was not finalized.

4. Manaku asked if there would be security for the fixed guideways due to the possibility of youths being disruptive to riders. Councilmember Todd Apo answered the question and commented that at this point there would be monitor’s who would maintain security as well as patrol officers who would be stationed on the platforms.

5. Awo asked what course would the rail move through Kapolei and also asked how commuters would get to the station. Lee reviewed the course with alternate routes shown in the power point presentation with more buses traveling into the neighborhoods and providing transportation to the stations where park and rides would be available.

6. Kelii asked Chair Teruya if the Board could take a position at its next meeting in order to send a letter out to the City Council before their final vote. Council member Todd Apo asked that the Board wait until November due to the City Council's upcoming vote at the end of November. Council member Apo mentioned that he would report back to the Board in October with all the information that could be provided on the transit plans in order to prepare the Board for their vote.

7. Pomaikai commented that the gas prices are rising and this project must go through in order to alleviate the traffic problem.

8. Johnnie Mae Perry asked whether the park and ride and station will be near the H-Power plant. Lee reported that the station will located right across the H-Power plant near the Advertiser building.

9. Chair Teruya asked if there is anything else on the Transit Committee agenda and Awana asked that all other items be deferred until next transportation committee meeting.

10. Recommendation to Waianae Coast Neighborhood Board #24 to approve Transportation Recommendations Package to assist vehicular traffic movement along the Waianae Coast into Downtown Honolulu – Karen Awana will defer until next transportation meeting.

Health, Human Services & Public Safety- Ms. Awana reported that the Weed and Seek Task steering committee participated within a Waianae Safe Summer for Youth event on July 22 and will also participate within the Waianae Sunset on the Beach event on August 12 and 13.

Planning & Zoning/Vision- Chair Teruya reported the P& Z Committee discussed the Recovering Alcoholics and Drug Shelter at 87-225 Maaloa Street, Nanakuli. Teruya thanked the many Board members as well as the several community members who come to the committee meeting.

Slocum moved and Jordan seconded that the Waianae Neighborhood Board No. 24 Planning & Zoning Committee recommends that the City & County, State of Hawaii authorities be advised of the situation that appears to be in non-compliance of zoning and the recently enacted Half-Way House Bill HRS.46.4. Further, that the operation be seized until all legal requirements are met.

Chair Teruya explained that the Committee's recommendation was made because of residents' concerns that several zoning regulations are in question and they request that the Department of Planning and Permitting (DPP) halt all action in the residence until these concerns have been answered or resolved. She also reported that she had asked the residents of 87-225 Maaloa Street, particularly speaking to a Mr. Bobby Christensen to attend the committee meeting concerning the residents to which no one did.

Discussion:

1. Hoohuli questioned whether this was a final vote. Chair Teruya explained that this was on the committee agenda as well as on the regular agenda for the last several months. Hoohuli also asked if the residents from the house in question would be able to speak. Chair Teruya noted that there was a large group from the 87-225 Maaloa Street residence and had hoped they would have spoken up at the committee meeting. She asked that a spokesperson make a statement to the Board.

2. Mr. Bobby Christensen is the leasee of the residence in questioned. He thanked the Board for the time granted him and explained the purpose of the house. The house is a transition house for single parent fathers who were once homeless and now share rent and other housing costs. There are children from the age of 9 to a 6 month old infant and the fathers are those who once lived on the beaches of the Waianae Coast. There is no a drug or alcohol policy in the house and residents must follow the strict

rules in which were provided to them. He hoped that the Board would take this into consideration and asked that they be given a chance.

3. Kelii questioned that the motion is not opposing the residents' actions but whether the residence is up to compliance with State and City zoning and Chair Teruya confirmed that this was the intent of the motion.

4. Jordan would like to change the wording of the motion. After HRS.46-4, add "and would like it to be investigated. Furthermore, we request that the operation cease until legal requirements are met". Slocum approved the changes.

5. Rezentes questioned if the Board was asking the right thing? She questioned that after hearing Mr. Christensen speak, she wondered if it the residence could be defined as a halfway house but rather a house rented by several individuals sharing rent.

6. Awo asked how many parents/children were presently residing in the home because of laws that restrict the number of residents in a household. Chair Teruya reiterated that the motion in question is asking officials to do the actual investigation because the Board is only an advisory entity.

7. Pomaikai questioned who made the assessment for this motion that the residence was in compliance. Slocum reported that it was the community who raised the issue that there are no permits that were taken and the community was up in arms on whether rules were being followed. Pomaikai stated that he can not vote in favor of this motion because he was not aware of the rules that were possibly being broken, did not know on whose authority that it can be made. Pomaikai would like to remove "appears to be non-compliant and to advise the situation of the zoning" from the motion but Slocum did not accept the request. Chair Teruya asked that Board members attend the committee meetings as they work tirelessly on these recommendations.

8. Awana recommended that the address including the TMK would be provided within the motion in order to be specific and is accepted by Slocum and Jordan.

The motion failed to carry with the necessary 8 votes. 5-4-4.Yea: Teruya, Awana, Slocum, Jordan, Leonida. Nay: Kelii, Kaipo, Adrian, Hoohuli. Abstain: Awo, Rezentes, Waiamau-Nunuha, Silva.

9. Chair Teruya asked that those concern residents to go ahead and write directly to State and City officials to look into the matter.

10. Hoohuli asked Chair Teruya if the residents at 87-225 Maaloa Street would best help the community and their concerns in acquiring the appropriate permits and Chair believed that this would help the situation.

Parks and Recreation/Parks Beautification- Ms. Jordan reported the following:

1. The next Parks and Rec committee meeting will be on Thursday August 10$^{th.}$

2. The Kaupuni project update price was $300,000. The City will dip into the current year's funds and release the funds in order to fund the project.

3. Puuhulu project has been revamped and will begin again shortly.

Education- Kelii gave the following report:

1. Simple Directory of all educational institutions on the Waianae Coast will be available very soon. A more in depth directory will be available at a later date.

2. The Imua project will begin later on this month. This project will include school representatives from all of the institutions on the Waianae Coast and they will strategize

3. Position on Kamehameha Schools Admission Policy – Mr. Kekoa Paulsen – Kelii will defer this item until September meeting.

4. University of Phoenix update - Ms. Lei Furukawa, Education Liaison reported that from the last invitation to the campus in Kapolei, there were several who enrolled for classes. Several programs available online with associate degree programs in 20 months; Bachelors degree available online as well. The goal is to have students attend the Kapolei campus at the present time but the future goal is to create a Waianae Campus.

Questions, comments and concerns:

1. Frank Slocum questioned what kind of campus is located in Kapolei? Furukawa stated that their campus is an unconventional campus located in office buildings, there is a learning center and several classrooms. She stated that much of the students who attend University of Phoenix are working professionals who have no need for a traditional campus.

2. Furukawa also commented on the school's regional accreditation. Because they have this certain level of accreditation, the credits earned are transferable to other institutions. The University of Phoenix is also approved by the Department of Education (DOE) and the National League for Nursing (NLN).

Housing- Manaku reported the Housing Committee will have a joint meeting with the Health Committee on Wednesday August 9, 2006 at the Waianae District Park starting at 6 p.m. They will be discussing the Laulima Project that will be assisting the homeless will begin shortly on the Waianae Coast.

Announcements – Chair Teruya provided the following announcements and correspondence received in the Board mail box. She informed everyone that all correspondence will be distributed to the Board.

1. Letter from the Executive Secretary regarding Board members running for public office. Running for office will not exclude a person from serving as a Board member but when a Board member wins an elected office they must resign from Board service.

2. A Notice of Public Hearing in front of the City Liquor Commission for Tacos & More LLC, located at 85-993 Farrington Highway, for the purpose of gaining a liquor license on September 14. Please attend if you would like to testify.

3. A letter from the Director of Planning and Permitting Mr. Henry Eng informed the Board that they are in the process of revising the Waianae Sustainable Communities Plan which will start in mid–late September 2006.

4. Kim and Shiroma Engineers, Inc. are requesting to remove the "no parking" signs on Leihoku Street due to the new development in the area. The Board will schedule this group at the next September Board meeting.

5. Voter registration is available for those eligible to vote. Chair Teruya has provided voter registration pamphlets as well as absentee voter registration.

6. Waiamau-Nunuha announced the Sunset on the Beach at Maili Beach on August 12-13 Saturday is movie *Beyond the Break* (filmed on the Waianae Coast) and *Shaggy Dog* and Sunday there will be the movie *Eight Below*.

7. Kelii announced the meeting at Nanakuli Beach Park tomorrow Wednesday August 2, 2006 at 5:00 p.m. regarding the deteriorating conditions at Nanakuli Park and what can be done in repairing these conditions.

8. Jordan announced the ground breaking of the transit center at the Waianae Mall at 10:00 a.m. She also announced the conference on sustainable communities that will take place this month at the Hawaii Convention Center and encouraged all to attend.

9. Pomaikai applauded the efforts of the committees and the work that they do and asked that all the Board members try to attend the meetings.

10. Colleen reported information regarding a program with the Hawaii Food Bank that will help the local farmers who were affected by the prolonged 40 days of rain. A City block grant was received in order to help with senior who were 60 years of age or older with income 20,800 single or 28,083 for a couple. Those who fall under this category may head down to HCAP on 9th August at 8:00 am and they will receive $144 which will be issued out in $3 increments and can be used at any of the open food markets. Please Xerox information and attach them to the HCAP forms that are available on the back table.

11. Faith Arakawa from the Waianae Library, reported the Library will be closed for two weeks August 21-September 4, for ADA renovation of their front access and handicapped parking. Books borrowed from the Library will be due after the renovation because access to the book drop will be closed. Any library book can be taken back to any other library and the Waianae Library apologizes for this inconvenience.

12. The Waianae Hawaiian Civic Club will have a booth at the Sunset on the Beach to register people to vote on August 12 and 13.

13. Pat Patterson also announced that Habitat for Humanity will have a booth at the Sunset on the Beach.

Community Concerns

1. Jordan had two concerns a) the agenda is still not formatted as it was voted on by the Board. b) The Waimanalo Landfill meeting notice that was mailed out with the agenda and what may set a precedent for what notices are sent and which ones that is not. Chair Teruya explained that she was accused last month of not notifying the community and Board and hoped that this would rectify the situation but will take Jordan’s concern into consideration.

2. Kaipo commended Pat Patterson and reported that the homeless young man they had referred to the Maritime Academy enrolled, on the third day after he enrolled, he was given clothes, boots, and other equipment for training and four days after the fourth day enrolled, he was given a place to stay. He has since graduated from the program and is now looking for work in the industry.

3. Manaku commented on the Hepatitis B problem on the Waianae Coast. Youth are having unprotected sex and it is becoming a health and safety issue. He also commented on the need for an alternate route to Ko Olina and Kapolei.

4. Johnnie Mae Perry prepared a presentation regarding proposals presented to the Board that have not had any action taken. She believes that this is in violation of the Board and also presented information on the status of how long Board members have served. Ms. Perry also commented on the prerequisites that are needed for a presentation to the Board and was prompted due to the telecommunication projects that have come before the Board. Chair Teruya had to ask Ms. Perry to finish her presentation due to the time constraints. Chair also asked Perry whether she is requesting this item on September agenda. Perry did not respond.

   Point of order was called and Chair Teruya asked that this would be directed towards the Executive Secretary for the Neighborhood Commission Office.

5. Alice U. Greenwood, who resides at Nanakuli Beach Park campsite 1, is a Houseless Maili resident who read a letter regarding the different offenses against the homeless and their constitutional and civil rights.

Meeting was taken out of order to allow for presentation of 7.1 on the agenda: due to Miss Rayford’s health.

Zoning Variance to develop a Multipurpose Community Facility – Honolulu Community Action Program, Inc. (HCAP) 85-555 Farrington Highway Waianae, HI 96702 Tax Map Key 8-0-2:12- Lou Chan & Associates.

Terrance Aratani is the program Chair

Joan White, the Executive Director for HCAP detailed the programs that were provided by the program. She also introduced to the Board the staff which provides service to the Waianae Community especially Daynette Rayford who has worked tirelessly in creating the

Lou Chen and Ryan Yamamoto gave the presentation of the proposed facility with a single floor extension running along Farrington Highway which will include a general meeting room, restrooms with lockers and several class rooms. The parking will be paved and include more parking stalls and the surround area around will be landscaped. The facility was designed in order to create a workable space for the program but at the same time blend into the Waianae Coast area.

Gerald Park commented on the allowances needed in order to gain approval of the permits needed from DPP. Due to the zoning in the area, variances are needed and part of the permit variance would be the support of the community.

Motion to support zoning variance to develop a Multipurpose Community Facility was made by Kelii and seconded by Albert H. Silva.

Discussion:

1. Manaku – Declared his conflict as he is active within the HCAP programs.

The Board voted unanimously to support the zoning variance to develop a Multipurpose Community Facility for HCAP.

The order of the agenda was resumed.

ELECTED OFFICIALS

Board of Education- A representative was not present.

Mayor's Representative- Mr. Ken Shimizu gave the following report:

1. Responses to last month's meeting:

    a. Regarding the request by Clarentia Batongbacal to clean a property that is overgrown and a possible fire hazard, the property near Ulehawa Channel is owned by the City and is under the jurisdiction of the Department of Facility Maintenance. Annual cleanup is scheduled for August/September.

    b. Regarding the request by Board member Manaku, The Department of Parks and Recreation will check the comfort stations that have the standing water and grade those areas to eliminate or diver the water problem. They will also look into the feasibility of establishing more camping sites along the Waianae Coast.

    c. Regarding the request by Board member Waiamau-Nunuha, The division of Urban Forestry (DPR) is responsible for the trimming of all trees and shrubs island wide. Due to the island wide infestation of the Gall Wasp affecting the Wili Wili trees, a large number may have been misdiagnosed as having a lack of water. The maintenance supervisor responsible for the Waianae Coast beach parks reported difficulty in maintaining adequate irrigation of the area due to repeated illegal manipulation of the systems. Repairs to the irrigation system are continually ongoing throughout the Waianae Coast and are dealt with as effectively as possible.

    d. Concerning the question by Board member Kelii, it was reported that the individuals appointed by the Mayor to serve as a member of the Community Benefits and the Oversight Committee were notified by the City of their appointment. In addition, the Mayor's Office put out a press release on the membership of these committees but a formal letter will be sent to everyone who expressed interest.

e. The volunteer who used to maintain the plants for the Lahilahi Botanical Park passed away several years ago and no one has maintained it since.

f. The request on status of the Nanakuli Canoe Halau was reported by the Department of Design and Construction (DDC) that they are negotiating cost with the contractor and construction should start by the end of the year.

g. Regarding whether the Community Benefits package meetings would be held in Waianae, at present the meetings are held at Kapolei Hale, since it is a City building which is available for the committees use. However, the members of the committees can decide when and where to hold their future meetings.

h. Board member Awo requested a response to speeding commercial trucks on the Waianae Coast who have illegible plates. Shimizu reported that under HRS Section 249-7, it prohibits obstruction of license plated or unclean license plates. The location, time and type of truck should be reported to the police so that the area can be monitored and enforcement action can be taken.

Questions, Comments and Concerns:

1. Perry relayed information to Shimizu and asked that he report back at next meeting concerning the presented information to the Board during the community concerns section of the meeting.

2. Kelii reported the dilapidation of the Nanakuli Beach Park Pavilion and asked that it be prioritized in the CIP funds this year.

Councilmember Todd Apo- Todd Apo gave the following reported that the $200 refund of Property taxes will be coming soon to property owners. They are also looking at for the next fiscal year a possible lowering of the residential rate.

Questions, Comments and Concerns:

1. Resident Sato questioned if there was a master list of potential housing for the area or for the entire island. Apo did not believe there was a list but would follow up.

2. Perry relayed information to Apo and asked that he report back to him concerning the presented information to the Board during the community concerns section of the meeting.

Office of United States Representative Ed Case- Randy Obata reported that the farm bill will be expiring soon and Rep. Case will be looking at renewing the different areas in which are still in need of help. He hoped that the Waianae Coast would benefit from the revised bill, especially with the large amount of specialty crops grown by the Waianae agriculture community.

Questions, comments and concerns:

1. Manaku – asked that farm animals be added to the revised farm bill because of the need that many Waianae residents face. It would create a more self reliant Waianae community knowing that they could provide for themselves.

2. Alice Greenwood asked how Rep. Case felt about the Waimanalo Landfill that was on Agricultural land. Obata replied that he would check with

Senator Colleen Hanabusa- A representative was not present. A report was distributed.

Representative Michael P. Kahikina- A representative was not present. A report was distributed.

Representative Maile Shimabukuro- Rep. Shimabukuro gave the following report:

1. On Saturday August 5, 2006 there will be a community clean up of the Waianae Coast primarily around Pokai Bay. Please attend if you would like to help beautify the Waianae Coast.

2. The Waianae High School complex pool has had funds released by the State for repairs. A total of $450,000 has been released and the School hopes to meet with State, City and YMCA officials in order to find an agreement in operating and maintaining the pool.

3. Rep. Shimabukuro is the appointed Chair of a newly created Rule Caucus with several different issues like affordable housing, economic development and land zoning guidelines.

Questions, Comments and Concerns:

1. Manaku – farmers should be encouraged to grow more goods from within the community rather than goods being shipped into the community. Also commented on the term “affordable” and believed that this was not what is actually affordable. Example: $235/month rent being affordable versus buying a home for the “affordable price” of $235,000.

2. Slocum commented on the concurrent resolution that was passed on to Washington D.C. and applauds the work done by Hanabusa and Shimabukuro. Rep. Shimabukuro stated that much of the thanks should be given to Senator Hanabusa who worked tirelessly on this resolution and will share the sentiments.

3. Sato asked how many Charter Schools there were and Shimabukuro stated there were 25 schools and that they were hoping to life the cap because several have closed down or lost accreditation.

Governor’s Representative- Ms. Marie Laderta gave the following report:

1. Laderta thanked the Board for the time provided and introduced the Governor’s homeless representative Mr. Kaulana Park. Mr. Park stated his background in the islands and explained his job as an executive assistant to Micah Kane, Director of The Department of Hawaiian Homelands. He further went on to report the passion and determination in which he felt were the reasons why Governor Linda Lingle appointed him as the homeless representative who would find lasting solutions to this epidemic. In the last 27 days since the Gov. Lingle appointed him they have set up a working office, met with government and community leaders in order to address the problems and have come up with several plans of action including several emergency shelters which will open in the next several months. They understand that the emergency shelters are not permanent situations and so they also targeted permanent housing through affordable housing and rentals. Park asked the community for help with social programs and agencies that will provide lasting help and maintained that the focus of their goals is families with children. Kaulana stated that 200 bed spaces will be targeted by October 1st in Kalaeloa and another 300 at the old UH building.

Questions, comments and concerns:

1. Kaipo commented on the good job that Park has gotten off to in combating the homeless problem.

2. Awana commended the efforts by the Governor and Park with the homeless situation.

3. Kelii welcomed Park to the meetings, whether it is Board, committee or community meetings that would allow him better insight into the homeless situation and the people that are faced with in on a daily basis.

4. Perry stated that the homeless situation is a major priority on the Waianae Coast and that the Governor as well as other governmental agencies is aware.

5. Alice Greenwood asked state status on loading rentals elders on fixed income.

Without objections, Chair Patty Teruya adjourned meeting at 10:24 p.m.

Submitted by:

Vanessa Matautia
Neighborhood Assistant

Reviewed by:

Karen Awana
Chair Patty Teruya