Ko'olau Loa Watershed Management Plan

O'ahu Water Management Plan

August 2009

PREPARED FOR: HONOLULU BOARD OF WATER SUPPLY

PREPARED BY: GROUP 70 INTERNATIONAL

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Watershed Health

A healthy watershed is characterized by natural processes working in dynamic equilibrium: *climate and soils, plant communities and animal communities (including humans), stream flow and streamwater quality, groundwater recharge and groundwater quality -- are all inter-related, inter-dependent, and functioning in a balanced and sustainable way.*

An unhealthy watershed is characterized by disruption and degradation of natural processes and their inter-relationships. *Indicators of an unhealthy watershed include: few or no* ***native*** *plants and animals; an abundance of invasive plants and animals* ***adversely impacting native species****; significant reduction in stream flow and stream water quality, significant increase in erosion, siltation, and flood flows; reduced groundwater quantity and quality.*

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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]

Instream Flow Standard

"a quality 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]

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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, *O'ahu Water Management Plan Technological Reference Document*, Department of General Planning City and County of Honolulu, p. 21.
[3] Wilson Okamoto & Associates, Inc., March 1990, *O'ahu Water Resource Management Plan Technical Reference Document*, Department of General Planning City and County of Honolulu, p. 21.
[4] *Hawai'i Stream Assessment: A Preliminary Appraisal of Hawai'i's Steam Resources*, 1990, p. 9.
[5] American Planning Association Hawai'i 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
[8] HRS §174 C-3, State Water Code.

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]

Groundwater Management Area

A geographic area where it has been determined that "water resources may be threatened by existing or proposed water withdrawals…". Under such a designation, users must first be permitted by CWRM.[14]

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.

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."[15]

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[9] *Oʻahu Water Management Plan*. 1992. p.11
[10] HAR §13-167-2.
[11] HRS §174 C-3, State Water Code.
[12] *Hawaiʻi Stream Assessment: A Preliminary Appraisal of Hawaiʻi's Stream Resources*, 1990, p. 9.
[13] *Hawaiʻi Stream Assessment: A Preliminary Appraisal of Hawaiʻi's Stream Resources*, 1990, p. 9.
[14] HRS §174 C-41, State Water Code
[15] HRS §174 C-3, State Water Code.

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."[16]

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.[17]

Recoverable Yield

The recoverable yield is an estimate of the amount of groundwater that could feasibly be developed for an aquifer system area. The Honolulu Board of Water Supply estimates recoverable yields for its own planning purposes.

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 interrupted. The fact that some parts of the bed or channel have been dredged or improved does not prevent the watercourse from being a stream."[18]

Streams are considered separate entities when they have a separate mouth to the sea.[19]

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."[20]

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."[21]

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

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."[22]

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.[23]

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."[24]

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."[25]

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.[26]

Water Pumpage

The volume of water pumped from a ground water source.

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 (1) specifically, a particular stream, other surface water body, spring, tunnel, or well or related combination thereof."[27]

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.

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[22] HAR §13-167-2.
[23] *O'ahu Water Management Plan*. 1992. p. 3
[24] HAR §13-167-2.
[25] HAR §13-167-2.
[26] *O'ahu Water Management Plan*. 1992. p. 7
[27] HAR §13-167-2.

ACRONYMS

AWUDP	Agricultural Water Use and Development Plan
BWS	Honolulu Board of Water Supply
CP	Capital Program
CWA	Clean Water Act
CWRM	State of Hawai'i Commission on Water Resource Management
CY	Calendar Year
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOH	State of Hawai'i Department of Health
DP	Development Plan
EPA	United States Environmental Protection Agency
FY	Fiscal Year
GIS	Geographic Information System
GP	General Plan
GPD	Gallons Per Day
GWMA	Groundwater Management Area
HWP	Hawai'i Water Plan
HRS	Hawai'i Revised Statutes
HSA	Hawai'i Steam Assessment
IFS	Instream Flow Standard
KSCP	Ko'olau Loa Sustainable Communities Plan
KLWMP	Ko'olau Loa Watershed Management Plan
MGD	Millions of Gallon Per Day
NRCS	United States Department of Agriculture Natural Resources Conservation Service
OWMP	O'ahu Water Management Plan
SCP	Sustainable Communities Plan
SDWA	Safe Drinking Water Act
SWAP	Source Water Assessment Program
SWPP	State Water Projects Plan
SWQP	State Water Quality Plan
SY	Sustainable Yield
U.S.	United States
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMA	Watershed Management Area
WMP	Watershed Management Plan
WQP	Water Quality Plan
WRPP	Water Resources Protection Plan
WUZ	Water Use Zone

OV

O'AHU WATER MANAGEMENT PLAN OVERVIEW

OV O‘AHU WATER MANAGEMENT PLAN OVERVIEW

OV.1 AUTHORITY AND PURPOSE
OV.2 BWS MISSION
OV.3 O‘AHU WATER MANAGEMENT PLAN FRAMEWORK
OV.4 O‘AHU WATER USE AND DEVELOPMENT
OV.5 PLAN IMPLEMENTATION

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 & 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.

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

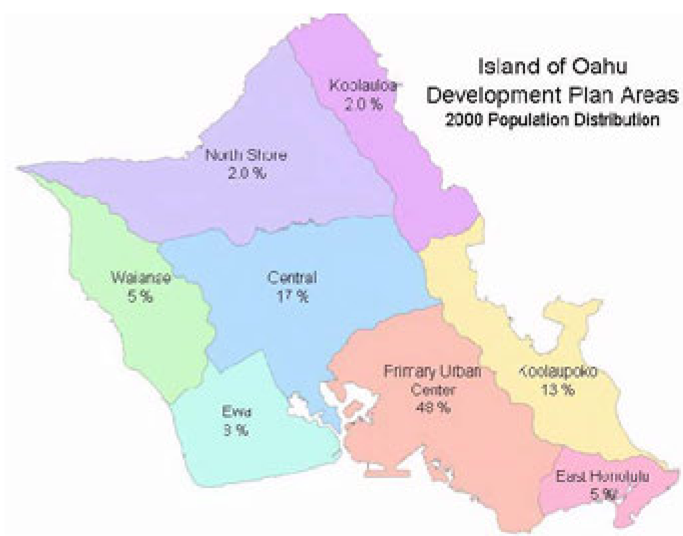

Figure OV.1 O‘ahu Development Plan Areas

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 O‘ahu’s surface water and groundwater 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
- Hawai'i State Water Plan
- State Water Code
- Statewide Framework for Updating the Hawai'i Water Plan
- Hawai'i Supreme Court Decisions on the Waiāhole Ditch and the Wai'ola O Moloka'i 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 O'ahu by providing world-class water services in a manner that:

- Protects the environment, including groundwater, watersheds, streams, and shoreline areas.
- Supports O'ahu'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 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.

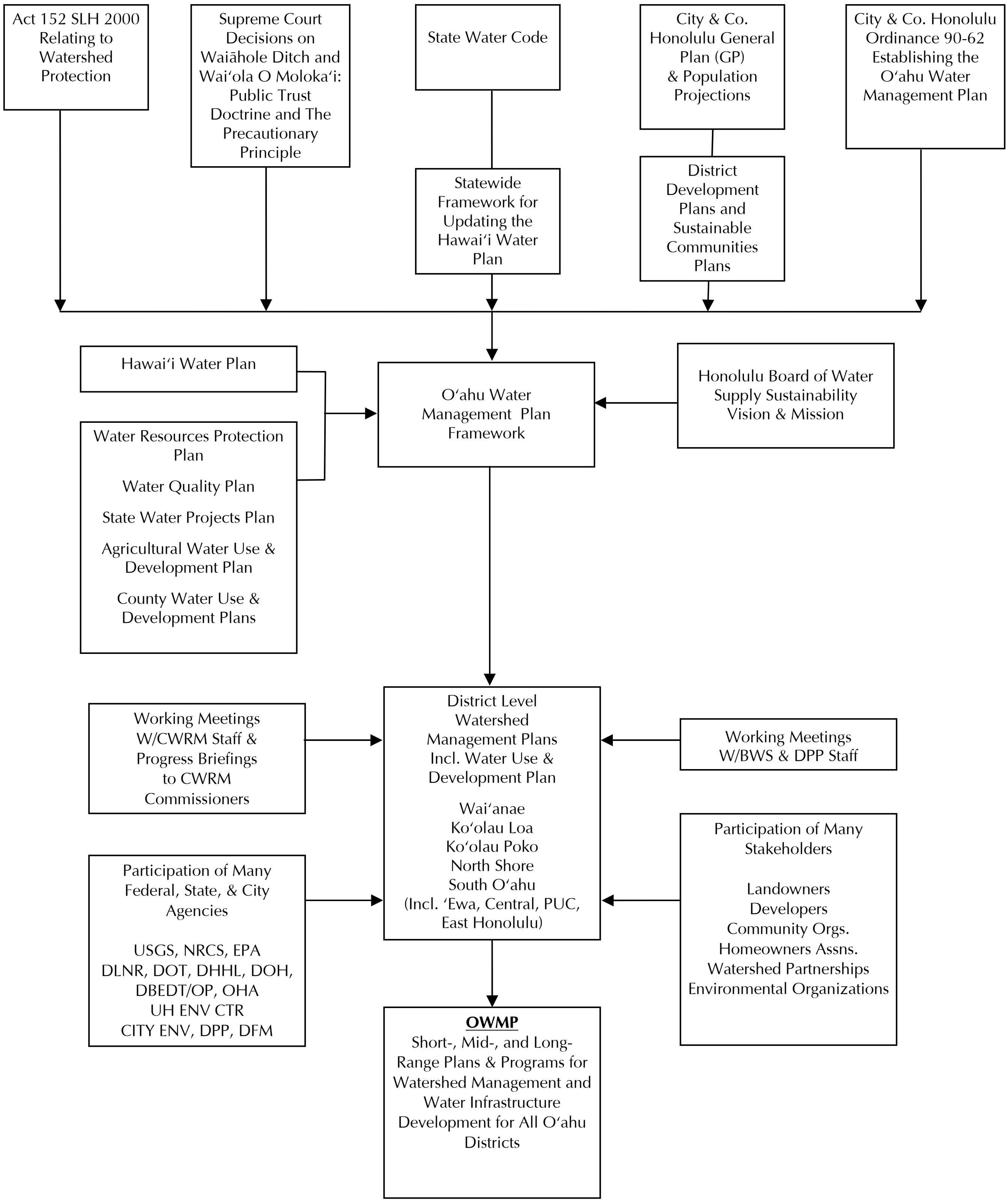

Figure OV.2 Watershed Management Plans for O‘ahu State and County Level Planning Framework Diagram

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 groundwater 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, groundwater 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 groundwater 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 groundwater 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 groundwater 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 groundwater aquifers and streams. The agencies will work together to fund, construct and utilize 3-dimensional solute transport groundwater 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 groundwater 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 Hawai‘i 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 In re Water Use Permit Applications, 94 Hawai‘i 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 groundwater sources that do not impact surface waters. However, if instream flow standards are established and surface water becomes available, groundwater 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 groundwater, 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 groundwater, surface water, recycled water, desalinated water and seawater resources maximizes system reliability especially during periods of drought, high growth spurts and impacts from groundwater 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

OV.4.1 Population Forecasts and Municipal Water Demand
OV.4.2 Agricultural Water Demand
OV.4.3 Groundwater Availability
OV.4.4 Surface Water Availability
OV.4.5 Planned Source Development
OV.4.6 Summary of Supply, Demand and Population Distribution
OV.4.7 Uncertainties and Contingencies

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 groundwater 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

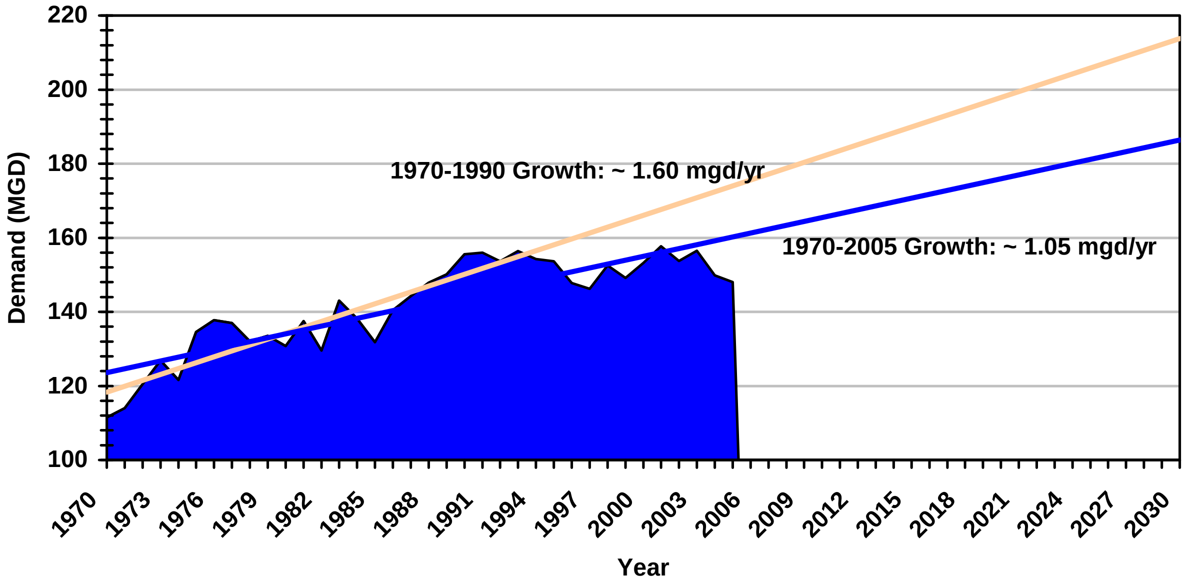

Figure OV.3 BWS Water System Demand Projections: Actual 1970 – 2005 and Linear Projection to 2030

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 groundwater use as of July 2005. Municipal groundwater use constitutes 80.5% of the total, with military, agriculture and irrigation and other uses taking up the remainder. Agriculture groundwater 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 Groundwater 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 groundwater by user including Waiāhole Ditch water uses but excluding saltwater and caprock water uses.

Table OV.3 O'ahu's Top Groundwater 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 an 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 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 Hawai'i's diversified agriculture industry.

Figure OV.4 shows the agricultural zoned lands on O'ahu with the four major irrigation systems: Waiāhole Ditch, Kaukonahua, Waimānalo and Punalu'u. 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.

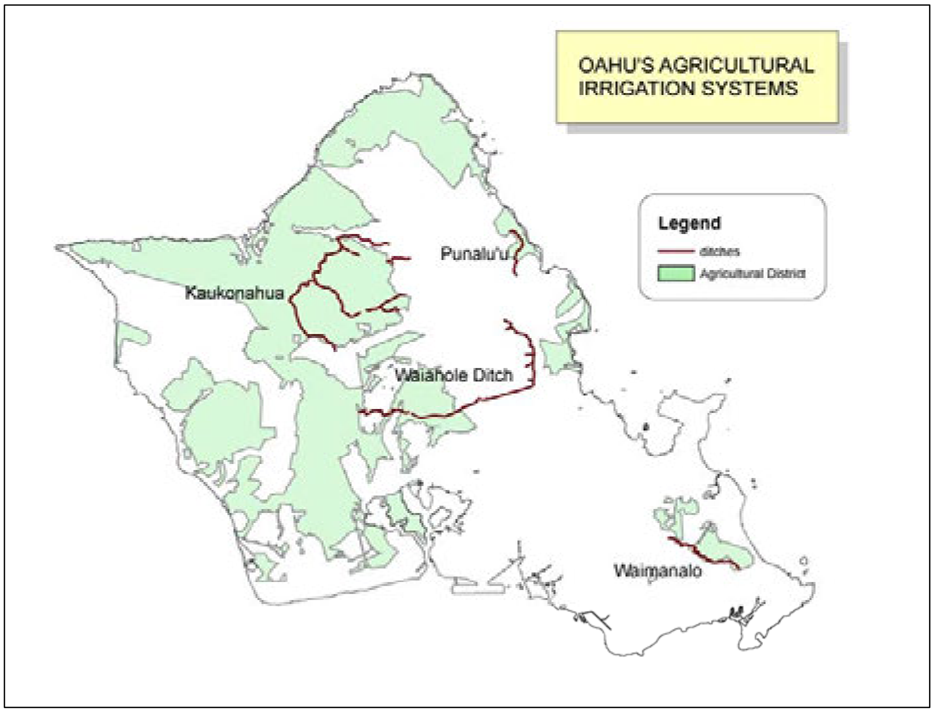

Figure OV.4 Agricultural Zoned Lands on O'ahu

Large tracts of agricultural lands exist in the 'Ewa, Central O'ahu, North Shore and Ko'olau 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 O'ahu

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 O'ahu	10,350	3,400	35
'Ewa	3,000	3,400	10
Ko'olau 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 'Ewa Caprock aquifer system area already provide a portion of this total. Additional potable groundwater supplies in Waialua, Kawailoa, Wahiawā and Waipahu-Waiawa could provide supplemental agricultural water supply. Groundwater development is more costly for agriculture than gravity and surface water sources and may compete with urban uses.

Diversified agriculture and traditional lo‘i kalo occur in the other districts as well. Ko‘olau 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 Ko‘olau Poko WMP. Agricultural water demands in Wai‘anae, 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, Mokulē‘ia 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 Groundwater Availability

The table of Sustainable Yield and Groundwater 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 groundwater 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 Groundwater 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	Waiʻalae-East		2	0.790	1.210	0.193	1.807
	Waiʻalae-West		4	2.797	1.203	0.385	3.615
	Pālolo		5	5.646	-0.646	4.431	0.569
	Nuʻuanu	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
	ʻEwa-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
Waiʻanae	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
	Waiʻanae	2	3	0.000	3.000	2.515	0.485
	Makaha	2,6	3	0.000	3.000	1.767	1.233
	Keaʻau	2,4	4	0.000	4.000	0.000	4.000
Total Waiʻanae			16	0.000	16.000	4.546	11.454
North	Mokulēʻia	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	Koʻolau Loa	6	36	21.508	14.492	9.738	26.262
	Kahana	4,6	15	1.101	13.899	0.085	14.915
	Koʻolau 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
ʻEwa Caprock	Malakole	5	1,000 mg/l	5.928		5.800	
	Kapolei	5	1,000 mg/l	2.033		0.471	
	Puʻuloa	5	1,000 mg/l	14.817		2.417	
Total ʻEwa 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 Waiʻanae is not a designated water management area, therefore, there is no permitted use.
3 Waiheʻe Tunnel + Waiheʻe 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 ʻEwa Caprock Sector Area. Excludes Waiāhole Ditch.

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

Table OV.6 Summary of Available Groundwater 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 groundwater 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 groundwater, 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 O'ahu's largest perennial streams.

Table OV.7 O'ahu's Largest Streams and Mean Flows 2004

Stream Name	USGS Stream Gage No.	Mean Flow 2004 (CFS)	Mean Flow 2004 (MGD)
Punalu'u	16303000	21.3	13.8
Kahana	16296500	53.5	34.6
Waikāne	16294900	19.1	12.3
Waiāhole	16294100	55.0	35.6
Waihe'e	16284200	9.21	6.0
Kamo'oali'i - Kāne'ohe	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
Ōpae'ula	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 nonpotable sources such as recycled water and desalination are listed in *Table OV.9*.

Table OV.8 Potential Groundwater Resources of Potable Water

	New Groundwater 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	Ko'olauloa	Ko'olauloa
2.	'Ōpana Wells	1.0	1.0	Ko'olauloa	Ko'olauloa
3.	Kaipapa'u Well (1)	1.0		Ko'olauloa	Ko'olaupoko
4.	Kaluanui Wells * (1)	1.5		Ko'olauloa	Ko'olaupoko
5.	Ma'akua Wells * (1)	1.0		Ko'olauloa	Ko'olaupoko
6.	Kū'ou Well III *	0.5		Ko'olaupoko	Ko'olaupoko
7.	Waimānalo Well III *	0.5	0.3	Waimānalo	Ko'olaupoko
8.	'Āina Koa Well II *	0.7		Waialae-West	East Honolulu
9.	Wai'alae Nui Well *	0.7		Waialae-West	East Honolulu
10.	Wahiawā Well III	3.0	3.0	Wahiawā	Central
11.	Waipi'o 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	'Ewa, Wai'anae
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	'Ewa, Wai'anae
19.	'Ewa Shaft *	10.0	3.0	Waipahu-Waiawa	'Ewa
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 Punalu'u 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 groundwater sources and alternative potable and nonpotable sources.

Resource	Quantity (mgd)
Groundwater – Potable	47
Desalination – Potable (minimum estimate)	5
Recycled Water (minimum estimate)	17
Groundwater – 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 groundwater 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.

Groundwater supplies will be constructed utilizing available sustainable yield including released agricultural water for agricultural lands rezoned to urban use. Groundwater supply evaluations will be conducted to refine available groundwater 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 groundwater 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 groundwater 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 groundwater available on O'ahu in 2005 (*Table OV.6*) is able to meet <u>most of</u> 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 groundwater, 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 groundwater, 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.

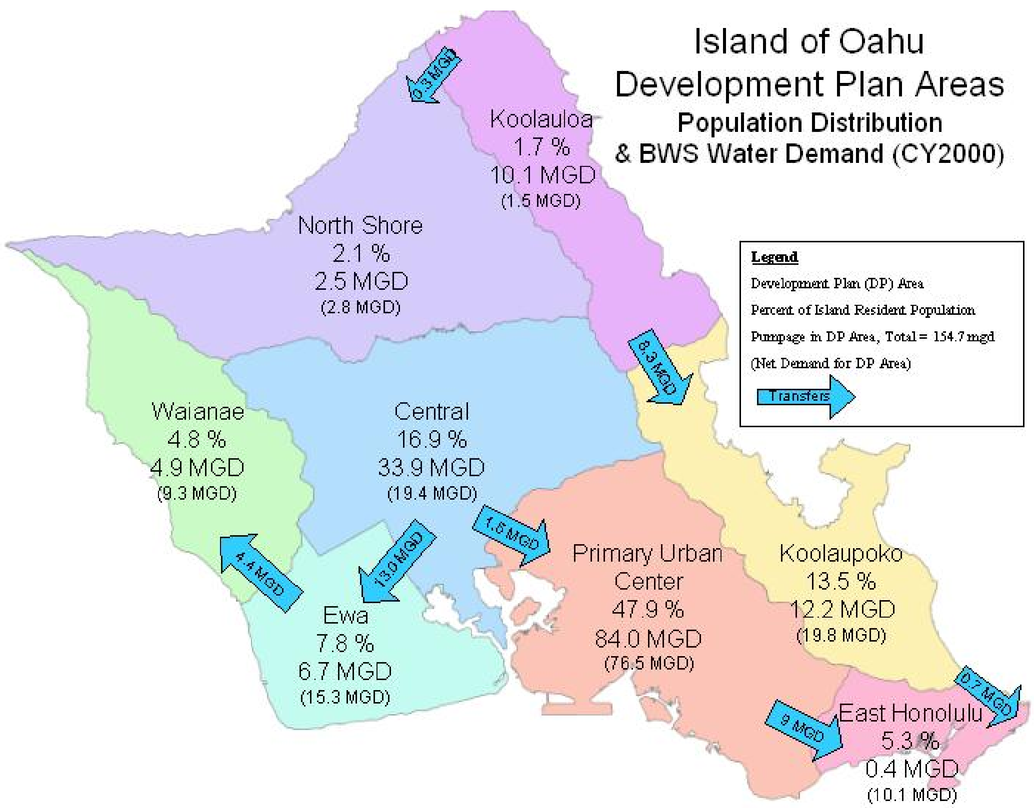

Figure OV.5 Population and Potable Water Demand Distribution 2000

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.

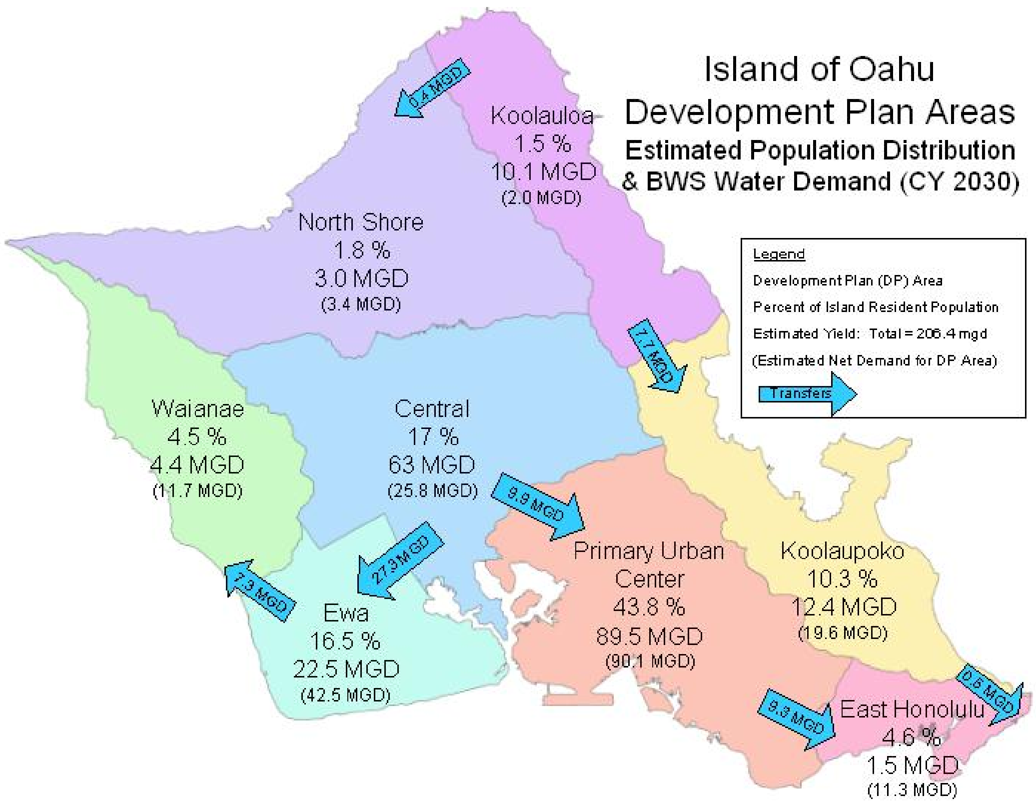

Figure OV.6 Estimated Population Distribution and Potable Water Demand 2030

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, groundwater, existing stream diversions, recycled water and desalination. New potable groundwater sources will be developed utilizing released agricultural groundwater in the Pearl Harbor aquifer. Brackish 'Ewa Plantation wells will continue to be converted for urban irrigation in 'Ewa to supplement potable groundwater. New 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 groundwater in 'Ewa.
- Projected water demand in Ko'olau Loa of 0.5 mgd can be met with conservation, existing and planned groundwater sources and recycled water within the district.
  - Groundwater 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.
  - Groundwater 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 groundwater 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 groundwater sustainable yields, a reasonable accounting of uncertainties, planned groundwater 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.

Groundwater Supply Uncertainties

Estimating Sustainable Yield

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.

Recoverability of Sustainable Yield

Recoverability is the ability to feasibly extract groundwater through wells or tunnels, up to the adopted sustainable yield. Recoverability is a major uncertainty due to surface and groundwater 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 groundwater 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]

Groundwater Contamination

Contaminants infiltrating into groundwater 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 groundwater contamination.

Recommended Contingency Plans for Groundwater Supply Uncertainties

Groundwater 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 groundwater 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 groundwater models to improve sustainable yield estimates. CWRM with BWS, USGS and the Navy participating, has created the Pearl Harbor Groundwater 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 groundwater 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 groundwater 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 groundwater plan and other progressively increasing conservation measures to reduce water demands.
    - Develop additional groundwater 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 Groundwater 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.

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 O‘ahu 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 O‘ahu’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 O‘ahu 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 groundwater 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 groundwater leakage as base flow, and is impacted more readily during drought than groundwater. Extended drought can have dire implications, especially for agriculture, much of which relies solely on surface water for irrigation.

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 groundwater 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 groundwater, 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 Groundwater)* shows the seasonal relationship between surface water in conjunction with groundwater for agricultural irrigation. During dry seasons and drought, when demand increases and limited stream water is available, groundwater 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 groundwater source to be replenished.

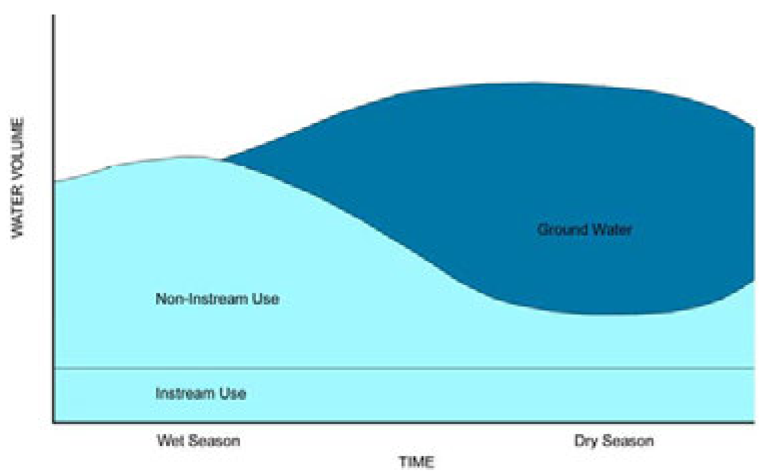

Figure OV.7 Seasonal Agricultural Water Use Supplementing Surface Water with Groundwater

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.

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 groundwater 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

ES

Executive Summary

ES Executive Summary

ES.1 INTRODUCTION
ES.2 KOʻOLAU LOA DISTRICT
ES.3 PLAN GOALS, OBJECTIVES AND SUB-OBJECTIVES
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ES.1 INTRODUCTION

The Koʻolau Loa Watershed Management Plan (KLWMP) provides a long range, 25 year plan, to the year 2030 for the protection, preservation, restoration, and balanced management of groundwater, surface water and related watershed resources for the Koʻolau Loa District on the island of Oʻahu. The KLWMP 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 together will form the Oʻahu Water Management Plan.

The Honolulu Board of Water Supply (BWS) has developed the KLWMP 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 *(Figure ES.1)* included extensive consultation with the Koʻolau Loa residents, community organizations, major landowners, and public agencies with a role in land and water planning and use. BWS began the KLWMP process in August 2004 and published a Public Review Draft of the KLWMP in October 2006.

The Public Review Draft was posted on the BWS website, and hard copies of the document were mailed to community members who have been part of the project's Working Group, an extension of the Koʻolauloa Neighborhood Board No. 28 Water Committee. Based on comments received, the KLWMP was revised to create a Pre-Final version of the Plan. The Pre-Final KLWMP was submitted to the Honolulu City Council and the CWRM for adoption/approval.

This Executive Summary provides a brief synopsis of findings and recommendations of the KLWMP.

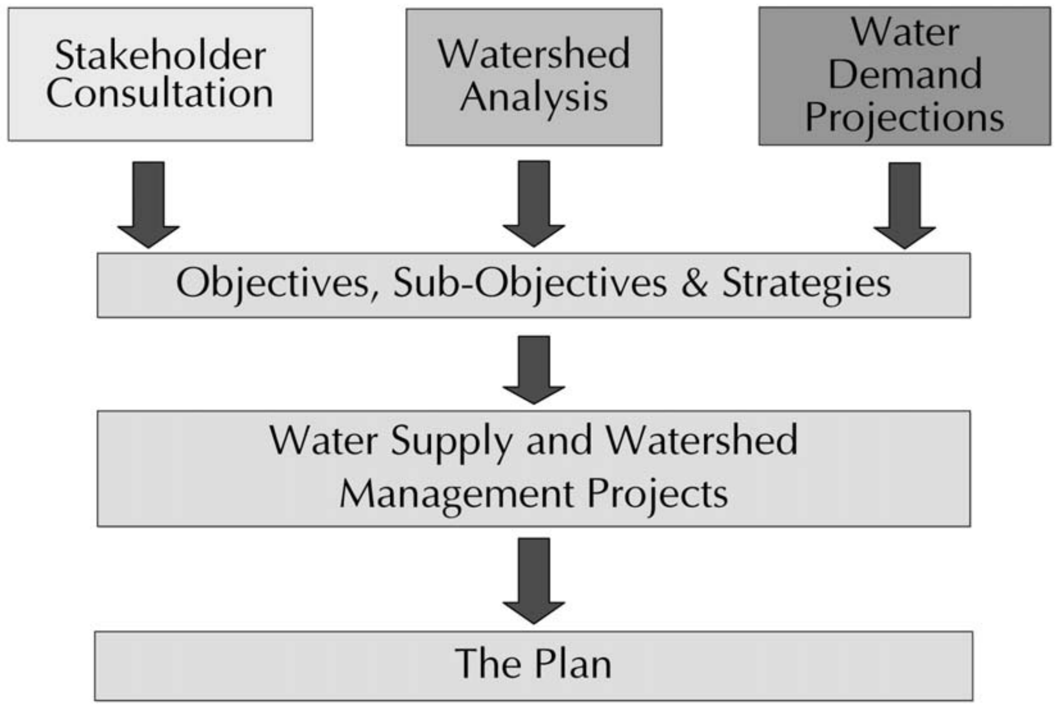


Figure ES.1 Koʻolau Loa Watershed Management Plan Process

ES.2 KOʻOLAU LOA DISTRICT

The Koʻolau Loa District encompasses roughly 37,135 acres and includes those lands of the upper Windward Oʻahu coastline that lie between Waialeʻe to the North and Kualoa to the South. The District is bounded by the Koʻolau mountain range to the west and the Pacific Ocean to the east. Koʻolau Loa is a traditionally rural area that includes the coastal settlements of Kahuku, Lāʻie, Hauʻula, Punaluʻu, Kahana, and Kaʻaʻawa. While much of the District's population now commutes out of the District to work, many residents still maintain their rural lifestyles. Koʻolau Loa has rich natural resources, and its residents continue to strengthen their social and cultural identity and maintain their rural way of life.

ES.3 PLAN GOALS, OBJECTIVES AND SUB-OBJECTIVES

Each district's Watershed Management Plan for Oʻahu will have the same overall goal and same major objectives to provide consistency. More detailed sub-objectives result from the stakeholder consultation process and capture the regional issues and district specific concerns.

The overall goal of the Watershed Management Plans is:

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

Stakeholder Values and Issues

The discussions held with stakeholders throughout Koʻolau Loa indicate there are critical values and principles that are held by residents of this community, which apply directly to watersheds in Koʻolau Loa. These values and principles include:

1) Sustaining the Rural Lifestyle of Koʻolau Loa
2) Cultural and Traditional Water Uses
3) Natural Resources & Watershed Ecology (holistic view)
4) Healthy and Plentiful Water Supply for Community (waiwai)
5) Preserving Agricultural Uses and Water Supply
6) Watershed Protection and Management Responsibilities

Many of these key values relating to the watershed were previously identified in the Sustainable Communities Plan process conducted from 1997 to 1999.

Also from the stakeholder discussion many issues arose, and these issues are listed below.

1) Relationship of Watershed Plan to Koʻolau Loa Land Use
2) Cultural and Traditional Water Uses
3) Koʻolau Loa Groundwater Quantities and Yield Potential Compatible with the Long-term Health of the Watershed
4) Plan Effects on Private Lands, Water Sources and Systems
5) Water Uses and Allocation
6) Punaluʻu Watershed Alliance Model
7) Instream Flow Standards, Species and Protected Habitat
8) Flooding Issues in Koʻolau Loa Watersheds
9) Kahuku Training Area – Stryker Brigade
10) Polluted Runoff Control and Ocean Protection
11) Policy Limits on Future Source Development in Koʻolau Loa
12) Forestry Management
13) Climate Change and Sea Level Rise

Plan Objectives & Sub-Objectives

The plan objectives are consistent for the eight O'ahu Watershed Management Plans, but the sub-objectives below reflect the Ko'olau Loa district environmental conditions and specific stakeholder issues and values.

OBJECTIVE #1: Promote Sustainable Watersheds

- *Strive to* ***protect and enhance natural resources*** *including land, streams and nearshore waters ecosystems.*
- *Strive to* ***set*** *measurable* ***instream flow standards****.*
- *Collaborate with responsible agencies to identify and implement environmentally friendly measures to* ***alleviate flooding issues and reduce pollution caused by runoff****.*
- *Promote initiatives that protect and* ***preserve species and habitat biodiversity****, particularly native species.*
- ***Ensure the export of water from Ko'olau Loa will not be detrimental to Ko'olau Loa****.*

OBJECTIVE #2: Protect and Enhance Water Quality and Quantity

- *Maintain and improve water* ***quality and quantity of groundwater.***
- *Maintain and improve water* ***quality and quantity of surface waters****.*
- *Maintain and improve the water* ***quality of nearshore waters****.*

OBJECTIVE #3: Protect Native Hawaiian Rights and Traditional & Customary Practices

- *Plan for the* ***enhancement of Native Hawaiian water rights*** *and cultural and traditional uses.*
- ***Consult with Native Hawaiian agencies/communities*** *on water-related issues.*

OBJECTIVE #4: Facilitate Public Participation, Education, and Project Implementation

- ***Implement watershed management projects and programs*** *through a combination of agency initiatives, watershed partnerships and community-based implementation entities.*
- ***Develop watershed protection curriculum*** *and programs to educate future generations and make curriculum available to area schools and organizations.*
- ***Empower residents to*** *facilitate public participation in water resources planning and management.*
- ***Provide education on watershed issues and protection and water conservation measures*** *to the general public.*
- ***Obtain funding*** *to implement the plan's projects and programs; funding types may include dedicated sources, grants and appropriations.*

OBJECTIVE #5: Meet Water Demands at Reasonable Costs

- ***Provide water at a reasonable cost*** *to the community in a way that provides for the long term health of the watershed.*
- *Efficiently* ***meet water demand****s and match quality (i.e. potable, brackish, recycled) with use (drinking, irrigation, etc.).*
- *Maintain and improve* ***BWS system reliability****.*

ES.4 PROPOSED PROJECTS

The projects below and Figure ES.2 have been identified as those which benefit the overall watershed and those used to supply water to meet current and future demands. They were developed based on the specific Koʻolau Loa plan sub-objectives. The projects are grouped into general categories based on area of the watershed. The project list identified in this plan does not preclude projects being added before the 5-year update of the plan.

The proposed projects of 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, and the implementation and funding of these projects are not the sole responsibility of the Board of Water Supply, the City and County of Honolulu, or the State of Hawaiʻi. This plan is intended to guide agencies and organizations in implementing the most important initiatives for Koʻolau Loa watersheds and water resources; however, implementation will likely depend on budgetary priorities, grant availability and partnering efforts over the long term.

Surface Water

- **Flood Control / Stormwater Management**
- Flood Channel Redesign
- **Measurable Instream Flow Standards**
- **Stream Water Quality Testing**
- **Nearshore Water Monitoring**

Groundwater

- **Sustainable Yield Estimates**
- **Groundwater Source Protection**
- Drought Mitigation Strategies
- **Punaluʻu Pumpage Optimization**

Land Management

- Stream Clearing / Management
- **Stream Conservation Buffers**
- Cesspool Inventory / Greywater Reuse
- **Pollution Prevention / Low Impact Development**
- **Invasive Species Assessment / Control**
- Feral Pig Management Plan
- **Muliwai / Wetland Restoration**
- Conservation District Boundary Review
- Wildfire Management Plan
- Crop Water Demand

Cultural Resources / Traditional Practices

- Loʻi Kalo Expansion
- Watershed Oral History Studies
- Cultural Educational Programs
- Fishpond (Loko Iʻa) Restoration
- Cultural Monitoring Program

Implementation

- Watershed Partnerships
- Water & Watershed Education
- **Koʻolau Loa Implementation Entity**
- Grant Funding

Water Supply

- Potable Well Development
- Agriculture (Non-Potable) Well Development
- **Increased Recycled Water**
- **Conservation Measures**
- Agricultural Water Loss Minimization
- Surface Water Use

The bold projects are priority projects designated by the community working group.

Figure ES.2 Managing the Ahupuaʻa Watershed

ES.5 EXISTING USE AND FUTURE WATER DEMANDS

Existing Water Use

The three main sources of water in Koʻolau Loa are ground, surface, and recycled water *(Figure ES.3)*. Groundwater supplies most of the Koʻolau Loa residential, commercial and agricultural needs and supplies water to Kailua, Kāneʻohe and Waimānalo in Koʻolau Poko. Surface water provides agricultural irrigation water for Punaluʻu and Kahana Valleys in Koʻolau Loa. Recycled water supplies some of the district's irrigation water needs in Lāʻie and at Turtle Bay.

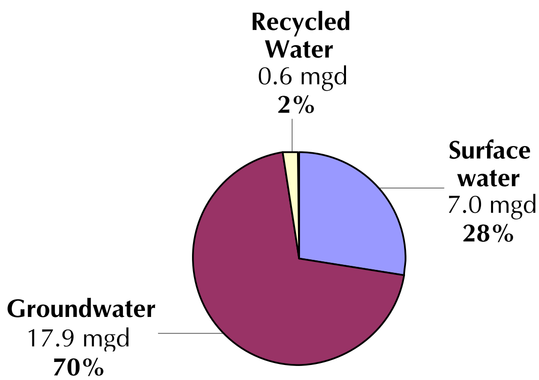


Figure ES.3 Koʻolau Loa District Water Sources (2000)

The Board of Water Supply delivery of drinking quality water is via three separate BWS systems. At the north end of Koʻolau Loa is the BWS Waialeʻe system that supplies the Kawela area of Koʻolau Loa. Waialeʻe Wells I and II are the water sources for this end of the system. Although this system is connected to the BWS Waialua-Haleʻiwa system, water transfer between the areas is considered minimal. The BWS Kahuku system supplies users in Kahuku and Mālaekahana and is not connected to other BWS systems. The Kahuku wells are the water source for this system. To the south of Lāʻie, the BWS system supplies water for both Koʻolau Loa communities of Hauʻula, Punaluʻu, Kahana and Kaʻaʻawa and Koʻolau Poko (Kailua, Kāneʻohe and Waimānalo).

Lāʻie Water Company is the provider of potable water to the Lāʻie community via their privately owned and operated system.

Future Water Demands

Water demands were projected through the year 2030. These projections provide an estimate of the amount of water needed over the next 25 years, and point to periods when increased demand may require infrastructure improvements.

Three scenarios of future water demand estimates are calculated. The domestic water usage is based upon the City and County of Honolulu Department of Planning and Permitting and State Department of Business, Economic Development and Tourism forecasts of population, jobs, and/or land use in five year increments from the year 2000 through 2030. Using these scenarios also fulfills the Statewide Framework's directive that, "*…demand forecasts shall be consistent with county land use plans, development plans and/or community plans*." The mid/policy demand scenario is consistent with the Koʻolau Loa Sustainable Communities Plan. Three distinct scenarios were developed for Koʻolau Loa *(Figure ES.4)*. The water demands include the nearly 8 mgd supplied to Kailua, Kāneʻohe, and Waimānalo in Koʻolau Poko District.

Table ES.1 Projected Demands

USE/SCENARIO	2000	2005	2010	2015	2020	2025	2030
Non-Potable Ag – Low Scenario	13.4	13.4	13.4	13.4	13.4	13.4	13.4
Non-Potable Ag – Mid Scenario	13.4	13.9	14.5	15.2	15.8	16.6	17.4
Non-Potable Ag – High Scenario	13.4	14.2	15.1	16.1	17.2	18.4	19.8
Non-Potable Other – Low Scenario	1.7	2.1	2.1	2.1	2.4	2.8	3.1
Non-Potable Other – Mid Scenario	1.7	2.1	2.2	2.2	2.5	2.8	3.2
Non-Potable Other – High Scenario	1.7	2.3	2.4	2.5	2.9	3.3	3.7
Lāʻie Water – Low Scenario	1.0	1.1	1.2	1.2	1.3	1.3	1.4
Lāʻie Water – Mid Scenario	1.0	1.2	1.3	1.4	1.5	1.5	1.6
Lāʻie Water – High Scenario	1.0	1.2	1.4	1.5	1.6	1.7	1.8
Non-BWS Subtotal – Low Scenario	**16.1**	**16.6**	**16.7**	**16.7**	**17.1**	**17.5**	**17.9**
Non-BWS Subtotal – Mid Scenario	**16.1**	**17.2**	**18**	**18.8**	**19.8**	**20.9**	**22.2**
Non-BWS Subtotal – High Scenario	**16.1**	**17.7**	**18.9**	**20.1**	**21.7**	**23.4**	**25.3**
BWS Koʻolau Loa – Low Scenario	1.5	1.6	1.7	1.7	1.7	1.8	1.8
BWS Koʻolau Loa – Mid Scenario	1.5	1.6	1.9	1.9	1.9	2.0	2.1
BWS Koʻolau Loa – High Scenario	1.5	1.8	2.0	2.3	2.6	2.9	3.1
BWS export to Koʻolau Poko and North Shore – Low Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS export to Koʻolau Poko and North Shore – Mid Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS export to Koʻolau Poko and North Shore – High Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS Subtotal – Low Scenario	**10.1**	**10.2**	**10.3**	**10.3**	**10.3**	**10.4**	**10.4**
BWS Subtotal – Mid Scenario	**10.1**	**10.2**	**10.5**	**10.5**	**10.5**	**10.6**	**10.7**
BWS Subtotal – High Scenario	**10.1**	**10.4**	**10.6**	**10.9**	**11.2**	**11.5**	**11.7**
TOTAL – LOW SCENARIO	**26.1**	**26.8**	**27.0**	**27.1**	**27.4**	**27.9**	**28.4**
TOTAL – MID SCENARIO	**26.1**	**27.4**	**28.5**	**29.3**	**30.3**	**31.5**	**32.9**
TOTAL – HIGH SCENARIO	**26.1**	**28.1**	**29.5**	**31.0**	**32.9**	**34.9**	**37.0**

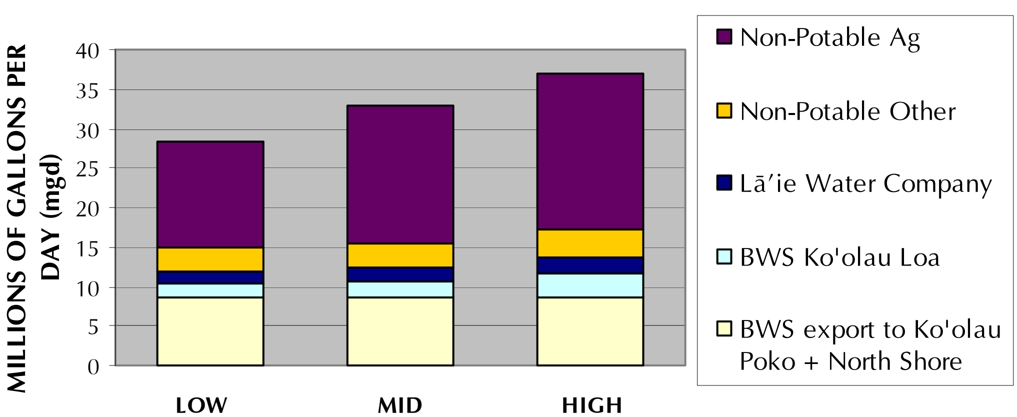


Figure ES.4 Water Projection Scenarios Summary - 2030 Projected Demand Low-Mid-High Comparisons

ES.6 MEETING FUTURE DEMANDS

Potable water demands should be met with potable water and non-potable water needs with non-potable water. However, in Ko'olau Loa, and around O'ahu, potable water is far more abundant than non-potable water, so potable water is commonly used to meet non-potable demand.

The challenge is to find cost effective alternatives to groundwater that can be used for non-potable / lower water quality demands to ensure ample high quality groundwater remains for existing and future use. The overall strategy for Ko'olau Loa is to develop appropriate and available alternatives.

Diversification in water supply resources is beneficial for increasing the reliability of supply. For example, recycled water provides a relatively drought resistant irrigation water supply. Recycled water, water conservation and agriculture water loss minimization are the alternatives for Ko'olau Loa.

Water Conservation

Water conservation reduces water loss and makes available more water for use, so that less groundwater or surface water is needed to meet existing demands. Water conservation also increase the existing system capacity for future needs.

The BWS infrastructure water loss program of leak detection and repair focuses on reducing the amount of system leakage. The BWS consumer programs focus on a variety of areas from changing behaviors to installation of water saving devices to reduce per capita demand.

The water conservation goal for Ko'olau Loa due to the wet climate is a 5% reduction in forecasted demand. The water conservation programs (such as rebates) used to accomplish this are listed in the project description *(Project 6d)*. Water conservation is an ongoing effort that will continue as long as water is supplied to O'ahu users.

Agricultural Water Loss Minimization

Water conservation, practices, devices, and repairs to reduce water usage are a responsibility of everyone using water. Agricultural water loss minimization can mean less ground or surface water is then needed.

Increased Recycled Water

Opportunities for recycled water in Ko'olau Loa are limited to areas where sewer collection systems and treatment plants exist, and encounter fiscal barriers when compared to groundwater. To increase usage of this resource, a more competitive pricing structure would be needed. An alternative to pricing would be mandating the use of recycled water where available. However, higher prices would likely place a burden on farmers operating in already tenuous situations. Government agencies could mandate themselves to use recycled water where available but would need to fund the associated capital and operating costs. Private developments creating non-potable demand will be required to investigate, develop and use recycled water.

Recycled water opportunities are listed below:

- Turtle Bay Resort recycled water will continue to be fully used on their golf courses and would increase with the expansion of the resort.
- Lāʻie Water Reclamation Facility recycled water at Brigham Young University - Hawaiʻi will continue to be used. The use of larger quantities of recycled water by others in Lāʻie is dependent on a changing market or market subsidies because of the higher cost compared to groundwater.
- Kahuku Wastewater Treatment Plant (WWTP) recycled water will be required for increased irrigation of Kahuku Golf Course. Additional filtration, disinfection, and a distribution system are needed.
- Waimānalo WWTP will require funding for the additional treatment and distribution. And, the recycled water will need to be designated to replace current BWS potable water in order to reduce demands on Koʻolau Loa water.

Surface Water

This Plan does not plan to allocate surface water, because measurable instream flow standards have not been set. However, the possible outcomes of measurable instream flow standards are three-fold:

a) The instream flow standard adequately protects instream uses, allows for current surface water diversions (if any), and additional surface water is available for non-instream use.
b) The instream flow standard adequately protects instream uses and allows for current surface water diversion (if any), but surface water is not available for additional non-instream uses.
c) The current streamflow is below the instream flow standard, therefore surface water from current surface water diversions must be restored to the stream.

The assumption for this plan is (b), that the current amounts of diversion and instream uses are maintained pending the setting of measurable instream flow standards. As with groundwater, surface water should be used wisely and not wasted. Unused stream diversions should be returned to the stream, or not diverted in the first place. Additional water from a diversion is only possible by decreasing system losses and increasing conservation as discussed in *Project 6e, Agricultural Water Loss Minimization.*

The two streams with significant flow and agricultural diversions are Punaluʻu and Kahana streams. For the Punaluʻu stream considerable study and progress has been made toward the establishment of new measurable instream flow standards. The Punaluʻu Ditch system is the primary means for distributing surface water in that valley. CWRM in the Waiāhole Ditch Contested Case has amended the interim instream flow standards for Kahana Stream with a quantified stream flow of 13.3 mgd.

One limitation to using surface water is the lack of reliability especially during periods of drought. By increasing the diversity of water sources, more irrigation water may be available year round. During drought periods when limited stream water is available, groundwater could be used to supplement or in lieu of surface water. During high rainfall periods, surface water can be used for irrigation and allow the groundwater source to be replenished. Surface water storage for drought periods may also extend the ability to irrigate.

Groundwater

Koʻolau Loa has groundwater resources that supply most of the district's water needs. The Koʻolau Loa Ground Water Management Area (GWMA) has basal water in mid to low valleys. Kahana GWMA, like Koʻolau Poko and Waimānalo GWMA consist of dike formations, and withdrawals in these areas may affect stream flow and amendments to the interim instream flow standards are needed.

The 2030 projected demands are below the CWRM's sustainable yields. The sustainable yields across the state were updated in August 2008. Koʻolau Loa GWMA is 36 mgd and Kahana GWMA is 15 mgd. The new well development projects for potable water use are shown in *Table ES.2* below.

Table ES.2 Groundwater Wells: Permit Amounts and Phasing

Existing/ New Well	State Well No.	Current Permitted Amount	Potential Permitted Amount	GWMA	Capital Costs	Phase	Note
New Mālaekahana (BWS)	3957-08 and -09	--	1.0 mgd	Koʻolau Loa	Low	Mid	Kahuku growth
New ʻŌpana Wells[1]	4100-02 to -05	--	1.0 mgd	Koʻolau Loa	Low	Short	Turtle Bay growth
Existing Lāʻie Wells (LWC)	3855-06	1.375 mgd	1.7 mgd	Koʻolau Loa	Low	Short	Lāʻie growth
New Mālaekahana (LWC)	--	--	0.7 mgd	Koʻolau Loa	Mid	Short/ Mid	Lāʻie growth
Existing Kūʻou Well III (BWS)	2348-06	0.196 mgd	0.5 mgd	Koʻolau Poko	Funded	Short	To decrease KL export
New Waimānalo Well III (BWS)	1942-01	0.200 mgd	0.5 mgd	Koʻolau Poko	Funded	Short	To decrease KL export
Existing Maʻakua Well (BWS)	3655-02	0.667 mgd	1.0 mgd[2]	Koʻolau Loa	-	Short	Punaluʻu Optimization
Existing Kaluanui Well (BWS)	3554-04 to -06	1.093 mgd	1.5 mgd[2]	Koʻolau Loa	-	Short	Punaluʻu Optimization
New Kaipapaʻu Well (BWS)	3655-03	--	1.0 mgd[2]	Koʻolau Loa	Mid	Mid	Punaluʻu Optimization

[1]The ʻŌpana Wells are being constructed and permitted by Turtle Bay Resort and will then be dedicated to the Board of Water Supply.

[2]Punaluʻu Wells would be reduced by the amount added to this well so there is no net increase in WUP amounts.

Because the wells for agriculture depend on the expansion of agriculture and are developed by individual landowners, it is difficult to predict where and when wells will be developed. If groundwater is needed to replace or supplement surface water in Punaluʻu, the development of

Makaliʻi Wells may be necessary. Agricultural non-potable well development could occur in the short, mid and long term.

Projected water supply sources for the low, mid/policy and high scenarios are presented in *Chapter 6 Implementation Plan* in *Section 6.1.5*.

ES.7 SUMMARY, PHASING, AND IMPLEMENTATION

This section summarizes the findings of the plan and describes possible mechanisms for implementation.

Water Supply

Water to meet the demands will come from a variety of sources which are summarized below.

- ***No new stream diversions*** are planned until there are measurable instream flow standards. Punaluʻu Stream IIFS is planned next through the Punaluʻu Watershed Alliance.
  - Kahana Stream IIFS was amended in the Waiāhole Ditch Contested Case; however, there are no planned new stream withdrawals.

  Existing stream diversions should improve water use efficiencies and return unused water back to the stream as close to the diversion structure as practical or reduce the diverted amount.
- ***The Koʻolau Loa GWMA will be the primary water source*** used to meet the additional water demands as it has available water.
  - Export from Koʻolau Loa to Koʻolau Poko decreases over time due to population decreases, two new wells in Koʻolau Poko, and transmission main leak detection and repair and advanced conservation measures reduce waste.
- ***No Kahana GWMA development*** is planned due to low expected source yield and possible groundwater interactions with streams because of dike influences.
- ***The Kawailoa GWMA will continue to supply the Kawela area.***
- ***Water conservation and agricultural water savings*** will lessen the amount of water needed to meet future demands.
- ***Punaluʻu Wells pumpage will decrease over time***.
  - Decrease in Koʻolau Loa export will result in less pumpage at Punaluʻu wells.
  - Portion of Punaluʻu pumpage and permitted use will be transferred to Kaluanui and Maʻakua Wells to reduce seawater intrusion caused by drought impacts to the Punaluʻu aquifer.

Project Phasing

A variety of projects will be required to ensure the health of watersheds in Koʻolau Loa. The current phasing is broken down into general timeframes of short, mid and long term. *Table ES.3* is a summary of the projects proposed for improving the health of watersheds in Koʻolau Loa and for meeting the existing and future water demands. 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, the Punaluʻu watershed is the most critical watershed in Koʻolau Loa and many of the watershed projects have been and will be implemented here. Other critical watersheds from a water supply perspective are Kaluanui, Maʻakua, Kahana, Kahuku and Lāʻie. Punaluʻu has the most groundwater and surface water use, has extensive agricultural lands and important cultural significance and the relatively large perennial stream flow has a direct affect on nearshore waters. There is an active community/landowner/agency partnership, called the Punaluʻu Watershed Alliance that is implementing many of the watershed projects and strategies.

Table ES.3 Summary of Short, Mid and Long Term Project Phases

Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Watershed Oral & Cultural History (4b)	——→	
Punaluʻu Pumpage Optimization (2d)	——→	
Potable Well Development (6a) ——	——→	
Flood Control/Storm Management (1a)	——	——→
Measurable Instream Flow Standards (1c) ——	——	——→
Estimation of Outstanding Water Rights (1g) ——	——	——→
Sustainable Yield Estimates (2a) ——	——	——→
Groundwater Source Protection (2b) ——	——	——→
Drought Mitigation Strategies (2c) ——	——	——→
Pollution Prevention / Low Impact Development (3d) ——	——	——→
Invasive Species Assessment / Control (3e) ——	——	——→
Feral Pig Management (3f) ——	——	——→
Wildfire Management Plan (3i) ——	——	——→
Cultural Education Programs(4c) ——	——	——→
Fishpond (Loko Iʻa) Restoration (4d) ——	——	——→
Cultural Monitoring Program (4e)	——	——→
Watershed Partnerships (5a) ——	——	——→
Water and Watershed Education (5b)	——	——→
Koʻolau Loa Implementation Entity (5c)	——	——→
Grant Funding (5d) ——	——	——→
Agriculture Non-Potable Well Development (6b) ——	——	——→
Increased Recycled Water (6c) ——	——	——→

Table ES.3 Summary of Short, Mid and Long Term Project Phases (continued)

Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Water Conservation (6d)		
Agricultural Water Loss Minimization (6e)		
Surface Water Use (6f)		
	Crop Water Demand (3j)	
	Flood Channel Redesign (1b)	
	Stream Water Quality (1d)	
	Nearshore Water Monitoring (1e)	
	Stream Clearing & Management (3a)	
	Stream Conservation Buffers (3b)	
	Cesspool Inventory / Greywater Reuse (3c)	
	Muliwai/Wetland Restoration (3g)	
	Loʻi Kalo Expansion (4a)	
		Conservation District Boundary Review (3h)

Implementation Mechanisms

This plan is intended to guide agencies and organizations in implementing the most important initiatives for Koʻolau Loa 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 in project implementation.

Agencies

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 mission 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.

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 common objectives 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.

Implementation Entity

A recommendation of this plan for ensuring project implementation is a community-based implementation entity which the Koʻolau Loa community working group advocated for and deserves serious consideration (see also *Appendix H*). An implementation entity could be essential to ensuring that the Koʻolau Loa watershed projects are implemented. *Project 5c, Koʻolau Loa Implementation Entity* provides a more extensive description of this concept.

This entity would:

- Have responsibility for implementing the Plan derived from a collaboration of community stakeholders, government agency representatives, private water purveyors, land owners, and non-profit organizations.
- Be community-based (an extension of the district approach to the Oʻahu Water Management Plan).
- Link implementation and organization continuity.
- Be funded adequately and professionally.

Funding

An estimated $28 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 agencies, many of the projects are not funded. Without a dedicated funding source, implementation will likely depend on budgetary priorities, grant availability and partnering efforts.

Possible Ongoing Funding Sources

Dedicated ongoing funding for unfunded 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
- Percentage of Capital Improvement Projects (CIP)
- Transient Accommodation Tax and Tourism Special Fund
- Watershed Sustainability Fee
- Portion of Sales Tax

A dedicated source of funding is likely to need 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 make up the gap between agency general funding and other dedicated funding sources. *Project 5d, Grant Funding* details many of the grants and research funds available. These 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 Koʻolau Loa.

1

OVERVIEW OF O‘AHU HYDROGEOLOGY

1 OVERVIEW OF OʻAHU HYDROGEOLOGY

1.1 SETTING
1.2 CLIMATE
1.3 WATER CYCLE
1.4 GEOLOGY
1.5 HYDROGEOLOGY
1.6 SUSTAINABLE YIELD
1.7 INSTREAM FLOW STANDARDS

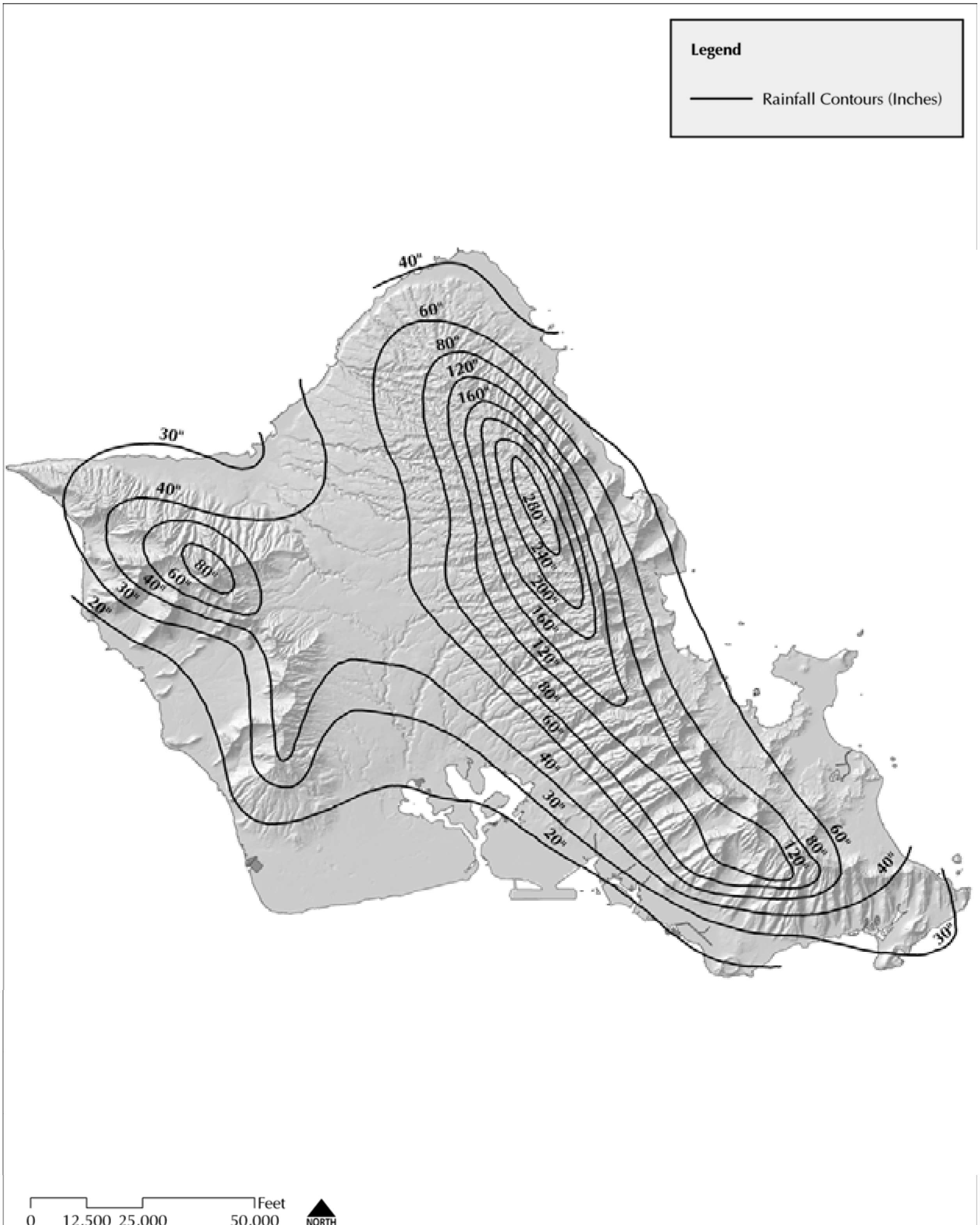
1.1 SETTING

The island of Oʻahu is approximately 600 square miles in size.[1] With less than ten percent of the land area of the State of Hawaiʻi, Oʻahu'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, Oʻahu is the State's economic mainstay, supporting tourism, military, agriculture, manufacturing, and research and development. Although the City and County of Honolulu and Kauaʻi 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

Oʻahu'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 Hawaiʻi 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 Oʻahu's lush green mountains and the arid lowland plains reflects extremely wide rainfall variations. Annual average rainfall on Oʻahu ranges from less than 20 inches on the leeward coast to almost 300 inches near the central crest of the Koʻolau Range *(Figure 1.1)*. Such a marked difference over a distance of less than 15 miles has a significant effect upon water resources.



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

Figure 1.1 Oʻahu Annual Average Rainfall

The sea surrounding Oʻahu 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 Koʻolau 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 Waiʻanae Range is a less effective rainmaker since it lies to the lee of the Koʻolau 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, Hawaiʻi'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 groundwater 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 groundwater will result in changes to aquifer levels, in base flows entering streams and in seepage losses from streams to groundwater.
- 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. Hawaiʻi 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. Groundwater may supply stream base flows. *Runoff* is measured by stream gages but additional

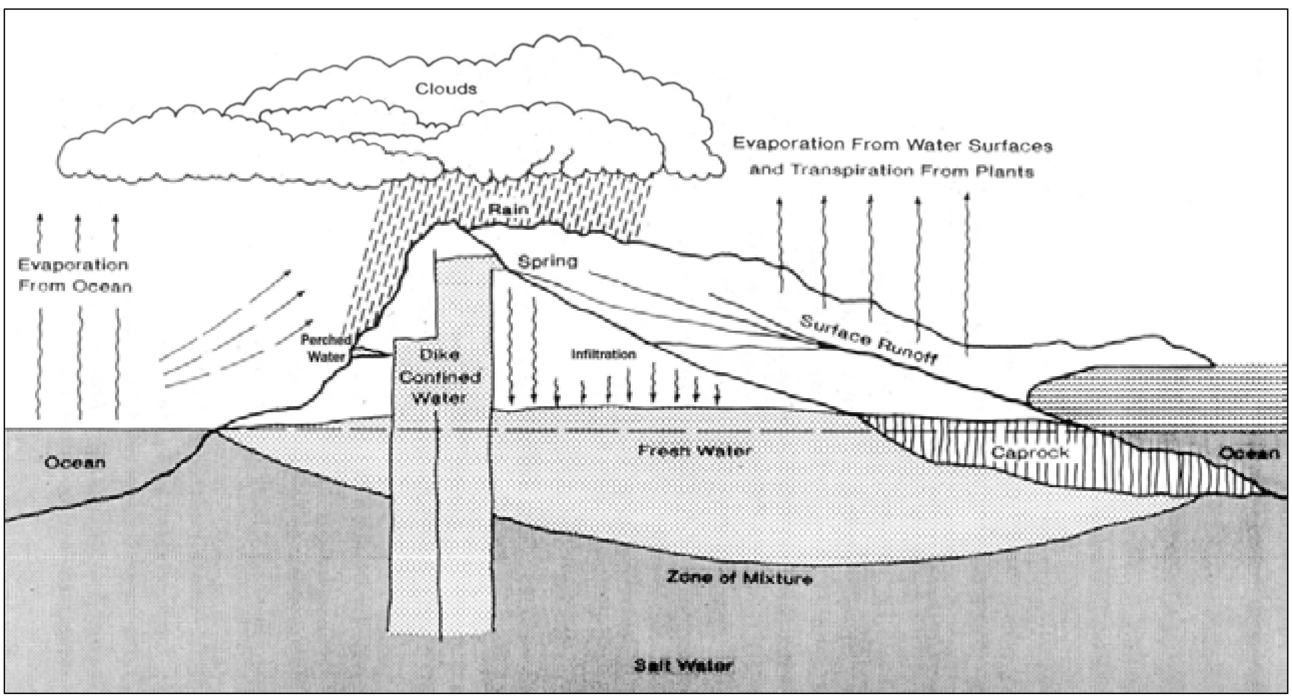


Figure 1.2 Hydrologic Cycle
O'ahu Water Management Plan, 1990

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 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 groundwater. 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 groundwater to nearshore waters in the form of springs, seeps and underflow. Leakage is not easily quantifiable and varies in aquifers due to the amount 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 groundwater 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 groundwater. 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 groundwater 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 groundwater bodies on which O'ahu depends for its water supply. It should be noted that while infilitration into the groundwater is great, much water is released into the atmosphere through evapotranspiration.

1.5.1 Groundwater

There are several types of general groundwater 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 groundwater 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 groundwater 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)*.

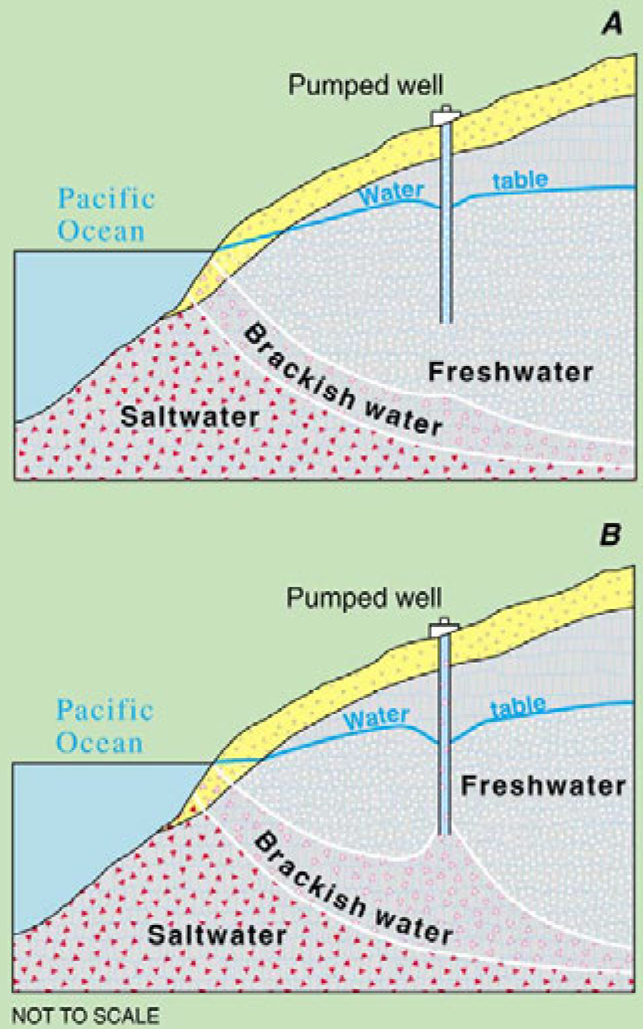
On O'ahu, the Leeward basal aquifer is much larger than the Windward basal aquifer. On the Windward side of the island, the dike complex makes this a much smaller or truncated lens *(Figure 1.2)*.

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)*.



*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
USGS Groundwater in Hawai'i

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 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 Waiʻanae region and on the windward side of the Koʻolau 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 Oʻahu.

1.5.1.3 Perched Water

Oʻahu 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 Oʻahu.

1.5.1.4 Caprock Water

The limestone in the caprock generally contains groundwater. 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 ʻEwa 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 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 groundwater 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.

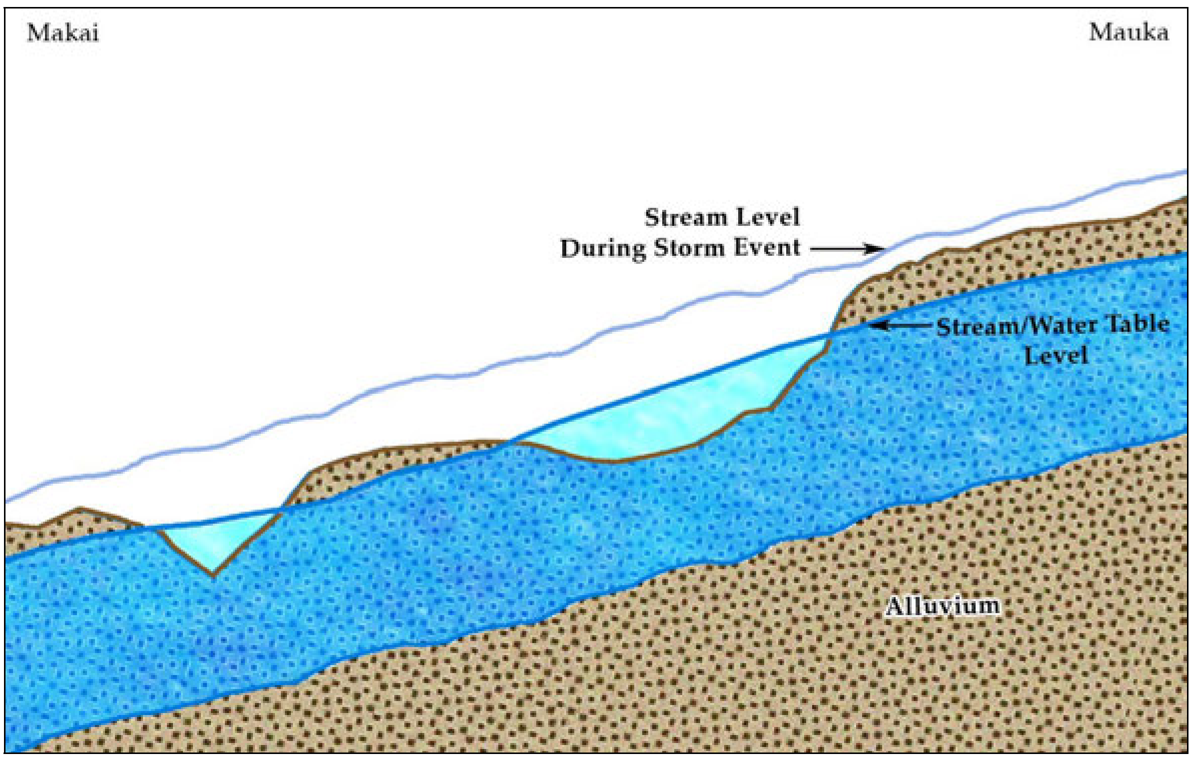


Figure 1.4 Intermittent Streams during Wet and Dry Periods Diagram

1.5.3 The Relationship between Ground and Surface Water

The aquifer systems in Windward Oʻahu 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, Koʻolau Poko and Kahana – are generally considered to have a direct relationship between surface and groundwater conditions. In Koʻolau 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 groundwater 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 groundwater are not hydraulically connected. This is a losing stream reach where streamflow is not directly supplied by the basal groundwater which occurs far below it. While shallow alluvial wells at this location may affect streamflow, basal well withdrawals of groundwater will not. This is the case for the mouth of the valley in Windward Oʻahu and for most locations in Leeward Oʻahu *(Figure 1.7)*. The groundwater and surface water relationship in the Koʻolau Poko Aquifer System Area will vary between different streams based on long-term well production experience and therefore, significant effects of groundwater withdrawal on surface water should be evaluated on a case-by-case basis.

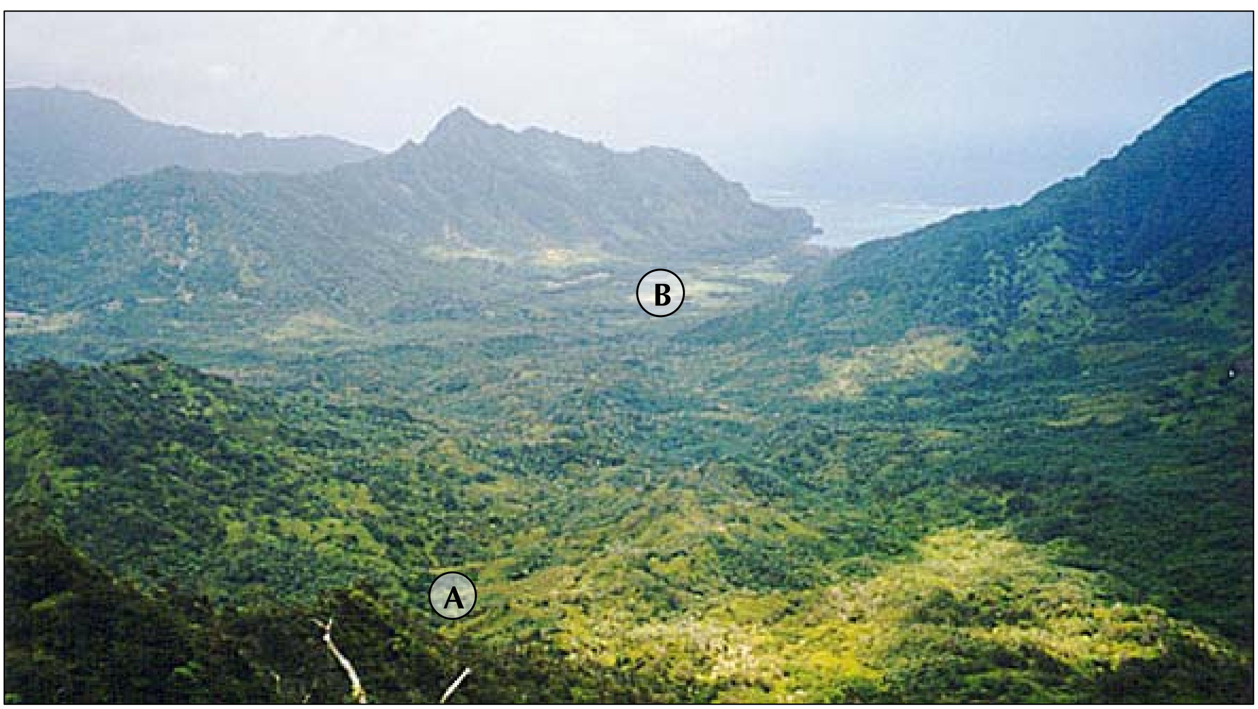
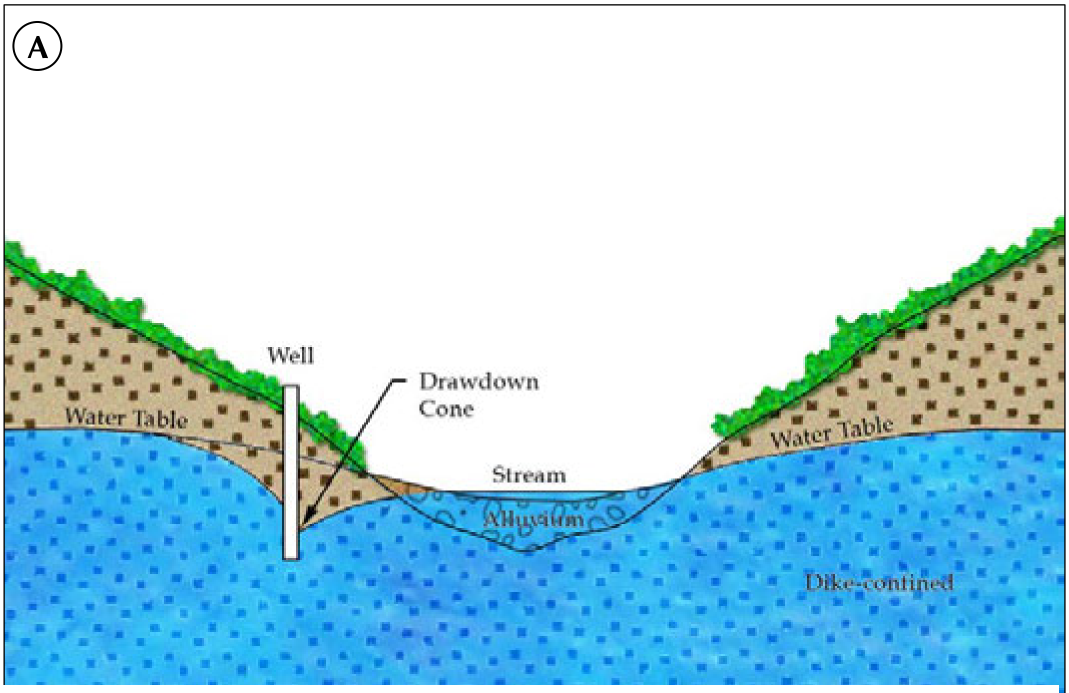
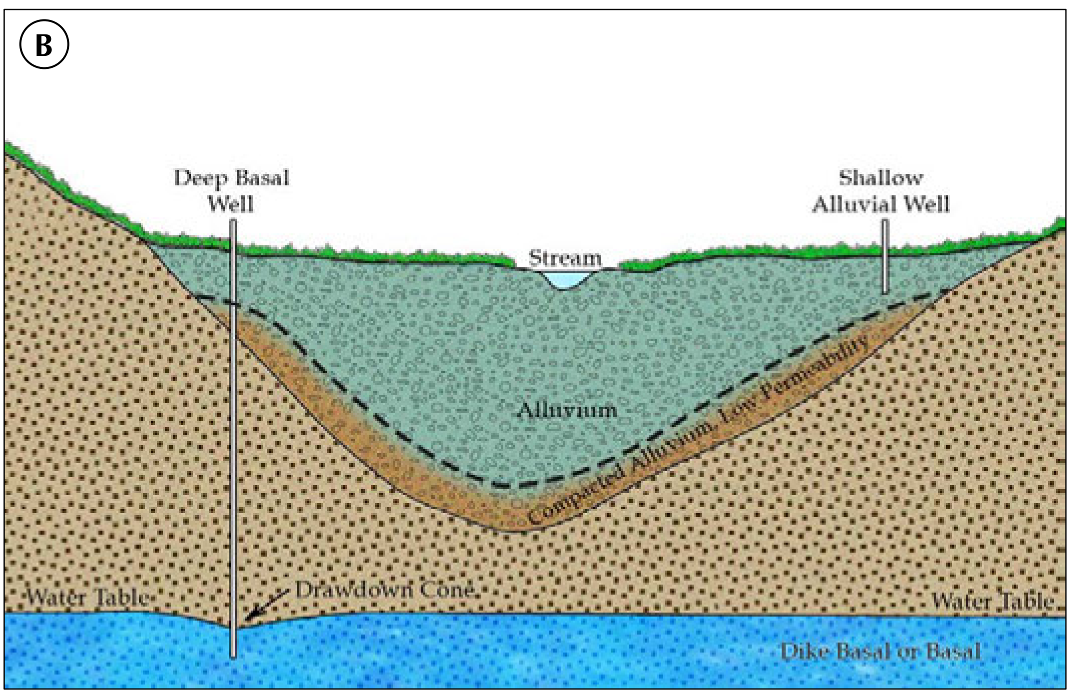


Figure 1.5 Typical Windward Valley with Upper (A) and Lower Elevation (B) Stream Locations



Well Affecting Stream Flow



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

Figure 1.6 Well/Groundwater Relationship

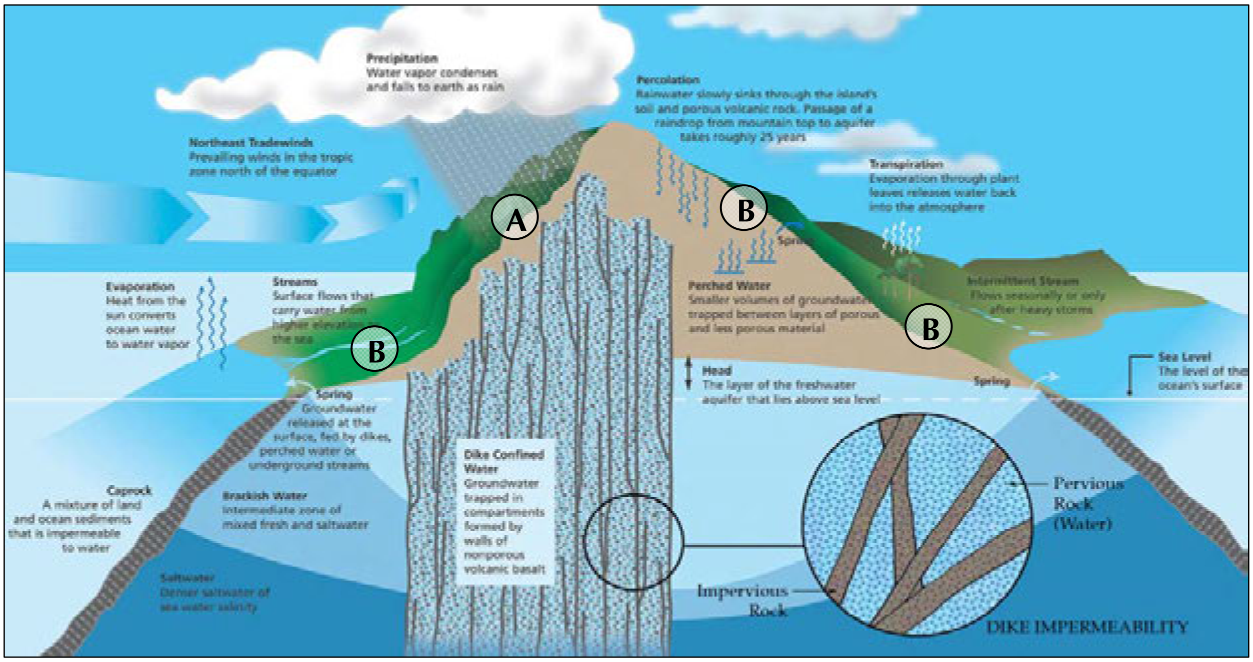


Figure 1.7 Island Cross Section with Stream Type and Elevation Locations

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 Hawaiʻi 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 groundwater hydraulic continuity.

Figure 1.8 shows the sustainable yields for the island of Oʻahu 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 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 ʻEwa-Kunia, 1993 Wahiawā and Pearl Harbor, 1997 ʻEwa Caprock, and 2000 Waipahu-Waiawa and ʻEwa-Kunia).

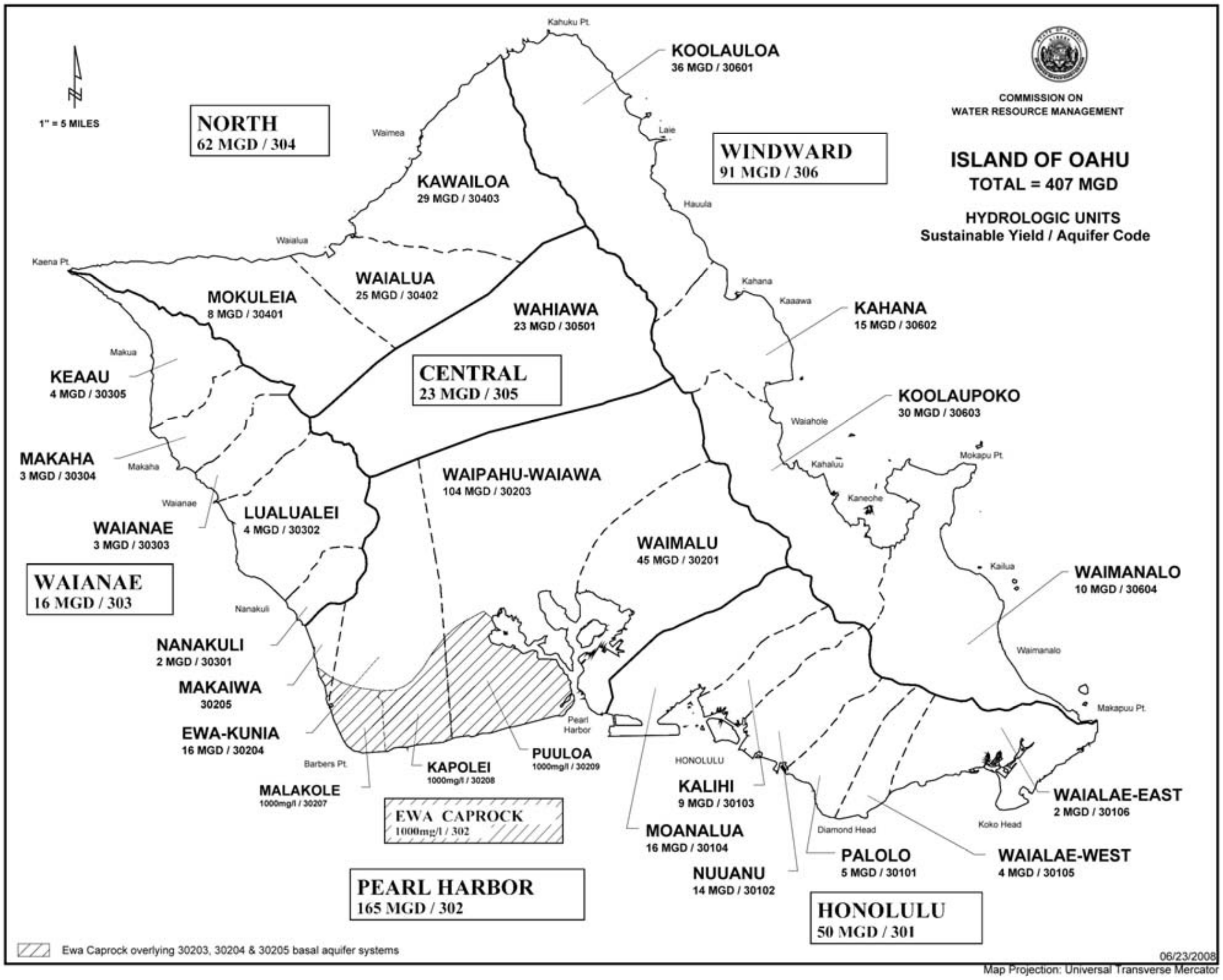


Figure 1.8 Aquifer Sector and Aquifer System Areas

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 groundwater 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.

Recoverability of Sustainable Yield

Recoverability is the ability to feasibly extract groundwater 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 groundwater, 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 groundwater interactions*****:** Full recoverability is affected if a portion of the sustainable yield impacts surface water. Kahana and Koʻolau Loa have dike formations (dike complex and marginal dike zones) near the crest and basal aquifers near the coast. Surface and groundwater interactions are more likely in dike formations. Groundwater development in the basal formations usually does not have an effect on stream flows. Stream impacts from groundwater 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 groundwater 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 recharge from the underlying basal aquifer with the result that sustainable yields are lower for some areas. The hydraulic interaction between these geologic formations is not fully understood, estimated or readily measurable and affect recoverability.

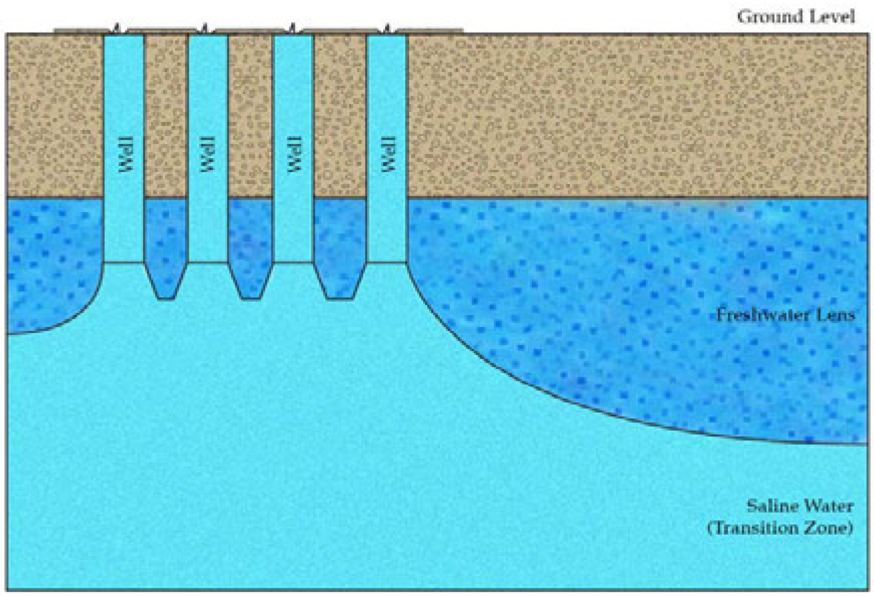
4. ***Extended Drought:*** Extended drought impacts all water resources and affects recoverability. Oʻahu experienced an extended, multi-year drought from 1998-2003 where rainfall averaged between 60% and 80% of normal levels and several source yields eventually dropped below permitted use. Dike sources 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 groundwater 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:

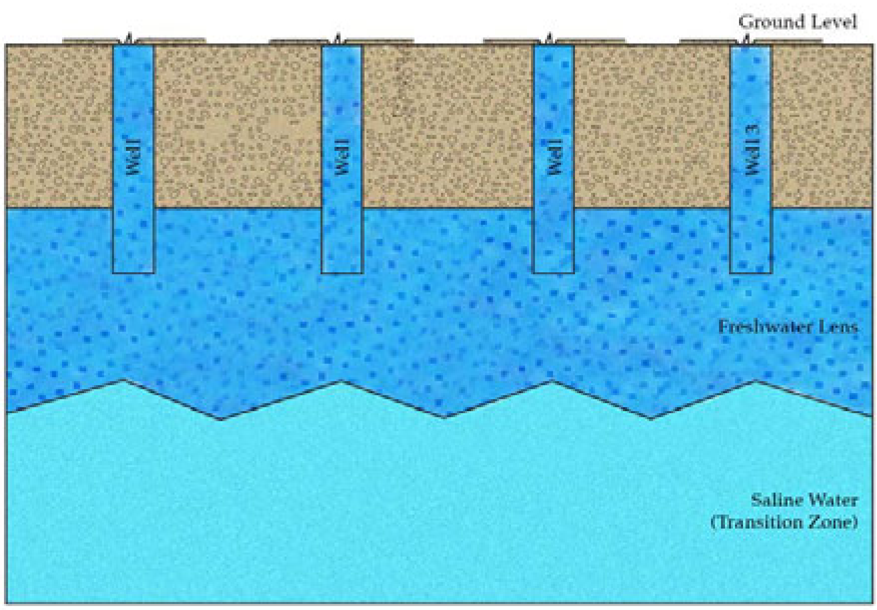
   a. ***Cost*** considerations limit the number of wells and length of connecting pipelines. Exploratory wells in dike and alluvial formations are risky due to potentially low yields and potential affects to IIFS.

   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.



Clustered Well with Saline "Upconing"



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

Figure 1.9 Clustered versus Distributed Aquifer Pumpage

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 groundwater 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 groundwater. 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 Koʻolau 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]

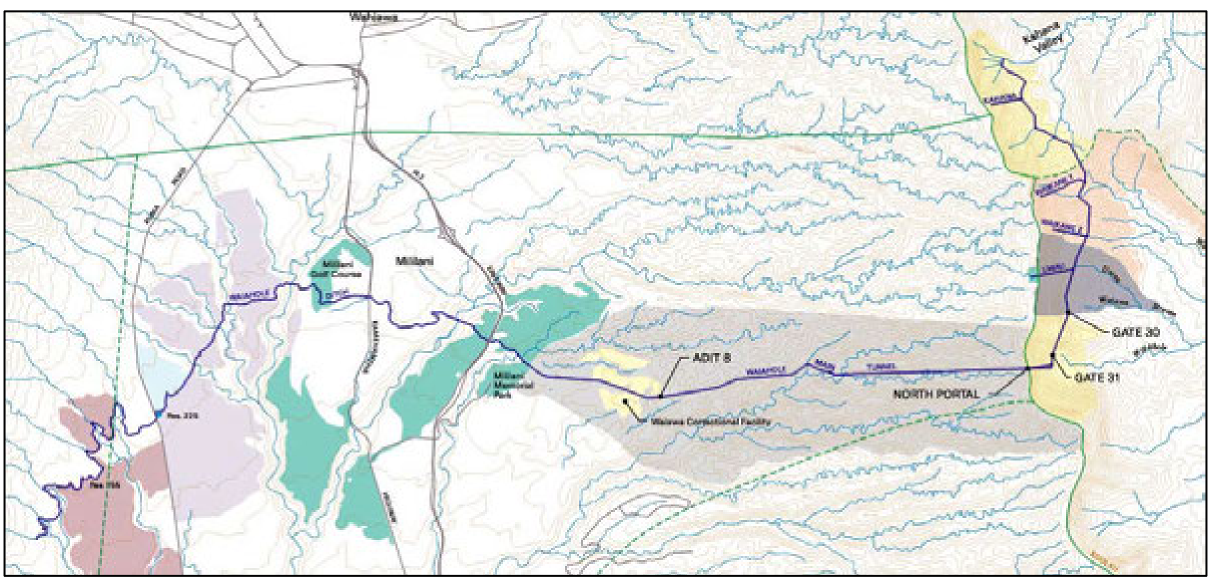


Figure 1.10 Waiāhole Ditch System (CWRM)

1.7 INSTREAM FLOW STANDARDS

Instream flow standards (IFS) are similar to sustainable yields for groundwater, 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.

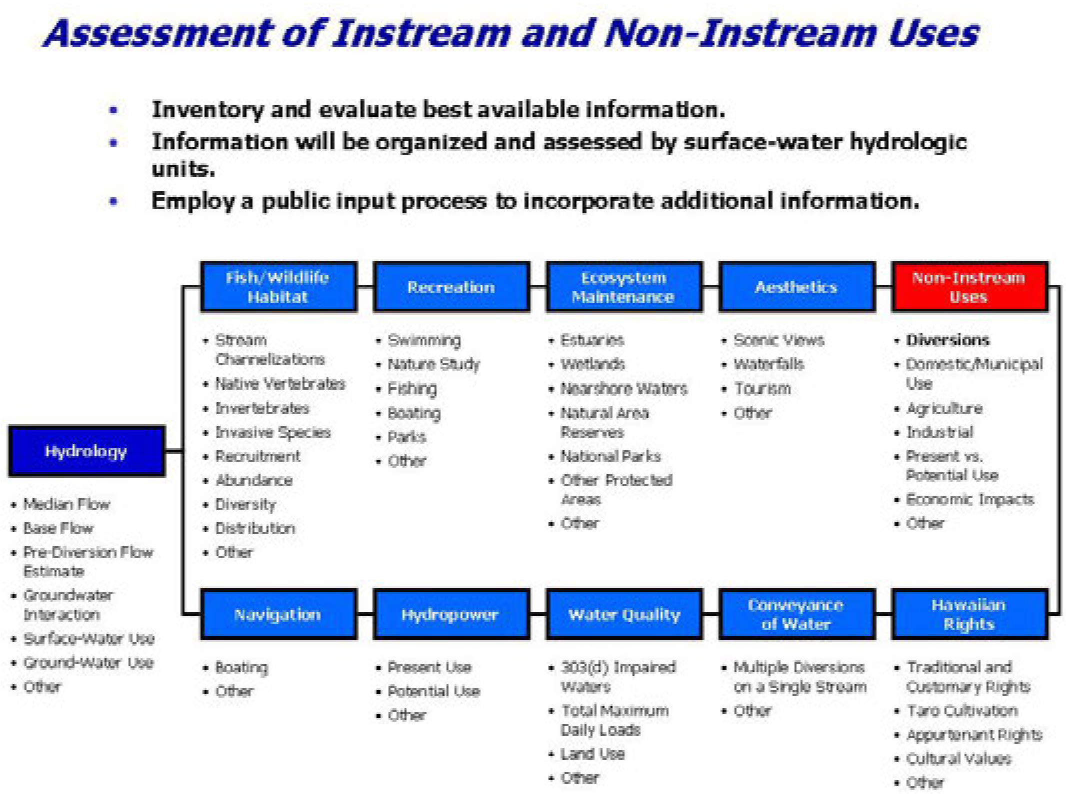


Figure 1.11 Information to Consider in Setting Measurable Interim Instream Flow Standards
(CWRM presentation to Water Commission, June 2006)

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 groundwater 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]

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*).

Table 1.1 Amended Oʻahu 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 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 Hawaiʻi, 1983

2 US Census, 2000

3 Oʻahu Water Management Plan Technical Reference Document, March 1990

4 Groundwater in Hawaiʻi. USGS, FS 126-00

5 State of Hawaiʻi 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, Hawaiʻi Public Radio, July 19, 2006

8 Atlas of Hawaiʻi, Third Edition, 1998

9 Groundwater in Hawaiʻi. USGS, FS 126-00

10 Report on the Hydrologic Investigation of Groundwater and Surface Water Conditions in the Windward Oʻahu 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
KO‘OLAU LOA WATERSHED PROFILE

2 KOʻOLAU LOA WATERSHED PROFILE

2.1 INTRODUCTION
2.2 PHYSICAL SETTING
2.3 WATER RESOURCES
2.4 TERRESTRIAL ECOSYSTEMS
2.5 CULTURAL RESOURCES AND TRADITIONAL PRACTICES
2.6 SETTLEMENT HISTORY
2.7 RESIDENTIAL AND VISITOR POPULATION DEMOGRAPHICS
2.8 LAND USE
2.9 STAKEHOLDER CONSULTATION
2.10 IMPLICATIONS FOR WATERSHED PLANNING

2.1 INTRODUCTION

The Koʻolau Loa Watershed Management Plan (KLWMP) is part of a comprehensive Honolulu Board of Water Supply (BWS) program to plan for County's future water resource needs as mandated by the State Water Code.

This chapter provides background for further study of management options and strategies for Koʻolau Loa over the next 25 years. This preliminary watershed profile provides an understanding of the water use over time and related resources. Data on many natural factors that interact within the stream watersheds of the Koʻolau Loa District are inventoried and analyzed here. These factors include climate, geology, topography, soils, surface water, groundwater, nearshore ocean waters, plants, animals, and ecological communities, as well as human uses and impacts with the goal of being environmentally holistic.

2.1.1 Methodology

The watershed profile process involved collecting data, identifying issues and needs, and identifying water resources management opportunities. Primary sources of data were previously conducted studies, plans and reports from various agencies, organizations, and academics. These documents provided information on topics specific to Koʻolau Loa and on general watershed issues. New/original research was not conducted, except for the stakeholder consultation section. Various individuals, agencies and organizations were contacted to provide additional details or updated information. For the stakeholder consultation process described in *Section 2.9*, included natural resource values, issues, and needs perceived by residents and stakeholders of Koʻolau Loa district.

The watershed profile data was analyzed in light of the stakeholder perspectives to develop an overall assessment of Koʻolau Loa's natural resources and to identify issues and needs. While many problems and issues were discussed in the literature, others were raised through discussions with agencies and stakeholders. The resulting water resources management opportunities were identified based on both sources.

2.2 PHYSICAL SETTING

2.2.1 Overview of the Koʻolau Loa Moku

The Hawaiian Islands contain historic land divisions called moku. On Oʻahu, these divisions are generally comparable to County Development Plan and Sustainable Communities Plan (SCP) districts. The Koʻolau Loa moku includes the north coast of the island of Oʻahu between Waimea Bay and Kualoa. The City and County Koʻolau Loa SCP area (hereinafter "Koʻolau Loa"), extends from Waialeʻe near Kawela Bay to Kualoa. The portion between Waimea Bay and Waialeʻe is within the North Shore SCP area.

Koʻolau Loa consists of 37,135 acres (about 58 square miles), approximately 10 percent of Oʻahu's 385,280 acres. The region is known for its dramatic coastline and jagged mountain ridges. The Koʻolau Mountains form the inland (mauka) boundary of the district, reaching a ridge elevation of 2,500 to 2,800 ft. The mountains extend closest to the ocean near Kaʻaʻawa and Kualoa to the south, with broad coastal plains to the north in Kahuku and Lāʻie; there are many deep valleys along this coast, particularly Kahana, Punaluʻu and Kaluanui.

As shown in *Figure 2.1*, Koʻolau Loa, translated as the "long Koʻolau" is one of six moku oloko, interior land districts that divide the mokupuni, the island of Oʻahu. The other moku oloko of Oʻahu include the districts of Kona, ʻEwa, Waiʻanae, Waialua, and Koʻolau Poko. These districts were traditionally subdivided into smaller tracts of land called ahupuaʻa that varied in size depending upon the natural resource yields within a particular region and the population density that these yields could sustain.[1]

These land divisions included both mountainous (mauka) and coastal (makai) resources and were often subdivided into smaller tracts of land with varying degrees of intended use, purpose, shape, and function.[2] This land and water resource management strategy was developed and implemented during the governance of Maʻilikūkahi during the Consolidation Period (1180-1450 AD).

According to the Kūhano Report on Ancient Land Divisions of Oʻahu (December 12, 1873) the moku oloko of Koʻolau Loa was divided into 34 ahupuaʻa that included the area of Kualoa and extended northwest until Waimea, as shown in *Figure 2.2*. Given the large number of ahupuaʻa divisions within the Koʻolau Loa district, the ahupuaʻa are categorized into their appropriate watershed designations *(Table 2.1)* for purposes of this study. For the KLWMP, the northwestern boundary of the Koʻolau Loa district ends at Waialeʻe ahupuaʻa.

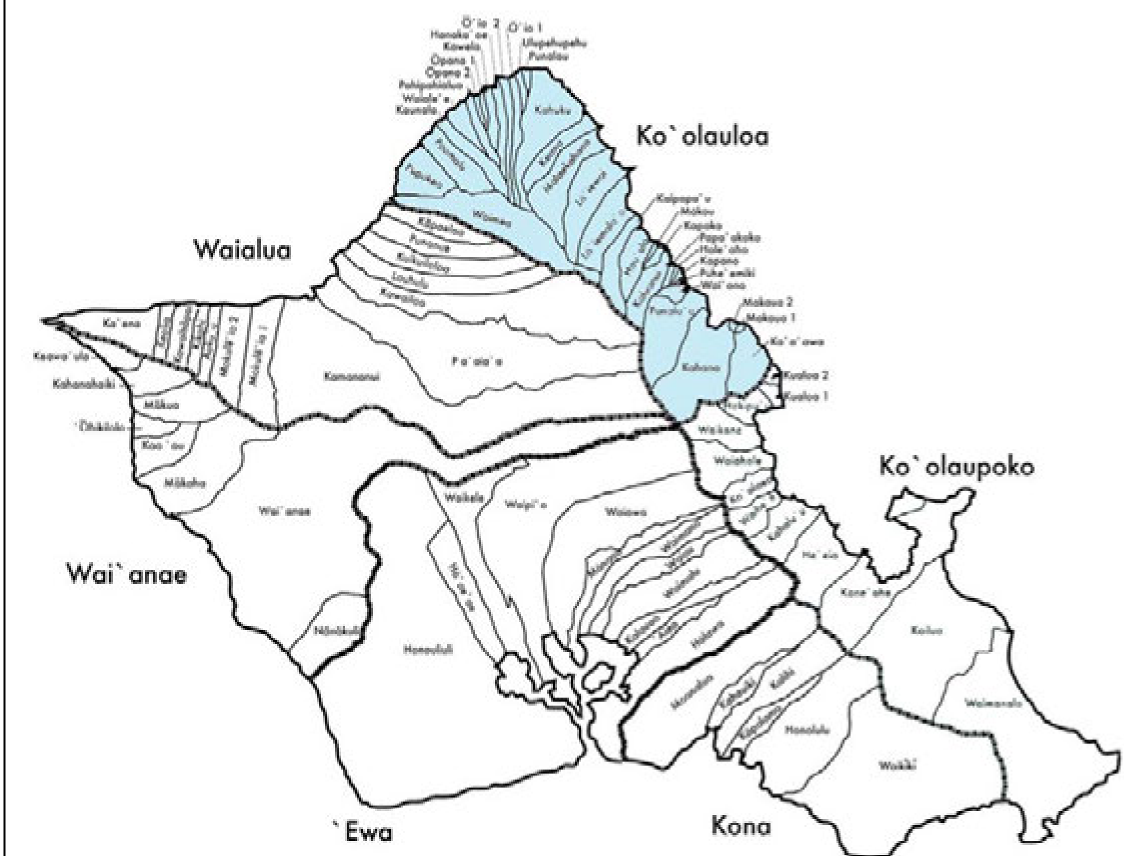


Figure 2.1 Traditional Land Divisions, Island of Oʻahu

Oʻahu's rural upper windward coastline is defined by its dramatic cliffs and numerous unique valleys. Koʻolau Loa's ample rainfall sustains lush tropical vegetation with small streams flowing to the sea from most valleys.

Knowledge of the physical environment is key to understanding the entry, storage and outflow water in Koʻolau Loa. This section describes Koʻolau Loa watershed area rainfall, underlying geology and the soil through which the rainfall may infiltrate.

2.2.2 Watershed Boundaries and Descriptions

Koʻolau Loa is comprised of 16 full watersheds and part of one watershed *(Figure 2.3 and Table 2.1)*. A watershed is a drainage basin that catches, collects and stores water which moves toward the ocean via rivers, streams or geologic formations.[3]

The southern third of the study area contains the watersheds of Haleʻaha, Punaluʻu, Kahana, Makaua, and Kaʻaʻawa. These are characterized by high elevations in the Koʻolau Mountains and rugged terrain in the back of the valleys. The valleys of these watersheds open near the ocean with agricultural lands and residences in the coastal plains. The Kahana and Punaluʻu streams' substantial flow provides agricultural irrigation and supports aquatic ecosystems. The middle third of the study area includes the watersheds of Papaʻakoko, Kaluanui, Waipuhi, Maʻakua, Kaipapaʻu, Koloa, and Wailele. These watersheds have steep narrow valleys with small coastal plains. Hauʻula town is in this portion of the Koʻolau Loa district.

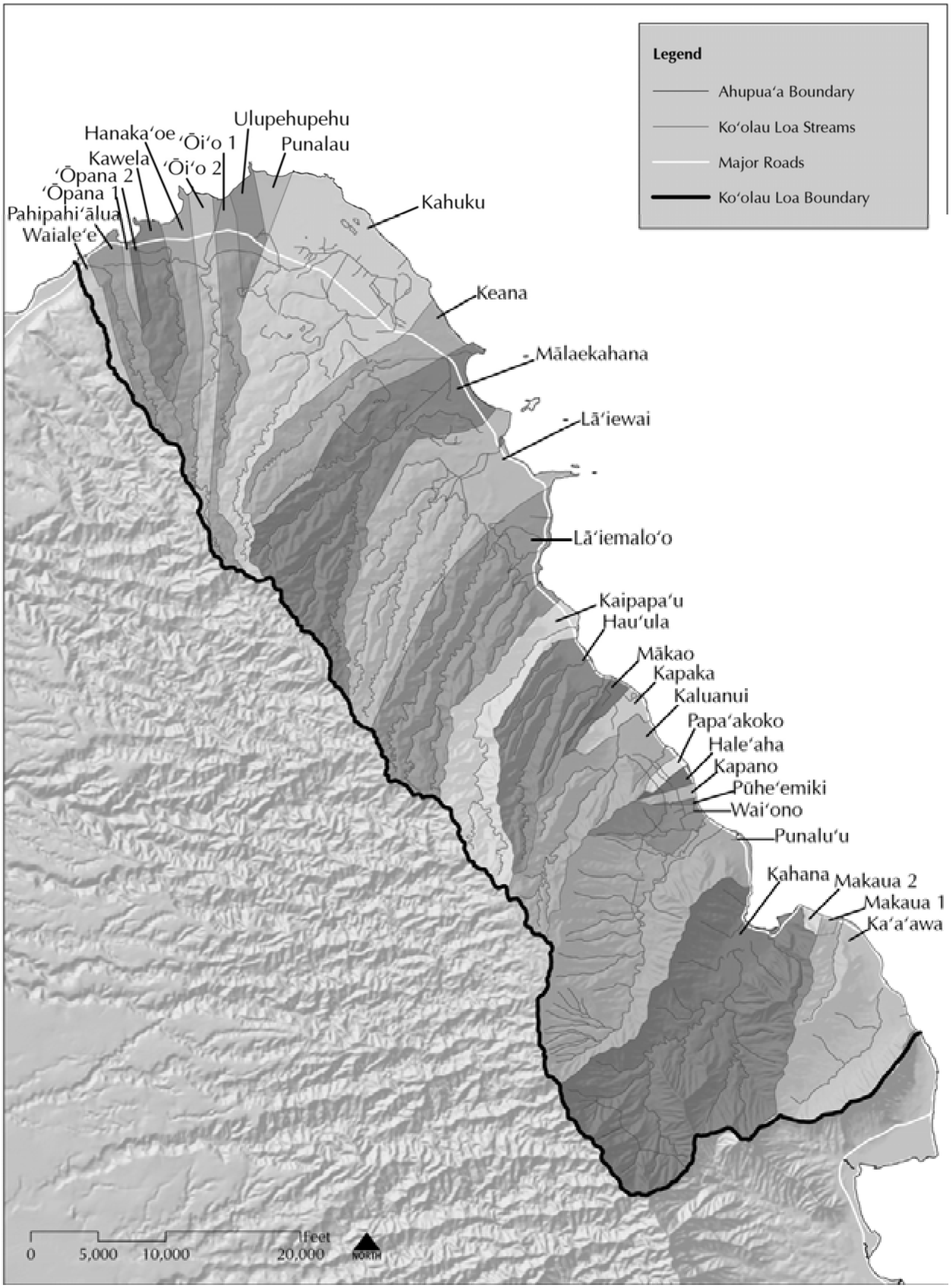


Figure 2.2 Nā Ahupuaʻa o Koʻolau Loa

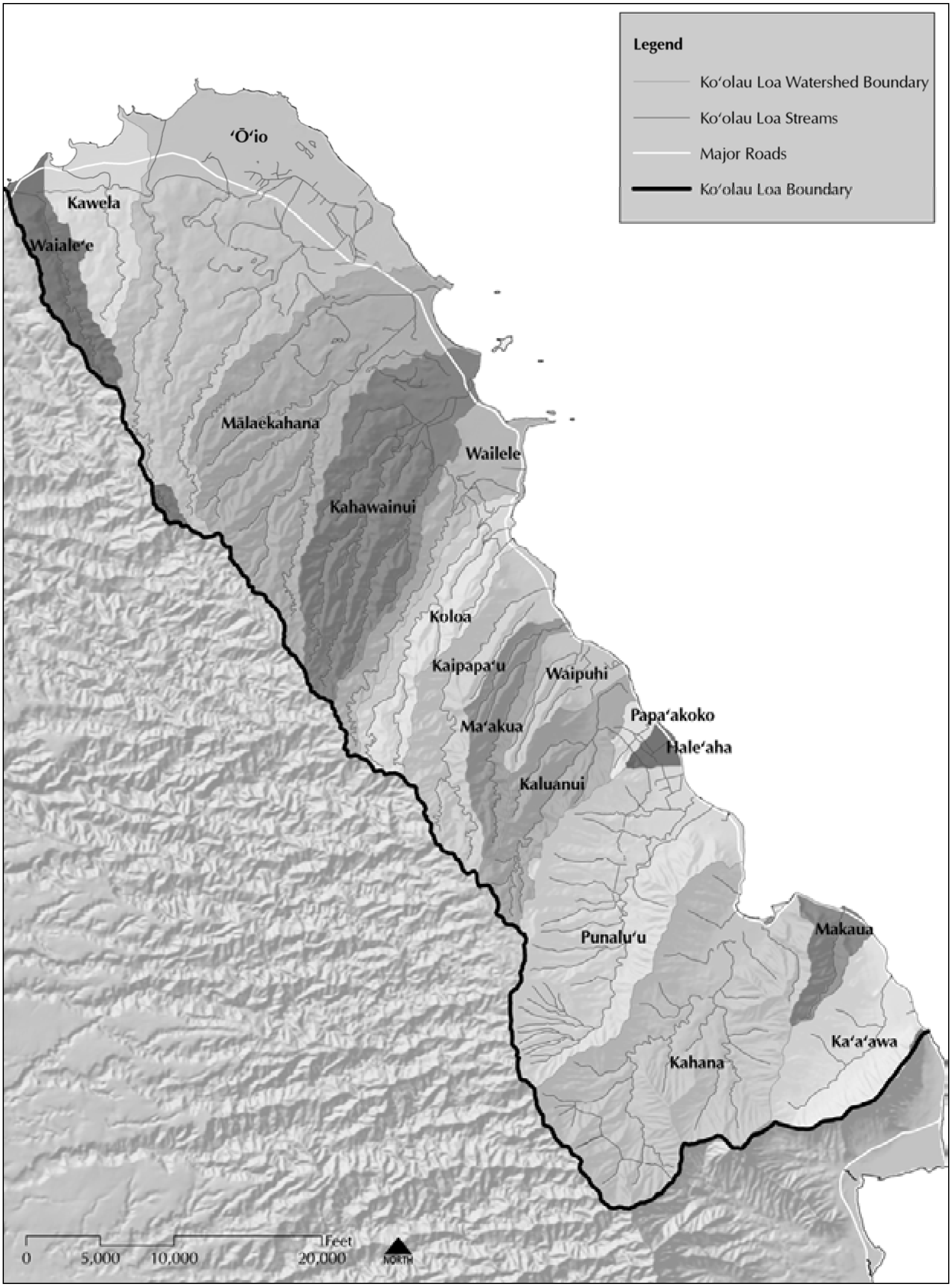


Figure 2.3 Koʻolau Loa Watersheds

The watersheds in the northern third of the study area are Wailele, Kahawainui, Mālaekahana, ʻŌʻio, Kawela and part of the Waialeʻe watershed. These watersheds start with slightly lower elevations in the back of the valleys than do the other watersheds in Koʻolau Loa, and have substantial gently sloped or flat areas suitable for agriculture. Large sections of the major population centers of Lāʻie and Kahuku are located within these watersheds. This area has traditionally been used for agriculture.

Table 2.1 List of Watersheds and Nā Ahupuaʻa o Koʻolau Loa

Watershed	Ahupuaʻa
Waialeʻe (partial)	Kawela Pahipahiʻālua ʻŌpana 1 ʻŌpana 2
Kawela	Kawela Hanakaoe
ʻŌʻio	ʻŌʻio 1 ʻŌʻio 2 Hanakaoe Ulupehupehu Punalau Kahuku Keana
Mālaekahana	Mālaekahana
Kahawainui	Lāʻiewai (partial)
Wailele	Lāʻiewai (partial) Lāʻiemaloʻo (partial)
Koloa	Lāʻiemaloʻo (partial)
Kaipapaʻu	Kaipapaʻu
Maʻakua	Hauʻula (partial)
Waipuhi	Hauʻula (partial)
Kaluanui	Hauʻula (partial) Mākao Kapaka
Papaʻakoko	Kaluanui (partial)
Haleʻaha	Papaʻakoko Haleʻaha
Punaluʻu	Kapano Pūheʻemiki Waiʻono Punaluʻu
Kahana	Kahana (partial)
Makaua	Kahana (partial) Makaua 1 Makaua 2 Kaʻaʻawa (partial)
Kaʻaʻawa	Kaʻaʻawa (partial)

2.2.3 Climate

Koʻolau Loa is the northern, upper windward coast of Oʻahu. For most of the year, the trade winds come from the northeast and bring warm moist air from the ocean onto the land. As the air is deflected up along the Koʻolau Mountains, the air cools, forms clouds and releases rain onto the land below. Therefore, the Koʻolau Loa rainfall is mostly a function of mountain elevation. Where the Koʻolau Mountains are higher, such as the back of Kahana and Punaluʻu watersheds, rainfall is greater *(Figure 2.4)*. Fog drip at higher elevations also contributes to overall precipitation.

Rainfall in the southern half of the study area, from Kaʻaʻawa to Koloa watershed, ranges from more than 60 inches per year along the ocean front to more than 240 inches per year at the upper elevations of the Koʻolau Mountains. As elevation declines, the rainfall averages also decline. In the northern half of Koʻolau Loa, the rainfall ranges from about 200 inches per year at the higher elevations to approximately 40 inches per year at the shoreline.

The two seasons in Hawaiʻi are the warmer and drier period from May to October and the cooler, cloudier, wet period from October to April. Flooding is more likely during the wet period; during the dry period, stream flow decreases, which can make the irrigation supply an issue.[4]

Rainfall in Koʻolau Loa is the highest on Oʻahu and is critical for recharging the aquifers that currently provide water for Koʻolau Loa and Windward Oʻahu.

2.2.4 Geology and Regional Hydrology

A remnant of a deeply eroded basaltic shield volcano forms the backbone of the Koʻolau Loa district. Initially the Koʻolau volcano was broad, similar to Mauna Loa on the island of Hawaiʻi. The Koʻolau volcano was primarily composed of a series of thin-bedded, overlapping gently-sloping basaltic lava flows fed by magma pouring out of fissures in the volcano. Molten rock solidified in the narrow cracks under pressure, creating rock much denser and much less permeable than the surrounding porous lava flows. These dense, usually vertical, geological structures are known as volcanic dikes.

Subsequently, Oʻahu underwent a series of submergences and emergences resulting from changes in the ocean level during glacial and interglacial phases. The island also substantially subsided into the earth's crust. Stream erosion carved a series of ridges and valleys in the Koʻolau shield creating the pali or cliffs of the Koʻolau Loa landscape.[5] This, along with wave erosion of cliffs, may have reduced the mountain height. Alluvium, consisting of clay, silt, sand, gravel cobbles, and boulders deposited by running water, accumulated in valley floors and coral reefs grew over low-lying coastal areas during higher stands of the ocean. Along the coast, deposits of terrestrial and marine sediments formed a relatively impermeable wedge of sedimentary material known as caprock.

The volcanic dikes control most high-level water in Windward Oʻahu.[6] The Koʻolau Loa dikes underlie the upper mountainous portions of the watersheds and prevent groundwater from easily moving from the upper part of the watershed to the coastal areas. Closely spaced dikes, called dike complexes, create many discrete compartments of water that are difficult to access due to terrain and are generally economically unfeasible to develop.

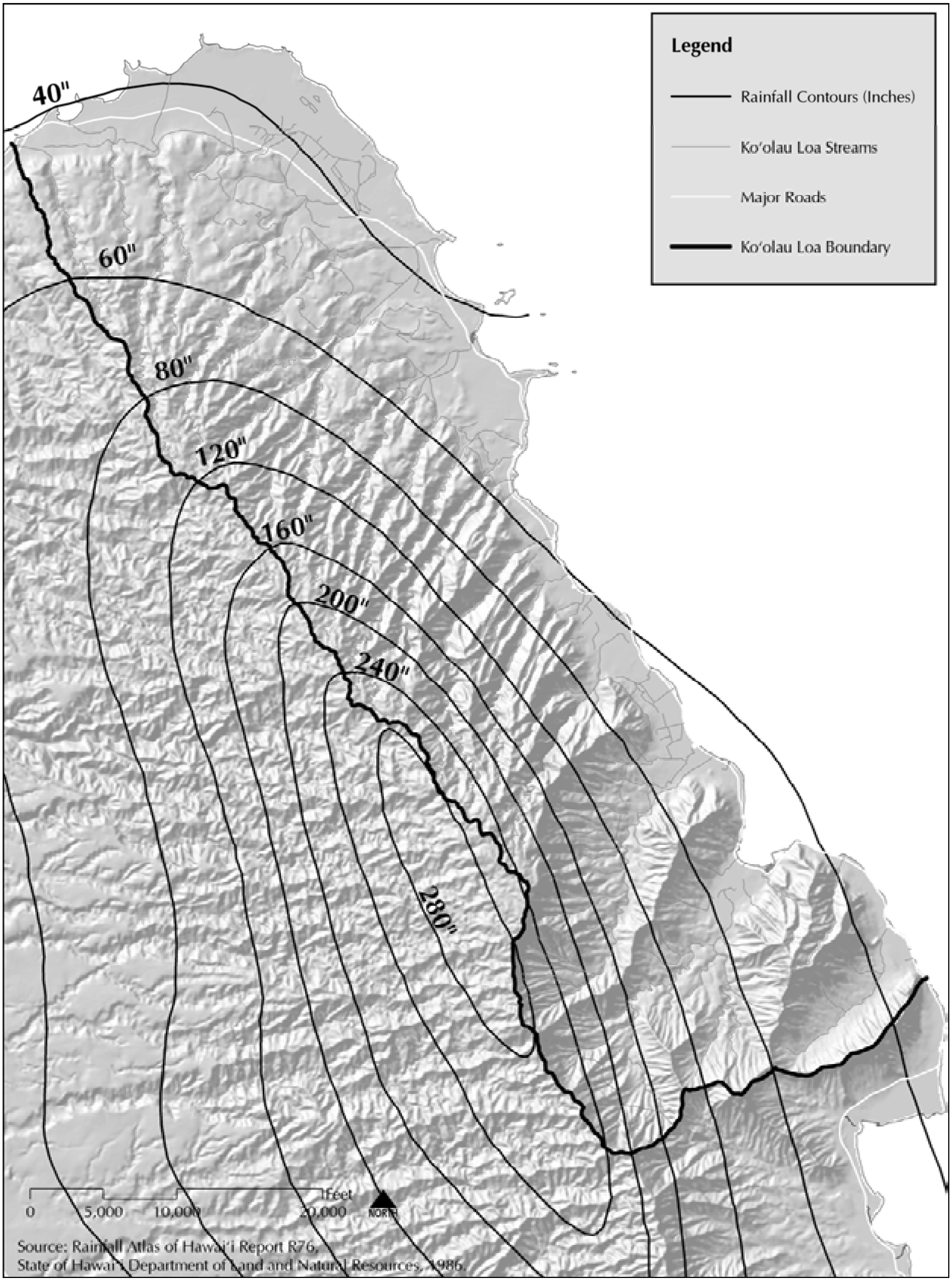


Figure 2.4 Koʻolau Loa Annual Average Rainfall

The dikes may facilitate upper mountain groundwater movement from ridgeline to adjacent stream valleys. At Kahuku, seepage occurs at and over the caprock resulting in large marshes.[7] A dike zone also extends from the Kawela and Waialeʻe watersheds all the way to the coast.

Dikes and dike complexes divide the Koʻolau Loa groundwater sources into upper mountain and lower coastal areas. The water stored behind the dikes is referred to as high-level water, since the dikes prevent the water from interacting with saltwater *(Figure 2.5)*. The high-level water recharges the basal aquifers, provides stream flow and provides high quality potable water.

Basal groundwater is a groundwater body that overlies seawater composition. Freshwater, which is less dense, floats on top of the denser salt water within the basalt formation. The lower part of Koʻolau Loa contains basal waters. Wells in these areas can be subject to salt water intrusion when freshwater is withdrawn more quickly than it can be replenished. Most Koʻolau Loa aquifers are dike-intruded, and are more accurately defined as dike basal aquifers.

An important distinction regarding basal water is whether or not it is confined. Confined water has a caprock that generally prevents basal water from freely flowing into ocean waters, creating a thicker body of freshwater. The Koʻolau Loa caprock extends along the coast from Punaluʻu to Kahuku Point. The caprock's low permeability also limits infiltration and contamination into the aquifer. Conversely, contamination is possible for the majority of the dike basal aquifer not overlaid by caprock.

In the Kahana aquifer area groundwater is mostly high-level dike confined, but there are also small dike basal aquifers in lower Punaluʻu and Kahana Valleys and along the coast into Kaʻaʻawa Valley. Unlike other systems, much high-level groundwater seeps into the streams, especially in areas where dikes have been breached through erosion. A significant amount of high level groundwater also seeps into small dike basal aquifers.[8]

2.2.5 Soils

Rainfall and surface flow infiltrate into groundwater through the rocks and soils. In general, the porous nature of volcanic soil and rock allows water to filter down into the underlying aquifer. Mountain soils are generally permeable clay soils and alluvium from the Koʻolau Range or as residuum on the ridges between streams. Old alluvium, perhaps compacted over millions of years, has reduced permeability and may limit recharge in some areas.

The Soil Conservation Service (SCS) soil associations in Koʻolau Loa are various. The Koʻolau Loa mountain peaks and cliffs are steep, well-drained, rocky and stony land and part of an association titled Rockland-Stony Steep Land. The Lolekaa-Waikane association is found in the more gently sloping mountain areas with deep, nearly level to very steep well-drained soils that have fine-textured subsoil. At the northern end of Koʻolau Loa, mountainous Land-Kapaʻa association is characterized by very steep land, numerous drainage ways and deep well-drained soils with fine textured to moderately fine textured subsoil. Along the Koʻolau Loa coastal plains is the Kaena-Waialua association with deep soil in flat or gently sloping areas that can be poorly to excessively drained with fine to coarse textured subsoil.[9]

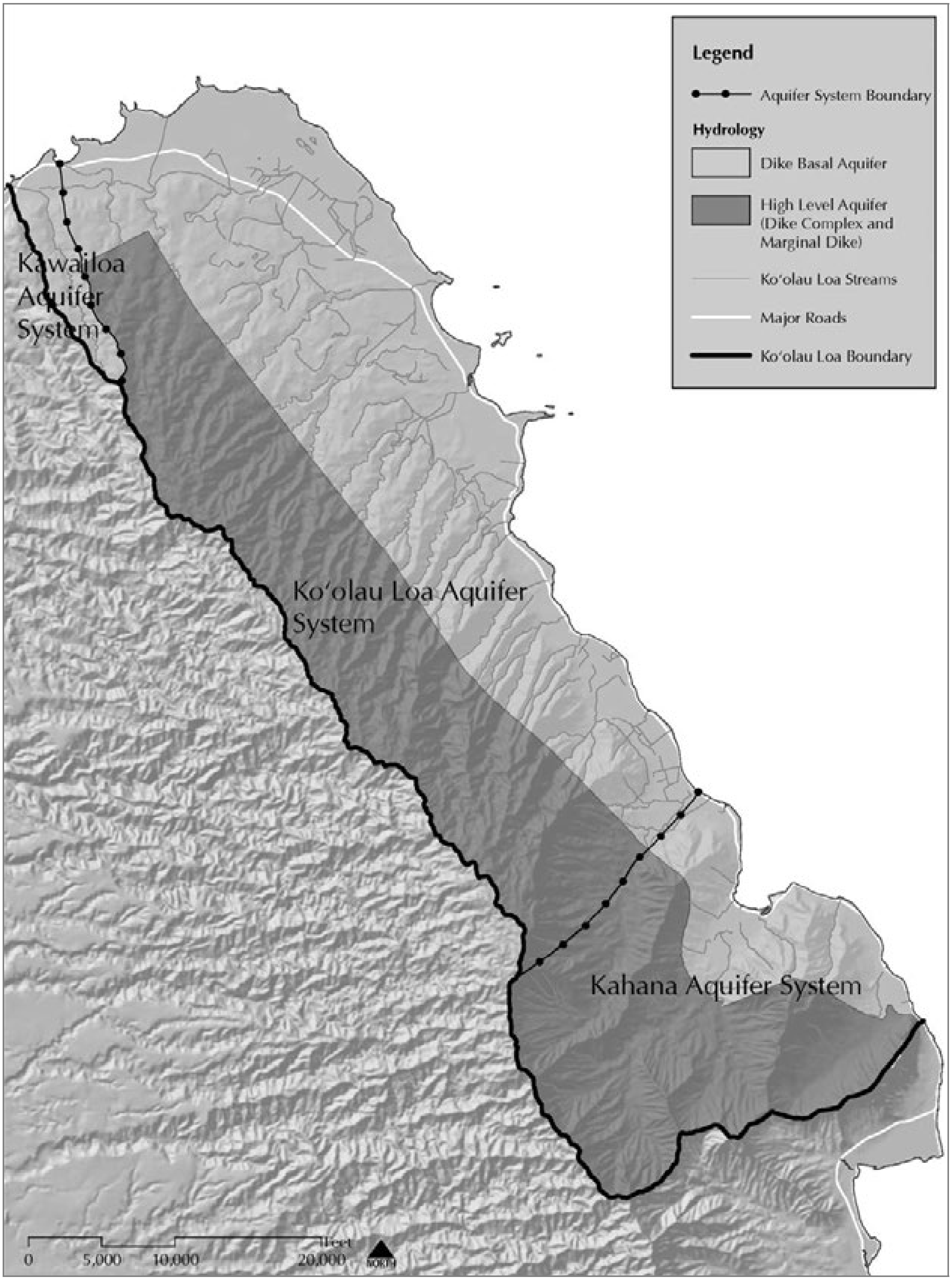


Figure 2.5 Ko'olau Loa Aquifer Systems

2.3 WATER RESOURCES

The State Commission on Water Resource Management (CWRM) has assigned hydrologic units or aquifer sector areas across Oʻahu generally based on regional geology which describes how water is held and its natural movement. These aquifer sector areas also serve as management boundaries for the regulation and allocation of groundwater resources. Koʻolau Loa district is part of the larger Windward Aquifer Sector Area which also includes Koʻolau Poko district.

The Windward aquifer is subdivided into system areas. These system areas are established based on hydrogeology, but are mainly for descriptive ease. There may be movement between the systems. Koʻolau Loa contains two aquifer system areas: one is the entire Koʻolau Loa System Area, and the other is part of the Kahana System Area *(Figure 2.5)*. Kahana System is located between the Koʻolau Loa and Koʻolau Poko systems. Approximately 82% of the Kahana System Area and the wells with permitted use are within the Koʻolau Loa study area. For the purposes of this document, the Kahana System Area will be included in its entirety in discussions of sustainable yield. The northern part of the Koʻolau Loa study area also includes a small sliver of the North Shore Aquifer Sector-Kawailoa Aquifer System Area around the Waileʻe area.

Sustainable yield is *"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."*[10] The currently used sustainable yield numbers from the Commission on Water Resource Management (CWRM) are 36 mgd for Koʻolau Loa system, and 13 mgd for Kahana system.

The 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 Koʻolau Loa system may approach the sustainable yield (36 mgd); however, for Kahana system, the likely recoverable yield is less than 13 mgd sustainable yield. This is also due to the potential effect of groundwater withdrawal on stream flows, since a substantial portion of stream flow is due to groundwater within the Kahana system. Low yields and prohibitive costs limit the development of groundwater.

Note: There are no Department of Hawaiian Home Lands (DHHL) lands in Koʻolau Loa, and therefore there are no associated water reservations.

2.3.1 Groundwater Quality

Koʻolau Loa groundwater quality is generally very high. The main issue for Koʻolau Loa is salinity which primarily concerns the basal water where freshwater floats on salt water. Most of the wells withdraw water from the dike basal aquifer, where salinity is lower than 1,000 mg/l of chlorides. The Department of Health Safe Drinking Water Act secondary standard for drinking water is 250 milligrams per liter (mg/l) chlorides. BWS maintains chlorides at less than 160 mg/l. These self-imposed lower chloride levels ensure conservation precautions with the pump operation. Chlorides in Koʻolau Loa usually range from 32 to 170 ppm, and depend on climatic conditions and pumping levels.

Several different entities monitor the water quality of groundwater sources. The BWS and Lāʻie Water Company test the water quality's compliance with the State Department of Health (DOH) Safe Drinking Water Branch Program standards. They also produce Consumer Confidence Reports that are distributed to their customers.

The State DOH assesses possible threats to groundwater quality through the Source Water Assessment Program (SWAP). SWAP establishes appropriate programs to protect wellhead areas from contamination. Records and field surveys are reviewed to determine groundwater susceptibility to contamination. None of the surveyed Koʻolau Loa wellhead areas were identified as having a high susceptibility to contamination. Potential Contaminating Activities (PCA) for Koʻolau Loa wells included septic tanks, agricultural lands, utility stations, residential parcels, sewer lines, transformer PCBs, and cesspools.

Non-point sources such as agricultural fumigants, herbicides and fertilizer nutrients, can contaminate groundwater sources. USGS report *Ground-Water Quality and its Relation to Land Use on Oʻahu, Hawaiʻi (2000)* samples wells for these and other contaminants across Oʻahu, but the report contains only one sample point of a public well on the edge of Koʻolau Loa on former sugar cane lands. The sampling for the single point did not indicate any contamination. Future study efforts will include more sampling within Koʻolau Loa.

Another concern for groundwater quality is the use of injection wells to dispose of treated wastewater from wastewater treatment plants. The BWS Pass/No-Pass line is a regulatory tool to protect groundwater quality from contamination from cesspools, such as landfills, wastewater treatment plants, but not injection wells.[11] The line was drawn along the boundaries of the thick caprock *(Figure 2.6)*. Regulatory authority of Pass/No-Pass line was transferred to DOH in 1988. The Underground Injection Control (UIC) line is based on chloride levels of groundwater at less than 10,000 parts per million (ppm). In general, the UIC line is more makai than the Pass/No-Pass line.

The Kahuku Wastewater Treatment Plant (WWTP) uses underground injection wells to dispose of wastewater, and the Lāʻie WRF uses back-up infiltration fields (only when land application is not available). These are both makai of the UIC and the Pass/No-Pass line. While there are no issues with groundwater drinking supply contamination, infiltration and the direct injection of treated wastewater introduce wastewater nutrients into the coastal zone, which would affect coastal water quality. Also, cesspools throughout Koʻolau Loa are affecting streams and estuaries, and those mauka of the Pass/No-Pass Line could affect the groundwater.

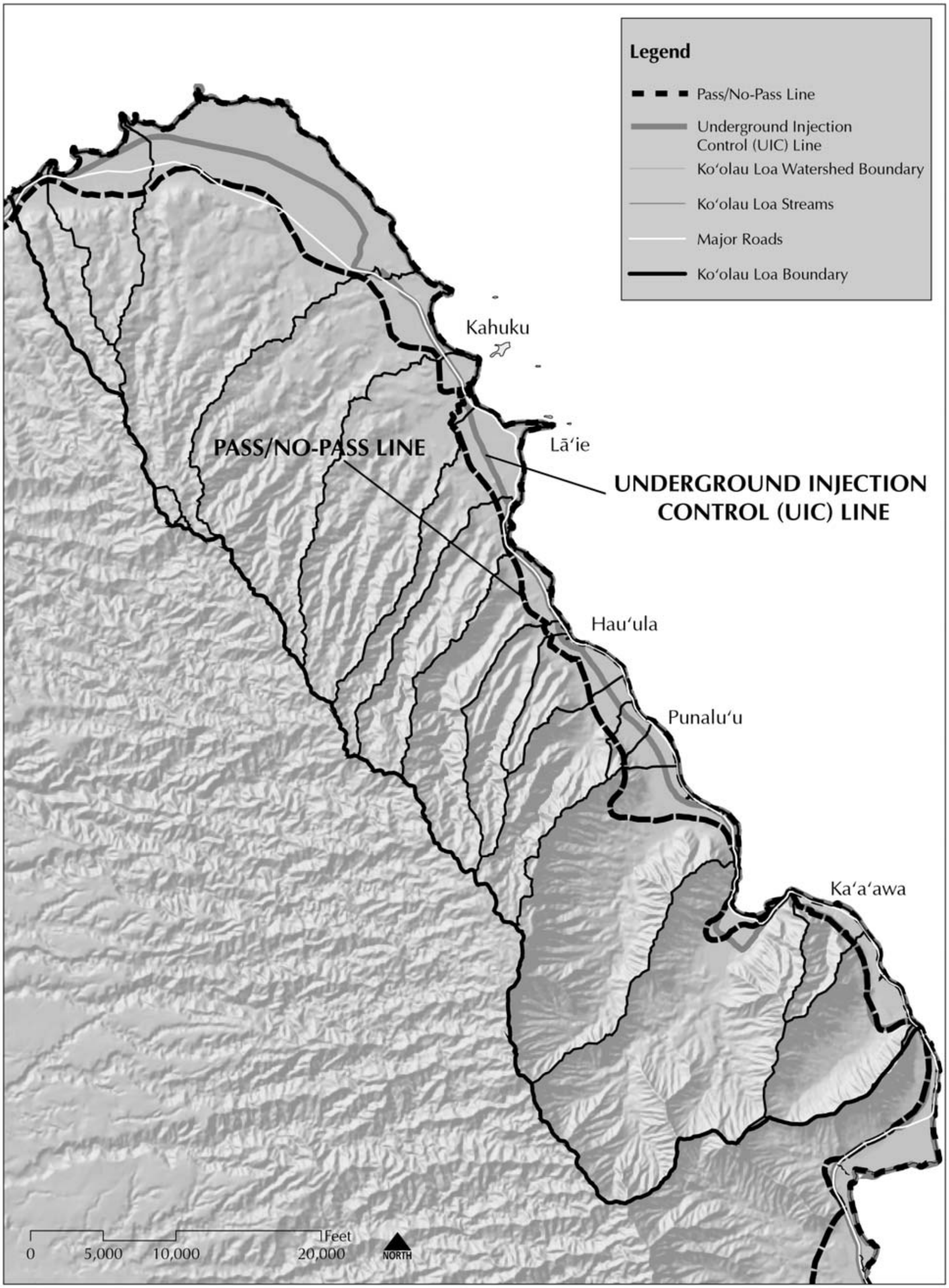


Figure 2.6 Koʻolau Loa Pass-No Pass Line

Surface Water

Streams in Koʻolau Loa are not used for the drinking water supply; however, streams are an important water source for agricultural uses, traditional/cultural practices, and habitat for freshwater fish, invertebrates and other aquatic organisms. Stream quality affects the coastal environment as stream and stormwater runoff flows to the ocean.

2.3.1.1 Streams and Stream Flow

The hydrologic units for streams are the watershed drainage basins that direct runoff into the streams. Flow is typically a function of rainfall and a large watershed drainage basin that directs and accumulates water into the stream. In order for a stream to be classified as perennial, there must be some amount of stream flow year round. The major streams in Koʻolau Loa are listed in *Table 2.2* and shown in *Figure 2.7*.

Table 2.2 Koʻolau Loa Streams

Stream Name	Rainfall	Watershed Size (Acres)	Streamflow, Median* (Cubic feet per second)	Streamflow, Average* (Cubic feet per second)	Diversions
Kawela	Low	Small (1,327)			
ʻŌʻio	Low	Large (6,689)			
Mālaekahana	Low	Large (4,445)	0.3	2.14	
Kahawainui	Med	Med (3,480)			
Wailele Gulch	Med	Small (962)			
Koloa Gulch	Med	Med (1,530)	2.0		
Kaipapaʻu	High	Med (1,899)			
Maʻakua	High	Small (982)			
Kaluanui	High	Med (1,505)	1.3	4.17	
Punaluʻu	High	Large (4,273)	12.0	17.70	Yes
Kahana	High	Large (5,334)	23.0	36.00	Yes
Makaua	High	Small (5,010)			
Kaʻaʻawa	High	Med (1,720)			Yes

* Stream flow median and average numbers from the 1990 Hawaiʻi Stream Assessment where available. Time periods vary for USGS data collection.

According to the U.S. Geological Survey (USGS), perennial streams in Koʻolau Loa are Kaʻaʻawa, Kahana, Punaluʻu, and Kaluanui and Mālaekahana Streams. Mālaekahana Stream is intermittent in its upper reaches, but perennial in the lower reaches. Average total runoff is typically much more than what enters the stream. From Punaluʻu Valley average runoff is about 24 mgd and from Kaluanui Valley is about 3 mgd.[12]

Data from USGS stream gages providing steam flow measurements are listed (*Table 2.2*). Kahana and Punaluʻu streams have the highest stream flows in Koʻolau Loa. For Hawaiʻi streams which have periodic storm events, the median flow (flow exceeded 50% of the time) is a more accurate account of instream conditions than average flow. The 1990 Hawaiʻi Stream Assessment classifies Punaluʻu and Kahana as medium-sized streams.

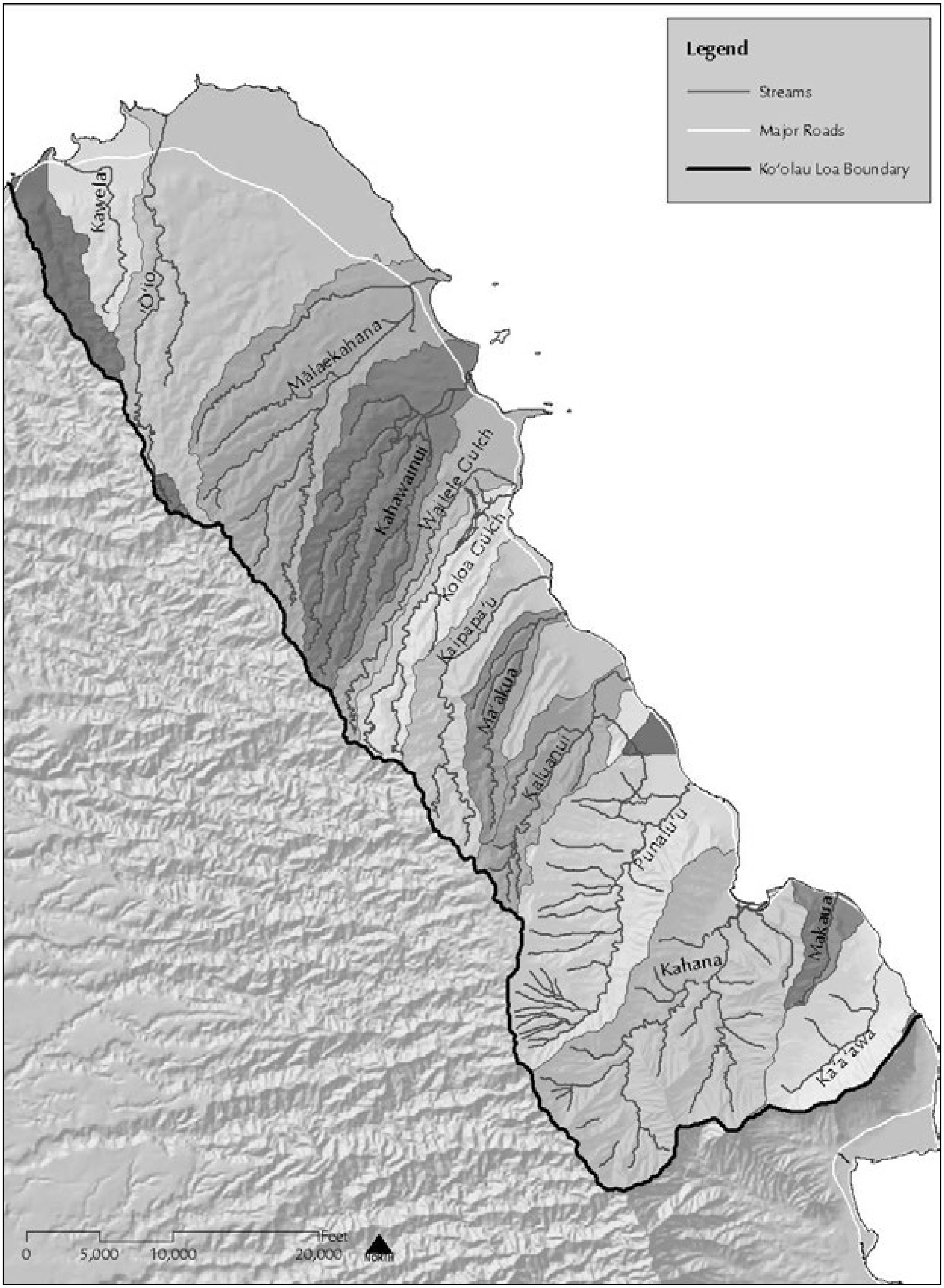


Figure 2.7 Koʻolau Loa Streams

More recent data for Punaluʻu Stream provided by USGS, for 1955 to 2004 indicates that the mean flow was 24.9 cfs, while data for 1995 to 2004 indicates a mean flow of 22.0 cfs. The latter number is likely the most accurate as the data is from the post-sugarcane irrigation period.

Streams in Hawaiʻi are characteristically very flashy due to intense storms, steep stream profiles, and small drainage basins. Typically, stream water sources are normal rainfall and storm events. Koʻolau Loa stream sources also include a perennial water supply from high-level dike confined waters where erosion has broken through dikes. Most Koʻolau Loa streams usually lose water to groundwater in the mid and lower reaches, but are intermittent due to hydrogeologic conditions.[13] Water resurfaces in the estuaries, usually from caprock leakage.

The Punaluʻu and Kaluanui Streams flow year round where their channels cross the caprock.[14] Both receive their permanent flow from high-level dike aquifer spillover and persistent high rainfall. In most of the other streams in Koʻolau Loa, aquifers are below the stream beds where flow may recharge the alluvial aquifer or infiltrate to the basal aquifer.

A USGS stream survey study[15] in September 2004 found that the base flow of streams (the flow not attributable to runoff) has decreased over time. This corresponds to long-term decreases in rainfall, and is likely due to decreases in concurrent groundwater storage and recharge.

2.3.1.2 Stream Water Quality

Water Quality Limited Segments are designated by the DOH based on factors including flow, type and quantity of pollutants, the degree to which water quality standards are exceeded, and the dispersive capacity of the receiving waters.[16] Kahana Bay in Koʻolau Loa has been designated as Water Quality Limited Segment. Levels of ammonia nitrogen, total nitrogen, total phosphorus, turbidity, and chlorophyll have greatly exceeded water quality standards. The rich vegetation of the valley contributes to the high levels of nitrogen and phosphorous. Existing cesspools are being replaced with septic tanks and leach fields as homes are renovated, but may still affect surface water quality.

Kahawainui and Kaʻaʻawa streams are both included on Hawaiʻi's 2004 *303(d) List of Impaired Waterbodies*. Factors for this listing include severity of pollution, water use, type and location of waterbody, degree of public interest and vulnerability of the waters.[17] The listing of Kahawainui and Kaʻaʻawa was based upon a visual assessment that rated their nutrients and turbidity at medium level. Kahana Bay is also listed as a low-priority Impaired Waterbody .

Runoff from the conservation area of the watershed can have a heavy sediment load especially where forest cover is not adequate to protect the soil from runoff effects. Feral pigs create large areas that are susceptible to higher rates of soil erosion and contribute to increased steam sedimentation. Feral pigs are associated with all of the Koʻolau Loa watersheds, however, the number of feral pigs is not known.

Other threats to the water quality of runoff are caused by human settlement. These include many of the same Potentially Contaminating Activities (PCA) such as septic tanks, agricultural lands pesticides and herbicides, utility stations, residential parcels, sewer lines, transformer PCBs, and cesspools.

Cesspools, where the sewage flows directly into the ground, pollute streams estuaries and nearshore waters. The BWS took water quality samples of Maʻakua stream estuary and found high coliform bacteria and detergent levels that are believed to have come from nearby cesspools.

2.3.1.3 Stream Biota and Threats

The diversity of native aquatic organisms is low; however, most of the species are endemic to the Hawaiian Islands. Most native stream animals spend part of their life in two different environments. *Table 2.3* lists the Native Hawaiian stream species by their Hawaiian name, scientific name and type of organism.

Table 2.3 Native Hawaiian Stream Species

Native Hawaiian Name	Scientific Name	Type of Organism
ʻOʻopu hiʻukole (alamoʻo)	*Lentipes concolor*	Fish (Goby)
ʻOʻopu nōpili	*Sicyopterus stimpsoni*	Fish (Goby)
ʻOʻopu nākea	*Awaous guamensis*	Fish (Goby)
ʻOʻopu naniha	*Stenogobius hawaiiensis*	Fish (Goby)
ʻOʻopu ʻakupa (ʻōkuhe)	*Elotris sandwicensis*	Fish (Eleotrid)
Hinana	N/A	Goby Larval Stage at Sea
ʻŌpae kalaʻole (kuahiwi)	*Atyoida bisulcata*	Crustacean
ʻŌpae ʻoehaʻa	*Macrobrachium grandimanus*	Crustacean
Hīhīwai	*Neritina granosa*	Mollusk
Hapawai	*Neritina vespertina*	Mollusk
Pīpīwai	*Theodoxus cariosus*	Mollusk
Pinapinao	*Megalagrion oceanicum*	Damselfly
Pinapinao	*Megalagrion leptodemas*	Damselfly
Pinapinao	*Megalagrion nigrohamatum migrolineatum*	Damselfly

The animals also have a regular distribution based on their typical habitat. ʻOʻopu hiʻukole and ʻōpae kalaʻole are usually found in the upper reaches of streams. ʻOʻopu nōpili, ʻoʻopu nākea and hīhīwai often live in the mid to lower reaches of streams. In the lower reaches and brackish areas are ʻoʻopu naniha, ʻoʻopu ʻakupa, ʻōpae ʻoehaʻa, hapawai, and pīpīwai.

The Koʻolau Loa area has three damselfly Threatened and Endangered Species Act candidates - *Megalagrion oceanicum, Megalagrion leptodemas, and Megalagrion nigrohamatum migrolineatum*. The concentration of the damselflies in Koʻolau Loa is the highest of any candidate Threatened and Endangered species on Oʻahu.

Many species feed on stream algae. Only 5% of freshwater algae in Hawaiʻi are believed to be endemic.[18] In general substantial stream flow and periodic flooding are required to flush the stream and support the algae growth for the native stream species.

1990 Hawaiʻi Stream Assessment recommended Kahana stream as a candidate for protection due to its aquatic, riparian, cultural and recreational resources. The State DLNR is studying this stream.

Regular stream flow is critical for streams to maintain a population of native stream organisms. The best habitat for native stream species is a clear cold stream that flows strongly all year. The stream bed should have little sedimentation and experience flash floods in the winter months to clear away accumulated leaf litter and other debris.

Most native stream species spend part of their life in the stream and part of their life in the ocean. Maintaining the stream connection to the sea is important for these native animals. In addition to cleansing streams of sedimentation, floods and storm events open passages to the ocean to release larvae into the sea and signal animals in the ocean to travel upstream.

An effort is in progress to create a GIS-based model determining the instream flow level needed to maintain the native ecosystem of fish, algae and invertebrates. Dr. Parham of the University of Nebraska is developing a model that analyzes stream morphology and other conditions to determine the flow needed to maintain aquatic habitat for each island stream.[19]

In 2001/2002, a study of Kahana stream assessed the biology of the rich valley resources as a baseline study prior to returning flow from the Waiāhole Ditch. The study found that hau trees dam the stream and may significantly reduce the stream flow. The recommendation is to remove hau trees from key areas to promote stream flow. This potential increase of instream flow and the return of Waiāhole Ditch water to the stream will help to cleanse the stream of debris, facilitate animal migration, signal animals to return upstream, reduce alien species, and protect valley residents and archeological sites.[20]

Punalu'u Stream has also received attention because of its sizable flow used for agriculture irrigation. Currently USGS is undertaking a two year study to evaluate stream flow and stream habitat, effects of groundwater withdrawals on stream flow, and the effect of diversions on instream temperatures. This study will provide the CWRM information to consider when setting the instream flow standard for Punalu'u stream.

In addition to lack of stream flow, one of the biggest threats to the native species is introduced species. These species are mainly fish that compete with and eat natives. They include banded jewel fish, swordtails, Japanese loaches, catfish, mosquito fish, wrinkled frogs, Tahitian prawns, apple snails, and crayfish. Diversions that facilitate water flow to and from streams can also be conduits for movement of introduced species upstream.[21]

2.3.1.4 Wetlands

Stream flow can be important for preventing increased salinity in the wetland areas. Wetlands occur in areas where the ground is highly saturated usually from streams. Wetlands can function as groundwater recharge areas, holding areas for stormwater, filters for waterborne pollutants and bird habitat.

Wetlands in Ko'olau Loa occur along the streams of Kawela, 'Ō'io, Mālaekahana, Kahawainui, Wailele, Koloa, Kaipapa'u, Ma'akua, Kaluanui, Punalu'u, Kahana, and Ka'a'awa.[22] In Kahuku, Punalu'u, Kahana and Ka'a'awa, wetland water supply comes mainly from caprock springs derived from basal groundwater.[23] Other Ko'olau Loa wetlands rely on dike-impounded water overflow or leakage.

The largest Ko'olau Loa wetland area is the Punaho'olapa Refuge (formerly the James Campbell National Wildlife Refuge Complex). The 164-acre area was established to provide habitat for the endangered Hawaiian stilt (ae'o), coot ('alae ke'oke'o), moorhen ('alae 'ula) and duck (koloa maoli). The closure of Kahuku Sugar Mill dried up the settling ponds that were important bird habitat. The spring fed marsh and U.S. Fish and Wildlife Service constructed ponds now provide an enhanced habitat for the endangered birds. Water quality in the refuge does not seem to be impacted by the proximity of wastewater disposal via injection well to the caprock from the Kahuku sewage treatment plant.[24]

2.3.2 Nearshore Waters

Another important water resource habitat is the interface of fresh and ocean waters. Estuaries and embayments provide habitats for native stream and marine species at various points in the life cycle. Estuaries are brackish coastal waters connected to the ocean which allows the entry of marine organisms. Embayments are waters protected by land with a restricted coastal water opening defined by the ratio of total bay volume to the cross-sectional entrance area of seven hundred to one or greater. The definitions of estuaries and embayments have some overlap. In Ko'olau Loa, Coastal Zone Management has identified Kaluanui and Punalu'u as estuaries. Kahana is identified as both a high quality estuary and as an embayment and is classified as AA water quality. AA waters should remain in their natural pristine state as much as possible with an absolute minimum of pollution or alteration of water quality from any human-caused sources or actions.[25]

Former fishponds were located in nearshore waters. Currently, there is only one operational fish pond in the area. The Huilua fish pond at the mouth of Kahana stream was designated as a national historic landmark in 1962. Restoration continues on this seven-acre pond fed by ocean water and freshwater springs. The fish pond is home to both salt and freshwater fish.

The Ko'olau Loa coastline has scattered beaches, surf breaks and coral reefs. The marine environment outside of the protected embayments and estuaries is subject to strong wave action that flushes offshore waters across the reef crest and flat, and prevents any major damaging effects from terrestrial runoff and sediment.

One of the threats to coral reef health off the coast Ko'olau Loa is sedimentation from runoff. The sediment runoff in Hawai'i from agriculture, ranching urban and industrial activities is estimated at 1 million tons per year.

Freshwater runoff which dilutes salinity can also be a threat. When salinity falls to 15 parts per thousand (ppt) for several days it can cause mass mortality of corals and invertebrates on shallow reefs. This occurred in Kāne'ohe Bay in 1965 and 1987 but has not occurred in Ko'olau Loa.[26] These events are triggered by very large surface water discharge from storm events, and could be entirely natural or could be increased above pre-development level due to land development and the increase in impervious surfaces.

The Ko'olau Loa coast has not yet been subjected to large amounts of alien algae which can out compete native corals, limu and seagrass. However, four of five well known alien algae species have already been found in Kāne'ohe Bay.[27]

2.4 TERRESTRIAL ECOSYSTEMS

The Ko'olau Mountain forests are essential to protecting the quality and quantity of ground and surface waters. The upper stories and understories of the forest buffer the ground from the forces of rain and wind, decreasing soil erosion and sedimentation in streams and on the coral reef. Forest vegetation also absorbs rainfall via the roots and leaves of trees, shrubs, ferns and mosses. Since rainfall that would otherwise quickly become surface runoff is absorbed, more precipitation can soak into the ground and recharge the groundwater.

Native plant communities in windward O'ahu are generally found above 1,000 feet in elevation. The *1990 Hawai'i Stream Assessment* estimated the percentage of native forest along the main course of the stream. The highest percentage was 40% in Kaluanui, followed by 20% in Kaipapa'u and 10% in each of Kahawainui, Wailele, Koloa, Ma'akua, Punalu'u, and Kahana. Hau'ula Forest Reserve and the Kaipapa'u Forest Reserve contain intact native forest and rare plants, in addition to stream damselflies and 'o'opu. Nearly all of Ko'olau Loa has been subjected to human influences at some point making intact native forest difficult to find except on ridges, in high gulches, and along the summit.[28]

The native plant communities are associated with Ko'olau Loa. These are described below, based on the elevations and climatic conditions in which they occur.[29]

Lowland wet communities are generally above 1640 feet and below 2000 feet along the Ko'olau Mountains in Ko'olau Loa. 'Ōhi'a Shrubland community is one of the wet communities that occur where rainfall is at least 100 inches but less than 190 inches in moderate to steep areas. Many dwarfed endemic native trees and shrubs are found in these windswept areas.

Lowland forest communities can be found between 600 and 2,000 feet, in less rainy and warmer and more sheltered conditions. 'Ōhi'a Forest and Uluhe Shrubland are two such communities.

Lowland Mesic communities below 3,000 feet include koa/'ōhi'a forest where there are well-drained soils and 30-35 inches of rain. 'Ōhi'a lowland mesic forest aoccurs below 3,000 feet, but is associated with windy ridges. Lowland dry communities such as lama forest occur between 600 and 900 feet. In the Kahuku Training Area contains lama forest stand in Pahipahi'ālua Gulch. [30]

For a number of species on the threatened and endangered species list in *Table 2.4*, the US FWS has designated critical habitat within Ko'olau Loa. These are all plant species except for one bird species. The critical habitat is mainly a contiguous area of the Ko'olau Mountains conservation area and a separate mountainous area in the Kahana area.

Surveys for rare and endangered species in this area are incomplete. Few species studies have been done, therefore, mapping the known distribution of rare and endangered species is not an accurate representation of Ko'olau Loa.

Alien plants and animals are threats to the native ecosystem. Detrimental plants along Ko'olau Loa streams include mangrove, hau and California Grass. As previously mentioned, feral pigs are also found throughout Ko'olau Loa.

Feral pigs have been found to spread weeds, inhibit reestablishment of native plants, destroy existing native plants, spread plant disease, displace plants and shift ecosystem plant composition, destroy native bird habitat, contaminate and fertilize streams with urine and feces, create breeding grounds for mosquitoes, and cause soil erosion and harm stream biota.[31] Other introduced mammals that are problematic for the native ecosystem are rats, mongoose, mice, and feral cats and dogs. Other introduced terrestrial species include birds, reptiles and amphibians and mosquitoes. [32]

Wildfires are another threat to portions of the Koʻolau Loa watersheds. During periods of low rainfall, wildfire can result in the loss of vegetation and groundcover and in large exposed areas vulnerable to erosion.

Table 2.4 Threatened and Endangered Species

SCIENTIFIC NAME	HAWAIIAN NAME	FAMILY NAME
Adenophorus periens	Pendant kihi fern	Fern
Chamaesyce rockii	ʻAkoko	Euphorbiaceae - Spurge family
Cyanea acuminata	Haha	Campanulaceae - Bellflower family
Cyanea crispa	Haha	Campanulaceae - Bellflower family
Cyanea humboldtiana	Haha	Campanulaceae - Bellflower family
Cyanea koolauensis	Haha	Campanulaceae - Bellflower family
Cyanea st.-johnii	Haha	Campanulaceae - Bellflower family
Cyanea truncata	Haha	Campanulaceae - Bellflower family
Cyrtandra subumbellata	Haʻiwale	Gesneriaceae - Gesneria family
Cyrtandra viridiflora	Haʻiwale	Gesneriaceae - Gesneria family
Eugenia koolauensis	Nīoi	Myrtaceae - Myrtle family
Gardenia mannii	Nānū	Rubiaceae - Coffee family
Hesperomannia arborescens	none	Asteraceae – Aster family
Labordia cyrtandrae	Kāmakahala	Loganiaceae - Logania family
Lobelia gaudichaudii koolauensis	none	Campanulaceae - Bellflower family
Lobelia Oahuensis	none	Campanulaceae - Bellflower family
Lysimachia filifolia	none	Primulaceae - Primrose family
Myrsine juddii	Kolea	Myrsinaceae
Phlegmariurus nutans	Wawaeʻiole	Lycopodiaceae - Ferns and Allies
Phyllostegia hirsuta	none	Lamiaceae - Mint family
Phyllostegia parviflora	none	Lamiaceae - Mint family
Platanthera holochila	none	Orchidaceae - Orchid family
Pteris lidgatei	none	Maidenhair – Fern family
Sanicula purpurea	none	Apiaceae – Parsley family
Schiedea kaalae	Maʻoliʻoli	Caryophyllaceae - Pink Family
Sesbania tomentosa	ʻOhai	Fabaceae - Flowering plants
Tetraplasandra gymnocarpa	ʻOheʻohe	Araliaceae - Ginseng family
Viola Oahuensis	none	Violaceae – Violet family
Panicum carteri	Panicum, Poaceae	Grass family
Chasiempis sandwichensis ibidis	ʻElepaio	Corvidae – Birds

2.5 CULTURAL RESOURCES AND TRADITIONAL PRACTICES

He kiu ka makani makai mai	*Strong and cold, like a fishhook, is the ocean wind*
He Mualua iho manae	*The Malualua wind is the net below*
He Peapueo ko Kaunala	*The Peapueo belongs to Kaunala*
He Ahamanu ko Kahuku	*The Ahamanu wind belongs to Kahuku*
He Lanakila ko Hauʻula	*The Lanakila wind belongs to Hauʻula*
He Moae ko Punaluʻu	*The Moae wind belongs to Punaluʻu*
He Ahiu ko Kahana	*The Ahiu wind belongs to Kahana*
He Holopali ko Kaʻaʻawa me Kualoa	*The Holopali wind belongs to Kaʻaʻawa and Kualoa*

Chanted by Kūapakaʻa in the Laʻamaomao oral tradition, this wind chant provides an excellent example of how traditional knowledge preserves the collective history of a place, reiterates community genealogy, characterizes the unique qualities of the associated natural forces, and defines one component of the cultural landscape of Koʻolau Loa.

Various oral traditions and written records traditionally describe the district as an area abundant with mountainous and coastal resources with broad valley bottoms and flatlands between the mountain and the sea. The region was endowed with a rich water supply stemming from several major tributary systems, including the Kaluanui, Punaluʻu, Kahana, Kaʻaʻawa, and Makaua Streams, whose headwaters lie in the upper mountain regions of the Koʻolau Range beyond the peaks of Puʻukānehoalani, Puʻumanamana, Puʻuomahie, Puʻupiei, Puʻuwaiahilahila, Puʻukī, and Puʻukauwewe'ole.

Native Hawaiian oral tradition credits Kalamakua, the ruling chief of Oʻahu in the 15th century, with establishing and cultivating the agricultural lands of the island with the immense construction of numerous ʻauwai, irrigation ditches integrated with magnificently built loʻi, and intricate agricultural terraces. The elaborate design and development of these irrigation systems in Koʻolau Loa created a productive agricultural community that impressed even early western contacts.

Rich alluvial soils, adequate rainfall, and abundant freshwater sources provided ideal terrain and nutrient conditions for planting taro, ʻuala *(Ipomoea batatas*, sweet potato), ʻulu *(Artocarpus altilis*, breadfruit), ʻuhi *(Dioscorea alata*, yams), kō *(Saccharum officinarum*, sugarcane), wauke *(Broussonetia papyrifera*, paper mulberry), for food, clothing, and storage resources. Toward the uplands, a diversified landscape of forest and fruit trees included koa *(Acacia koa subsp. Koa*), kukui *(Aleurites moluccana*, candlenut tree), hau *(Hibiscus tiliaceus)*, ʻohe *(Schizostachyum glucifolium*, Hawaiian bamboo), olonā *(Touchardia latifolia*), hala (*Pandanus tectorius*, screwpine), and ʻōhiʻa ʻai (*Syzygium malaccense*, mountain apple).[33]

Abundant flowing water from an immense water distribution system created numerous opportunities in Koʻolau Loa to construct shoreline fishponds, known as loko iʻa or loko kuapa. Offshore reef and bay fishing was supported by the construction of designated fishing grounds, known as koʻa or kūʻula during the late Expansion (1100-1650) through Protohistoric (1650-1795) periods. An example of this is Kapaʻeleʻele, a koʻa on the west side of Kahana Bay. These fishing resources were all part of an intense aquacultural production system that is still utilized today.

It was estimated that in 1900, the entire island of Oʻahu had over 100 fishponds but that estimate has since diminished to about 6 to 7 remaining today. These fishing resource areas contained various species of fish, including ʻamaʻama (striped mullet), ʻanae, awa (milkfish), and āholehole (silver perch). The fishponds were also home to Samoan crabs, tilapia, ʻōpae huna (freshwater shrimp), and ʻoʻopu nākea (goby). Waterbirds such as the ʻalae ʻula (Hawaiian mudhen) and the ʻalae keʻokeʻo (Hawaiian coot) fed on algae within the pond's waters, while the ʻaukuʻu (black-crowned night heron) stalked along the banks of the pond to prey upon fish and crustaceans. As previously noted, Huilua situated along Kahana's shores and currently under restoration is a fishpond on the National Register of Historic Sites.

The cultural significance of the Koʻolau Loa district in the consciousness of Native Hawaiians is illustrated in several oral traditions which describe the district as an area of residence for akua (gods) and ruling aliʻi (often referred to as "chiefs" but considered living akua who bear the kuleana of developing and practicing appropriate land and coastal stewardship practices).

Several oral traditions acknowledge the cultural significance and contributions of the akua, Kāne and Kanaloa, two deities associated with two essential elements of life: freshwater and saltwater, respectively. The form most associated with Kāne is that of freshwater, whether from rain-filled clouds or streams that flow from upland to coastal regions. In the epistemological understanding of Native Hawaiians, freshwater is a life-giver rather than a mere physical element. The gift of using water is a kapu, a sacred privilege, as water belonged to the gods.

Additional oral traditions detail Koʻolau Loa's association with Wākea and Haumea, considered in cosmogonic tradition as Sky Father and Earth Mother, respectively. Further, the accounts of Hiʻiakaikapoliopele, the younger sister of Pele and an akua recognized as a healer and restorer of the land, are also well-documented, as well as stories of specific encounters with several ancestral figures whose legacy has been preserved in the natural landscape as mountain and/or ocean features.

The tradition of Kamapuaʻa tells us that he was from Kaluanui (Kaliuwaʻa) in the Koʻolau Loa district, and that he was a kupua, a supernatural being. He could assume a variety of kinolau, multiple body forms, primarily those of a pig, or a man, but if necessary could also take the form of the fish humuhumunukunukuapuaʻa, or any of many plant forms, including kukui and ʻamaʻu. The kinolau of Kamapuaʻa also included multitudes of pigs, or a gigantic eight-eyed, eight-legged pig-monster, pig-shaped clouds in the sky, a giant pig-ladder as high as a waterfall to aid his relatives' escape. The virility of Kamapuaʻa is considered one source of fertility for the ʻāina.[34]

2.6 SETTLEMENT HISTORY

Historical documentation indicates that as early as the Voyaging Period (1000-1180 AD) during the reign of Laʻamaikahiki, Koʻolau Loa, with its vast natural resources, was a preferred location for royal residence, second only to that of the Waikīkī-Nuʻuanu-Mānoa region. Numerous native oral traditions and foreign accounts from the late 1700s suggest that the various ahupuaʻa within the district were part of a larger and significant political and population center primarily sustained by a variety of wetland agricultural practices and aquaculture activity.

After western contact in the late 1800s, there was a dramatic decrease in the native population due to the introduction of foreign diseases and changes in land tenure practices. Between 1812 and 1830, the increased demand for sandalwood created a new trade that influenced and changed previous land tenure practices in Koʻolau Loa. The timber, cut from the upland slopes of the Koʻolau Mountains, was hauled down to Waialua Bay for transport and trade.

Records indicate that after the unification of the islands in 1812, Kamehameha appointed several of his advisors as district aliʻi to restore efficient levels of agricultural production on all the islands. After Kamehameha's death in 1819, Liholiho continued extensive government-initiated efforts in several commercial agricultural activities including sandalwood trade. By 1827, a major initiative promoted the continued extraction of this natural commodity specifically to decrease debts incurred by the government. As the labor-intensive harvest efforts of sandalwood increased, the maintenance and sustainability of the traditional agricultural terraces decreased.

In 1848, during the reign of Kauikeaouli (Kamehameha III), the Māhele, a western concept of land tenure, was incorporated into legislation, which reformed the existing land system in Hawaiʻi. The Māhele led to the division and distribution of land, thus creating the islands' first system of possession rights and private title to land. During this process, all lands were placed into one of three categories: Crown Lands (for the occupant of the throne), Government Lands, and Konohiki Lands.

Approximately 30% of the lands within Koʻolau Loa were classified as Crown Lands and the remaining 70% as Government Lands. According to source documents, Kamehameha III retained the ahupuaʻas of Kahuku and Kawela. Native interests that were awarded lands were a small portion of the overall population. The majority of awardees were the local elite, who possessed the financial and social authority to sustain further occupancy and usage of the property in question. Large tracts of land were obtained in fee or in leasehold by foreign interests, as in the case of C.G. Hopkins and Robert Moffitt Stoney, who purchased thousands of acres of district lands to raise cattle and horses. In the late 1870s, James Campbell, Esq. acquired the Moffitt lands, which included 25,000 acres in fee simple and large tracts of land under long-term leases. In 1865, Francis Hammond, a Latter-day Saints missionary, purchased 6,000 acres in Lāʻie for the church and subsequently established an agricultural colony.

Sources suggest that by the late 1860s, much of the land within the region was utilized by established plantations to support ranching and sugarcane activities, which were emerging as new profit sources within the region. In 1890, two prominent U.S.-based interests, Campbell and Benjamin F. Dillingham, worked together to establish and expand lands for sugarcane production under the Kahuku Plantation Company and the development of the Oʻahu Railway and Land Company (OR&L). By 1898, this rail system connected the areas of Kahuku to Waialua, Honolulu, Pearl City, and Waiʻanae, fortifying the island's production and distribution efforts in sugarcane production. A subsidiary of the OR&L, the Koʻolau Railway Co., connected Kahana to Kahuku and served as a common freight carrier until 1931. It is estimated that during this period, over 1,000 acres were utilized in sugarcane cultivation which yielded approximately 5,200 tons of sugar annually. During the sugar era, draft from the Kahuku Plantation operations from the basal aquifer was 25 to 30 mgd. In 1947 the maximum draft was 50 mgd. Subsequent leases of land were acquired to seek new water sources at Bishop Estate lands in Punaluʻu and Zions Securities in Lāʻie.

In the early 1900s, the plantation began leasing portions of its land for another emerging crop industry: pineapple cultivation. Small individual growers were obligated to sell their crops to Hawaiian Pineapple Co., Libby, McNeill & Libby of Honolulu, and the California Packing Corporation. During the post-World War II period, sugar sales fluctuated. The OR&L finally ceased its rail line operations in 1947, with the plantation finally closing in 1971. During the post-plantation period, much of the land throughout the district was still utilized for agriculture, ranching and pasture. Small-scale farming and diversification of crops began in the 1980s and is still prevalent today.

2.7 RESIDENTIAL AND VISITOR POPULATION DEMOGRAPHICS

2.7.1 Residential Population and Housing

According to the 2000 U.S. Census, the residential population within the Koʻolau Loa census county division was 18,899, an approximate increase of 2.41% from 1990. The population within the Koʻolau Loa district represents approximately 2.16% of the island's total residential population. There are 5,172 households with an average household size of 3.51 persons. The Koʻolau Loa Sustainable Communities Plan (SCP) projects that the Koʻolau Loa population will increase less than 1% per year until 2020. Adjusting for the difference in geographical boundaries of the Census and this Plan's study area, the population has been estimated at 14,649 with 3,717 households.[35] Approximately 36% of the residential population is under the age of 19, representing a 4.6% decrease from 1990. Approximately 48% of the population is between the ages of 24 to 54. The remaining 16% of the population is over the age of 55 with the median age at 29.2 years.

The 2000 median household income within Koʻolau Loa was $46,610, with approximately 82% of the residential population generating some level of wage and salary income of which approximately 20% are self-employed. Approximately 18% of the population receives retirement income while another 9.6% of the population receives public assistance.

According to adjusted 2000 Census data, there are approximately 4,509 housing units within the Koʻolau Loa district. Approximately 82% of these units are occupied. Of the occupied units, 53% are renter-occupied as compared to 47% owner-occupied. The median age of homes constructed within Koʻolau Loa is 30 years, with 39% of units built prior to 1960. Approximately 98% of the housing units have complete plumbing and kitchen facilities.

2.7.2 Visitor Population and Facilities

In 2002, the average daily visitor census was 82,121 on the island of Oʻahu.[36] The average rate of occupancy in 2003 was 73.1%. On Oʻahu, there are 199 visitor properties that consist of 35,644 visitor units. The average visitor party size for the State in 2002 was 2.13 persons. In the Koʻolau Loa district, there are approximately 600 visitor units that include hotel and condominium units, individual visitor units, and bed and breakfast establishments.[37] The resort units are situated at the Turtle Bay Resort, north of Kahuku, and the Lāʻie Inn in Lāʻie.

2.8 LAND USE

This section provides an overview of Koʻolau Loa land uses, based on policy information from existing State and County-level land use regulatory agencies, data from public and private sector data sources including previously conducted studies and user group interviews, and high-altitude aerial photographs and infrared images for the identification of land cover and uses.

2.8.1 State Land Use Designations (SLUD)

Under Hawaiʻi Revised Statutes, §205, State of Hawaiʻi lands are to be classified as one of four categories: urban, rural, agricultural, or conservation. The governor-appointed State Land Use Commission (LUC) is responsible for setting the standards that determine the boundaries of each district.[38] The LUC is also responsible for administering all requests for district reclassifications and/or amendments to district boundaries.[39] *Table 2.5* and *Figure 2.8* illustrate the total acreage and coverage of lands under the SLUD system within the Koʻolau Loa region.

Table 2.5 Acreage of Koʻolau Loa by State Land Use Designations

Watershed	Agriculture (acres)	Conservation (acres)	Urban (acres)	Total
Waialeʻe (Paumalu)	815	137	11	963
Kawela	1,093	0	233	1,326
ʻŌʻio	4,602	1,322	765	6,689
Mālaekahana	2,427	1,742	275	4,444
Kahawainui	1,993	1,399	89	3,481
Wailele	316	726	399	1,441
Koloa	119	1,349	63	1,513
Kaipapaʻu	71	1,628	199	1,898
Maʻakua	0	932	50	982
Waipuhi	253	287	159	699
Kaluanui	441	1,057	8	1,506
Papaʻakoko	142	27	8	177
Haleʻaha	119	1	40	160
Punaluʻu	815	3,363	94	4,272
Kahana	10	5,323	3	5,336
Makaua	12	380	119	511
Kaʻaʻawa	745	930	45	1,720
TOTAL	**13,974**	**20,601**	**2,560**	**37,135**
Percentage	**38%**	**55%**	**7%**	**100%**

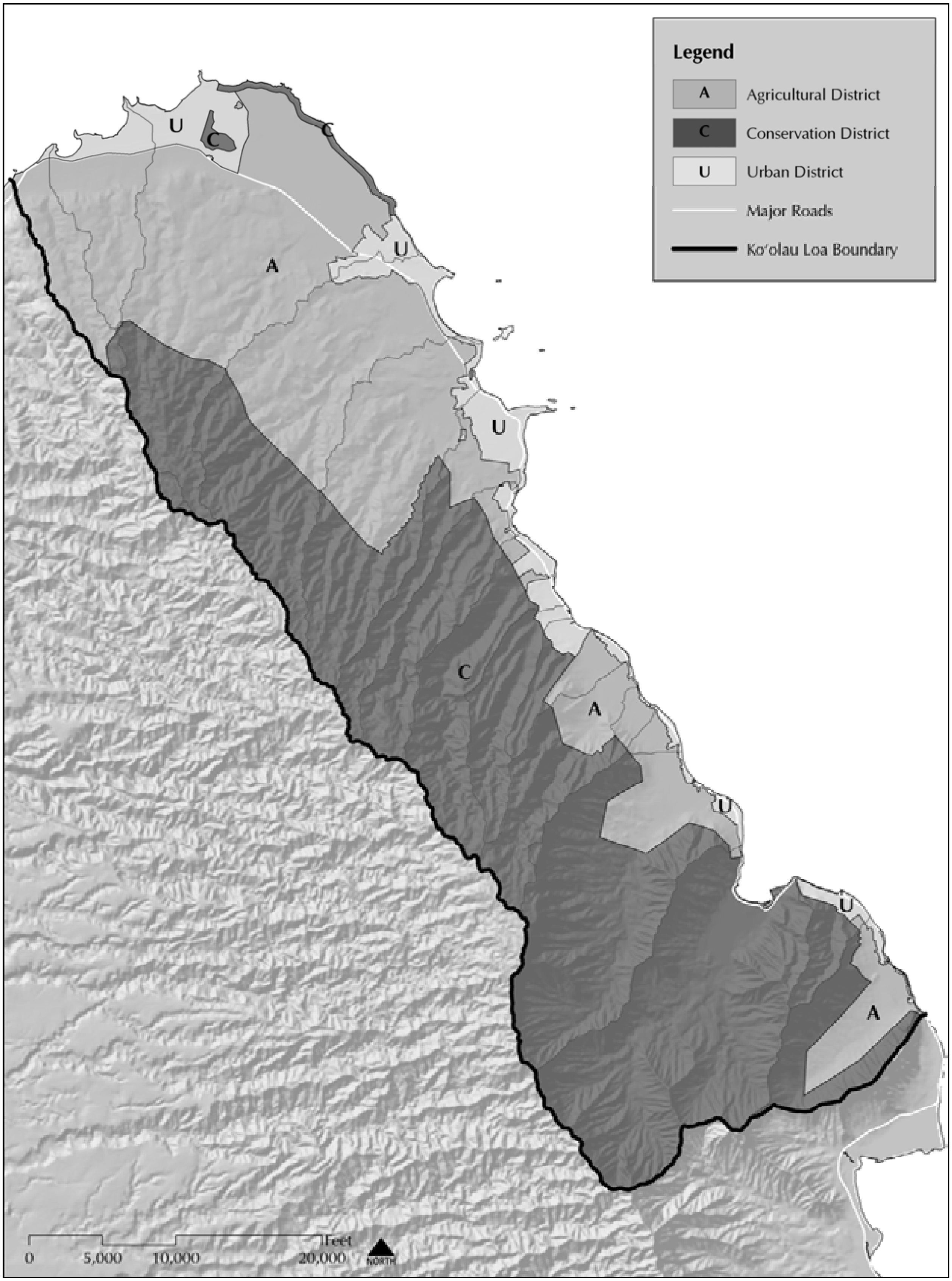


Figure 2.8 State Land Use Designation (SLUD)

2.8.2 Koʻolau Loa Sustainable Community Plan - Land Use Map

As shown in *Figure 2.9*, the KLSCP-Land Use Map illustrates the desired long-range land use pattern for the Koʻolau Loa region, which supports the vision and policies of the SCP. The map defines rural residential areas, country towns, rural regional commercial centers, rural community commercial centers, resort areas, visitor facilities, a technology park, and industrial and institutional space.

Table 2.6 Koʻolau Loa Sustainable Communities Plan Land Use

Type	Acres	Percentage
Preservation	17,470	47%
Agricultural	8,880	24%
Military	7,400	20%
Rural Residential	1,370	4%
Golf Course	770	2%
Park	455	1%
Resort	350	<1%
Institutional	230	<1%
Industrial	80	<1%
Visitor Facilities	80	<1%
Technology Park	50	<1%
TOTAL	**37,135**	100%

2.8.3 City and County of Honolulu Land Use Ordinance

The purpose of the Land Use Ordinance (LUO) is to regulate land use in a manner that will encourage orderly development in accordance with adopted land use policies, including the County General Plan and Sustainable Communities Plans. The LUO is also designed to promote and protect the public health, safety and welfare through various actions such as:

- Minimizing adverse effects resulting from the inappropriate location, use or design of sites and structures;
- Conserving the city's natural, historic and scenic resources and encouraging design which enhances the physical form of the city; and
- Assisting the public in identifying and understanding regulations affecting the development and use of land.

The LUO is also intended to provide reasonable development and design standards. These standards concern the location, height, bulk and size of structures, yard areas, off-street parking facilities, open spaces, and the use of structures and land for agriculture, industry, business, residences or other purposes.[40] *Table 2.7* and *Figure 2.10* illustrate the total acreage and coverage of lands designated under the LUO zoning codes.

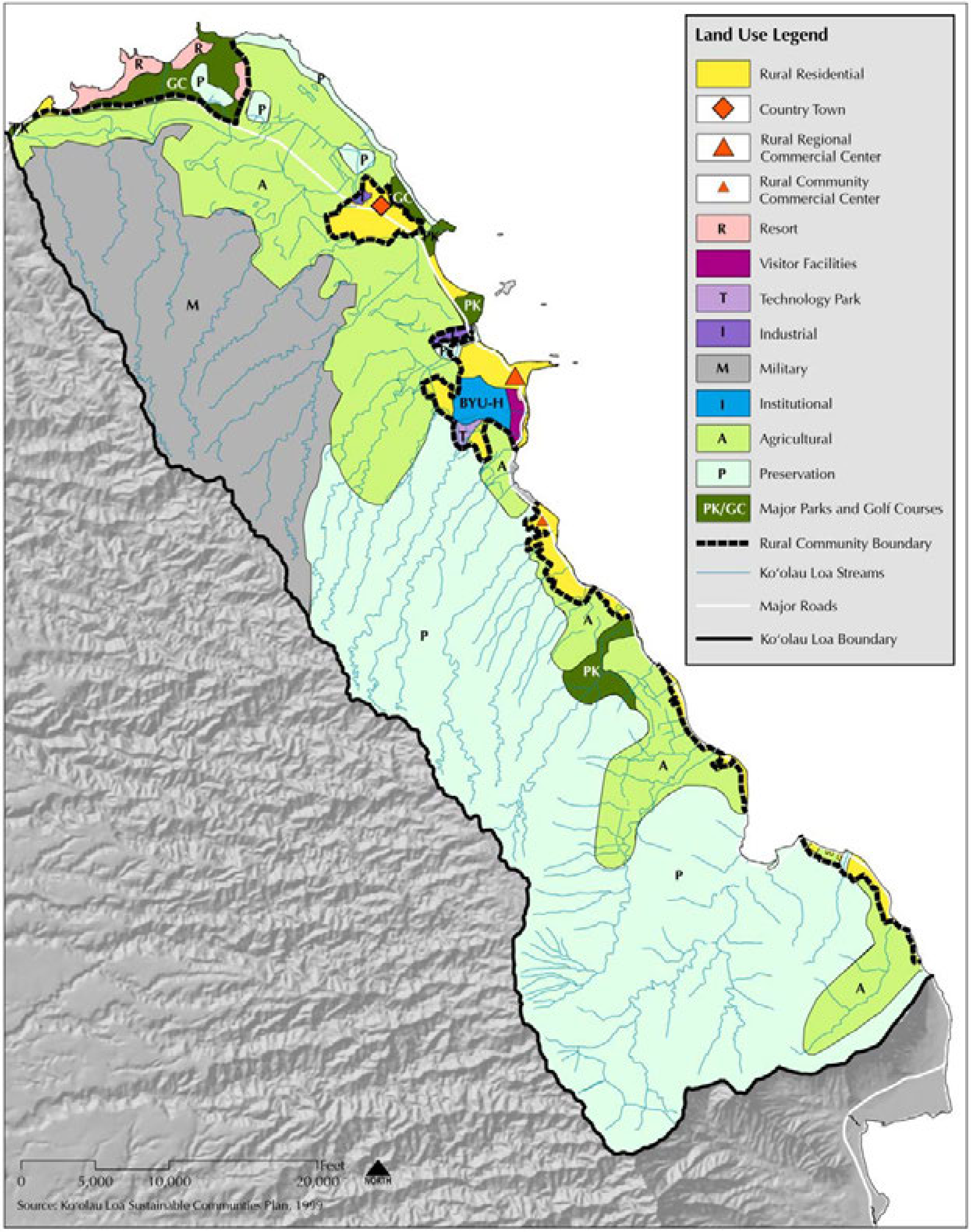


Figure 2.9 Koʻolau Loa Sustainable Communities Plan - Land Use

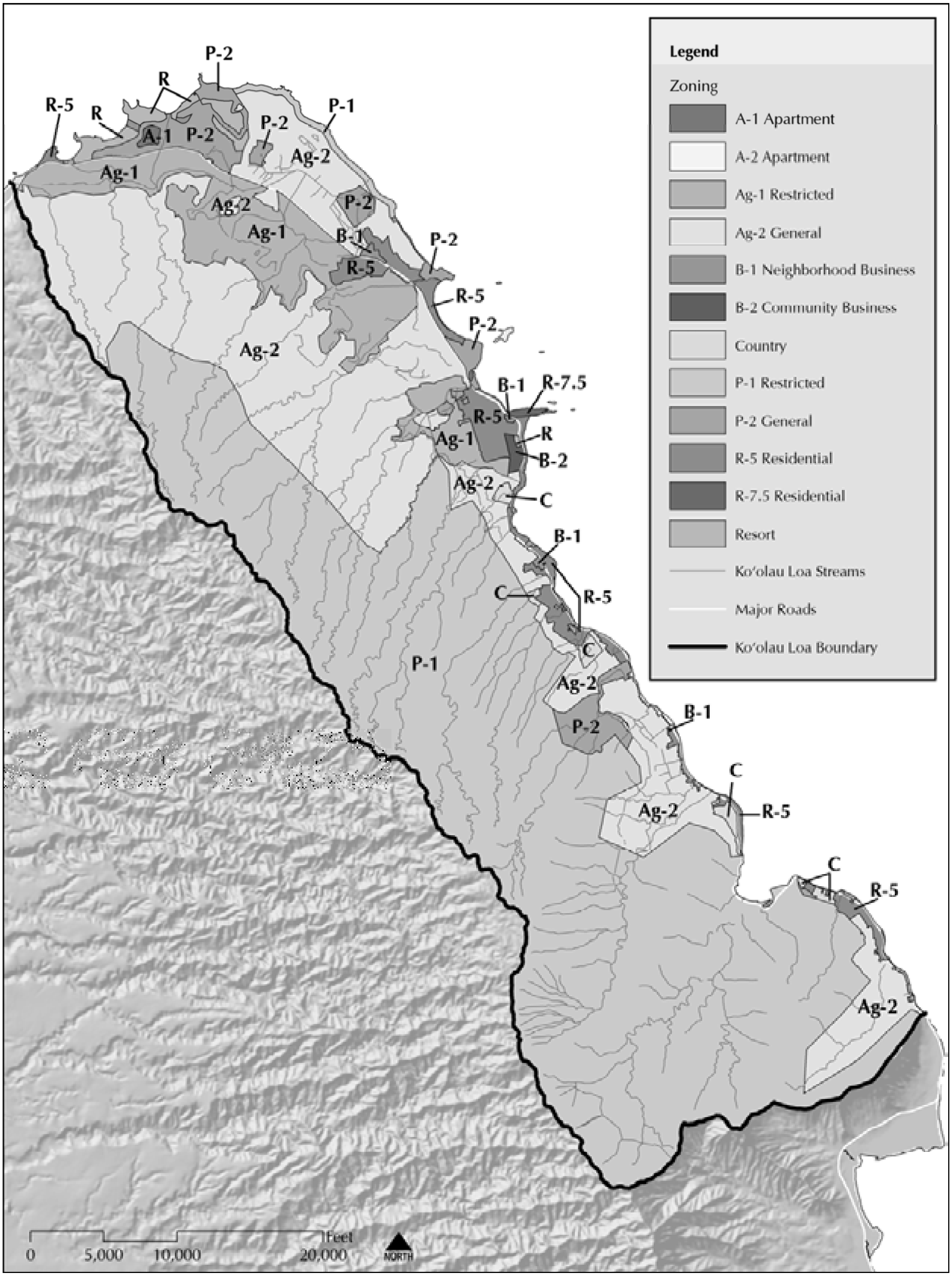


Figure 2.10 Land Use Ordinance Zoning

Table 2.7 Acreage of Koʻolau Loa by County Zoning District

Zone Use	Acreage (acres)	Percentage
P-1 Restricted	20,582	55%
P-2 General	1,115	3%
R-5 Residential	1,094	3%
R-7.5 Residential	27	<1%
A-1 Apartment	35	<1%
A-2 Apartment	5	<1%
B-1 Neighborhood Business	57	<1%
B-2 Community Business	46	<1%
AG-1 Restricted	3,082	8%
AG-2 General	10,625	29%
Country	180	<1%
Resort	287	<1%
TOTAL	**37,135**	100%

2.8.4 Agriculture

Developed by the University of Hawaiʻi, College of Tropical Agricultural and Human Resources and the State Department of Agriculture, the Agricultural Lands of Importance in the State of Hawaiʻi (ALISH) system classifies agricultural lands in three categories: prime, unique, and other. This classification system corresponds to the national SCS classification system.

Prime agricultural lands are best suited for the production of food, feed, forage, and fiber crops due to the soil quality, growing season, and moisture supply needed to sustain high yields of productivity with relatively little input and with the least damage to the environment.

Unique agricultural lands are non-prime agricultural lands that, due to a combination of area-specific features, are currently utilized for specific high-value crops. In Hawaiʻi, examples of such crops include coffee, taro, rice, watercress, and non-irrigated pineapple.

Table 2.8 indicates approximately 2,885 acres of agricultural land within the Koʻolau Loa district that are designated as either prime or unique.

Other agricultural lands are lands that are neither prime nor unique but are of statewide or local importance for crop cultivation. These lands exhibit certain properties, such as seasonal rainfall or moisture, erosion, slope, flooding, or drought that exclude them from either the prime or unique categories. However, these lands can be farmed with greater inputs of fertilizers or other soil amendments, drainage improvements, and erosion control. Another 5,210 acres of agricultural land is reserved as other lands (*Table 2.8*).

Table 2.8 Acreage of ALISH Lands in Koʻolau Loa

Watershed	Prime & Unique Lands (acres)	Other Lands (acres)
Waialeʻe (Paumalu)	81	129
Kawela	236	348
ʻŌʻio	1,178	1,407
Mālaekahana	438	556
Kahawainui	322	500
Wailele	150	55
Koloa	30	56
Kaipapaʻu	34	101
Maʻakua	0	0
Waipuhi	19	85
Kaluanui	85	176
Papaʻakoko	2	97
Haleʻaha	0	92
Punaluʻu	90	436
Kahana	60	658
Makaua	0	8
Kaʻaʻawa	160	507
SUBTOTAL	**2,885**	**5,210**

Within the State of Hawaiʻi, Agricultural Parks are areas set aside to encourage the continuation or initiation of agricultural activity. The program, administered by the State Department of Agriculture, makes lands available to farmers interested in small-scale farming at a reasonable cost with long-term tenure. Within the Koʻolau Loa district, there is an Agricultural Park located in Kahuku, which is composed of 686 acres and subdivided in 25 lots. Water is supplied to the park via an irrigation system intended only for crop production.[41]

2.8.5 Recreational Resources

The State of Hawaiʻi, Department of Land and Natural Resources, Division of State Parks manages several recreational areas that comprise approximately 6,716 acres in Koʻolau Loa. These areas include the Mālaekahana State Recreational Area, Sacred Falls State Park, Lāʻie Point State Wayside, and the Kahana Valley State Park.

The Mālaekahana State Recreation Area, comprised of 110 acres, is situated 1.3 miles north of Lāʻie and is a wooded beach park with a variety of beach-related and camping activities. The Sacred Falls State Park, comprised of 1,374 acres, is closed indefinitely due to a landslide tragedy that occurred in 1999. The Lāʻie Point State Wayside provides a scenic view of an offshore sea arch and bird sanctuary with good shore fishing from sea cliffs. The Kahana Valley State Park is a scenic wilderness valley comprised of 5,229 acres with a variety of beach-related, hiking, camping, and picnicking activities.

The City and County of Honolulu, Department of Parks and Recreation (DPR) manages 12 recreational areas within the Koʻolau Loa district. Eight of these facilities are beach and shoreline parks, which cover approximately 70 acres. The County manages one District Park of approximately 16 acres, and a 9-hole golf course (87 acres) in Kahuku.

2.8.6 Forestry Uses

2.8.6.1 Forest Reserves and Game Management

The State of Hawaiʻi has the 11th largest state forested area in the nation. Within the Koʻolau Loa district, Department of Forestry and Wildlife (DOFAW) manages nearly 6,000, including the primary areas of the Hauʻula and Kaipapaʻu Forest Reserves. Existing draft management guidelines reflect the agency's focus on maintaining ecosystem habitats and resources. The integrity of these habitats are a guiding factor for DOFAW to determine appropriate activities and levels of uses in these areas such as hunting, recreation, and timber product harvesting.

The DOFAW oversees the Natural Area Reserve System (NARS), which are designated areas held to higher management standards and are priority areas for manpower resources. Currently the only NARS sites on the island of Oʻahu are in the Waiʻanae area. However, the upper region of Kaluanui in Koʻolau Loa has been proposed as a NARS area.

Ungulate data is not precise, but there is a consensus among landowners that feral pigs are distributed throughout the Koʻolau range. Since the majority of hunting activity occurs within the confines of State-managed and Army hunting grounds, the concentration of feral pigs may be higher on private lands. Due to high reproduction rates, it is estimated that 70% of the feral pig population must be removed annually to maintain and prevent overpopulation for the long term.[42]

The Army has designated one game hunting area for Army personnel and their guests. And, as designated by the State DLNR, DOFAW, a portion of the Kahuku Training Area (KTA) is for public game hunting.

2.8.6.2 Hiking and Biking

Within the Koʻolau Loa district, the DOFAW manages the Hauʻula and Kaipapaʻu Forest Reserves and is responsible for the Nā Ala Hele, Trail and Access System (NAH). NAH trails in the Koʻolau Loa district include the Hauʻula Loop, the Maʻakua Ridge, and Maʻakua Gulch Trails. The Hauʻula Loop Trail extends 2.5 miles along dry and mountainous terrain at an elevation of 700 ft. The Maʻakua Ridge Trail extends 2.5 miles along varied terrain from wet gulches to an open ridgeline at an elevation of 800 ft. Hiking, nature study, and hunting are features of both trail systems utilized by pedestrians and bicyclists. There are some footing hazards along the trail. Additionally, this trail provides shelter amenities including tables and benches. The Maʻakua Gulch Trail is currently closed due to the potential of natural hazards such as flash floods and falling rocks.

The primary non-military use of KTA is recreation, specifically hiking, biking, and hunting. Hiking is permitted along the 2.5 mile Kaunala-West Trail which is open on weekends and state and national holidays as long as maneuvers are not being conducted by the Army. The Pūpūkea Summit Trail passes along the border of KTA. Hiking along this trail is allowed with an Army Department of Public Works permit. Bicycle races are sometimes held on KTA, and the Hawaiʻi Motorsports Association leases the motorcross course on KTA and sponsors 12 races annually.

2.8.7 Military Operations

Consisting of 9,398 acres, the Kahuku Training Area (KTA) is the second largest Army maneuver training area on Oʻahu. Of the total acreage, approximately 4,569 acres are considered suitable for tactical maneuver training. KTA is primarily utilized to conduct and support multiple infantry battalion-sized Army Training and Evaluation Program (ARTEP) missions, which include mountain and jungle warfare, and air support training.[43] Ammunition used on KTA is currently limited to blanks and pyrotechnics (e.g., smoke and incendiary devices), but no pyrotechnics are allowed in designated training areas or within 3,281 feet (1,000 meters) of the KTA borders. There are no existing ordnance impact areas or Surface Danger Zones on KTA. KTA does not have a defined cantonment area set aside to support Army-related operations.[44]

2.9 STAKEHOLDER CONSULTATION

The findings of the consultations are presented in this section. The summary includes the ideas and issues that were discussed in stakeholders' meetings and public informational meetings. The section also presents preliminary critical watershed values expressed in these consultations.

Stakeholders for this process include individuals, organizations and agencies. The stakeholder consultation process has involved numerous one-on-one interviews, small group meetings, Working Group meetings, and an Inter-Agency meeting. Project updates were made at the Koʻolau Loa Neighborhood Board meetings and Punaluʻu Watershed Alliance meetings.

2.9.1 Goals and Objectives of Stakeholder Consultation

The goal of consultation with the stakeholders in Koʻolau Loa is to involve organizations and individuals on local watershed and water resources issues. In the process, information on the Board of Water Supply's mission, sustainable island-wide water resources, and watershed planning and management, is provided.

The process included the following:

- Defining key issues, problems, and needs
- Formulating principles to guide the plan
- Development of actions and strategies in response to issues

2.9.2 Methodology for Stakeholder Consultations

Obtaining direct consultation with stakeholders on watershed values and issues involved a variety of methods. Individuals were contacted for one-on-one or small group meetings. Presentations were made to organizations, such as the Koʻolau Loa Neighborhood Board No. 28. Agency consultations ranged from telephone and email correspondence to direct meetings, depending upon the extent of available information, agency interest, and the depth of consultation required. This section presents the details of the consultation process.

2.9.2.1 Individual Consultation

Preliminary consultations with communities, agencies and landowners were conducted to provide an introduction to the watershed planning process. Initial meetings addressed the project scope, purpose of study, and a project timetable. The consultations sought to elicit critical watershed values and issues, and mostly took place in 2003 and 2004.

2.9.2.2 Community Groups and Associations

The active participants in the watershed planning process were invited to provide input on the consultation process and the direction and intended outcomes of the plan. Specific advisory groups included the Koʻolau Loa Neighborhood Board No. 28 and the Punaluʻu Watershed Alliance. Representatives from the Kahuku, Lāʻie, Hauʻula, Punaluʻu, Kahana and Kaʻaʻawa Community Associations were consulted to provide specific regional input.

2.9.2.3 Watershed Management Plan Working Group

The Koʻolau Loa Neighborhood Board No. 28 authorized the formation of a Working Group under their Water Committee. This group participated in a series of intensive meetings in 2004, 2005, 2006 and 2007 with BWS and the consultant to address planning issues and review interim plan products. Notes and presentation materials from the Working Group meetings are posted on the BWS website at http://www.boardofwatersupply.com/cssweb/display.cfm?sid=1414

2.9.2.4 Inter-Agency Workshops and Additional Consultations

The first Inter-Agency meeting was held in March 2005. A total of 23 agency staff were invited to participate in this meeting, which was co-hosted by the BWS and the Koʻolau Loa and Waiʻanae WWMP Projects. Appropriate Federal, State, and City government agencies, with water responsibilities related to the Koʻolau Loa region, were consulted about their existing and future water use plans, policies, and water-based strategies. A second interagency meeting was held in November 2006 to attain further agency comments on the KLWMP Public Review Draft. Additional consultations with agencies were conducted on an as-needed basis to request more detailed information.

2.9.2.5 Public Information Process

The community was notified of the various meetings through organization agenda publication, association newsletters, and published public notice. Initial meetings were accompanied with a fact sheet and study area map providing the essential project information including study area, project objectives, work tasks and timetable. Preliminary consultations included more detailed interaction and information on specific resource issues in the project area. As noted above, the BWS website also provides public information on the Koʻolau Loa Watershed Management Plan.

2.9.3 Stakeholder Identification

The stakeholders for the Koʻolau Loa Watershed Management Plan represented the full range of individual community members, community and not-for-profit organizations, and public agencies interested in or affected by activities related to the Koʻolau Loa Watershed Management Plan.

Koʻolau Loa Sustainable Communities Plan Participants

In 1999, the City and County of Honolulu Department of Planning and Permitting completed the Koʻolau Loa Sustainable Community Plan. This two-year planning process for the Koʻolau Loa community resulted in a land use policy guide with projections to 2020. Several of the individuals who actively participated in this process were contacted to encourage their participation in the watershed planning process.

2.9.3.1 Community References

The communities of Koʻolau Loa are represented as a whole by the Koʻolau Loa Neighborhood Board (NB) No. 28, with 11 members representing each of the individual communities. The NB is a volunteer advisory body that seeks to inform and involve the community in the decisions affecting them. NB 28 is responsible for reviewing community issues and proposed projects and programs affecting the region, and for facilitating community and government interaction.

Within Koʻolau Loa, there are established community associations in Kahuku, Lāʻie, Hauʻula, Punaluʻu, Kahana and Kaʻaʻawa. Individuals from these groups were contacted for meetings to discuss critical watershed values and issues.

The Punaluʻu Watershed Alliance addresses specific watershed issues in Punaluʻu Valley, and includes representatives of landowners, agencies and community.

Mālama ʻOhana was established in 1997 with the assistance of the Queen Emma Foundation. This group's representation comes from across Koʻolau Loa, and takes a holistic approach to addressing community and social issues.

Queen Liliʻuokalani Children's Center in Punaluʻu provides permanency planning information and services (ʻohana home placement, foster care, adoption, and legal guardianship), counseling, tutoring, community building group experiences (educational, cultural enrichment), advocacy, collaboration, and community development activities. Priority of services is offered to half-orphan or orphan Hawaiian or part-Hawaiian children up to age 18. The service area extends from Kualoa to Kaʻena Point. There is a small taro loʻi that was established on their property, which was fed by a small stream water diversion.

Dedicated to preserving and enhancing Hawaiian culture, the Koʻolau Loa Hawaiian Civic Club promotes community-based social programs and economic development for Native Hawaiians and the Koʻolau Loa community.

Individual referrals from the community led us to further contacts with direct experience and involvement in watershed. These contacts included farmers, hunters, and naturalists.

2.9.3.2 Government Agencies

This plan seeks to integrate the guidance of Federal, State and County agencies with water resource and watershed planning and management responsibilities. Water resource and watershed planning relates to the use of urban, conservation, and agricultural lands. The preliminary consultation process involves input from the key agencies.

Federal Agencies. The U.S. Geological Survey (USGS) has conducted various groundwater and surface water studies of Koʻolau Loa, with ongoing studies concentrated in Punaluʻu Valley. The U.S. Fish and Wildlife Service (FWS) has specific concerns about native and endangered species in Koʻolau Loa. In Kahuku, the U.S. Army has a 9,398 acre training range in upper elevation lands.

State of Hawaiʻi. The State Commission on Water Resource Management (CWRM) is attached to the Department of Land and Natural Resources (DLNR). CWRM's general mission is to protect and enhance the water resources of the State of Hawaiʻi through wise and responsible management. The Division of Forestry and Wildlife (DOFAW) is the DLNR division responsible for managing watershed lands. Mauka watershed lands are typically designated by the State as Conservation District, and are therefore regulated by the Board of Land and Natural Resources, through the DLNR Office of Conservation and Coastal Land. The State

Department of Agriculture manages agricultural production in the State and the system of State Agricultural Parks, including the Kahuku Agricultural Park. Other State agencies with planning and regulatory responsibilities include the Department of Health and Office of Planning.

City and County of Honolulu. The City Department of Planning and Permitting (DPP) which responsible for land planning and regulation, promulgated the Ko'olau Loa Sustainable Communities Plan in 1999. The Department of Environmental Services is responsible for County recycled water and stormwater systems.

2.9.3.3 Ko'olau Mountains Watershed Partnership

In August 1999, the Ko'olau Mountains Watershed Partnership (KMWP) was formed through a Memorandum of Understanding between eight major public and private landowners. Since the initial formation of the KMWP, there are 15 landowning partners that are members with an additional six associate partnering agencies or organizations. *Table 2.9* provides a listing of KWMP partners and associates and identifies, with those that have an interest specifically within the Ko'olau Loa district printed in boldface.

Table 2.9 Ko'olau Mountains Watershed Partnership Membership Information

Ko'olau Mountains Watershed Partners	Partner Type	Private/Public Interest	Possess Land in Ko'olau Loa district
Hawai'i Reserves, Inc.	**Landowner**	**Private**	**Yes**
Kamehameha Schools	**Landowner**	**Private**	**Yes**
Kualoa Ranch	**Landowner**	**Private**	**Yes**
City & County of Honolulu BWS	**Landowner**	**Public**	**Yes**
Dept. of Land and Natural Resources	**Landowner**	**Public**	**Yes**
U.S. Army	**Landowner**	**Public**	**Yes**
U.S. Fish and Wildlife	**Landowner**	**Public**	**Yes**
Dole Food Company, Inc.	Landowner	Private	No
Bishop Museum	Landowner	Private	No
Manana Valley Farm, LLC	Landowner	Private	No
O'ahu Country Club	Landowner	Private	No
Queen Emma Foundation	Landowner	Private	No
Agribusiness Development Corporation	Landowner	Private	No
Tiana Partners, et al	Landowner	Private	No
Department of Hawaiian Home Lands	Landowner	Public	No
Natural Resources Conservation Service	Associate	Private	No
Nature Conservancy of Hawai'i	Associate	Private	No
State Department of Health	Associate	Public	No
Environmental Protection Agency	Associate	Public	No
U.S. Forest Reserve	Associate	Public	No
U.S. Geological Survey	Associate	Public	No

2.9.3.4 Major Landowners

The major landowners in Koʻolau Loa are consulted as participants in this plan, including Turtle Bay Resort (Kawela), U.S. Army (Kahuku Training Area), Hawaiʻi Reserves, Inc. (Lāʻie, Mālaekahana), State of Hawaiʻi (Kaluanui, Kahana), Kamehameha Schools (Punaluʻu), and Kualoa Ranch (Kaʻaʻawa).

2.9.4 Profile of Koʻolau Loa Stakeholders – Individuals, Community Organizations and Landowners

The following discussion presents a profile of the various stakeholders involved in the consultation phase.

2.9.4.1 Koʻolau Loa Residents

Interviews and direct correspondence with Koʻolau Loa residents provided substantial details about local and regional watershed values and issues of concern. The community resident consultations were grouped by areas within Koʻolau Loa for organizational purposes. Several of the Koʻolau Loa communities are physically defined as classic ahupuaʻa, and other areas are clusters of ahupuaʻa and watersheds that make up recognized settlement areas.

Kawela to Kahuku Area *(Figure 2.11)***.** This area is the northern portion of Koʻolau Loa, which includes the ahupuaʻa of Waialeʻe (portion), Kawela, ʻŌʻio 1, ʻŌʻio 2, Hanakaoe, Ulupehupehu, Punalau, Kahuku and Keana.

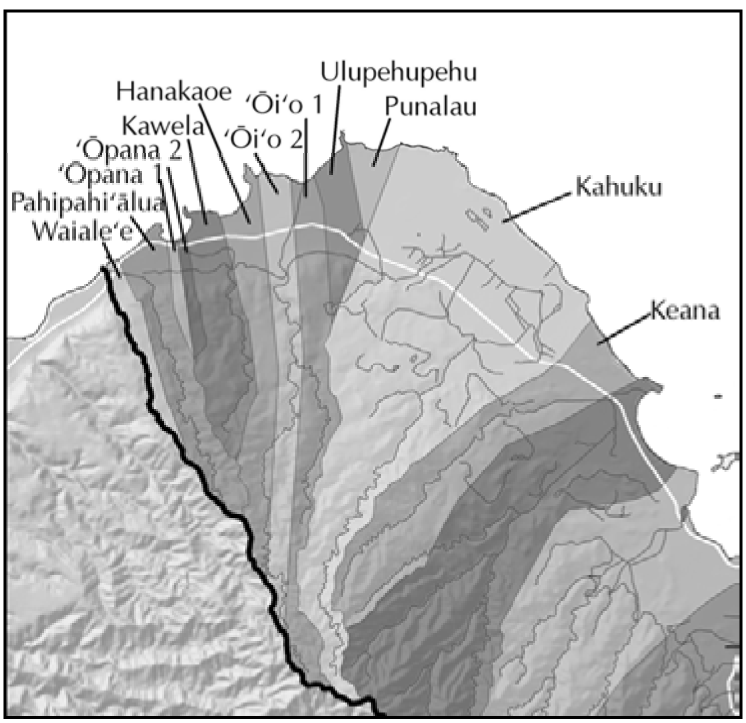


Figure 2.11 Kawela to Kahuku Area

Notable land uses in these ahupuaʻa include settlements in the Kahuku community and Turtle Bay Resort. Significant agricultural areas include Kawela (truck crops), makai aquaculture operations in ʻŌʻio, and Kahuku State Agricultural Park. The wetlands areas include the James Campbell Wildlife Preserve. Mauka lands include the U.S. Army's Kahuku Training Area.

Key community leaders in the Kawela to Kahuku area were contacted in the consultation process. There is a Kahuku Community Association, and three people represent Kahuku on the Koʻolau Loa Neighborhood Board No. 28.

Existing water sources that serve the Kahuku area include the BWS Waialeʻe (Kawela) wells serving the Sunset Beach area and Turtle Bay Resort, and the BWS Kahuku wells and water system. Turtle Bay Resort is developing the ʻŌpana wells, and after obtaining a water use permit, will dedicate them to the BWS.

Residents prefer that BWS not establish new wells in the Mālaekahana and Kahuku aquifers. The consensus was that these water sources should remain unused for the foreseeable future, but should be available for potential future source needs.

The community has proposed that the City revise its method of wastewater disposal at Kahuku Wastewater Treatment Plant from injection well to reclaimed water for irrigation of the Kahuku Golf Course. There is community interest in extending the Kahuku golf course into 18-holes, with the establishment of a new stormwater desilting basin within the golf course grounds. Concern has been expressed over the Army's use of the mauka lands in terms of potential drainage, erosion, and vegetation impacts.

Mālaekahana to Lāʻie Area *(Figure 2.12)***.** This area of Koʻolau Loa includes the ahupuaʻa of Mālaekahana, Lāʻiewai and Lāʻiemaloʻo. Watersheds in this area include Mālaekahana, Kahawainui, Wailele and Koloa. Mālaekahana has very few residents, with a few beach homes, and Mālaekahana State Park. The mauka side of Kamehameha Highway contains agricultural lands between Kahuku and Lāʻie, supporting some truck crops and aquaculture, with the majority of the land used for grazing.

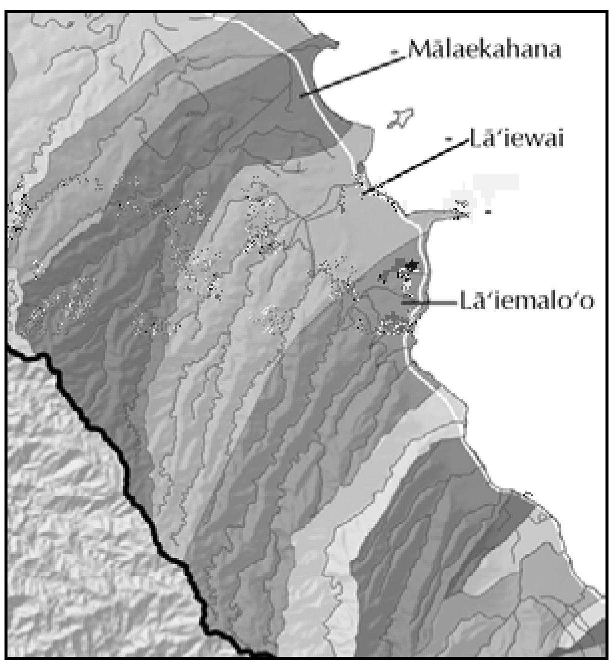


Figure 2.12 Mālaekahana to Lāʻie Area

Lāʻie community, the largest settlement on the Koʻolau Loa coastline, is the location of the Hawaiʻi Mormon Temple of the Church of Jesus Christ of the Latter-day Saints (LDS). Most of the people residing in Lāʻie are members of the LDS. Major employers in Lāʻie include the Brigham Young University - Hawaiʻi Campus (BYU-H) and the Polynesian Cultural Center. The Lāʻie Shopping Center is a commercial focal point for Koʻolau Loa, with the area's only major grocery store, bank, and other retail and service businesses.

Hawaiʻi Reserves, Inc. (HRI), the land manager for church-owned properties in Lāʻie, is responsible for managing the private components of the community infrastructure (roads, sewer, water). Lāʻie is served with potable water from the Lāʻie Water Company, a private water utility, with wells near the Lāʻie Quarry and a storage reservoir.

Various community members contacted in the preliminary consultation included the Lāʻie Community Association and representatives of the BYU-H Hawaiian Studies Program. Lāʻie residents have attended briefings of the Watershed Management Plan at the Neighborhood Board meetings. These individuals are also members of the Lāʻie Community Association.

The Lāʻie community values the long-term availability of high-quality water for community residents and support services. For nearly two decades, Lāʻie has been interested in building new affordable housing for its community. Infrastructure deficiencies, such as wastewater treatment and disposal, have held back this progress. Hawaiʻi Reserves, Inc. is planning to develop approximately 550 new affordable homes on 663 acres of agricultural zoned land purchased from the Estate of James Campbell at the northern edge of Lāʻie toward Mālaekahana. These new homes will help but not solve Lāʻie's affordable housing need. Looking 20 years ahead, the community will need additional affordable housing. Lāʻie residents would like to be assured that the potable water supply will not preclude future housing projects.

In Lāʻie, wastewater is treated by the Lāʻie Water Reclamation Facility. After a difficult period of violations and court-mandated improvements, the new Lāʻie Water Reclamation Facility was upgraded, expanded and brought into compliance with state environmental laws and regulations. Reclaimed wastewater is used to irrigate landscape and agricultural areas on and adjacent to the BYU-H campus. On Novermber 1, 2006, the operations of the Lāʻie Water Reclamation Facility were transferred to the City and County of Honolulu.

In the Kahawainui watershed, there are kuleana land owners in Lāʻie adjacent to former taro loʻi ponds. Several residents have actively supported land and water rights for Native Hawaiian practices in Lāʻie.

Hauʻula to Kaluanui Area *(Figure 2.13)*. Hauʻula is composed of several ahupuaʻa, including Kaipapaʻu, Hauʻula, Mākao, Kapaka, and Kaluanui. Watersheds in this area include Kaipapaʻu, Makaua, Waipuhi and Kaluanui.

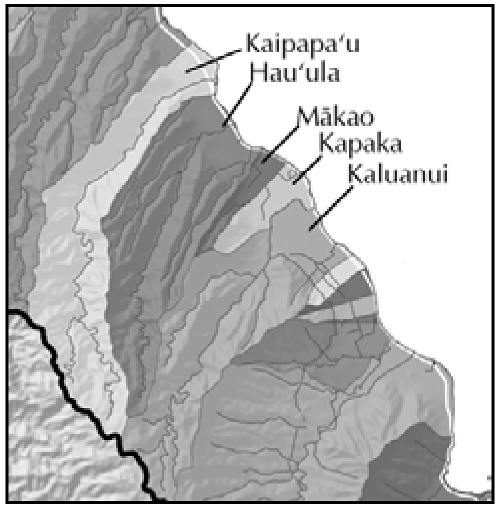


Figure 2.13 Hauʻula to Kaluanui Area

The residential community in Hauʻula has a commercial shopping center and other retail operations along Kamehameha Highway. Kaluanui is State-owned land, and includes the Sacred Falls State Park (currently closed). BWS has a production well in Kaluanui, and has installed an exploratory well in Kaipapaʻu.

Discussions with Hauʻula residents identified regional watershed issues similar to those of Lāʻie and Punaluʻu. They shared local watershed concerns about the specific stream flooding conditions, recreation (hiking and hunting) in the mountains, and future BWS plans for source development in their area. Hauʻula residents have concentrated on the planning with the State for future re-opening of the State Park at Kaluanui (Sacred Falls) since the park was closed due to a fatal rock slide in 1999. The residents also shared questions about the extent of the water source in Koʻolau Loa, and the plans for future inter-district transfers out of Koʻolau Loa.

Punaluʻu Area *(Figure 2.14)*. The Punaluʻu area includes the small ahupuaʻa of Papaʻakoko, Haleʻaha, Kapano, Puheʻemiki, and the major ahupuaʻa of Punaluʻu. The three defined watersheds in this area are Papaʻakoko, Haleʻaha and Punaluʻu. Punaluʻu is a classic physical example of an ahupuaʻa, bordered by the Koʻolau ridge, and dividing finger ridges north and south, with several tributaries from the watershed feeding Punaluʻu stream, which flows to the sea.

There are several agricultural uses in the valley. A large portion of Punaluʻu is owned and managed by Kamehameha Schools. BWS has several wells and storage reservoir in Punaluʻu. Many years ago, the Kahuku sugar plantation constructed and managed a ditch to route stream and surface water to fields north of Punaluʻu. The ditch has been a water source for properties along its route (by formal or informal agreement); however, the ditch and tunnels are in need to repairs and restoration.

Punaluʻu community residents have historically been very active in land use and environmental issues affecting Punaluʻu and Koʻolau Loa. This community has been diligent in addressing water development and water use concerns specific to Punaluʻu and Kaluanui. The Punaluʻu

Community Association has actively monitored the major landowner in Punaluʻu (Kamehameha Schools) and their farming tenant activities.

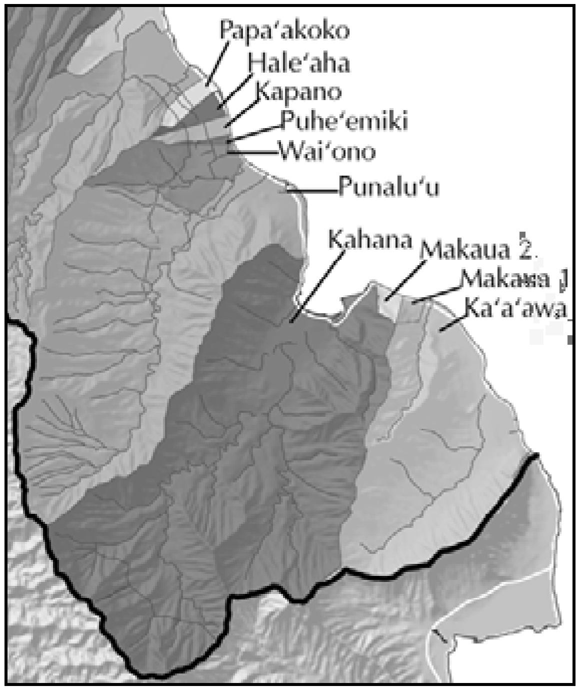


Figure 2.14 Punaluʻu, Kahana and Kaʻaʻawa Areas

The PCA has issued a draft mission statement outlining for their community values, including preservation of rural lifestyle, environment, agriculture, surface water and ʻohana-centered activities. The ongoing protection and management of Punaluʻu watershed has been of particular interest. The community has monitored groundwater source development at the BWS Punaluʻu wells, and has monitored the rate of pumping and noticeable changes to water quality. Surface diversions to Punaluʻu Stream occur at the former plantation ditch, which feeds water to individual farms, including the Kamehameha Schools agricultural lease lands. Ongoing access to surface water for small farmers and private landowners is a concern. The Punaluʻu Watershed Alliance was established to address community, landowner and agency issues regarding this watershed.

Kahana. Kahana is a deep broad watershed valley and the largest ahupuaʻa in Koʻolau Loa, owned by the State of Hawaiʻi and managed as a State Park. Much of the valley is natural open space, serving recreational interests and conservation purposes. There is a small settlement of about 35 homes near Kamehameha Highway in Kahana. There are no commercial services, and home sites are leased from the State or occupy kuleana parcels. These homes are affected by flooding during high rainfall and runoff periods.

The BWS Kahana well and reservoir supplies Kahana and Kaʻaʻawa, and feeds the BWS system in Koʻolau Poko. A surface water ditch system in the mauka portion of Kahana also transfers water out of Kahana Valley.

The watershed concerns raised by Kahana residents included flooding, water development, inter-district transfers out of Koʻolau Loa, and State lease issues. A taro loʻi restoration project is under way in Kahana Valley, as well as a fishpond restoration project at the southern edge of Kahana Bay.

Kaʻaʻawa Area. Kaʻaʻawa is the southernmost area of Koʻolau Loa. Watersheds in this area include Makaua and Kaʻaʻawa. Kalaeʻōʻio Point is the border of Koʻolau Loa and Koʻolau Poko. Kaʻaʻawa is a small residential community, and includes several hundred homes, an elementary school, limited commercial uses and some beach parks. Kaʻaʻawa Valley is a part of Kualoa Ranch owned by the Morgan family, which is used for livestock grazing, outdoor recreation, and film productions.

Discussions with Kaʻaʻawa residents identified concerns about the long-term preservation of Kaʻaʻawa Valley, water development plans for Kaʻaʻawa, preservation of Makaua Valley, and flooding issues. Regional water development and planning issues were also notable concerns.

A list of community stakeholders contacted in this process is included in *Table 2.10*.

2.9.4.2 Koʻolau Loa Organizations

Koʻolau Loa Neighborhood Board No. 28

Meetings with the Neighborhood Board in October and November 2004 elicited initial comments regarding the scope, values and issues to be addressed in the watershed planning study. Their input included:

- Request for ongoing input to the plan from the Neighborhood Board, specifically from the Water Committee
- Request for Waiʻanae Watershed Management Plan community values and issues
- Public information to be posted via BWS website links
- Flood control in Koʻolau Loa watersheds
- Habitat of Koʻolau Loa streams, and effects of flood control improvements
- Future BWS water development plans in Koʻolau Loa
- Cooperation of private landowners in the planning process

Punaluʻu Watershed Alliance

The Punaluʻu Watershed Alliance (PWA) was formed in 2001 to address community, landowner and agency issues regarding this watershed. This group consists of Punaluʻu residents, farmers and resource conservation interests, in conjunction with the landowner Kamehameha Schools, the Honolulu Board of Water Supply, and the U.S. Geological Survey.

Surface diversions to Punaluʻu Stream occur at the former plantation ditch, which feeds water to individual farms, including the Kamehameha Schools agricultural lease lands. Ongoing access to surface water for small farmers and private landowners is a concern. Short term goals include the inventory of agricultural water diversions and the development of measurable instream flow standards. The PWA members signed a Memorandum of Understanding in 2005.

Mālama ʻOhana – Hoʻopono Koʻolau Loa

Mālama ʻOhana was established in 1997 with the assistance of the Queen Emma Foundation. This group's representatives come from across the moku of Koʻolau Loa, and take a holistic approach to community and social issues. A presentation to this group was made at their October 2004 meeting. Their comments and recommendations included the following:

- A request to address farmers' needs for surface water, as has historically been allowed.
- Future BWS water development plans in Koʻolau Loa.
- Planning should address water supply for the Punaluʻu farmers via surface diversion.
- Flood control planning should be addressed.

Table 2.10 Community Stakeholders

Community Stakeholders	Community	Affiliation
Barbara Kahana	Hauʻula	Neighborhood Board Water Comm. / Hauʻula Comm. Assoc.
John Kaina	Hauʻula	Mālama ʻOhana
Moana Kaluau	Hauʻula	Neighborhood Board / Hauʻula Comm. Assoc.
Zenobia Iese	Hauʻula	Neighborhood Board / Hauʻula Comm. Assoc.
Summer Greene	Hauʻula	Vision Champion for Hauʻula Watershed Project
Winona Kaniko	Hauʻula	Mālama ʻOhana/ Hauʻula Community Association
Adeline Keama	Hauʻula	Hauʻula Community Association
Kapua Sproat Fonoimoana	Hauʻula	Punaluʻu Community Association
Mahi Trevenen	Hauʻula	Punaluʻu Community Association
Patsy Trevenen	Hauʻula	Punaluʻu Community Association
Sunny Greer	Kahana	Sustainable Community Plan
Ululani Biernie	Kahana	Mālama ʻOhana
Jolene Peapealalo	Kahana	President, Kahana Comm. Assoc.
Ron Johnson	Kahana	Fireman /Taro Loʻi Restoration
Mae Au	Kahana	Kupuna
Kaipo Gurai	Kahana	Taro grower
Debbie Gurai	Kahana	Taro grower
Heitare Wallace	Kahana	
Uilani Wallace	Kahana	
B. Williams	Kahana	Friends of Kahana
Adela Johnson	Kahana	Kahana Community Association
Ben Shafer	Kahana	Friends of Kahana
Clyde Connors	Kahuku	Kahuku Farmers
Don Hurlbut	Kahuku	Kahuku Comm. Assoc. / Neighborhood Board
Lisa DeLong	Kahuku	Principal, Kahuku High School
Fred Mencher	Kahuku	Hawaiian Marine Enterprises
Junior Primacio	Kahuku	
Warren Soh	Kahuku	Kahuku Comm. Assoc. / Neighborhood Board
John Pascual	Kāneʻohe	KWA
Shannon Wood	Kāneʻohe	Windward Ahupuaʻa Alliance
Jim Wood	Kāneʻohe	Windward Ahupuaʻa Alliance
Dee Dee Letts	Kaʻaʻawa	Neighborhood Board Chair / Kaʻaʻawa Comm. Assoc.
Dr. Jim Anthony	Kaʻaʻawa	President, HLA/ Kaʻaʻawa Comm. Assoc.
May Au	Kaʻaʻawa	Kahana Community Association
Reb Bellinger	Kaʻaʻawa	Kaʻaʻawa Community Association

Community Stakeholders	Community	Affiliation
Kapiolani Gorai	Kaʻaʻawa	Kahana Community Association
Travis Hylton	Kaʻaʻawa	
John Olszowka	Laʻie	Hauʻula Community Association
Pane Meatoga	Lāʻie	Lāʻie Community Association
Bill Wallace	Lāʻie	BYU Hawaiian Studies Prog. / Lāʻie Comm. Assoc.
Dawn Wasson	Lāʻie	Kuleana Land in Kahawainui Watershed
Les Stewart	Lāʻie	KL NB No. 28 / Lāʻie Comm. Assoc.
Patrick Macy	Lāʻie	KL NB No. 28 / Lāʻie Comm. Assoc.
John Elkington	Lāʻie	KL NB No. 28 / Lāʻie Comm. Assoc.
Norman Kaluhiokalani	Lāʻie	
Noel Bragg	Lāʻie	Lāʻie Point Community Association
Creighton Mattoon	Punaluʻu	Neighborhood Board
Cathleen Mattoon	Punaluʻu	Koʻolau Loa Hawaiian Civic Club / Punaluʻu Comm. Assoc.
Lee Pouha	Punaluʻu	Queen Liliʻuokalani Children's Center (QLCC)
Pomaikai Kanaiaupio-Crozier	Punaluʻu	St. Louis HS Teacher / UH Ctr. for Hawaiian Studies
Katy Darlington	Punaluʻu	Punaluʻu Community Association
Gwen Kim	Punaluʻu	Queen Liliʻuokalani Children's Center (QLCC)
Sam Rowland	Punaluʻu	Punaluʻu Community Association
David Mikoncyk	Punaluʻu	Punaluʻu Community Association
Elected Officials	**District**	**Position**
Donovan Dela Cruz	Koʻolau Loa	City Council Member Chair
Collen Meyer	Koʻolau Loa	House Representative
Michael Magaoay	Koʻolau Loa	House Representative
Clayton Hee	Koʻolau Loa	State Senator
Landowners	**Landowner Company / Agency**	**Position**
Ralph Makiau	Turtle Bay Resort	Consultant
Lloyd Haraguchi	Estate of James Campbell	Land Manager
Joel Godfrey	U.S. Army Garrison, Hawaiʻi	Kahuku Training Range Env. Div.
Eric Beaver	Property Reserve, Inc. / Hawaiʻi Reserves, Inc.	President
Eric Marler	Property Reserve, Inc. / Hawaiʻi Reserves, Inc.	CFO
Martha Yent	State of Hawaiʻi DLNR - Land Management	DLNR State Parks Division
Peter Hanohano	Hanohano Family	
Jim Basset	Kamehameha Schools	Land Manager
Manabu Tagomori	Kamehameha Schools	Water Manager

Landowners (continued)	Landowner Company / Agency	Position
Ulalia Woodside	Kamehameha Schools	Manager
John Morgan	Kualoa Ranch	President
Government Stakeholders	**Agency**	**Position**
Delwyn Oki	U.S. Geological Service (USGS)	
Dudley Kubo	U.S. Dept. of Agriculture, NRCS	
Sheila Cox	U.S. Dept. of Agriculture, NRCS	District Conservationist
Kevin Kinvig	U.S. Dept. of Agriculture, NRCS	Resource Conservation and Dev. Program
Sylvia Pelizza	U.S. Fish and Wildlife Service, Pacific Region	Refuge Manager
Joel Godfrey	U.S. Army Garrison, Hawaiʻi (USAG-HI)	Environmental Div.
Milton Yoshimoto	U.S. Army Corps of Engineers, Honolulu District	Project Manager
Wayne Ching	DLNR - Div. of Forestry and Wildlife	
Sam Lemmo	DLNR - Conservation and Coastal Lands	
Glenn Higashi	DLNR - Div. of Aquatic Resources	
Martha Yent	DLNR - Div. of State Parks	
Sam Lemmo	DLNR - Conservation and Res. Enforcement	
Sarah Collins	DLNR - Historic Preservation Div.	
Chris Chung, OP	DBEDT - Office of Planning: CZM	
Abe Mitsuda	DBEDT - Office of Planning: CZM	Senior Planner
Herman Tuiolosega	Dept. of Health, Environmental Health	Planner
Earl Yamamoto	Dept. of Agriculture	Planner
Matt Higashida	Dept. of Planning & Permitting	Planner
Tim Houghton	Dept. of Environmental Services	Deputy Director
Other Organizations	**Agency**	**Position**
Jason Sumiye	Koʻolau Mountains Watershed Partnership	Coordinator

Koʻolau Loa Civic Club

The Koʻolau Loa Hawaiian Civic Club indicated that the Watershed Management Plan for Koʻolau Loa needs to address Native Hawaiian water rights including surface water, protection and improvement of native species habitat, and cultural access and gathering.

Queen Liliʻuokalani Children's Center

Queen Liliʻuokalani Children's Center (QLCC) expressed concern about the care of Kaliuwaʻa (Sacred Falls area) and Makana Valley.

2.9.4.3 Koʻolau Loa Elected Officials

City Council Member

At the time of this investigation, the City Council representative for the area is Donovan Dela Cruz. Councilmember Dela Cruz also serves as the City Council Chair. A briefing was conducted with Chair Dela Cruz and his staff in October 2004. His office is very interested in supporting the community's agricultural and residential water needs, as well as preserving surface water for environmental and cultural benefits. The City Council is involved in supporting the flood control planning and improvements for the Koʻolau Loa community.

State Senator and House Representatives

At the time of this investigation, State Representatives Collen Meyer and Michael Magaoay were the two House Representatives for this region, and the State Senator Clayton Hee. These officials are informed of this project through direct communications and from their representatives attending Neighborhood Board meetings. Fact sheets, presentation notes, and meeting minutes were provided to their offices. These elected officials are important to identifying community watershed concerns, particularly where State authority and resources may be helpful.

2.9.4.4 Federal Agencies

U.S. Geological Survey

The U.S. Geological Survey (USGS) has conducted numerous studies of the geology, hydrogeology and aquifer systems of windward Oʻahu. Takasaki (1969) published the definitive study on windward Oʻahu and Koʻolau Loa aquifers, defining the dike systems and basal aquifers in the region. Subsequent studies have looked closely at groundwater in Kahuku and Punaluʻu.

USGS, a member of the Punaluʻu Watershed Alliance, provides technical assistance in specific studies of seepage, stream geometry, stream flow and groundwater quality. The specific studies being conducted in Punaluʻu may apply to other watersheds in Koʻolau Loa. USGS is also providing technical support to the Koʻolau Mountains Watershed Partnership.

U.S. Dept. of Agriculture, Natural Resources Conservation Service - Hawaiʻi

The USDA Natural Resources Conservation Service (NRCS) encompasses the former Soils Conservation Service, providing technical resources and programs. The NRCS partners with Conservation Districts and others to provide technical and some cost-share assistance to private landowners. Their main goal is to protect, enhance, and preserve our soil, water, air, plants, and animals. Participation in their programs is voluntary.

The Hawaiʻi NRCS serves as staff and technical advisor to the Windward Soil and Water Conservation District. NRCS provides consultations to farmers and large landowners in an effort to implement measures to protect soils and conserve other natural resources in the agricultural areas of the watershed. In Koʻolau Loa, NRCS advises farmers on specific measures that can be taken to retain soils and minimize soil loss from stormwater erosion. These efforts are mainly focused on the active agricultural areas of Kahuku, Mālaekahana and Punaluʻu.

U.S. Fish and Wildlife Service, Pacific Region

The U.S. Fish and Wildlife Service (FWS) works to conserve, protect and enhance fish, wildlife, and plants and their habitats. The FWS manages the James Campbell National Wildlife Refuge on 164 acres of leased land in Kahuku (Campbell Estate). There are two units: including the Kiʻi Unit (126 acres) and the Punamanō Unit (38 acres).

In cooperation with the U.S. Army, the FWS also manages habitat for endangered plant species at several locations in Koʻolau Loa, including Makaua watershed in Kaʻaʻawa. Programs for species protection and habitat management will be addressed in the watershed plan.

U.S. Army Corps of Engineers, Honolulu District, Civil Works Branch

The U.S. Army Corps of Engineers, Honolulu District, Civil Works Branch (the Corps) has historically been involved in several drainage and flood control projects in Koʻolau Loa. These studies and projects have been completed in conjunction with funding from the City and County of Honolulu, as local sponsor.

In response to many damaging floods that occurred in the Lāʻie area, the Corps and the City and County of Honolulu constructed the Kahawainui Stream Flood Control project in 1990. This stream flows within the ahupuaʻa of Lāʻiewai. The Wailele Stream Flood Control Project (Lāʻiemaloʻo ahupuaʻa) is now advancing in the southern portion of Lāʻie, with new funding granted in 2004.

The Kahuku Environmental Restoration Study was planned to identify opportunities to expand, enhance and protect wetland habitat within the James Campbell Wildlife Refuge, administered by the FWS. Local interest was to redirect this funding to address ongoing flooding and drainage problems that impact the Kahuku community. In 2004, the funding was reallocated to Flood Control Feasibility Study of the Kahuku community.

2.9.4.5 State of Hawaiʻi Agencies

Commission on Water Resources Management

The Commission's staff is consists of Surveying, Planning, Groundwater Regulation, and Stream Protection and Management Branches. Overall responsibilities include the following:

- Administer the Hawaiʻi Water Plan and its constituent parts
- Regulate the use of water resources in water management areas, including provisions to protect of Native Hawaiian water rights.
- Administer the instream use protection program by establishing appropriate interim and permanent instream flow standards.
- Receive and process permit applications for stream channel alterations, well drilling, pump installations, and diversion works construction.
- Conduct hydrologic investigations and recommend appropriate action regarding designation of water management areas.

Department of Land and Natural Resources

Several divisions of the Department of Land and Natural Resources (DLNR) have jurisdiction and involvement in watershed resources, lands and regulation in Koʻolau Loa, as listed below.

Division of Forestry and Wildlife. Responsible for the management of State-owned forests, natural areas, public hunting areas, and plant and wildlife sanctuaries. Programs cover watershed protection, native resources protection including unique ecosystems and endangered species of plants and wildlife, outdoor recreation, and commercial forestry. DOFAW also issues hunting permits. DOFAW is directly involved in the Ko'olau Mountains Watershed Partnership.

Office of Conservation and Coastal Lands (OCCL). The OCCL is responsible for overseeing private and public lands within the State Land Use Conservation District. In addition, OCCL is responsible for overseeing beach and marine lands out to the seaward extent of the State's jurisdiction.

Division of Aquatic Resources (DAR). DAR manages the State's marine and freshwater resources through programs in commercial fisheries and aquaculture; aquatic resources protection, enhancement and education; and recreational fisheries. In Ko'olau Loa, their major program areas include projects to maximize aquaculture productivity, and protecting native and resident aquatic species and their habitat. DAR has conducted species surveys of Punalu'u Stream and other Ko'olau Loa streams.

Division of State Parks. This Division manages and administers State parks which offer varied outdoor recreation and heritage opportunities. The park environments range from landscaped grounds with developed facilities to wildland areas with trails and primitive facilities. In Ko'olau Loa, these include Kahana Valley State Park and Mālaekahana State Park. This Division also issues camping permits.

Division of Conservation and Resource Enforcement. This Division is responsible for the Department's enforcement activities. The division, with full police powers, enforces all State laws and rules administered by the Department of Land and Natural Resources, which includes State lands, State Parks, historic sites, forest reserves, aquatic life and wildlife areas, coastal zones, Conservation districts, and shorelines.

State Historic Preservation Division (SHPD). This DLNR Division works to preserve and sustain reminders of earlier times which link the past to the present. SHPD's three branches, History and Culture, Archaeology, and Architecture, strive to accomplish this goal through a number of different activities. The Division records and regulates the archaeological and cultural resources of Ko'olau Loa.

Land Division. This DLNR Division is responsible for the management of all State-owned lands in Ko'olau Loa not set aside for use by other government agencies. The division also serves as an office of record and maintains a central repository of all government documents dating back to the Māhele of 1848.

State Office of Planning - Coastal Zone Management

Through the Department of Business, Economic Development and Tourism (DBEDT), the Office of Planning is the State's land use planning policy agency. The Office of Planning implements the Hawai'i Coastal Zone Management Program. It is the mission of the Hawai'i Coastal Zone Management Program to balance marine and coastal resources protection and sustainable economic development, anticipating emerging issues and facilitating their resolution by coordinating interests, developing and articulating appropriate management policies, and involving the public in resource management efforts. In Ko'olau Loa, projects and programs involving Federal funding or review (permits) are subject to review for consistency with State and Federal CZM policies and objectives.

The Office of Planning also provides policy and technical review support to the State Land Use Commission. Actions to change the State Land Use District classification of lands in Koʻolau Loa (Agriculture, Urban and Conservation Districts) require review and approval of petition to the State Land Use Commission.

Department of Health, Environmental Health

The Department of Health (DOH) is responsible for three primary areas of water quality. The Clean Water Branch administers and enforces statewide water pollution laws and rules. The Safe Drinking Water Branch administers federal and state safe drinking water regulations and the Wastewater Branch implements the construction of county wastewater facilities. In Koʻolau Loa, the DOH has regulatory authority over water-related facilities and surface waters. The recently completed report HI-SWAP presents information on the water quality in the Koʻolau Loa region.

The Environmental Planning Office is responsible for strategic planning, data collection and analysis, and the development of scientifically-based environmental standards. Current programs include the Water Quality Management Program, the Goals and Indicators Program, and the Land Use Planning Review.

Department of Agriculture

The Department of Agriculture's (DOA) mission is to stimulate growth in agriculture in Hawaiʻi. The Department's main objectives are to preserve, promote and develop essential agricultural resources and infrastructure; to create and maximize opportunities for exporting; and to facilitate growth of existing and new agricultural commodities and by-products. In addition, the Department works to prevent the introduction and establishment of plants, animals and diseases that are detrimental to the State's agriculture industry and the environment.

In Koʻolau Loa, the DOA serves to assist agricultural development. The 686-acre Kahuku Agricultural Park provides land (25 lots) to small farmers at reasonable cost with long-term tenure. The DOA Aquaculture Development Program also assists shrimp and prawn farm operations in Koʻolau Loa.

2.9.4.6 City and County of Honolulu Agencies

Department of Planning and Permitting (DPP)

This department is responsible for land use planning and permitting, including long-range planning for Koʻolau Loa. DPP completed the Koʻolau Loa Sustainable Communities Plan in 1999, which establishes policy and directs development in the region. An update of the Koʻolau Loa SCP is in progress.

Land use and population in Koʻolau Loa is directed under the City General Plan (GP) and the Sustainable Communities Plan, which essentially calls for no substantial growth in Koʻolau Loa. Under the GP Population Distribution Guidelines, residential population in Koʻolau Loa is to be limited to 1.4% of the island's population. The SCP also includes a section which addresses water supply and distribution infrastructure.

Board of Water Supply

The Board of Water Supply (BWS) manages Oʻahu's municipal water sources and distribution system to provide water service. Monies collected from water sales finance its operations and projects. As a semi-autonomous agency, the BWS is governed by a seven-member Board of Directors.

The Board of Water Supply's mission is Water for Life or Ka Wai Ola. This mission expanded the BWS' focus from just water systems and services to the broader mission of meeting the needs of the community, the economy, and the environment. 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 that protect the environment and support Oʻahu's economy while achieving sustainable water supplies for future generations. BWS has oversight for the development of this plan.

Department of Environmental Services

This department has authority over wastewater management facilities and solid waste management facilities and operations. In Koʻolau Loa, these include the Kahuku Wastewater Treatment Plant. The Lāʻie Wastewater Reclamation Facility and its associated collection system were transferred to the City and County of Honolulu Department of Environmental Services on November 1, 2006.

Department of Design and Construction

This department has authority over construction projects involving City funds, including roadways, drainage and flood control facilities, and City buildings. Flood control projects at Kahuku and Lāʻie have been partially supported by City funding, serving as the local sponsor for Federal Army Corps projects.

2.9.4.7 Major Landowners

Turtle Bay Resort (Kawela)

The North Shore's only resort is Turtle Bay Resort, located on 880 acres in the Kawela area, including portions of several ahupuaʻa including Kawela, ʻŌʻio 1, ʻŌʻio 2, Hanakaʻoe, Ulupehupehu. Kuilima Hotel was first constructed in 1972 by Del Webb, including a golf course. Approvals were granted in 1987 for the expansion of the Kuilima Resort to include 3000 visitor units, with five new hotels and 1000 condominium units, a second golf course, and a commercial retail complex. In 1988, the resort was sold to Asahi Jyuken, and the second golf course was constructed, along with the start of a new hotel at Kawela Bay. However, the owners experienced financial hardship during the Japan's economic downturn in 1990, which led to the eventual sale of the property. After several ownership transitions, Oaktree Capital Management LLC took control of Turtle Bay in December 2000. About $50 million in renovations were completed. The property is now in foreclosure and future plans are uncertain.

Water supply for the resort is obtained through the BWS. Plans are in progress for the ʻŌpana wells to be improved and dedicated to the BWS. Wastewater from the resort is currently being treated and reused on the golf course. The second golf course contains numerous wetlands that sustain endangered Hawaiian waterbird species. The low circulation of the inner bay waters has trapped sediment which creates chronic turbidity conditions in nearshore waters. In response, the resort plans to relocate a small portion of Kawela Stream so that the discharge of upstream sediment is into the better flushed ocean waters instead of Kawela Bay.

Estate of James Campbell (Kahuku Lands)

The Estate of James Campbell has been a major North Shore landowner since the plantation days, owning much of the land in the Kawela and Kahuku areas for the Kahuku Sugar Plantation. Their holdings include the Kahuku Sugar Mill, which was closed in 1986 and demolished in 2004. As the sugar plantation production slowed, many of the fields were released from farming and large tracts were sold.

In preparation for the Estate transition to James Campbell Co. LLC in 2007, many real property assets were sold. Over 8,200 acres in the mauka portion of the Kawela-Kahuku area was sold in 1999 to the U.S. Army Kahuku Training Range for the 25th Infantry Division based at Schofield Barracks. Another 663 acres in Mālaekahana was sold in 2003 to Hawaiʻi Reserves, Inc.. The Estate anticipates further land sales in this area.

Campbell Estate owns the existing 9-hole City and County of Honolulu golf course in Kahuku. There is significant community interest in seeing the golf course expanded to include reclaimed water application from the City's Kahuku Wastewater Treatment Plant. The golf course expansion could also support a potential drainage detention area to control upland runoff.

U.S. Army Garrison, Hawaiʻi - Kahuku Training Range

For decades, the Army has trained infantry in the mauka hills of Kahuku. Approximately 8,216 acres were purchased in 1999 to support the U.S. Army Kahuku Training Range for the 25th Infantry Division based at Schofield Barracks. Purchasing the property assured the continued availability of a training area on Oʻahu. The Army has long considered the Kahuku Training Area essential to its mission in the Pacific, since the area is large enough to let field commanders conduct tactical maneuver training at both the company and battalion levels. Hawaiʻi Army National Guard and Marine Corps units also train at Kahuku.

The U.S. Army Garrison Hawaiʻi, Environmental Division has prepared an Integrated Natural Resources Management Plan (INRMP) for Training Areas in Hawaiʻi. This plan addresses the comprehensive management of natural resources in the Kahuku Training Area. The goal of this plan is to conserve and rehabilitate natural resources consistent with military preparedness. Over time, the Army seeks to maintain ecosystem viability and ensure the sustainability of desired military training conditions.

Property Reserve, Inc. and Hawaiʻi Reserves, Inc. (Mālaekahana, Lāʻie, Hauʻula)

Property Reserve, Inc. is the land holding entity of The Church of Jesus Christ of the Latter-day Saints. The church in Mālaekahana, Lāʻie and Hauʻula owns about 6,500 acres. Hawaiʻi Reserves, Inc. (HRI) is the land management entity responsible for these lands. The community of Lāʻie is also served with private water, sewer and roadway infrastructure managed through subsidiary companies of HRI.

In 1999, HRI updated the Lāʻie Master Plan to provide land use planning information to the City during the preparation of the Koʻolau Loa Sustainable Communities Plan. The approved areas in the 1999 plan allow for approximately 550 units of affordable housing, which have been needed for many years in Lāʻie.

HRI is planning a new affordable housing development in Mālaekahana. HRI purchased 663 acres in Mālaekahana from Campbell Estate in 2003. The housing development will use less than half of the 663 acres and the remaining land will remain open space. The governing principles include sustainability, quality, affordability, pedestrian-friendliness, and variety of services. The plan is to shift the site of the 1999 approved areas to this new location, which is estimated to take five years before construction begins.

The mauka lands of HRI stretch to the Koʻolau ridge in the ahupuaʻa of Lāʻiewai and Lāʻiemoloʻo, and portions of Mālaekahana. These areas include the watersheds of Kahawainui and Wailele, and a portion of Mālaekahana. The mauka areas mostly include conservation district lands. HRI has long-term plans to establish a hardwood forestry project in a portion of this area. HRI has agricultural leases for areas under their control in the makai areas. Flood control has also historically been a challenge in the community, and HRI has participated in joint agency flood protection and control projects at Kahawainui and Wailele Streams.

State of Hawaiʻi (Kahana, Kaluanui, Mālaekahana)

The State of Hawaiʻi owns land at Kahana Valley State Park, Sacred Falls State Park (Kaluanui), and Mālaekahana State Recreation Area. These lands are managed by the DLNR State Parks Division. As State Parks, these lands are actively utilized, but also serve as natural preserve areas.

Mālaekahana is a rural beach park with limited improvements and camping. Kahana Valley State Park is the largest area with about 35 residents on leased land and kuleana parcels. This large watershed area receives some of the greatest annual rainfall in Koʻolau Loa, and hence is very water rich with a high-volume stream flow.

Kaluanui contains the historically popular Sacred Falls State Park. The park has been closed since the 1999 landslide, which resulted in several fatalities. The park will likely be reopened in the future, following release of a new park master plan and risk assessment report.

Hanohano Family (Punaluʻu)

The Hanohano family owns significant land in Punaluʻu, including the condominium facilities at Pat's at Punaluʻu. The Ponds at Punaluʻu is an adult assisted-living facility located mauka of the highway. The family also owns several hundred acres of undeveloped agricultural land in Punaluʻu. There are no specific plans for the future use of these lands, which are mostly low-lying lands susceptible to ponding and flooding.

Kamehameha Schools (Punaluʻu)

Kamehameha Schools owns and manges a large portion of Punaluʻu, including the mauka watershed areas. BWS has several wells and storage reservoirs on Kamehameha Schools property in Punaluʻu. The land is generally used for agriculture, through lease agreements with individual farmers. The water system includes pipes, valves and water meters and utilizes several private wells and a surface water diversion as water sources. Many years ago, the Kahuku sugar plantation constructed and managed a ditch to route stream and surface water to fields. While the ditch has continued to be a water source for properties along its route (by formal or informal agreement), the ditch and tunnels are in need of some repairs.

Kualoa Ranch (Kaʻaʻawa)

Kaʻaʻawa Valley is a part of the 4,000-acre Kualoa Ranch owned by the Morgan family, which is used for livestock grazing, outdoor recreation, and as a location for film productions. Kualoa Ranch and Activity Club extends onto the ahupuaʻa of Kualoa and Hakipuʻu, which are in the Koʻolau Poko moku.

2.9.4.8 Koʻolau Mountains Watershed Partnership

Projects have been developed in response to issues and needs assessed by the Partnership. *Table 2.11* lists land use management activities currently employed by those KWMP members with landholdings within the Koʻolau Loa district. One of the most significant measures is fencing and controlled hunts for feral ungulate control.

Table 2.11 KMWP Management Activities

Koʻolau Mountains Watershed Partnership Management Activities
Ungulate Control A comprehensive ungulate management strategy and an umbrella Environmental Assessment and Conservation District Use Application for priority ungulate fences
Hunting A controlled hunt template to work with landowners adjacent to DoFAW hunting areas to improve hunter access and develop an integrated ungulate management program.
Invasive Species A site-based invasive weed management strategy for the KMWP area based on aerial and on-the-ground surveys to collect data on weed species, focusing on resource-rich, high priority areas with high potential for weed introduction.
Monitoring A water monitoring program to measure sedimentation, stream flow, turbidity and nutrients on a subwatershed, valley or ahupuaʻa level in collaboration with U.S. Geological Survey, EPA, DOH and the Commission on Water Resource

2.9.5 Summary of Community Values Relating to Water Resources

The preliminary discussions held with stakeholders throughout Koʻolau Loa pointed out several critical values and principles held by residents of this community, which apply directly to watersheds in Koʻolau Loa. These values and principles include:

1. Sustaining the Rural Lifestyle of Koʻolau Loa
2. Cultural and Traditional Water Uses
3. Natural Resources & Watershed Ecology (holistic view)
4. Healthy and Plentiful Water Supply for Community (waiwai)
5. Preserving Agricultural Uses and Water Supply
6. Watershed Management Responsibilities

Many of these key values relating to the watershed were previously identified in the Sustainable Communities Plan process conducted from 1997 to 1999. A further discussion of each of these Koʻolau Loa community values and principles is presented below.

2.9.5.1 Sustaining the Rural Lifestyle of Koʻolau Loa

Community members of Koʻolau Loa generally accept the vision for a sustainable rural lifestyle. Individuals and community groups emphasized retaining and protecting green open spaces, agricultural areas, streams and riparian habitat, rural residential area character, and low-key commercial services. Sustaining the rural lifestyle does not mean that new development or redevelopment cannot occur, but the scale and context of such projects should be consistent with the Koʻolau Loa Sustainable Communities Plan.

A specific example within Koʻolau Loa is reflected in the vision statement of the Punaluʻu Community Association (November 2004 draft), with relevant excerpts provided below:

> *"...to protect and enhance the Hawaiian rural lifestyle of the areas by promoting: health and safety of ʻOhana, wise management of the ʻāina, educational activities and economic opportunities."*
>
> *"Hawaiian rural lifestyle is defined as: Open space; Rural design of the built environment...; Viable agricultural uses; Healthy shoreline, streams and ocean resources; Natural resources that are accessible and well cared for by all who access them; ʻOhana-centered, Small diversified ʻOhana-owned businesses, Based on cultural values.."*

The Punaluʻu Community Association values statements are believed to be generally accepted across the Koʻolau Loa region.

2.9.5.2 Cultural and Traditional Watershed Uses

The consultations indicated community interest in protecting and enhancing Native Hawaiian cultural and traditional watershed places, access and uses. Access to the watershed resources and conservation of these resources are important to continuing traditional gathering of plants and stream biota. Watershed access for spiritual worship is another cultural value. Pig hunting is another cultural use of the watershed.

Diverting stream water for traditional agriculture uses is important, typically for taro loʻi and other subsistence crops. Taro loʻi of various sizes are being farmed in Kahana, Punaluʻu, Hauʻula, and Lāʻie. These loʻi provide both crop production and cultural education to Koʻolau Loa residents. Kamehameha Schools has also planted a taro loʻi in Punaluʻu for student visits.

2.9.5.3 Natural Resources and Watershed Ecology (Holistic View)

The watersheds of Koʻolau Loa possess important natural resources as viewed in a holistic perspective. The traditional Hawaiian land division of the ahupuaʻa is classically defined by an entire watershed and the flow of water. Rainfall on the upper mountain ridges flows down the mountain slopes and drainages, collecting into the stream channels, flowing through the lowland plains, to the shoreline muliwai mixing with the salt water, and eventually releasing into the ocean and crossing the reef. Resources within this watershed include rock formations, soils, upland plants and fauna, groundwater, stream waters, stream biota, shoreline beaches, and a rich nearshore ocean environment.

Koʻolau Loa residents include farmers, fisherman, hunters, hikers, conservationists, Native Hawaiian practitioners, and water sports enthusiasts. These residents are directly affected by the quality of the watershed resources and actions within the watershed affecting the quality and quantity of these natural resources.

2.9.5.4 Healthy and Plentiful Water Supply for Community Use

Members of the Koʻolau Loa community view the proper use and stewardship of water resources as a key component of a sustainable lifestyle. The health and availability of a water supply for community use is a critical value.

With a naturally rich water supply along this coast, this community has not generally been concerned with drought or water shortages; Koʻolau Loa is blessed with ample rainfall and rich surface and ground waters. The community's preference is to limit future inter-district transfers of groundwater from Koʻolau Loa to other districts.

Residents believe that protection of the watersheds and underlying aquifers is essential to the future management of Koʻolau Loa's watersheds. The water quality of aquifers on the upper windward coast is very high, and BWS and land owners should take measures to ensure continued vigilance toward protecting groundwater quality.

Adequate supply of surface water for agriculture and stream flow is another community desire. This relates to past and existing surface water diversions used for Native Hawaiian cultural purposes, such as taro loʻi and other traditional agriculture.

2.9.5.5 Preserving Agricultural Use and Water Supply

The Koʻolau Loa community remains in touch with its plantation past. From the late 1800s to the mid-1900s, much of Koʻolau Loa was utilized by the sugar cane plantations which developed and maintained a system of field roads and ditch irrigation water systems. A major ditch system transmitted stream water from Punaluʻu to the north, serving cane fields planted on the rolling hills and broad fields of Lāʻie, Mālaekahana and Kahuku. With the demise of sugar, large areas became fallow or were converted to grazing land.

Parts of Koʻolau Loa still contain portions of field roads and remnant ditch sections. However, much of the former plantation land in Koʻolau Loa is now green open space. The largest areas of commercial agriculture are found in the Kaʻaʻawa, Punaluʻu, Mālaekahana, Kahuku and Kawela areas. Grazing lands constitute much of Kaʻaʻawa and Mālaekahana, while diversified truck crops are found mostly in Punaluʻu, Kahuku and Kawela areas. The Sustainable Communities Plan places much of the existing agricultural land in the same category to provide for continued farming uses and potential future growth in agriculture.

Water supply for Koʻolau Loa agriculture has traditionally been very dependent upon the high annual rainfall received along this coast. The irrigation ditch system provided supplemental water to fields, which is only partially intact in some areas of Punaluʻu and ʻŌʻio (Kahuku and Kawela). Current agricultural irrigation requirements are supplemented or entirely provided by groundwater, from wells tapping either the lowland caprock aquifer or the higher quality deep aquifer. Both landowners and the community note the importance of continued future use of both stream diversions and groundwater sources for agricultural irrigation supply.

2.9.5.6 Watershed Protection and Management Responsibilities

Consultations with landowners and the community have noted their responsibilities for managing the watershed areas of Koʻolau Loa, both to protect natural resources and ensure the potential for its productive use.

Many individuals feel there is value in protecting and managing Koʻolau Loa's watersheds, to ensure a future supply of pure drinking water, and to maintain and enhance stream flow for agricultural use and natural stream resources. There is a community desire to reduce flooding in some of the Koʻolau Loa watersheds. However, flood control structures in the lower stream sections may conflict with habitat protection.

In general, landowners are interested in learning more about land management practices that could be undertaken on their property to help protect groundwater and streams. Landowners are also aware of individual requests for access to the mauka watershed lands for traditional cultural practices.

2.9.6 Summary of Community Issues Relating to Water Resources

Consulting with Koʻolau Loa residents, landowners and responsible agencies has identified a number of water resources issues. Brief discussions of community issues follow.

2.9.6.1 Relationship of Watershed Plan to Koʻolau Loa Land Use

Many of the individuals, organizations, landowners and agencies consulted in this process were participants in the Koʻolau Loa Sustainable Communities Plan (SCP). The SCP presents the planned land use pattern for the region. With a sustainable focus, the SCP largely indicates a continuation of the existing land use patterns. Only a few areas, mostly in the Lāʻie area, were targeted for potential growth for affordable homes and local job base expansion.

Landowners and individuals in the community wish to better understand how the Koʻolau Loa Watershed Management Plan could relate to future land use in Koʻolau Loa. With the policy setting established in the SCP, there is a concern that this Watershed Management Plan could potentially expand or restrict water supply in certain areas of Koʻolau Loa, thereby affecting the land use plan.

2.9.6.2 Cultural and Traditional Water Uses

Cultural and traditional water uses in Koʻolau Loa relate to surface waters in streams flowing through individual watersheds. In some instances, stream flows are affected by surface diversions for agricultural uses. There is community interest in continuing existing cultural water use practices, such as taro loʻi fed by surface diversion water source. There is also interest in expanding the understanding of past cultural water uses in Koʻolau Loa and, in some cases, restoring some of former water uses.

2.9.6.3 Koʻolau Loa Groundwater Quantities and Yield Potential Compatible with the Long-term Health of the Watershed

Several stakeholders raised questions about groundwater aquifer sources in Koʻolau Loa, regarding issues such as the total quantity of water and how much could be tapped without affecting water quality and stream flows. Aquifer capacity information is essential to evaluating of potential sustainable yield by the BWS wells and other groundwater users in the region.

The USGS has conducted several studies of the regional aquifer systems in past decades, going back to Takasaki (1969). There have also been studies of some individual areas, such as Punaluʻu and Kahuku. BWS and CWRM have also estimated sustainable yield from areas within Koʻolau Loa. Additional groundwater source information, including water use and demand, will be needed for the future management of watershed areas.

2.9.6.4 Plan Effects on Private Lands, Water Sources and Systems

Most watershed areas that feed the existing aquifer sources in Koʻolau Loa are privately owned, with the exception of Kahana Valley and Kaluanui. Most of the BWS wells tap aquifer sources that are down-gradient of these private lands. The major land owners in Koʻolau Loa have voiced concerns about the potential effects of the Watershed Management Plan on private interests, specifically future water and land use.

The actions of these major landowners will be critical to the future protection of ground and surface water resources in Koʻolau Loa. One objective of this watershed management plan is to assist land owners in providing sound management of the source areas for groundwater. Private watershed land owners are participating in this planning process, and will have input on the formation of management guidelines expressed in this plan, including specific watershed protection initiatives.

The Lā‘ie community is the only residential area in Ko‘olau Loa served by the private Lā‘ie Water Company. Additional source development may be sought to serve affordable housing in this watershed area within the 20-year planning timeframe.

2.9.6.5 Water Uses and Allocation

The water supply in Ko‘olau Loa is generally plentiful, and water availability has not been a limiting factor for local demand. The only exception has been rising chlorides at the Punalu‘u BWS wells during recent drought periods. There are concerns, however, that this plan could limit domestic, commercial, and agricultural water users.

Ko‘olau Loa residential demand is not planned to grow substantially, with only modest residential growth in Lā‘ie for affordable housing. The Lā‘ie Water Company possesses the capacity to serve the projected 550 new homes. Kahuku and Ka‘a‘awa may also see some additional housing over the next 20 years. The largest potential water demand in the region could be future growth in diversified agriculture.

A significant concern of stakeholders is the BWS policy for future inter-district transfers of water outside of Ko‘olau Loa. Currently, up to 8.5 mgd is being transferred out of Ko‘olau Loa, mostly to the south to serve demand in Kāne‘ohe and Kailua. Of this total, only a small amount (0.3 mgd) is transmitted from the Kawela BWS system to the Pūpūkea BWS system on the North Shore. The BWS has expressed their commitment to not increasing the transport of water out of Ko‘olau Loa in the future.

The BWS transmission system is not inter-connected across Ko‘olau Loa. The Kahuku BWS system is an independent system, with no connection to the Kawela/Pūpūkea BWS system. The Kahuku system has its own source and storage, and is not connected to the Lā‘ie Water Company system or the next closest BWS system to the south at Hau‘ula. The physical separation of the BWS transmission systems at Kahuku prohibits the potential to transfer large quantities of water from Ko‘olau Loa to the North Shore.

2.9.6.6 Punalu‘u Watershed Alliance Model

The Punalu‘u Community Association has worked towards establishing the Punalu‘u Watershed Alliance (PWA) to address ongoing and future use of surface water and groundwater and watershed management for Punalu‘u. The PWA is pursing the establishment of measurable instream flow standards for Punalu‘u Stream by cooperatively participating in both instream and off stream studies and cultural studies. BWS has wells in Punalu‘u, and Kamehameha Schools and the Punalu‘u Community Association, maintain surface water diversions for agricultural operations. Irrigation ditch restoration will give users north of the stream diversion the opportunity to participate in the PWA and will restore agricultural use of their property.

The members of the PWA include the major landowner Kamehameha Schools, Punalu‘u Community Association, the Honolulu Board of Water Supply, USGS, and the State Commission on Water Resource Management. The group meets monthly to address current projects and issues. A Memorandum of Understanding (MOU) has been created to address the responsibilities of the various parties. Kamehameha Schools is currently undertaking a master plan process for the entire ahupuaʻa.

Several cultural projects have been undertaken in conjunction with the BWS, including kapa cloth making and drystack wall building. These projects support future interment of burial remains encountered in recent years as a result of replacing the Punaluʻu section of the main water line along Kamehameha Highway. Kamehameha Schools has commissioned and completed an oral history study of cultural resources. Conversations on establishing a Punaluʻu Watershed Center as a place of learning and research have begun.

USGS has conducted a study of Punaluʻu Streamflow and Stream-Macrofauna Characteristics which includes stream flows, stream channel geometry, seepage studies and species surveys. This study is equally funded by Kamehemeha Schools and the Board of Water Supply. R.M. Towill has conducted an assessment of the Punaluʻu agricultural surface water system. These are data gathering contributions for the eventual setting of measurable in-stream flow standards.

Punaluʻu can be considered a model for future studies in Koʻolau Loa. Other watersheds in the region will require technical and cultural studies, and the Punaluʻu model of involving the community with the landowner and resource agencies could be replicated elsewhere in the region. Identifying priority watersheds for future study will be an issue of discussion with the community and stakeholders.

2.9.6.7 Instream Flow Standards, Species and Protected Habitat

The community expressed concerns about the lack of the measurable instream flow standards for streams in Koʻolau Loa. Stream flows greatly affect habitat quality for the native species, such ʻoʻopu, ʻōpae, and hīhīwai. Measurable instream flow standards would more easily provide for additional non-instream uses and would help to expand agricultural production in Punaluʻu Valley if more stream water was available after the setting the standard. By setting measurable instream flow standards there can be better planning for instream and non-instream uses.

2.9.6.8 Flooding Issues in Koʻolau Loa Watersheds

Flooding is a major community issue in Koʻolau Loa, and the community and landowners wanted to ensure that this Plan addresses watershed flooding concerns. This Plan can begin to meet this community need by documenting watersheds with recognized flooding problems.

Accumulated storm runoff in stream channels is a natural watershed function. Flooding problems in Koʻolau Loa occur in areas of human settlement that are affected by water overtopping these stream channels. Changes to upstream conditions in the watershed, such as erosion or diversions, can sometimes cause downstream flooding. For example, several years ago some grading activities in the upper portion of the ʻŌʻio watershed in the Kahuku area caused greater runoff volume and silt runoff. Therefore, the plan will address land management measures for agricultural and conservation lands to mitigate flooding downstream.

The balance between constructing flood control structures and protecting stream habitat characteristics is a concern. Stream channel hardening and flood control structures, such as the Kahawainui Stream Flood Control Structure, serve flooding needs well. However, such modifications adversely affect the stream habitat; possible effects include, flow widening and dispersion, higher stream temperatures, elimination of shade and protective cover.

2.9.6.9 Kahuku Training Area – Stryker Brigade

The community is concerned about about the activities within the U.S. Army's Kahuku Training Area affecting the natural watershed properties. Vehicle activities and road grading/maintenance within the training area disrupt soils and vegetation, potentially leading to erosion and silt runoff. Further, the use of any chemicals relating to soldier training could potentially leach into the groundwater.

The U.S. Army Garrison Hawaiʻi has prepared management plans for their training ranges, including an Integrated Natural Resources Management Plan (INRMP). The INRMP provides plans for managing environmental conditions at the Kahuku Training Area, including groundwater, soils, erosion, vegetation, and habitat for several plant species that are threatened or endangered. Ongoing consultation with the Army could assess the effectiveness of management efforts affecting the upper watershed in the Kahuku area.

2.9.6.10 Polluted Runoff Control and Ocean Protection

The extent of seasonal rainfall along the Koʻolau Loa coastline raises ongoing concerns about the effect of stream runoff on ocean water quality. This very rural coastline hosts only a few concentrations of urban development, which contribute a relatively small portion of the region's water pollution. Agricultural areas in the Kawela, Kahuku, Mālaekahana and Punaluʻu areas may also contribute small amounts of agricultural chemical constituents into runoff. Clearly the largest potential effect on ocean water quality comes from the large undeveloped natural watershed areas of Koʻolau Loa, including debris and eroded soil in runoff.

Stream surface water discharges and soil erosion have affected this windward coastline for thousands of years. The ocean currents and waves provide a strong mixing regime along this exposed coast. Only a few small embayments provide a low ocean circulation which allows suspended sediment to collect. The marine life of this area is generally adapted to these periodic events of high stream discharge and coastal silt plumes.

However, the effects of human activities in the watersheds have, in some instances, increased the rate of soil erosion and the volume of discharge to the ocean. The watershed plan addresses this concern, and proposes measures and activities to minimize soil loss.

2.9.6.11 Policy Limits on Future Source Development in Koʻolau Loa

Some stakeholders are concerned about the potential development of new BWS sources in the largely untapped aquifers of Kaʻaʻawa, Mālaekahana, and other undeveloped sources in the region. Although there may be test wells or older agricultural wells in these areas, they have yet to be linked into the regional BWS production, storage and distribution system.

There are also concerns about the BWS source development policies for this region. Kaʻaʻawa Valley is not developed, nor is it planned for development, and the owners (Kualoa Ranch) have noted a desire to not drill new wells in this valley. The stream channel at Kaʻaʻawa Valley is used to water cattle, and the owners would like to preserve the existing flows. Several of the small valleys between Kaluanui and Hauʻula are being explored for water. To the north, Mālaekahana, Kaeana and Kahuku do have very modest water development, with the exception of the BWS Kahuku system and State Ag Park wells. Stakeholders have pointed out that certain areas of Koʻolau Loa may not need to be developed to serve the future water needs of the area. The water resources in these areas could be preserved for the future or for emergency conditions.

2.9.6.12 Forestry Management

The Ko'olau Mountains Watershed Partnership is the principal entity involved with Forestry Management in Ko'olau Loa and Ko'olau Poko, and the watersheds on the 'Ewa side of the ridge. Combining all the major Ko'olau landowners (those with over 100 acres) in the State Forest Reserve, this organization seeks to protect and preserve the natural water resources along the Ko'olau Mountains. The Partnership focuses on exotic species control and ungulate control.

The Ko'olau Loa Watershed Management Plan will address the measures being proposed in the KLWP management plan, as applicable to Ko'olau Loa. Specific projects have been proposed by KLWP, and some are being implemented. These ideas for management will be considered for direct application in the Ko'olau Loa Watershed Areas.

2.9.6.13 Climage Change and Sea Level Rise

Concern was expressed regarding the uncertainties of water demand and supply projections given the changing nature of the global climate. As more drought and flooding are forecast, questions arise as to the rates of which water supply will be replenished and available to meet local demands. Also, predictions are being made about the possible effects of rising sea level on O'ahu. Community members asked that these issues be considered in water and watershed planning.

2.9.7 Summary of Agency Issues

Several issues were identified during the Inter-Agency meeting held in March 2005. A total of 18 government agencies, private entities, and utility companies participated in the meeting. Participants are listed in *Table 2.12.* The following summary presents agency issues for Ko'olau Loa and Wai'anae expressed at this session and in follow-up.

Watershed Issues

- Effective management, use and monitoring of groundwater and surface water.
- Working to develop surface water hydrologic units and coding system.
- Surface water issues present challenges, e.g., interim stream flow standards.
- Land without water is not productive; you need forests to have water.
- Plans should focus on holistically protecting the forestry resources which will cost money.
- Wildfires can increase erosion; with a plan, erosion can be kept to less than 1 ton of loss of soil per year.
- Need to maintain water quality.
- Water data collection budgets reduced due to lack of funding; state-wide problem with insufficient data to observe changes over time.
- DOE may be another partner to develop public education and outreach in Agriculture projects, including specific resources and aquaculture.
- Major users of water, such as the military, need to be involved.

Water Use and Conservation Issues

- State agency water conservation - CWRM prepared a prototype conservation plan for DLNR in February of 2005 and intends to expand the program to other State agencies.
- Setting measurable instream flow standards is a difficult, complex and costly task. Over $500,000 in stream studies have been conducted for Punaluʻu Stream under the objectives of the Punaluʻu Watershed Alliance.
- Creating a methodology for setting the measurable instream flow standards can be challenging due to the range of diverse and competing interests.
- Non-potable water usage, such as stormwater capture should be explored.
- Sustainable Communities Plans are being scheduled for their five-year review.
- 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 which use less electricity and water.

Community Issues

- 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 to ensure implementation.
- DOE may be another partner to develop public education and outreach in agriculture projects, including specific resources and aquaculture.

Management Issues

- Planning efforts need to be coordinated and implemented, without duplicating 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.

Table 2.12 Inter-Agency Meeting Participants

Attendee	Agency/Organization	Meeting #1	Meeting #2
Michelle Mansker	U.S. Army, Department of Public Works	X	
Gordon Tribble	U.S. Geological Survey		X
Kathy Sokugawa	Department of Planning and Permitting, City and County of Honolulu	X	X
Randall Hara	Department of Planning and Permitting, City and County of Honolulu	X	X
Matt Higashida	Department of Planning and Permitting, City and County of Honolulu	X	X
Gerald Takayesu	Department of Environmental Services, City and County of Honolulu	X	X
Scott Nakamatsu	Department of Design and Construction, City and County of Honolulu		
Gary Hashiro	Hawaiian Electric Company	X	
Craig Shigeta	Hawaiian Electric Company		X
Jason Sumiye	Koʻolau Mountain Watershed Partnership	X	
Mikalani Souza	Mapping Change	X	
Leslie McLees	Mapping Change	X	
Stan Kato	NAVMAG, Environmental Resources	X	
John Muraoka	NAVMAG, Environmental Resources	X	
Randy Miyashiro	NAVMAG, Environmental Resources	X	
Terrance Tengan	NAVMAG, Environmental Resources	X	
Dean Nakano	State Commission on Water Resource Management	X	X
Lenore Nakama	State Commission on Water Resource Management	X	X
Glenn Bauer	State Commission on Water Resource Management	X	
Brian Kau	State Department of Agriculture	X	X
Robert Chong	State Department of Health	X	
William Wong	State Department of Health	X	
Dan Chang	State Department of Health		X
Andrew Monden	State Department of Land and Natural Resources, Engineering	X	
Mark Mazzola	State, Office of Planning Coastal Zone Management	X	
Dan Polhemus	State, DLNR Aquatic Resources		X
Mike Yamamoto	State, DLNR Aquatic Resources		X
Pat Costales	State, DLNR Department of Forestry and Wildlife	X	X
Nelson Ayers	State, DLNR Department of Forestry and Wildlife		X
Koalani Kaulukukui	Office of Hawaiian Affairs		X
Timothy Lim	UH College of Tropical Agriculture and Human Resources		X
Wayne Nishijima	UH College of Tropical Agriculture and Human Resources		X
Pauline Sato	The Nature Conservancy	X	
Stephanie Jeffs	The Nature Conservancy		X
Barry Usagawa	Honolulu Board of Water Supply	X	X
George Kuo	Honolulu Board of Water Supply	X	X
Chester Lao	Honolulu Board of Water Supply	X	
Bruce Tsuchida	Townscape, Inc. (Waiʻanae WMP Consultant)	X	
Konia Freitas	Townscape, Inc. (Waiʻanae WMP Consultant)	X	
Sherri Hiraoka	Townscape, Inc. (Waiʻanae WMP Consultant)	X	X
Jeff Overton	Group 70 International, Inc. (Koʻolau Loa WMP Consultant)	X	X
Cami Kloster	Group 70 International, Inc. (Koʻolau Loa WMP Consultant)	X	X
Kawika McKeague	Group 70 International, Inc. (Koʻolau Loa WMP Consultant)	X	
Walter Chong	RM Towill (BWS Consultant)		X

2.10 IMPLICATIONS FOR WATERSHED PLANNING

This section provides a summary of the implications for watershed and water resource planning which watershed analysis and agency and stakeholder consultations identified. It is critical to recognize the scientific data, agency issues and community concerns to understand the basic watershed planning needs and opportunities.

2.10.1 Groundwater Resources

The two main aspects of groundwater are supply and quality. Groundwater availability for potable consumption is a primary concern.

Managing Groundwater Withdrawal

Wells that draw water from basal aquifer freshwater lens are vulnerable to brackish water which mixes with freshwater. The main issues are the quantity of groundwater available for use and the amount of groundwater needed to ensure that withdrawal does not cause salt water intrusion. The BWS Punaluʻu wells experienced rising chloride levels during recent drought periods. As a result pumping was decreased and BWS repaired leaks along Kamehameha Highway, saving about 1 mgd. To reduce localized impact on Punaluʻu wells, BWS will disperse pumping in Koʻolau Loa among several wells. Kaluanui and Maʻakua wells will decrease pumpage on the Punaluʻu wells. Another possibility is the development and use of Kaipapaʻu well, currently an exploratory well.

Groundwater Sustainable Yield

Another related issue is the determination of the aquifer system sustainable yields. Sustainable yields vary with rainfall infiltration, general climatic conditions, and aquifer pumpage levels. A range that reflects this variability would more accurately reflect the status of sustainable yield at a given time. Sustainable yields should be periodically reviewed using data from monitoring wells, and chloride and water levels in existing BWS production wells should continue to be monitored closely.

Groundwater and Surface Water Interaction

The impacts of groundwater pumping on surface water needs to be monitored to ensure minimal impacts on stream flow. BWS gages, or pays USGS to gage, streams in watersheds where BWS dike tunnels extract drinking water, such as Waiheʻe, Kahaluʻu, Haiʻkū and Luluku streams. BWS will not develop new wells that impact streams until measurable instream flow standards are set and it is determined that stream flow can be reduced.

Groundwater Protection Strategies

Protecting the groundwater quality from surface contamination into the aquifer is essential. While the amount of development in Koʻolau Loa is much lower than other areas on Oʻahu, many human activities do occur over vulnerable parts of the aquifer which lack caprock protection. Koʻolau Loa sources are generally located in the conservation district, where allowed uses do not involve potential groundwater contaminants. Agricultural chemical use could potentially affect potable groundwater reserves in some Koʻolau Loa watersheds. Cesspools, which do not involve treatment of effluent, can contaminate groundwater; cesspools in No-Pass zones should be converted to high-level wastewater treatment.

2.10.2 Surface Water Resources

Concerns about surface water relate to quality and quantity. Major issues include ecosystem health, human health, agricultural uses and maintenance of traditional and customary practices.

Instream Flow Standards

Measurable instream stream flow standards are needed to ensure adequate stream flow for native stream species and other instream uses and to protect water resources. As noted in the Overview section, current instream flow standards are based on the amount of water flowing in each stream on the effective date of May 4, 1992 for Windward Oʻahu streams, and are not based on a weighing of present or potential instream and non-instream uses.

Non-Point Source Pollution

Non-point source pollution potentially affects surface water runoff and infiltration into the groundwater. Agriculture, businesses and construction sites can contaminate water sources and stream habitats. Communities and/or schools may want to monitor stream quality to assess stream health, which may indicate whether best management practices are being followed in the area surrounding the stream.

Nutrient-rich runoff from agriculture and cesspools can affect nearshore waters. The use of best management practices for agriculture may prevent excess runoff. The replacement of cesspools with septic systems, or connections to municipal wastewater systems (where available) may alleviate some of the negative effects on the environment.

Intermittent Streams

Stream flow concerns are focused on mainly on perennial streams; however, intermittent streams have other issues and need to be identified. Landowners should not dam, divert or alter intermittent streams for development purposes as alterations can contribute to the local flooding problems in Koʻolau Loa area.

2.10.3 Nearshore Waters

Nearshore Water Quality

Nearshore water quality should be monitored in Koʻolau Loa to assess the conditions related to human health and marine ecosystems. Ocean monitoring would allow for tracking of trends at points along the coastline with active public beach use and important marine resource areas.

Actions should be taken to protect nearshore ecosystems in Koʻolau Loa and public health. The inputs of overland runoff and subsurface disposal to coastal waters should be managed to reduce nearshore water quality impacts.

2.10.4 Land Use Zones

Land uses in Koʻolau Loa can affect water quantity and quality. Issues regarding existing and future land uses were categorized by zones, including: conservation, agriculture, military and urban. Concerns about land use are briefly described below for each zone.

2.10.4.1 Conservation Zone

Forested Watershed Protection

Terrestrial ecosystems with trees and understory provide temporary water storage and cleansing for a healthy watershed. The vegetation retains rainfall for groundwater infiltration and minimizes runoff. The ecosystem's ability to retain water and hold the soil, decreases stream sedimentation rates.

Forest management falls under the State DLNR, State Department of Health and City and County of Honolulu's Board of Water Supply are responsible for maintaining drinking water quality. Surface water quality is the responsibility of the State Department of Health and City and County Environmental Services Department. The potential disconnect between agency responsibilities for these linked resources may create conflicts or limit resources for forest management because of the agencies' differing missions.

Watershed management strategies often assume that native plants provide better watershed health and water quality and quantity protection than non-natives. While the native forest is known to be essential to animal species habitat, there has not been a study that confirms or denies the assumption that native plants are best for an ecosystem. The Hawaiʻi Tropical Forest Recovery Act of 1992 contains a provision of the establishment of a Hawaiʻi Experimental Tropical Forest. A search for a suitable site is under way. Plans have begun to locate a site. One possible experiment would be to examine the effects of native forest versus introduced forest on overall watershed health.

Feral Pig Control

By disturbing to forest vegetation, feral pigs contribute significantly to soil erosion and stream sedimentation; therefore, the Koʻolau Mountains Watershed Partnership is developing a feral pig management plan. Management options may include fencing and controlled hunting within the boundaries of the Forest Reserve area.

Threatened and Endangered Native Species Protection

The Koʻolau Loa forested area contains threatened and endangered native species which should continue to be identified and protected in the watershed areas. Unfortunately funding for their protection, especially on public lands, is limited. The DLNR budget continues to be generally under-funded for land management. For example, the more intensively managed Natural Area Reserves (NARS) has lands that are set aside for management to preserve and protect representative samples of Hawaiian biological ecosystems and geological formations. (There have not been any NARS lands designated in Koʻolau Loa.) The management budget for NARS program lands is about $10/acre. By comparison, other public entities that manage similar types of lands generally have 4 to 12 times that budget.

Invasive Forest Species

The presence of invasive species, such as *Miconia*, threaten the diversity of the Koʻolau Loa forests. When a single plant can out-compete natives and less invasive alien species, the forest lacks diversity and potentially has less ability to catch and store water. *Miconia's* roots are too shallow to hold the soil in place, which makes the soil susceptible to erosion. Newly arrived invasive species should be eradicated or controlled while such efforts are still economically feasible. Koʻolau Mountains Watershed Partnership is conducting surveys in Koʻolau Loa for invasive species and developing plans for removal. In Punaluʻu, the USGS is conducting stream surveys and seepage measurements in an effort toward establishing instream flow estimates.

Criteria for Evaluating Hawaiʻi's Watersheds

Currently, there no set of agreed upon watershed criteria for evaluating the health of Hawaiʻi's watersheds. Part of the difficulty in watershed evaluation is the lack of data. In the parts of the annual report sent to the 21st Legislature, 2001 Regular Session, *Relating to Watershed Protection*,

Appendix 5 contained a set of criteria. The criteria do not include interpretation for what would be desirable in a healthy watershed. Recent studies conducted for urban watersheds (Ala Wai, West Honolulu) provide some initial guidance.

2.10.4.2 Agricultural Zone

Protection of Agricultural Lands

Many large tracts of agricultural lands in Koʻolau Loa are presently underutilized or fallow. There are concerns about the potential for future large scale conversion of agricultural land for residential and other urban uses, and about related water demands. The Sustainable Communities Plan growth policies should be enforced to address these concerns.

Water Availability for Agriculture

The availability of surface diversion water for agricultural irrigation in Koʻolau Loa is a concern, particularly in areas involved with traditional agricultural practices. The ongoing permissions, operation and maintenance of agricultural water diversion systems are related concerns. Groundwater is readily available for agricultural use. While recycled water is a more expensive option than groundwater, it is more reliable during periods of drought.

2.10.4.3 Military Zone

Mauka Training Areas

Military training activities in the Kahuku Training Area may impact the mauka watershed habitat, surface runoff water quality and, groundwater quality. Training activities should include measures to protect watershed resources and mitigate water quality impacts.

2.10.4.4 Urban Zone

Potable Water Demands

Growth in the Koʻolau Loa communities and the Turtle Bay Resort area will place demands on the groundwater resources being tapped to provide potable water. Groundwater is available and wells have been identified and tested. Measures should be implemented to avoid overusing groundwater resources and adverse effects to aquifer integrity.

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3

WATER USE & PROJECTED DEMAND

3 WATER USE AND PROJECTED DEMAND

3.1 WATER AVAILABILITY AND EXISTING USE
3.2 PROJECTING FUTURE WATER DEMAND
3.3 MOST PROBABLE WATER DEMAND SCENARIO
3.4 IMPLICATIONS FOR WATER SUPPLY PLANNING

To provide a context for future projects and water allocations in Ko'olau Loa watersheds, this chapter first presents the existing water usage by source (ground, surface, recycled) and descriptions of the water delivery systems. Then, water use is forecast to 2030 using three different scenarios and the assumptions are explained. The most likely scenario is also discussed.

3.1 WATER AVAILABILITY AND EXISTING USE

The three main sources of water in Ko'olau Loa are ground, surface, and recycled water *(Figure 3.1)*. Groundwater supplies most of the Ko'olau Loa residential, commercial and agricultural needs and supplies water to Kailua, Kāne'ohe and Waimānalo in Ko'olau Poko. Surface water provides agricultural irrigation water for Punalu'u and Kahana Valleys in Ko'olau Loa. Recycled water supplies some of the district's irrigation water needs in Lā'ie and at Turtle Bay. *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 Ko'olau Loa District and can be used with the 2000 US Census data.*

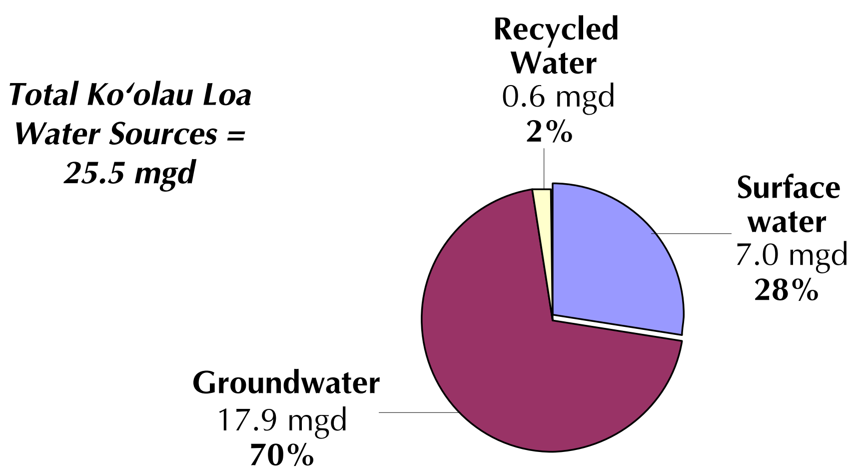


Figure 3.1 Ko'olau Loa District Water Sources (2000)

This section covers the three types of water use in detail. Groundwater usage is presented first as groundwater is the major water source for the district and beyond. There are separate subsections for potable use and non-potable uses of groundwater. Following the groundwater discussion are sections on surface water, recycled water and the Waiāhole Ditch.

3.1.1 Groundwater Use and Delivery

The sustainable yield for the Koʻolau Loa Aquifer System Area is 36 million gallons per day (mgd) and for the Kahana Aquifer System Area, 15 mgd as of the August 2008 CWRM Water Resources Protection Plan. The Koʻolau Loa and Kahana Aquifer System Areas are designated groundwater management areas (GWMA). A water management area 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," with the exception of domestic consumption by individual users or catchment systems must first be permitted by CWRM. For each Koʻolau Loa and Kahana well, a water use permit is required and users withdrawing greater than 1,700 gallons per day are required to report their usage.

Total well (non-saltwater) permitted use and the available reported pumpage amounts for the Koʻolau Loa and Kahana GWMAs are shown in *Table 3.1*. The total 2000 permitted use is 20.586 millions of gallons per day (mgd) and 1.101 mgd, respectively. The total pumpage based on 2000 reports is 17.860 mgd for Koʻolau Loa and 0.604 mgd for Kahana.

Table 3.1 Koʻolau Loa District Aquifer System Withdrawals (2000) and Sustainable Yields (2008)

Aquifer System Area	BWS		State		Private		Total		Sustainable Yield (mgd)	Available Yield[6] (mgd)
	Permitted Use (mgd)	Pumpage (mgd)	Permitted Use (mgd)	Pumpage (mgd)	Permitted Use (mgd)	Pumpage (mgd)	Permitted Use (mgd)	Pumpage (mgd)		
Koʻolau Loa	8.915	8.603[1]	0.307	0.459	11.364	7.515[2]	20.586	16.577	36	15.414
Kahana	0.600	0.604	0.008	--	0.493	--	1.101	0.604	15	13.899[3]
Kawailoa	0.750	0.679	0.026	--	--	--	0.776	0.679	39[4]	--[4]
Total	10.265	9.886	0.341	0.459	11.857	7.515	22.463	17.860	51[4]	28.313[4]

[1] includes water supplied to Koʻolau Poko
[2] includes 0.6 of non-reporting small users
[3] Per CWRM "sustainable yields are not directly available because any withdrawal may have a one-to-one effect on stream flows. The interim instream flow standards adopted by the CWRM as well as appurtenant rights, riparian rights, and existing uses directly affect the availability of water for future uses and requires the approval of the CWRM. Current CWRM policy allows for further pumpage even if quantified instream flow standards have not been established provided that it can be shown through pumping tests that additional withdrawals will not impact stream flows. Even if the pumping test shows stream impacts, further pumpage would be allowed if a successful petition to amend the current interim instream flow standards was made." The Board of Water Supply (BWS) has no plans to pursue well development in this water management area.
[4] The sustainable yield for Kawailoa System Area is not included in the total because the primary region for withdrawals is the North Shore area. The available yield is also not included for this reason.
[5] includes 0.572 of non-reporting small users
[6] Available yield equals sustainable yield minus permitted pumpage of the Water Use Permit.

The permitted use for the sliver of the Kawailoa GWMA in the Koʻolau Loa district is 0.776 mgd with 0.679 mgd of pumpage in 2000. The sustainable yield for the entire Kawailoa GWMA is 39 mgd.

As indicated in *Table 3.1* and the chart in *Figure 3.2*, the majority of groundwater withdrawn is from the Koʻolau Loa Aquifer System Area. Approximately 8.6 mgd of groundwater is exported from Koʻolau Loa.

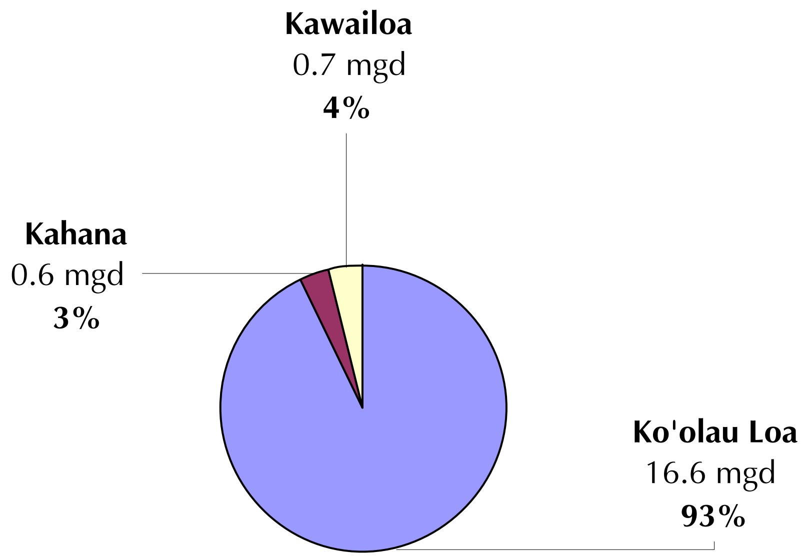


Figure 3.2 Koʻolau Loa District Withdrawals by Groundwater Management Area (GWMA), 2000

The BWS is the public agency supplying potable water to most of Windward Oʻahu. There is also a private entity, Lāʻie Water Company which supplies potable water to the Lāʻie community. The remainder of the district withdrawals are via private wells which supply non-potable groundwater for agriculture and resort irrigation/amenities *(Figure 3.3)*.

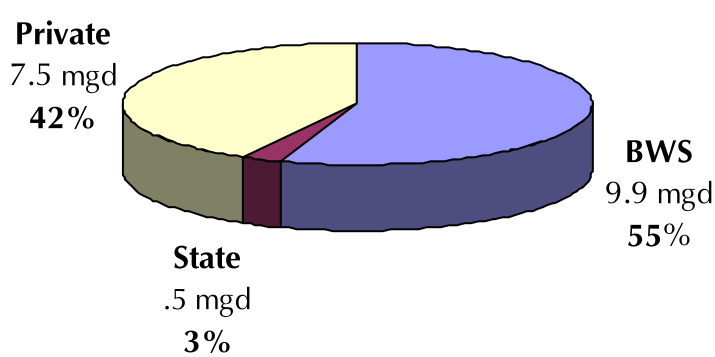


Figure 3.3 Koʻolau Loa District Withdrawals by Purveyor (2000)

3.1.1.1 Potable Water Systems

Groundwater is supplied for urban uses by two water purveyors in the district, one public and one private. The BWS provides water to residents, commercial establishments and government facilities (schools, parks and offices) in the Koʻolau Loa communities of Kaʻaʻawa, Kahana, Punaluʻu, Hauʻula, Kahuku and Kawela. Total in-district use in 2000 was 1.5 mgd. In addition, BWS exports water from Koʻolau Loa to Koʻolau Poko for urban uses in that district. A private water company, Lāʻie Water Company, provides water to the Lāʻie community. About 1 mgd was provided to their customers in 2000.

Board of Water Supply

The BWS delivers drinking-quality water via three separate BWS systems *(Figure 3.4).*

At the north end of Koʻolau Loa is the BWS Waialeʻe system that supplies the Kawela area of Koʻolau Loa. Waialeʻe Wells I and II are the water sources for this end of the system. Although this system is connected to the BWS Waialua-Haleʻiwa system, water transfer between the areas is considered minimal.

The BWS Kahuku system supplies users in Kahuku and Mālaekahana and is not connected to other BWS systems. The Kahuku wells are the water source for this system.

To the south of Lāʻie, the BWS system supplies water for Koʻolau Loa (communities of Hauʻula, Punaluʻu, Kahana and Kaʻaʻawa) and Koʻolau Poko (Kailua, Kāneʻohe and Waimānalo). BWS utilizes the following wells for this groundwater: Kahana, Hauʻula, Kaluanui, Maʻakua, and Punaluʻu I, II, and III. BWS water usage in Koʻolau Loa is shown in *Table 3.2* with subtotals by water use area and by sector usage. The usage numbers are based on an average for the years 1994 to 2003.

The largest Koʻolau Loa user of BWS-supplied water is the residential sector with an average of 0.776 mgd. The commercial sector is the next largest user of BWS water at 0.289 mgd. Resorts and state government follow at 0.160 mgd and 0.132 mgd respectively. Agriculture and city government usage is 0.049 mgd. (Most agriculture users access water through private wells or surface water diversions.) The total BWS average use for Koʻolau Loa over a ten year period is 1.463 mgd. The percentages of each sector are shown in *Figure 3.5*.

Since residential areas are the largest consumer of BWS water in Koʻolau Loa, it is not surprising that Kahuku, the area with the largest residential population, has the highest water usage. Lāʻie also has a large residential area; however, that community is served by Lāʻie Water Company. Kuilima's usage is second highest of the BWS-supplied areas, due to both residential and the resort use. Kaluanui, where the majority of Hauʻula community is located, is the third largest user.

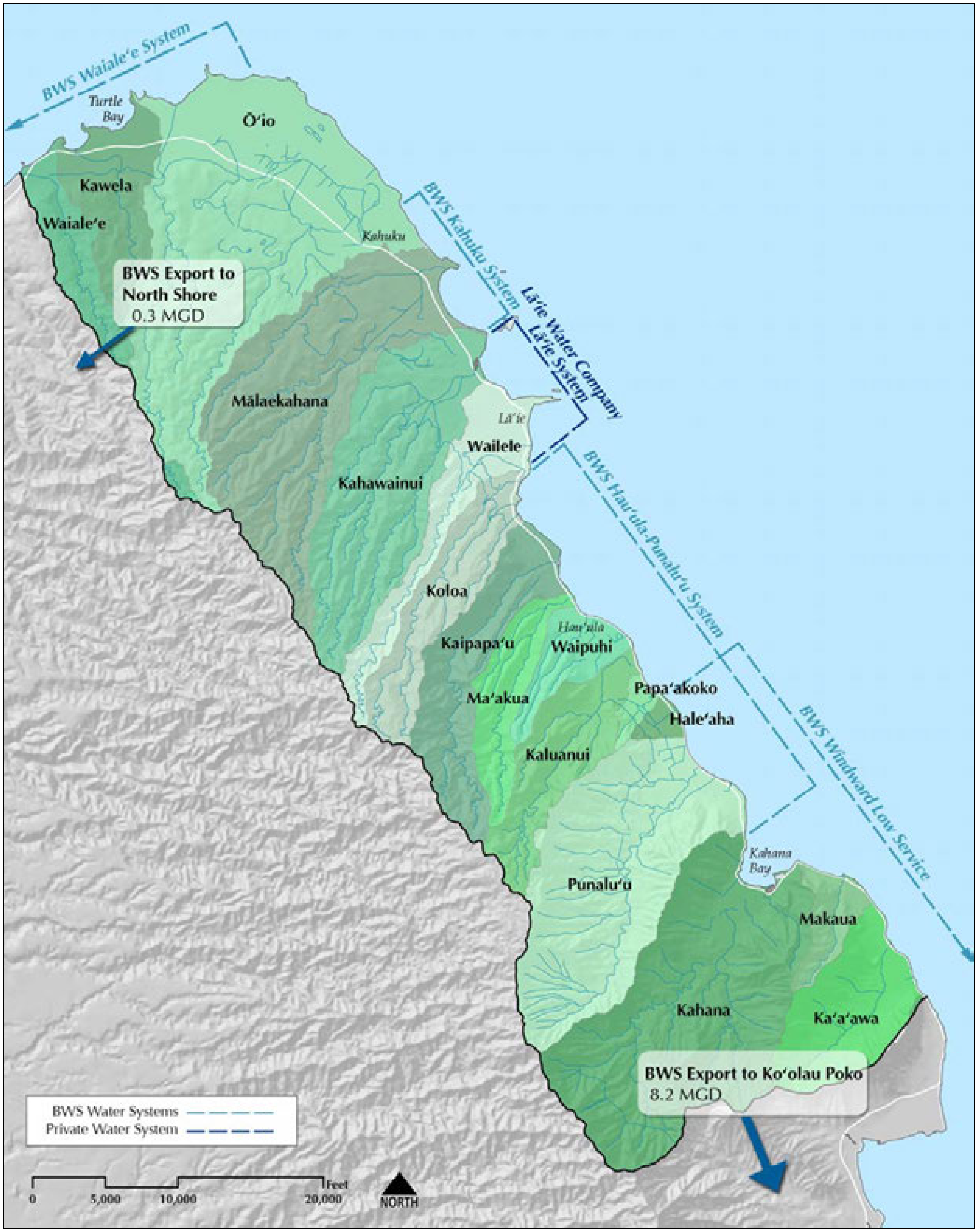


Figure 3.4 Potable Water Delivery Systems (2000)

Table 3.2 BWS Average Daily Consumption in Koʻolau Loa (1994-2003 Average)

	Water Use Sector (mgd)								
Area	Residential	Commercial	Temporary[1]	Hotel	State Government	City Government	Agriculture	Religious Institutions	*Totals*
Kaʻaʻawa	0.130	0.005	0.000	0.000	0.002	0.005	0.015	0.000	**0.158**
Punaluʻu	0.117	0.024	0.000	0.000	0.000	0.001	0.014	0.000	**0.156**
Hauʻula/Kaluanui	0.204	0.006	0.005	0.000	0.006	0.004	0.011	0.004	**0.239**
Hauʻula/Kaipapaʻu	0.098	0.004	0.000	0.000	0.000	0.003	0.006	0.000	**0.112**
Kuilima Resort Area	0.092	0.046	0.000	0.160	0.000	0.000	0.001	0.000	**0.299**
Kahuku	0.135	0.203	0.000	0.000	0.124	0.036	0.002	0.000	**0.500**
Total	**0.776**	**0.289**	**0.005**	**0.160**	**0.132**	**0.049**	**0.049**	**0.004**	**1.463**

[1] Temporary water use includes fire fighting, construction, etc

Note: The BWS well pumpage in *Table 3.1* will not equal the BWS usage in *Table 3.2* for two reasons. The first is that some groundwater from Koʻolau Loa is transported for use in Koʻolau Poko (Kailua, Kāneʻohe and Waimānalo). The second reason is that water loss occurs in the process of withdrawing groundwater and transporting it to users. The BWS estimated losses in the year 2000 to be 20% for the entire windward district which includes all of Koʻolau Loa and Koʻolau Poko. (Typically, these losses average 10%.) Numerous leak detection, repairs and pipeline improvements to the Koʻolau Loa infrastructure reduced the losses in the Windward District to 16% since 2002.

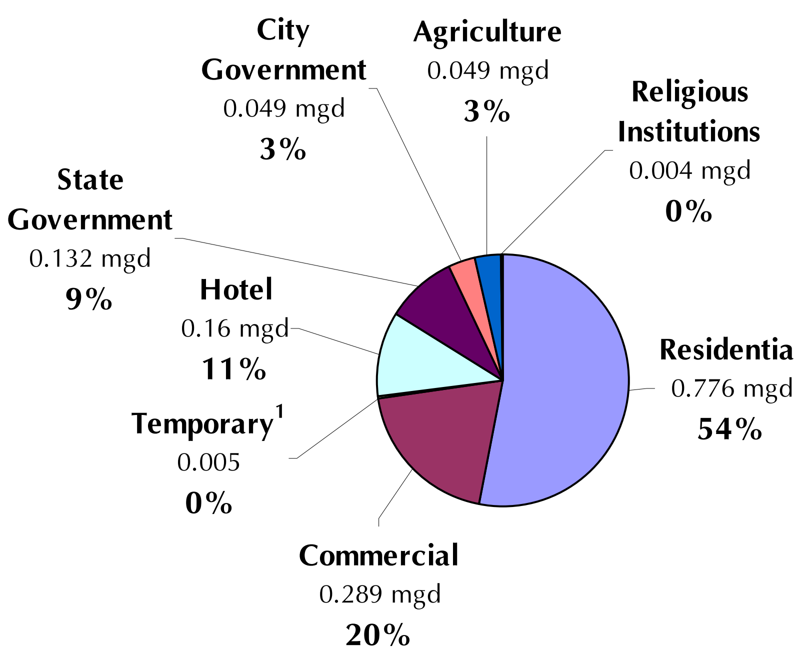


Figure 3.5 BWS 1994-2003 Average Water Use by Sector

The largest users of BWS-supplied water include: Turtle Bay Resort, Kahuku Schools (Department of Education), Kahuku Village Association, Kahuku District Park, and Kahuku Elderly Housing as shown in *Table 3.3*.

Table 3.3 Koʻolau Loa District BWS Largest Users (2004)

BWS Water User	Average Daily Consumption (mgd)
Turtle Bay / Kuilima	0.346
Kahuku Schools (DOE)	0.159
Kahuku Village Association *(includes Kahuku Golf Course)*	0.097
Kahuku District Park	0.051
Kahuku Elderly Housing	0.048

The Board of Water Supply system delivers a small amount of potable water for irrigation uses. These irrigation uses consist mainly of the State's school fields and the State and City and County's parks. There is also a small amount of water provided via the BWS for agriculture irrigation. Total estimated irrigation uses of BWS provided water is 0.2 mgd of the 1.5 total mgd.

The BWS consumption data for Windward Oʻahu shows a slight increase from 15 mgd in 1970 to 18 mgd in 2004, an increase of 3 mgd over 34 years (*Figure 3.6*). Multiple factors affect consumption as seen in the graph. Population growth had been increasing even before 1970. Once the DPP General Plan was developed in 1977, Windward population growth leveled considerably. Population growth has continued for Windward Oʻahu but generally within the General Plan guidelines. Climate now has the greatest effect on Windward water use. Several years of drought have also contributed to higher consumption such as the unprecedented 6 years of drought from 1998-2003. In the 1990's water conservation programs were implemented and may have mitigated even higher water consumption levels in Windward Oʻahu.

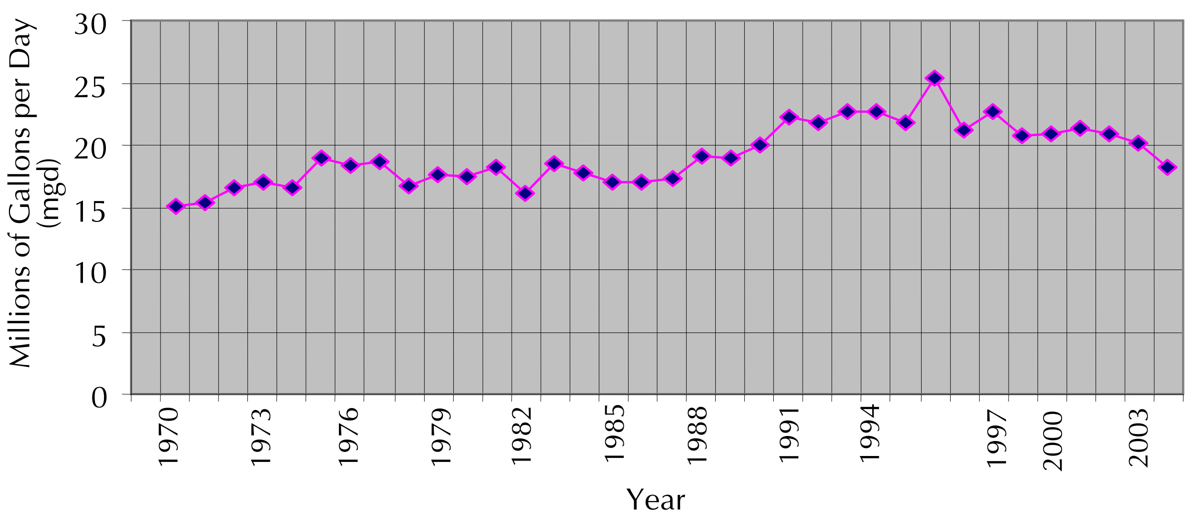


Figure 3.6 BWS Historical Windward Potable Groundwater Pumpage 1970-2004 (Kahuku to Waimānalo)

Board of Water Supply 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 3.4*. 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 from within the organization or agency. 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 also 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%, and the BWS goal for Oʻahu is to reduce losses to less than 10%. The BWS estimated these year 2000 losses to be at 20% for the entire Windward District, which includes all of Koʻolau Loa and Koʻolau Poko. Numerous leak detection, repairs and pipeline improvements to the Koʻolau Loa infrastructure since 2002 reduced the losses in the Windward District to 16%.

BWS programs for leak detection, repair and maintenance are ongoing. Approximately 20,000 linear feet of water main replacement at an estimated design and construction cost of approximately $8 million have been identified in the Koʻolau Loa area and will be scheduled beyond the 6-year planning horizon. The majority of the programmed waterline replacement projects are along Kamehameha Highway.

Table 3.4 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 –Hawaiʻi State Science Fair • **Tours** –Fred Ohrt Museum –Hālawa Xeriscape Garden –Nuʻuanu 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 Groundwater (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	• **Non-potable Water System Standards and Master Plans** • **Residential Toilet Rebate Program** • **Non-potable Source Development** –Caprock –Brackish –Surface Springs • **Wastewater Reuse** –Honouliuli Water Recycling Facility –Wahiawā/Central Oʻahu –Distributed Reuse using Membrane Bioreactors • **Desalination Plants** –Kalaeloa Seawater –Kapolei Brackish Water • **Seawater District Cooling** • **Future Studies** –Evapotranspiration Study –Evaluation of Water-Saving Fixtures –Rain Catchments for non-potable irrigation –Rebates for water efficient appliances

Under a BWS leak detection promotion program, Kahuku Villages repaired leaks to their water lines in 1997 reducing water losses by about 40%, or about 67,000 gallons per day thereby, saving $4,000/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 program 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% - 27%.

Lāʻie Water Company

The Lāʻie Water Company also has a private system that serves the residents of Lāʻie *(Figure 3.4)*. Several wells supply the water to the Lāʻie community through this independent system which used about 1.0 mgd in 2000. The largest Lāʻie Water Company water user is BYU-Hawaiʻi campus.

3.1.1.2 Private / Agricultural Wells

Groundwater is also utilized via private wells and water distribution systems by private landowners with water use permits. *Table 3.5* lists the largest users of water via these private wells. Turtle Bay Resort (Kuilima Resort) has a well used for golf course irrigation and the Polynesian Cultural Center has a well that feeds the attractions' lagoons. The Campbell Wildlife Refuge uses groundwater for wildlife habitat creation and maintenance. The only other federal-level water use in Koʻolau Loa is the Kahuku Training Area which brings their own water via trucks and bottles.

However, most of the private wells are used for agricultural purposes with nearly 8.9 mgd in permitted use in Koʻolau Loa GWMA and 0.5 mgd for Kahana GWMA. In Koʻolau Loa GWMA the largest agricultural users of groundwater are Hawaiʻi Reserves, Inc. and Campbell Estate. The State Department of Agriculture well supplies water to the Kahuku Agriculture Park. In Kahana GWMA, the largest agricultural user is Kualoa Ranch.

Table 3.5 Koʻolau Loa Private Agricultural Well – Largest Water Use Permits/Pumpage

Well Owner	Total Water Use Permit (mgd)	2000 Reported Pumpage
Campbell Estate / ʻĀina Nui Corporation	5.340	2.648
Hawaiʻi Reserves, Inc.[1]	2.281	2.290
James Campbell Wildlife Refuge	1.000	0.237
Polynesian Cultural Center	0.568	0.615
Kualoa Ranch	0.493	none reported
Hanohano Enterprises	0.432	none reported
State DOA (Kahuku Ag Park)	0.307	0.459
Kuilima Resort	0.302	0.187

[1] Does not include Lāʻie Water Company potable water

3.1.2 Surface Water Availability and Use

The streams providing surface water for non-instream uses are Punaluʻu, Kaʻaʻawa, Hauʻula and Kahana Streams. The streams are used for agricultural irrigation and provision of Native Hawaiian Rights. Surface water is not used in Koʻolau Loa as a potable water source.

The CWRM database, based on the 1992 Declarations of the Water Use, lists Punalu'u diversions at 14.0 mgd, and Ka'a'awa stream diversions at 0.05 mgd. The diversions in the database have not been comprehensively surveyed or verified. Since 1988, all new stream diversions have been tracked through a permit system and captured in a database.

Kahana State Park is a "living park" in which residents maintain traditional and customary Native Hawaiian practices, some of which, like lo'i kalo, depend upon stream diversions. These Kahana stream diversions are not quantified.

A recent USGS study in Punalu'u provides an estimate of the Kamehameha Schools stream diversions via the Punalu'u Ditch System at approximately 6.98 mgd. The Punalu'u Ditch System consists of a diversions dam, flue, 12 transmission tunnels and an open concrete ditch flowing water into an underground pipe distribution system. The ditch has several gates to release unused water back into the stream and prevent overflow of the ditch. The stream water is used to irrigate lo'i kalo, flowers, Vietnamese herbs, commercial grass, potted plants, and aquaculture over an area of approximately 400 acres.

3.1.3 Recycled Water Availability and Use

Recycled water from the Lā'ie and Turtle Bay Resort wastewater treatment facilities is used for some of Ko'olau Loa's non-potable irrigation needs. In Lā'ie, 0.3 mgd of recycled water is used at Brigham Young University - Hawai'i Campus and other nearby institutions for irrigation and the remainder is put into injection wells. At Turtle Bay Resort a wastewater treatment facility produces about 0.264 mgd of recycled water for golf course and other irrigation.

3.1.4 Waiāhole Ditch System

The Waiāhole Ditch begins in Ko'olau Loa in the back of Kahana Valley at an elevation of 790 feet and continues along the Ko'olau Mountains into Ko'olau Poko, where more water is added to the system before extending through the mountain range and into Central O'ahu. (See *Chapter 1, Overview of O'ahu Hydrogeology*, for a more detailed discussion on the Waiāhole Ditch System.)

Groundwater from Kahana Valley is sent out of Ko'olau Loa via the Waiāhole Ditch at the rate of about 1.1 mgd. Previously, 2.6 mgd flowed from Kahana to the Ditch until the installation of a bulkhead that provides a mechanism for recharge of the dike compartment.

For surface water from Kahana Stream, Findings of Fact Conclusions of Law and Decision and Order from the Waiāhole Ditch Contested Case Hearing, Second Remand includes the return of 2.1 mgd of diverted Kahana Stream water by formally cutting off the diversions.

The Waiāhole Ditch System will also be addressed in the Ko'olau Poko Watershed Management Plan in more detail.

3.2 PROJECTING FUTURE WATER DEMAND

To prepare for Koʻolau Loa's future water needs, water demand was projected through the year 2030. These projections provide an estimate of the amount of water needed over the next 25 years, and point to periods when increased demand may require infrastructure improvements.

Water demand is forecast for public and private systems. Per the Statewide Framework for Updating the Hawaiʻi Water Plan (Statewide Framework) in *Appendix A*, the County Water Use and Development Plans (WUDP) shall *"include forecasts of water requirements of federal and private sector purveyors."* Potable and non-potable water needs are also identified to match appropriate water sources with demand.

For all three scenarios, the amount of agriculture water use from the Punaluʻu and Kahana Streams remains unchanged through 2030. This includes approximately 400 acres of irrigated truck crops, orchards and loʻi kalo. Studies of Punaluʻu stream habitat and water use have been completed to facilitate the establishment of measurable instream flow standards.

All three scenarios the amount of water transferred from Koʻolau Loa to the adjoining districts is assumed constant at the 2000 amount of 8.6 mgd to produce conservative water demand projections. The amount of water exported from Koʻolau Loa will likely decrease by 2030, given the aging population in Koʻolau Poko. However, it is possible that, in the event of high population growth in Koʻolau Poko, water from Koʻolau Loa at the 2000 level or higher may be needed. Because Koʻolau Poko well development is in the dike aquifer and streams may be affected, in-district development opportunities are limited. Depending on the scenario outcomes in the Koʻolau Poko WMP, the amount of water from Koʻolau Loa planned for export may be adjusted.

3.2.1 Three Scenarios

The Statewide Framework recommends *"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."*

Three scenarios of future water demand estimates are calculated. The urban water usage is based upon the City and County of Honolulu Department of Planning and Permitting forecasts of population, jobs, and/or land use in five year increments from the year 2000 through 2030. These scenarios also fulfill the Statewide Framework's directive that, *"…demand forecasts shall be consistent with county land use plans, development plans and/or community plans"* as the policy or mid scenario is consistent with the Koʻolau Loa Sustainable Communities Plan. Three distinct scenarios were developed for Koʻolau Loa and are described below and summarized in *Table 3.6*.

All three scenarios assume that agriculture water demands from the Punaluʻu and Kahana Streams remain unchanged through 2030. This includes water to irrigate truck crops and loʻi kalo.

3.2.1.1 Low Demand Scenario

The first scenario is the Low Demand Scenario which assumes less population gain than the City and County of Honolulu Department of Planning and Permitting (DPP) policy projections. The Low Demand Scenario projects minor population growth and no growth in agriculture. The number of hotel rooms would double; however, the increase in units is only part of the landowners' plans for full-build-out.

3.2.1.2 Mid/Policy Demand Scenario

The Mid/Policy Demand Scenario uses the DPP policy data projections, which conform to the Sustainable Communities Plan and the General Plan directed growth policy. The General Plan distribution of residential population for Koʻolau Loa is 1.4% of the island-wide population by 2025. (This also follows a "trend" scenario produced by DPP; because the numbers for the Koʻolau Loa policy and trend are so similar, only the policy population projections are used.) Over 700 of the projected housing units are due to specific projects in Lāʻie (550 units) and Kahuku (177 units) described in the Sustainable Communities Plan, while the remainder of the units are the result of infill and increased lot density. A partial build out of Turtle Bay (1,652 units) and a full build out of Lāʻie Inn (220 units) by 2030 is assumed for the Mid Demand Scenario. This scenario assumes an approximately 60% increase in agricultural water use for irrigated truck crops and orchards.

3.2.1.3 High Demand Scenario

The High Demand Scenario assumes residential growth well beyond current plan, a doubling in agricultural production and a full build-out of both Turtle Bay with 4,000 units and Lāʻie Inn with 220 units.

Table 3.6 Water Projection Scenarios Summary

SECTOR	LOW	MID (DPP Policy)	HIGH
Municipal	+ 1,200 people + 625 housing units	+ 2,100 people + 1,100 housing units *Lāʻie + 550 units* *Kahuku & KL + 550 units*	+ 3,350 people + 1,850 housing units *Lāʻie + 1,040 units* *Kahuku & KL + 810 units*
Resort	Turtle Bay + 400 units Lāʻie Inn +170 units	Turtle Bay +1,100 units Lāʻie Inn +170 units	Turtle Bay +3,400 units Lāʻie Inn +170 units
Agriculture (Groundwater)	No change *(1, 700 acres)*	60% increase *(2,100 - 3,300 acres)*	Double 2000 water use *(2,800 – 4,300 acres)*
Agriculture (Surface Water)	No change*	No change*	No change*
Instream Uses (Surface Water)	No change*	No change*	No change*
Recycled Water	Lāʻie - no change Turtle Bay - no change	Lāʻie increases by 30% Turtle Bay increases	Lāʻie increases by 60% Turtle Bay increases

* Pending establishment of instream flow standards

3.2.2 Methodologies Used: Per Capita & 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 straightforward process of dividing Koʻolau Loa pumpage by population served and using DPP population projections. The BWS uses this method for their future demand forecasting.

A second approach, end use inventory, breaks down the various uses – residential, resort, commercial, government and agricultural – to assess demands. For agriculture, future acreage is projected based on local land use plans.

More detailed description of the methodologies is found in *Appendix E.*

3.2.3 Water Demand Projections

The projected demands for the next 25 years are presented in *Figures 3.7* and *3.8* and *Table 3.7*. The estimates for future Koʻolau Loa water demand by the year 2030 range from 28.4 mgd to 37.0 mgd with the *end use inventory* method, and from 28.1 to 36.6 mgd with the p*er capita* method.

Figure 3.7 compares the three scenarios and the methodologies used to calculate each projection. The results are that the two methodologies produce similar results for each of the three scenarios.

The *Table 3.7* and *Figure 3.8* highlight the elements of the end use inventory demand projections that contribute to the increases in demand. Agriculture is the biggest unknown and accounts for much of the differences between the three scenarios. Other lesser contributing factors are the number of residential units throughout the district and the number of resort units at Turtle Bay.

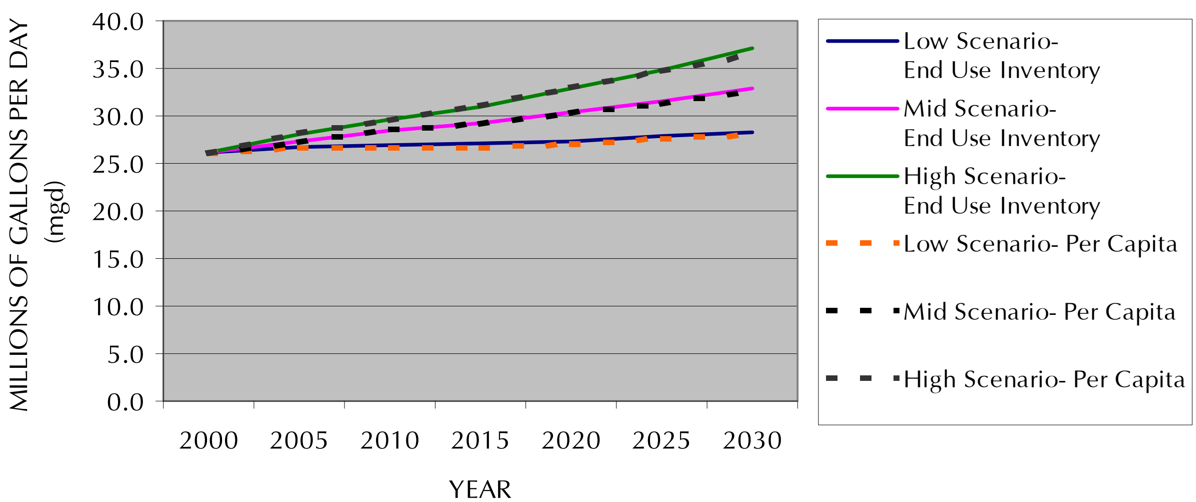


Figure 3.7 Projected Demands

Table 3.7 Projected Demands

USE/SCENARIO	2000	2005	2010	2015	2020	2025	2030
Non-Potable Ag – Low Scenario	13.4	13.4	13.4	13.4	13.4	13.4	13.4
Non-Potable Ag – Mid Scenario	13.4	13.9	14.5	15.2	15.8	16.6	17.4
Non-Potable Ag – High Scenario	13.4	14.2	15.1	16.1	17.2	18.4	19.8
Non-Potable Other – Low Scenario	1.7	2.1	2.1	2.1	2.4	2.8	3.1
Non-Potable Other – Mid Scenario	1.7	2.1	2.2	2.2	2.5	2.8	3.2
Non-Potable Other – High Scenario	1.7	2.3	2.4	2.5	2.9	3.3	3.7
Lāʻie Water – Low Scenario	1.0	1.1	1.2	1.2	1.3	1.3	1.4
Lāʻie Water – Mid Scenario	1.0	1.2	1.3	1.4	1.5	1.5	1.6
Lāʻie Water – High Scenario	1.0	1.2	1.4	1.5	1.6	1.7	1.8
Non-BWS Subtotal – Low Scenario	**16.1**	**16.6**	**16.7**	**16.7**	**17.1**	**17.5**	**17.9**
Non-BWS Subtotal – Mid Scenario	**16.1**	**17.2**	**18**	**18.8**	**19.8**	**20.9**	**22.2**
Non-BWS Subtotal – High Scenario	**16.1**	**17.7**	**18.9**	**20.1**	**21.7**	**23.4**	**25.3**
BWS Koʻolau Loa – Low Scenario	1.5	1.6	1.7	1.7	1.7	1.8	1.8
BWS Koʻolau Loa – Mid Scenario	1.5	1.6	1.9	1.9	1.9	2.0	2.1
BWS Koʻolau Loa – High Scenario	1.5	1.8	2.0	2.3	2.6	2.9	3.1
BWS export to Koʻolau Poko and North Shore – Low Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS export to Koʻolau Poko and North Shore – Mid Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS export to Koʻolau Poko and North Shore – High Scenario	8.6	8.6	8.6	8.6	8.6	8.6	8.6
BWS Subtotal – Low Scenario	**10.1**	**10.2**	**10.3**	**10.3**	**10.3**	**10.4**	**10.4**
BWS Subtotal – Mid Scenario	**10.1**	**10.2**	**10.5**	**10.5**	**10.5**	**10.6**	**10.7**
BWS Subtotal – High Scenario	**10.1**	**10.4**	**10.6**	**10.9**	**11.2**	**11.5**	**11.7**
TOTAL – LOW SCENARIO	**26.1**	**26.8**	**27.0**	**27.1**	**27.4**	**27.9**	**28.4**
TOTAL – MID SCENARIO	**26.1**	**27.4**	**28.5**	**29.3**	**30.3**	**31.5**	**32.9**
TOTAL – HIGH SCENARIO	**26.1**	**28.1**	**29.5**	**31.0**	**32.9**	**34.9**	**37.0**

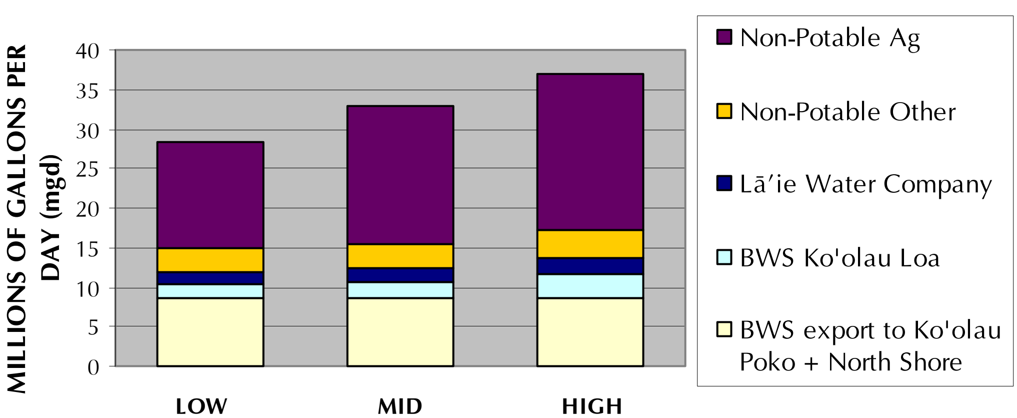


Figure 3.8 2030 Water Demand Projections: Low-Mid-High Scenarios

The 2000 water use was 26.2 mgd of which about 11 mgd is potable water demand (including export of water from Ko'olau Loa to Ko'olau Poko and North Shore) and about 15 mgd is non-potable water. Ko'olau Loa will therefore need perhaps as little as 2.3 mgd (9% increase) to as much as 10.9 mgd (42% increase) additional water in the future.

3.3 MOST PROBABLE WATER DEMAND SCENARIO

The most probable scenario is the Mid/Policy Demand Scenario which is based on the land uses described in the City and County of Honolulu Department of Planning and Permitting Sustainable Communities Plan. This scenario also includes a possible 60% increase in irrigated agriculture which would bring water use to the current total water permit amount.

The other two scenarios, Low and High, bracket the Mid/Policy Demand scenario and provide a range of possible outcomes. The full proposed build out of Turtle Bay occurs only in the high scenario. While the number of units at the resort is a factor in the water demand projections, the biggest unknown is agricultural water needs. While appropriate land for irrigated agriculture is available, much is not currently used as intensively as it could be. If agriculture use increased in the Ko'olau Loa, the amount of water for this non-potable demand would greatly increase as indicated in *Figure 3.8*.

The end use inventory methodology is used to calculate the most likely scenario. The end use inventory allows for more detailed tailoring by water use for this district level analysis. The per capita lumps together various uses assuming the relative proportions of uses remains constant over time; this is seen most clearly in the agriculture sector where increases in agriculture in Ko'olau Loa are not necessarily directly related to increases in population.

3.3.1 Water Conservation

Water conservation measures may reduce future demands. A BWS Water Conservation Effectiveness Study is being conducted in an effort to increase future conservation levels. Possible Ko'olau Loa water conservation savings are discussed in *Chapters 5* and *6*.

3.4 IMPLICATIONS FOR WATER SUPPLY PLANNING

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

Water Conservation

Water conservation is especially important in Ko'olau Poko. Because of the greater population compared to Ko'olau Loa and the relatively larger amount of water use, the opportunities for water conservation are great.

Increased Population in Ko'olau Loa

Increased population in Ko'olau Loa would require additional potable water. The groundwater supply would be used to meet this demand.

Agricultural Water Demand as the "Wildcard"

The amount of future irrigated agriculture in Ko'olau Loa is the largest unknown in the water demand projections. If more water were needed to meet increased agricultural water demands, groundwater would likely be the largest likely readily available source.

Diversification of Water Supply Sources

There is a need for more diversification of water supply sources. Non-potable water demands largely use potable water. By meeting non-potable demands with non-potable water, more potable water will be reserved for future potable water demands. Diversification of supply sources can also lower risks during periods of drought, particularly if recycled water is utilized.

Instream Flow Standards

Surface water uses cannot practically be planned for until measurable instream flow standards are set. Once the measurable instream flow standards are set it might be possible to expand the amount of stream irrigated agriculture in Punalu'u and Kahana Valleys.

While it can be difficult to estimate flows, the data on amount of water being diverted for non-instream uses and the amount of water for instream uses is important information for setting measurable instream flow standards. The lack of reporting and/or requirements for stream diversion has several negative aspects. Without knowledge about the amount of water being used, it is difficult to plan for future needs, know the amount of water being wasted, or identify reasonable and beneficial uses. Without reporting, it is difficult to know if diversion amounts are within the measurable instream flow standards. Surface Water Management Area designation is an option to require measuring and reporting.

4

OBJECTIVES, SUB-OBJECTIVES & STRATEGIES

4 OBJECTIVES, SUB-OBJECTIVES AND STRATEGIES

4.1 OBJECTIVE #1: PROMOTE SUSTAINABLE WATERSHEDS
4.2 OBJECTIVE #2: PROTECT AND ENHANCE WATER QUALITY AND QUANTITY
4.3 OBJECTIVE #3: PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES
4.4 OBJECTIVE #4: FACILITATE PUBLIC PARTICIPATION, EDUCATION AND PROJECT IMPLEMENTATION
4.5 OBJECTIVE #5: MEET WATER DEMANDS AT REASONABLE COSTS

Each district's Watershed Management Plan for Oʻahu will have the same overall goal (see box below) and same major objectives for consistency. More detailed sub-objectives capturing regional issues and district-specific concerns result from the stakeholder consultation process.

The goal, objectives and sub-objectives guide the development of the Koʻolau Loa Watershed Management Plan. The objectives and sub-objectives reflect the desired outcomes; the strategies and projects are the ways to implement them. The strategies and projects are directly linked to and listed after each sub-objective. These strategies and projects form the Koʻolau Loa Watershed Management Plan.

The projects are detailed in *Chapter 5: Watershed Management and Water Supply Projects* and proposed phasing of the projects is presented in *Chapter 6: Implementation / 5-Year Action Plan.*

Note: The proposed strategies and projects within this plan are the result of a comprehensive watershed analysis and stakeholder consultation process. The strategies and projects may involve various governmental agencies and non-governmental organizations, and 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 Hawaiʻi. This plan is intended to guide agencies and organizations in implementing the most important initiatives for Koʻolau Loa watersheds and water resources; however, implementation will likely depend on budgetary priorities, grant availability and partnering efforts over the long term.

OVERALL GOAL OF THE WATERSHED MANAGEMENT PLANS

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 Oʻahu's watersheds, and

(2) sustainable groundwater and surface water use and development to serve present users and future generations.

4.1 OBJECTIVE #1: PROMOTE SUSTAINABLE WATERSHEDS

Sustainable watersheds are the 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 inter-relationship among watershed resources including geologic structures, soil characteristics, forest communities, endemic and indigenous animals, introduced species, streams and wetlands, reefs and nearshore 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.

Sub-objective 1.1: Strive to enhance and protect natural resources including land, streams and nearshore waters ecosystems through land use measures.

One concern from the community input process was the relationship between the Watershed Management Plan and the Koʻolau Loa Sustainable Communities Plan. Land use plans relate directly to maintaining healthy watersheds. The following strategies concern land uses in the conservation, agriculture and urban areas of Koʻolau and their relationship to watershed health.

Strategy 1.1.1: Ensure mountain watersheds and other conservation zoned lands are actively protected and healthy.

Conservation zoned lands in Koʻolau Loa, which total about 22,000 acres or almost 60% of the land area, are owned by a variety of landowners with varying interests. To manage these lands and make the most of available resources, Koʻolau conservation district landowners are participating in watershed partnerships. These partnerships provide an opportunity to combine resources and knowledge to implement land management projects that would be much more difficult for individual landowners. Some lands not currently included in the conservation district might be appropriate for inclusion and could be assessed for incorporation. Wildfire prevention is also needed to protect the mauka conservation lands.

The following projects address this strategy:

- Watershed Partnerships (including Koʻolau Mountains Watershed Partnership)
- Conservation District Boundary Review
- Wildfire Management Plan

Strategy 1.1.2: Manage agricultural lands for watershed health in addition to income generation.

In Koʻolau Loa district nearly 14,000 acres of land are designated for agriculture by the Koʻolau Loa Sustainable Communities Plan, current city and county zoning and state land use. This equates to almost 40% of the district. Agricultural practices can be compatible with healthy watersheds when appropriate practices are used to reduce possible erosion, prevent pollution of the surface and ground waters, and slow the flow of storm waters. In addition, more accurate and regionally specific crop demand numbers are needed to assist in agriculture water planning.

The following projects address this strategy:

- Pollution Prevention / Low Impact Development
- Crop Water Demand

Strategy 1.1.3: Ensure that the additional urban growth is clustered within the Sustainable Communities Plan Rural Community Boundary and is designed for minimal impact on the environment.

The City and County growth projections for Koʻolau Loa are for an additional 2,200 people to the district by 2030. While some of this additional housing will be in-fill housing in already developed areas, other growth will be new developments. Techniques that can be employed to reduce the impact include the consolidation / clustering of housing, multi-use retention basins, grass swales, pervious paving, stream conservation buffers, and where there is not a wastewater treatment plant, greywater reuse systems (where washing machine and shower water are reused in the yard).

The following projects address this strategy:

- Pollution Prevention / Low Impact Development
- Stream Conservation Buffers
- Cesspool Inventory / Greywater Reuse

Sub-objective 1.2: Strive to set measurable in-stream flow standards.

Strategy 1.2.1: Develop measurable instream flow standards for priority streams in Koʻolau Loa.

Currently interim instream flow standards (IIFS) are based on the "amount of water flowing in each stream on the effective date of the standard (1992 for Windward Oʻahu) without further amounts of water being diverted off-stream through new or expanded diversions" (Chapter 13-169, Hawaiʻi Administrative Rules). Instream flow standards (IFS) protect the public interest in the waters of the State. In formulating proposed standards, the Commission shall weigh the importance of present or potential instream values with the importance of present or potential uses of water from the stream for non-instream purposes, including the economic impact of restriction of such uses. Additional studies are needed to update the "status quo" interim IFS to advance resources planning and decision-making. The precautionary first step is understanding and protecting the public trust uses of stream waters. If water is determined available for other non-instream uses, these quantities can be used for planning purposes and may be available for allocation.

The following project addresses this strategy:

- Measurable Instream Flow Standards

Sub-objective 1.3: Collaborate with responsible agencies to identify and implement measures to alleviate flooding issues and reduce polluted runoff.

There is a need for local drainage and flood mitigation plans for flood-prone areas in Koʻolau Loa. Local flooding problems are a threat to public health and safety in many areas. Drainage systems, both constructed and natural require continual maintenance to ensure proper function. Blocked and broken drainage systems have reduced capacity during heavy storms. In many sections of Koʻolau Loa the elevation of Kamehameha Highway relative to the surrounding lands impedes drainage flow, causing the impoundment of surface runoff and floodwaters.

Strategy 1.3.1: Plan and implement flood control measures.

Flood control studies that assess the local flooding issues and construction of mitigation measures are needed for various areas of Koʻolau Loa. Construction may include a redesign of the flood control channels to increase effectiveness of flood control while maintaining habitat in perennial and intermittent streams.

The following projects address this strategy:

- Flood Control / Stormwater Management
- Flood Channel Redesign

Strategy 1.3.2: Improve management of streams and stream banks.

The ability of stream water to flow to the ocean in Koʻolau Loa is partially dependent on human management of natural systems to prevent flooding. When stream areas become clogged with vegetation, water will find other ways to flow to the ocean including through urban areas.

The following project addresses this strategy:

- Stream Clearing and Management

Strategy 1.3.3: Restore muliwai and wetlands for flood protection.

Flood waters could be managed in part by restoring and managing the muliwai and wetlands along Koʻolau Loa streams. Muliwai and freshwater wetlands help to reduce flood damage by storing flood waters during heavy rains and thereby reducing flood damage to surrounding lands.

The following project addresses this strategy:

- Muliwai / Wetland Restoration

Sub-objective 1.4: Promote initiatives that preserve species and habitat biodiversity, particularly native species, where practical.

Hawaiʻi is home to more threatened and endangered species than anywhere in the United States. Koʻolau Loa is critical habitat for 30 threatened and endangered species, mostly plants and one bird species. In addition to ensuring that land use practices do not affect habitat of these species, measures to protect native species from invasive species must be established.

Strategy 1.4.1: Protect native species by reducing the threats of invasive plant species.

Invasive plant species can create a hostile environment by crowding out native plant species (competing with them for sun, water nutrients or space), by increasing soil erosion (the shallow roots of invasive species do not hold the soil) or by increasing the threat of fire (increased combustible material). Entire ecosystems can quickly change from native to non-native. Early detection of invasive species is the best prevention. Most of the Koʻolau Loa's native species are in the mountainous conservation district of the Koʻolau Mountains. The Koʻolau Mountains Watershed Partnership and the US Army's Kahuku Training Area have programs that monitor invasive species.

The following project addresses this strategy:

- Invasive Species Assessment / Control

Strategy 1.4.2: Protect native species by reducing the effects of feral pigs.

Feral pigs can spread weeds, inhibit the re-establishment of native plants, destroy existing native plants, cause shifts in ecosystem composition and destroy native bird habitat. Feral pigs are well established in the conservation lands of Koʻolau Loa. Eliminating pigs from areas where there are native plants and birds has been shown to facilitate their recovery and re-establishment and decrease soil erosion in the watershed.

The following project addresses this strategy:

- Feral Pig Management Plan

Sub-objective 1.5: Ensure that the export of water from Koʻolau Loa will not be detrimental to Koʻolau Loa.

The rate and quantity of withdrawals from the Koʻolau Loa GWMA sector area are within CWRM established permitted uses and sustainable yields and the State Water Code allows inter-basin transfers. However, it is the expressed intent of the Koʻolau Loa community to ensure that water exported from Koʻolau Loa to Koʻolau Poko is used wisely and not wasted. If Koʻolau Poko can conserve water use, reduce water loss and find alternative water supplies, Koʻolau Loa water export could be reduced. Population projections for Koʻolau Poko forecast a decrease as households become smaller.

Strategy 1.5.1: Increase water conservation measures in Koʻolau Poko.

Increasing the Koʻolau Poko residents and businesses levels of conservation can directly reduce the need for water currently supplied from wells in Koʻolau Loa.

The following projects address this strategy:

- Conservation Measures (including infrastructure replacement)
- Agricultural Water Loss Minimization
- Increased Recycled Water (Waimānalo)

A summary table of Objective #1 sub-objectives and associated strategies and projects follows below *(Table 4.1)*.

Table 4.1 Summary Table for Objective #1: Promote Sustainable Watersheds

Sub-Objectives / Strategies	Projects
1.1 Strive to enhance and protect natural resources including land, streams and nearshore waters ecosystems	
1.1.1 Ensure that mountain watersheds and other conservation zoned lands are actively protected and healthy	• Watershed Partnerships • Conservation District Boundary Review • Wildfire Management Plan
1.1.2 Manage agricultural lands for watershed health in addition to income generation	• Pollution Prevention / Low Impact Development • Crop Water Demand
1.1.3 Ensure that the additional urban growth is clustered within the Sustainable Communities Plan Rural Community Boundary and is designed for minimal impact on the environment	• Pollution Prevention / Low Impact Development • Stream Conservation Buffers • Cesspool Inventory / Greywater Reuse
1.2 Strive to set measurable instream flow standards	
1.2.1 Develop measurable instream flow standards for priority streams in Ko'olau Loa	• Measurable Instream Flow Standards
1.3 Collaborate with responsible agencies to identify and implement environmentally-friendly measures to alleviate flooding issues and reduce pollution caused by runoff	
1.3.1 Plan and implement flood control measures	• Flood Control / Stormwater Management • Flood Channel Redesign
1.3.2 Improve management of streams and stream banks	• Stream Clearing and Management
1.3.3 Restore muliwai and wetlands for flood protection	• Muliwai / Wetland Restoration
1.4 Promote initiatives that preserve species and habitat biodiversity, particularly native species	
1.4.1 Protect native species by reducing the threats of invasive plant species	• Invasive Species Assessment / Control
1.4.2 Protect native species by reducing the effects of feral pigs	• Feral Pig Management Plan
1.5 Ensure the export of water from Ko'olau Loa will not be detrimental to Ko'olau Loa	
1.5.1 Increase water conservation in Ko'olau Poko	• Conservation Measures • Ag Water Loss Minimization • Increased Recycled Water

4.2 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, and freshwater streams and groundwater environments across coastal and inland areas. Water has two dimensions that are closely linked - quality and quantity. 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. In a healthy environment water quality and quantity supports a rich and varied community of organisms and protects public health.

Sub-objective 2.1: Maintain and improve the water quality and quantity of groundwater.

The drinking water for Koʻolau Loa and the rest of the island comes from the groundwater within the aquifer. The watersheds filter the water into the ground and over time the water is stored in the aquifer away from many possible contaminates. The water is then pumped to the surface and used for drinking water and agriculture. The sustainable yield identifies the amount of water than can be pumped for use while not affecting a base level of water in the aquifer. Withdrawal rates should be within established sustainable yields, which protect the long-term viability of the water resource. A number of measures pertain to the maintenance of groundwater quality, including prevention of water contamination.

Strategy 2.1.1: Implement source water protection measures.

Source water protection measures are critical to preventing contamination and ensuring public health, safety and confidence in Oʻahu's drinking water supplies. Land use decisions may be affected by certain uses in well areas.

The following project addresses this strategy:

- Groundwater Source Protection

Strategy 2.1.2: Maintain aquifer quality and integrity.

Monitoring is the best way to assess the status of the aquifer. Monitoring includes tracking hydrologic indicators of rainfall, stream and spring flows, aquifer water levels and chloride levels of BWS index wells, and the top and mid-point of the freshwater-seawater transition zone of new deep monitor wells in Punaluʻu, Lāʻie and Kahuku. This ensures that sources are sustainable, especially during drought and post-drought periods. There are already indications that the Punaluʻu wells periodically stress the aquifer during drought periods. To remedy this situation and to be able to meet water needs, the pumpage may be spread out over a larger area of the aquifer. Optimizing the Punaluʻu well pumpage can help to maintain aquifer integrity.

The following projects address this strategy:

- Drought Mitigation Strategies
- Punaluʻu Pumpage Optimization

Strategy 2.1.3: Continue to provide high quality drinking water supply that meets or exceeds Safe Drinking Water Standards.

Water purveyors are responsible for ensuring that high quality drinking water is supplied to their customers. Through various means, such as testing and system maintenance, this can be achieved.

The following project addresses this strategy:

- Various ongoing BWS initiatives, including regular monitoring and reporting

Strategy 2.1.4: Periodically review the sustainable yield estimate.

The sustainable yield varies over time with the changing climatic conditions, and new methods of measuring the various elements that affect the sustainable yield calculation will become available over time. Periodic updates are important to make sure that planning processes have the current information.

The following project addresses this strategy:

- Sustainable Yield Estimates

Sub-objective 2.2: Maintain and improve the water quality and quantity of surface waters.

Healthy and vibrant stream habitat depends upon quality surface waters. Degraded water quality can mostly be attributed to non-point source pollution, which occurs when rainfall moves mauka to makai along the ground and picks up pollutants (sediments, nutrients, toxins, pathogens, etc.) along its path. Because different pollutants can enter the water at different points, there are multiple methods needed to improve the water quality. Monitoring will determine whether the projects being implemented are having the desired effect and if other efforts are needed.

Strategy 2.2.1: Implement measures that improve the quality of surface waters that come from urban and agricultural land uses.

Various land uses can create non-point source pollution that contributes to degraded water quality in Ko'olau Loa surface waters. In the urban and agricultural areas, certain practices can mitigate or eliminate adverse effects on surface and stream waters that flow ultimately to the ocean, and in doing so will create better habitat for local species.

The following projects address this strategy:

- Pollution Prevention / Low Impact Development
- Stream Conservation Buffers
- Cesspool Inventory / Greywater Reuse

Strategy 2.2.2: Monitor water quality of surface waters.

Water quality testing is important to chart the progress of projects designed to improve surface water quality. Test results of type and source of pollutants can guide future initiatives.

The following project addresses this strategy:

- Stream Water Quality Testing

Sub-objective 2.3: Maintain and improve the water quality of nearshore waters.

The nearshore water quality is related the quality of the surface waters that flow into the ocean. Surface water quantity can be increased by retaining water and preventing it from directly flowing into the nearshore waters. Also, nearshore water quality can be improved reducing groundwater contamination because some groundwater ultimately flows into the nearshore waters.

Strategy 2.3.1: Improve the ability of natural systems to capture and retain surface water.

By identifying, collaborating on and conducting watershed protection projects and programs, forest and watershed health can be improved to ensure that aquifers and streams are adequately recharged with surface waters.

The following projects address this strategy:

- Watershed Partnerships
- Invasive Species Assessments/Control
- Feral Pig Management Plan
- Muliwai / Wetland Restoration

Strategy 2.3.2: Monitor nearshore waters water quality.

The monitoring of nearshore waters provides a feedback mechanism for identifying groundwater contaminants and then target possible land uses for improvement. Baseline studies have been conducted and further research can track changes over time.

The following projects address this strategy:

- Nearshore Water Monitoring

A summary table of Objective #2 sub-objectives and associated strategies and projects follows below *(Table 4.2)*.

Table 4.2 Summary Table for Objective #2: Protect and Enhance Water Quality and Quantity

OBJECTIVE #2 – PROTECT AND ENHANCE WATER QUALITY AND QUANTITY	
Sub-Objectives / Strategies	**Projects**
2.1 Maintain and improve the water quality and quantity of groundwater	
*2.1.1 Implement **source water protection and security** measures*	• Groundwater Source Protection
2.1.2 Maintain aquifer integrity	• Drought Mitigation Strategies • Punaluʻu Pumpage Optimization
*2.1.3 Continue to provide **high quality drinking water supply** that meets or exceeds Safe Drinking Water Standards*	• *Various ongoing BWS initiatives, including regular monitoring and reporting*
2.1.4 Periodically review the sustainable yield estimate	• Sustainable Yield Estimate
2.2 Maintain and improve the water quality and quantity of surface waters	
2.2.1 Implement measures that improve the quality of surface waters that come from urban and agricultural land uses	• Pollution Prevention / Low Impact Development • Stream Conservation Buffers • Cesspool Inventory/Greywater Reuse
2.2.2 Monitor surface water quality	• Stream Water Quality Testing
2.3 Maintain and improve the water quality of nearshore waters	
2.3.1 Improve the ability of natural systems to capture and retain surface water	• Watershed Partnerships • Invasive Species Assessments / Control • Feral Pig Management • Muliwai / Wetland Restoration
2.3.2 Monitor nearshore water quality	• Nearshore Water Monitoring

4.3 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. 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 they are in an abundance that allows 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 freshwater into the nearshore 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 and plentiful water resources available for exercising these rights.

Sub-objective 3.1: Plan for the enhancement of Native Hawaiian water rights and cultural and traditional uses.

The amount of water available for Native Hawaiian rights depends in part on how well the water resource in general is managed. The strategies under this sub-objective can have a direct effect on water availability. In addition, the strategies and projects in *Objective #1, Promote Sustainable Watersheds,* and *Objective #2, Protect and Enhance Water Quality and Quantity*, also support a healthy watershed and efficient water use.

<u>Strategy 3.1.1</u>: Use surface water more effectively and efficiently so as to minimize leakage, evaporation and waste.

Because Koʻolau Loa surface water diversions are exposed to the elements and are frequently older systems, they can be opportunities for reducing water loss through system improvements. With more efficient water delivery systems, less diverted surface water will be needed. Improvements can be made to the systems that divert and transport water out of the stream and to the agricultural irrigation systems that deliver the water to the plants. For example, drip irrigation is more efficient at water delivery than sprinkler systems.

The following project addresses this strategy:

- Agricultural Water Loss Minimization

<u>Strategy 3.1.2</u>: Develop new groundwater sources that do not impact surface waters.

The only wells considered for new development in Koʻolau Loa are those that do not impact surface waters. Test pumping and stream monitoring should occur to ensure no impacts. Instream flow standards should be set first to ensure that stream uses and rights are addressed before new well development.

The following project addresses this strategy:

- Measurable Instream Flow Standards

Strategy 3.1.3: Promote and preserve Native Hawaiian practices in the watershed.

While Native Hawaiians once utilized the local land and water resources for subsistence and cultural and spiritual practices, today this knowledge and practice is not widespread in the Hawaiian community. Education can perpetuate these ways of using natural resources.

The following projects address this strategy:

- Lo'i Kalo Expansion
- Watershed Oral History Studies
- Cultural Educational Programs
- Fishpond (Loko I'a) Restoration

Sub-objective 3.2: Consult with Native Hawaiian agencies/community on water-related issues.

Respecting Native Hawaiian water-related rights requires an awareness of those rights and a mechanism for exercising them. Consultation with Native Hawaiian agencies and communities provides an opportunity.

Strategy 3.2.1: Prior to constructing projects in culturally sensitive areas, consult with the Native Hawaiian community.

In development areas that are likely to impact Native Hawaiian cultural sites, a cultural monitor can provide additional assurances to the Native Hawaiian community that cultural resources are being properly treated. A cultural monitor acts as an independent observer with knowledgeable of Hawaiian site management who has the trust of members of his or her community.

The following project addresses this strategy:

- Cultural Monitoring Program

Strategy 3.2.2: Use the guidance from the Kapa'akai (2000) court decision on Native Hawaiian consultation on providing for the ability to exercise Native Hawaiian traditional and customary rights.

Land decisions can also affect water rights in terms of access, quality and quantity. The Kapa'akai court decision stated that development projects should review and analyze the extent of cultural resources and how the ability to exercise Native Hawaiian traditional and customary rights will be protected. The guidance provided in this court case can provide a means for Native Hawaiian consultation on water rights issues in land use decision-making.

- Various agencies with land use decision-making authority to review projects for Native Hawaiian issues.

A summary table of Objective #3 sub-objectives and associated strategies and projects follows below *(Table 4.3)*.

Table 4.3 Summary Table for Objective #3: Protect Native Hawaiian Rights and Traditional and Customary Practices

Sub-Objectives / Strategies	Projects
3.1 Plan for the enhancement of Native Hawaiian water rights and cultural and traditional uses	
3.1.1 Use surface water more effectively and efficiently so as to minimize leakage, evaporation and waste	• Agricultural Water Loss Minimization
3.1.2 Develop new groundwater sources that do not impact surface waters	• Measurable Instream Flow Standards
3.1.3 Promote and preserve Native Hawaiian practices in the watershed	• Loʻi Kalo Expansion • Watershed Oral History Studies • Cultural Educational Programs • Fishpond (Loko Iʻa) Restoration
3.2 Consult with Native Hawaiian agencies/community on water-related issues	
3.2.1 Prior to constructing projects in culturally sensitive areas, consult with the Native Hawaiian community	• Cultural Monitoring Program
3.2.2 Use the guidance from the Kapaʻakai (2000) court decision on Native Hawaiian consultation on providing for the ability to exercise Native Hawaiian traditional and customary rights	• *Various agencies with land use decision-making authority to review projects for Native Hawaiian issues*

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 from 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 for the public on water resource issues can support collaboration through informed stakeholders. Directed water resource curricula for schools will encourage knowledge of and respect for water resources in future generations. Ultimately public participation will benefit water users, water resources and the related ecosystems.

Sub-objective 4.1: Implement watershed management projects and programs including partnerships with public agencies and the community.

Community groups, agencies and organizations often have overlapping watershed objectives. By forming partnerships, funding and resources and be combined to create initiatives toward common objectives. Where the groups differ on objectives, the partnership can provide a forum for discussing diverse interests and problem solving.

Strategy 4.1.1: Support the existing and future watershed partnerships in Ko'olau Loa.

Partnerships use resources to collectively preserve, protect, enhance, and restore watersheds. Citizen participation and independent scientific inquiry can be part of the process and would develop archives of traditional knowledge. Board of Water Supply participates with partnerships involving areas that benefit major BWS watershed recharge areas.

The following project addresses this strategy:

- Watershed Partnerships

Note: These include the Punalu'u Watershed Alliance (consisting of the Punalu`u Community Association, Kamehameha Schools, CWRM, USGS and BWS) and the Ko'olau Mountains Watershed Partnership (includes major landowners in the Ko'olau Moutains).

Sub-objective 4.2: Establish watershed protection educational curriculum and programs on sustainability in area schools and organizations to educate future generations.

Participation by residents and stakeholders is most effective when there is a good baseline of knowledge about where water comes from and the importance of ecosystem health to our water supply and the related ecosytems.

Strategy 4.2.1: Continue BWS educational programs in schools and develop a curriculum that promotes the health of our watersheds.

Programs with children create generational change. As children learn about sustaining the health of the watersheds and how to use water wisely, they carry that lesson through their lives and often teach their parents and family as they live out the lessons learned.

The following project addresses this strategy:

- Water and Watershed Education

Sub-objective 4.3: Empower residents to be part of resource planning processes and provide education on watershed issues and protection and water conservation measures.

Strategy 4.3.1: Provide opportunities for residents to participate in resource planning through existing or new organizations.

Participation will need to include education on the water and watershed related issues. The more people know and participate, the more they become invested in the outcomes of planning effort. At this time opportunities are through existing groups such as Mālama 'Ohana, Neighborhood Board No. 28, Punalu'u Watershed Alliance, and Ko'olau Mountians Watershed Partnership.

The following project addresses this strategy:

- Watershed Partnerships

Sub-objective 4.4: Establish an implementation entity to facilitate public participation in water resources planning and management.

While the Ko'olau Loa Watershed Management Plan provides recommended projects for the district, the scope of the plan does not include a mechanism for continued local involvement in the projects. During the community consultation process, the community expressed a strong desire to ensure projects are implemented and desired the creation of a community-based implementation entity.

Strategy 4.4.1: Support creation of an implementation entity through an existing or new organization in Ko'olau Loa.

The following project addresses this strategy:

- Ko'olau Loa Implementation Entity

Sub-objective 4.5: Obtain funding to implement the plan's projects and programs.

Implementing projects requires allocating resources on the behalf of agencies and other funding sources. The available funding is a limiting factor in implementing projects.

Strategy 4.5.1: Identify sources of governmental funding and non-profit funding sources available for project implementation.

The following project addresses this strategy:

- Grant Funding

A summary table of Objective #4 sub-objectives and associated strategies and projects follows below *(Table 4.4)*.

Table 4.4 Summary Table for Objective #4: Facilitate Public Participation, Education, and Project Implementation

OBJECTIVE #4 – FACILITATE PUBLIC PARTICIPATION, EDUCATION AND PROJECT IMPLEMENTATION	
Sub-Objectives / Strategies	**Projects**
4.1 Implement watershed management projects and programs, through a combination of agency initiatives, watershed partnerships and community-based implementation entities	
4.1.1 Support the existing and future watershed partnerships in Koʻolau Loa	• Watershed Partnerships
4.2 Develop watershed protection curriculum and programs to educate future generations and make curriculum available to area schools and organizations	
4.2.1 Continue BWS educational programs in schools and develop a curriculum that promotes the health of our watersheds	• Water and Watershed Education
4.3 Empower residents to facilitate public participation in water resources planning and management	
4.3.1 Provide opportunities for residents to participate in resource planning through new or existing organizations	• Watershed Partnerships
4.4 Provide education on watershed issues and protection and water conservation measures to the general public	
4.4.1 Support creation of an implementation entity through an existing or new organization for Koʻolau Loa	• Koʻolau Loa Implementation Entity
4.5 Obtain funding to implement the plan's projects and programs; funding types may include dedicated sources, grants and appropriations	
4.5.1 Identify sources of governmental funding and non-profit funding sources available for watershed management project implementation	• Grant Funding

4.5 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 groundwater, surface water, recycled and seawater resources that meet water demands while balancing the other plan objectives.

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. Rate-payers should not bear an unreasonable burden.

Strategy 5.1.1: Make the best use of existing sources before developing new water sources.

The development of new water sources requires substantial capital expenditures; therefore it is more efficient to optimize use of existing sources which can then defer the development of new sources. Using up to the permitted amount of water for existing groundwater sources is more economical than developing new sources which would require capital cost for design and construction. The best use also includes protecting the existing source, as in the case of Punalu'u where pumpage can be spread over existing wells.

The following projects and initiatives address this strategy:

- Punalu'u Pumpage Optimization
- Various initiatives to optimize use of existing sources

Strategy 5.1.2: When new sources are needed, balance least-cost options with environmentally, culturally and socially acceptable options.

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 related infrastructure such as transmission lines must be built.

It is 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.

The existing water supplies should be used most efficiently and water conservation measures implemented before developing new groundwater sources. If the need for additional sources still exists, then develop available groundwater supplies within the GWMA sustainable yields established by CWRM.

When new sources are needed, potable water demand is likely to be developed with new potable wells. This will include sources in both Koʻolau Loa and Koʻolau Poko. By increasing the self-sufficiency of Koʻolau Poko with the construction of new wells, this can reduce the need for water from Koʻolau Loa. Due to the hydrologic conditions of Koʻolau Poko, there are limited opportunities, but nonetheless potable wells can continue to be investigated on a localized case by case basis.

The following project addresses this strategy:

- Potable Well Development

Sub-objective 5.2: Efficiently meet water demands and match water quality to appropriate use.

With the growing population on Oʻahu and across the State, every effort should be made to make the best use of water supplies. The quality of water supply should correspond to its use such that high-quality water is used for drinking or potable water needs and lower quality non-potable water is used for irrigation and industrial processes.

Strategy 5.2.1: Increase water conservation measures.

One way to meet demand is to increase the amount of water conserved. Conservation measures can be implemented by residents and businesses in Koʻolau Loa – and in Koʻolau Poko where the most potable water is used. Conservation also includes a program of renewal and replacement program for water system facilities, pipelines, pump stations, reservoirs and treatment systems to reduce water system losses in potable and non-potable systems. The delivery of water from the system to the crops creates an additional opportunity for water savings. Maintaining and expanding water conservation programs will protect and existing resources and defer development of new sources.

The following projects address this strategy:

- Conservation Measures
- Agricultural Water Loss Minimization

Strategy 5.2.2: Develop and use recycled water to meet non-potable demands, where feasible.

Develop and use recycled water for irrigation of large landscaped areas and agricultural use. Where practical, convert existing potable irrigation uses to recycled water to replace existing groundwater demand. Recycled water has the advantage of being a “drought-proof” source of water for irrigation needs. Greywater reuse is a small scale version of recycled water.

The following projects address this strategy:

- Increased Recycled Water
- Cesspool Inventory / Greywater Reuse

Strategy 5.2.3: Use surface water within current interim and future instream flow standards.

For Punaluʻu and Kahana valleys, surface water fills most agriculture and appurtenant rights needs including loʻi kalo. The current surface water use will be continued until measurable instream flow standards are set.

The following project addresses this strategy:

- Surface Water Use

Strategy 5.2.4: Develop new agricultural/aquaculture wells.

If agricultural needs increase as projected, increased recycled water will not meet demands. Additional groundwater sources will need to be developed. Agriculture and aquaculture wells will be developed by individual landowners to supply water for themselves and/or lessees. Water use permits for well pumpage are required from the Commission on Water Resource Management. For agricultural areas served by stream diversions, groundwater wells provide additional supply and are less impacted by drought. *City and County of Honolulu Drought Mitigation Strategies* (November 2004) discusses the need to monitor the impacts of drought on agriculture. Windward farming areas are identified as having high drought risk.

The following projects address this strategy:

- Agriculture (Non-Potable) Well Development
- Drought Mitigation Strategies

Sub-objective 5.3: Maintain and improve BWS system reliability.

A reliable system can minimize the frequency, magnitude and duration of water shortages and ensure a consistent supply of high quality water to customers. Reliability of water supply can be obtained in various ways. As mentioned above, the diversification of water sources can increase system reliability. A secure system can also 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 and projects that support BWS system reliability by protecting groundwater sources and aquifer quality and integrity.

Strategy 5.3.1: Continue to provide high quality drinking water supply that meets or exceeds Safe Drinking Water Standards.

Disinfection and treatment protocols are used to meet the Safe Drinking Water Standards. The water sources are continuously tested for regulatory and operational compliance. In addition to meeting the existing standards, the BWS must monitor and anticipate new changes to the Safe Drinking Water Standards. During drought conditions the BWS can implement conservation and other measures to protect the drinking water from critically low groundwater conditions.

The following projects and initiatives address this strategy:

- Groundwater Source Protection
- Various ongoing BWS initiatives, including regular monitoring and reporting

Strategy 5.3.2: Continue BWS's ongoing main replacement program and other system upgrades.

To achieve water 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 BWS water system including hydraulic efficiency, system capacity, regulatory compliance, and aesthetic quality of the water. A program of infrastructure improvements includes treatment plants, pipeline renewals, pump stations, storage capacity, fire flows, service pressures, and transmission system redundancy.

Examples of improvements are main replacements, new facilities for reliability / redundancy (reservoirs, etc.), boosters, and well pumps. BWS capital projects upgrades in Koʻolau Loa are listed in the BWS Capital Program (CP).

The following initiatives address this strategy:

- BWS Capital Program *(Appendix F)*

Strategy 5.3.3: Optimize system operations.

The BWS system can be optimized for flexibility, reliability, and efficiency and to potentially reduce operating costs. Leak detection programs, back-up supplies, standby generators, systems supervisory control, and emergency maintenance procedures provide reliability to system operations. Optimization of operations includes facility power management. Optimizing the distribution of source pumpage with efficient water system operations to meet new demands is a continuing challenge.

The following projects and initiatives address this strategy:

- Punaluʻu Pumpage Optimization
- Various ongoing BWS system management measures

Strategy 5.3.4: Implement security measures.

System reliability also means ensuring security around the sources and reservoirs. Security measures include hardening of facilities, surveillance alarms and having emergency response plans in place.

The following initiatives address this strategy:

- Various ongoing BWS facilities security initiatives

A summary table of Objective #5 sub-objectives and associated strategies and projects follows below *(Table 4.5)*.

Table 4.5 Summary Table for Objective #5: Meet Water Demands at Reasonable Costs

OBJECTIVE #5 – MEET WATER DEMANDS AT A REASONABLE COST	
Sub-Objectives / Strategies	**Projects**
5.1 Provide water at a reasonable cost to the community in a way that provides for the long term health of the watershed	
5.1.1 Make the best use of existing supplies before developing new water sources	• Punalu'u Pumpage Optimization • *Various initiatives to optimize use of existing sources*
5.1.2 When new sources are needed, balance least cost options with environmentally, culturally, and socially acceptable options	• Potable Well Development
5.2 Efficiently meet water demands and match quality (i.e. potable, brackish, recycled) with use (drinking, irrigation, etc.)	
5.2.1 Increase water conservation measures	• Conservation Measures • Agriculture Water Loss Minimization
5.2.2 Develop and use recycled water to meet non-potable demands, where feasible	• Increased Recycled Water • Cesspool Inventory / Greywater Reuse
5.2.3 Use surface water within current and future instream flow standards for non-potable demand	• Surface Water Use
5.2.4 Develop new agricultural / aquaculture wells for non-potable demand	• Agriculture (Non-Potable) Well Development
5.3 Maintain and improve BWS system reliability	
5.3.1 Continue to provide high quality drinking water supply that meets or exceeds Safe Drinking Water Standards	• Groundwater Source Protection • *Various ongoing BWS initiatives, including regular monitoring and reporting*
5.3.2 Continue BWS' ongoing main replacement program and other system upgrades	• *Refer to BWS Capital Program (Appendix F)*
5.3.3 Optimize system operations	• Punalu'u Pumpage Optimization • *Various ongoing BWS system management measures including leak detection and back-up supplies*
5.3.4 Implement security measures	• *Various ongoing BWS facilities security initiatives*

5

WATERSHED AND WATER SUPPLY PROJECTS

5 WATERSHED AND WATER SUPPLY PROJECTS

5.1 PROJECT INDEX
5.2 PROJECT DESCRIPTIONS

The purpose of this chapter is to present detailed descriptions of the Plan's projects. The projects include those which benefit the overall watershed and those used to supply water to meet current and future demands. The projects were developed from the objectives, sub-objectives and strategies, discussed in *Chapter 4*, and may meet multiple objectives. The development of other projects is not precluded by this plan.

Note: The proposed strategies and projects within this plan are the result of a comprehensive watershed analysis and stakeholder consultation process. The strategies and projects may involve various governmental agencies and non-governmental organizations, and 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. This plan is intended to guide agencies and organizations in implementing the most important initiatives for Ko'olau Loa watersheds and water resources; however, implementation will likely depend on budgetary priorities, grant availability and partnering efforts over the long term.

5.1 PROJECT INDEX

The *Table 5.1* lists the Plan projects and serves as an index for the projects contained in this Chapter. *Figure 5.1* shows the locations of the projects within a typical Ko'olau Loa ahupua'a.

5.2 PROJECT DESCRIPTIONS

The following project descriptions are of projects that will potentially improve watershed health and fulfill the objectives of the sub-objectives described in *Chapter 4*. The watershed projects (1a through 5d) are described in terms of a problem statement, general background, general actions and best management practices, issues in Ko'olau Loa, preliminary scope, potential participating entities, cost and references. The Water Supply Options, projects 6a through 6e are described in terms of occurrence, current and potential future use, cost, development issues and limiting constraints and conclusions.

Participation identified in project descriptions is not exclusive; other agencies and organizations who desire to participate are encouraged.

Table 5.1 Project Listing

SURFACE WATER
1a) Flood Control / Stormwater Management
1b) Flood Channel Redesign
1c) Measurable Instream Flow Standards
1d) Stream Water Quality Testing
1e) Nearshore Water Monitoring

GROUNDWATER
2a) Sustainable Yield Estimates
2b) Groundwater Source Protection
2c) Drought Mitigation Strategies
2d) Punaluʻu Pumpage Optimization

LAND MANAGEMENT
3a) Stream Clearing / Management
3b) Stream Conservation Buffers
3c) Cesspool Inventory / Greywater Reuse
3d) Pollution Prevention / Low Impact Development
3e) Invasive Species Assessment / Control
3f) Feral Pig Management Plan
3g) Muliwai / Wetland Restoration
3h) Conservation District Boundary Review
3i) Wildfire Management Plan
3j) Crop Water Demand

CULTURAL RESOURCES / TRADITIONAL PRACTICES
4a) Loʻi Kalo Expansion
4b) Watershed Oral History Studies
4c) Cultural Educational Programs
4d) Fishpond (Loko Iʻa) Restoration
4e) Cultural Monitoring Program

IMPLEMENTATION
5a) Watershed Partnerships
5b) Water & Watershed Education
5c) Koʻolau Loa Implementation Entity
5d) Grant Funding

WATER SUPPLY
6a) Potable Well Development
6b) Agriculture (Non-Potable) Well Development
6c) Increased Recycled Water
6d) Conservation Measures
6e) Agricultural Water Loss Minimization
6f) Surface Water Use

Figure 5.1 Managing the Ahupuaʻa/Watershed

1a Flood Control/Stormwater Management

PROBLEM STATEMENT

Areas in Koʻolau Loa such as Lāʻie and Kahuku are prone to flooding which damages property. Large amounts of freshwater laden with sediment discharging into nearshore waters are detrimental to the nearshore environment and coral.

GENERAL BACKGROUND

Streams in Hawaiʻi tend to be "flashy" in nature, meaning that during storms they are quick to rise, and during non-storm periods return to a minimal level. The quick rise can be due to intense rainfall, the sudden release of runoff stored behind a wall of debris that gives way or a combination of the two.


Lāʻie Flooding in 1994

During the plantation times, much of the surface water was managed for agricultural crops. Ditch systems were maintained and used to distribute surface water to the fields, including storm runoff. During those times plantation camps and other developments grew on the flat areas alongside streams and natural runoff areas. With the change from plantation agriculture to other land uses, these ditch systems fell into disrepair. Now runoff over fields and through residential areas has become a significant problem.

While freshwater is essential to the nearshore waters and estuaries, large amounts of freshwater and sediment entrained in the storm runoff are harmful to the marine environment, especially to coral.

ISSUES IN KOʻOLAU LOA

Koʻolau Loa is located on the windward side of the Koʻolau Mountains. The major streams drain though steep valleys or gulches with flat lands adjacent to the ocean. The distance from the steep portions of the valleys and gulches to the ocean increases from Hauʻula to Kawela. During storms, the steep slopes and heavy rainfall at the top of these valleys and gulches produce intense runoff. This runoff must be conveyed by the lowland channel to the ocean and can overwhelm the stream channel's capacity. Debris can also be carried downstream from the uplands, which clogs the lowland channels. The combination of intense runoff and the reduced capacity due to clogging tends to increase the flooding potential in Koʻolau Loa.

During the post-plantation era, housing was built in the communities of Lāʻie and Kahuku, which are especially prone to flooding. Major floods have occurred in Lāʻie and Kahuku. Studies have been conducted to better understand the issues around flooding that results from stormwater runoff.

The Kahawainui Stream Flood Control Project was completed in May of 1990 for the Lāʻie area. The 1992 Wailele Stream Flood Control Study by the U.S. Army Corps of Engineers recommends levee along the stream to protect adjacent homes and property from flood damage. In 2004, the pre-final draft of the Lāʻie Town Drainage Master Plan was presented to the community. This study is ongoing.

In 1991, a major flood in Kahuku caused significant damage to residences, schools, agricultural landS, and wildlife reserves. Residents west of Kahuku Town were cut off from police and fire services and from the Kahuku Hospital. A major driving force behind flood control in Kahuku is the Phase IV affordable housing project, which will replace the old plantation housing. The Kahuku Village Association has been trying to construct the Phase IV project for many years, but unresolved flooding issues have affected financing for the plan.

The Kahuku Watershed Project began after the City and State determined that they did not have the funds to implement the findings of the 1997 Kahuku Regional Drainage Master Plan. The Federal government was asked to help the City and State implement the findings of the Master Plan. The State Department of Transportation improved the Hospital Ditch Bridge and ʻŌʻio Stream Bridge. The flood control system for land between these bridges and the sand dunes at the coast was initiated as a project to address ecosystem restoration of the James Campbell Wildlife

Kaʻaʻawa March 2006 Flooding

Refuge in 2001, but was re-formulated in 2004 to address the flooding of ʻŌhiʻa Stream and Hospital Ditch. This feasibility study is being conducted by the U.S. Army Corps of Engineers, with local sponsorship by City and County of Honolulu Department of Design and Construction and from the State Department of Land and Natural Resources. This study does not include Kalaeokahipa Stream, Hoʻolapa Stream or ʻŌʻio Stream which also contribute to the flooding of Kahuku Town, nor does it include and Mālaekahana Stream which can flood the southern portion of the Kahuku community. While less studied, smaller communities in Koʻolau Loa, such as Hauula and Kaʻaʻawa, are also vulnerable to flooding, demonstrated in March 2006.

In 2002, the City and County of Honolulu completed Nearshore Baseline Environmental Monitoring Reports for the Kawela Stream Outlet, ʻŌʻio Stream Outlet, Bakahan Stream Outlet, Kiʻi Outlet, Japanese Cemetery Outlet and Mālaekahana Stream Outlet for Flood Control Improvements to facilitate the environmental permitting of proposed flood control improvements. Additional Baseline Environmental Monitoring was proposed for Lāʻie and Hauʻula to facilitate the permitting of flood control improvements in these communities.

Concrete channels are an effective way to deal with flood waters; however, they do not prevent sediments from entering the channel and are not optimal riparian habitat (*Project 1b Flood Channel Redesign and Construction*). Flood control measures that allow the stormwater to infiltrate into the ground are much more effective at preventing pollution because they trap particles before they can enter the stream or ocean. The City and County of Honolulu does not allow grass swales to be used because their maintenance costs exceed those of concrete channels. While maintaining concrete channels may be more cost effective, the costs of the channels to the ecosystems are much higher.

Intermittent streams are preferably maintained in their natural course, not dammed, diverted or altered, which may also contribute to flooding problems.

BEST MANAGEMENT PRACTICES (BMP)

- Implement practices such as bioretention, filters, planters, green roofs, infiltration trenches, cisterns, open channels/swales; modify existing detention ponds; storage above roadway culverts; new facilities below outfalls to manage urban stormwater runoff.
- Construct outlets directly to the ocean.
- Construct bridges with ample capacity for flood waters.
- Promote the use of pervious paving to increase storm water infiltration and decrease runoff that contributes to soil erosion and runoff.
- Disallow new development in areas historically subject to flooding.

PRELIMINARY SCOPE

- Investigate possible cost sharing of flood management structures that may have higher maintenance costs but will benefit multiple partners.
- Participate in the U.S Army Corps of Engineers study project for Hospital Ditch and ʻŌhiʻa Stream and initiate one for Kalaeokahipa and Hoʻolapa Streams.
- Initiate baseline environmental monitoring in Lāʻie and Hauʻula.
- Continue with study of funding alternatives to implement the Lāʻie Town Drainage Master Plan.
- Participate in the U.S Army Corps of Engineers study project for the Wailele Stream.
- Explore the option of expanding the Kahuku Golf Course to provide a flood control area.
- Address flooding issues relating to Kamehameha Highway in Koʻolau Loa (DOT is presently working on ʻŌʻio, Kaipapaʻu, Punaluʻu and Kahana Bridges).
- Focus studies on smaller communities that also have flooding issues.
- Consider submitting updates to the FEMA Flood Insurance Rate Maps based on construction of flood mitigation improvements.
- Implement the proposed *Project 3a Stream Clearing and Management.*

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- City and County of Honolulu Department of Design and Construction
- City and County of Honolulu Department of Environmental Services
- State Department of Land and Natural Resources
- State Department of Transportation
- Windward Soil and Water Conservation District
- U.S. Army Corps of Engineers
- U.S. Geological Survey

ESTIMATED COST

$250,000 to 500,000 per flood study

REFERENCES

Wailele Stream Flood Control Study Lāʻie, Oʻahu, Hawaiʻi Final Reconnaissance Report, U.S. Army Corps of Engineers Honolulu District, February 1992.

1b Flood Channel Redesign

PROBLEM STATEMENT

The design of existing concrete flood channels reduces or eliminates aquatic habitat for native species, prevents natural water exchange between stream flow and stream banks, and detracts from the natural aesthetics of streams and riparian areas.

GENERAL BACKGROUND

Some streams in Koʻolau Loa have been channelized in sections to control flooding which has helped to prevent property damage and maintain local roadway function. However, the flood control structures also have negative effects on stream ecology. Many native aquatic species have life cycles that require them to migrate between estuaries and upstream locations. Most stream channelizations inhibit the ability of native stream organisms to do this.

The typical concrete channel designs include steep concrete banks with a wide, flat bottom. Concrete lining is impervious, eliminating natural water flow between the stream and its banks. Typical concrete linings also eliminate the pools, runs, and riffles which Hawaiʻi's native fish and invertebrates prefer as habitat. The wide, flat concrete channel bottoms increase the stream flow width, reduce the oxygen content in the water, and result in slow, shallow flows during low flow periods, which favor the alien aquatic species. The shallow channel flows and lack of stream side riparian vegetation heat the water to levels that native species cannot tolerate.

This watershed project considers the possible redesign of these concrete-lined stream reaches, which 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, which would concentrate stream flow and increase depth 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.

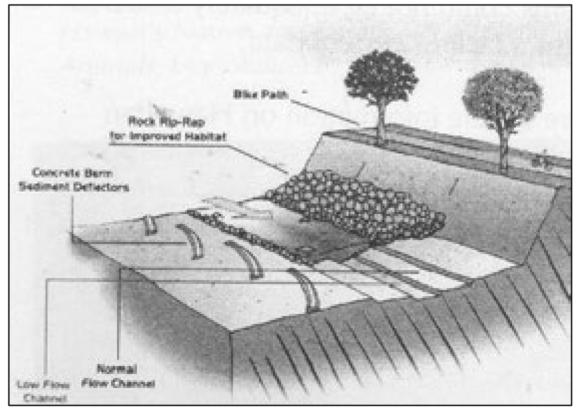
ISSUES IN KOʻOLAU LOA

Major floods have been experienced in Lāʻie and Kahuku and related flood control projects have been the response. The Kahawainui Stream Flood Control Project in Lāʻie was completed in May of 1990. The *1992 Wailele Stream Flood Control Study* by the U.S. Army Corps of Engineers recommends a levee along the stream to protect adjacent homes and property from flood damage. In Kahuku, the flooding of ʻŌhiʻa Stream and Hospital Ditch is being studied for drainage improvements.

Flood channels such as the one at Kahawainui Stream, are massive, concrete-lined and fenced structures, which are considered an eyesore by many in the community. They restrict access to the stream, appear aesthetically out of place in the rural community, do not provide for riparian trees and other vegetation, and eliminate the benefits of a natural riparian system. These effects on the stream ecosystem could be lessened through an approach that accommodates both flood management and aquatic ecosystem concerns.

BEST MANAGEMENT PRACTICES (BMP)

Design standards for ideal native stream habitat have not been developed beyond conceptual level. Potential conceptual design for low and high flow management in different areas of the channel is shown at right. 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, and maintenance considerations — cost and access.



PRELIMINARY SCOPE

- Conduct an investigation of existing channelized stream conditions in Koʻolau Loa.
- Maintain flood water capacity of existing structures.
- Consider permeable or semi-permeable materials for subsurface water exchange.
- Provide community access to streams.
- Provide for riparian vegetation.
- Pilot a concrete stream channel reconstruction based on the scope and these principles:
  - Site design utilizes an integrated approach to deal with stormwater quantity, quality and protection of downstream properties and/or stream banks.
  - Stormwater management practices strive to utilize the natural drainage design principles and require as little maintenance as possible.
  - Structural stormwater controls implemented after site design and nonstructural options have been exhausted.
  - Structural stormwater solutions are multi-purpose and aesthetically integrated into a site's design.
  - Native plants species used for landscaping in stormwater management facilities.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

City and County of Honolulu Departments of: Design and Construction, Environmental Services, and Facilities Maintenance; State Department of Land and Natural Resources, Division of Aquatic Resources; State Department of Transportation, Highways Division; U.S. Army Corps of Engineers, Civil Works Branch; U.S. Geological Survey

ESTIMATED COST

Project costs range from an estimated $1.0 million to $5 million per stream

REFERENCES

USFWS, 1978, *Stream Channel Modification in Hawaiʻi.*

Federal Interagency Stream Restoration Working Group, 10/1998, *Stream Corridor Restoration: Principles, Processes, and Practices.* GPO Item No. 0120-A; SU Docs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3

"Low Impact Development: A Practitioner's Guide", June 2006 Hawaiʻi State Office of Planning, Coastal Zone Management Program.

1c Measurable Instream Flow Standards

PROBLEM STATEMENT

Instream flow standards (IFS) protect the public interest in the waters of the State. In formulating proposed standards, the CWRM shall weigh the importance of present or potential instream values with the importance of present or potential uses of water from the stream for non-instream purposes, including the economic impact of restriction of such uses. Additional studies are needed to update the "status quo" interim IFS to advance resources planning and decision-making. The precautionary first step is to understand and protect the public trust uses of stream waters. If water is determined available for other non-instream uses, then such quantities can be used for planning purposes and may be available for allocation.

GENERAL BACKGROUND

Currently, interim instream flow standards (IIFS) 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" (see the *Oʻahu Water Management Plan Overview*).

Punaluʻu Stream

Instream flow standards are defined by the State Water Code in Hawaiʻi Revised Statutes (HRS) Chapter 174C 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."* *Figure OV.6* highlights the types of information as well as additional factors that may be considered in setting IFS. The categories of information include hydrology, fish/wildlife habitat, recreation, ecosystem maintenance, aesthetics, non-instream uses, navigation, hydropower, water quality, conveyance of water, and Hawaiian rights.

It is the responsibility of the CWRM to establish instream flow standards (IFS) to protect the public interest in the waters of the State. Flows should be expressed in terms of variable flows of water necessary to protect fishery, wildlife, recreational, aesthetic, scenic, or other beneficial instream uses. In formulating IFS, the CWRM must also weigh the importance of the present or potential uses of water from the stream for non-instream purposes, including the economic impact of restriction of such uses HRS Chapter 174C-71(1)(E). When preserving, enhancing, or restoring instream values, the CWRM must consider water exchanges, alternative sources, or any other solutions in order to avoid or minimize the impact on existing uses HRS Chapter 174C-71(1)(E).

Setting IFS is a collaborative process where the CWRM, with input from interested parties and agencies, must determine and weigh present or potential instream values against present or potential non-instream uses, while protecting the public interest and avoiding or minimizing the impact on existing uses. CWRM is developing a methodology for establishing measurable IFS, based upon best available information.

Decisions regarding IFS must take into account the Public Trust Doctrine. The four trusts identified by the Hawaiʻi Supreme Court are: (1) maintenance of water in its natural state; (2) domestic water use of the general public (particularly drinking water); (3) the exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights; (4) reservations of water for Hawaiian home lands. Also, the precautionary principle, in cases where there is not scientific certainty, also applies.

ISSUES IN KOʻOLAU LOA

Stream Priorities

The priority for setting measurable IFS is given to streams with diversions where there may be issues with the amount of water remaining for instream uses versus non-instream uses. Also, perennial streams are prioritized over non-perennial/intermittent streams because of the possibility of potential diversions for non-instream uses.

For Koʻolau Loa, Punaluʻu Stream is a priority because of its many agricultural diversions, and because it is a perennial stream. Several studies are already under way and the results of these efforts will be used in setting IFS. Later priorities might be Kaluanui and Kaʻaʻawa Streams, which are perennial streams in Koʻolau Loa. In the Waiāhole Ditch Contested Case CWRM has amended the IIFS for Kahana Stream with a quantified stream flow of 13.3 mgd.

The amount of stream information available varies from stream to stream across the state and in Koʻolau Loa. Available information on streams in regards to setting measurable IFS is summarized below.

Koʻolau Loa Streams

The "Hawaiʻi Stream Assessment: A Preliminary Appraisal of Hawaiʻi's Stream Resources" (HSA) (1990) developed by the National Park Service and DLNR provides a compiled information on streams. The HSA lists 13 streams for Koʻolau Loa. (See *Chapter 2 Watershed Profile* for more information). The stream flow measurements are available for five streams in the Koʻolau Loa district: Kahana, Punaluʻu, Kaluanui, Koloa Gulch and Mālaekahana (*Table 2.2*). The first three streams listed, along with Kaʻaʻawa Stream, are perennial, and the other streams in Koʻolau Loa are non-perennial/intermittent, where water only flows during part of the year.

A range of information exists on Hawaiian stream fauna and their habitat needs; however, there is limited information on the role of estuaries on their life cycle. Most native stream species, such as ʻoʻopu (native gobies) and native damselflies (*megalarion*), favor clear, well-oxygenated, fast-flowing water and stream beds with boulders, cobbles, and gravel bottoms. There is limited information on most streams in Koʻolau Loa regarding instream uses such as native species, habitat, ecosystem stability, and threats, which are important components of IFS.

The HSA lists Kahawainui, Koloa, Kaipapaʻu, Maʻakua, Kaluanui, Punaluʻu, Kahana, and Kaʻaʻawa Streams as having outstanding aquatic resources with the best examples of native species habitat because of the presence of native species and relatively low amount of introduced species. However, the HSA was compiled in 1990, and, therefore, gives little indication of current or recent biological health.

A recent survey of Punaluʻu Stream (USGS, 2006) found large amounts of introduced species and few natives. The *Biological Assessment of Kahana Stream* (September 2002) describes the locations of three species of ʻoʻopu, ʻōpae (native shrimp) and other native species in the stream. The study also discusses the introduced species found and their possible impacts. This study hypothesizes that the hau may be decreasing the possible flow in the area and that clearing out the hau would have a beneficial impact on maintaining and possibly improving stream diversity.


Punaluʻu Stream USGS Gaging Station

BWS conducted biological assessments of Maʻakua and Kaipapaʻu Streams as part of well development projects. Maʻakua Stream findings (1996) revealed that cesspools were affecting the water quality of the estuary. For Kaipapaʻu Stream, the 2006 biological assessment determined that the stream is of very high quality due to its relatively undisturbed riparian surroundings, presence of adult populations of native goby fish, and abundance of relatively rare insect species.

Stream diversions in Koʻolau Loa are used mainly for agricultural purposes often using the old plantation irrigation systems or ancient ʻauwai. The primary non-instream uses for stream flow are diversified agriculture and loʻi kalo. Loʻi kalo and aquatic species habitat uses may be generally compatible because much of the loʻi kalo water is returned to the stream. However, the returned water can cause issues with sedimentation and temperature increases. General agriculture crop water use demands and aquatic species habitat requirements can conflict if water availability is limited.

Several streams in Koʻolau Loa have reported diversions: Punaluʻu, Kaʻaʻawa, Hauʻula, and Kahana. Kahawainui, Maʻakua, and Lāʻiewai may have small, unquantified diversions. Stream diversions in Koʻolau Loa have not been verified, with the exception of Punaluʻu Stream diversions and distribution systems conducted by Kamehameha Schools, BWS, USGS and CWRM as part of the Punaluʻu Watershed Alliance. CWRM has requested funds to survey the State's diversion works systems.

Stream Information Needed/ Desired

Instream Flow

In order to balance various possible stream water usages, the stream flow should be determined. The high amount of rainfall and dike formations in Kahana, Punalu'u and Kaluanui areas directly contributes to perennial stream flow. To account for the various hydro-geologic factors in the areas stream flow may be measured and/or estimated. Stream gages are used for actual measurements; existing methodologies for estimating stream flow can be applied.

It is important to know which segments in perennial streams gain flow from dike formations and lose flow to percolation into the stream sediments. Seepage runs during dry periods at appropriate segments within the stream are recommended. It is equally important to survey non-perennial and intermittent streams to determine the extent and quality of the perennial stream segments in the mauka reaches.

Non-Instream Use (Diversions) and End Uses

An inventory of diversion works, distribution systems, existing and potential irrigated areas, GIS mapping and measuring diverted and return flows are important components of instream flow standards. This information is also important for determining reasonable and beneficial use, managing water loss, and monitoring surface water availability. Inventorying and verifying all Ko'olau Loa diversions and quantifying the use would be a substantial task. CWRM's statewide survey of diversion works structures will provide an important step toward assessing non-instream uses. The irrigation systems distributing diverted stream water and the types and locations of uses would complete this task.

Biological Assessment

Hawai'i'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. It is especially important for streams with diversions to determine the impact on the stream's macrofauna. As noted, some studies have been conducted and more are needed to more accurately assess stream health and to be the basis of IFS and stream management plans (*Project 3a Stream Clearing* and *Management* and *Project 3d Pollution Prevention/Run-Off Water Quality*). While stream flow is one factor that affects native riparian communities, other factors such as water temperature (related to stream flow), water quality, and presence of invasive species also affect native species.

Appurtenant Rights

State of Hawai'i law under Title 13 Department of Land and Natural Resources, Subtitle 7 Water Resources, Chapter 172 Hawaiian Water Rights addresses the appurtenant rights to the use of stream waters tied to their kuleana land owner rights. Kuleana lands refers to plots of land awarded to tenants pursuant to the Kuleana Act of 1850. Appurtenant right means the right, as defined by the Hawai'i Supreme Court, to use that quantity of water necessary to cultivate traditional products (such as taro), by approximating those utilized at the time that the same parcel of land was first granted by the government. This right attaches to the specific parcel of land and not any individual person.

Traditional and customary practices mean those practices relating to water which were established by Hawaiian usage. These practices include, but are not limited to, the cultivation or propagation of taro on one's own kuleana and the gathering of hihiwai, ʻōpae, ʻoʻopu, limu, thatch, ti leaf, aho cord, and medicinal plants for subsistence, cultural, and religious purposes. See *Appendix B, Plans, Policies, Guidelines and Controls*.

A number of Koʻolau Loa residents claim rights to the use of stream waters tied to their kuleana landowner rights. The extent of these water rights claims and rights should be quantified to assess and manage this element of regional water use.

PRELIMINARY SCOPE

The scope for obtaining key components for CWRM to set measurable IFS is based upon the Punaluʻu Watershed Alliance objective of setting measurable IFS for Punaluʻu Stream through partnership rather than by contested case. The experience gained with the coordinated studies of Punaluʻu stream and agricultural irrigation systems illustrate a potential model for obtaining key components of measurable IFS for other diverted streams.

- Determining characteristics of stream flow and stream macrofauna:
    - Conduct a biological assessment of the streams macrofauna.
    - Measure current stream flow at various points along the stream and conduct seepage runs.
    - Estimate pre-diversion flow; when not possible to conduct field measurements, utilize an estimate model for watersheds.
    - Verify existing stream diversions.
    - Assess the effects of the existing surface water diversion on flow characteristics.
    - Characterize the effects of the surface water diversion on instream temperature variations.
    - Estimate the effects that stream flow restoration (full or partial will have on habitat availability for native stream fauna (fish, shrimp and snails)).
- Assessment of Non-Instream Uses:
    - Develop an Agricultural Water Use and Development Plan for each diversion system
        - Compile a brief history of system.
        - Create a GIS map of existing and proposed agricultural zoned lands and kuleana lands. Define water uses accounting for climate and crop type.
        - Create a water system distribution map to supply water to the identified agricultural and kuleana lands.
        - Obtain stream diversion data.
        - Estimate locations and return flows back to stream.
        - Estimate water losses and location of leaks.
        - Propose the installation, renovation and/or new pipelines/flumes/ʻauwai, stream gages and meters to manage water use and billing, when applicable.
        - Evaluate the feasibility of new and existing wells and storage to supplement surface water to protect instream uses and provide for additional supply and drought mitigation.
        - Provide cost estimates and funding sources.

- Cultural Uses and Appurtenant Rights Survey:
  - Conduct oral histories and archival research to learn where lo'i kalo and other Hawaiian water uses were previously practiced and quantify the amount of possible Native Hawaiian water rights that could be exercised.
  - Identify opportunities for community and school involvement in educational field trips, water quality testing, stream flow monitoring, research, and clean-ups. See *Project 5a Watershed Partnerships, Project 5b Water and Watershed Education.*
- Utilize data from the stream flow measurements and biological assessments to develop management actions such as stream clearing, identifying appropriate riparian buffer widths, removing invasive species, redesigning flood channels, restoring streams and protecting streams by establishing measurable IFS.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State Commission on Water Resource Management
- United States Geological Survey
- State Department of Land and Natural Resources Division of Aquatic Resources
- State Parks
- State Department of Health
- University of Hawai'i Water Resources Research Center and other university researchers
- U.S. Army Corps of Engineers
- U.S. Fish & Wildlife
- State Historic Preservation Division
- Bureau of Conveyances
- Punalu'u Watershed Alliance
- Landowners

ESTIMATED COST

$350,000 to study the characteristics of stream flow and stream macrofauna (estimate is based on the Punalu'u Stream study)

$75,000 for non-instream use study

$40,000 for an oral history and archival/historical research on Native Hawaiian water rights and community involvement

1d Stream Water Quality Testing

PROBLEM STATEMENT

More stream water quality information is required for making management decisions and evaluating projects, programs, and other actions in the watershed.

GENERAL BACKGROUND

The level of impairment and the overall status of water quality are assessed by the State Department of Health (DOH) throughout the state using existing data. To protect the health of natural ecosystems, biota, and human users, regular monitoring is needed in order to adequately assess water quality and determine if standards are being met. Stream water quality monitoring could also provide data to assess the effects of land use on the environment and the effectiveness of different water quality protection programs and projects. Water quality monitoring is costly, making it infeasible to collect large amounts of data.

Typical water quality monitoring parameters include rainfall, stream flow, temperature, turbidity, dissolved oxygen content, salinity, and pH. These measurements should be taken at strategic locations to minimize the number of monitoring locations, maintenance, and other costs. Monitoring should be restricted to data that are necessary for evaluating the most important watershed questions. The monitoring of other water quality parameters should be included in individual project design to determine specific effects.

To minimize cost and provide maximum benefits for data collection effort, there should be a coordinated effort to share information and eliminate repetition. At present, the various government agencies, groups, and individuals collect different types of data. The current uncoordinated data collection and management approach makes it difficult to determine whether desired information is available, and which group holds a particular data set. Additionally, multiple agencies and entities often use different sampling methodologies, which may make it infeasible to compare data sets. Historical information which is often stored at various locations, is also difficult to access. A centralized database would make research more accessible to decision-makers and others who wish to execute projects.

ISSUES IN KOʻOLAU LOA

Only a few of the Koʻolau Loa streams have stream flow gages, and median stream flow is only available for Punaluʻu and Kahana Streams. USGS has recommended adding gaging stations in order to address future issues, including surface water availability and perennial streams. As part of their role with the Punaluʻu Watershed Alliance, USGS is completing a survey of Punaluʻu Stream, which includes temperature conditions. DOH's 2004 List of Impaired Waters in Hawaiʻi includes testing results for Kahana Stream and Punaluʻu Stream.

PRELIMINARY SCOPE

This study will help to assess the condition of Koʻolau Loa surface water quality and monitor changes due to land use and other management projects and programs. New surface water gaging stations could be added for other major streams in the region. Monitoring should focus on the two major streams of Kahana Stream and Punaluʻu Stream. Data should be input into a Koʻolau Loa watershed information clearinghouse for distribution and use.

Water quality testing and monitoring should include the following steps:

- Organize and analyze available baseline data.
- Identify agencies and organizations that have the capacity to monitor surface water quality.
- Identify an agency or working group to gather and disseminate the collected stream water quality data.
- 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.
- Assess 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 and make recommendations.
- Indentify cesspool inventory and locations to target replacement efforts *(Project 3cCesspool Inventory and Greywater Reuse)*
- Maintain a regular schedule for monitoring.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

U.S. Geological Survey, State Department of Health, State Department of Education, C & C Environmental Services Department, EPA, University of Hawaiʻi – Sea Grant & Water Resources Research Center, Koʻolau Mountains Watershed Partnership, Landowners.

ESTIMATED COST

$50,000 - $100,000 per stream per year

REFERENCES

Anthony, Stephen S., C.D. Hunt, Jr., A.M.D. Brasher, L.D. Miller, and M.S. Tomlinson. (2004). *Water Quality on the Island of Oʻahu, Hawaiʻi, 1999-2001.* Department of the Interior USGS.

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Koch, L., J. Harrigan-Lum, and K. Henderson. *(2004). Final 2004 List of Impaired Waters in Hawaiʻi: Prepared Under Clean Water Act 303(d).* Hawaiʻi State Dept. of Health Environmental Planning.

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, Oʻahu, Hawaiʻi:* USGS Water-Resources Investigations Report 03-4156.

1e Nearshore Water Monitoring

PROBLEM STATEMENT

Surface water runoff from natural lands, agricultural and urban areas, and leaching from cesspools affects the quality of nearshore waters.

GENERAL BACKGROUND

Ocean waters surrounding the islands receive runoff from streams and drainage channels across the state. 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 Hawaiʻi (List), is developed by the Hawaiʻi State Department of Health every two years. A total of 70 streams and 174 coastal stations were listed in 2004. This is an increase 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. Although information from environmental assessments and other related investigations can be used, none were used for the 2004 listing.

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.

The State Department of Health (DOH) is 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, Waimāanalo Stream, and the Ala Wai Canal. DOH is conducting a TMDL study for Waikele Stream.

ISSUES FOR KOʻOLAU LOA

Ocean water quality in Koʻolau Loa is generally very good, due to the extensive coastal mixing conditions established by constant tradewinds, ocean waves and coastal currents. During storm conditions, significant discharge of sediment-laden overland runoff is released via streams and drainage channels. These events cause periodic high turbidity conditions along the coastline. The nearshore coastal environment is adapted to these periodic high turbidity events. The large embayments along the coast, such as Kahana Bay and Kawela Bay are affected by higher turbidity conditions due to limited circulation.

Limited coastal water monitoring has been conducted near Kahuku and Hauʻula under City and County programs. Nearshore water quality in Lāʻie has also been studied. Leaching cesspools, agricultural fertilizers, and animal waste in runoff contribute nitrogen to the nearshore waters. Management measures could control and reduce these man-made inputs below current levels. Nitrogen pollutants have been detected in very low concentrations only near some stream and drainage outlets, but are not currently known to cause adverse environmental conditions in the nearshore marine environment. Injection wells, such as those for the Kahuku Wastewater Treatment Plant, should be monitored and a plan developed for the water to be reused *(Project 6c Increased Recycled Water).*

PRELIMINARY SCOPE

- Create additional coastal water monitoring programs with regular monitoring.
- Storm water improvements to reduce runoff of agricultural wastes into streams.
- Install silt collection basins to reduce the amount of silt in streams.
- Create program for cesspool mitigation including: incentives for conversion from cesspools to sewer.
- Undertake stream cleanups.
- Create of stream buffers.
- Implement debris booms.
- Educate farmers on agricultural best management practices.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- U.S. Natural Resource Conservation Service
- U.S. Geological Survey
- State Department of Health
- State Department of Land and Natural Resources
- City and County of Honolulu Department of Planning and Permitting
- City and County of Honolulu Department of Environmental Services

ESTIMATED COST

Annual regional coastal water monitoring programs for Kawela-Kahuku, Lāʻie-Hauula, Punaluʻu-Kahana-Kaʻaʻawa: were approximately $100,000 per outlet (based on past City and County Vision Project)

REFERENCES

EPA Water Programs http://www.epa.gov/Region9/water/wemap/coastal.html
Hawaiʻi Coastal Zone Mgmt., Aquatic Environments http://home.hawaii.rr.com/cpie/Hawaqua.html
Hawaiʻi Coral Reef Initiative http://www.hawaii.edu/ssri/hcri/ah/priorities.htm

2a Sustainable Yield Estimates

PROBLEM STATEMENT

Sustainable yield estimates are used for groundwater resource protection, management and development. The adopted sustainable yields are based on the best available information on hydrogeology but have acknowledged limitations in estimating the water budget components due to aquifer leakage to streams and estuaries and difficulties in defining aquifer boundary conditions. These estimates are also affected by long-term changes in climate, land use and the health of the watershed and should be reevaluated periodically.

GENERAL BACKGROUND

Sustainable yield is defined by the State Water Code (HRS Chapter 174-C) 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."* (See also the sustainable yield discussions in *OV.4.3 Groundwater Availability* and *1.6 Sustainable Yield)*.

CWRM recently updated the Water Resource Protection Plan (WRPP) through a contract with University of Hawai'i; sustainable yields statewide were reevaluated using a modified robust analytical model (RAM) and deep monitor well data as a calibration tool. Results indicated that the Ko'olau Loa aquifer system area's previous sustainable yield of 35 mgd was conservative. The upper range of the revised sustainable yield was estimated at 41 mgd. A sustainable yield range is another means to account for uncertainty and long-term climate variations. The revised sustainable yield for the WRPP for Ko'olau Loa aquifer system is 36 mgd, and Kahana aquifer system is 15 mgd.

Water availability is regulated through the CWRM water use permit application process and pumpage is monitored to avoid exceeding the sustainable yield. As of 2005, the Ko'olau Loa aquifer system area permitted use was 21.5 mgd or 60% of the 36 mgd sustainable yield. Total reported pumpage under these permits was 9.7 mgd or 27% of the 36 mgd sustainable yield. The Kahana aquifer system area has a sustainable yield of 15 mgd, of which 1.1 mgd or 7.3% is permitted and 0.08 mgd or 0.5% pumped.

In general, well development in the dike formations will have a proportional effect on streams, especially in the Kahana aquifer system area. All Water Use Permit (WUP) applications are considered on a case-by-case basis by CWRM, and if streams are affected, amendments to the IIFS are required *(see Project 1c Measurable Instream Flow Standards)*. Source development should account for uncertainties in sustainable yield estimates and recoverability, including drought *(OV.4.7 Uncertainties and Contingencies)*. To account for these uncertainties, BWS has estimated recoverable yields for their planning purposes.

ISSUES IN KO'OLAU LOA

Like instream flow standards, sustainable yields are essential to ensuring that water withdrawals do not threaten or harm the long-term viability of the resource. They also provide a basis for resource planning and decisions regarding future water supplies for new uses.

The Ko'olau Loa community working group has expressed concerns that the sustainable yields maybe too high, and that planned urban and agricultural development in Ko'olau Loa may exceed the aquifer's ability to sustain higher levels of pumping. The group also expressed concerns that the sustainable yields may not adequately account for climate change and leakage into streams, estuaries and nearshore waters. And they stated that more research is needed and that aquifer protection measures should be in place before additional water use permits are approved *(see Projects 2b Groundwater Source Protection and 3c Cesspool Inventory/Greywater Reuse)*. However, BWS water transfers out of Ko'olau Loa are expected to reduce over time because Ko'olau Poko's population is forecasted to decrease; advances in water conservation and recycled water development will further reduce Ko'olau Poko's demand *(see Projects 2d Punalu'u Pumpage Optimization, 6c Increase Recycled Water and 6d Conservation Measures).*

There are no plans for additional well development in the Kahana aquifer system area due to the likelihood of impacts on streams, the cost of IIFS studies and the capital investment risk of low-yield wells based on previous exploratory well experience.

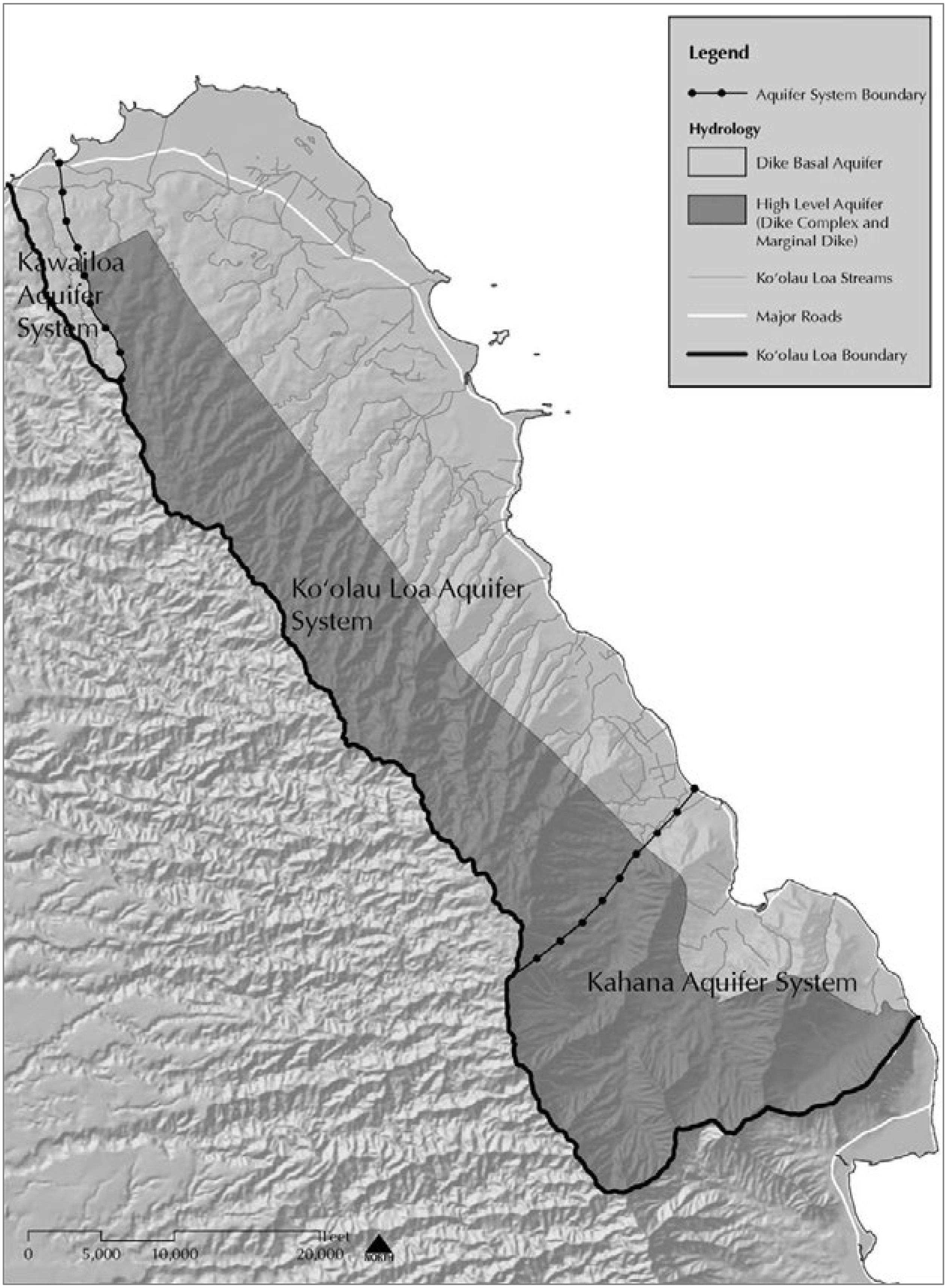
As a precautionary measure, CWRM, in adopting revised sustainable yields for the Waipahu-Waiawa and 'Ewa-Kunia aquifer system areas, created a milestone framework that required increasingly higher levels of study, monitoring and optimization as pumpage and allocation approached the sustainable yield. A similar approach could be applied to Ko'olau Loa.

A three-dimensional (3-D) numerical groundwater model calibrated to new deep monitor well data could provide discrete analysis of groundwater/surface water interaction, and could address climate change and other uncertainties.

PRELIMINARY SCOPE

Sustainable yield estimates should be updated periodically: 1) when pumpage and/or allocation approach the adopted sustainable yield; 2) to account for variations in hydrologic data such as rainfall, evapo-transpiration and runoff from changes in climate and land use; and 3) when new scientific technologies, research, methodologies and funding become available. This project reevaluates the Ko'olau Loa and Kahana aquifer system area sustainable yields.

- Develop a regulatory milestone framework for the Ko'olau Loa and Kahana aquifer system areas along the following areas:
    - Propose pumpage and allocation milestones triggering the implementation of various component hydrologic studies and monitoring data that will become the basis for a numerical groundwater modeling effort. For example, when Ko'olau Loa permitted use approaches 70% of the sustainable yield, or 25 mgd, reevaluation of sustainable yield is initiated as a precautionary measure.
    - Evaluate recharge by updating monitoring efforts for rainfall, runoff, evapo-transpiration and leakage into streams, caprock and estuaries, especially as climate change progresses.
    - Evaluate and account for aquifer boundary conditions of dike, dike basal, basal, alluvial and caprock formations.
    - Select an appropriate 3-D solute transport numerical model for determining sustainable yield. Utilize existing deep monitor wells in Punalu'u, Lā'ie and Kahana to calibrate the model.
    - Establish a cost estimate and obtain commitments from stakeholders to contribute to the hydrologic studies and the groundwater model's construction.
- Contract with USGS to conduct the modeling effort under the administration of the CWRM, whose direct responsibility is to regulate water resource protection and use.



Ko'olau Loa Aquifer Systems

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State Commission on Water Resource Management
- U. S. Geological Survey
- Honolulu Board of Water Supply
- University of Hawaiʻi Water Resources Research Center
- Koʻolau Loa Community

ESTIMATED COST

$500,000 for model construction and calibration

REFERENCES

CWRM Report on *the Hydrologic Investigation of Groundwater and Surface Water Conditions in the Windward Oʻahu Management area*, CWRM, 1990.
HRS 174-C, State Water Code.
Oʻahu Water Management Plan, 1990.
USGS Plan for Water-Resources Science in the Pacific Region, January 15, 2003.
Liu, Clark. Interim Report of a Research Project on Analytical Groundwater Flow and Transport Modeling for the Estimation of the Sustainable Yield of Pearl Harbor Aquifer. May 10, 2005.

2b Groundwater Source Protection

PROBLEM STATEMENT

The finite potable groundwater resources of Koʻolau Loa and Koʻolau Poko districts serve the entire Windward Oʻahu population. It is important to protect groundwater sources from potential contamination caused by land use activities and from seawater intrusion caused by over-pumping.

GENERAL BACKGROUND

The most significant potential threats to potable water sources are microbiological and chemical contamination and seawater intrusion from over-pumping. 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.

The State of Hawaiʻi Department of Health has complied with the federal act by sponsoring the University of Hawaiʻi Water Resources Research Center compilation of the Source Water Assessment Program (HISWAP, 2004). The report contains four elements including:

(1) Delineating zones of influence around drinking water sources where contaminants may reach the water supply;
(2) Identifying activities in the area that may contribute microbiological or chemical contaminants;
(3) Evaluating the susceptibility of the drinking water sources to contamination from these activities; and
(4) Increasing public awareness and providing access to the assessment information.

The HISWAP defines source water "susceptibility" as *"the potential for a Public Water System to draw water contaminated by inventoried potential contaminating activities (PCAs), at concentrations that would pose concern."* Relative susceptibility was determined using a numerical scoring system. The HISWAP addresses some 465 drinking water sources in the State of Hawaiʻi.

One example of establishing aquifer protection zones is the U.S. Navy's Waiawa lands, where a Hydrologic Zone of Contribution protects their potable water. This zone delineates the area above the Waiawa Shaft where development is restricted, and might serve as a model for other water purveyors.

ISSUES IN KOʻOLAU LOA

BWS potable water sources are located in Kawela, Kahuku, Kaipapaʻu, Maʻakua, Kaluanui, Punaluʻu and Kahana. These sources are located mauka of urban and agricultural activities, within or near the State Conservation District where development is restricted. The Hauʻula Well is surrounded by homes with cesspools, but is located over the thick caprock formation protecting the basal source water quality from ground disposal of wastewater into the caprock. The Lāʻie source on Hawaiʻi Reserves, Inc. land, and its protection is managed by the landowner.

BWS Rules and Regulations establish the Pass/No-Pass Zones *(Figure 2.6)* to protect the potable aquifer from contamination caused by cesspools, landfills, wastewater treatment plants and other waste disposal activities.

In the State SWAP report, susceptibility scores for groundwater sources on Oʻahu ranged from 0 to 2,119, with higher scores indicating greater susceptibility to contamination. By comparison, scores for Koʻolau Loa sources ranged from 0 to 99. This indicates that, on an island-wide scale, Koʻolau Loa's sources have a low potential for contamination. As treatment of contaminated wells is expensive, every effort should be made to prevent contamination.

BWS regularly monitors source water quality and salinity trends in deep monitor wells and adjusts pumping operations to prevent seawater intrusion impacts *(see Project 2d Punaluʻu Pumpage Optimization)*. DOH requires sanitary surveys to ensure that water system facilities are maintained and improved to prevent contamination from surface influences.

PRELIMINARY SCOPE

Establish a source water protection program and implementation plan that will:

- Convert all cesspools in the vicinity of potable drinking water wells to septic tanks and leach fields to improve the level of biological treatment before ground disposal.
- Continue to apply the BWS Pass/No-Pass Zone rules and regulations for new developments to protect potable aquifers, meaning no injection wells above the Pass/No-Pass Line.
- Establish "acceptable land uses" within source water capture zones and require new developments to conform either through agreements or changes to the zoning code to protect the water capture zones.
- Work to remove or mitigate existing PCAs from source water capture zones.
- Site new potable wells above existing urban and agricultural activities. Ensure pumping operational procedures that will prevent seawater intrusion.
- Establish specific best management practices for land use management applications.
- Increase public education and awareness to eliminate illegal dumping of chemicals, motor oil, batteries and other contaminants within source water capture zones and along streams.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

State Department of Health, U.S. Geological Survey, State Department of Agriculture, State Commission on Water Resource Management, Board of Water Supply, County Department of Planning and Permitting, Landowners, U.S. Army Garrison Hawaiʻi, Lāʻie Water Company.

ESTIMATED COST

Individual source area protection plan/studies could range from $50,000 to $100,000

REFERENCES

Counties Protecting Drinking Water Through Partnering, 2000, National Association of Counties.

Hawaiʻi Source Water Assessment Program Report, November 2004, EI-Kadi, Aly, Chittaranjan Ray, et. Al, Water Resources Research Center University of Hawaiʻi at Mānoa, prepared for State of Hawaiʻi Department of Health Safe Drinking Water Branch.

Hawaiʻi Ground Water Protection Strategy, 1990, State of Hawaiʻi Department of Health.

2c Drought Mitigation Strategies

PROBLEM STATEMENT

There is a statewide effort to address and mitigate the effects of drought, which 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 sizeable 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:

1) An analysis of past, current and projected water demand, instream flow needs for appropriate ecosystem protection, water availability, and potential water shortages;
2) A description of how shortages would be met, by increased supply, leak detection, water use efficiency, demand management and associated cost estimates;
3) A description of interagency coordination and public participation; and
4) Consideration of social and economic factors.

ISSUES IN KOʻOLAU LOA

Despite Koʻolau Loa's high rainfall, which ranges from 40" to 280" annually, the district is still affected by long-term drought. The dike formations in the Kahana, Koʻolau Poko and Waimānalo aquifer sector areas do not store as much groundwater as the basal aquifers in Koʻolau Loa, and while both areas are impacted by drought, the dike sources are impacted first. During long-term drought, well yields especially dike sources, drop below permitted uses. Drought plans should account for these long-term variations in climate.

In September 2003, CWRM completed a statewide Drought Risk and Vulnerability Assessment and GIS Mapping Project illustrating the spatial extent and severity of drought risk for different sectors throughout the state. The Lāʻie to Kahuku area of Koʻolau Loa (including Kawela) was identified as vulnerable to drought because of the potential impact on agricultural and commercial sectors. The plan also considered areas with less than 30″ of annual rainfall at severe or extreme risk for wildland fires (See *Project 3i Wildfire Management Plan*).

BEST MANAGEMENT PRACTICES (BMP)

State Drought Plan lists the following drought mitigation strategies:

1. Statewide Water Resources Monitoring and Impact Assessments
2. Development of New or Alternative Water Sources
3. Water Conservation Practices
4. Public Education Awareness and Outreach
5. Watershed Protection Partnerships
6. Legislation
7. 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 groundwater plan is activated if three or more index stations meet the prescribed low groundwater conditions.

The Punaluʻu aquifer low groundwater levels and chloride triggers are:

Caution:	17-feet or Chloride rises 8-12 ppm over three months
Alert:	16-feet or Chloride rises 12-16 ppm over three months
Critical:	14-feet or Chloride rises 16 or more ppm over three months

PRELIMINARY SCOPE

The Koʻolau Loa drought mitigation strategies should include:

- **Monitoring:** Establish low groundwater conditions for the larger users of groundwater wells and stream diversions. Evaluate and expand rain gages in Koʻolau Loa.
- **Alternative Sources:** See *Project 6c Increased Recycled Water* and *Project 6b Agriculture Well Development.*
- **Water Conservation Practices:** See *Project 6d Conservation Measures* and *Project 6e Agricultural Water Loss Minimization.*
- **Public Education Awareness and Outreach:** See *Project 5b Water and Watershed Education*
- **Watershed Protection Partnerships:** See *Project 5a Watershed Partnerships.*
- **Legislation:** Formally establish and authorize the Hawaiʻi Drought Council and its leadership structure to validate the recommendations of the Hawaiʻi Drought Plan. Provide funding: see *Project 5e Funding Mechanism and Fundraising*. 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 Koʻolau Loa Sustainable Communities Plan and zoning ordinances.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- National Weather Service
- U.S. Geological Survey
- Natural Resources Conservation Service
- State Department of Land and Natural Resources
- Commission on Water Resource Management
- State Department of Agriculture
- Windward Soil and Water Conservation District
- Honolulu Board of Water Supply
- City Department of Planning and Permitting
- Honolulu Fire Department
- Oʻahu Civil Defense
- Hawaiʻi Reserves, Inc.

ESTIMATED COST

See the various watershed and water supply projects cost estimates in this chapter

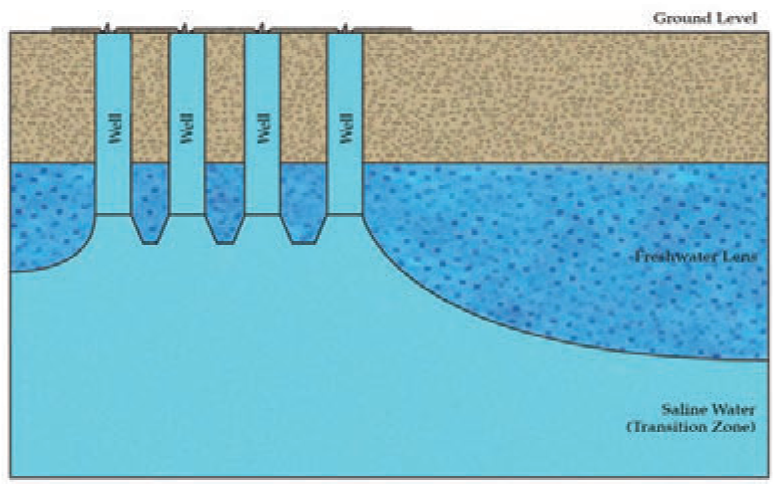
REFERENCES

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

2d Punalu'u Pumpage Optimization

PROBLEM STATEMENT

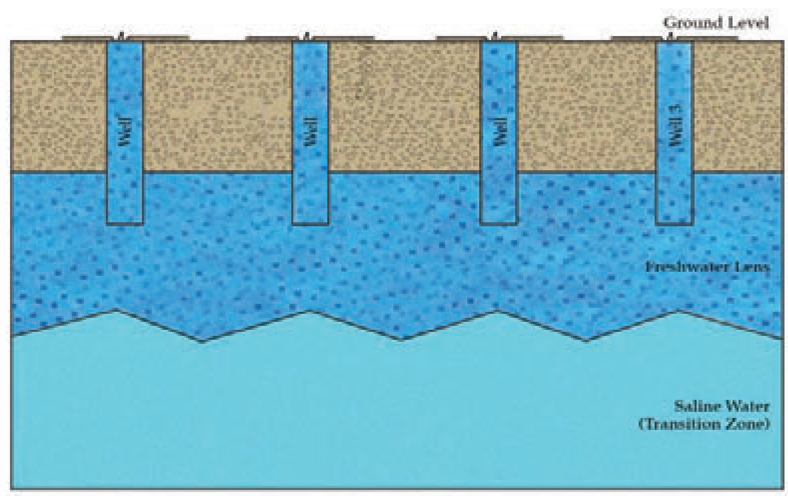
Groundwater withdrawal from the aquifers in Koʻolau Loa and the regional transport of water into Koʻolau Poko requires optimization, the even distribution of pumping, to ensure that pumping levels can be sustained with no detrimental impacts and to manage the high costs of transporting water over 25 miles into Kāneʻohe, Kailua and Waimānalo.



Clustered Well with Saline "Upconing"

GENERAL BACKGROUND

Pumpage optimization is applicable to both the sustainability of the aquifer and the management of operation and maintenance (O&M) costs from pumping and distributing water within the potable water system. With respect to aquifer health, pumpage is more sustainable if spread out among several wells and aquifers rather than concentrated at a few.



*Distributed Wells: **No** Significant Saline "Upconing" (CWRM)*

With respect to the water system, O&M costs are reduced if pumpage occurs within the area of demand, rather than being transported from far away. Pumpage optimization in Koʻolau Loa can occur by reducing pumpage from Punaluʻu wells and redistributing demand to smaller wells in Koʻolau Loa and Koʻolau Poko. Optimizing pumpage will reduce aquifer impacts in Punaluʻu during drought and reduce O&M costs of regional transmission between the two regions.

During the six-year drought from 1998 to 2003, source yields from dike sources within Koʻolau Poko dropped below permitted uses, increasing dependence on Koʻolau Loa's basal aquifer sources to meet demand. BWS Punaluʻu wells experienced decreasing groundwater levels and rising chlorides despite pumping within State permitted use.

Koʻolau Poko only has dike sources, while Koʻolau Loa has both dike and basal sources. Both are impacted by drought, but dike sources have smaller storage volumes than basal aquifers and thus are impacted first.

Punaluʻu wells supply about one quarter of Windward Oʻahu's drinking water; however, based on the long-term drought experience, BWS hydrologists recommend reducing pumpage below the State permitted use and distributed to other smaller wells, in addition to the conservation measures and diversification of alternative water supplies in Koʻolau Poko described in the water supply projects.

In response to the drought, BWS focused its leak detection and repair crews to Windward transmission mains. In two years of work, approximately 1.0 mgd of leaks were repaired, which benefited the aquifer and reduced BWS pumping costs. The leak repairs helped reduce Punaluʻu pumpage and allowed the aquifer to recover in a shorter period of time. Since other leaks will occur as pipelines age, leak detection and repair is a continuous process. Currently about 2,000 miles of pipelines on Oʻahu require maintenance.

ISSUES IN KOʻOLAU LOA

The Koʻolau Loa community has expressed concerns about the amount of water pumped to Koʻolau Poko. They understand that water can be transported out of Koʻolau Loa, but that transport should not be detrimental to Koʻolau Loa and should be used wisely and not wasted. Each district should strive for reliance on their region's natural resources.

Koʻolau Poko's hydrogeology does not support large water sources. Dike compartments are small except in Waiheʻe and Waiāhole but tapping dike water usually impacts stream flows. Therefore, Koʻolau Loa sources are needed to support the Kāneʻohe, Kailua and Waimānalo communities.

During drought, reliance on Punaluʻu Wells increases and water levels subsequently decrease while chlorides increase. During high rainfall periods, Punaluʻu pumpage decreases, allowing aquifer to recover.

The regional transport of water increases BWS O&M costs. It is more cost effective to pump sources within the areas of demand, but not enough source capacity exists in Koʻolau Poko. Distributing pumping from Punaluʻu wells to other sources will incur capital costs of constructing new wells to replace existing capacity. However, long-term sustainability justifies the additional capital investment.

PRELIMINARY SCOPE

Pumpage optimization combined with reducing regional water demand has several benefits for aquifer sustainability and water system O&M efficiency.

(1) Evaluate ways to reduce O&M costs by fully utilizing Koʻolau Poko's sources before importing water from Koʻolau Loa. Full utilization of groundwater sources in Koʻolau Poko will need to address impacts to surface waters.

(2) Affect advanced conservation and recycled water use and evaluate new wells that do not impact streams in Koʻolau Poko, such as Kūʻou Well III and Waimānalo Well III, to further reduce pumping from Koʻolau Loa. It is uncertain whether pumping Kūʻou Well III will impact surface water and if so, to what degree.

(3) Conduct regular leak detection and repairs of major transmission mains to reduce pumping in Koʻolau Loa.

(4) Transfer a portion of Punaluʻu Permitted Use to other wells within the Koʻolau Loa Ground Water Management Area, such as Maʻakua Well and Kaluanui Well.

(5) Reduce pumping in Punaluʻu to allow sufficient aquifer storage in anticipation of drought. It is also important to allow adequate post drought aquifer recovery.

(6) Improve the management of electrical power demand by operating smaller sources at a steady state, with larger sources and reservoir storage used for meeting peak hour demands.

If the above actions do not significantly reduce Punaluʻu pumpage, the development of the Kaipapaʻu exploratory well, which could reduce Punaluʻu pumpage by 1.0 mgd, will be pursued.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State Commission on Water Resource Management
- Board of Water Supply
- City and County of Honolulu Department of Planning and Permitting
- Department of Environmental Services
- Koʻolau Loa Community

ESTIMATED COST

New well development will cost about $6.0 million per 1 mgd of capacity, including connecting pipelines for planning, permitting, design and construction.

Water conservation and recycled water development in Koʻolau Poko can be invested in, up to the avoided cost of a new well.

3a Stream Clearing / Management

PROBLEM STATEMENT

Stream flow and its ability to reach to the ocean depend partially on human management of natural systems. Riparian habitat requires certain conditions that stream management practices can enhance. And, during a flood event, a lack of stream clearing and management can compound the effects of the storm on local communities.

GENERAL BACKGROUND:

Stream flow is important in many respects. ʻOʻopu, depend upon a stream's connection or flow to the ocean. Native algae species need ample stream flow, and stream flow may reduce the occurrence of invasive species. The ability of streams to flow to the ocean can also prevent some flooding issues.

Stream maintenance responsibility is somewhat confusing in Hawaiʻi. Part of the issue depends on the stream ownership. While water is a public trust resource, the stream bed in which it flows has individual ownership. Ownership typically extends from land parcels to the middle of the stream. This means that one landowner can own one side of a stream and another landowner the other side. This can create difficulties when undertaking a stream cleaning project.

Kahana Stream

ISSUES IN KOʻOLAU LOA

Over the years there have been changes in land use and stream maintenance in Koʻolau Loa. During the plantation era, stream management was more intensive especially around areas with diversions. In the past, vegetation in Kahana was regularly trimmed away from the stream bank edges on State land.

The mouths of streams and their ability to flow to the ocean are frequently dammed by silt and sand. Sand build-up prevents the stream from draining and can flood areas inland. As human activities such as agriculture and housing occur in Koʻolau Loa, the amount of runoff and soil erosion has increased, as has the damming effect. The City and County of Honolulu periodically obtains a permit from the State Department of Health to clear "stream outs", where the mouths of streams empty into the ocean. Often this occurs when there is a threat of a major storm/flooding event.

BEST MANAGEMENT PRACTICES (BMP)

Best management practices still need to be developed and shared with landowners. Landowners and land managers need to understand when can and should the stream mouths be opened to the ocean, what are the guidelines for vegetation trimming along stream banks, and what plants should be used along the stream to decrease the amount of stream cleaning maintenance. Some of the best management practices in *Project 3b Stream Conservation Buffers* would also be applicable once developed for Hawaiʻi.

PRELIMINARY SCOPE

- Develop and provide clear guidance to landowners and community groups on streamside clearing, optimizing native species habitat and providing flood relief.
- Develop a Koʻolau Loa Stream Restoration and Maintenance Community Guidebook to provide recommendations on stream buffers and restoration projects.
- Determine best management practices for Hawaiʻi streams to establish times for opening the streams to the ocean.
- Utilize "streamkeepers", area residents who care for and clean-up local streams with coordination provided by the City and County of Honolulu Adopt-a-Stream Program.
- Provide a streamlined system for clearing stream mouths during approved periods.
- Look into having City and County of Honolulu, State, or other designated entity own streambeds and provide appropriate and necessary maintenance. Establish a funding mechanism for the acquisition of the stream lands and for ongoing stream maintenance costs.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- City and County of Honolulu Department of Facilities Maintenance
- Department of Health Clear Water Branch
- Windward Soil and Water Conservation District
- U.S. Army Corps of Engineers
- University of Hawaiʻi College of Tropical Agriculture and Human Resources (CTAHR)
- State Office of Planning Hawaiʻi Coastal Zone Management (CZM) Program
- Landowners
- Koʻolau Mountains Watershed Partnership
- State Department of Transportation

Punaluʻu Stream

ESTIMATED COST

$200,000 to develop specific best management practices for Koʻolau Loa streams

REFERENCES

Kāneʻohe-Kahaluʻu Stream Restoration & Maintenance A Community Guidebook. City and County of Honolulu, Wilson Okamoto and Kāneʻohe-Kahaluʻu Vision Team. June 2004.

3b Stream Conservation Buffers

PROBLEM STATEMENT

Surface water runoff can carry soil and pollutants into streams and the ocean. When human activities such as agriculture and housing increase, runoff and soil erosion can increase as well.

GENERAL BACKGROUND

Because agriculture and housing threatened stream health, stream conservation buffers are frequently used on the U.S. Mainland. These buffers consist of land on the sides of streams that are permanently vegetated to slow runoff. Stream conservation buffers can help decrease the entry of sediment, nutrients and pesticides into streams from farm activities and housing areas. They can also lower stream temperatures and help to provide a better habitat for native stream species. Studies from the Conservation Technology Information Center (CTIC) indicate that stream conservation buffers can remove up to 50% nutrients and pesticides, up to 60% of pathogens, and up to 75% of sediment in runoff.

The USDA FarmShare program provides funds for farmers who create conservation areas, such as stream side areas. Although the program is well utilized on the Mainland, in Hawai'i the funding is not competitive with potential farming profits. Very few farms have stream conservation buffers. Only farmers leasing from State agricultural parks are required to have conservation plans and include stream conservation buffers, where applicable.

ISSUES IN KO'OLAU LOA

High levels of rainfall, especially in Ka'a'awa, Kahana, and Punalu'u, mean that there are large amounts of runoff that travel to the ocean predominately via streams. Also, agriculture in Ko'olau Loa is integrally related to streams, especially when surface water is used for irrigation.

Also, a concern is that landowners and tenant farmers may not be financially able to take land out of cultivation for stream conservation buffers. A program may be needed to provide ample compensation for implementing stream conservation buffers.

Stream Conservation Buffer Example
Cooperative Extension Services College of Tropical Agriculture & Human Resources University of Hawai'i

BEST MANAGEMENT PRACTICES (BMP)

Best management practices by Natural Resources Conservation Service (NRCS) and CTAHR should be actively promoted. The *Best Management Practices for Maintaining Water Quality in Hawaiʻi* (DLNR, February 1996) contains guidance for Stream Size Management Zones width, depending on percent slope and how erodible the soil is. The minimum buffer size is 35 feet on each side of the stream.

PRELIMINARY SCOPE

Questions, such as what constitutes an appropriate buffer in Hawaiʻi, still remain. Other questions to be addressed are: what types of native, and non-native, vegetation are best suited to protecting the stream and which options are the lowest maintenance for farmers and government agencies? While there are no regulations for maintaining riparian or wetland buffers, crucial water resources provide habitat and filtering functions for water quality.

- Develop supplemental financial compensation to the USDA Farmshare program and tailor it for both small and large landowners in Hawaiʻi.
- Inventory streams and prioritize those most in need of stream conservation buffers.
- Establish a task force to investigate the steps needed to integrate stream conservation buffers into new and existing farms and new developments.
- Conduct research to refine knowledge on the size and types of buffers needed, based upon factors such as adjacent land use, aquatic species habitat needs, and maintenance costs.
- Support organizations/native plant nurseries that provide plants for stream restoration.

Possible Participating Agencies/Organizations:

Natural Resource Conservation Service; Windward Soil and Water Conservation District; University of Hawaiʻi College of Tropical Agriculture and Human Resources; State Office of Planning Hawaiʻi Coastal Zone Management Program; City and County of Honolulu; State DLNR; U.S. Geological Survey; Landowners; Koʻolau Mountains Watershed Partnership.

ESTIMATED COST

$20,000 to 30,000 per stream for research and planning
Financial compensation for farmers is also needed

REFERENCES

Minimizing Pollution Risk from Forest and Streamside Areas Management, Cooperative Extension Service College of Tropical Agriculture & Human Resources University of Hawaiʻi at Mānoa. Dec. 2000.

"Evaluation of the Performance of Riparian Fencing on Stream Bank Stability and Stream Water Quality" and "Regional Approaches to Water Protection from Nonpoint Sources of Microbial Contaminants", CTAHR studies in progress.

Conservation Technology Information Center (CTIC) http://www.ctic.purdue.edu/CTIC/CTIC.html

Best Management Practices for Maintaining Water Quality in Hawaiʻi, DLNR, February 1996.

Riparian Restoration Plant Database (developed by Bishop Museum)

http://www.ctahr.hawaii.edu/rnre/Riparian_Restoration_Plant_Database.asp.

Hawaiʻi's Coastal Non-Point Pollution Control Program Management Plan, State Coastal Zone Management, 1996.

Stream Corridor Restoration: Principles, Processes, and Practices, Natural Resources Conservation Service, 1998.

3c Cesspool Inventory/Greywater Reuse

PROBLEM STATEMENT

Cesspools are used throughout Hawai'i for disposal of human wastes. They result in the direct discharge of raw sewage into the ground. The discharge to groundwater and surface water poses environmental and public health risks. They can release disease-causing pathogens and other contaminants, such as nitrate, to groundwater. Untreated sewage moves through the ground and can contaminate groundwater, streams and ocean waters.

from EPA Region 9 website

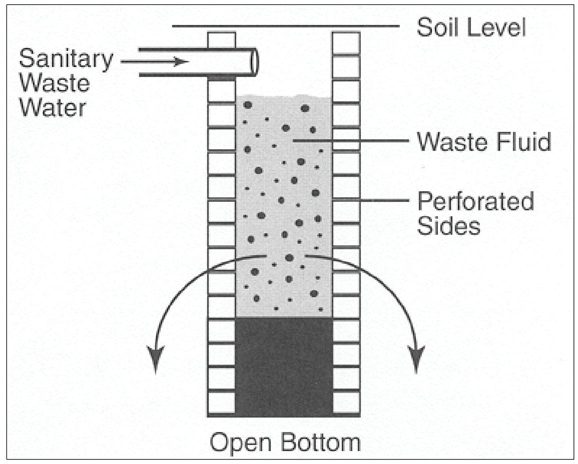


Diagram of a Cesspool

In contrast, greywater, which is the wastewater from all sources other than the toilet, can be resued for watering gardens thereby serving as supplemental water supply source to potable water sources.

GENERAL BACKGROUND

In areas where there are no sewer connections and a wastewater treatment plant, cesspools and septic tanks are frequently used to dispose of raw sewage. Often this occurs in rural areas where hooking up to an existing system or creating a treatment plant would be extremely expensive. Large-capacity cesspools for multifamily dwellings (non-residential facilites which serve 20 or more persons) are required as of April 5, 2005 to be closed. A 2005 estimate is that more than 1,500 large capacity cesspools are in violation statewide. The number of single-family cesspools in Ko'olau Loa is not known.

ISSUES IN KO'OLAU LOA

In Ko'olau Loa only limited areas have sewer connections to a wastewater treatment plant. The City and County of Honolulu operates a system in Kahuku and Lā'ie. Turtle Bay also has a wastewater treatment facility for the hotel and condominiums. The remaining areas in Ko'olau Loa lack a centralized treatment system and use on-site cesspools or septic tanks for sewage disposal.

The cesspools, which do not treat raw sewage, are mostly along the shoreline. As a result, nearshore waters may be contaminated with untreated sewage, and sewage may infiltrate into the caprock waters. It is unlikely that cesspools will affect drinking water sources, because the groundwater recharge areas for the aquifers are mauka of the conservation areas. The Pass/No-Pass line *(Figure 2.6)* serves to protect groundwater from contamination from cesspools and other contaminants by not allowing them mauka of the coastal caprock area.

Ideally, monitoring of the nearshore waters would provide more information on where the biggest sources of contamination are located. However, the constant mixing of ocean waters along the coastline of Koʻolau makes identification of contaminating cesspool locations difficult. A further complication is that the contamination of nearshore waters from cesspools would come via groundwater which is not easily traceable.

BEST MANAGEMENT PRACTICES (BMP)

Best management practices remove organic matter and harmful micro-organisms from the wastewater before it enters the ground, streams or ocean. A sewer system and secondary water treatment plant or an anaerobic treatment unit provide(s) the most treatment. A septic system provides some opportunity for breakdown through the leach field.

The cesspool system releases the wastewater almost directly into the ground without opportunity for treatment and is not a best management practice. Reducing the amount of water entering the cesspool can slow the flow of raw sewage into the surroundings. Water conservation is one way to reduce the amount of water entering the cesspool. Greywater resuse can also reduce the amount of water entering the cesspool. Where it is not feasible to replace cesspools, this is a desirable strategy.

PRELIMINARY SCOPE

- Work with landowners to replace the large-capacity cesspools in Koʻolau Loa.
- Work with DOH Safe Drinking Water Branch to inventory and verify that small-capacity cesspools are not threatening groundwater quality in recharge areas.
- Assist with developing alternative treatment mechanisms to cesspools.
- Permit homes with cesspools to recycle their greywater to reduce their water disposed and slow the flow of sewage into the surrounding area.
- Identify funding sources for the conversion of cesspools to other systems.
- Study the feasibility of wastewater treatment plant(s) for Kaʻaʻawa, Punaluʻu and Hauʻula areas.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

Koʻolau Loa Landowners, Mālama ʻOhana, EPA Region 9, Department of Health Wastewater Branch, State Department of Education, University of Hawaiʻi Sea Grant College Program, University of Hawaiʻi Water Resources Research Center, City and County of Honolulu Environmental Services Department, Wastewater Division, City and County of Honolulu Department of Parks and Recreation, Honolulu Board of Water Supply, Oʻahu Resource and Conservation Council, Rural Community Assistance Corporation (http://www.rcac.org/)

ESTIMATED COST

$20,000 to 25,000 to inventory cesspools; $12,000 to 15,000 to replace each cesspool

REFERENCES:

EPA Region 9: http://www.epa.gov/region09/water/groundwater/uic-hicesspools.html

"Many cesspool users likely to miss deadline" *Honolulu Advertiser*, February 28, 2005.

3d Pollution Prevention/ Low Impact Development

PROBLEM STATEMENT

The activities of residential and agricultural areas have the potential to pollute surface waters with trash, debris, and chemical contaminants that leach into the water, pose health threats, and degrade aquatic habitat both in the streams and nearshore waters.

GENERAL BACKGROUND

Urban stormwater drainage systems on Oʻahu are designed to prevent flooding, not to dispose of waste or pollutants. Stormwater flows from residences onto roadways and sidewalks, into drains, and directly to streams. In agricultural areas water and sediments flow through drainage channels to the streams. Agricultural chemicals may affect surface and groundwater quality. Water quality and aquatic life can be harmed when pollutants enter the storm drainage system and flow out to nearshore waters. The dumping of trash into streams can also contribute to the degradation of runoff water quality in communities around the island.

Green space is often desired for aesthetic reasons. However, it also performs an important ecological function. Pervious green spaces can reduce stormwater volumes and peak runoff rates, and remove pollutants from stormwater. Compact development that concentrates human impacts and maximizes green space can help to minimize effects of pollutants. A University of Connecticut study for the Nonpoint Education for Officials (NEO) program indicated that at 10% imperious cover, sensitive stream elements may begin to be lost from the system. At 11-25% pervious cover, streams are impacted and will likely experience degradation. The percentage of impervious cover is an indicator of stream quality and help in watershed management.

Low impact development (LID) techniques help to mitigate the potential environmental impacts of development by capturing and infiltrating stormwater into the soil as close to the source as possible. These techniques include bioretention areas, grass swales, and permeable pavements.

ISSUES IN KOʻOLAU LOA

As one of the most rural areas of Oʻahu, Koʻolau Loa contains few municipal drainage systems. Turtle Bay Resort, Kahuku, and Lāʻie have community storm drainage systems. The region's perennial streams, intermittent drainages and community drainage channels all intersect with Kamehameha Highway on their routes to the ocean. These waterways collect waste and pollutants from human activities on the adjoining lands and from the roadways.

Varying by location, the streams and drainage channels in Koʻolau Loa collect debris and pollutants from stormwater runoff or from people directly dumping rubbish and debris into streams and storm drainage canals. The agricultural practices may contribute to runoff pollutants, and forested areas also contribute nutrients, suspended solids. In a coastal community such as Koʻolau Loa, pollutants such as these can affect nearshore water quality and community health and safety in places where people fish, surf, and swim.

BEST MANAGEMENT PRACTICES (BMP)

- Keep watershed impervious surfaces at less than 25%.
- Encourage compact development with green space for stormwater infiltration.
- Minimize the amount of impermeable surface in developed areas using methods such as alternative parking lot surfaces.
- Promote stream and drainage ditch vegetated buffers in agricultural areas to prevent sediment loading and chemical contamination of stormwater run-off.
- Have residents keep yards, sidewalks, curbs and gutters clean and gather grass and tree cuttings and dispose as green waste or compost yard trimmings.
- Keep streams and drainage areas clear of rubbish and debris.
- Educate agricultural land users on best management practices with use of chemicals and fertilizers to avoid contamination of groundwater, streams, and coastal waters.

PRELIMINARY SCOPE

The scope of this project could be as follows:

- Encourage homeowners to minimize their impact on the watershed through practices such as sweeping instead of hosing down outside messes, and LID practices such as minimizing the amount of pervious surface.
- Integrate LID practices into building code and subdivision standards.
- Implement *Project 3b Stream Conservation Buffers*.
- Involve residents, community groups, and schools in conducting regular community cleanups that target streams and drainage channels and promote the City's Adopt-A-Stream program.
- Educate students, residents and farmers on point and non-point source pollution, stormwater issues, and the connections to the streams and nearshore waters.
- Conduct onsite walks to collect data that identifies human impacts on storm drains.
- Increase awareness of the City's various hotlines: Environmental Concern 692-5656 and Household Hazardous Waste Disposal 692-5411.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

City and County Environmental Services Department, Department of Health Stormwater Quality Branch, Landowners, Industries and Businesses; Schools; Youth Groups and Service Groups: Boy Scouts, Girl Scouts, Boys and Girls Club, Mālama ʻOhana

ESTIMATED COST

$10,000 per stream per year

REFERENCES

Tips to Protect Our Waters....For Life, City and County of Honolulu Department of Environmental Services.

Honolulu's Clean Water Program, City and County of Honolulu Department of Environmental Services.

Nonpoint Education for Municipal Officials Impervious Surface Research Report. 2003. Dr. Jack Clausen, Glenn Warner, Dan Civco and Mark Hood, University of Connecticut.

3e Invasive Species Assessments / Control

PROBLEM STATEMENT

Invasive species can create a hostile environment by crowding out native plant species (out-competing them for sun, water, nutrients or space), increasing soil erosion (the shallow roots of invasive species do not hold the soil), or increasing the threat of fire (increased combustible material).

GENERAL BACKGROUND

Invasive species can quickly change an ecosystem from native to non-native. These changes have the potential to harm the watershed by increasing soil erosion, decreasing surface water infiltration to groundwater, increasing the threat of fire, and decreasing diversity of plant types and roles in the environment.

Manuka (Leptospermum scoparium)

Preventing introductions of invasive species is the best strategy. The Coordinating Group on Alien Pest Species (CGAPS) has found that on average, over 100 documented alien species are newly established annually. The level of resources allocated is currently insufficient to protect Hawaiʻi from alien species invasions.

Invasive plant species are easiest to control if caught in the early stages when elimination may be possible. For example, one invasive species, the Fire/Faya Tree (*Morella faya*), was found in the Koʻolau Mountains and was removed entirely. Once a species is established, eradication may not be an option, and controlling the spread into other areas may be the goal. Mechanical, chemical and biological measures are all options used to control invasive species.

ISSUES IN KOʻOLAU LOA

In general, fewer invasive species are introduced in the mauka areas with their rugged, less accessible terrain. However, easy to access makai areas have more invasive and fewer native species. Efforts to protect the existing native plant species and remove of invasive species are focused mainly in the mauka areas.

Manuka (*Leptospermum scoparium*) can be found in the Kahuku and Lāʻie areas in Koʻolau Loa. It is a popular ornamental and can shade out native plant species. Some nurseries still sell this plant, which has fire-resistant seeds. The Kahuku Training Area contains a large manuka population in an area with few natives. Monitoring of the manuka is ongoing. Other invasive species in the Kahuku Training Area are *Melochia umbellata*, *Pennisetum setaceum* (fountain grass), and *Acacia mangium* (Mangium wattle) species, and are being monitored or controlled by the Army Natural Resource Center.

Many mauka areas have not been surveyed for invasive species. There may be plants in early stages of establishment that could be completely removed with early detection. The Koʻolau Mountains Watershed Partnership is undertaking a project to assess the invasive species present in the conservation areas and determine best practices to eradicate or control them.

BEST MANAGEMENT PRACTICES (BMP)

- Monitor periodically for invasive species and remove populations where feasible.
- Educate hikers, hunters, and gatherers to clean off shoes that may have soil from other areas of the island or from off-island as soil can be a carrier of invasive species seeds.

PRELIMINARY SCOPE

- Survey mauka areas for invasive species.
- Assist landowners in establishing invasive species control.
- Prioritize areas where native plant species are threatened and prioritize invasive species that may be a threat to groundwater recharge areas.
- Provide information to the public on invasive species that should not be purchased from plant nurseries.
- Work to ban invasive species from the plant nurseries and distributors.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- U.S. and State Department of Agriculture
- Koʻolau Mountains Watershed Partnership
- Coordinating Group on Alien Pest Species (CGAPS)
- Oʻahu Invasive Species Committee (OISC)
- State Department of Land and Natural Resources Division of Forestry and Wildlife
- Board of Water Supply
- U.S. Army Public Works, Environmental Division
- U.S. Department of the Interior
- U.S. Geological Survey

ESTIMATED COST

$130,000 project to develop strategy for the Koʻolau Mountains Watershed Partnership for invasive weed management; GIS mapping $1,500 per acre

REFERENCES

Coordinating Group on Alien Pest Species (CGAPS) http://www.hear.org/cgaps/

Oʻahu Invasive Species Committee http://www.hear.org/oisc/

U.S. Army Garrison Hawaiʻi, *Oʻahu Training Areas Natural Resource Management Final Report*, August 2004.

3f Feral Pig Management Plan

PROBLEM STATEMENT

Feral pigs and other hoofed animals in the forest spread weeds, inhibit reestablishment of native plants, destroy existing native plants, spread plant disease, displace plants and shift ecosystem plant composition, destroy native bird habitat, contaminate streams with urine and feces, create breeding grounds for mosquitoes, cause soil erosion, and harm stream biota.

GENERAL BACKGROUND

While various introduced mammals such as rats, mongoose, mice, pigs, and feral cats and dogs, are problematic for the native ecosystems, some of the greatest damage in watersheds results from feral pigs.

Animal control is a controversial topic. For some people there are concerns about harm to animals. For other people, the concern is that the introduced animals are destroying native species, and the lack of a "natural balance" between game mammals and the native plants and animals.

The ancestors of Native Hawaiians brought a species of pig to the islands as a food source. Pigs have long had cultural significance and continue to provide subsistence to many people. Since their introduction, however, the original species has been crossbred with larger domesticated pigs. The resulting pigs, have proliferated throughout the state.

Around the Hawaiian Islands, efforts are being made to protect native plant ecosystems from the harmful effects of pigs. These efforts have included fencing, hunting, and baiting. State records show that the number of wild pigs killed on O'ahu grew from 200 in 1999 to 294 in 2002. Those numbers only include pigs killed in hunts on public lands, not on private property, where many pigs are taken. To tackle the problem, the state is considering a return to a regular pig-hunting season that would offer three months of open hunting followed by a three-month hunting hiatus to increase the annual kill. The state now has sporadic open hunting for pigs.

ISSUES IN KO'OLAU LOA

Large land tracts in the mauka areas of Ko'olau Loa are affected by feral pig populations which contribute to significant loss of vegetation cover and soil erosion. These areas require management programs to avoid further growth of the feral pig population and the resulting damage to the watershed. The Ko'olau Mountains Watershed Partnership is a group of agencies and landowners organized to protect the mauka forested watersheds in the forestry reserve boundary. The Partnership has begun to address the issue of feral pig management as described below.

BEST MANAGEMENT PRACTICES (BMP)

- Identify and manage key watershed areas in Koʻolau Loa and native forest ecosystems for feral pig management areas.
- Initiate appropriate control measures which could range from fencing projects to protect the resources from feral pigs to management of pig hunting areas in heavily disturbed ecosystems.

PRELIMINARY SCOPE

- Develop a comprehensive feral pig management plan for the conservation areas, determining the most feasible control strategy for each area.
- Develop an umbrella Environmental Assessment and Conservation District Use Application for priority fences through range for construction within 5 years.
- Survey to define the extent of feral pig populations in Koʻolau Loa outside of the conservation areas.
- Determine feral pig control needs for the agricultural lands.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State and U.S. Department of Agriculture
- Koʻolau Mountains Watershed Partnership
- Landowners in the Koʻolau Mountains
- State Department of Land and Natural Resources
- U.S. Department of the Interior
- U.S. Army
- U.S. Geological Survey
- Board of Water Supply
- Queen Emma Foundation
- Kualoa Ranch
- Local Farmers
- Kamehameha Schools
- Hawaiʻi Reserves Inc.

ESTIMATED COST

Fencing projects are very expensive, ranging from $50,000 to $250,000. Hunting programs for management require funding to coordinate permits, negotiate access, train hunters, and monitor and report program results and efficacy; this may require a dedicated position. Opening an area for recreational hunting is considerably cheaper, but is not pig management.

REFERENCES

Scientific Research Relating to the Effects and Management of Pigs in Native Hawaiian Ecosystems, 2000.

Ecosystem consequences of low-density feral pig populations in Hawaiian montane rainforests, 2002, Vitousek and Foote, Stanford University, Department of Biological Sciences, and USGS Biological Resources Division, Pacific Island Ecosystems Research Center.

Policy on Feral Pigs in Hawaiʻi, 1987. Sierra Club Hawaiʻi, Chapter Executive Committee.

3g Wetland / Muliwai Restoration

PROBLEM STATEMENT

Many streams have nearshore wetlands and muliwai which provide a wide range of valuable natural functions; however, many have been filled or channelized near their ocean interface.

GENERAL BACKGROUND

A description of Hawaiʻi's wetlands includes those areas which *"…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."* About 110,000 acres of wetlands exist in Hawaiʻi in a variety of locations from the coast to the mountaintops. Despite this, nearly one-third of coastal wetlands were destroyed over the past 200 years.

Hawaiʻi's wetlands, both natural and man-made, provide many ecological functions, such as providing habitat for numerous native plants and animals. Wetland functions include infiltration and recharge of groundwater supplies, settling basins for sediment, and flood control. Further, Hawaiʻi's 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.

Environmental engineers and ecologists have installed constructed wetlands to take advantage of these bioremediation functions. Similarly, wetlands have been incorporated into water recycling projects as a method of filtering nutrients from greywater. Water from these systems may then be reused in toilets or as irrigation water for landscape. Existing and constructed wetlands also absorb stormwaters and prevent or reduce flooding of adjacent developed areas. Some developments have even incorporated "mini-wetlands" into their project designs for such purposes.

Natural wetlands and existing constructed 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 IN KOʻOLAU LOA

The largest wetland in Koʻolau Loa is the James Campbell National Wildlife Refuge in Kahuku and Mālaekahana, which provides habitat for various waterfowl, including native, migratory, and federally-listed threatened or endangered birds. The Koʻolau Loa region is a water-rich area, so wetlands are also found in areas of the major watersheds in Kaʻaʻawa, Kahana, Punaluʻu, Hauʻula, Wailele, Kahawainui and Kawela. Each of the streams in Koʻolau Loa has lower reaches that form muliwai, some with richer wetland characteristics than others.

Streams along the windward Oʻahu coastline empty into the ocean through a shoreline wetlands area known as a muliwai. These features vary in water volume, size and form due to the volume and frequency of major stream flows, and the physical factors from wind, ocean tides and ocean wave energy. Historically, some of the muliwai and coastal wetlands in Koʻolau Loa may have functioned as fishponds or taro loʻi, but many have since been filled in or degraded by the construction of Kamehameha Highway, highway culvert/drainage facilities, and coastline residential and park development. There is the potential to improve the physical and ecological characteristics of the affected muliwai areas, and recapture and enhance wetland values.

BEST MANAGEMENT PRACTICES (BMP)

Wetland restoration and preservation is often seen as a best management practice in itself. However, there may be significant benefit from the following actions: (1) inventory wetlands, biota, functions, and cultural and historic uses; (2) coordination among resource agencies, landowners, and community organizations; (3) vegetated buffers; (4) native plant restoration; (5) alien species removal; (6) interpretive signs/education; (7) fencing; (8) upstream water flow control/augmentation; (9) periodic management of debris, sedimentation and beach sand/ocean connection; and (10) constructed wetlands for water recycling.

PRELIMINARY SCOPE

Specific actions that could help to create, restore, and protect wetlands in Koʻolau Loa include:

- Follow proven approaches to wetland management from James Campbell National Wildlife Refuge.
- Monitor invasive species and conduct regular eradication efforts.
- Whenever feasible, restore cultural activities such as loʻi kalo or fishpond functions where they once occurred, for example, at Kahana.
- Identify and restore coastal wetlands.
- Restore native wetland vegetation for habitat and phytoremediation of muliwai waters.
- Fence areas to protect water birds from feral cats and other predators.

POTENTIAL PARTICIPATING ENTITIES

U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Geological Survey, Department of Land and Natural Resources Division of Aquatic Resources, State Department of Land and Natural Resources Division of Forestry and Wildlife, University of Hawaiʻi, Punaluʻu Watershed Alliance.

ESTIMATED COST

$1,500 to $2,500 per acre

REFERENCES

Hawaiʻi Wetland Management Policy, 1999, Hawaiʻi Wetland Management Policy Workgroup, State of Hawaiʻi Department of Health.

Ecologically Sensitive Wetlands on Oʻahu: Groundwater Protection Strategy for Hawaiʻi, 1987, University of Hawaiʻi Environmental Center.

USFWS Partners for Fish and Wildlife, Hawaiʻi and Pacific Islands, http://partners.fws.gov/pdfs/HI-iieeds.pd

3h Conservation District Boundary Review

PROBLEM STATEMENT

Portions of Koʻolau Loa's watersheds are classified within the State Agricultural District, but some watershed resources could more appropriately be managed as Conservation District lands.

GENERAL BACKGROUND

In the 1920's, many mauka areas were mostly treeless. The islands had lost large portions of forests to wild cattle and fires, and there was a lack of appreciation for Hawaiʻi's watershed and water supply areas. This spurred the private sector and territorial government to push laws for animal control, fencing and reforestation of these key mauka watershed lands.

Much of the history and reasoning behind the establishment of Hawaiʻi's land use classification system relates to large plantation agriculture areas and the intent to preserve the mauka watershed recharge and stream headwaters to supply irrigation water. The passage of the Land Use Law in 1961 established the State of Hawaiʻi Land Use Commission which has classified all lands in the State within one of four broad land use categories: Urban, Rural, Agriculture and Conservation.

The State Office of Conservation and Coastal Lands is responsible for overseeing Conservation District lands, including forest reserves and mauka watersheds. Stream headwaters and the upper elevation interior areas are typically designated as Conservation District areas.

Where the "non-agricultural" mauka lands transition into agricultural lower slopes, these became classified as the State Agricultural District, and are regulated by each County. The Agricultural District includes roughly 1.93 million acres for the cultivation of crops, aquaculture, raising livestock, wind energy facility, timber cultivation, agriculture-support activities (i.e., mills, employee quarters, etc.) and land with significant potential for agriculture uses. Some lands along the boundary of the Agricultural District possess resource characteristics that would more appropriately be classified as Conservation District.

With the decline of plantations over the past 20 to 30 years, much of the Agricultural District lands which had previously been cultivated are now overgrown. In transition areas, the resource characteristics merge, and the artificial Conservation-Agricultural boundary is even less clearly defined. Today, new pressures are mounting to develop the fallow mauka agricultural lands into agricultural homesteads and new urban uses.

The State Office of Planning last conducted a 5-Year Boundary Review of State Land Use classifications in the early 1990s (under Hawaiʻi Administrative Rules 205). Limited resources have hindered attempts to conduct a more recent review. The completion of the technical study itself does not result in a reclassification of land uses; a separate process is needed for district reclassification and is via a contested case, a quasi-judicial process.

ISSUES IN KOʻOLAU LOA

Much of Koʻolau Loa is classified as State Conservation District or State Agricultural District, with pockets of State Urban District land along the coastline Kamehameha Highway corridor.

Koʻolau Loa has many well-defined, distinct physical ridge and valley systems with traditional Hawaiian ahupuaʻa names. Upper elevation areas are designated as Conservation District. In certain valleys and mauka areas of Koʻolau Loa, however, the transition area land designated as Agricultural District clearly contains resources which are important to the stream headwaters, recharge to aquifer system, and natural watershed systems.

These range of uses and activities that are allowed under Agricultural District generally do not promote sound management practices for long-term protection of watershed resources. This issue concerns mostly private lands of Koʻolau Loa designated as Agricultural District in Kaʻaʻawa, Punaluʻu, Hauʻula, Lāʻie, Mālaekahana, Kahuku and Kawela. Some landowners have their own land management activities which respect and enhance the watershed resources of their lands, while lands owned by other landowners could benefit from improved land management practices. The range of issues includes small individual parcels being converted to agricultural plots with homesteads, to larger proposals for agricultural subdivisions and urban reclassification. Specific community concerns have been raised in Koʻolau Loa include a request for an expansion of the Conservation District boundary to encumber specific resource lands, which are currently designated as Agricultural District.

BEST MANAGEMENT PRACTICES (BMP)

In the most sensitive resource areas of Koʻolau Loa, best practices for managing resources in the mauka Agricultural District areas are as follows:

- Consider resource indicators, such as slope, soils, natural vegetation, habitat and watershed characteristics, which are unsuited for agricultural activities.
- Individual landowners should address resource values in future agricultural uses.
- Public decision-making on land use district reclassifications from Conservation to Agricultural District should consider overall watershed resource values.

PRELIMINARY SCOPE

The following actions are recommended:

- Conduct a 5-Year State Land Use Boundary Review, including an evaluation of the watersheds resource indicators such as slope, soils, natural vegetation, habitat and watershed characteristics, which are unsuited for agricultural activities.
- Educate landowners about resource management options for the transition lands, and encourage projects to enhance the mauka agricultural lands with sensitive resources.
- Petition to reclassify the Conservation District Boundary in specific instances where resource values are threatened by ongoing or future agricultural activities.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

State Office of Planning, Department of Land and Natural Resources, City and County Department of Planning and Permitting, U.S. Geological Survey, Landowners, Community, Koʻolau Mountains Watershed Partnership

ESTIMATED COST

$150,000 for the Statewide Boundary Review

REFERENCES

DLNR, State Conservation District Study, Pacific Planning, 1998.

3i Wildfire Management Plan

PROBLEM STATEMENT

Wildfires cause widespread damage to native ecosystems, increasing erosion and destroying native species and their habitat. Portions of the Koʻolau Loa watersheds are susceptible to wildfires during low rainfall periods, which results in loss of vegetation groundcover and large exposed areas vulnerable to erosion.

GENERAL BACKGROUND

Wildfires are a common summer occurrence on Oʻahu, particularly in leeward areas. In 2004, Oʻahu experienced 465 wildfires, and in 2005 had over 800 brushfires. Brush fires are generally fought by Honolulu Fire Department personnel, and additional fire suppression support may come from the military, State, and the private sector. Fire fighting unit participation usually depends on the location of the fire and the resources threatened. The DLNR has primary responsibility for fires in forest and natural area reserves, and their budget for a fire protection program has proven inadequate during years with very active wildfire seasons.

Native species, including threatened and endangered species and their habitat, can be 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. Structural damage to private property or government facilities is also a potential hazard.

Wildfires often start in accessible urban and agricultural zones and travel upslope to native forests. While some brushfires are caused by human carelessness, accidents, or electrical malfunctions, many of the wildfires witnessed in recent years are believed to be intentionally set.

ISSUES IN KOʻOLAU LOA

Wildfire prevention is an important element during periods of drought and is part of the drought mitigation plan for Oʻahu. Due to its generally wet climate, much of Koʻolau Loa has been spared from significant wildfires.

Koʻolau Loa's forests are home to many species of native plants and animals, including some threatened or endangered plant species. The presence of sensitive species complicates decisions when helicopters are used for water drops on areas that are difficult to access on foot. If no freshwater dipping ponds are available for use, helicopter operators may choose to use ocean water. However, the use of seawater to control fires often damages the very plants that fire fighters are trying to protect. Brush fires in the mauka-forested areas can affect ecosystem dynamics.

BEST MANAGEMENT PRACTICES (BMP)

In the agricultural slopes and mauka watershed areas wildfire prevention measures can include:

- Engineering fire management structures such as fuel breaks, dip ponds, and fire caches.
- Educating the public on the dangers of careless behavior and how they can reduce risks.
- Conducting fire-wise campaigns in high-risk communities.
- Developing coordinated operational plans among landowners, managers, and agencies.
- Acquiring needed equipment, training, and budget.
- Restoring buffer between conservation and agriculture/urban zones for fire control.
- A wildfire prevention education component; youth/landowners participation; keeping fuels low; cooperating to minimize threat to property.

PRELIMINARY SCOPE

The following actions are recommended for consideration in preventing or preparing for wildfires in Koʻolau Loa:

- Increase community awareness through known user groups: hunters, hikers, etc.
- Identify and prepare freshwater sources (dipping ponds) for aerial fire fighting use.
- 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 to 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.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- Honolulu and Federal Fire Departments
- State Department of Land and Natural Resources
- U.S. Army
- Oʻahu and State Civil Defense
- U.S. Geological Survey
- Landowners and Koʻolau Mountains Watershed Partnership
- Board of Water Supply

ESTIMATED COST

$25,000 to $50,000

REFERENCES

U.S. Army, Hawaiʻi and 25th Infantry Division, January 2000, *Wildland Fire Management Plan, Pōhakuloa & Oʻahu Training Areas.*

Wakida, Charles K., 1997, *Mauna Kea Ecosystem Wildland Fire Management Plan*, State of Hawaiʻi Department of Land and Natural Resources Division of Forestry and Wildlife.

3j Crop Water Demand

PROBLEM STATEMENT

The potential range of agricultural water needs should be evaluated by individual crop type for more accurate future water planning and allocations. Crops needing evaluation include those grown using traditional agricultural practices.

GENERAL BACKGROUND

The State has large areas of unused agricultural land which were previously served by various water systems during the days of the sugar plantations. The State should complete the agricultural water system inventory and the State Agricultural Water Use and Development Plan to establish crop water demands. Diversified agriculture, in this post-sugar plantation era has emerged as an expanding agricultural market.

State Department of Agriculture Kahuku Agriculture Park

It is critical to define the future needs for agricultural water in rural areas of the state. If agricultural water use is not established or planned, unused agricultural groundwater could potentially be reallocated to other uses, such as domestic use, especially if low priority agricultural lands near urban centers are considered for future rezoning. Water needs for current and future farming can be matched with either groundwater or surface water sources.

ISSUES IN KOʻOLAU LOA

Farming areas located in Kawela, Kahuku, Lāʻie, Hauula, Punaluʻu and Kahana depend upon a reliable and affordable supply of irrigation water. There is interest in continuing the existing agricultural water systems, and expanding irrigation supply systems with new crop areas. In Koʻolau Loa, agricultural water supply is primarily served by groundwater sources. Surface water diversions also provide irrigation supply to agricultural areas in Punaluʻu and Kahana. Traditional and customary practices include irrigating agriculture via stream diversions or spring-fed sources. There is also interest in restoring and expanding traditional agricultural uses, such as loʻi kalo.

Data and participation on water usage studies has been historically difficult to obtain. Water use data are often considered proprietary by agricultural operators; people may fear regulatory consequences of reporting their water use. The process of gathering water use information needs to ensure confidentiality to the participants.

PRELIMINARY SCOPE

- Conduct an inventory of Koʻolau Loa agricultural enterprises, including specific crop types, acres in cultivation and irrigation type.
- Quantify existing water uses by area and associated water source.
- Examine actual water use by individual crop type in Koʻolau Loa.
- Project future water use for agricultural purposes for the Koʻolau Loa region based on a range of agricultural development scenarios.
- Account for traditional agricultural uses, including potential expansion and restoration of traditional crops.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State Department of Agriculture
- State Commission on Water Resource Management
- Department of Land and Natural Resources
- Office of Hawaiian Affairs
- Kamehameha Schools
- U.S. Natural Resources Conservation Service
- Kahuku Farmers
- Punaluʻu Farmers

ESTIMATED COST

Koʻolau Loa Agricultural Inventory & Irrigation Survey: $100,000-$150,000

Agricultural Plan for Koʻolau Loa: $75,000 to $100,000

Individual Crop Studies: $25,000 to $50,000

REFERENCES

Agricultural Water Use and Development Plan, State of Hawaiʻi Department of Agriculture, December 2004.

UH College of Tropical Agricultural Research and Human Resources (CTAHR).

http://www.ctahr.hawaii.edu/ctahr2001/Research/index.html

4a Loʻi Kalo Expansion

PROBLEM STATEMENT

The extent of active kalo (taro) cultivation in Koʻolau Loa is quite limited despite an historical record of kalo cultivation throughout the region. There are a number of loʻi (paddies) kalo systems that are no longer functioning.

GENERAL BACKGROUND

Kalo *(Colocasia* esculenta), well known throughout Polynesia, Asia, and Indonesia, is one of the oldest known cultivated crops in the world. Kalo, has long been integral to the agricultural, nutritional, and spiritual traditions of Hawaiians.

In Hawaiʻi, a sophisticated system of terraced farming was and is used. These wetland agricultural systems consist of irrigation channels and irrigated terraces; they range from small plots that could be farmed by families, to large complex structures that required coordinated community efforts. Remnants of these agricultural systems may be found in some areas of the Koʻolau Loa watersheds.

Today kalo is an important crop to the many cultures represented in Hawaiʻi, thus creating a large demand. Fifty years ago, there were 14 million pounds of taro grown on thousands of acres and poi cost 13 cents a pound at the market; this is in contrast to today's prices where poi can cost more than $3.50 a pound.

Wetland kalo farming is not without its obstacles. Disputes over water rights can emgage parties in legal battles for years. Farmers' concerns include soil loss, invasive pests, kalo pathogens, kalo rot, weed control, crop damage by feral pigs, lack of infrastructure to meet water needs, lack of land to meet production demands, farmland conversions to non-agricultural uses, and potential increases in regulations on farms (e.g., Endangered Species Act, Clean Water Act).

ISSUES IN KOʻOLAU LOA

The communities of Kahuku, Lāʻie, Hauʻula, Punaluʻu, Kahana and Kaʻaʻawa all contain areas of active kalo cultivation. Some of these are small individual residential-scale loʻi, and others involve more expansive cultivation over several acres. Kahana Valley and Punaluʻu have the most extensive loʻi kalo, with committed individuals and groups of people maintaining these systems. The Punaluʻu loʻi is part of an educational program established by Kamehameha Schools.

Despite demand, significantly less kalo is grown locally. Farmers may lack land ownership and or access to existing kalo fields on either private or public lands. Additionally, farmers are unable to utilize functional agricultural systems such as ʻauwai and loʻi fields because new water diversions may not be granted.

The most promising impetus for kalo recovery, restoration, and renewal in Ko'olau Loa is embedded in the cultural significance of the practice. Opportunities exist to open small, manageable plots for cultural, educational, and social fulfillment. Many practitioners have moved into the educational aspect of kalo cultivation, coupling labor with education and the art and technology of agriculture, while teaching Hawaiian culture.

PRELIMINARY SCOPE

This project will support those interested in pursuing kalo cultivation on a community scale.

- Conduct *Project 4b Watershed Oral History Studies* and archival research to identify lo'i kalo systems in Ko'olau Loa.
- Identify and prioritize lo'i systems that can be restored for use.
- Rezone lands as "cultural agricultural districts."
- Establish "lo'i agricultural parks" (public lo'i parcels).
- Identify minimum water demand per acres and water sources for taro restoration.
- Identify government agencies to coordinate maintenance of agricultural irrigation systems.
- Develop cooperative agreements to manage irrigation systems in the government and community.
- Provide incentives for kalo growing and community support.
- Provide tax relief for privately owned parcels used for kalo farming use.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- U.S. Natural Resources Conservation Service
- Office of Hawaiian Affairs
- Hawai'i State Department of Agriculture
- Farm Bureau
- University of Hawai'i College of Tropical Agriculture and Human Resources
- Families, farmers, and community organizations

ESTIMATED COST

Individual project cost varies by individual lo'i conditions, with project costs ranging from major lo'i restoration projects $100,000+, to an estimated $50,000+/year to manage each lo'i.

REFERENCES

UH CTAHR website located at: http://www.ctahr.hawaii.edu/ctahr200l/

Kalo Kanu o Ka 'Āina. County of Maui, 1995.

Uyehara, Kimberly, *Conservation Practices for Native Wildlife Habitat on Wetlands Taro Farms*, USDA, NRCS, Tropical Technology Consortium, August 2, 2004.

WEC Project website located at: http://www3.csc.noaa.gov/waianae/

Hayworth, Phil, *No Mo' Poi?*, Midweek Magazine, March 16, 2005.

Gima Craig, *Demand Makes Poi Shortage Possible,* http://starbulletin.com/2004/05/16/news/ story6.htm

4b Watershed Oral History Studies

PROBLEM STATEMENT

Native Hawaiians watershed or ahupuaʻa management involved a relationship with the ʻāina (land) that developed over hundreds of years. In more recent history, families that worked the plantations also had an intimate understanding of the landscape. Much of this knowledge and information may be lost with their passing and needs to be recorded.

GENERAL BACKGROUND

Recording the oral histories of the watershed will provide an opportunity to utilize local knowledge for sound decision making in resource management while preserving the legacy and traditions of the its people and places.

Huilua Fishpond

During periods of ahupuaʻa-based management, appointed konohiki (resource managers), delegated land uses and fishing. They were assisted by recognized loea, experts in various specialties such as forest use, irrigation, and fishing. This knowledge and expertise has been handed down through families, and should be sought out and preserved.

The plantation days were times of great change for the land and water resources. Oral histories can help to record the types of management used during periods of intense cultivation and their subsequent outcomes.

ISSUES IN KOʻOLAU LOA

Koʻolau Loa possesses a rich agricultural history from pre-contact to present. Understanding past management can help inform future decisions and projects. There may be heiau, burial sites and other historic sites in need of preservation and/or protection. Former loʻi kalo areas may be targeted for restoration. Information on how water resources have redirected over time may guide discussion and decisions on flood control.

Kamehameha Schools' report with oral histories for the Punaluʻu area may serve as the foundation for other watershed projects in the Puanluʻu ahupuaʻa.

PRELIMINARY SCOPE

- Conduct interviews with elders who have or have had associations with the watershed.
- Research Bishop Museum and other historical archives for maps and photos related to past land and water uses.
- Review known or recorded oral traditions in historical archives and newspaper accounts including moʻolelo (historical accounts), kaʻao (legendary accounts), and oli (chants) of areas within Koʻolau Loa that may provide information to traditional land use patterns and practices.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- Community Elders
- Office of Hawiian Affairs
- State Department of Historic Preservation
- Bernice Pauahi Bishop Museum
- University of Hawaiʻi College of Tropical Agriculture and Human Resources
- Landowners
- Hawaiʻi Historical Society
- University of Mānoa Oral History Center
- Hula hālau and other community cultural organizations

ESTIMATED COST

$20,000 to 30,000 per community

REFERENCES

He Wahi Moʻolelo no Punaluʻu, Kumu Pono Associates for Kamehameha Schools, 2005.

Ka poʻe kahiko o Waiʻanae: Oral Histories of the Waiʻanae Coast of Oʻahu. Waiʻanae Coast Culture and Arts Society, 1986.

Kalo Kanu o ka ʻĀina: A Cultural Landscape Study of Keanae and Wailuanui, Island of Maui, County of Maui Planning Department, May 1995.

Native Planters in Old Hawaiʻi Their Life, Lore and Environment, Handy and Handy, Hawaiʻi 1991.

Olelo Noeau, Mary Kawena Pukui, 1983.

4c Cultural Educational Programs

PROBLEM STATEMENT

There is a need to educate youth and the general community on Native Hawaiian cultural practices, particularly those related to watershed or ahupuaʻa management in Koʻolau Loa.

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 Hawaiians to practice and perpetuate traditional cultural practices and values.

Cultural knowledge is necessary for sound decision-making in resource management to preserve the legacy and traditions. During periods of ahupuaʻa-based management, there were appointed konohiki (resource managers), who delegated land uses and fishing. They were assisted by recognized loea, experts in various specialties such as forest use, irrigation, and fishing. This knowledge and expertise has been handed down through families and should be sought out. Oral histories are being taken to record the types of management that were used during periods of intense cultivation and the subsequent outcomes. Growing knowledge of Native Hawaiian cultural practices would support cultural and natural restoration activities, as well as individual development.

ISSUES IN KOʻOLAU LOA

Understanding the cultural setting of Koʻolau Loa and the traditional uses of the land are critical to future decisions regarding watershed management in this region.

Opportunities for cultural education exist at many levels. Pre-kindergarten children's programs at QLCC in Punaluʻu are presently integrating cultural elements into the classroom. Elementary schools in the DOE system have a 4th grade module in Hawaiian culture. However, there are few formal programs for older students or adults to continue learning about cultural history. Older students and adults that participate in a hula hālau are able to enrich their understanding of Hawaiian culture. The Koʻolau Loa Hawaiian Civic Club and Mālama ʻOhana also conduct programs which aid the community's understanding of history and culture.

A deeper understanding of Hawaiian culture is needed in the community to provide a stronger grasp of the reasons for cultural-based watershed planning and management. The key cultural leaders in Koʻolau Loa may have the desire to reach out to the broader Koʻolau Loa community for cultural education programs, but this will take time and resources.

PRELIMINARY SCOPE

- Define existing cultural education programs in Koʻolau Loa, such as QLCC, QEF, KS, and others, to establish a cultural education program, network and baseline database.
- Research Bishop Museum and other historical archives for maps, photos and accounts related to past land and water uses. See also *Project 4b Watershed Oral History Studies.*
- Work with key participating agencies and organizations to define a Strategic Plan for Cultural Education.
- Initiate regional program for Koʻolau Loa cultural education, including focused programs to specific ahupuaʻa (Punaluʻu, Kahana, etc.).
- Work with local schools to implement cultural education curricula, with units tied to the Koʻolau Loa setting.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State Department of Land and Natural Resources, State Historic Preservation Division
- Bernice Pauahi Bishop Museum
- Kamehameha Schools, ʻĀina Ulu Program
- Office of Hawaiian Affairs
- Queen Emma Foundation, Mālama ʻOhana
- Queen Liliuokalani Children's Center
- Landowners
- Hawaiʻi Historical Society
- Hula Hālau and other community cultural organizations
- Individual Kupuna/Elders of Koʻolau Loa

ESTIMATED COST

$10,000 to $20,000 for program start-up

REFERENCES

Ka poʻe kahiko o Waiʻanae: Oral histories of the Waiʻanae Coast of Oʻahu. Waiʻanae Coast Culture and Arts Society, 1986.

Kalo Kanu o Ka ʻĀina: A Cultural Landscape Study of Keanae and Wailuanui, Island of Maui, County of Maui Planning Department, May 1995.

Native Planters in Old Hawaiʻi Their Life, Lore and Environment, Handy and Handy, Hawaiʻi 1991.

Olelo Noeau, Mary Kawena Pukui, 1983.

4d Fishpond (Loko Iʻa) Restoration

PROBLEM STATEMENT

In earlier days, Native Hawaiians constructed rock wall impoundments in the shallow nearshore waters to grow and hold fish for future harvest. Most of the historic fishponds of the Koʻolau Loa region have disappeared; however, people are beginning to re-create these features and restore their function.

GENERAL BACKGROUND

Huilua Fishpond (Kahana)

In ancient Hawaiʻi, fishponds were an integral part of the ahupuaʻa, the land area that stretched from the mountains to the coral reefs. The Hawaiians built rock-walled enclosures in nearshore waters, to raise fish for their communities and families. Fish entered the pond through a makaha, a sluice or wooden gate in the stone wall that enclosed the seaward side of the pond. The fish soon grew too large to swim back out through the gate and were easily caught. More than 75 of these ponds were believed to have been in production at one time or another on the island of Molokaʻi alone, and an estimated 488 statewide.

As Hawaiʻi agricultural system began to focus on cash crops, fishpond use declined. In some cases, the fishponds became significantly contaminated by polluted runoff from urbanization, overgrazing, and agricultural production. It is estimated that up to 95% of these ponds require some level of restoration. A revival of traditional aquaculture techniques has been ongoing for several years in Hawaiʻi. For many Hawaiians, fishpond restoration is a step toward a sustainable future and preserving an important part of Hawaiian culture. In September 2004, a statewide fishpond conference of fishpond operators was held at Heʻeia Fishpond with over 70 people representing fishpond operators, non-profit foundations, government officials, educators, scientists, entrepreneurs and interested community members attending.

Thirteen fishponds have been restored statewide, with six ponds currently in use: three on Molokaʻi, one on the island of Hawaiʻi, and two on Oʻahu. Through Project Loko Iʻa, the Hawaiian Learning Center at the Keawanui fishpond on Molokaʻi has been established to provide the local, state, aquaculture and research community an opportunity to view, discuss and experience a working fishpond and demonstration ahupuaʻa. The strategic plan also calls for continued education and research in fishpond management, aquaculture, ecosystems, water quality, business/marketing and Hawaiian culture.

ISSUES IN KOʻOLAU LOA

Kahana's Huilua Fishpond covers seven acres at the mouth of Kahana Stream. Currently under restoration, fed by the ocean and springs, the fishpond was designated a national historic landmark in 1962 and is home to salt and freshwater fish. Historians believe Hawaiians built the fishpond between 1400 and 1600 A.D., when many such ponds were built along the windward coast.

Mullet (*ʻamaʻama*) and Milkfish (*awa*) are commonly seen in and around Huilua Fishpond. Huilua Fishpond and other lowland areas are also home to the Black Crowned Night Heron (*ʻaukuʻu*), Golden Plover (*kolea*), Ruddy Turnstone (*ʻakekeke*), Sanderling (*huna kai*), and Wandering Tattler (*ʻulili*), as well as two endangered species, the Hawaiian Coot (*ʻalae keʻokeʻo*) and the Hawaiian Gallinule (*ʻalae ʻula*).

Opposite the fishpond on Kahana Bay's northern shore is Kapaʻeleʻele Koʻa, a fishing shrine where Hawaiians performed ceremonies and made offerings to ensure good catches. Above the shrine is a lookout point for sentinels who scanned the ocean for schools of fish and then signaled their location to fishermen below. Due to the high wave energy along the remainder of the Koʻolau Loa coastline, there may be no other sites with the same conditions as Kahana Bay. Historical research of the region may yield other locations in Koʻolau Loa where fishpond restoration may be considered.

PRELIMINARY SCOPE

The Fishpond Restoration project will support those interested in pursuing fishpond construction and management at a community scale.

- Seek programs and organize efforts to continue the Huilua Fishpond Restoration.
- Organize volunteers at Huilua to help gather rocks and clear mangrove.
- Develop cooperative agreements with government and community.
- Clarify regulations and streamline permitting for fishpond restoration.
- Identify and prioritize potential other fishpond restoration locations in Koʻolau Loa.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

- State of Hawaiʻi Department of Land and Natural Resources
- Koʻolau Loa families and community organizations
- University of Hawaiʻi (Sea Grant)
- Office of Hawaiian Affairs
- U.S. Environmental Protection Agency

ESTIMATED COST

Project costs ranging from major fishpond restoration projects $100,000+, to an estimated $30,000 to $40,000/year to manage a fishpond.

REFERENCES

U.S. Environmental Protection Agency, Region 9. http://www.epa.gov/Region9/water/lokoia.html

HI Dept. of Land and Natural Resources. http://www.hawaii.gov/dlnr/dsp/kahana.html#panoramas

4e Cultural Monitoring Program

PROBLEM STATEMENT

Construction projects by the BWS, their contractors, and other contractors/developers can affect cultural resources. Consultation with the Native Hawaiian community is critical to protecting these cultural resources.

GENERAL BACKGROUND

Without proper precautions, valued historic and cultural resources in Hawai'i can be unknowingly disturbed, or completely destroyed. Care must be taken to develop and follow appropriate procedures and protocols to handle each potential encounter with foresight and sensitivity. While archaeological monitoring is one contingency tool provided in the State's historic preservation review process, another valuable tool is the use of cultural monitors. Although cultural monitoring is not legally defined in applicable State and County rules, the use of such monitoring has become standard practice supported by regulatory agencies when addressing possible impacts of a project's design or construction within or near vicinity to highly sensitive areas known to contain historic or cultural resources. These resources can be tangible elements such built historic properties, features, or sites as well as intangible properties such as traditional cultural landscapes or culturally important visual corridors.

In development areas likely to impact Native Hawaiian cultural sites, a cultural monitor can provide additional assurances to the Native Hawaiian community that important resources are being properly treated. Cultural monitors: act as independent observers who are both knowledgeable of and sensitive to Hawaiian site management, and who have the trust of the local community. They work closely with archaeologists as a liaison with the Native Hawaiian community;,provide additional expertise as to identifying specific elements of historical or cultural importance within an affected area (especially when sites are found or inadvertently discovered during construction or while conducting the project activity), and assist in the care and treatment of these sites or in specific cases, the care of iwi kupuna, ancestral remains.

ISSUES IN KO'OLAU LOA

Ko'olau Loa possesses a rich cultural history and the BWS uses its cultural monitoring program for projects in the area. Cultural monitors for work in Ko'olau Loa need to possess local knowledge or genealogical ties to the area in addition to established community credibility and authority.

Although BWS is currently the only entity employing this program, cultural monitoring is relevant to other projects being developed in Ko'olau Loa. Other development/construction projects by other agencies can build on BWS experience.

PRELIMINARY SCOPE

- Strengthen the existing BWS program in Koʻolau Loa for cultural consultation, facilitation/liaison and monitoring as related to BWS repair and replacement or new projects.
- Expand the program to other entities and developers.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

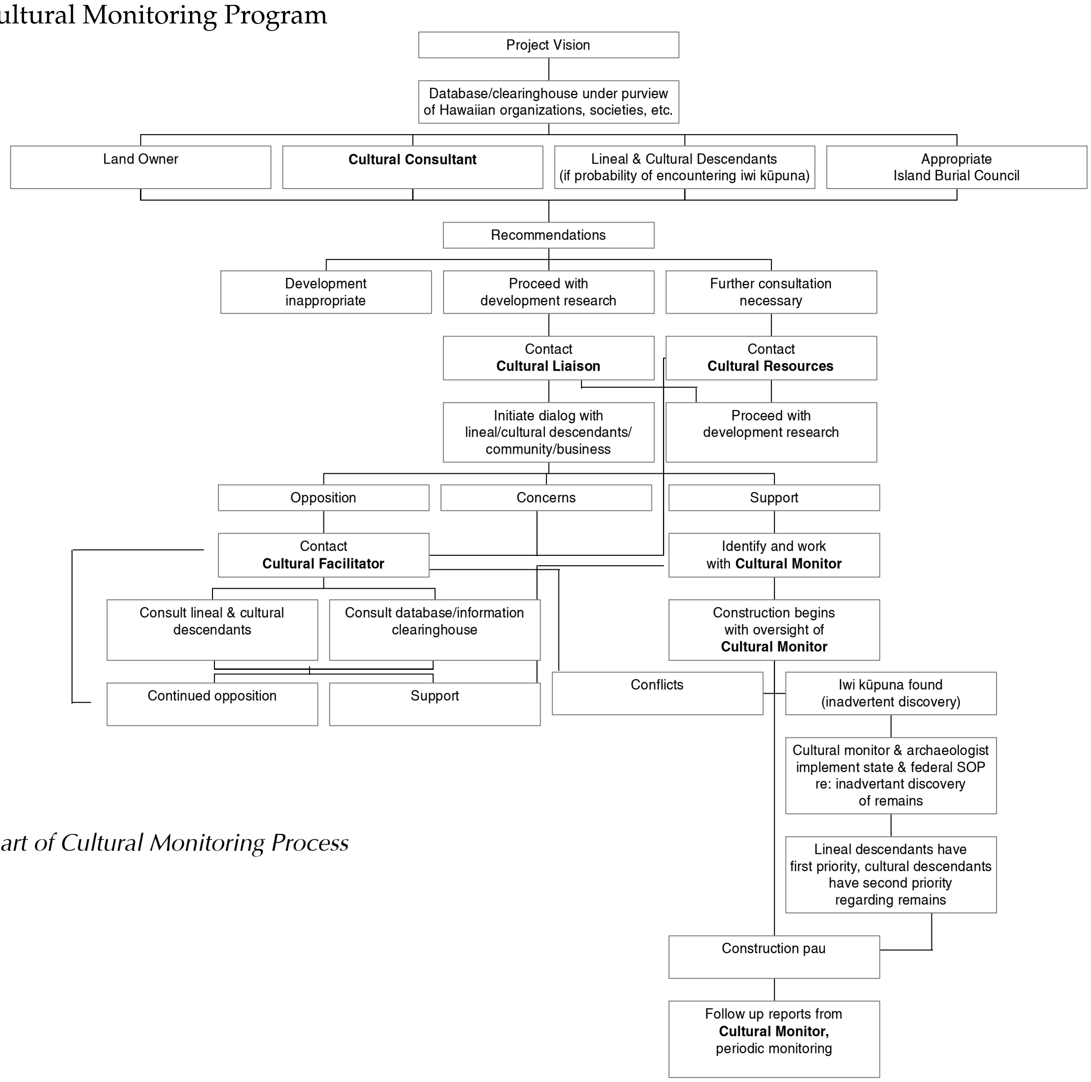
State Department of Land and Natural Resources, State Historic Preservation Division; State Department of Transportation; Honolulu Board of Water Supply, Cultural Consultation Program; Office of Hawaiian Affairs; Koʻolau Loa Landowners; Hula Hālau and other community cultural organizations; Individual Kupuna/Elders of Koʻolau Loa

ESTIMATED COST

$20,000 to 50,000 for program administration

REFERENCES

BWS Cultural Monitoring Program



Flow Chart of Cultural Monitoring Process

5a Watershed Partnerships

PROBLEM STATEMENT

Watersheds can benefit from combining the responsibilities and efforts of community, landowners, and agencies with a mandate for managing specific watershed elements, into a cooperative organization that can comprehensively address watershed issues for the region.

GENERAL BACKGROUND

Management and maintenance of Hawaiʻi'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. EPA and the USDA suggest 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. Since watersheds transcend political and other socially constructed boundaries, collaboration among interested parties is necessary.

Watershed partnerships in Hawaiʻi 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." Currently, more than 750,000 acres of important watershed areas lie within the management areas of the 10 existing partnerships: East and West Maui watersheds, Koʻolau Mountains watershed, Lanaʻi Hale watershed, East Molokaʻi watershed, Leeward Haleakala watershed, ʻOlaʻa-Kilauea, Kauaʻi watershed, Waiʻanae Kai Community Forest, and the Kohala Mountain watershed. The large partnership areas encompass only the upper forested Conservation District.

Most of the partnerships coordinate actions among their members, who typically consist of Federal, State, and local agencies. Each watershed partnership develops a management plan to direct their focus, identify priorities, and outline 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.

Partnerships can develop and maintain a "data bank" that includes historical and current information.

ISSUES IN KOʻOLAU LOA

Koʻolau Loa watersheds issues that partnership programs may address include polluted runoff, stream and ʻauwai clearing and management, feral pig management, invasive species, and the need for measurable instream flow standards.

Funding for watershed projects conducted by partnerships is an ongoing need. The number of projects that could be implemented and are needed in the watershed exceeds the available funding. Also, the available funding sources cannot be guaranteed from year to year, making it difficult to plan for ongoing multi-year programs. Funding is also critical to having a staff to facilitate implementation of programs and improvements.

PRELIMINARY SCOPE

Ko'olau Loa has two watershed partnerships already implementing projects. The Ko'olau Mountains Watershed Partnership (KMWP) consists of landowners and related agencies that interact throughout the Ko'olau Mountains *(Table 2.10)*. This organization focuses on efforts in the forested areas of the conservation district. KMWP is already implementing important projects to this Plan, such as the comprehensive ungulate management strategy for the conservation areas (*Project 3f Feral Pig Management Plan*) and invasive weed species (*Project 3e Invasive Species Assessment/Control*). Future projects will expand these efforts to implementation.

The Punalu'u Watershed Alliance is community based and encompasses the Punalu'u ahupua'a. It focuses primarily on the stream and agriculture irrigation system. This alliance can serve as a model for other Ko'olau Loa communities. The Punalu'u Watershed Alliance includes agencies, landowners and community members with common interests in:

- Preservation, protection, enhancement, restoration and recovery of watersheds in the interest of present and future generations.
- Citizen participation and independent scientific inquiry.
- Developing archives of traditional knowledge for purposes related to sound management of the Watershed and its resources as well as for the learning/educational component of the Alliance's mission.
- Managing the water system for the protection, restoration and management of the watershed.
- Conducting major studies to petition CWRM to set measurable instream flow standards for Punalu'u Stream.
- Identifying agricultural water for rights, farming, instream flow and traditional and customary rights.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

Ko'olau Mountains Watershed Partnership, Punalu'u Watershed Alliance members (including: Punalu'u Community Association, State Department of Land and Natural Resources Commission on Water Resource Management, Board of Water Supply, U.S. Geological Survey, Kamehameha Schools), Coastal Zone Management, U.S. Army, Natural Resources Conservation Service, Windward O'ahu Soil and Water Conservation District, landowners, Ko'olau Loa Neighborhood Board, Individual Community Associations, Mālama 'Ohana

ESTIMATED COST

Establishment: $50,000

Coordination: $20,000 annually

REFERENCES

Ko'olau Mountains Watershed Partnership Management Plan, Ko'olau Mountains Watershed Partnership, 2002.
"People Power: The Social Side of Watershed Restoration", *The Wildland Waters*, Spring 2006, USDA
Punalu'u Watershed Alliance Memorandum of Understanding.
West Maui Mountains Watershed Management Plan, West Maui Mountains Watershed Partnership, 1999.

5b Water and Watershed Education

PROBLEM STATEMENT

There is a need in Koʻolau Loa to educate children and adults on water and watershed-related issues with a cultural understanding, and to conduct applied watershed research that guides future watershed management.

GENERAL BACKGROUND

Water and watershed education can help to encourage watershed restoration and enhancement. Education and behavioral changes can take time and often depend upon generational change.

Watershed improvements can also tap into the existing social capital or ways in which the community already comes together. Existing community networks for water and water resource education can empower watershed residents. Watershed education can also increase the pool of skilled resource managers who can identify issues and apply necessary actions.

Although some schools and local non-profits already offer programs on water and watershed education, many of the programs through the schools are more general environmental education, not necessarily based in the local surroundings, and may not directly contribute to improvement of the local watershed. Cultural knowledge of respectful and responsible relationships with the natural resources is an essential to water and watershed educational and research programs.

BEST MANAGEMENT PRACTICES (BMP)

In Hawaiʻi several water and watershed educational programs are positively affecting people and resources of the islands by connecting people's actions with a positive impact on the watershed. On Oʻahu and Maui, the Hawaiʻi Nature Center provides students with hands on environmental education. Another example of an effective education program is charter schools with environmental and cultural programs, such as Kua o ka Lā in Puna on Hawaiʻi Island.

The Kuleana Project through Mālama O Mānoa in partnership with BWS is an example of children initiating change. Students conducted surveys to educate their family and neighbors about watershed conservation and pollution control.

The Waimea Water Roundtable on the Island of Hawaiʻi allows citizens to participate on water resource issues. Members of the roundtable have expertise in and familiarity with local water issues, meet regularly to discuss water resource related issues, and participate in larger water and watershed discussions with relevant agencies.

PRELIMINARY SCOPE

- Develop a curriculum focused on local watershed improvements for local schools. Utilize techniques for students to share knowledge using the Kuleana Project model.
- Promote volunteerism through greater knowledge and awareness about the local watersheds and provide volunteering opportunities in the watershed.
- Provide a physical location for ahupuaʻa-based learning on watershed dynamics and for conducting research, and facilitate watershed management. A watershed center would provide a permanent educational institution to facilitate a long-term, sustained watershed restoration.

Further development of the Watershed Center concept may include the following tasks:

- Establish a 501(C)3 to operate and construct the Watershed Center.
- Consult relevant agencies, landowners, school, and community groups concerned with education in the watersheds.
- Establish education and research program funding, both capital and operating.
- Identity and evaluate alternative sites.
- Conduct community meetings to receive input on educational programs, center sites, and related issues.

Interim steps may be needed as resources and partners are established. One possibility is to use existing infrastructure, such as a charter school or the Queen Liliʻuokalani Children's Center to develop the curriculum and outreach before reaching out to larger funding sources for construction funds.

POTENTIAL PARTICIPATING ENTITIES

Punaluʻu Watershed Alliance members (including: Punaluʻu Community Association, State Department of Land and Natural Resources Commission on Water Resource Management, Board of Water Supply, U.S. Geological Survey, Kamehameha Schools), Koʻolau Mountains Watershed Partnership, Koʻolau Loa Neighborhood Board No. 28, Mālama ʻOhana, Kaʻaʻawa, Kahana, Punaluʻu, Hauʻula, Lāʻie, and Kahuku Community Associations, State Department of Land and Natural Resources, University of Hawaiʻi - Sea Grant Program, Brigham Young University-Hawaiʻi, Koʻolau Mountains Watershed Partnership, U.S. Natural Resources Conservation Service

ESTIMATED COST

Estimated costs of establishing the Watershed Center is $0.5 to 1.5 million

Ongoing annual operating costs could be $100,000 to 250,000

REFERENCES

"Kua o ka Lā Charter School Going Solar," *Ka Wai Ola, The Living Waters of OHA*, April 2006. http://www.oha.org/pdf/kwo06/0604/8.pdf
The Hawaiʻi Nature Center http://www.hawaiinaturecenter.org/

5c Koʻolau Loa Implementation Entity

PROBLEM STATEMENT

In the past the Koʻolau Loa community has had limited involvement planning and managing watersheds and water resources. Local expertise in watershed management and enhancement is not always utilized. Currently, a wide variety of government agencies and departments at the federal, state, and county levels have executive authority for water and watershed related programs in Koʻolau Loa. This can result in different agencies and/or programs being at cross purposes in pursuit of a healthy watershed.

GENERAL BACKGROUND

The Koʻolau Loa Watershed Management Plan provides a list of water supply and watershed protection projects and programs for the district. The water supply projects will be pursued by BWS, other city agencies and private landowners. The implementation of the watershed protection projects by agencies, watershed partnerships, and community-based groups will depend on policy, staffing and funding resources. The Plan's adoption will guide agencies and organizations to implement the projects and can be used to pursue needed resources.

During the community consultation process, the community has expressed a strong desire to ensure that projects and programs are implemented and wants the creation of a community-based implementation entity. Not every district on Oʻahu may be interested in assuming this level of responsibility for watershed project implementation; the Waiʻanae community through their participation in their WMP has choosen not to pursue implementation responsibilities to the same degree as Koʻolau Loa.

ISSUES IN KOʻOLAU LOA

The Koʻolau Loa Working Group (a committee of Neighborhood Board 28) which worked extensively on this plan, discussed the following principles for implementation:

- An implementation entity must be charged with the coordination, facilitation and other tasks necessary to implement this plan in a timely and responsible manner.
- Successful implementation of any plan depends on the proposed entity providing organizational continuity.
- This entity must have significant and meaningful community input, i.e., it must be community based.
- The implementation of a County Water Use and Development Plan that views watershed health as a priority is a departure from past practices. Therefore, innovative administrative arrangements should be explored to implement this Plan.
- For the reasons outlined above, the implementation entity must have a significant and meaningful share of responsibility that grows out of collective responsibility and–joint consultation and mutual agreement between community stakeholders, representatives of government agencies, private purveyors of water, major landowners and others such as representatives of non-profits.

- Details of how precisely the implementation entity is to be structured in terms of operations, composition, its rules of procedure and so on are to be decided in consultation between all parties, including the City's Corporation Counsel Department and the State's Department of Attorney General. A Memorandum of Understanding involving all parties is needed to establish can capture the pertinent structure, terms and responsibilities.

The implementation entity and the work that it is asked to do must be funded in a manner that provides for continuity, stability and the ability to adequately perform its tasks. Upon the request of applicable City, State and Federal agencies, the implementation entity must maintain and provide a complete accounting of the fair distribution of watershed protection projects among Ko'olau Loa's watersheds and how funding sources are spent to implement the Ko'olau Loa Watershed Management Plan.

An organization with these principles does not currently exist. The scope of this Plan is limited and its adoption by ordinance does not create the entity nor does it create a dedicated funding source. The entity's structure and responsibilities must be consistent with the City Charter and all other applicable laws. Because of these prerequisites for a Ko'olau Loa Implementation Entity, agency initiatives, watershed partnerships and community-based groups should continue to be utilized for project implementation.

BEST MANAGEMENT PRACTICES (BMP)

There is no single agreed upon best management practice for community watershed groups. Various organizations in Hawai'i have water and watershed-related missions and connect communities in caring for their watersheds; examples of such organizations in Hawai'i are in the Punalu'u Watershed Alliance (Ko'olau Loa), the Waimea Round Table (Hawai'i), Eastside Hui (East Maui), the Waipā Foundation (Kaua'i), and in California the Watershed Research and Training Center.

Existing social capital and working relationships are key to sustaining a community-based organization's efforts over the long term. Any organization should involve people from various networks in order to have a broad base of participation.

PRELIMINARY SCOPE

- Explore the feasibility of a Ko'olau Loa Implementation Entity, including legal issues, operating cost, accountability and liability effects on existing agencies and organizations.
- Develop coordination role and responsibilities with involved agencies.
- Identify, prioritize, guide and staff watershed projects and programs with preference for people from/living in Ko'olau Loa.
- Obtain funding through agencies, in-kind contributions, grants, and legislation to implement studies, projects and programs in Ko'olau Loa watersheds.

POSSIBLE PARTICIPATING AGENCIES/ORGANIZATIONS

Ko'olau Loa Neighborhood Board No. 28, Mālama 'Ohana, Ka'a'awa, Kahana, Punalu'u, Hau'ula, Lā'ie, and Kahuku Community Associations, Brigham Young University – Hawai'i, Hawai'i Lā'iekawai Association, Board of Water Supply, State Department of Land and Natural Resources Department of Aquatic Resources, Department of Health Environmental Planning Office, State Office of Planning Hawai'i Coastal Zone Management Program, University of Hawai'i Department of Urban and Regional Planning and Sea Grant Program, U.S. Geological

Survey, East County Farm Bureau, State Department of Agriculture, Commission on Water Resource Management, and Department of Planning and Permitting.

ESTIMATED COST

$30,000 to study and establish an organizational structure

5d Grant Funding

PROBLEM STATEMENT

Watershed management projects and programs that improve the health of watersheds often require funding. This project explores the existing grant sources and possible future mechanisms for funding projects and programs in Koʻolau Loa.

GENERAL BACKGROUND

Well-managed land benefits everyone. One study lists the value of the Koʻolau Mountains in recharging the Pearl Harbor aquifers at $1.42 billion. Unfortunately this valuation is not captured in today's market economy. Managing land for aquifer recharge and other ecoystem benefits can cost land managers. A 2001 report to the legislature lists the estimated dollars per acre spent by various agencies and organizations to manage lands as ranging from $11/acre to $271/acre. While specific amounts of funding needed may vary, some general level of funding is needed to preserve, protect and restore watershed ecosystems.

Existing grant funding sources include local, state and federal government agencies, foundations, non-profits, utilities, and schools. However, determining who can access the funds and for what purposes is as important as identifying the sources.

Watershed management projects and programs fall in to several categories:

- ***Landowner or Lessee Projects:*** Land management projects and programs conducted by a large landowner or a lessee (such as a farmer or company) that operates as a for-profit business.
- ***Community Projects:*** Watershed health projects and programs that use volunteers or pay others to implement. These could be community organizations with mission statements that do not directly relate to watershed management or could be watershed partnerships.
- ***Government Projects:*** Government implemented projects and programs.
- ***Research Projects:*** Projects or programs with the goal to provide knowledge that will be used to improve watershed health.

ISSUES IN KOʻOLAU LOA

Many of the organizations that provide grant funding will only give to 501c(3) (non-profit) organizations. An existing organization may need to provide the needed fiscal sponsorship.

Securing a permanent funding source could greatly facilitate the implementation of watershed projects and programs and could expand the number and scope of projects implemented. One recently instituted mechanism is a percentage of the conveyance tax is used for management of DLNR Natural Area Reserves land and the mauka watershed partnerships around the state.

While government budget appropriations seem an obvious funding mechanism for projects, they cannot be permanently guaranteed. A watershed fee could provide a base of funding. Determining the fee, how to collect it, and the appropriate distribution mechanism and entity are issues that would need to be resolved beforehand.

POSSIBLE GRANT FUNDING SOURCES

This list is provided to guide the search for funding and is not necessarily a complete list of all grant funds. Funding information can change from year-to-year and the information provided is a current snapshot. Details such as deadlines, amounts and general availability of funds will need to be verified before pursuing.

Landowner or Lessee Projects

- *NRCS Farm Bill Program* - Pays for a certain percent of the costs to install conservation practices or acquire easements that provide conservation benefits. (Dollar amounts are the Hawaiʻi 2005 funding allowances, yearly deadlines).
  - Environmental Quality Incentive Program ($5.2M)
  - Grasslands Reserve Program ($1.3M)
  - Ground and Surface Water Conservation ($1.2M)
  - Wildlife Habitat Incentives Program ($1.1M)
  - Wetland Reserves Program ($770K)
  - Conservation Security Program (currently only Hilo and North Shore)
  - Farm and Ranch Land Protection Program ($1.9M)
- *State DLNR Landowner Assistance Program* - administers U.S. Fish and Wildlife Service funds
- *State DLNR Forest Stewardship Program* – provides funds on a dollar (state) for dollar (private) match
- *State DLNR Natural Area Partnership Program* – "for private lands of natural reserve area quality" through matching funds
- *U.S. Fish and Wildlife Service Private Stewardship Grants Program* – provides funds that benefit species listed, proposed or candidates for listing under the Endangered Species Act, or other at-risk species native to the U.S. ($7 million nationally, 10% match in cash or in-kind required).

  It is important to note that national and State Safe Harbor Policies give assurance to landowners that no additional future regulatory restrictions will be imposed. In Koʻolau Loa, critical habitat (for threatened and endangered species) has been designated in the mauka areas Kaʻaʻawa, Kahana, Punaluʻu, and up to the Lāʻie area.

Community Projects

Many of the community project grants require that the grantee be a non-profit. Another organization that is a non-profit, such as Mālama ʻOhana, may serve as a fiscal sponsor.

- *BWS Watershed Management Partnership Program* – funds for watershed studies, watershed resource protection, educational outreach, invasive species control, forest protection, water conservation activities (must be a non-profit).
- *EPA Targeted Watersheds Grants* ($700K average/May deadline/Hanalei Bay).
- *Kahuku Community Foundation* - through the Hawaiʻi Community Foundation funded with a percentage of the proceeds from the sale of Campbell lands in the Kahuku area.
- *Office of Hawaiian Affairs (OHA) Grants Program* - provides funding awards up to $50K for the purpose of community development in the areas of education, health, human services and culture.

- *NOAA Community-Based Marine Debris Prevention and Removal Project Grants* ($15-100K, October deadline)
- *NOAA Community-based (Marine) Habitat Restoration Project* - includes anadromouse fish ($50-200K, October deadline)
- *NOAA FY06 Western Pacific Demonstration Projects* – "promote the use of traditional indigenous fishing practices and /or develop or enhance Western Pacific community-based fishing opportunities.." Can be use for research or materials/equipment for project implementation.
- *NOAA General Coral Reef Conservation* – can be used for 1) preservation or restoration; 2) management and sustainable use; 3) increasing public awareness; 4) development ($15K-50K)
- *NOAA Coral Reef Ecosystem Study* – create "scientific results that can be used to develop alternative management strategies to restore and protect coral reef ecosystems"
- *DOH Polluted Runoff Control Program* - administers grant money it receives from the EPA through Section 319(h) of the Federal Clean Water Act. Generally, projects must implement a portion and/or accomplish an activity in the State's Coastal Non-point Pollution Control Management Plan, Volume 1 dated June 1996 and/or Hawai'i's Implementation Plan for Polluted Runoff Control dated July 2000. This includes Kahana Bay. Grant funds must be matched 100% with match funding or in-kind contributions.
- *Atherton Family Foundation* – non-profit funding; has an environment category for grants (6 deadlines per year)
- *Cooke Foundation, Limited* – non-profit funding (2 deadlines per year).

Government Projects

- EPA Targeted Watersheds Grants ($700K average/May deadline/Hanalei Bay).
- NRCS Small Watersheds - $3.7 million in FY05.
- U.S. Army - Environmental Program.
- U.S. Army Corps of Engineers - studies and project construction with matching funds from local sponsoring agencies. Matching funds needed ranges from 10 -70%. Private funding can be contributed.
- FEMA funds for drought projects.
- DOH Safe Drinking Water Branch Funding for Source Water / Wellhead Protection.

Research Projects

- *USGS Pacific Islands Water Science Center* - federal matching funds to state and local agencies as part of its Cooperative Water Program (average $50K - $70K in federal matching funds). Projects include regional assessments of the quantity and quality of water resources and surface and groundwater related projects.
- *NOAA Hydrologic Research* – that will improve the accuracy of forecasts and warnings of rivers and flash floods by applying scientific knowledge and information.

Also, partnering with agencies that do extension/research may increase funding resources and information into the community. Examples of organizations that do related research and extension:

- *UH Sea Grant Extension* – extension agents "serve a critical role in identifying real-world research gaps that hinder wise resource stewardship or sustainable business development."
- *University of Hawaiʻi Water Resources Research Center*

Partnerships also can provide non-grant resources to a project. For example, Kamehameha Schools is not a grant making entity, but is helping to fund a research project through the Punaluʻu Watershed Alliance.

PRELIMINARY SCOPE

- Initially, a local sponsoring non-profit agency may be needed to apply for and administer grant funds. Identifying such an agency is a key activity.
- Establish an advisory group to find partners and researchers to collaborate with.
- Advocate the establishment of a permanent funding source for watershed projects and programs.

6a Potable Well Development

OCCURRENCE

The primary source of potable drinking water in Koʻolau Loa district is groundwater supplied by abundant rainfall, between 40 and 280 inches annually and stored in geologic formations such as the dike complex, marginal dike zones, and basal and dike/basal aquifers. The caprock aquifer along the coastal plain is not tapped for drinking water because it is generally brackish and contaminated in places by cesspool discharges. However, the caprock slows the underflow of freshwater into the ocean, creating large basal aquifers behind it. Caprock water also flows into the estuaries of intermittent streams in Koʻolau Loa.

There are two Commission on Water Resource Management (CWRM)-adopted groundwater management areas (GWMA) in the Koʻolau Loa district. The Koʻolau Loa GWMA has a sustainable yield of 36 mgd of which 21.5 mgd is permitted, leaving an available balance of 14.5 mgd. The Kahana GWMA has a sustainable yield of 15 mgd of which 1.1 mgd is permitted. The unused sustainable yield may interact with streams due to dike influences, and, therefore, availability may be limited. In general, wells located in basal aquifers do not affect stream flows because aquifer water levels are located below the stream elevation. Conversely, dike water levels are usually higher than streams and contribute to the streams' base flow. Dikes exist in the Kahana and Koʻolau Loa aquifers along the crest, and basal and caprock aquifers exist from mid-valley to the coast (*Figure 2.5)*. As of July 2005, a wet year, pumpage from the two aquifers was below their respective permitted uses.

CURRENT AND POTENTIAL USE

The BWS and Lāʻie Water Company are the two providers of drinking-quality water to residents in Koʻolau Loa.

The BWS utilized its Kahana, Punaluʻu I, II, and III Wells, Hauʻula, Kaluanui, Maʻakua, Kahuku, and Waialeʻe Wells to supply 1.5 mgd to Koʻolau Loa, 8.3 mgd to Koʻolau Poko and 0.3 mgd to the Sunset Beach and Pūpūkea communities in 2000.

Lāʻie Water Company used the Campus, Ceramics, Library, and Quarry Wells to supply nearly 1.0 mgd of water to their customers in 2000.

For the expected growth in the Kahuku area, the BWS may develop existing exploratory wells in Mālaekahana that could supply 1.0 mgd of water.

The future growth of Turtle Bay Resort will also require an additional drinking water source. The resort is currently developing ʻŌpana Wells, which will be dedicated to BWS to supply that need.

Lāʻie Water Company expects population growth in its service area per City and County projections, and anticipates that the increased water demands could be met with an additional 0.5 mgd of water use permit and pumpage on existing wells, and an additional 0.7 mgd well in the Mālaekahana area (separate from the BWS Mālaekahana well site).

Additional source capacity from two BWS Koʻolau Poko wells will reduce the pumpage exported from Koʻolau Loa to Koʻolau Poko. Increased permitted use (0.3 mgd) at the existing Kūʻou Well III and the new Waimānalo Well III (0.5 mgd) could yield approximately 0.8 mgd of potable water. Long-term test pumping will determine the actual yields. The water use permit amounts are listed in the summary table below. These well amounts are within the sustainable yield for Koʻolau Poko GWMA.

PUMPAGE OPTIMIZATION

Pumpage optimization is applicable to both the sustainability of the aquifer and the management of operation and maintenance costs from pumping and distributing water within the potable water system. Pumpage optimization in Koʻolau Loa can result from distributing pumpage from Punaluʻu wells to other smaller wells in Koʻolau Loa and Koʻolau Poko, which will reduce aquifer impacts during drought and reduce operation and maintenance costs of transmission between the two regions. This is detailed in *Project 2d, Punaluʻu Pumpage Optimization.*

COSTS

The capital costs for the wells discussed above are listed in the summary table below. Low is under $4 per gallon, mid is $5-7 per gallon and high is $8-10 per gallon. For comparison, recycled water costs are considered mid, and desalination would be high.

Groundwater Wells – New and Increased Permit Amounts

Existing / New Wells	State Well No.	Current Permitted Amount (mgd)	Potential Permitted Amount (mgd)	GWMA	Capital Costs	Note
New Mālaekahana (BWS)	3957-08 and -09	--	1.0	Koʻolau Loa	Low	Kahuku growth
New ʻŌpana Wells[1]	4100-02 to -05	--	1.0	Koʻolau Loa	Low	Turtle Bay growth
Existing Lāʻie Wells	3855-06	1.4	1.7	Koʻolau Loa	Low	Lāʻie growth
New Malaekahana (LWC)	--	--	0.7	Koʻolau Loa	Mid	Lāʻie growth
Existing Kūʻou Well III	2348-06	0.2	0.5	Koʻolau Poko	Existing	To reduce KL export
New Waimānalo Well III	1942-01	0.2	0.5	Koʻolau Poko	Funded	To reduce KL export
Existing Maʻakua Well	3655-02	0.7	1.0[2]	Koʻolau Loa	Existing	Punaluʻu Optimization
Existing Kaluanui Well	3554-04 to -06	1.1	1.5[2]	Koʻolau Loa	Existing	Punaluʻu Optimization
New Kaipapaʻu Well	3655-03	--	1.0[2]	Koʻolau Loa	Mid to High	Punaluʻu Optimization

[1]The ʻŌpana Wells are being constructed and permitted by Turtle Bay Resort and will then be dedicated to the Board of Water Supply.

[2]Punaluʻu Wells would be reduced by the amount added to this well so there is no net increase in WUP amounts.

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

Historically development of groundwater has been the lowest cost source of Oʻahu's drinking water. The primary development issue with wells is the interaction between groundwater and stream flow, particularly in the Kahana GWMA due to its dike complex formations. Stream gaging can determine which stream segments are gaining and losing stream water while monitor wells can determine aquifer water levels relative to stream elevations. In general, dike water will be at or above streams elevations, and basal water will be below stream elevations. Until more hydrologic information is obtained, new wells should be located within the basal aquifers, not within the dike formations.

Operational experience and hydrologic monitoring have shown that aquifer thickness and well yields are influenced by long-term drought and high rainfall periods. During normal rainfall years, source yields approximate permitted uses. However, during long-term drought, well yields, especially dike sources, drop below permitted uses. Drought plans should account for these long-term variations in climate. In general, during dry seasons, groundwater storage can meet demand, but during wet seasons, pumpage must be reduced to allow the aquifer water levels to recover in anticipation of the next dry season.

In contrast to non-potable well development, a constraint of potable well development is high transmission costs since the water is transported long distances from the well. Non-potable well users tend to be smaller users who can develop smaller sources because the water is locally used and transmission costs are lower.

CONCLUSIONS

Groundwater will continue to be an important source for Koʻolau Loa drinking water and related urban needs. There is ample supply groundwater to meet drinking-quality water needs for the projected growth in Koʻolau Loa.

6b Agricultural (Non-Potable) Well Development

OCCURRENCE

In Koʻolau Loa groundwater meets most non-potable water needs for agriculture, irrigation and the wildlife refuge. Because of the Koʻolau Loa district's abundant groundwater resources and low population density, groundwater has been readily available for the non-potable needs and can be developed at a relatively low cost.

CURRENT AND POTENTIAL USE

Agriculture and aquaculture uses accounted for more than 6 mgd of groundwater in 2000. Saltwater wells require a water use permit but are not subtracted from the sustainable yield. Brackish wells require a water use permit and are subtracted from the sustainable yield.

Additional private wells will likely be needed if the agriculture and aquaculture sectors expand. The amount of land designated for agriculture could support a doubling of the current amount of agriculture in production. If the biofuels market increases, water demand for agriculture crops would substantially increase. An unknown factor in Koʻolau Loa is the fate of the Campbell lands in the Kahuku area which are currently for sale.

In Punaluʻu, the Makaliʻi wells can be developed to provide additional irrigation supply to the agricultural surface water system or can factor into water shortage plans during low stream flow periods.

Non-agricultural private wells supply water used for Turtle Bay golf course irrigation (about 0.9 mgd), the Polynesian Cultural Center lagoons (about 0.6 mgd) and the James Campbell Wildlife Refuge (about 0.25 mgd). See *Appendix C* for a complete list of wells and water use permit amounts. Private wells are expected to continue at current levels. Turtle Bay's wells supplement their recycled water system for golf course irrigation because of insufficient wastewater flows. Campbell Wildlife Refuge is currently using about 25% of its 1.0 mgd permitted use, but in the future the total permitted amount may be used as the refuge expands.

COST

Non-potable agricultural wells developed by private landowners cost less per well than potable well development. Wells less than 1.0 mgd would likely cost less than $0.5 million of private/non-BWS funds. For the Makaliʻi Wells, which have already been drilled, it will cost a roughly estimated $0.4 million to bring them into production.

Groundwater Wells – New and Increased Permit Amounts

Potential New Well	State Well No.	Current Permitted Amount (mgd)	Potential Permitted Amount (mgd)	GWMA	Capital Cost	Note
Makaliʻi Wells	3452-02 3453-13 3453-16	--	1.364[1]	Koʻolau Loa	Low	For Punaluʻu Agriculture
Prawn Farm	3856-07	--	0.147	Koʻolau Loa	Low	For Lāʻie Agriculture
Lāʻiemaloʻo	3755-04	--	0.025	Koʻolau Loa	Low	For Lāʻie Agriculture

[1] Previously permitted amount for this well

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

There are relatively few issues regarding, or constraints on developing groundwater, in the Koʻolau Loa GWMA, which continues to be the lowest cost option for businesses and farmers. In the Kahana GWMA, the dike complex presents a higher level of investment risk to private farmers. Wells previously drilled there have low yields and may interact with surface water *(Project 2a, Sustainable Yield Estimates).*

CONCLUSIONS

Through 2030, there will likely be ample groundwater supply for agricultural and other irrigation. However, using drinking quality water for non-potable uses is not considered its highest and best use. Over time, as the drinking supply becomes more limited, other water sources (such as recycled water, greywater reuse, and rainbarrels) should be investigated and implemented to meet non-potable water demands.

6c Increased Recycled Water

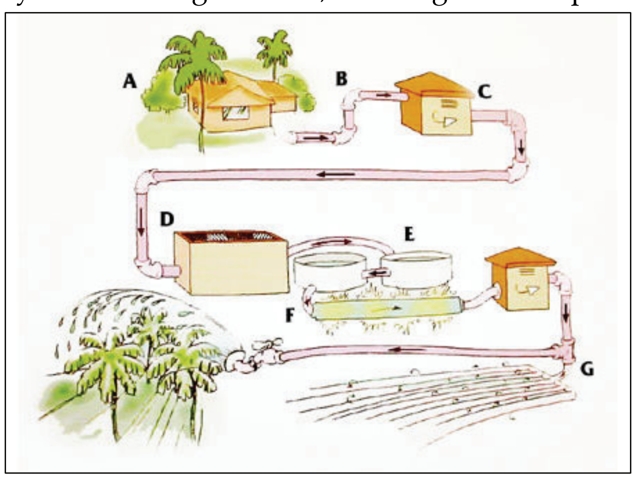
OCCURRENCE

The Koʻolau Loa district currently contains two recycled water systems. One is the Lāʻie Water Company system used primarily for irrigation at Brigham Young University – Hawaiʻi, and the other is the Turtle Bay resort system used for grounds and golf course irrigation.

CURRENT AND POTENTIAL USE

In Hawaiʻi, the State Department of Health (DOH) designates three different levels of recycled water quality. R-1 is tertiary treated water, the highest-quality recycled water. This water has undergone a filtration and disinfection process, and the water is approved for use on lawns, golf courses, parks, and agricultural crops, including leafy vegetables. R-2 is lower quality, secondary (biologically) treated recycled water that has also been disinfected. R-2 requires more monitoring and restrictive controls than R-1 water and is normally applied by drip or furrow irrigation. R-3 is the lowest class of recycled water that has been treated to the secondary level but without disinfection. It can be used only for irrigation at places where people rarely go.

The Lāʻie Water Reclamation Facility (WRF) produces R-1 water and has a total average day capacity of 0.9 mgd. Currently, Lāʻie WRF produces 0.36 mgd and distributes 0.30 mgd of recycled water. An expanded distribution system is needed for the undistributed recycled water. Potential areas that could use this supply would be agriculture, and large landscaped areas such as roadway landscaping, parks, schools and golf courses. If more housing is constructed, more wastewater would be available for treatment and distribution. This system is now owned and operated by the City and County of Honolulu Environmental Services Department.



Lāʻie Wastewater Treatment Plant Diagram

The Turtle Bay WWTP produces R-2 water and has an average day capacity of 1.32 mgd. Currently the plant is running at 20% capacity (0.264 mgd). As the resort expands, more recycled water will be produced and utilized on site for golf course and landscaping irrigation. There are also plans to upgrade the WWTP to produce R-1 quality water which will simplify the regulatory conditions of use. Turtle Bay owns and maintains this private system.

The City and County of Honolulu Kahuku WWTP, which produces R-3 quality water, is currently not utilized as a recycled water supply resource. The treatment plant has a capacity of 0.40 mgd and treats an average of 0.12 mgd. After receiving secondary treatment, the water is sent to injection wells. While not a large amount, the water comes from residential sources and therefore has potential for reuse. Additional treatment filtration and disinfection of the effluent would be needed before utilizing the water and constructing a distribution system. A potential user of the recycled water is the Kahuku Golf Course expansion.

In Koʻolau Poko, the ʻAikahi WWTP effluent has a high salinity due to seawater inflow, which would require extensive desalination. For the Waimānalo WWTP, upgrades and distribution of recycled water through the Maunawili State Department of Agriculture system are possible but not planned at this time. Recycled water could be used by existing users of the State DOA surface water system and adjacent urban areas. Recycled water use in the Maunawili agricultural system would reduce the need to use BWS potable water to supplement the limited surface water supply, especially during drought.

COST

Recycled water produced by Lāʻie WRF is available. However, the recycled water costs more than locally available groundwater.

Turtle Bay Resort recycled water system has already been constructed, and distribution of the water for golf course and other irrigation needs will expand as more water becomes available. This water will be used onsite. The system construction and operating costs will be borne by the resort.

The cost to upgrade the Kahuku WWTP and distribute water for reuse to the Kahuku Golf Course expansion is an estimated $4.6M. This estimate includes treatment, storage and distribution, including an irrigation system (BWS, *Island Non-Potable Water Master Plan,* July 2007).

The Waimānalo WWTP's capacity was recently upgraded. However, additional upgrades are needed to treat the R-3 effluent and produce R-1 quality recycled water for irrigation purposes as proposed in the Koʻolau Poko Sustainable Communities Plan (August 2000). The estimated cost for these upgrades is $3.4M. Also, a distribution system to deliver the recycled water to end users would incur significant additional cost. Cost recovery of recycled water costs from farmers is not likely possible; subsidies may be necessary.

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

As discussed previously, recycled water is difficult to market to farmers because it is more expensive than available ground or surface water.

For Kahuku recycled water, the wildlife refuge currently has a well from which they pump groundwater, so they would not to want to pay for lower-quality recycled water. As with Lāʻie WRF, selling recycled water to farmers is unlikely because it costs more than groundwater. The Kahuku municipal golf course currently uses potable water for irrigation. The golf course expansion would be required to develop and use recycled water releasing potable water for domestic uses. The recycled water would be priced lower than potable water providing an economic incentive to the City. There are many demands for increased agricultural water in Waimānalo without a readily available water supply. Because of the many demands for water in Koʻolau Poko, it would be best to first replace usage of the potable water with non-potable water. This would also reduce Koʻolau Poko's reliance on water from Koʻolau Loa.

Recycled water is limited to those areas where sewer collection systems exist – namely Turtle Bay, Kahuku and Lāʻie. The remaining communities in Koʻolau Loa are sparsely populated, and too distant to feasibly connect with these treatment plants to feasibly connect them. See *Project 3c, Cesspool Inventory / Greywater Reuse* regarding possible improvements to wastewater disposal and small scale water recycling in areas without a central treatment facility.

The quality of recycled water can be limiting and may discourage produce farmers from using recycled water out of fear of product integrity being degraded. Salinity levels of recycled water may not be compatible with some crops. Some Waimānalo farms and nurseries have also been resistant to use the DOA surface water irrigation system because of their perception that the water may contain harmful organisms, such as nematodes. Thus, some farmers and nurseries would still prefer not to use the DOA water system and remain using BWS potable water.

CONCLUSIONS

Recycled water is a "drought-proof" irrigation source for Koʻolau Loa and Koʻolau Poko agriculture since the groundwater is fairly dependent on rainfall. Unfortunately, the low cost of readily available groundwater makes it difficult for recycled water to compete economically. To increase recycled water usage, a more competitive pricing structure would be needed, or the use of recycled water, where available, could be facilitated and subsidized. However, higher prices would likely place a burden on farmers already operating in tenuous situations. Government agencies could mandate themselves to use recycled water where available, but would need to fund the associated capital and operating costs.

6d Conservation Measures

OCCURRENCE

Water conservation is a fundamental component of effective water resource management. Water conservation can be defined as practices, techniques, and technologies that eliminate waste and improve the efficiency of water use to sustain our valuable water resources. Increased efficiency expands the use of water resources, redistributing water supplies for other uses such as population growth, commercial and industrial developments and resource conservation. Water is a precious resource on Oʻahu, and it is everyone's kuleana to use it wisely. This conservation ethic is applicable to those who deliver/supply water as well as the end-users.

Water conservation is often equated with temporary restrictions on water use and is a useful tool in service disruptions and drought. However, water conservation programs can emphasize lasting everyday improvements in water use efficiency. The development of new water supplies is the traditional method for meeting increased water demands. However, water conservation programs can reduce current and future water demands and defer some of the need to develop new water supplies for the benefit of BWS, the community and the environment.

Increasing efforts in water conservation, often called demand-side management, are driven by rising costs and difficulties of developing new supplies, optimization of existing sources, drought, delays or reduction of capital investments in capacity expansion and growing community support for conservation of limited natural resources to preserve cultural uses, ecology and the environment. Conservation is one of several complementary and diverse water supply strategies to meet and balance all watershed management plan objectives.

Although focused on the Board of Water Supply and its customers' conservation efforts, this project could also apply to other water purveyors and their customers.

CURRENT AND POTENTIAL USE

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

- 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.

Next Steps

Expanding existing conservation gains will require a renewed effort and systematic approach to increase water conservation opportunities. This can be accomplished through water efficiency planning, 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 BWS is undertaking a Water Conservation Program Development Study.

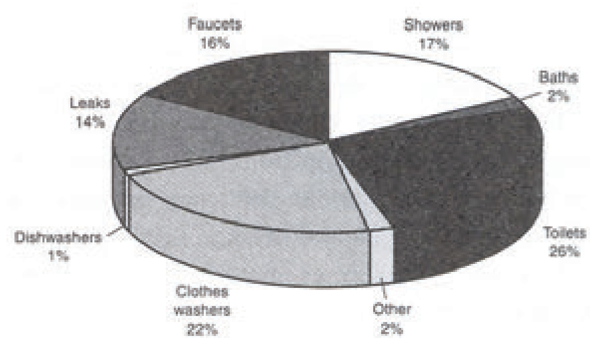
The list below describes the proposed methods of advancing conservation to the next level.

- ***Assess the water efficiency of existing users and quantify opportunities for water savings and identify areas for improvement.***

  A conservation program needs to establish a baseline and solid understanding of specific water use. 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 BWS water use.

  The chart below 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.

  Market research will be conducted to develop a Water Efficiency Social Marketing Survey and Measure Saturation Evaluation for all prescreened water efficiency measures. The social marketing survey will test messaging, willingness to pay and key motivators for voluntary water conservation and possible acceptability of any potentially mandated changes incentives to water efficiency or waste prohibition enforcement. A saturation evaluation will provide more data on the conservation (water savings) potential and potential effectiveness.



Source: *Guide to Preparing Urban Water-Use Efficiency Plans*, Water Resources Series No. 83, United Nations (2003)

- ***Develop a wide range of new conservation programs based on national benchmarking best practices, tailored toward specific classes of users in each district.***

  Possible future conservation measures are listed in the figure on the next page. Industry best practices incorporating innovative measures can help to provide meaningful program models. The list of measures will reflect acceptability by customers and stakeholders, ease of agency implementation, demand peaking factors, and the weighted average cost per unit of water saved. The selection of conservation programs should be based on the highest possible water conservation savings at the least cost. For larger non-residential users, audits can be a cost effective tool to identify opportunities for water savings. For residential users, education and regulation measures typically provide the most water conservation at the lowest cost.

  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 State Department of Education and the University of Hawai'i are candidates for water conservation surveys and measures with an educational component. Both hardware and behavior modification approaches can be successfully in increase water savings. Economic incentive programs will also increase consumer participation.

Possible Future Water Conservation Measures

Residential

- Multi-family (Apartments, Townhouses, Condos) Submetering
- Multi-family Property Manager Workshops
- High Efficiency Clothes Washer Regulations or Rebates
- Homeowner Water Use Audits
- Promote WaterSense Labeled Products

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
- Increase Incentives for Installing 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 and Pre-rinse Spray Valve Rebates
- High Efficiency Clothes Washer Regulations or Rebates
- Cooling Tower Audits
- Hawai'i Green Business Program

Other

- Increase the Incentives of Existing Tiered Water Pricing
- LEED (Leadership in Energy and Environmental Design) Certification for Government Facilities
- Regular Communication with Hotel/Resorts on New Water Conservation Techniques and Technologies

- ***Develop a Benefit Cost Model for Water Efficiency Program to assess the cost and savings of implementing water efficiency measures.***

  A benefit cost model is needed to properly evaluate the costs and savings of new conservation measures. Conservation programs typically involve up-front costs, including revenue losses from reduced water use. The model will provide the basis of a business case evaluation of the most effective conservation measures that achieve a cost-effective benefit. The evaluation measures will determine the most appropriate measures to be included in an implementation strategy.

These beneficial measures will target emerging technologies for outdoor water use, indoor water use, and the commercial, industrial, and institutional sectors. These packages of conservation measures will be bundled into incrementally more aggressive conservation programs based on successful conservation program measures from elsewhere in the nation that may be applicable to the island of Oʻahu. For screening purposes potential measures will be based on the following criteria:

- Technology/market maturity
- Water saving potential matching
- Customer acceptance/equity
- Best available measure of long-term sustainability purposes

- ***Research and expand alternative resources development for the use of recycled water and brackish groundwater 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. In Koʻolau Loa and Koʻolau Poko, additional opportunities may be economically viable in the not too distant future *(Project 6c, Increased Recycled Water).*

- ***Expand partnerships with community organizations and agencies for promoting water conservation.***

  Many community organizations and agencies have missions that also support the goal of water conservation. Partnering with them can yield greater gains in promoting conservation messages and implementing water saving practices *(Project 5a, Watershed Partnerships).*

- ***Continue and expand water conservation education and incentive programs.***

  Current programs have been particularly effective 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.

  One of the most successful educational programs is the BWS water conservation poster contest for students K-6th grade. Educating students helps to teach lifelong conservation (*Project 5b, Water and Watershed Education).*

- ***Reduce water losses in the system.***

  System losses can be reduced through leak detection and repair, and through main failure analysis that includes the collecting and investigating of main failures, and the identifying the potential causes of and solutions to premature pipeline failure (*Project 2d, Punaluʻu Pumpage Optimization).*

COST

The island-wide projected breakdown of estimated dollars spent on water conservation programs is as follows:

- $200,000 per year for Public Education and Outreach and Large Water Users Programs.
- $500,000 per year for Leak Detection, Repair & Maintenance.
- $7 million over 10 years for Toilet Rebates. Through a partnership with the City and County Environmental Services Department and CWRM, the program has been extended until June 2009.
- $15 million over the next six years for Alternative Source Development, Recycling & Conservation Alternatives.
- $114 million over the next six years for Pipeline Replacement. (This proactive infrastructure renewal program reduces water losses and increases system reliability.)

The Board of Water Supply spends an estimated $1.4 million each year (not including alternative source development, recycling, conservation alternatives or pipeline replacements).

Over the long-term, conservation can decrease the need and costs of new capital facilities for supply, acquisition, treatment, storage, pumping and distribution. Operation and maintenance costs will also be reduced. Conservation may lower water rates. At an average 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 if the water conserved was available instead of developing a new source.

Water conservation can benefit wastewater collection and treatment systems. Reduced hydraulic loadings can improve treatment performance for effluent quality, reduce operating and maintenance costs, and defer the need to increase wastewater treatment facilities.

Customers will experience water, sewer and electricity cost savings, particularly if less hot water is used. Environmental benefits could also result from using less of the available water supply.

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

While new technologies and changes in behavior can decrease water consumption, they may not eliminate a need for developing new water supplies. As conservation measures are implemented, the amount of water use that can be reduced tends to decrease over time, as does the cost effectiveness ratio of consumer conservation program dollars expended to additional gallons of water saved.

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, water 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 sent, existing drought or weather conditions, and costs.

In order to utilize water conservation as a water supply option, potential programs can be evaluated 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, and weather affect water usage. Yet prioritization of efforts beyond general conservation is needed.

CONCLUSIONS

Water conservation is often the most cost-effective alternative option for conserving resources, decreasing operating costs, and deferring source development. Using water wisely is everyone's responsibility. Striving to conserve water at the lowest possible cost may save more groundwater. *Chapter 6* of this Plan presents water conservation as a supply source to meet some of the demand. BWS can partner with Hawaiian Electric Company (HECO) to implement new water and energy related conservation measures.

The table below details the BWS usage in Koʻolau Loa (refer also to *Chapter 3, Existing and Projected Water Use*). Residential usage is the predominant use. Large users/institutions in other categories, such as resort, commercial and public facilities, can also provide significant savings. The largest opportunity for water conservation savings is in Koʻolau Poko with 8.2 mgd of water use from Koʻolau Loa. The North Shore uses 0.3 mgd. The plans for these districts should include advanced water conservation measures to lower their demand for water from Koʻolau Loa. The water conservation achieved with the Leak Detection, Repair and Maintenance Program will be maintained by continuing improvements as needed in Koʻolau Loa.

BWS Usage in Koʻolau Loa

Koʻolau Loa BWS Customer Usage	2000 Usage (MGD)
Residential	1.00
Resort	0.21
Commercial	0.13
Public Facilities	0.13
Various customer types in Koʻolau Poko & North Shore using water from Koʻolau Loa	8.50

REFERENCES

American Water Works Association, *Water Conservation Programs, a Planning Manual, M52*, 2006.
BWS Conservation Program Development Study Scope of Work; Brown and Caldwell, 2006.
Guide to Preparing Urban Water-Use Efficiency Plans; United Nations Water Resources Series No. 83, 2003.
Economic and Social Commission for Asia and the Pacific.

6e Agricultural Water Loss Minimization

OCCURRENCE

Water conservation in the agricultural sector is an important means of conserving ground and surface water resources in Koʻolau Loa. While water losses are an unavoidable part of water distribution systems, routine maintenance and appropriate cropping techniques can ensure efficient water delivery.

CURRENT AND POTENTIAL USE

Systems maintenance can be challenging for small farmers who purchase water from an established ground or surface water distribution system. They may only be able to repair the distribution system pipes or ditches that bring the water to their area.

For mid to large agricultural water systems, such as the Punaluʻu System, one of the first steps in addressing possible water loss minimization is using water source and water end-use meters to assess water losses. Water management and system improvements can then be developed from this information.

For larger-scale systems, major improvements can minimize leakage from the system and increase water availability. Restoring old ʻauwai to transport surface water to agricultural areas is expensive with high water loss from seepage. PVC piping could more efficiently distribute surface water, and, if placed within the old ʻauwai, would have superior hydraulics to new pipeline alignments. Caution needs to be exercised as these ʻauwai are historic features.

Many farmers already use a variety of water conserving practices to keep their costs down. Drip irrigation rather than spray irrigation results in significant savings. Using mulch to retain water in the soil by slowing evaporation is another technique. Other farmers may use field leveling or dike furrowing to conserve water on site.

Larger farms may use evapotranspiration (ET) controllers and field soil moisture monitoring to schedule irrigation only when it is necessary. These are useful technologies but require a large scale to be cost efficient.

Environmental benefits accompany these savings in agricultural water use, especially of surface water. With increased water savings, more water may be available for stream flow restoration and instream uses.

COST

The Natural Resources Conservation Service (NRCS) provides free consultation services to farmers interested in using conservation practices on their farms. However, NRCS has limited funding for water conservation related measures. Major system repairs are usually privately funded, with cost recovery through fees to the users. Costs vary depending on the magnitude of repairs and upgrades.

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

Most farmers are motivated to use conservation techniques to decrease their business costs. Keeping up on the latest techniques can be challenging, and not all farmers may be aware of the extension services and funding available. Some of the water conservation measures require substantial investment over multiple years; for lessee with year-to-year leases, investing is not feasible.

Overall system repairs can be substantial, especially for systems where maintenance has been deferred for many years. These costs would be passed on to customers, who may not have the means to purchase more expensive water.

CONCLUSIONS

Farmers are economically motivated to save water while farming. By making low cost techniques and funding options available, farmers can save water and money. In cases where farmers are leasing property, lack of tenure may hinder conservation efforts. Larger-scale system improvements will also provide substantial water conservation. These costs may pose problems for farmers already operating in already tenuous situations if the cost of water increases significantly.

Punalu'u Stream and Diversion

6f Surface Water Use

OCCURRENCE

Surface water is important for instream and non-instream uses. Instream flow standards established by the Commission on Water Resource Management are the amount of water *"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."* In Koʻolau Loa the primary non-instream use is for agricultural purposes and is the focus of this project. (See also *Project 1c Measurable Instream Flow Standards*.)

CURRENT AND POTENTIAL USE

The streams providing surface water for non-instream uses are Punaluʻu, Kaʻaʻawa, Hauʻula and Kahana Streams, which are used for agricultural irrigation and provision of Native Hawaiian Rights. Surface water is not used as a potable water source in Koʻolau Loa.

The two streams with the largest flows in Koʻolau Loa are Kahana and Punaluʻu Streams, which account for the majority of district surface water use. The 1990 Hawaiʻi Stream Assessment lists the median flow for these streams as 23 mgd and 12 mgd, respectively. Other streams in Koʻolau Loa have much less flow and few or no diversions.

Kahana Stream runs through Kahana State Park which is a "living park", and more than thirty families farm kalo and use the stream for irrigation. These diversions have not been measured in total but have a fairly low flow and serve a small amount of agricultural area in the valley. The Findings of Fact, Conclusions of Law, and Decision and Order 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 second remand includes the return of 2.1 mgd of diverted Kahana Stream water as a component of the 13.3 mgd instream flow standard.

A recent USGS study in Punaluʻu estimates the Kamehameha Schools stream diversions via the Punaluʻu Ditch System at approximately 6.98 mgd. The study also evaluates the macrofauna of the stream. A report by RM Towill describes the Punaluʻu Ditch System as consisting of a diversion dam, flue, 12 transmission tunnels and an open concrete ditch channeling water into an underground pipe distribution system. The ditch has several gates to release unused water back into the stream and prevent overflow of the ditch. The stream water is used to irrigate loʻi kalo, flowers, Vietnamese herbs, commercial grass and potted plants, and aquaculture over an area of approximately 400 acres. These studies will be used in support of setting measurable instream flow standards and will guide future development of the surface water.

Currently, interim instream flow standards are based on the 1992 status quo stream flows and existing diversions. The stream flows and diversions were not quantified in the standard.

Various landowners and farmers have expressed interest in new irrigation water. However, until the instream flow standards are set, it is difficult to discuss stream water usage beyond the current allowable uses. For all intents and purposes, surface water is not available for any new uses due to the cost of stream studies required to amend the interim instream flow standards.

Diversions that are relatively small in relation to the total stream flow may be allowed on a case-by-case basis.

If additional water is required to meet the new instream flow standard, water currently diverted may need to be returned to the stream. To meet new demands, whether instream or non-instream uses, new sources of water may need to be developed. One possibility is to improve the distribution system to reduce the water lost to leaks (*Project 6e, Agricultural Water Loss Minimization*).

Any users proposing new or expanded diversions should petition to amend the interim instream flow standard. Infrastructure improvements would be made at the parties' own risk if such improvements are made prior to the CWRM acting on the petition. The CWRM determines what additional studies are needed, if any, in its evaluation of petitions to amend the interim instream flow standard.

Another possibility for increasing the amount of water available would be the development of the Makali'i Wells. These wells are dike basal, not high level dikes, with very small capacity and possible salinity issues. A water use permit of 1.364 mgd was granted for three of the wells; it was later determined that the amount was not possible on an ongoing basis. However, for periodic agricultural needs and during times of drought, these wells could be beneficial. These would be private agricultural wells.

Because of the variability of seasonal surface flow and annual rainfall, existing diversions and systems should have a drought plan/water shortage plan and reliable back-up supply, such as a groundwater well to supplement high use periods while minimizing withdrawal from the stream. Instream flows and habitat are most impacted during low flow periods, and if diversions can be reduced while well pumpage increases, streams will benefit. During normal rainfall periods, stream water use is most economical and wells can be recover until the next dry period.

COSTS

Delivering stream water using gravity is fairly inexpensive once a system has been constructed. Maintaining a system to prevent leakage also incurs costs. Expanding the Punalu'u system because of available stream flow after measurable instream flow standards have been set, could cost around $10,000. Improvements to reduce water losses in the Punalu'u system have not been identified at this time.

DEVELOPMENT ISSUES AND LIMITING CONSTRAINTS

Numerous issues affect instream and non-instream surface water use. The flow variability throughout the year can be an issue for farmers' crops which depend on a consistent water flow. Surface water can be rationed during low rainfall periods because there is no storage for times of low rainfall. Storm events and resulting floods can damage the irrigation water distribution systems.

CONCLUSIONS

Until measurable instream flow standards are set for the larger streams in Ko'olau Loa, only minor changes in use are possible. Once the measurable instream flow standards have been set, surface water use, instream and non-instream, will need to be evaluated. With standards, care will need to be taken during drought to ensure that instream and non-instream uses of water can be maintained, and if necessary, supplemented with non-surface water.

6
IMPLEMENTATION

6 IMPLEMENTATION

6.1 PROJECT PHASING BY OBJECTIVE
6.2 SUMMARY, PHASING, AND IMPLEMENTATION

6.1 PROJECT PHASING BY OBJECTIVE

The purpose of this chapter is to guide the implementation of the Plan's projects. *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 WMP:

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

While every project is considered important to the watershed and the water supply, they cannot all be accomplished at the same time or in every watershed. By phasing the projects into short term (5 years), mid term (6-14 years), and long term (15+ years), different projects can be implemented at different times. 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 Development Plan for Ko'olau Loa in terms of future water allocations.

Phasing

The selection of watershed management project phasing is a subjective process based on community input and working group meetings, agency meetings and interviews, capital plans and objectives and the watershed profile. 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. Also, each project is not necessarily implemented in each watershed.

The general rationale for the project phasing is listed below. Explanations of specific project phasing are detailed later in this section.

- S*hort-term projects* (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 later. 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.

Agency and Organization Participation

The strategies and projects will involve many governmental agencies and non-governmental organizations to implement these proposed actions. While the Board of Water Supply is one of the involved and participating agencies, it alone does not have the resources or the mandate 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 Koʻolau Loa watersheds and water resources.

6.1.1 Project Phasing for Objective #1: Promote Sustainable Watersheds

The projects for *Objective #1*, are summarized in *Tables 6.1* and *6.2.* They support sustainable watersheds by: enhancing the protection of natural resources; setting instream flow standards; flood control; preservation of biodiversity; and reduction of water export. Many of these projects are being implemented (in part or whole) indicating the importance already placed on them.

The projects are described briefly below with an explanation of which terms (short, mid, and/or long) in which they are likely to occur.

Watershed Partnerships are an ongoing effort. There are currently two active partnerships: Punaluʻu Watershed Alliance and the Koʻolau Mountains Watershed Partnership. Partnerships can have large impacts on the watersheds because of their ability to combine resources toward accomplishing common goals. They also broaden the participation of stakeholders in the watershed. These partnerships are expected to continue into the mid and long term.

Wildfire Management Plan can provide protection of watershed species and preserve the ecosystem, both of which are essential especially during periods of drought. Efforts will be needed into the long term to prevent wildfire damage to the watershed.

Pollution Prevention / Low Impact Development includes various projects and initiatives to prevent pollutants from entering the watershed streams and nearshore waters. Green recharge belts also help to minimize impacts. Low impact development addresses design measures to minimize pollution creation. Some projects are ongoing and some are still to be developed. These projects need to be ongoing and will continue into the mid and long term.

Measurable Instream Flow Standards are important for promoting sustainable watersheds by determining the amount of water needed for instream uses. Studies needed may include streamflow gaging, seepage runs, verification of diversions and biological stream assessments. Setting measurable instream flow standards is in progress for Punaluʻu Stream and may carry over into the mid and long term for other streams in Koʻolau Loa.

Table 6.1 Summary of Objective #1 Sub-Objectives, Strategies and Projects

OBJECTIVE #1 – PROMOTE SUSTAINABLE WATERSHEDS	
Sub-Objectives / Strategies	**Projects**
1.1 Strive to protect and enhance natural resources including land, streams and nearshore waters ecosystems	
1.1.1 Ensure mountain watersheds and other conservation zoned lands are actively protected and healthy	• Watershed Partnerships (5a) • Conservation District Boundary Review (3h) • Wildfire Management Plan (3i)
1.1.2 Manage agricultural lands for watershed health in addition to income generation	• Pollution Prevention / Low Impact Development (3d) • Crop Water Demand (3i)
1.1.3 Ensure that the additional urban growth is clustered within the Sustainable Communities Plan Rural Community Boundary and is designed for minimal impact on the environment	• Pollution Prevention / Low Impact Development (3d) • Stream Conservation Buffers (3b) • Cesspool Inventory / Greywater Reuse (3c)
1.2 Strive to set measurable instream flow standards	
1.2.1 Develop measurable instream flow standards for priority Ko'olau Loa streams	• Measurable Instream Flow Standards (1c)
1.3 Collaborate with responsible agencies to identify and implement environmentally-friendly measures to alleviate flooding issues and reduce pollution caused by runoff	
1.3.1 Plan and implement flood control measures	• Flood Control / Stormwater Management (1a) • Flood Channel Redesign (1b)
1.3.2 Improve management of streams and stream banks	• Stream Clearing and Management (3a)
1.3.3 Restore muliwai and wetlands for flood protection	• Muliwai / Wetland Restoration (3g)
1.4 Promote initiatives that protect and preserve species and habitat biodiversity, particularly native species	
1.4.1 Protect native species by reducing the threats of invasive plant species	• Invasive Species Assessments / Control (3e)
1.4.2 Protect native species by reducing the effects of feral pigs	• Feral Pig Management (3f)
1.5 Ensure the export of water from Ko'olau Loa will not be detrimental to Ko'olau Loa	
1.5.1 Increase water conservation in Ko'olau Poko	• Conservation Measures (6d) • Ag Water Loss Minimization (6e) • Increased Recycled Water (6c)

Flood Control/Stormwater Management is not necessarily the highest priority for watershed health, but is extremely important to the residents in the watershed impacted by periodic flooding. This project may begin in the short term for planning efforts, but solutions may not be selected and implemented until the mid and long terms.

Invasive Species Assessments/Control has begun for some mauka conservation lands through the Koʻolau Mountains Watershed Partnership. Assessments to identify areas with invasive plant species are underway for the short term. Hopefully, if detected early, eradication measures will be successful. The earlier the intervention, the easier and cheaper are the remedies that improve the watershed health. Vigilance in assessing invasive species will need to expand to the entire area and to continue into the mid/long term and beyond.

Feral Pig Management begun by the Koʻolau Mountains Watershed Partnership is another initiative aimed at improving the watershed. The Partnership is conducting an evaluation of some conservation lands and will propose feral pig management techniques. The Feral Pig Management Plan and an Environmental Assessment are planned for the short term. A more extensive management plan for additional areas and project implementation will be needed in the mid and long term.

Conservation Measures reduce both Koʻolau Poko and Koʻolau Loa use of water and promote sustainable watersheds. BWS infrastructure conservation program found and repaired approximately 1.0 mgd of pipeline water loss in Koʻolau Loa and Koʻolau Poko between 2003 and 2005. Various types of conservations measures will be implemented in the short, mid and long term.

Agricultural Water Loss Minimization can reduce water demands for agricultural waters and may reduce potable water use for agriculture in Koʻolau Poko. By decreasing the demand for agricultural water, more water would be available to meet existing Koʻolau Poko residential/commercial demands meaning less water needed from Koʻolau Loa. This project is designed for the short, mid and long term.

Increased Recycled Water could also reduce the use of potable water for irrigating crops in Koʻolau Poko, specifically in Waimānalo. By decreasing the use of potable water for agriculture, more is available to meet residential/commercial demands, meaning less water is needed from Koʻolau Loa. This project is designed for the short, mid and long term.

Crop Water Demand studies are needed for more accurate agricultural demand estimates. The estimates should account for rainfall, soils and slopes, operations, etc. There are institutional barriers to obtaining information, and regional and site specific research is needed. This project is likely a mid-term project.

Stream Conservation Buffers provide capture areas to keep pollutants and soil from entering streams. However, the mechanisms, responsible agency(s), and landowner issues remain to be worked out. Until the institutional barriers can be overcome, this project is a mid-term project that will likely extend into the long term.

Cesspool Inventory / Greywater Reuse begins with an inventory of homes and businesses using cesspools and an analysis to locate areas at high risk of contaminating ground, surface and nearshore waters. The water flowing out of cesspools can transport raw sewage toward and into the groundwater, streams, estuaries, and nearshore waters. Replacing the cesspools with septic tanks or wastewater treatment plant sewer connections would be the best options; however they are expensive. Alternatively, diverting greywater from the washing machine and shower for reuse on the yard, reduces the amount of water entering and leaving the cesspool.

Currently, County plumbing codes do not allow greywater reuse. Discussions on reviewing the uniform building code will be conducted in the short term and if successful, a program, for greywater reuse could be developed in the mid term and continue into the long term.

Flood Channel Redesign would assist in flood control efforts while promoting better stream habitat for stream species. Changing the established designs of flood control measures will take considerable time and research before changes can be implemented; therefore, this project is mid to long term.

Stream Clearing and Management serves an essential role in flood prevention by providing a clear path to the ocean for stormwater runoff. This project would also restore streams by providing high quality stream species habitat. Stream clearing responsibilities are not enforced nor is there sufficient information on stream bank maintenance for landowners along streams. Therefore, this project is mid to long term.

Muliwai/Wetland Restoration could be a component of flood control and habitat rehabilitation. This effort will require knowledge and resources as well as a champion for each area before implementation is possible. In addition, cesspool seepage into the estuary degrades water quality and would need to be addressed first. This project may begin in the mid term and continue to the long term.

Conservation District Review may involve agricultural lands that are more suitable as conservation lands. Identification of lands and the process of reclassification will require considerable effort and resources. This is a long-term project.

Table 6.2 Summary of Objective #1 Projects – Short, Mid and Long Term Phases

OBJECTIVE #1 – PROMOTE SUSTAINABLE WATERSHEDS		
Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Watershed Partnerships	→	→
Wildfire Management Plan	→	→
Pollution Prevention / Low Impact Development	→	→
Measurable Instream Flow Standards	→	→
Flood Control / Stormwater Management	→	→
Invasive Species Assessment / Control	→	→
Feral Pig Management	→	→
Conservation Measures	→	→
Agricultural Water Loss Minimization	→	→
Increased Recycled Water	→	→
	Crop Water Demand →	
	Stream Conservation Buffers	
	Cesspool Inventory / Greywater Reuse	→
	Flood Channel Redesign	→
	Stream Clearing & Management	→
	Muliwai/Wetland Restoration	→
		Conservation District Boundary Review →

6.1.2 Project Phasing for Objective #2: Protect and Enhance Water Quality and Quantity

The projects in *Table 6.3* are considered essential to protecting and enhancing water quality and quantity in Koʻolau Loa. Once degraded, water quality can be difficult or impossible to recover. Protecting the water from potential sources of contamination is the best line of defense. Water quantities should also be enhanced and protected where possible. Because promoting sustainable watersheds *(Objective #1)* also affects water quality and quantity, some projects are repeated in this objective.

Table 6.3 Summary of Objective #2: Sub-Objectives, Strategies and Projects

OBJECTIVE #2 – PROTECT AND ENHANCE WATER QUALITY AND QUANTITY	
Sub-Objectives / Strategies	**Projects**
2.1 Maintain and improve the water quality and quantity of groundwater	
2.1.1 Implement ***source water protection and security*** *measures*	• Groundwater Source Protection (2b)
2.1.2 Maintain aquifer integrity	• Drought Mitigation Strategies (2c) • Punaluʻu Pumpage Optimization (2d)
2.1.3 Continue to provide ***high quality drinking water supply*** *that meets or exceeds Safe Drinking Water Standards*	• *Various ongoing BWS initiatives, including regular monitoring and reporting*
2.1.4 Periodically review the sustainable yield estimate	• Sustainable Yield Estimate (2a)
2.2 Maintain and improve the water quality and quantity of surface waters	
2.2.1 Implement measures that improve the quality of surface waters that come from urban and agricultural land uses	• Pollution Prevention / Low Impact Development (3d) • Stream Conservation Buffers (3b) • Cesspool Inventory/Greywater Reuse (3c)
2.2.2 Monitor surface water quality	• Stream Water Quality Testing (1h)
2.3 Maintain and improve the water quality of nearshore waters	
2.3.1 Improve the ability of natural systems to capture and retain surface water	• Watershed Partnerships (5a) • Invasive Species Assessments / Control (3e) • Feral Pig Management (3f) • Muliwai / Wetland Restoration (3g)
2.3.2 Monitor nearshore water quality	• Nearshore Water Monitoring (1e)

Punaluʻu Pumpage Optimization has several different components. In the short term, some of the Punaluʻu well pumpage can be transferred to Maʻakua Well and Kaluanui Well which are further away to reduce pumping of Punaluʻu wells. Another optimization option in the mid term is to develop Kaipapaʻu well if needed to further reduce Punaluʻu pumpage.

Groundwater Source Protection is an ongoing effort to assess existing and proposed land uses around groundwater sources that may affect groundwater quality. This effort will continue into the mid and long term.

Drought Mitigation Strategies are important for protecting groundwater sources during periods of drought. Extended dry conditions on the typically rainy windward side can create drought conditions because of the aquifer's relatively small storage size. Implementing drought mitigation strategies in the short, mid and long terms provides for aquifer recovery in the post-drought period.

Sustainable Yield Estimates for Koʻolauloa and Kahana aquifers were revised in the August 2008 update of the Water Resources Protection Plan (WRPP). Recognizing the importance and current utilization of sustainable yield estimates for groundwater regulation and planning purposes, the CWRM will continue to enhance its data collection efforts and conduct periodic review and assessment of best available information for purposes of refining and improving its statewide estimates of sustainable yield. This is an ongoing effort that will continue into the mid and long term.

Pollution Prevention / Low Impact Development, as noted in *Objective #1*, includes various projects and initiatives to prevent pollutants from entering the watershed streams and nearshore waters. Some projects are ongoing and some have yet to be implemented. These projects will extend into the mid and long term.

Watershed Partnerships, as noted in *Objective #1*, are ongoing efforts that have implications for the quality and quantity of surface water and, in many cases, for groundwater as well. These partnerships are expected to continue into the mid and long term.

Invasive Species Assessments / Control project has begun for some mauka conservation lands and the initial project is being conducted by the Koʻolau Mountains Watershed Partnership, as noted in *Objective #1*. By protecting the watershed from invasive species, the diverse ecosystem can better retain and filter surface water. Expansion of this program to other areas and vigilance in assessing invasive species will need to continue into the foreseeable future.

Feral Pig Management is another initiative of the Koʻolau Mountains Watershed Partnership aimed at improving the watershed as noted in *Objective #1*. The possible soil erosion from feral pig activity can cause sedimentation to enter the nearby streams. Once the Partnership creates the initial feral pig management plan and an environmental assessment is conducted in the short term, implementation, expansion and maintenance will continue into the mid and long terms.

Stream Conservation Buffers as noted in *Objective #1*, provide an important capture area that reduces the amount of pollutants and soils entering streams. However, the mechanism and responsible agency(s) and landowner issues remain unresolved. Until the institutional barriers can be overcome, this project is a mid-term project that would extend into the long-term phase.

Cesspool Inventory / Greywater Reuse as described in *Objective #1* could reduce contaminants entering into nearby streams, estuaries and nearshore waters. Due to institutional barriers, this is likely a mid to long term project.

Stream Water Quality Testing like Nearshore Monitoring, stream water quality testing and monitoring provides an assessment of the health of the stream habitat. Establishing a testing program throughout the district is a mid- to long-term project.

Nearshore Water Monitoring provides an indicator of the health of the nearshore waters based on land practices. The monitoring is needed in the mid and long term to assess whether the pollution prevention projects are effective and what further efforts may be needed.

Muliwai / Wetland Restoration can increase surface water retention and filtering and has the potential to increase groundwater recharge. In addition, cesspool seepage into the estuary degrades water quality and would need to be addressed first. Restoring muliwai/wetlands is a large undertaking and will require a long time frame; therefore this project is likely mid to long term.

Table 6.4 Summary of Objective #2 Projects – Short, Mid and Long Term Phases

OBJECTIVE #2 – PROTECT AND ENHANCE WATER QUALITY AND QUANTITY		
Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Punaluʻu Pumpage Optimization	⟶	
Groundwater Source Protection	———	⟶
Drought Mitigation Strategies	———	⟶
Sustainable Yield Estimates	———	⟶
Pollution Prevention / Low Impact Development	———	⟶
Watershed Partnerships	———	⟶
Invasive Species Assessment / Control	———	⟶
Feral Pig Management	———	⟶
	Stream Conservation Buffers	⟶
	Cesspool Inventory / Greywater Reuse	⟶
	Stream Water Quality Testing	⟶
	Nearshore Water Monitoring	⟶
	Muliwai/Wetland Restoration	⟶

6.1.3 Project Phasing for Objective #3: Protect Native Hawaiian Rights and Traditional & Customary Practices

The projects in *Table 6.5* are needed to ensure that Native Hawaiian rights and traditional and customary practices in Koʻolau Loa are protected. These projects promote a riparian habitat with abundant stream species and a quantity of water for cultural uses, kalo, and other traditional agriculture. Projects which help to promote watershed sustainability and surface water quality also help to meet this objective.

Table 6.5 Summary of Objective #3 Sub-Objectives, Strategies and Projects

OBJECTIVE #3 – PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL & CUSTOMARY PRACTICES	
Sub-Objectives / Strategies	**Projects**
3.1 Plan for the enhancement of Native Hawaiian water rights and cultural and traditional uses	
3.1.1 Use surface water more efficiently	• Agricultural Water Loss Minimization (6e)
3.1.2 Develop new groundwater sources that do not impact surface waters	• Measurable Instream Flow Standards (1c)
3.1.3 Promote and preserve Native Hawaiian practices in the watershed	• Loʻi Kalo Expansion (4a) • Watershed Oral History Studies (4b) • Cultural Educational Programs (4c) • Fishpond (Loko Iʻa) Restoration (4d)
3.2 Consult with Native Hawaiian agencies/communities on water-related issues	
3.2.1 Prior to constructing projects in culturally sensitive areas, consult with the Native Hawaiian community	• Cultural Monitoring Program (4e)
3.2.2 Use the guidance from the Kapaʻakai (2000) court decision on Native Hawaiian consultation on providing for the ability to exercise Native Hawaiian traditional and customary rights	• *Various agencies with land use decision-making authority to review projects for Native Hawaiian issues*

Watershed Oral and Cultural History project is time-sensitive as its main contributors are the older individuals in the community. The information provided by oral and cultural histories would be invaluable for other projects such as: Cultural Education; Water and Watershed Education; and Loʻi Kalo Restoration. Kamehameha Schools has recently conducted oral histories for the Punaluʻu area.

Agricultural Water Loss Minimization can conserve groundwater and surface waters by maintaining or improving the water distribution to the fields and by using efficient crop irrigation methods. This will be an ongoing effort to maintain distribution systems and use efficient irrigation and cropping methods. These improvements can be immediately implemented in the short term and will require maintenance and use into the long term.

Measurable Instream Flow Standards are important for promoting sustainable watersheds by determining the amount of water needed for instream uses such as traditional and customary uses. Studies needed may include streamflow gaging, seepage runs, verification of diversions and biological stream assessments. Punaluʻu Stream has considerable data and will likely be the next stream to have a measurable instream flow standard. Setting measurable instream flow standards for other streams in Koʻolau Loa will likely be in the mid and long term.

Cultural Monitoring Program is ongoing. Cultural monitors represent the lineal descendants of each ahupuaʻa regarding inadvertent findings of iwi kupuna caused by construction projects. This is an ongoing project to that will continue in the short, mid and long terms and could be expanded to other projects at the city, state and federal level.

Cultural Educational Programs are ongoing in Punaluʻu where Kamehameha Schools leads watershed field trips. These programs should be continued and expanded throughout the district. The development of the Watershed Oral and Cultural Histories will contribute greatly to educational programs and sharing of local knowledge and history.

Fishpond (Loko Iʻa) Restoration has begun with Huilua Fishpond Restoration in Kahana Bay. Restoring fishponds requires a variety of conditions including good quality surface waters to support the aquatic habitat. This restoration effort is under way and will continue into the future.

Loʻi Kalo Expansion will involve opening up or restoring old loʻi and ʻauwai and building on the strengths of the existing loʻi kalo in Kahana, Punaluʻu, and Hauʻula, and at Brigham Young University – Hawaiʻi. The Watershed Oral and Cultural Histories project can help in locating loʻi kalo areas. Implementation is likely in the mid to long term.

Table 6.6 Summary of Objective #3 Projects – Short, Mid and Long Term Phases

OBJECTIVE #3 – PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL & CUSTOMARY PRACTICES		
Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Watershed Oral & Cultural History ———	———→	
Agricultural Water Loss Minimization ———	———	———→
Measurable Instream Flow Standards ———	———	———→
Cultural Education Programs ———	———	———→
Fishpond (Loko Iʻa) Restoration	———	———→
Cultural Monitoring Program ———	———	———→
	Loʻi Kalo Expansion ———	———→

6.1.4 Project Phasing for Objective #4: Facilitate Public Participation, Education and Project Implementation

The projects in *Table 6.7* involve stakeholders in the planning and management of water and its related resources. Ultimately public participation will result in benefits to the water users, water resources and the related ecosystems.

Table 6.7 Summary of Objective #4 Sub-Objectives, Strategies and Projects

OBJECTIVE #4 – FACILITATE PUBLIC PARTICIPATION, EDUCATION AND PROJECT IMPLEMENTATION	
Sub-Objectives / Strategies	**Projects**
4.1 Implement watershed management projects and programs, through a combination of agency initiatives, watershed partnerships and community-based implementation entities	
4.1.1 Support the existing and future watershed partnerships in Koʻolau Loa	• Watershed Partnerships (5a)
4.2 Develop watershed protection curriculum and programs to educate future generations and make curriculum available to area schools and organizations	
4.2.1 Continue BWS educational programs in schools and develop a curriculum that promotes the health of our watersheds	• Water and Watershed Education (5b)
4.3 Empower residents to facilitate public participation in water resources planning and management	
4.3.1 Provide opportunities for residents to participate in resource planning through new or existing organizations	• Watershed Partnerships (5a)
4.4 Provide education on watershed issues and protection and water conservation measures to the general public	
4.4.1 Support creation of an implementation entity through an existing or new organization for Koʻolau Loa	• Koʻolau Loa Implementation Entity (5c)
4.5 Obtain funding to implement the plan's projects and programs; funding types may include dedicated sources, grants and appropriations	
4.5.1 Identify sources of governmental funding and non-profit funding sources available for watershed management project implementation	• Grant Funding (5d)

Watershed Partnerships that increase the number of involved stakeholders can have large scale positive impacts on the watersheds. As noted in *Objectives #1* and #2, this is an ongoing project that will continue into the mid and long term.

Water and Watershed Education helps to inform the watershed communities about water supply and watershed health. The educational programs should be continued in the short, mid and long term.

Koʻolau Loa Implementation Entity would promote community-based project implementation. This could be through an existing or new organization and would be ongoing through the short, mid and long term.

Grant Funding will be needed to implement Plan projects that lack funding from agencies and landowners. Obtaining the financial resources will be critical in the short, mid and long term.

Table 6.8 Summary of Objective #4 Projects – Short, Mid and Long Term Phases

OBJECTIVE #4 – FACILITATE PUBLIC PARTICIPATION, EDUCATION AND PROJECT IMPLEMENTATION		
Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Watershed Partnerships ———	——————————	——————————→
Water and Watershed Education	——————————	——————————→
Ko'olau Loa Implementation Entity ———	——————————	——————————→
Grant Funding ———	——————————	——————————→

6.1.5 Project Phasing for Objective #5: Meet Water Demands at Reasonable Costs

The phasing for water supply projects that "meet water demands at reasonable cost" depends on a variety of factors. In addition to cost, other factors include system service and reliability, environmental stewardship, water supply, delivery and conservation, the ability to implement projects and water-related policies, and the ability to meet the other objectives of the Plan.

In this section, the demand projections are briefly recapped, the water supply projects are discussed, and then project phasing (short, mid and long term) is presented. The projects and phasing in this section will help guide CWRM in issuing future water use permits in Ko'olau Loa.

6.1.5.1 Water Demand

The allocation and phasing of water is based on the 2030 water demand projections for Ko'olau Loa, which are presented in detail in *Chapter 3, Water Use and Projected Demands*. The water demand projections are based on City and County of Honolulu *Ko'olau Loa Sustainable Communities Plan* (1999) land use designations and City and County's Department of Planning and Permitting (DPP) 2030 population and visitor projections. A brief summary of these demands is presented below.

Two methodologies for projecting future water demands were used: *per capita* and *end use inventory*. The demand scenarios presented here were calculated using the end use inventory method.

Three different scenarios provide a range of likely outcomes. The Low Demand Scenario assumes lower population and visitor growth than the DPP population projections and no increase in the amount of irrigated agriculture lands. The Mid/Policy Demand Scenario assumes population and visitor growth consistent with the DPP population projections and irrigated agriculture acreage increases by 60%. The High Demand Scenario assumes higher population and visitor numbers than projected by DPP and irrigated agriculture acreage doubling by 2030.

All three demand scenarios assume 8.6 mgd of water exported from Ko'olau Loa to Ko'olau Poko and the North Shore *(Figure 6.1)*; keeping export constant is consistent with 2005 DPP 2030 population and visitor projections for Ko'olau Poko which project a slight decrease in population by 2030.

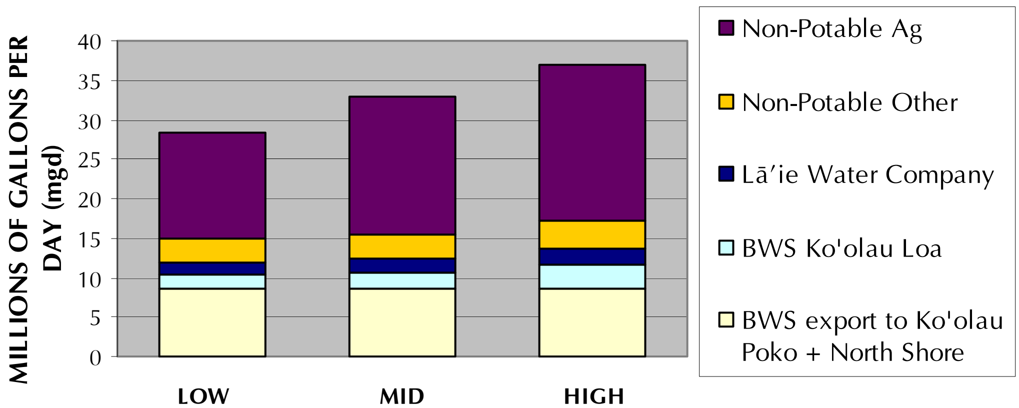


Figure 6.1 Koʻolau Loa 2030 Demand Projections: Low, Mid and High Scenarios

The most likely scenario is the Mid / Policy demand scenario which is based on the end use inventory method and the City and County of Honolulu DPP *Koʻolau Loa Sustainable Communities Plan*. The other two scenarios, Low and High, bracket the policy scenario and provide a range of possible outcomes.

The Mid / Policy demand scenario does not include the full proposed build out of Turtle Bay resort; full build out at 4,000 units is included in the high demand scenario. While the number of units at the resort is a factor in the water demand projections, the biggest unknown or "wild card" is agricultural water needs. Koʻolau Loa has much farmland, and only a portion of it is intensively farmed and irrigated at this time. If the amount of irrigated agriculture lands increases in Koʻolau Loa, the amount of water for this non-potable demand would greatly increase as shown in the Mid / Policy and High Scenarios (*Figure 6.1)*.

6.1.5.2 Water Supply Projects

The Koʻolau Loa water supply projects to meet water demands are listed in *Table 6.9* and fall into three general categories: groundwater, alternatives to ground and surface water, and surface water. The water supply projects in each category are discussed and their phasing follows.

Table 6.9 Summary of Objective #5 Sub-Objectives, Strategies and Projects

OBJECTIVE #5 – MEET WATER DEMANDS AT A REASONABLE COST	
Sub-Objectives / Strategies	**Projects**
5.1 Provide water at a reasonable cost to the community in a way that provides for the long term health of the watershed	
5.1.1 Make the best use of existing supplies before developing new water sources	• Punaluʻu Pumpage Optimization (2d) • *Various initiatives to optimize use of existing sources*
5.1.2 When new sources are needed, balance least cost options with environmentally, culturally, and socially acceptable options	• Potable Well Development (6a)
5.2 Efficiently meet water demands and match quality (i.e. potable, brackish, recycled) with use (drinking, irrigation, etc.)	
5.2.1 Increase water conservation measures	• Conservation Measures (6d) • Agriculture Water Loss Minimization (6e)
5.2.2 Develop and use recycled water to meet non-potable demands, where feasible	• Increased Recycled Water (6c) • Cesspool Inventory / Greywater Reuse (3c)
5.2.3 Use surface water within current and future instream flow standards for non-potable demand	• Surface Water Use (6f)
5.2.4 Develop new agricultural / aquaculture wells for non-potable demand	• Agriculture (Non-Potable) Well Development (6b)
5.3 Maintain and improve BWS system reliability	
5.3.1 Continue to provide high quality drinking water supply that meets or exceeds Safe Drinking Water Standards	• Groundwater Source Protection (2b) • *Various ongoing BWS initiatives, including regular monitoring and reporting*
5.3.2 Continue BWS' ongoing main replacement program and other system upgrades	• *Refer to BWS Capital Program (Appendix F)*
5.3.3 Optimize system operations	• Punaluʻu Pumpage Optimization (2d) • *Various ongoing BWS system management measures including leak detection and back-up supplies*
5.3.4 Implement security measures	• *Various ongoing BWS facilities security initiatives*

The primary criteria used to evaluate the need and feasibility of water supply projects include forecasts of growth, promoting efficient use of water, cost effectiveness, drought mitigation, system reliability, ability to deal with uncertainty, ease of implementation, and minimal environmental impacts. The BWS is committed to diversifying its water sources to ensure reliability to its customers and to meet the other objectives of the Watershed Management Plans.

Groundwater: Potable Well Development and Agriculture Non-Potable Well Development

Koʻolau Loa has groundwater resources that supply most of the district's water needs. The three scenarios (low, mid, and high) 2030 projected demands are below the State Commission on Water Resource Management's sustainable yield. There is no planned Kahana GWMA development due to low expected source yield and possible groundwater interactions with streams because of dike influences. The groundwater projects are listed in *Table 6.10*. The Koʻolau Loa BWS 6-year Capital Program (FY 2006-2011) is found in *Appendix F*.

Table 6.10 Groundwater Wells: Permit Amounts and Phasing

Existing / New Wells	State Well No.	Current Permitted Amount	Potential Permitted Amount	GWMA	Capital Costs	Phase	Note
New Mālaekahana (BWS)	3957-08 and -09	--	1.0 mgd	Koʻolau Loa	Low	Mid	Kahuku growth
New ʻŌpana Wells[1]	4100-02 to -05	--	1.0 mgd	Koʻolau Loa	Low	Short	Turtle Bay growth
Existing Lāʻie Wells (LWC)	3855-06	1.375 mgd	1.7 mgd	Koʻolau Loa	Low	Short	Lāʻie growth
New Mālaekahana (LWC)	--	--	0.7 mgd	Koʻolau Loa	Mid	Short/ Mid	Lāʻie growth
Exisiting Kūʻoū Well III (BWS)	2348-06	0.196 mgd	0.5 mgd	Koʻolau Poko	Funded	Short	To decrease KL export
New Waimānalo Well III (BWS)	1942-01	0.200 mgd	0.5 mgd	Koʻolau Poko	Funded	Short	To decrease KL export
Existing Maʻakua Well (BWS)	3655-02	0.667 mgd	1.0 mgd[2]	Koʻolau Loa	-	Short	Punaluʻu Optimization
Existing Kaluanui Well (BWS)	3554-04 to -06	1.093 mgd	1.5 mgd[2]	Koʻolau Loa	-	Short	Punaluʻu Optimization
New Kaipapaʻu Well (BWS)	3655-03	--	1.0 mgd[2]	Koʻolau Loa	Mid	Mid	Punaluʻu Optimization

[1]The ʻŌpana Wells are being constructed and permitted by Turtle Bay Resort and will then be dedicated to the Board of Water Supply.

[2]Punaluʻu Wells would be reduced by the amount added to this well so there is no net increase in WUP amounts.

Potable Well Development (Project 6a) The new well development projects for potable water use (detailed in *Chapter 5)* are shown in *Table 6.10* with the proposed phasing. Well construction is focused on the short and mid term to serve demands in the mid and long term.

Punalu'u Pumpage Optimization (Project 2d) has several different components. In the short term, some Punalu'u well pumpage can be transferred to Ma'akua Well and Kaluanui Well to reduce pumping of the Punalu'u wells. Another optimization option is to develop Kaipapa'u Well if needed to further reduce Punalu'u pumpage in the mid term.

Groundwater Source Protection (Project 2b) is an ongoing effort to assess existing and proposed land uses around groundwater sources that may affect groundwater quality. This will continue into the mid and long term.

Agricultural (Non-Potable) Well Development (Project 6b) is the primary source of irrigation aside from surface water in Punalu'u and Kahana Valleys. Ideally, potable water demands should be met with potable water and non-potable water demands with non-potable water. However, in Ko'olau Loa and the rest of O'ahu, potable water is far more abundant than non-potable water, so potable water is commonly used to meet non-potable agricultural demand.

Because the agricultural water demands are difficult to project and the wells to meet the demand are developed by individual landowners, it is hard to predict where and when wells will be developed. If groundwater is needed to replace or supplement surface water in Punalu'u during drought, the development of Makali'i Wells may be necessary. Agricultural non-potable well development could occur in the short, mid and long term.

Note: There are two private wells that provide groundwater for non-potable uses that are not agriculture related; however, no increases in use are proposed. The Polynesian Cultural Center uses groundwater for their attraction's lagoons and will not need additional non-potable water. Turtle Bay Resort utilizes wells for golf course irrigation and supplements it with recycled water. Expansion at Turtle Bay Resort will provide additional recycled water for the golf courses and at full buildout the resort's overall demand for groundwater to irrigate the two golf courses will decrease.

Alternatives: Increased Recycled Water, Water Conservation, and Agricultural Water Loss Minimization

Diversification in water supply resources increases reliability of supply. For example, recycled water provides a relatively drought resistant water supply and supplements and replaces potable irrigation. Recycled water, water conservation and agriculture water loss minimization are the alternatives for Ko'olau Loa. Use of potable water for non-potable uses should be reduced, and potable water should not be used for non-agricultural non-potable needs such as golf courses. Recycled water helps to match non-potable water quality with non-potable water demands.

Increased Recycled Water (Project 6c) The Turtle Bay WWTP produces R-2 water and currently the plant is running at 20% capacity (0.264 mgd). As the resort expands, more recycled water will be produced and utilized on site for golf course and landscaping irrigation. Also, there are plans to upgrade the WWTP to produce R-1 quality water which will simplify the regulatory conditions of use. Turtle Bay owns and maintains this private system.

The Lā'ie WRF produces R-1 water and has a total average day capacity of 0.9 mgd. Currently Lā'ie WRF produces 0.36 mgd of recycled water and distributes 0.30 mgd of recycled water. To utilize the remaining recycled water, an expanded distribution system is needed. Potential areas that could use this supply would be agriculture, and large landscaped areas such as roadway landscaping, parks, and schools. If more housing is constructed, more wastewater would be available for treatment and distribution. This system is now owned and managed by the City and County of Honolulu Environmental Services Department. Lāʻie recycled water is difficult to market to farmers because it is more expensive than available groundwater.

The City and County of Honolulu Kahuku WWTP is currently not utilized as a recycled water supply resource, in part because it produces R-3 quality water. The water currently receives secondary treatment and is then sent to injection wells. Additional treatment filtration and disinfection would be needed before it could be utilized and a distribution system constructed. The treatment plant has a capacity of 0.40 mgd and treats an average of 0.12 mgd. While this is not a large amount of water, it comes from residential sources and therefore has a potential for reuse. A potential user of the recycled water is the Kahuku Golf Course expansion.

The State is in the process of upgrading the Waimānalo WWTP to increase its capacity. Upon completion of the upgrades, the WWTP will be dedicated to the City and County of Honolulu. To produce R-1 quality water for reuse, additional upgrades would be needed. Recycled water could then be used for irrigation to reduce the amount of BWS potable water used and to supplement limited surface water supply, especially during drought.

Recycled water phasing for the individual system is listed below:

- Turtle Bay Resort recycled water will be used in the short, mid and long term.
- Lāʻie WRF recycled water at Brigham Young University-Hawaiʻi will be used in the short, mid and long term. The use of larger quantities is dependent on a changing market or market subsidies; therefore, increases are likely in the mid or long term.
- Kahuku WWTP recycled water is likely to be used with the expansion of Kahuku golf course. The golf course expansion and the additional treatment and distribution system are likely in the long term.
- Waimānalo WWTP will require both funding for the additional treatment and distribution, and the recycled water will need to be designated to replace current BWS potable water; this is likely a long-term project.

Cesspool Inventory / Greywater Reuse (Project 3c) is a smaller scale version of recycled water where "greywater" from the washing machine or shower can be used for reuse in the yard. During drier periods this could help to reduce the use of groundwater. This project might be implemented in the mid to long term.

Conservation Measures (Project 6d) the efficient management of our water resources promotes sustainability of the resource. As an alternative, water conservation reduces water use so that less groundwater or surface water is needed.

The ongoing BWS program of infrastructure leak detection and repair focuses on reducing the amount of system leakage. The BWS consumer programs focus on a variety of areas from changing behaviors to the installation of water saving devices. Conservation behaviors are very challenging to predict, and therefore are used primarily for seasonal/drought conservation needs, which are temporary in nature. Estimating the savings from conservation devices is somewhat less challenging. The choice to adopt the measures is still a behavior component. However, once devices are installed the savings generally continue.

The goal for water conservation in Koʻolau Loa, a high rainfall area, is a 5% reduction in forecasted demand. The water conservation types of programs to accomplish this are listed in the project description including a BWS Water Conservation Effectiveness Study. Water conservation is an ongoing effort that is a cost-effective means of reducing operating costs and minimizing capital expenditures for new source development.

Agricultural Water Loss Minimization (Project 6e) practices, devices and repairs to reduce water usage are the responsibility of everyone using water. Agricultural water loss minimization can mean less groundwater or surface water is then needed. This project is ongoing into the short, mid, long term and beyond.

Surface Water Use (Project 6f) is not allocated in this plan, because measurable instream flow standards have not been set except for Kahana Stream. However, the possible outcomes of measurable instream flow standards are three-fold:

(a) The instream flow standard adequately protects instream uses, allows for current surface water diversions (if any), and additional surface water is available for non-instream use.

(b) The instream flow standard adequately protects instream uses and allows for current surface water diversion (if any), but surface water is not available for additional non-instream uses.

(c) The current streamflow is below the instream flow standard, therefore surface water from current surface water diversions must be restored to the stream.

The assumption for this plan is (b), that the current amounts of diversion and instream uses are maintained pending the setting of measurable instream flow standards that set aside water for non-stream uses. As with groundwater, surface water should be used wisely and not wasted. Unused diverted stream water should be returned to the stream as close to the diversion as possible or not diverted in the first place unless a reasonable and beneficial non-instream use is identified. Additional water from a diverted water system is only possible by decreasing system losses and increasing conservation as discussed in *Project 6e, Agricultural Water Loss Minimization.*

One limitation in using surface water is its lack of reliability especially during periods of drought (*Project 2c, Koʻolau Loa Drought Mitigation Strategies)*. By increasing the diversity of water sources more irrigation water may be available on a year round basis. By increasing water storage, or by supplementing surface water with groundwater, additional agricultural lands may be irrigated cost effectively with minimal impact. During drought periods when limited stream water is available, groundwater can be used to supplement or in lieu of surface water. When surface water is readily available, the groundwater sources can have time to replenish.

Other Supply Options Considered

The following supply options were considered but were deemed not appropriate at this time for Ko'olau Loa:

1) North Shore Groundwater Export to Ko'olau Loa

   The export of North Shore water to Ko'olau Loa is not feasible. The new transmission lines would cost more than the cost of developing new water sources in Ko'olau Loa, and the water is not needed as Ko'olau Loa has sufficient water resources.

2) Surface Water for Potable Water

   BWS study has found the use of surface water for potable water supply unfeasible at this time due to environmental constraints, instream flow standards uncertainties, and the high costs of treatment and the extensive distribution system water quality monitoring required (Surface Water Study for Kahana, Punalu'u and Waiawa Streams, March 1996.).

3) Desalination

   Development of a desalination plant in Ko'olau Poko to decrease exports from Ko'olau Loa is an expensive option and would likely happen only if there were extreme pressures on the water source such as long term drought or unforeseen population increases. Cost effectiveness and sensitive shoreline development issues are limiting factors for the development of a desalination plant in the Ko'olau Poko district. The BWS has no plans to construct a desalination plant in a Windward area.

4) Stormwater

   A recent report prepared for the U.S. Department of the Interior, Bureau of Reclamation (BOR), entitled "Hawai'i Storm Water Reclamation Appraisal Report" (July 2005) analyzes the feasibility of thirty-one "storm water reuse" opportunities in the Hawaiian Islands, but does not include a project in the Ko'olau Loa district.

   Larger scale stormwater capture projects involving impoundments or infiltration pits are generally fairly costly. A relatively small reservoir proposed for Wai'anae 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. In addition to high capital and maintenance costs for relatively low volumes of water, the larger scale stormwater capture techniques have health, safety, and environmental impact issues.

   Because groundwater for irrigation purposes is available and relatively inexpensive, stormwater capture in Ko'olau Loa is not a recommended alternative for increasing water supply. However, if stormwater capture projects were designed for flood control/mitigation, it could benefit flood prone areas in Ko'olau Loa provided that the environmental and safety issues were addressed.

   One stormwater reuse option that is feasible for Ko'olau Loa is individual rain barrel catchment systems for residential and commercial landscape irrigation as discussed in the Conservation Measures Project 6d in Chapter 5.

Table 6.11 Summary of Water Supply Options

WATER SUPPLY OPTIONS	Capital Cost ($/Gal)	Current Use (mgd)	Potential Future Use (mgd)	Development Feasibility	Feasibility Notes
1) GROUNDWATER					
a. BWS Well: ʻŌpana for Turtle Bay	To be dedicated	0	1.0	High	Source readily available and relatively cost effective
b. BWS: Mālaekahana / Kahuku Pump 3	$3.54	0	1.0	High	
c. Lāʻie Water Company: Expanded use of existing wells	$1.00	1.4	1.7	High	
d. Lāʻie Water Company: Malaekahana Well	$5.00	0	1.0	High	
e. BWS Koʻolau Poko Wells: Kūʻou III & Waimānalo III	Existing Under construction	0.2 0	0.5 0.5	High	
f. Private Ag Wells	$0.50	6.3	depends on agricultural demands	High	
2) RECYCLED WATER					
a. Koʻolau Loa: Láʻie	existing infrastructure	0.3	0.9	Moderate	Challenging markets
b. Koʻolau Loa Loa: Turtle Bay	existing infrastructure	0.26	1.32	High	Can use all recycled water produced
c. Koʻolau Loa Loa: Kahuku	$5 to $12	0	0.4	Moderate	Required for Kahuku Golf Course expansion
d. Koʻolau Loa Poko: Waimānalo	$5 to $12	0	1.1	Low to Moderate	City would need to upgrade after WWTP is dedicated
3) SURFACE WATER					
a. Streams (Non-Instream Use)	Site Specific	5.4	Requires metering to verify use	Low	Up to capacity of existing diversions. Additional water pending measurable instream flow standards
b. Stormwater (Flood detention)	$39	0	--	flood detention - not feasible	Environmental, social and cost issues
c. Rain Catchments (Residential)	$200/home	0	--	High	Rain catchments for landscaped irrigation have a high feasibility
4) CONSERVATION					
Conservation in Koʻolau Loa, Koʻolau Poko and North Shore and agricultural water loss minimization in Koʻolau Loa	up to cost of new well	difficult to quantify current savings	0.05	High	Feasible although difficult to quantify; due to wet climate, estimated at 1-5% of new uses.
5) DESALINATION					
Desalination for Koʻolau Poko	$9.00	0	1.0	not cost effective	Not a need at this time

6.1.5.3 Phasing Summary and Quantities for Water Supply Projects

Supply sources are matched with demand projections in the graphs and tables below for each of the three scenarios *(Tables 6.12-6.14* and *Figures 6.2-6.4)*. For planning purposes, three scenarios are shown instead of only one to provide a range of possible outcomes.

Projections and water supply amounts are shown in 5-year increments from 2000-2030 and provide a numerical summary. Demand is categorized as potable and non-potable and shown as lines on the charts. The lower line is the non-potable demand and the upper line is the cumulative total of both potable and non-potable demand.

Bar charts indicate the volume of water provided by each of the supply sources which are:

- Groundwater by GWMA
- Surface Water
- Recycled Water
- Water Conservation / Agricultural Water Loss Minimization

Water conservation and agricultural water loss minimization are presented as a supply source in this plan *(Figures 6.2, 6.3, and 6.4)*. Potential BWS water conservation savings are assumed to be 1% of the existing water use by 2030 and even further savings for the additional water demand may be possible. As noted previously there is a goal of 5% reduction in forecasted demands. Because of the high rainfall levels of Koʻolau Loa, the opportunities for water conservation are mainly for indoor water use. Agricultural water savings are assumed to be 1% of water usage. The greatest opportunity for agricultural irrigation savings is the Punaluʻu Ditch system. The assumptions for water conservation are purposefully conservative so as not to overestimate its capacity as a supply source.

Table 6.12 Koʻolau Loa Low Demand Scenario: Projected Water Demand and Supply Options

DEMAND (mgd)	2000	2005	2010	2015	2020	2025	2030
BWS Potable	1.46	1.55	1.68	1.70	1.73	1.80	1.84
BWS Potable export to Koʻolau Poko & North Shore	8.60	8.60	8.60	8.60	86.0	8.60	8.60
LWC Potable	0.95	1.13	1.17	1.22	1.28	1.34	1.40
Total Potable Demand	**11.01**	**11.29**	**11.45**	**11.52**	**11.61**	**11.74**	**11.83**
Non-Potable Agriculture	13.25	13.25	13.25	13.25	13.25	13.25	13.25
Non-Potable Other	1.88	2.27	2.27	2.27	2.53	2.90	3.27
Total Non-Potable Demand	**15.13**	**15.53**	**15.53**	**15.53**	**15.79**	**16.16**	**16.52**
TOTAL DEMAND	**26.14**	**26.81**	**26.98**	**27.05**	**27.40**	**27.90**	**28.36**
SUPPLY (mgd)							
Koʻolau Loa GWMA[1]	17.24	17.91	18.08	18.14	18.32	18.69	19.02
Kahana GWMA[2]	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Kawailoa GWMA	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Surface Water[3]	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Recycled Water	0.56	0.56	0.56	0.56	0.74	0.86	0.98
Agriculture Water Savings	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Water Conservation	0.00	0.00	0.01	0.01	0.01	0.01	0.02
TOTAL SUPPLY	**26.14**	**26.81**	**26.98**	**27.05**	**27.40**	**27.90**	**28.36**

[1] Sustainable yield for Koʻolau Loa GWMA is 36 mgd.
[2] Sustainable yield for Kahana GWMA is 15 mgd.
[3] Surface Water is assumed to be the existing water use pending measurable instream flow standards.

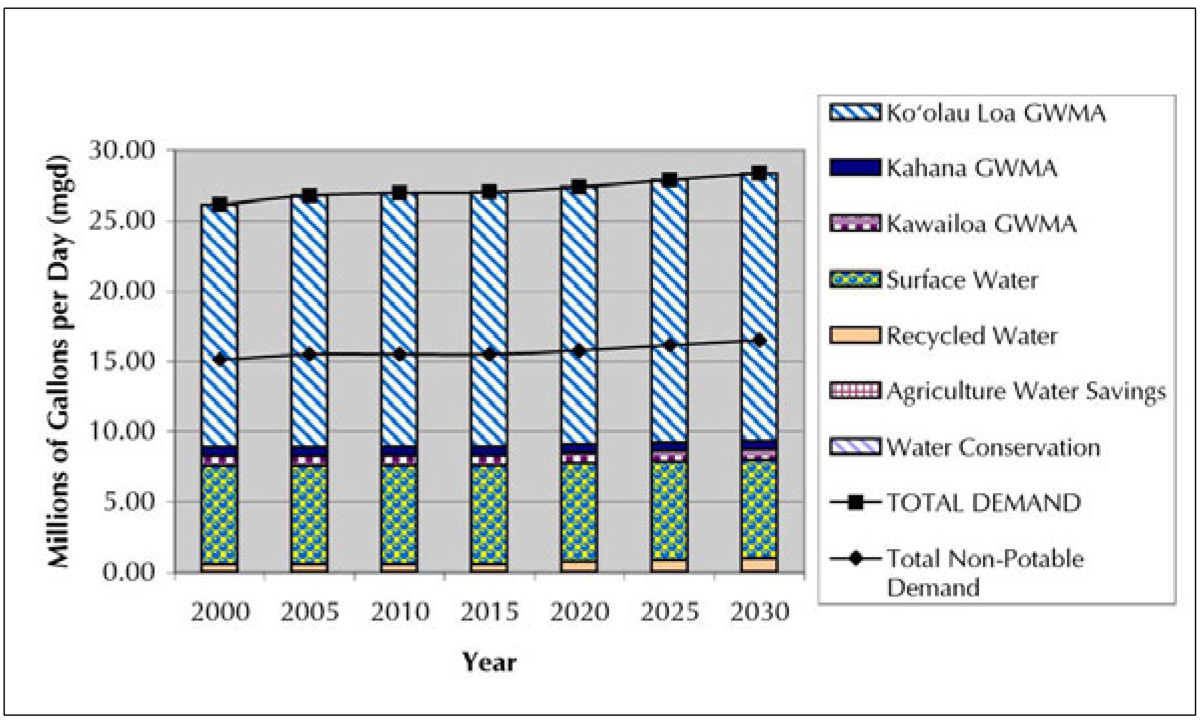


Figure 6.2 Koʻolau Loa Low Demand Scenario: Projected Water Demand and Supply Options

Table 6.13 Koʻolau Loa Mid/Policy Demand Scenario: Projected Water Demand and Supply Options

DEMAND (mgd)	2000	2005	2010	2015	2020	2025	2030
BWS Potable	1.46	1.57	1.86	1.89	1.92	1.96	2.15
BWS Potable export to Koʻolau Poko & North Shore	8.60	8.60	8.60	8.60	8.60	8.60	8.60
LWC Potable	0.95	1.15	1.32	1.39	1.46	1.52	1.59
Total Potable Demand	**11.01**	**11.32**	**11.78**	**11.87**	**11.97**	**12.08**	**12.34**
Non-Potable Agriculture	13.25	13.79	14.37	14.99	15.68	16.42	17.22
Non-Potable Other	1.88	2.28	2.39	2.40	2.67	3.02	3.37
Total Non-Potable Demand	**15.13**	**16.07**	**16.75**	**17.39**	**18.34**	**19.44**	**20.59**
TOTAL DEMAND	**26.14**	**27.39**	**28.53**	**29.26**	**30.32**	**31.52**	**32.93**
SUPPLY (mgd)							
Koʻolau Loa GWMA[1]	17.24	18.47	19.49	20.01	21.06	22.05	23.36
Kahana GWMA[2]	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Kawailoa GWMA	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Surface Water[3]	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Recycled Water	0.56	0.57	0.68	0.89	0.90	1.10	1.20
Agriculture Water Savings	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Water Conservation	0.00	0.01	0.02	0.02	0.02	0.03	0.03
TOTAL SUPPLY	**26.14**	**27.39**	**28.53**	**29.26**	**30.32**	**31.52**	**32.93**

[1] Sustainable yield for Koʻolau Loa GWMA is 36 mgd.
[2] Sustainable yield for Kahana GWMA is 15 mgd.
[3] Surface Water is assumed to be the existing water use pending measurable instream flow standards.

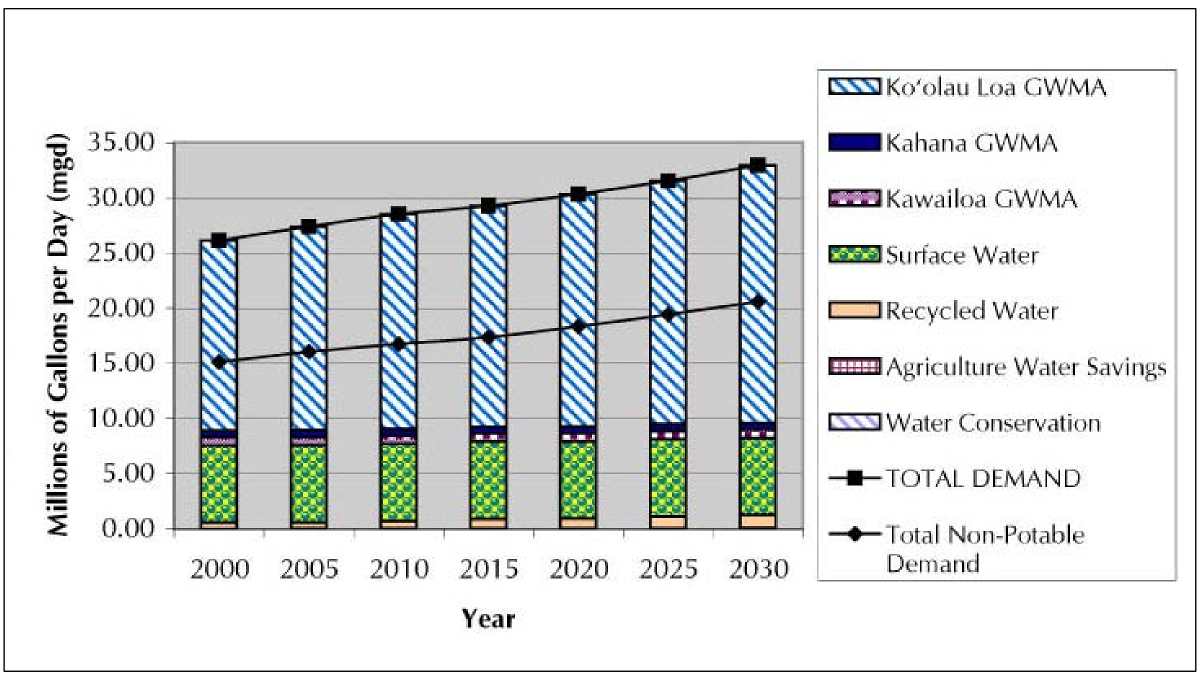


Figure 6.3 Koʻolau Loa Mid/Policy Demand Scenario: Projected Water Demand and Supply Options

Table 6.14 Koʻolau Loa High Demand Scenario: Projected Water Demand and Supply Options

DEMAND (mgd)	2000	2005	2010	2015	2020	2025	2030
BWS Potable	1.46	1.81	2.04	2.31	2.59	2.86	3.14
BWS Potable export to Koʻolau Poko & North Shore	8.60	8.60	8.60	8.60	8.60	8.60	8.60
LWC Potable	0.95	1.18	1.39	1.49	1.61	1.72	1.84
Total Potable Demand	**11.01**	**11.59**	**12.02**	**12.41**	**12.80**	**13.19**	**13.57**
Non-Potable Agriculture	13.25	14.03	14.89	15.87	16.96	18.19	19.57
Non-Potable Other	1.88	2.48	2.61	2.74	3.14	3.52	3.90
Total Non-Potable Demand	**15.13**	**16.50**	**17.50**	**18.61**	**20.10**	**21.71**	**23.47**
TOTAL DEMAND	**26.14**	**28.10**	**29.53**	**31.01**	**32.90**	**34.89**	**37.04**
SUPPLY (mgd)							
Koʻolau Loa GWMA[1]	17.24	18.96	20.17	21.18	22.83	24.50	26.42
Kahana GWMA[2]	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Kawailoa GWMA	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Surface Water[3]	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Recycled Water	0.56	0.77	0.98	1.43	1.64	1.94	2.15
Agriculture Water Savings	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Water Conservation	0.00	0.03	0.04	0.06	0.08	0.10	0.12
TOTAL SUPPLY	**26.14**	**28.10**	**29.53**	**31.01**	**32.90**	**34.89**	**37.04**

[1] Sustainable yield for Koʻolau Loa GWMA is 36 mgd.
[2] Sustainable yield for Kahana GWMA is 15 mgd.
[3] Surface Water is assumed to be the existing water use pending measurable instream flow standards.

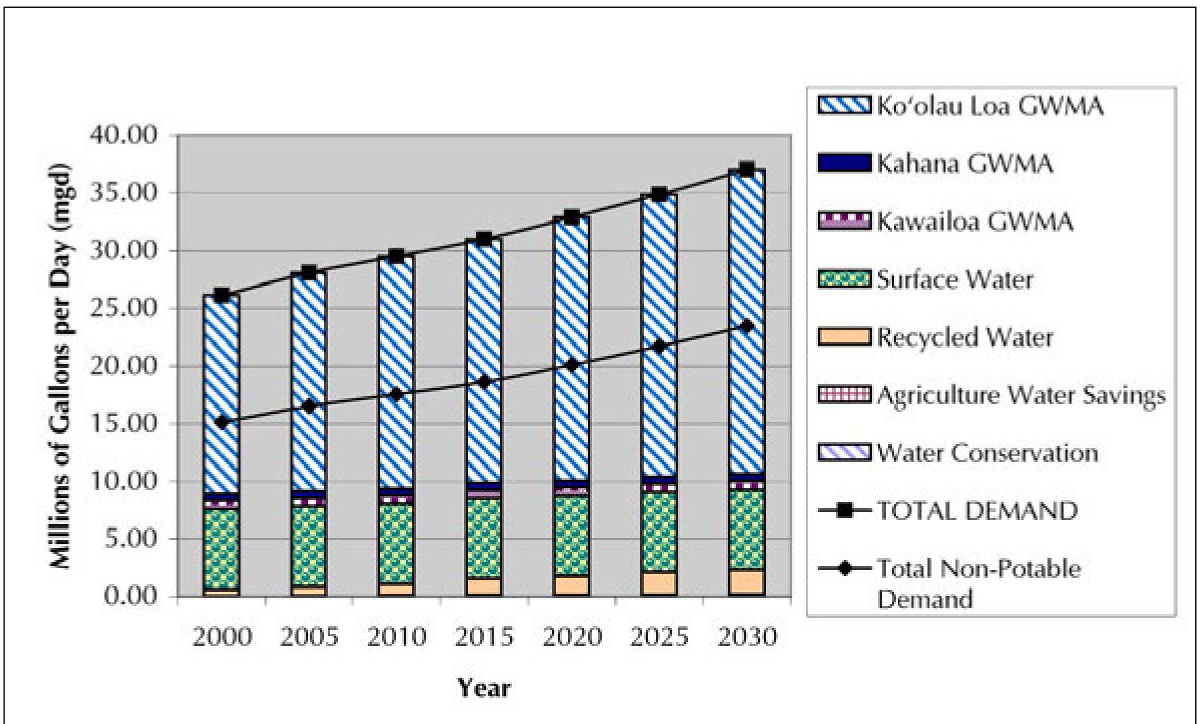


Figure 6.4 Koʻolau Loa High Demand Scenario: Projected Water Demand and Supply Options

Water supply to meet the demands will come from a variety of sources including groundwater, surface water and recycled water as indicated on the preceding tables and figures. Water conservation savings and agricultural water savings will also help to lessen the total amount of water needed in the future. Under the Low Scenario, approximately 28 mgd of water would be needed by 2030. For the Mid/Policy Scenario, about 33 mgd is forecast as demand and for the High Scenario, 37 mgd. The Mid and High Scenarios, agriculture demands account for the largest amount of water needed.

The greatest supply source will continue to be groundwater. The groundwater supply to meet demands will come from three GWMA system areas.

The Kawailoa GWMA will continue to supply the Kawela area and the Kawailoa GWMA's demand and supply in total will be addressed in the upcoming North Shore Watershed Management Plan.

The Kahana GWMA demands and supply are to continue as status quo with 0.6 mgd of BWS demand supplied; BWS has no plans to pursue well development in this GWMA.

The Ko'olau Loa GWMA will be the primary source used to meet the additional water demands. The *Figure 6.5* shows the GWMA's sustainable yield (36 mgd) and the possible supplies to be drawn from the GWMA under the three demand scenarios. The three demand scenarios are below the sustainable yield for the aquifer *(Figure 6.5)*. For the Low scenario, about an additional 2 mgd by 2030 would be required. For the Mid/Policy and High scenarios, approximately 6 and 9 mgd of additional water will be needed, respectively. The projected increase in agricultural water demands is the primary factor for the increased demands in the Mid/Policy and High scenarios.

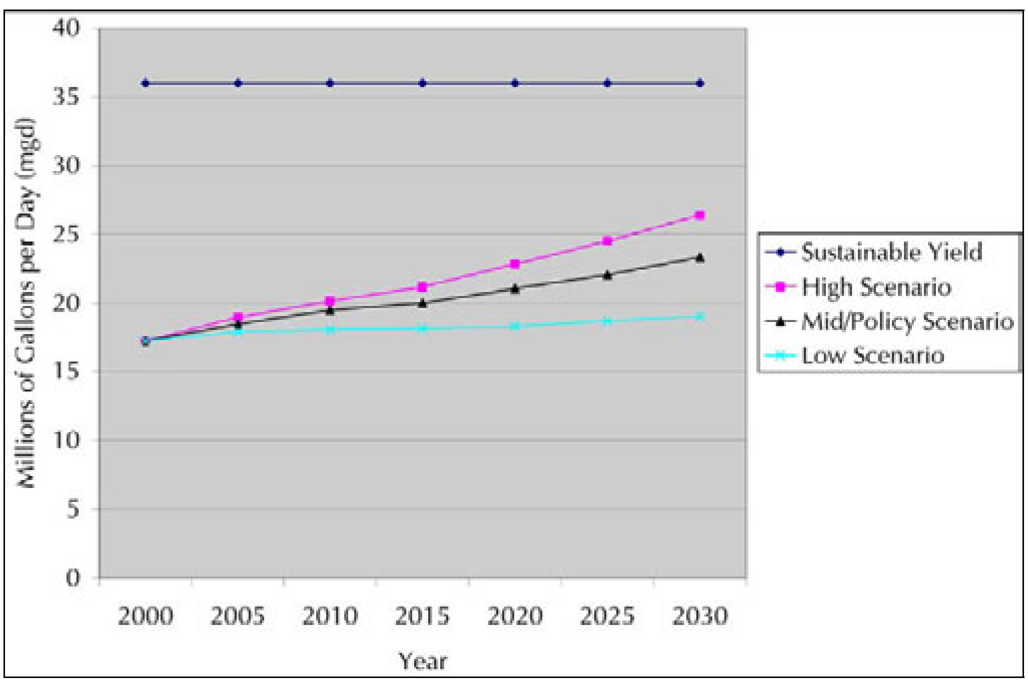


Figure 6.5 Ko'olau Loa GWMA: Projected Supply Needs

The summary for the *Objective #5* projects is provided in *Table 6.15.* The phasing of the projects anticipates future growth to provide the needed capacity.

Table 6.15 Summary of Objective #5 Projects – Short, Mid and Long Term Phases

OBJECTIVE #5 – MEET WATER DEMANDS AT A REASONABLE COST		
Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Potable Well Development ——	——→	
Punaluʻu Pumpage Optimization ——	——→	
Groundwater Source Protection	——	——→
Agriculture Non-Potable Well Development ——	——	——→
Increased Recycled Water ——	——	——→
Cesspool Inventory / Greywater Reuse ——	——	——→
Water Conservation ——	——	——→
Agricultural Water Loss Minimization ——	——	——→
Surface Water Use ——	——	——→

6.2 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.

6.2.1 Summary and Phasing

Water Supply

Water to meet the demands will come from a variety of sources which are summarized below.

- ***No new stream diversions*** are planned until there are measurable instream flow standards. Punaluʻu Stream IIFS is planned next through the Punaluʻu Watershed Alliance.
  - Kahana Stream IIFS was amended in the Waiāhole Ditch Contested Case; however, there are no planned new stream withdrawals.

  Existing stream diversions should improve water use efficiencies and return unused water back to the stream as close to the diversion structure as practical, or reduce the diverted amount.
- ***The Koʻolauloa GWMA will be the primary water source*** used to meet the additional water demands as it has available water.
  - Export from Koʻolau Loa to Koʻolau Poko decreases over time due to population decreases, two new wells in Koʻolau Poko, and transmission main leak detection and repair and advanced conservation measures that reduce waste. As noted in the Neighborhood Board No. 29 Minutes for July 12, 2000 *(Appendix G)*, there are no plans to transfer additional water from Windward Oʻahu.
- ***No Kahana GWMA development*** is planned due to low expected source yield and possible groundwater interactions with streams because of dike influences.
- ***The Kawailoa GWMA will continue to supply the Kawela area.***
- ***Water conservation and agricultural water savings*** will lessen the amount of water needed to meet future demands.
- ***Punaluʻu Wells pumpage will decrease over time***.
  - Decrease in Koʻolau Loa export will result in less pumpage at Punaluʻu wells.
  - Portion of Punaluʻu pumpage and permitted use will be transferred to Kaluanui and Maʻakua Wells to reduce seawater intrusion caused by drought impacts to the Punaluʻu aquifer.

Project Phasing

A variety of projects will be required to ensure the health of watersheds in Koʻolau Loa. The current phasing is broken down into general timeframes of short, mid and long term. *Table 6.16* is a summary of the projects proposed for improving the health of watersheds in Koʻolau Loa and for meeting the existing and future water demands. 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, the Punaluʻu watershed is the most critical watershed in Koʻolau Loa and many of the watershed projects have been and will be implemented here.

Other critical watersheds from a water supply perspective are Kaluanui, Maʻakua, Kahana, Kahuku and Lāʻie. Punaluʻu has the most groundwater and surface water use, has extensive agricultural lands and important cultural significance and the relatively large perennial stream flow has a direct affect on nearshore waters. There is an active community/landowner/agency partnership, called the Punaluʻu Watershed Alliance that is implementing many of the watershed projects and strategies.

Table 6.16 Summary of Short, Mid and Long Term Project Phases

Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
Watershed Oral & Cultural History (4b)	→	
Punaluʻu Pumpage Optimization (2d)	→	
Potable Well Development (6a)	→	
Flood Control/Storm Management (1a)	—	→
Measurable Instream Flow Standards (1c)	—	→
Sustainable Yield Estimates (2a)	—	→
Groundwater Source Protection (2b)	—	→
Drought Mitigation Strategies (2c)	—	→
Pollution Prevention / Low Impact Development (3d)	—	→
Invasive Species Assessment / Control (3e)	—	→
Feral Pig Management (3f)	—	→
Wildfire Management Plan (3i)	—	→
Cultural Education Programs(4c)	—	→
Fishpond (Loko Iʻa) Restoration (4d)	—	→
Cultural Monitoring Program (4e)	—	→
Watershed Partnerships (5a)	—	→
Water and Watershed Education (5b)	—	→
Koʻolau Loa Implementation Entity (5c)	—	→
Grant Funding (5d)	—	→
Agriculture Non-Potable Well Development (6b)	—	→
Increased Recycled Water (6c)	—	→
Conservation Measures (6d)	—	→
Agricultural Water Loss Minimization (6e)	—	→
Surface Water Use (6f)	—	→

Table 6.16 Summary of Short, Mid and Long Term Project Phases (continued)

Short-Term Projects (<5 years)	Mid-Term Projects (6-14 years)	Long-Term Projects (15+ years)
	Crop Water Demand (3j)	
	Flood Channel Redesign (1b)	
	Stream Water Quality Testing (1d)	
	Nearshore Water Monitoring (1e)	
	Stream Clearing & Management (3a)	
	Stream Conservation Buffers (3b)	
	Cesspool Inventory / Greywater Reuse (3c)	
	Muliwai/Wetland Restoration (3g)	
	Loʻi Kalo Expansion (4a)	
		Conservation District Boundary Review (3h)

Note: The projects in bold are priority projects designated by the community working group.

6.2.2 Implementation Mechanisms

This plan is intended to guide agencies and organizations in implementing the most important initiatives for Ko'olau Loa 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.

Agencies

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.

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.

Implementation Entity

A recommendation of this plan for ensuring project implementation is a community-based implementation entity which the Ko'olau Loa community working group advocated for and deserves serious consideration (see also *Appendix H*). An implementation entity could be essential to ensuring that the Ko'olau Loa watershed projects are implemented. *Project 5c Ko'olau Loa Implementation Entity* provides a more extensive description of this concept.

This entity would:

- Have responsibility for implementing the Plan derived from a collaboration of community stakeholders, government agency representatives, private water purveyors, land owners, and non-profit organizations.
- Be community-based (an extension of the district approach to the O'ahu Water Management Plan).
- Link implementation and organization continuity.
- Be funded adequately and professionally.

Funding

An estimated $28 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 from stakeholders and are currently being implemented, many of the projects are not funded. Without a dedicated funding source, implementation will likely depend on budgetary priorities, grant availability and partnering efforts, focused on the most critical watersheds first.

Dedicated ongoing funding for unfunded 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 of which the Koʻolau Mountains Watershed Partnership is one). While this funding will address a couple of the projects, many others remain unfunded.
- ***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 Hawaiʻi 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 legislative action and 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 make up the gap between agency general funding and other dedicated funding sources. *Project 5d, Grant Funding* details many of the grants and research funds available. These 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 Koʻolau Loa.

APPENDICES

APPENDIX A

APPROVAL OF WATERSHED MANAGEMENT PLAN SCOPE AND APPROACH

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

February 20, 2004

Mr. Ernest Lau, Deputy Director
Commission on Water Resource Management
Department of Land and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Lau:

Subject: Oahu Water Management Plan Framework and Scope of Work for Wai'anae and Ko'olauloa Watershed Management Plans, in Compliance with the Statewide Framework for Updating the Hawaii Water Plan, County Water Use and Development Plan

We submit for your review and approval, the proposed Oahu Water Management Plan (OWMP), Framework, which by City and County of Honolulu Ordinance 90-62, is the Oahu County Water Use and Development Plan. Our submittal is consistent with Section IV of the Statewide Framework for Updating the Hawaii Water Plan, which sets out a 3-phased schedule and preliminary implementation plan and states that the OWMP shall be coordinated with updates of the other Hawaii Water Plan components. We understand that the State Water Projects Plan was recently completed and the State Agricultural Water Use and Development plan is now underway.

We have discussed this proposal with the planning staff of the Commission on Water Resource Management (CWRM) and the City Department of Planning and Permitting and will keep them apprised of our progress. Presentation to the CWRM will occur regularly, as coordinated with your staff.

We request our proposal be placed on the next available CWRM agenda to present our proposed OWMP Framework, supporting background information, watershed planning approach, funding and approval schedule, specific scopes of work and current water distribution summary.

We appreciate the assistance of your staff as we restart our planning process. If you have any questions, please contact Barry Usagawa, Water Resources Principal Executive, at 748-5900.

Very truly yours,

CLIFFORD S. JAMILE
Manager and Chief Engineer

Attachment

cc: Department of Planning and Permitting
Department of the Corporation Counsel
Townscapes, Inc.
Group 70 International, Inc.
R. M. Towill Corporation

MINUTES
FOR THE MEETING OF THE
COMMISSION ON WATER RESOURCE MANAGEMENT

DATE:	March 17, 2004
TIME:	9:00 am
PLACE:	DLNR Board Room Kalanimoku Bldg.

A. CALL TO ORDER

Chairperson Peter T. Young called the meeting of the Commission on Water Resource Management to order at 9:08 A.M.

B. ROLL CALL

The following were in attendance:

MEMBERS: Mr. Peter T. Young, Ms. Meredith Ching, Mr. Clayton Dela Cruz, Ms. Stephanie Whalen, Mr. James Frazier and Dr. Chiyome Fukino

STAFF: Ernie Lau, Dean Nakano, Roy Hardy, Ed Sakoda, Glenn Bauer, Lenore Nakama, Dean Uyeno, Kevin Gooding, David Higa, Charley Ice, Ryan Imata, Dean Nakano, Tiffany Mathias

COUNSEL: Linda Chow, Yvonne Izu

OTHERS: Kapua Sproat, George Kuo, Manabu Tagomori, Rosemary Liu, Barry Usagawa, Ron Englund, Mr. and Mrs. Frederick Holcomb, Delwyn Oki, Bill Beach, Klaus Conventz, Katina Henderson, Bruce Tsuchida, Robert Lum, Marjorie Ziegler, Jim Yamamoto, Jeff Overton, Nelson Ayers, Betsy Gagne and Reid Yamashiro

All written testimonies submitted at the meeting are filed in the Commission office and are available for review by interested parties.

C. ACCEPTANCE OF AGENDA

The items were taken out of order and they are shown in the order taken up by the Commission.

D. APPROVAL OF MINUTES

MOTION: (Frazier/Whalen)

Kamehameha it has improved. Mr. Beach asked that the Commission consider keeping the reservoir open for wild fire control in the region.

Kapua Sproat, attorney from Earthjustice representing the Waipi'o Valley Community Association, urged the Commission to support the staff's recommendation and to vote to provide Kamehameha Schools with the permit to abandon the Lalakea Ditch System. Ms. Sproat mentioned that various groups in the community, her clients included, and other educational programs like the Edith Kanakaole Foundation and Kanoa O Kaina have praised Kamehameha's decision to abandon the ditch system. They recognize that it is visionary and that the system that they have in place has been diverting water for over 15 years has no consistent use.

Marjorie Ziegler from the Conservation Council for Hawaii presented her testimony. Ms. Ziegler strongly supports staff's recommendation to grant the permit for abandonment of the Lalakea Ditch System. Instream uses are important. By putting the water back into the streams, we would be offering potential habitat for the native stream fauna as well as supporting the taro farmers that would like to use more water on Hiilawe Stream. The reservoir is very shallow and inefficient.

RECOMMENDATION:

1. Approve a stream diversion works abandonment permit for the abandonment of Lalakea Ditch, TMK: 4-8-003:006, Hamakua, Hawaii.

2. The diversions works abandonment permit will be valid for a period of one year subject to our standard conditions.

MOTION: (Whalen/Dela Cruz)
To approve as presented by staff.
UNANIMOUSLY APPROVED

Recess at 10:27a.m.
Resumed at 10:33a.m.

2. Approval of the Oahu Water Management Plan Framework and Scope of Work for Waianae and Koolauloa Watershed Management Plans

PRESENTATION OF STAFF SUBMITTAL: Dean Nakano

Mr. Barry Usagawa from the Board of Water Supply gave an overview of their proposed framework and water use and development plan update. Mr. Usagawa was accompanied by his staff George Kuo from Long Range Planning Section and consultants Jimmy Yamamoto from R.M. Towill, Bruce Tsuchida from Townscapes Inc., and Jeff Overton from Group 70 who will be assisting BWS in the development of watershed plans and water use strategies for Waianae and Koolauloa.

A handout covering the Oahu Water Management Plan Framework (OWMP) and Watershed Planning Approach for the Waianae and Koolauloa Watershed Management Plans were distributed by Mr. Usagawa.

Mr. Dean Nakano stated that the statutory and framework provisions described in the submittal set forth the minimum requirements for updating the WUDP including the overall planning framework that should be followed by the Counties in updating their respective plans. In accordance with these provisions, the City and County of Honolulu and the Board of Water Supply have submitted to the Commission for review and approval the "Oahu Water Management Plan Framework and Scope of Work for Waianae and Koolauloa Watershed Management Plans" dated February 20, 2004.

Staff reported that they have evaluated the submitted planning framework, scope of work and the planning elements described therein and have determined that the proposed WUDP updating process for Waianae and Koolauloa meets with the provisions and guidelines set forth in the State Water Code and the Commission's Statewide Framework for Updating the Hawaii Water Plan.

Staff looks forward to the Board of Water Supply's implementation of a comprehensive planning approach which facilitates the development and regular updating of a WUDP that conforms to the intentions of the county land use plans. The WUDP should provide guidance for decision-making on water allocation requests as well as guidance for the formulation of recommended and alternative strategies for resource development to meet future water needs.

RECOMMENDATION:

Staff recommends that the Commission:

1. Approve the City and County of Honolulu, Board of Water Supply's Oahu Water Management Plan Framework and Scopes of Work for the Waianae and Koolauloa Watershed Management Plans;

2. Require that the Board of Water Supply, prior to the commencement of the other watershed plans for North Shore, Koolaupoko, and South Oahu (Ewa, Central Oahu, Primary Urban Center, and East Honolulu), submit proposed scopes of work (i.e., "Project Descriptions") for those regional areas to the CWRM for review and approval; and

3. Authorize staff to participate in meetings and/or workshops, as necessary, with pertinent State and County agencies to facilitate implementation of statutory and framework provisions for updating Oahu's County Water Use and Development Plan.

MOTION: (Ching/Whalen)
To approve as presented by staff.
UNANIMOUSLY APPROVED

Honolulu Board of Water Supply

O'ahu Water Management Plan Framework And Scope of Work for Wai'anae and Ko'olau Loa Watershed Management Plans

Submitted to the
State Commission on Water Resource Management in Compliance with the Statewide Framework for Updating the Hawai'i Water Plan, O'ahu County Water Use and Development Plan.

Attachment to BWS Transmittal Letter to CWRM, Dated February 20, 2004.

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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 O'ahu'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, Hawai'i Water Plan, State Water Code.
2. The Statewide Framework for Updating the Hawai'i 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 O'ahu'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 O'ahu. 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/O'ahuGenPlan.asp
4. 8 Development Plan (DP) and Sustainable Community Plan (SCP) land use planning regions of O'ahu. 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.

O‘ahu’s Land Use Planning Regions	Web Page Links to the Plans
Wai‘anae	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 O‘ahu	http://www.honoluludpp.org/Planning/DevSust_CentralO‘ahu.asp
East Honolulu	http://www.honoluludpp.org/Planning/DevSust_EastHonolulu.asp
Primary Urban Center	http://www.honoluludpp.org/Planning/DevSust_PrimaryUrbanCenter.asp

1. City and County of Honolulu Ordinance 90-62, Water Management establishing the O‘ahu Water Management Plan establishing water management policies and strategies "for water use and development within each development plan area."
2. 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.
3. Supreme Court Decision on Waiahole Ditch Contested Case applying the Public Trust Doctrine and the Precautionary Principle to water resource management.
4. 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 O‘ahu'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 Hawai‘i 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 O‘ahu 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 O'ahu's water situation was in a state of flux, with major changes in the agriculture industry, including the closing of the O'ahu 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 O'ahu Water Management Plan, O'ahu'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 O'ahu because approximately 3/4s of O'ahu'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 Hawai'i 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 Hawai'i 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 O'ahu'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 O'ahu 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 Mānoa "Kuleana Project" to change the residential practices of the Mānoa Ahupua'a to increase awareness of water conservation and polluted runoff control.
- Watershed protection studies in Ala Wai, West Honolulu and Central O'ahu.
- 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 Mānoa
- Wai'anae Kai Watershed Partnership
- University of Hawai'i Mānoa / 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 O'ahu Water Management Plan. The regional watershed management plans will address the water needs, both present and future, for the 8 land use districts on O'ahu. 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".

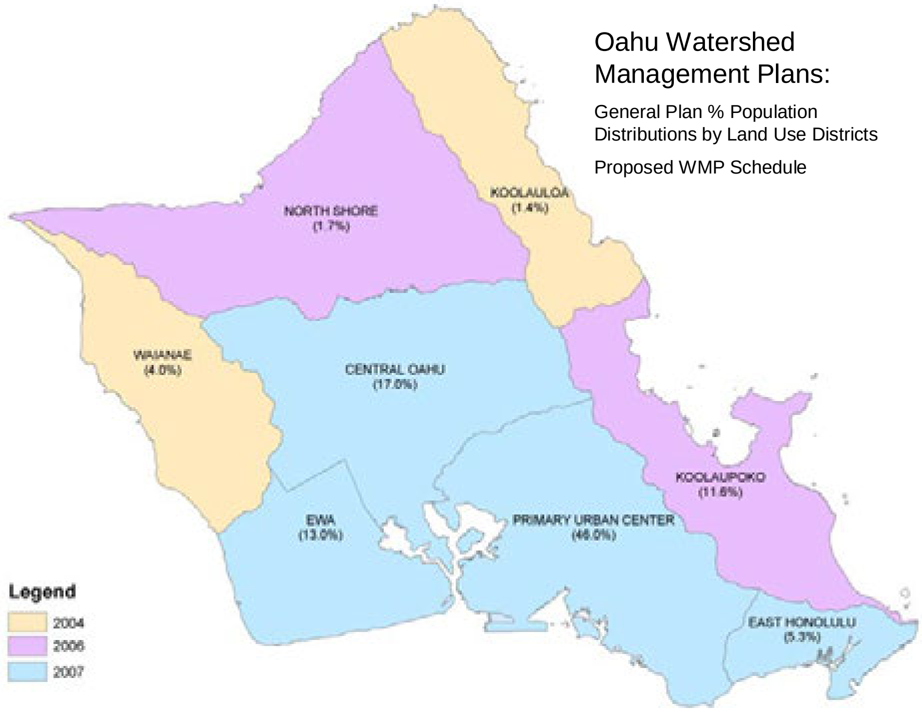
- The Statewide Framework for Updating the Hawai'i Water Plan, Page 3-26, Need for Flexibility, recognizes the need for appropriate flexibility in the county plans due to institutional and /or funding constraints, to encourage innovation as well as to accommodate unique and county-specific concerns.
- 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 O'ahu graphic below, shows the 8 land use areas on O'ahu 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 O'ahu: ('Ewa, Central O'ahu, 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 Hawai'i 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 O'ahu 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 Hawai'i 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 O'ahu 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 O'ahu 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 O'ahu consumed about 78% of the islandwide municipal source pumpage of 154.6 mgd. We anticipate that the South O'ahu watershed management plan(s) will fully utilize the IRP decision tools as described in the Statewide Framework for Updating the Hawai'i Water Plan. The scope of work contemplated for the South O'ahu 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.

Commitment for Agency Coordination

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.

Proposed Scope of Work, Major Project Elements

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 Waiʻanae and Koʻolauloa 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 Waiʻanae and Koʻolaupoko, and their feedback incorporated. The major project elements for the FY 2004 watershed management plans for Waiʻanae and Koʻolauloa 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 Hawaiʻi 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 Oʻahu.

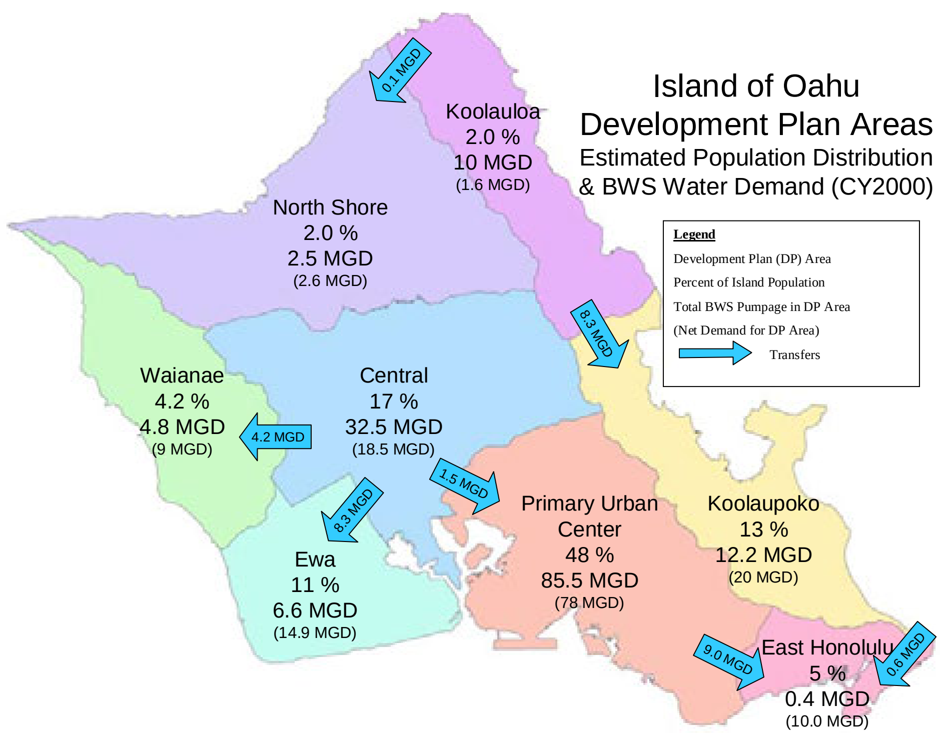
The sustainable communities of Waiʻanae, North Shore, Koʻolauloa and Koʻolaupoko have essentially the same water demand throughout the planning period. The existing sources and infrastructure in these areas are adequate to provide potable water service through the planning horizon and therefore, additional integration of water supplies between these regions will be limited.

In South Oʻahu, 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 Oʻahu.

- The City's General Plan directs the majority of the growth to South Oʻahu.

- Based on the City's growth forecast evaluating population, visitors, housing and employment factors, we forecast an increase in potable water demand for O'ahu averaging about 1.1 million gallons per day per year, most of which will occur in South O'ahu. 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 O'ahu 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 O'ahu.
- 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 O'ahu'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. This essentially is the base case of existing water demand and distribution in the BWS system, which will referenced in the watershed management plans.



APPENDIX B

WATER RESOURCE PLANS AND POLICIES

B PLANS, POLICIES, GUIDELINES, AND CONTROLS

B.1 OVERVIEW
B.2 FEDERAL PLANS AND CONTROLS
B.3 STATE OF HAWAIʻI PLANS AND CONTROLS
B.4 WATER RIGHTS IN HAWAIʻI
B.5 THE PUBLIC TRUST DOCTRINE AND THE PRECAUTIONARY PRINCIPLE
B.6 CITY AND COUNTY OF HONOLULU PLANS AND CONTROLS
B.7 PUBLIC/PRIVATE PARTNERSHIPS
B.8 REFERENCES

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 Hawaiʻi Water Plan
- Oʻahu 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 Hawai'i State Plan

It is the goal of the State, under the Hawai'i 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

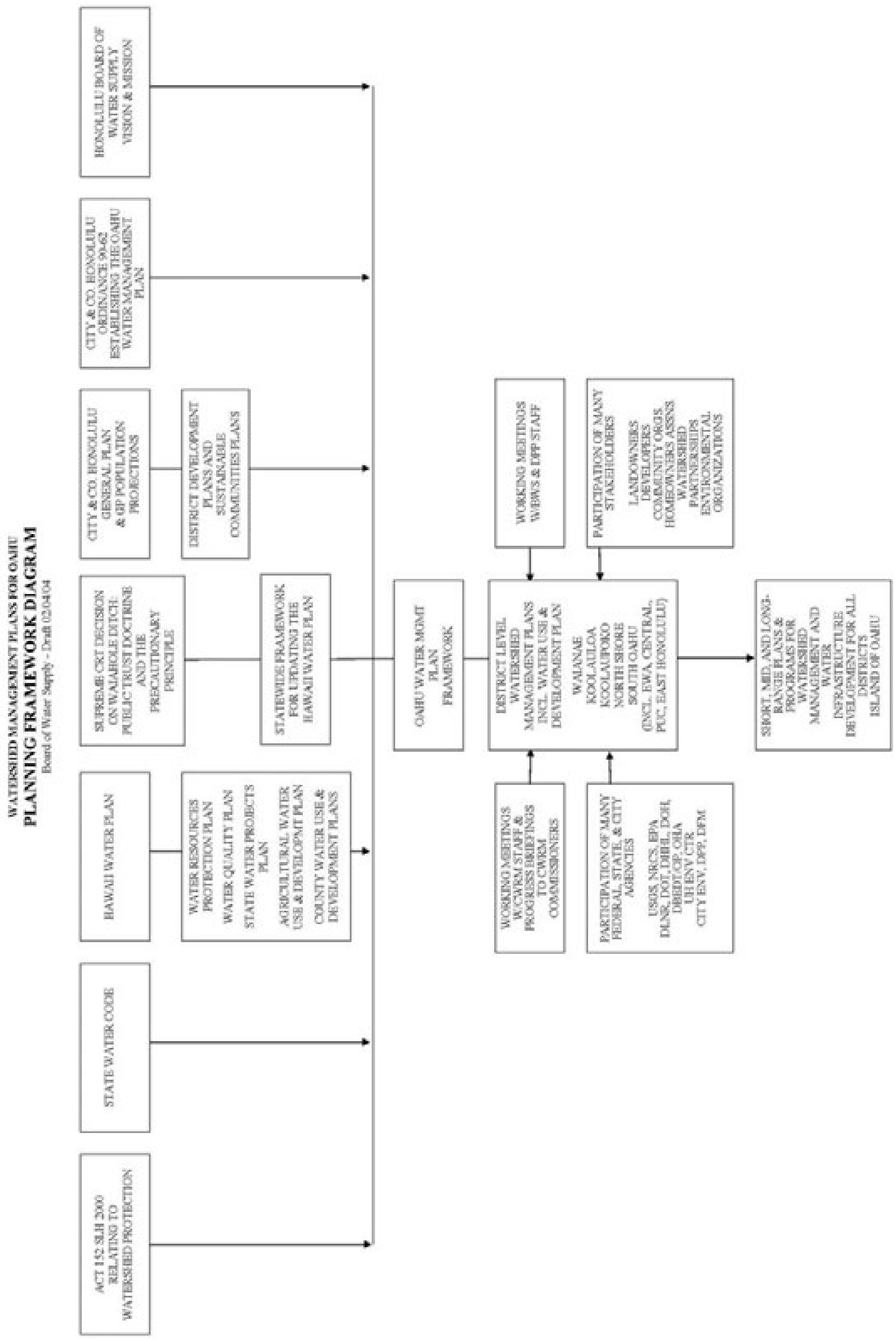
It is the objective of the State to maintain and pursue an improved quality of land, air, and water resources and to promote greater public awareness of Hawaii's environmental resources. In support of this, it is the policy of the State to:

- 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
ACT 152 SLH 2000 RELATING TO WATERSHED PROTECTION
STATE WATER CODE
HAWAII WATER PLAN
WATER RESOURCES PROTECTION PLAN
WATER QUALITY PLAN
STATE WATER PROJECTS PLAN
AGRICULTURAL WATER USE & DEVELOPMT PLAN
COUNTY WATER USE & DEVELOPMENT PLANS
SUPREME CRT DECISION ON WAIAHOLE DITCH: PUBLIC TRUST DOCTRINE AND THE PRECAUTIONARY PRINCIPLE
STATEWIDE FRAMEWORK FOR UPDATING THE HAWAII WATER PLAN
CITY & CO. HONOLULU GENERAL PLAN & GP POPULATION PROJECTIONS
DISTRICT DEVELOPMENT PLANS AND SUSTAINABLE COMMUNITIES PLANS
CITY & CO. HONOLULU ORDINANCE 90-62 ESTABLISHING THE OAHU WATER MANAGEMENT PLAN
HONOLULU BOARD OF WATER SUPPLY VISION & MISSION
OAHU WATER MGMT PLAN FRAMEWORK
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/BWS & DPP STAFF
PARTICIPATION OF MANY STAKEHOLDERS
LANDOWNERS
DEVELOPERS
COMMUNITY ORGS
HOMEOWNERS ASSNS
WATERSHED PARTNERSHIPS
ENVIRONMENTAL ORGANIZATIONS
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 Hawaiʻi 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] The complete text of the State Water Code can be viewed at: http://www.state.hi.us/dlnr/cwrm/regulations/Code174C.pdf.

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 August 2008, 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	Pending
State Water Projects Plan (SWPP)	February 2003	Oʻahu update in progress
Water Resources Protection Plan (WRPP)	August 2008	Adopted
Agricultural Water Use and Development Plan (AWUDP)	December 2004	Update in progress
Hawaiʻi WUDP	1990	Update in progress
Kauaʻi WUDP	1990	Pending
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 Hawaiʻi 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 Hawaiʻi 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 Waiʻanae and Koʻolau 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 Koʻolau forests are a primary water resource for the island of Oʻahu 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 Koʻolau 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]
- Waiʻanae 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 HAWAIʻI

Water rights and uses in Hawaiʻi 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 Waiʻola o Molokaʻi, Inc. and Molokaʻi 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.

[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.

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;
- 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.

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[2] While these principles are directed at surface water resources, they apply equally to ground water resources.

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:

Population
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 Koʻolau Loa 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 Koʻolau Loa 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 Koʻolau Loa SCP that have implications for the Koʻolau Loa Watershed Management Plan:

- ***Open Space Preservation***

  Maintain the region's rural character, protect scenic views and provide recreational resources.

- ***Agricultural Areas***

  Preserve the availability and crop production potential of agricultural lands.

  Protect agricultural lands from conversion to uses that are primarily residential, industrial or commercial.

  Encourage diversification of agriculture-related enterprises.

  Allow residential use in agricultural areas only as secondary to agricultural activity.

  Allow facilities necessary to support intensive cultivation to be located in agricultural areas.

  Allow for appropriate non-agricultural uses that are of a compatible open space and resource character, such as outdoor recreation, on agricultural lands not currently suitable for intensive cultivation.

  Recognize the function of agricultural areas as an important part of the region's natural drainage system.

- ***Historic and Cultural Resources***

  Preserve and restore historic and cultural resources associated with native Hawaiian and pre-contact periods.

  Preserve significant historic features from earlier periods such as the plantation era.

- ***Residential Uses***

  Respect and help to preserve the natural setting of the Koʻolau Loa region by requiring development in residential areas to be sensitive to physical constraints and have minimal impact on the area's rural character.

  Provide a sufficient capacity within the Rural Community Boundary to accommodate existing and future housing needs.

  Maintain the existing residential capacities for the communities of Kaʻaʻawa, Hauʻula and Punaluʻu. Future residential needs in these communities will be met through infill residential development.

- ***Water Allocation And System Development***

  Integrate management of all potable and nonpotable water sources, including groundwater, stream water, storm water and effluent, following State and City legislative mandates.

  Adopt and implement water conservation practices in the design of new developments and the modification of existing uses, including landscaped areas.

- ***Wastewater Treatment***

  Provide collection systems, where practical, to eliminate individual cesspools, to protect aquifers, streams, estuaries and nearshore waters from contamination.

  Replace outdated individual cesspools with septic tanks and leaching fields.

  Treat and beneficially use, where feasible, reclaimed water for irrigation as a water conservation measure.

- ***Drainage Systems***

  Emphasize and implement comprehensive or systemic solutions to local flooding and drainage problems.

  Emphasize control and minimization of non-point source pollution and the retention of storm water on-site and in wetlands in the design of drainage systems in accordance with existing City, State and Federal regulations while maintaining the existing habitat capability and water quality of streams and nearshore waters.

  View storm water, where appropriate, as a potential irregular source of water for recharge of the aquifer that should be retained for absorption rather than quickly moved to coastal waters.

  When drainageways must be modified for flood control purposes, select approaches and solutions which:

  1. Improve existing habitat capability;
  2. Maintain existing rural and aesthetic qualities;
  3. Avoid degradation of existing coastline and estuarine areas or nearshore water quality;
  4. Avoid degradation of the quality of water entering nearshore waters;
  5. Avoid increase in the volume or rate of freshwater intrusion into nearshore waters.

  Encourage coordination between public agencies and private landowners on needed drainage improvements with community input.

  Keep drainageways clear of debris to avoid flooding problems.

Create buffer zones and/or setbacks along rivers and streams. In keeping with the *ahupuaʻa* concept, and to support the anadramous fish life cycle, streams should be protected along their entire length from headwaters to the ocean.

The State should assess areas of Kamehameha Highway where the pavement diverts or detains overland flow of stormwater runoff causing localized flooding of the highway and *mauka* properties.

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 Oʻahu.[50]

The complete ordinance can be accessed at: http://www.honolulu.gov/refs/roh/30.htm.

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 O'ahu, 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 ahupua'a 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' 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:

- Enhanced water conservation
- Sustainable groundwater use
- Watershed partnerships and management plans
- Diversified and integrated water systems of groundwater, recycled water, seawater desalination and ocean resources
- Infrastructure renewal and replacement

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 Ko'olau Loa and Wai'anae.

B.7.1 Punualu'u Watershed Alliance

The Punalu'u Watershed Alliance was established to address community, landowner and agency issues regarding this watershed. Formed in 2001, this group consists of Punalu'u Community Association members, farmers and resource conservation interests, in conjunction with the landowner Kamehameha Schools, the Honolulu Board of Water Supply, CWRM, and as a collaborator, the US Geological Survey. These residents and agencies have collaborated to address the particular concerns about the ongoing protection and management of Punalu'u watershed.

B.7.2 Ko'olau Mountains Watershed Partnership

In August 1999, the Ko'olau Mountains Watershed Partnership (KMWP) was formed through a signing of a Memorandum of Understanding between eight major public and private landowners. Since the initial formation of the KMWP, there are a total of 15 landowning partners that are members with an additional six associate partnering agencies or organizations. *Table B.1* provides a listing of KWMP partners and associates and identifies in bold those that have an interest specifically within the Ko'olau Loa district.

Table B.1 Koʻolau Mountains Watershed Partnership Membership Information

Koʻolau Mountains Watershed Partners	Partner Type	Private/Public Interest	Possess Land in Koʻolau Loa district
Hawaii Reserves, Inc	**Landowner**	**Private**	**Yes**
Kamehameha Schools	**Landowner**	**Private**	**Yes**
Kualoa Ranch	**Landowner**	**Private**	**Yes**
City & County of Honolulu BWS	**Landowner**	**Public**	**Yes**
Dept. of Land and Natural Resources	**Landowner**	**Public**	**Yes**
U.S. Army	**Landowner**	**Public**	**Yes**
U.S. Fish and Wildlife	**Landowner**	**Public**	**Yes**
Dole Food Company, Inc.	Landowner	Private	No
Bishop Museum	Landowner	Private	No
Manana Valley Farm, LLC	Landowner	Private	No
Oʻahu Country Club	Landowner	Private	No
Queen Emma Foundation	Landowner	Private	No
Agribusiness Development Corporation	Landowner	Private	No
Tiana Partners, et al	Landowner	Private	No
Department of Hawaiian Home Land	Landowner	Public	No
Natural Resources Conservation Service	Associate	Private	No
Nature Conservancy of Hawai'i	Associate	Private	No
State Department of Health	Associate	Public	No
Environmental Protection Agency	Associate	Public	No
U.S. Forest Reserve	Associate	Public	No
U.S. Geological Survey	Associate	Public	No

Notes

[1] Federal Water Pollution Control Act (33 U.S.C. 1251 et. seg.) Title I—Research and Related Programs Declaration of Goals and Policy. §101(a).

[2] State of Hawaiʻi Department of Health, Final 2004 List of Impaired Waters in Hawaii, June 2004, p. 6 of 67.

[3] State of Hawaiʻi, The Constitution of the State of Hawaiʻi, Article XI, Section 1.

[4] State of Hawaiʻi, The Constitution of the State of Hawaiʻi, Article XI, Section 7.

[5] State of Hawaiʻi, Hawaiʻi Revised Statutes Chapter 226, Hawaiʻi State Planning Act, §226-11

[6] Ibid, §226-13.

[7] Ibid, §226-16.

[8] State of Hawaiʻi, Hawaiʻi Revised Statutes Chapter 174C, State Water Code, 1992, §174C-2.

[9] Ibid, §174C-5.

[10] Ibid, §174C-31.

[11] Ibid.

[12] State of Hawaiʻi Commission on Water Resource Management, *Statewide Framework for Updating the Hawaii Water Plan*, 2000, pp. 2-1 to 2-3.

[13] Ibid, pp. 3-19 to 3-27.

[14] State of Hawaiʻi, *Act 152 SLH 200 (HB 2835, HD2, SD2, CD1): Relating to Watershed Protection*, 2000, p. A1-1.

[15] Ibid.

[16] State of Hawaiʻi Department of Land and Natural Resources, *Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152 SLH 2000 (HB 2835, HD2, SD2, CD1): Relating to Watershed Protection*, October 2001, pp. 61-62.

[17] Ibid, pp. 43-45.

[18] Ibid, p. 44.

[19] State of Hawaiʻi, *Act 152 SLH 2000 (HB 2835, HD2, SD2, CD1): Relating to Watershed Protection*, 2000, Appendix 7: DLNR and County Boards of Water Supply Testimony for HB 2835, p. A7-10.

[20] HRS 174C, §§ 174C-1 to 174C-101.

[21] *In re Water Use Permit Applications*, 94 Haw. 97, at 173; 9 P3d 409, at 485 (2000).

[22] *City Mill Co. v Hon. S. & W. Com.*, 30 Haw. 912 (1929).

[23] *McBryde v Robinson*, 54 Haw. 174, at 198; 504 P.2d 1330, at 1344 (1973); *aff'd on rehearing*, 55 Haw. 260; 517 P.2d 26 (1973); *appeal dismissed for want of jurisdiction and cert. denied*, 417 U.S. 962 (1974).

[24] *Reppun v Board of Water Supply*, 65 Haw. 531, at 553; 656 P.2d 57, at 72 (1982).

[25] 54 Haw. 174, at 188; 504 .2d 1330, at 1339.

[26] 65 Haw. 531, at 554; 656 P.2d 57, at 72.

[27] *Peck v Bailey*, 8 Haw. 658, at 665 (1867).

[28] 54 Haw. 174; 504 P.2d 1330.

[29] 65 Haw. 531, at 552; 656 P.2d 57, at 71 (1982).

[30] 94 Haw. 97 at 179, 9 P.3d 409 at 491 (2000).

[31] 94 Haw. 97, at 178; 9 P3d 409, at 490 (2000).

[32] 65 Haw. 531, at 553-554; 656 P.2d 57, at 72 (1982).

[33] 54 Haw. 174; 504 P.2d 1330 (1973).

[34] *Davis v Afong*, 5 Haw. 216 (1884).

[35] *Wong Leong v Irwin*, 10 Haw. 265 (1896).

[36] *City Mill Co. v Hon. S. & W. Com.*, 30 Haw. 912 (1929).

[37] *Territory v Gay*, 31 Haw. 376 (1930); *aff'd* 52 F.2d 356 (9th Cir. 1931); *cert. denied* 284 U.S. 677 (1931).

[38] 54 Haw. 174, at 198; 504 P.2d 1330, at 1344 (1973).

[39] 94 Haw. 97, at 130-133; 9 P3d 409, at 443-445.

[40] City and County of Honolulu, *General Plan*, 1992, as amended, Preamble.

[41] Ibid, Title I: Population.

[42] Ibid, Title II: Economic Activitiy.

[43] Ibid, Title III: Natural Environment.

[44] Ibid, Title IV: Housing.

[45] Ibid, Title V: Transportation and Utilities.

[46] Ibid, Title VII: Physical Development and Urban Design.

[47] Ibid, Title IX: Health and Education.

[48] Ibid, Title XI: Government Operations and Fiscal Management.

[49] City and County of Honolulu, *Revised Ordinances of Honolulu, Chapter 30: Water Management*, 1990, as amended by Ordinance 90-62, §30-2.1.

[50] Ibid, §30-2.2.

[51] Honolulu Board of Water Supply, *Oahu Water Management Plan Framework and Scope of Work for Wai'anae and Ko'olauloa Watershed Management Plans*, February 2004, p.10.

B.8 REFERENCES

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APPENDIX C

O‘AHU WATER USE PERMIT INVENTORY

APPENDIX C: O'AHU WATER USE PERMIT INVENTORY (2008)

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*

APPENDIX C: O'AHU WATER USE PERMIT INVENTORY (2008)

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**	

APPENDIX C: O'AHU WATER USE PERMIT INVENTORY (2008)

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**	

APPENDIX C: O'AHU WATER USE PERMIT INVENTORY (2008)

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	0.008	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	7.989	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	2658-04	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 1-8	2301-34 to 39	8.810	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	0.880	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.	2358-10	0.005	Domestic for 10 residential units
Robinson Estate	Robinson 1 & 2	2802-01, 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, 28	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**	

APPENDIX D

WELL USE DATA (2000)

APPENDIX D: WELL USE DATA (2000)

AQUIFER SYSTEM AREA	OWNER/OPERATOR	WELL NO.	WELL NAME	WATER USE PERMIT AMOUNT (mgd)	2000 Average Use	Type of Use (CWRM Categories)
KAHANA	KUALOA RANCH, INC.	3251-01	TOMASU	0.288	0.000	AGRICULTURE
KAHANA	KUALOA RANCH, INC.	3251-03	SAITO	0.200	0.000	AGRICULTURE
KAHANA	KUALOA RANCH, INC.	3351-04	YAMAMOTO	0.005	0.000	AGRICULTURE
KAHANA	KAHANA VALLEY STATE PARK	3352-01	KAHANA ARTESIAN	0.008	0.000	IRRIGATION
KAHANA	HONOLULU BWS	3353-01	KAHANA WELLS	0.600	0.604	MUNICIPAL
KAHANA	HONOLULU BWS	3353-02	KAHANA WELLS	0.000	0.000	MUNICIPAL
KOOLAULOA	OTA, GENTARO	3453-03	OTA	0.006	0.000	AGRICULTURE
KOOLAULOA	HONOLULU BWS	3453-06	PUNALUU III	1.327	1.339	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3453-07	PUNALUU III	0.000	0.000	MUNICIPAL
KOOLAULOA	HANOHANO ENTERPRISES, INC	3553-01	HANOHANO	0.432	0.000	AGRICULTURE
KOOLAULOA	HONOLULU BWS	3553-02	PUNALUU I	0.360	0.103	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3553-03	PUNALUU II	4.618	5.713	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3553-04	PUNALUU II	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3553-06	PUNALUU II	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3553-07	PUNALUU II	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3553-08	PUNALUU II	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3554-03	PUNALUU II	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3554-04	KALUANUI	1.093	0.812	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3554-05	KALUANUI	0.000	0.000	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3554-06	KALUANUI	0.000	0.000	MUNICIPAL
KOOLAULOA	HOLT, LEMON	3654-02	LW HOLT	0.002	0.000	AGRICULTURE
KOOLAULOA	HONOLULU BWS	3655-01	HAUULA	0.250	0.187	MUNICIPAL
KOOLAULOA	HONOLULU BWS	3655-02	MAAKUA	0.667	0.059	MUNICIPAL
KOOLAULOA	E.L.C. FOUNDATION	3755-03	HAUULA	0.019	0.000	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3755-06	TRUCK FARM	0.142	0.007	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3855-04	WELFARE FARM	0.091	0.002	AGRICULTURE
KOOLAULOA	WHITE, R.E. JR.	3855-05	WHITE	0.013	0.000	AGRICULTURE
KOOLAULOA	LAIE WATER CO., INC.	3855-06	CAMPUS WELL	1.375	0.430	MUNICIPAL
KOOLAULOA	LAIE WATER CO., INC.	3855-07	CERAMICS WELL	0.000	0.000	MUNICIPAL
KOOLAULOA	LAIE WATER CO., INC.	3855-08	LIBRARY WELL	0.000	0.000	MUNICIPAL
KOOLAULOA	LAIE WATER CO., INC.	3856-05	QUARRY E	0.000	0.536	MUNICIPAL
KOOLAULOA	LAIE WATER CO., INC.	3856-06	QUARRY F	0.000	0.000	MUNICIPAL
KOOLAULOA	LAIE WATER CO., INC.	3956-03	TEMPLE WELL	0.000	0.000	MUNICIPAL
KOOLAULOA	POLYNESIAN CULTURAL CEN.	3855-09	PCC LAGOON WELL	0.568	0.615	IRRIGATION
KOOLAULOA	NIHIPALI, GEORGE N.	3855-12	NIHIPALI	0.009	0.000	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3956-01	MALAEKAHANA PUMP 7	0.062	0.047	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3856-04	QUARRY WELL D	0.036	0.018	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3856-07	PRAWN FARM	0.147	0.279	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3956-05	EGG FARM	0.001	0.000	AGRICULTURE
KOOLAULOA	KAIO, JACOB I. SR.	3956-07	KAIO ARTESIAN	0.017	0.000	AGRICULTURE
KOOLAULOA	AINA NUI CORPORATION	3957-01	KP3	1.244	0.034	AGRICULTURE
KOOLAULOA	AINA NUI CORPORATION	3957-03	KP3A	0.000	0.120	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	3957-07	KP6	0.026	0.010	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	4056-01	KAWANANAKOA	0.576	0.625	AGRICULTURE
KOOLAULOA	STATE DOA	4057-01	PUMP 1	0.307	0.459	AGRICULTURE
KOOLAULOA	AINA NUI CORPORATION	4057-06	PUMP 8	0.670	0.040	AGRICULTURE
KOOLAULOA	AINA NUI CORPORATION	4057-07	KAHUKU PUMP 12	0.300	0.234	AGRICULTURE
KOOLAULOA	HAWAII RESERVES, INC.	4057-10	PUMP 12A	1.200	1.302	AGRICULTURE
KOOLAULOA	CAMPBELL ESTATE	4057-11	SUGAR MILL PUMP	0.028	0.009	AGRICULTURE
KOOLAULOA	HONOLULU BWS	4057-15	KAHUKU BATTERY	0.600	0.390	MUNICIPAL
KOOLAULOA	HONOLULU BWS	4057-16	KAHUKU BATTERY		0.000	MUNICIPAL
KOOLAULOA	CAMPBELL ESTATE	4100-01	#388	0.206	0.183	IRRIGATION
KOOLAULOA	CAMPBELL ESTATE	4157-04	PUMP 15	1.517	1.204	AGRICULTURE
KOOLAULOA	CAMPBELL ESTATE	4157-04	PUMP 15 (ARMY)	0.000	0.000	AGRICULTURE

APPENDIX D: WELL USE DATA (2000)

AQUIFER SYSTEM AREA	OWNER/OPERATOR	WELL NO.	WELL NAME	WATER USE PERMIT AMOUNT (mgd)	2000 Average Use	Type of Use (CWRM Categories)
KOOLAULOA	CAMPBELL ESTATE	4157-05	KII WILDLIFE REFUGE 1	1.000	0.080	IRRIGATION (Habitat Maintenance)
KOOLAULOA	CAMPBELL ESTATE	4157-06	KII WILDLIFE REFUGE 2	0.000	0.059	IRRIGATION (Habitat Maintenance)
KOOLAULOA	CAMPBELL ESTATE	4157-07	KII WILDLIFE REFUGE 3	0.000	0.098	IRRIGATION (Habitat Maintenance)
KOOLAULOA	CAMPBELL ESTATE	4157-13	KII WILDLIFE REFUGE 4	0.000	0.000	IRRIGATION (Habitat Maintenance)
KOOLAULOA	CAMPBELL ESTATE	4158-12	KAHUKU AIR BASE	0.300	0.206	AGRICULTURE
KOOLAULOA	CAMPBELL ESTATE	4158-13	KAHUKU AIR BASE	0.000	0.000	AGRICULTURE
KOOLAULOA	KUILIMA RESORT CO.	4158-14	KUILIMA 1	0.302	0.187	IRRIGATION
KOOLAULOA	CAMPBELL ESTATE	4159-01	KP2	1.075	0.612	AGRICULTURE
KOOLAULOA	CAMPBELL ESTATE	4159-02	KP2A	0.000	0.006	AGRICULTURE
KAWAILOA	HONOLULU BWS	4101-07	WAIALEE I	0.339	0.263	MUNICIPAL
KAWAILOA	HONOLULU BWS	4101-08	WAIALEE II	0.411	0.416	MUNICIPAL
KAWAILOA	UH DEPT OF ANIMAL SCIENCE	4101-10	WAIALEE	0.026	0.000	AGRICULTURE

APPENDIX E

WATER DEMAND FORECASTING METHODOLOGY

E WATER DEMAND FORECASTING METHODOLOGY

E.1 END USE INVENTORY METHODOLOGY
E.2 PER CAPITA DEMAND METHODOLOGY

Two methodologies are used to project Koʻolau Loa future water demands: *End Use Inventory* and *Per Capita*. Using two methodologies provides a verification of the projected water demands.

The *End Use Inventory* method uses the various water end use categories (residential, commercial, visitor, government, agriculture, etc.). Existing (2000) water use amounts are used as the starting point for the water demand calculations. The growth factors are assigned to each category based on land use and job projections.

The *Per Capita* approach is standard methodology used by BWS in their demand forecasting. It uses a per capita (per person) water use amount and multiplies it by the projected population numbers provided by the City and County of Honolulu Department of Planning and Permitting (DPP).

Both methodologies are used with the three scenarios of future water demand (low, mid/policy and high) and provide a range of projections. Demands are calculated for five-year increments to the year 2030. More detailed descriptions of the methodologies follow.

E.1 END USE INVENTORY METHODOLOGY

The End Use Inventory method estimates future water demand by water use type. Water demand is estimated for potable (both BWS and non-BWS systems) and non-potable water. The potable water use types are residential, commercial, public facilities, resort and agriculture. The non-potable water use types are agriculture, resort/visitor, and habitat maintenance. The non-potable recycled and surface water demands for agriculture and resort uses are calculated separately as they are independent water supply systems.

Descriptions of the assumptions and data used follows below. A summarized version of the scenario assumptions is found in *Table E.1.* Detailed and annotated tables using the end use inventory method for calculating demand are found at the end of this Appendix in *Tables E.3, E.4, and E.5*.

For **potable water**, the BWS and Lāʻie Water Company 2000 water amounts by end use category are used. Then for each category, the DPP growth projections, expressed as a percentage, are used to project future water needs for that category. The following list discusses the growth factors used by category and by scenario.

- For Koʻolau Loa **residential** end use, the increase in the number of housing units is used as the growth factor to 2030. For the mid/policy scenario, the number of housing units projected by DPP are used; this equates to a total of 1,093 additional housing units over the

25 year planning horizon. For the low scenario, only 625 additional housing units are used under the assumption economic growth will occur at a slower rate than the DPP policy projections. And, for the high scenario, 1,843 additional housing units are assumed in an economy stronger than DPP has projected. The year 2000 housing units are divided between BWS and Lā'ie Water Company proportional to the year 2000 population ratio between the two service areas. For the additional units, 35% were assumed to be in the BWS service areas and 65% in the Lā'ie Water Company Service area based on where growth is expected. BWS residential use is calculated by multiplying the BWS average daily demand of 256 gallon per housing unit per day[1] by the number of housing units projected for the BWS Ko'olau Loa service area. Lā'ie Water Company demand is calculated using the BWS average daily demand and multiplying it by the number housing units projected for Lā'ie Water Company service area.

- **Commercial** water demand growth for the three scenarios is based on the total number of commercial jobs[2] estimated by DPP and the percent increase for the five year intervals. The BWS commercial water use does not include Kahuku Village Association's nearly 0.1 mgd; it is included partially with residential (housing) and partly under agriculture (golf course).
- For **public facilities**, a preliminary study by City and County of Honolulu Parks and Recreation Department[3] indicates that additional park land for the district is needed. Schools, which make up the other primary component of public facilities category are not assumed to have substantial increases planned. Therefore, a 25% increase in related water use is planned into the water demand projections over the next 25 years.
- For **resort** water usage, the growth factor is the increase in the number of Ko'olau Loa hotel/condo units projected by DPP. The mid/policy scenario uses the DPP projection of 1880 units at Turtle Bay and Lā'ie Inn. The low scenario uses 1200 resort units and the high scenario has the full build out of 4000 units at Turtle Bay and 220 units for Lā'ie Inn. The Turtle Bay demand is supplied by BWS and the Lā'ie Inn demand is supplied by Lā'ie Water Company.
- For **BWS-supplied agricultural water** the growth factor is based on the DPP projections of agricultural jobs. The agricultural water includes 0.016 mgd used by Kahuku Village Association for the Kahuku golf course. BWS agricultural water demand is fairly minor compared to the agricultural water supplied via private wells.

For the **non-potable groundwater systems**, the 2000 data reported to the State Commission on Water Resource Management are available. The categories for these are listed below:

- For **agriculture**, there is a great deal of acreage in Ko'olau Loa that could be irrigated. It is estimated that in 2000, roughly 1,700 acres of land was irrigated for use. The growth assumptions are: for the low scenario that agriculture water use stays at the 2000 level of 6.3 mgd; for the mid/policy scenario that agriculture water uses increases by 60% to 10.2 mgd by 2030 (for an estimated total irrigated acreage of between 2,100 and 3,300 acres); and for the high scenario, agricultural water use doubles to 12.6 mgd (supplying between 2,800 to 4,300 acres).
- For the **resort/visitor**, private wells are used only PCC lagoons and for the Turtle Bay golf course. Increases in these water use permits are not planned. The current water use permit amounts are assumed constant over the planning horizon for the three scenarios.
- The **habitat maintenance** water use is via one water use permit for groundwater at the James Campbell Wildlife Refuge. The refuge is currently using only 25% of the allocated 1.0

mgd water use permit. The refuge's water demand will not exceed 1.0 mgd within 2030 timeframe. This assumption is used for the low, mid/policy and high scenarios.

- **Recycled water demand for agricultural irrigation** from Lāʻie Waste Water Treatment Plant is assumed to stay constant in the low scenario, to increase by 10% in the mid/policy scenario, and to increase by 20% in the high scenario.
- **Recycled water demand for Turtle Bay resort** is assumed to increase directly proportional to the increase in hotel/condo units. Under the high scenario the wastewater treatment plant will increase production up to the average day plant capacity of 1.32 mgd for the high scenario with full build out by 2030. Also under the high scenario with increased recycled water, the demand for non-potable ground for irrigation is expected to decrease slightly.
- **Surface water** demands for agriculture are assumed constant at the current 5.4 mgd level pending the establishment of measurable instream flow standards.

Table E.1 Summary of the Scenario Assumptions: End Use and Per Capita Methods

SECTOR	LOW	MID (DPP Policy)	HIGH
Municipal	+ 1,200 people + 625 housing units	+ 2,100 people + 1,100 housing units *Lāʻie + 550 units* *Kahuku & KL + 550 units*	+ 3,350 people + 1,850 housing units *Lāʻie + 1,040 units* *Kahuku & KL + 810 units*
Resort	Turtle Bay + 400 units Lāʻie Inn +170 units	Turtle Bay +1,100 units Lāʻie Inn +170 units	Turtle Bay +3,400 units Lāʻie Inn +170 units
Agriculture (Groundwater)	No change *(1, 700 acres)*	60% increase *(2,100 - 3,300 acres)*	Double 2000 water use *(2,800 – 4,300 acres)*
Agriculture (Surface Water)	No change*	No change*	No change*
Instream Uses (Surface Water)	No change*	No change*	No change*
Recycled Water	Lāʻie - no change Turtle Bay - no change	Lāʻie increases by 10% Turtle Bay increases	Lāʻie increases by 20% Turtle Bay increases

*pending establishment of measurable instream flow standards

E.2 PER CAPITA DEMAND METHODOLOGY

The *per capita* approach estimates future potable water demand based on the projected population of the Koʻolau Loa District. The assumptions are that the water demand is directly proportional to population growth and that per capita water use will not change in the future.

The per capita methodology directly links future potable demand to future population:

Total Demand **(gallons) =** ***2000 Per Capita Water Use*** **(gallons per person) x** ***Future Defacto Population*** **(# of persons)**

The Koʻolau Loa population numbers are obtained from the U.S. Census 2000 through DPP. Per capita water use (2000) amounts are obtained from a BWS water consumption survey with 15%

water volume added to account for water loss. A *de facto* population is calculated using the following equation:

De Facto Population = Residents – Residents Absent + Visitors

The residents absent[4] and visitors present numbers are obtained from State DBEDT data through DPP.

The *per capita* methodology is applied to the projected Ko'olau Loa population for the low, mid/policy and high-growth scenarios to estimate future municipal potable water demands in five-year increments through the year 2030. This method assumes that *per capita* water use will remain constant over the course of the planning horizon, which is 2030.

Per capita water use is calculated based on the total water used divided by the number of persons served. The example of the BWS calculation is shown below and the 139 gallon per person number is used for the BWS demand calculations *(Table E.2).* A similar calculation is used to determine the Lā'ie Water Company per capita demand of 141 gallons per person.

Table E.2 BWS Ko'olau Loa District per Capita Water Demand Calculation

2000 Resident Population	Residents Absent	Visitors Present	De Facto Population	Population on State/ Federal/ Private Water Systems	BWS-Served Population	2000 Total Potable Water Demand (mgd)	2000 Per Capita Demand (gpd)
14,456	591	1,391	15,346	6,000	9,346	1.3	**139**

The scenario assumptions for the per capita method are the same as those for the end use inventory method and are shown in *Table E.1* and are discussed below.

While the per capita methodology is used to calculate the potable water demands in Ko'olau Loa, it does not capture the non-potable water demands. Non-potable demands are calculated using the end use inventory method.

The Mid/Policy scenario used the DPP projected increase of 2,100 persons by 2030 in the population. *Table E.2* highlights the numbers used in calculating the defacto population.

The Low scenario assumes less than the DPP projected population number for a total increase of 1,200 persons in Ko'olau Loa by 2030.

The High scenario assumes an additional increase above the DPP projected population, for a total of nearly 3,600 additional persons in Ko'olau Loa.

Detailed and annotated tables using the per capita inventory method for calculating demand for each of the three scenarios are found in T*ables E.6, E.7 and E.8*.

ENDNOTES

[1] Average daily residential demand was derived by dividing the known residential demand for the year 2000 by the number of housing units for the same year.
[2] Included in the "commercial" job category were DPP's individual categories of finance, insurance, and real estate jobs; service jobs; retail jobs; and office jobs.
[3] "Study Calls for New Parks in Koolau Loa", Kaleo o Ko'olauloa, May 10, 2005.
[4] The number of residents absent from the entire City and County of Honolulu (Honolulu County) was calculated by adding the number of visitors present to the total population and subtracting the *de facto* population. The Honolulu County total *de facto* population was retrieved from the State Department of Business, Economic Development and Tourism (DBEDT) *Population and Economic Projections for the State of Hawaii to 2030*. The percent of the county-wide population Ko'olau Loa was used to determined Ko'olau Loa portion of the residents absent figures. For example, if Ko'olau Loa accounted for 1.5% of Honolulu County's population in the year 2000, then the number of Ko'olau Loa residents absent was 1.5% of the number of Honolulu County residents absent for that same year.

Table E.3 Koʻolau Loa Water Demand - End Use Inventory Method, Low Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	Comments/Assumptions
Residential								
DPP Projected Housing Units	4,473	4,573	4,673	4,773	4,873	4,998	5,098	assumption/calc: housing units increase at approximately half the rate of the DPP population projections; housing units are Census Bureau defined
Additional Housing Units (above the base year of 2000)		100	200	300	400	525	625	calc: additional housing units above the year 2000 level; cumulative over time
% increase in housing units		2.2%	2.2%	2.1%	2.1%	2.6%	2.0%	calc: KL projected housing units divided by Oahu projected housing units
BWS Service Area Housing Units	3,273	3,308	3,343	3,378	3,413	3,457	3,492	calc: DPP projection - Lāʻie pop (6000) / 5) assumption: household size is approximately 5 assumption: additional units are 35% BWS and 65% Laie
Laie Service Area Housing Units	1,200	1,265	1,330	1,395	1,460	1,541	1,606	calc: DPP KL households - BWS households
BWS Typical water consumption - gallons per housing unit per day	265	265	265	265	265	265	265	calc: 2000 BWS consumption, residential and religious institutions / BWS service area housing units
Laie Typical water consumption - gallons per housing unit per day	300	300	300	300	300	300	300	Lāʻie reported number
BWS Average daily demand (MGD)	*0.92*	*1.01*	*1.02*	*1.03*	*1.04*	*1.05*	*1.06*	calc: year 2000 - reported data; year 2005 and on = BWS service area housing units * BWS average daily demand (includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.41*	*0.44*	*0.46*	*0.48*	*0.50*	*0.53*	*0.55*	calc: year 2000 - reported data; year 2005 and on = LWC service area housing units * LWC/BWS average daily demand (includes 15% loss to pumpage)
Total Residential Demand (MGD)	***1.33***	***1.45***	***1.48***	***1.51***	***1.54***	***1.59***	***1.62***	calc: BWS + LWC demand
Commercial								
DPP Projected Jobs	1,662	1,660	1,680	1,747	1,832	1,902	1,971	source: DPP 2030 Projections for Finance, Insurance, Real Estate, Service, Retail, & Office Jobs
% increase in Jobs/Commercial		-0.12%	1.20%	3.99%	4.87%	3.82%	3.63%	calc
BWS Average daily demand (MGD)	*0.13*	*0.13*	*0.13*	*0.14*	*0.14*	*0.15*	*0.15*	calc: year 2000 is BWS reported commercial consumption - minus Kahuku Village Association (golf course usage is public facilities and other usage is residential); year 2005 and on = (increase in jobs * previous 5 year interval usage) + previous 5 year amount (includes 15% loss to pumpage)
Laie Water Company expected increase in commercial sector		35.00%	1.20%	3.99%	4.87%	3.82%	3.63%	calc
Laie Water Company Average daily demand (MGD)	*0.43*	*0.57*	*0.58*	*0.60*	*0.63*	*0.66*	*0.68*	calc: year 2000 is LWC reported commercial consumption; year 2005 and on is calc of % times previous year (includes 15% loss to pumpage)
Total Commercial Demand (MGD)	***0.55***	***0.70***	***0.71***	***0.74***	***0.78***	***0.81***	***0.83***	calc: BWS + LWC demand
Public Facilities (Schools / Parks / Government Services)								
Projected increase in parks and recreational facilities		3.85%	3.85%	3.85%	3.85%	3.85%	3.85%	assumption: 25% increase total or 3.85% every 5 years based on City and County study on parks and recreational facilities in Koʻolau Loa that recommends additional facilities
BWS Average daily demand (MGD)	*0.15*	*0.16*	*0.16*	*0.17*	*0.17*	*0.18*	*0.19*	calc: year 2000 is from BWS reported use; year 2005 and beyond includes the potential increase in parks & schools (includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.10*	*0.10*	*0.10*	*0.11*	*0.11*	*0.12*	*0.12*	calc/assumption: LWC portion of the government water needs supplied (includes 15% loss to pumpage)
Total Public Facilities Demand (MGD)	***0.25***	***0.25***	***0.26***	***0.27***	***0.29***	***0.30***	***0.31***	calc: BWS + LWC demand
Resort								
Total DP Area Visitor Units	595	595	1047	1047	1047	1160	1200	source: DPP 2030 Projection; DBEDT Visitor Plant Inventory for Oahu
Kuilima/Turtle Bay Visitor Units	546	546	827	827	827	940	980	calc: DPP 2030 Projection - Laie Visitor Units
Laie Visitor Units	49	49	220	220	220	220	220	source: HRI
BWS Average Daily Demand - Resort	*0.21*	*0.21*	*0.32*	*0.32*	*0.32*	*0.36*	*0.38*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Laie Water Company Average Daily Demand - Resort	*0.02*	*0.02*	*0.02*	*0.03*	*0.03*	*0.04*	*0.04*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Total Resort Demand (MGD)	***0.23***	***0.23***	***0.34***	***0.35***	***0.35***	***0.40***	***0.42***	calc: BWS + LWC demand
Agriculture, BWS Distributed								
DPP Projected Agriculture Jobs	422	409	426	438	449	466	477	source: DPP 2030 Policy Projection for agriculture jobs
BWS Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	source: year 2000 BWS reported consumption
Total BWS Agriculture Demand (MGD)	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	calc: BWS ag + Kahuku golf course assumption: no increase in BWS provided agricultural water
BWS Average daily demand (MGD)	*1.46*	*1.55*	*1.68*	*1.70*	*1.73*	*1.80*	*1.84*	calc: total of BWS demand
Laie Water Company Average daily demand (MGD)	*0.95*	*1.13*	*1.17*	*1.22*	*1.28*	*1.34*	*1.40*	calc: total of LWC demand
POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	***2.41***	***2.69***	***2.85***	***2.92***	***3.01***	***3.14***	***3.23***	calc: total potable water demand

POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
BWS Demand (MGD)	8.60	8.60	8.60	8.60	8.60	8.60	8.60	assumption: exports held constant at 2000 amounts - Koʻolau Poko 8.3 and North Shore 0.3 mgc

Total Potable Demand	11.01	11.29	11.45	11.52	11.61	11.74	11.83	calc: Potable water demand for in-district use and export

Table E.3 Koʻolau Loa Water Demand - End Use Inventory Method, Low Scenario (continued)

NON-POTABLE DEMANDS

NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount

NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.47	1.47	1.47	1.47	1.47	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: recycled water use remains unchanged from 2005 to 2030

NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	6.27	6.27	6.27	6.27	6.27	6.27	assumption: CWRM 2000 reported agriculture well pumpage remains unchanged to 2030

TOTAL GROUNDWATER DEMAND, Koʻolau Loa District	*18.60*	*19.27*	*19.43*	*19.51*	*19.85*	*20.23*	*20.58*	calc: groundwater potable and non-potable demand

NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lāʻie Water Treatment Plant)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	assumption: 2000 recycled water use continues to 2030
Irrigated Landscaping, Turtle Bay	0.26	0.26	0.26	0.26	0.26	0.38	0.50	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.56	0.56	0.56	0.56	0.68	0.80	

NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurabke instream flow standards will not							

Total Non-Potable Demand	15.13	15.53	15.53	15.53	15.79	16.16	16.52	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands

TOTAL WATER DEMAND IN KOOLAU LOA	**26.14**	**26.81**	**26.98**	**27.05**	**27.40**	**27.90**	**28.36**	calc: Potable + Non-Potable Demand in Koʻolau Loa

Table E.4 Ko‘olau Loa Water Demand - End Use Inventory Method, Mid-Policy Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	Comments/Assumptions
Residential								
DPP Projected Housing Units	4473	4680	4994	5138	5301	5440	5566	source: DPP 2030 Policy Projection; housing units are Census Bureau defined
Additional Housing Units (above the base year of 2000)		207	521	665	828	967	1093	calc: additional housing units above the year 2000 level; cumulative over time
% increase in housing units		4.6%	6.7%	2.9%	3.2%	2.6%	2.3%	calc: KL projected housing units divided by Oahu projected housing units
BWS Service Area Housing Units	3,273	3,345	3,455	3,506	3,563	3,611	3,656	calc: DPP projection - Laie pop (6000) / 5) assumption: household size is approximately 5 assumption: additional units are 35% BWS and 65% Laie
Laie Service Area Housing Units	1,200	1,335	1,539	1,632	1,738	1,829	1,910	calc: DPP households - BWS households
BWS Typical water consumption - gallons per housing unit per day	265	265	265	265	265	265	265	calc: 2000 BWS consumption, residential and religious institutions / (DPP housing units - Laie)
Laie Typical water consumption - gallons per housing unit per day	300	300	300	300	300	300	300	Lā‘ie reported number
BWS Average daily demand (MGD)	*0.92*	*1.02*	*1.05*	*1.07*	*1.09*	*1.10*	*1.11*	(includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.41*	*0.46*	*0.53*	*0.56*	*0.60*	*0.63*	*0.66*	(includes 15% loss to pumpage)
Total Residential Demand (MGD)	***1.33***	***1.48***	***1.58***	***1.63***	***1.69***	***1.73***	***1.77***	calc: BWS + LWC demand
Commercial								
DPP Projected Jobs	1,662	1,660	1,680	1,747	1,832	1,902	1,971	source: DPP 2030 Projections for Finance, Insurance, Real Estate, Service, Retail, & Office Jobs
% increase in Jobs/Commercial		-0.12%	1.20%	3.99%	4.87%	3.82%	3.63%	calc
BWS Average daily demand (MGD)	*0.13*	*0.13*	*0.13*	*0.14*	*0.14*	*0.15*	*0.15*	calc: year 2000 is BWS reported commercial consumption - minus Kahuku Village Association (golf course usage is public facilities and other usage is residential); year 2005 and on = (increase in jobs * previous 5 year interval usage) + previous 5 year amount (includes 15% loss to pumpage)
Laie Water Company expected increase in commercial sector		35.00%	5.00%	5.00%	5.00%	5.00%	5.00%	LWC projection - 2005 large increase in BYU population, more increases to come
Laie Water Company Average daily demand (MGD)	0.43	*0.57*	*0.60*	*0.63*	*0.66*	*0.70*	*0.73*	calc: year 2000 is LWC reported commercial consumption; year 2005 and on is calc of % times previous year (includes 15% loss to pumpage)
Total Commercial Demand (MGD)	***0.55***	***0.70***	***0.73***	***0.77***	***0.81***	***0.85***	***0.89***	calc: BWS + LWC demand
Public Facilities (Schools / Parks / Government Services)								
Projected increase in parks and recreational facilities		3.85%	3.85%	3.85%	3.85%	3.85%	3.85%	assumption: 25% increase total or 3.85% every 5 years based on City and County study on parks and recreational facilities in Koolau Loa that recommends additional facilities
BWS Average daily demand (MGD)	*0.15*	*0.16*	*0.16*	*0.17*	*0.17*	*0.18*	*0.19*	calc: year 2000 is from BWS reported use; year 2005 and beyond includes the potential increase in parks & schools (includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.10*	*0.10*	*0.10*	*0.11*	*0.11*	*0.12*	*0.12*	calc/assumption: LWC portion of the government water needs supplied (includes 15% loss to pumpage)
Total Public Facilities Demand (MGD)	***0.25***	***0.25***	***0.26***	***0.27***	***0.29***	***0.30***	***0.31***	calc: BWS + LWC demand
Resort								
Total DP Area Visitor Units	595	595	1416	1416	1416	1447	1880	source: DPP 2030 Projection; DBEDT Visitor Plant Inventory for Oahu
Kuilima/Turtle Bay Visitor Units	546	546	1196	1196	1196	1247	1660	calc: DPP 2030 Projection - Laie Visitor Units
Laie Visitor Units	49	49	220	220	220	200	220	source: HRI
BWS Average Daily Demand - Resort	*0.21*	*0.21*	*0.46*	*0.46*	*0.46*	*0.48*	*0.64*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Laie Water Company Average Daily Demand - Resort	*0.02*	*0.02*	*0.08*	*0.08*	*0.08*	*0.08*	*0.08*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Total Resort Demand (MGD)	***0.23***	***0.23***	***0.55***	***0.55***	***0.55***	***0.56***	***0.73***	calc: BWS + LWC demand
Agriculture, BWS Distributed								
DPP Projected Agriculture Jobs	422	409	426	438	449	466	477	source: DPP 2030 Policy Projection for agriculture jobs
% increase		-3.08%	4.16%	2.82%	2.51%	3.79%	2.36%	source: year 2000 BWS reported consumption
BWS Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	source: Kahuku Village Association submeter for the Kahuku golf course
Total BWS Agriculture Demand (MGD)	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	calc: BWS ag + Kahuku golf course assumption: no increase in BWS provided agricultural water
BWS Average daily demand (MGD)	*1.46*	*1.57*	*1.86*	*1.89*	*1.92*	*1.96*	*2.15*	calc: total of BWS demand
Laie Water Company Average daily demand (MGD)	*0.95*	*1.15*	*1.32*	*1.39*	*1.46*	*1.52*	*1.59*	calc: total of LWC demand
POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	***2.41***	***2.72***	***3.18***	***3.27***	***3.37***	***3.48***	***3.74***	calc: total potable water demand

POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
BWS Demand (MGD)	8.60	8.60	8.60	8.60	8.60	8.60	8.60	assumption: exports held constant at 2000 amounts - Ko‘olau Poko 8.3 and North Shore 0.3 mgd
Total Potable Demand	11.01	11.32	11.78	11.87	11.97	12.08	12.34	calc: Potable water demand for in-district use and export

Table E.4 Ko'olau Loa Water Demand - End Use Inventory Method, Mid-Policy Scenario (continued)

NON-POTABLE DEMANDS

NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	*assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount*

NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.47	1.47	1.47	1.47	1.47	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: recycled water use remains unchanged from 2005 to 2030

NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	6.81	7.39	8.01	8.70	9.44	10.24	assumption: by 2030 use increases to the total permitted water amounts which equals an approximate 60% increase in irrigated agriculture
TOTAL GROUNDWATER DEMAND, Ko'olua Loa District	10.00	11.23	12.27	12.99	14.04	15.14	16.45	calc: groundwater potable and non-potable demand

NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lā'ie Water Treatment Plant)	0.30	0.31	0.32	0.33	0.34	0.35	0.36	assumption: 10% increase in capacity by 2030
Irrigated Landscaping, Turtle Bay	0.26	0.26	0.36	0.36	0.36	0.45	0.54	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.57	0.68	0.69	0.70	0.80	0.90	

NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurable instream flow standards will not preclude the exercising of these rights.							
Total Non-Potable Demand	15.13	16.07	16.75	17.39	18.34	19.44	20.59	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands
TOTAL WATER DEMAND IN KOOLAU LOA	**26.14**	**27.39**	**28.53**	**29.26**	**30.32**	**31.52**	**32.93**	calc: Potable + Non-Potable Demand in Ko'olau Loa

Table E.5 Koʻolau Loa Water Demand - End Use Inventory Method, High Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	Comments/Assumptions
Residential								
DPP Projected Housing Units	4473	4680	4994	5138	5301	5440	5566	source: DPP 2030 Policy Projection; housing units are Census Bureau defined
Scenario #3 Additional Projected Housing Units		125	250	375	500	625	750	assumption: an additional 25 units per year beyond the DPP projected housing units
Scenario #3 Projected Housing Units	4473	4805	5244	5513	5801	6065	6316	calc: DPP 2030 Policy Projection plus Scenario #3 additional units
Additional Housing Units (above the base year of 2000)		332	771	1040	1328	1592	1843	calc: additional housing units above the year 2000 level; cumulative over time
% increase in housing units		7.4%	9.1%	5.1%	5.2%	4.6%	4.1%	calc: KL projected housing units divided by Oahu projected housing units
BWS Service Area Housing Units	3,273	3,389	3,543	3,637	3,738	3,830	3,918	calc: DPP projection - Laie pop (6000) / 5) assumption: household size is approximately 5 assumption: additional units are 35% BWS and 65% Laie
Laie Service Area Housing Units	1,200	1,416	1,701	1,876	2,063	2,235	2,398	calc: DPP households - BWS households
BWS Typical water consumption - gallons per housing unit per day	265	265	265	265	265	265	265	calc: 2000 BWS consumption, residential and religious institutions / (DPP housing units - Laie)
Laie Typical water consumption - gallons per housing unit per day	300	300	300	300	300	300	300	Lāʻie reported number
BWS Average daily demand (MGD)	*0.92*	*1.03*	*1.08*	*1.11*	*1.14*	*1.17*	*1.19*	(includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.41*	*0.49*	*0.59*	*0.65*	*0.71*	*0.77*	*0.83*	(includes 15% loss to pumpage)
Total Residential Demand (MGD)	***1.33***	***1.52***	***1.67***	***1.76***	***1.85***	***1.94***	***2.02***	calc: BWS + LWC demand
Commercial								
DPP Projected Jobs	1,662	1,660	1,680	1,747	1,832	1,902	1,971	source: DPP 2030 Projections for Finance, Insurance, Real Estate, Service, Retail, & Office Jobs
% increase in Jobs/Commercial		-0.12%	1.20%	3.99%	4.87%	3.82%	3.63%	calc
BWS Average daily demand (MGD)	*0.13*	*0.13*	*0.13*	*0.14*	*0.14*	*0.15*	*0.15*	calc: year 2000 is BWS reported commercial consumption - minus Kahuku Village Association (golf course usage is public facilities and other usage is residential); year 2005 and on = (increase in jobs * previous 5 year interval usage) + previous 5 year amount (includes 15% loss to pumpage)
Laie Water Company expected increase in commercial sector		35.00%	7.00%	7.00%	7.00%	7.00%	7.00%	LWC projection - 2005 large increase in BYU population, more increases to come
Laie Water Company Average daily demand (MGD)	*0.43*	*0.57*	*0.61*	*0.66*	*0.70*	*0.75*	*0.81*	calc: year 2000 is LWC reported commercial consumption; year 2005 and on is calc of % times previous year(includes 15% loss to pumpage)
Total Commercial Demand (MGD)	***0.55***	***0.70***	***0.74***	***0.79***	***0.85***	***0.90***	***0.96***	calc: BWS + LWC demand
Public Facilities (Schools / Parks / Government Services)								
Projected increase in parks and recreational facilities		3.85%	3.85%	3.85%	3.85%	3.85%	3.85%	assumption: 25% increase total or 3.85% every 5 years based on City and County study on parks and recreational facilities in Koolau Loa that recommends additional facilities
BWS Average daily demand (MGD)	*0.15*	*0.16*	*0.16*	*0.17*	*0.17*	*0.18*	*0.19*	calc: year 2000 is from BWS reported use; year 2005 and beyond includes the potential increase in parks & schools (includes 15% loss to pumpage)
Laie Water Company Average daily demand (MGD)	*0.10*	*0.10*	*0.10*	*0.11*	*0.11*	*0.12*	*0.12*	calc/assumption: LWC portion of the government water needs supplied (includes 15% loss to pumpage)
Total Public Facilities Demand (MGD)	***0.25***	***0.25***	***0.26***	***0.27***	***0.29***	***0.30***	***0.31***	calc: BWS + LWC demand
Resort								
Total DP Area Visitor Units	595	1200	1805	2410	3015	3620	4220	source: DPP 2030 Projection; DBEDT Visitor Plant Inventory for Oahu
Kuilima/Turtle Bay Visitor Units	546	1151	1585	2190	2795	3400	4000	calc: DPP 2030 Projection - Laie Visitor Units
Laie Visitor Units	49	49	220	220	220	220	220	source: HRI
BWS Average Daily Demand - Resort	*0.21*	*0.45*	*0.61*	*0.85*	*1.08*	*1.32*	*1.55*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Laie Water Company Average Daily Demand - Resort	*0.02*	*0.02*	*0.08*	*0.08*	*0.08*	*0.08*	*0.08*	calc: year 2000 reported consumption; year 2005 and on = a visitor unit amount based on 2000 usage * # of visitor units (includes 15% loss to pumpage)
Total Resort Demand (MGD)	**0.23**	**0.46**	**0.70**	**0.93**	**1.17**	**1.40**	**1.63**	calc: BWS + LWC demand
Agriculture, BWS Distributed								
DPP Projected Agriculture Jobs	422	409	426	438	449	466	477	source: DPP 2030 Policy Projection for agriculture jobs
% increase		-3.08%	4.16%	2.82%	2.51%	3.79%	2.36%	source: year 2000 BWS reported consumption
BWS Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	source: Kahuku Village Association submeter for the Kahuku golf course
Total BWS Agriculture Demand (MGD)	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	***0.05***	calc: BWS ag + Kahuku golf course assumption: no increase in BWS provided agricultural water
BWS Average daily demand (MGD)	*1.46*	*1.81*	*2.04*	*2.31*	*2.59*	*2.86*	*3.14*	calc: total of BWS demand
Laie Water Company Average daily demand (MGD)	*0.95*	*1.18*	*1.39*	*1.49*	*1.61*	*1.72*	*1.84*	calc: total of LWC demand
POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	***2.41***	***2.99***	***3.42***	***3.81***	***4.20***	***4.59***	***4.97***	calc: total potable water demand
POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
BWS Demand (MGD)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	assumption: exports held constant at 2000 amounts - Koʻolau Poko 8.3 and North Shore 0.3 mgd
Total Potable Demand	11.01	11.59	12.02	12.41	12.80	13.19	13.57	calc: Potable water demand for in-district use and export

Table E.5 Ko'olau Loa Water Demand - End Use Inventory Method, High Scenario (continued)

NON-POTABLE DEMANDS

NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount

NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.40	1.32	1.25	1.18	1.10	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: a 25% decrease in Turtle Bay usage by 2030 dues to increased use of recycled water

NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	7.05	7.91	8.89	9.98	11.21	12.59	assumption: by 2030 use is double the 2000 amount

TOTAL GROUNDWATER DEMAND, Ko'olau Loa District	*18.60*	*20.35*	*21.57*	*22.85*	*24.53*	*26.32*	*28.26*	calc: groundwater potable and non-potable demand

NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lā'ie Water Treatment Plant)	0.30	0.33	0.36	0.39	0.42	0.45	0.48	assumption: 20% increase in capacity by 2030
Irrigated Landscaping, Turtle Bay	0.26	0.44	0.62	0.79	0.97	1.14	1.32	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.77	0.98	1.18	1.39	1.59	1.80	

NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurable instream flow standards will not preclude the exercising of these rights.							

Total Non-Potable Demand	15.13	16.50	17.50	18.61	20.10	21.71	23.47	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands

TOTAL WATER DEMAND IN KOOLAU LOA	**26.14**	**28.10**	**29.53**	**31.01**	**32.90**	**34.89**	**37.04**	calc: Potable + Non-Potable Demand in Ko'olau Loa

Table E.6 Ko‘olau Loa Water Demand – Per Capita Inventory Method, Low Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	Comments/Assumptions
DPP Projected Resident Population	14,546	14,746	14,946	15,146	15,346	15,546	15,746	calc: DPP 2030 Policy Projection less about 1/2 the increase
Additional Population		200	400	600	800	1,000	1,200	calc: additional population above the year 2000 level; cumulative over time
DPP Islandwide Projection	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300	source: DPP 2030 Policy Projection
% of Oahu	1.7%	1.6%	1.6%	1.5%	1.5%	1.4%	1.4%	calc: KL projected population divided by Oahu projected population
Defacto Population, Oahu (DBEDT)	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Residents Absent, Oahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030 Table 1-1
Residents Absent, Koolau Loa	591	595	603	611	619	627	636	calc: total residents absent * KL population as % of island population
Visitors Present, Oahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Visitor Units, Oahu	36,321	37,261	44,586	47,162	47,162	47,400	50,700	source: DPP 2030 Policy Projection
Visitor Units, Koolau Loa	595	708	821	934	1047	1160	1273	calc: DPP 2030 Policy Projection, adjusted down
% Visitor Units in Koolau Loa	1.6%	1.9%	1.8%	2.0%	2.2%	2.4%	2.5%	calc: KL visitor units divided by Oahu visitor units
Visitors Present, Koolau Loa	1,391	1,689	1,793	2,114	2,533	2,985	3,274	calc: % visitors in KL * Oahu visitors present
Defacto Population, Koolau Loa	15,346	9,563	16,136	16,648	17,260	17,904	18,385	calc: Defacto population = Projected population - residents away + visitors
BWS-Served Population	9,346	9,625	9,784	10,074	10,424	10,795	11,066	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
Laie Water Company Served Population	6,000	6,215	6,353	6,575	6,836	7,109	7,319	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
BWS Per Capita Demand (Gal/Day)	139	139	139	139	139	139	139	calc: 2000 BWS KL water consumption / population served
Laie Per Capita Demand (Gal/Day)	141	141	141	141	141	141	141	calc: 2000 LWC water consumption / population served
BWS Demand (MGD)	1.49	1.54	1.56	1.61	1.67	1.73	1.77	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Laie Water Company System Demand (MGD)	0.97	1.01	1.03	1.07	1.11	1.15	1.19	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Potable Water Demand: BWS/Lā‘ie Water Company	2.47	2.55	2.59	2.68	2.78	2.88	2.96	calc: total of BWS & LWC
POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
Export Water Demand (MGD)	8.60	8.60	8.60	8.60	8.60	8.60	8.60	assumption: exports held constant at 2000 amounts - Ko‘olau Poko 8.3 and North Shore 0.3 mgd
Total Potable Demand	11.07	11.15	11.19	11.28	11.38	11.48	11.56	calc: Potable water demand for in-district use and export
NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	6.27	6.27	6.27	6.27	6.27	6.27	assumption: CWRM 2000 reported agriculture well pumpage remains unchanged to 2030
NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.47	1.47	1.47	1.47	1.47	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: recycled water use remains unchanged from 2005 to 2030
NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount
TOTAL GROUNDWATER DEMAND, Ko‘olau Loa District	18.66	19.13	19.18	19.26	19.62	19.97	20.30	calc: groundwater demand for in district use
NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lā‘ie Water Treatment Plant)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	assumption: 2000 recycled water use unchanged to 2030
Irrigated Landscaping, Turtle Bay	0.26	0.26	0.26	0.26	0.26	0.38	0.50	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.56	0.56	0.56	0.56	0.68	0.80	
NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurable IFS would not preclude the exercising of these rights.							
Total Non-Potable Demand	15.13	15.53	15.53	15.53	15.79	16.16	16.52	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands
TOTAL WATER DEMAND IN KOOLAU LOA	**26.20**	**26.67**	**26.72**	**26.80**	**27.16**	**27.64**	**28.08**	calc: Potable + Non-Potable Demand in Ko‘olau Loa

Table E.7 Koʻolau Loa Water Demand – Per Capita Inventory Method, Mid-Policy Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	Comments/Assumptions
DPP Projected Resident Population	14,546	15,099	15,749	16,135	16,378	16,563	16,725	source: DPP 2030 Policy Projection
Additional Population (above the base year of 2000)		553	1,203	1,589	1,832	2,017	2,179	calc: additional population above the year 2000 level; cumulative over time
DPP Islandwide Projection	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300	source: DPP 2030 Policy Projection
% of Oahu	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.5%	calc: KL projected population divided by Oahu projected population
Defacto Population, Oahu (DBEDT)	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Residents Absent, Oahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030 Table 1-1
Residents Absent, Koolau Loa	591	609	636	651	661	668	675	calc: total residents absent * KL population as % of island population
Visitors Present, Oahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Visitor Units, Oahu	36,321	37,261	44,586	47,162	47,162	47,400	50,700	source: DPP 2030 Policy Projection
Visitor Units, Koolau Loa	595	595	1,416	1,416	1,416	1,447	1,880	source: DPP Policy Projection
% Visitor Units in Koolau Loa	1.6%	1.6%	3.2%	3.0%	3.0%	3.1%	3.7%	calc: KL visitor units divided by Oahu visitor units
Visitors Present, Koolau Loa	1,391	1,419	3,093	3,204	3,426	3,724	4,836	calc: % visitors in KL * Oahu visitors present
Defacto Population, Koolau Loa	15,346	15,909	18,207	18,688	19,143	19,619	20,886	calc: Defacto population = Projected population - residents away + visitors
BWS-Served Population	9,346	9,628	10,957	11,208	11,459	11,728	12,482	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
Laie Water Company Served Population	6,000	6,281	7,719	7,480	8,154	8,360	8,873	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
BWS Per Capita Demand (Gal/Day)	139	139	139	139	139	139	139	calc: 2000 BWS KL water consumption / population served
Laie Per Capita Demand (Gal/Day)	141	141	141	141	141	141	141	calc: 2000 LWC water consumption / population served
BWS Demand (MGD)	1.49	1.54	1.75	1.79	1.83	1.87	2.00	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Laie Water Company System Demand (MGD)	0.97	1.02	1.25	1.21	1.32	1.36	1.44	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Potable Water Demand: BWS/Lāʻie Water Company	2.47	2.56	3.00	3.00	3.15	3.23	3.43	calc: total of BWS & LWC

POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
Export Water Demand (MGD)	8.60	8.60	8.60	8.60	8.60	8.60	8.60	assumption: exports held constant at 2000 amounts - Koʻolau Poko 8.3 and North Shore 0.3 mgd
Total Potable Demand	11.07	11.16	11.60	11.60	11.75	11.83	12.03	calc: Potable water demand for in-district use and export

NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	6.93	7.59	8.25	8.91	9.57	10.23	assumption: by 2030 use increases to the total permitted water amounts which equals an approximate 60% increase in irrigated agriculture

NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.47	1.47	1.47	1.47	1.47	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: recycled water use remains unchanged from 2005 to 2030

NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount
TOTAL GROUNDWATER DEMAND, Koʻolua Loa District	10.05	11.20	12.31	12.97	14.04	15.03	16.14	calc: groundwater demand for in district use

NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lāʻie Water Treatment Plant)	0.30	0.31	0.32	0.33	0.34	0.35	0.36	assumption: 10% increase in capacity by 2030
Irrigated Landscaping, Turtle Bay	0.26	0.26	0.36	0.36	0.36	0.45	0.54	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.57	0.68	0.69	0.70	0.80	0.90	

NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurable IFS would not preclude the exercising of these rights.							
Total Non-Potable Demand	15.13	16.20	16.96	17.63	18.56	19.57	20.59	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands
TOTAL WATER DEMAND IN KOOLAU LOA	**26.20**	**27.35**	**28.56**	**29.24**	**30.32**	**31.41**	**32.62**	calc: Potable + Non-Potable Demand in Koʻolau Loa

Table E.8 Koʻolau Loa Water Demand – Per Capita Inventory Method, High Scenario

POTABLE WATER DEMAND: BWS/LAIE WATER COMPANY	2000	2005	2010	2015	2020	2025	2030	**Comments/Assumptions**
DPP Projected Resident Population	14,546	15,099	15,749	16,135	16,378	16,563	16,725	source: DPP 2030 Policy Projection
DPP Islandwide Projection	876,156	912,900	952,650	995,550	1,037,250	1,078,050	1,117,300	source: DPP 2030 Policy Projection
Koʻolau Loa population as a % of Oahu population	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.5%	calc: KL projected population divided by Oahu projected population
Scenario #3 Additonal Growth (within the Sustainable Community Plan Rural Community Boundary)		250	500	750	1,000	1,250	1,500	assumption: an increase of 250 persons every 5 years above DPP 2030 Projection; this line is cumulative
Total Projected Population	14,546	15,349	16,249	16,885	17,378	17,813	18,225	calc: DPP projected population + additional growth
Total Additional Population		803	1,703	2,339	2,832	3,267	3,679	calc: total Scenario #3 projected population - year 2000 population
Defacto Population, Oahu (DBEDT)	925,444	964,950	1,011,600	1,062,100	1,109,500	1,156,550	1,202,600	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Residents Absent, Oahu	35,623	36,829	38,444	40,172	41,851	43,487	45,114	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030 Table 1-1
Residents Absent, Koolau Loa	591	609	636	651	661	668	675	calc: total residents absent * KL population as % of island population
Visitors Present, Oahu	84,911	88,879	97,394	106,722	114,101	121,987	130,414	source: DBEDT Population and Economic Projections for the State of Hawaii to 2030
Visitor Units, Oahu	36,321	37,261	44,586	47,162	47,162	47,400	50,700	source: DPP 2030 Policy Projection
Visitor Units, Koolau Loa	595	1,200	1,805	2,410	3,015	3,620	4,225	assumption: full build out of Turtle Bay and Laie Inn
% Visitor in Koolau Loa	1.6%	3.2%	4.0%	5.1%	6.4%	7.6%	8.3%	calc: KL visitor units divided by Oahu visitor units
Visitors Present, Koolau Loa	1,391	2,862	3,943	5,454	7,294	9,316	10,868	calc: % visitors in KL * Oahu visitors present
Defacto Population, Koolau Loa	15,346	17,602	19,556	21,687	24,011	26,461	28,418	calc: Defacto population = Projected population - residents away + visitors
BWS-Served Population	9,346	10,632	11,724	12,953	14,314	15,759	16,905	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
Laie Water Company Served Population	6,000	6,910	7,701	8,561	9,497	10,482	11,275	calc: Defacto population = Projected population - residents away + visitors assumption: base population, residents away, and visitors split between BWS and LWC proportion to 2000 population. assumption: 50/50 split of additional population between BWS and LWC
BWS Per Capita Demand (gallons per day)	139	139	139	139	139	139	139	calc: 2000 BWS KL water consumption / population served
Laie Per Capita Demand (Gal/Day)	141	141	141	141	141	141	141	calc: 2000 LWC water consumption / population served
BWS Demand	1.49	1.70	1.87	2.07	2.29	2.52	2.70	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Laie Water Company System Demand	0.97	1.12	1.25	1.39	1.54	1.70	1.83	calc: BWS Population served * BWS per capita demand (includes 15% loss to pumpage)
Potable Water Demand: BWS/Lāʻie Water Company	2.47	2.82	3.12	3.46	3.83	4.22	4.53	calc: total of BWS & LWC
POTABLE WATER DEMAND FOR EXPORT	2000	2005	2010	2015	2020	2025	2030	
Export Water Demand (MGD)	8.60	8.60	8.60	8.60	8.60	8.60	8.60	assumption: exports held constant at 2000 amounts - Koʻolau Poko 8.3 and North Shore 0.3 mgd
Total Potable Demand	11.07	11.42	11.72	12.06	12.43	12.82	13.13	calc: Potable water demand for in-district use and export
NON-POTABLE DEMAND AGRICULTURE/AQUACULTURE (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.27	7.32	8.37	9.41	10.46	11.50	12.55	assumption: by 2030 use is double the 2000 usage
NON-POTABLE DEMAND RESORT & PCC (PRIVATE WELLS)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	1.08	1.47	1.40	1.32	1.25	1.18	1.10	source: CWRM water use permits PCC (0.568 MGD) & Turtle Bay Golf Courses (0.508 MGD); add'l 0.394 permitted for Turtle Bay in 2003 assumption: a 25% decrease in Turtle Bay usage by 2030 dues to increased use of recycled water
NON-POTABLE DEMAND HABITAT MAINTENANCE (PRIVATE WELLS) (Campbell Wildlife Refuge)	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	0.24	0.24	0.24	0.24	0.50	0.75	1.00	assumption: includes water for future expansion of the refuge; 0.237 mgd is 2000 pumpage and 1.0 mgd is water use permit amount
TOTAL GROUNDWATER DEMAND, Koʻolau Loa District	***18.65***	***20.45***	***21.72***	***23.03***	***24.64***	***26.25***	***27.78***	calc: groundwater potable and non-potable demand
NON-POTABLE DEMAND RECYCLED WATER	2000	2005	2010	2015	2020	2025	2030	
Irrigated Agriculture and Landscaping, BYU (Lāʻie Water Treatment Plant)	0.30	0.33	0.36	0.39	0.42	0.45	0.48	assumption: 20% increase in capacity by 2030
Irrigated Landscaping, Turtle Bay	0.26	0.44	0.62	0.79	0.97	1.14	1.32	calc: Turtle Bay currently using 20% of 1.32 mgd WTP capacity assumption: increase in production mirrors increase in hotel units
Water Demand	0.56	0.77	0.98	1.18	1.39	1.59	1.80	calc
NON-POTABLE DEMAND SURFACE WATER FOR AG	2000	2005	2010	2015	2020	2025	2030	
Water Demand (MGD)	6.98	6.98	6.98	6.98	6.98	6.98	6.98	source: USGS preliminary data on Punaluu Stream Study assumption: once quantifiable instream flow standards are set, this amount may change
Appurtenant Water Rights and Traditional & Customary Water Rights	These are unquantified rights to water that may be exercised at any time. The setting of measurable instream flow standards will not preclude the exercising of these rights.							
Total Non-Potable Demand	15.13	16.78	17.96	19.13	20.58	22.00	23.43	calc: Agricultural + Resort + Habitat Maintenance + Recycled Water + Surface Water Non-Potable Demands
TOTAL WATER DEMAND IN KOOLAU LOA	**26.20**	**28.20**	**29.68**	**31.19**	**33.00**	**34.82**	**36.56**	calc: Potable + Non-Potable Demand in Koʻolau Loa

APPENDIX F

BWS 6-YEAR CAPITAL PROGRAM

2006-2011

F KOʻOLAU LOA BWS CAPITAL PROGRAM

Project	Total Cost $ M	Fiscal Year Construction
Kaluanui Wells Renovation	$2.650	2009
Maʻakua & Kaluanui Line Booster Renovations	$0.285	2008
Hauʻula Wells Renovation	$1.300	2009
Kahuku Wells Renovation	$1.340	2010
Kahuku Standby Well Addition	$0.660	2011
Maʻakua Standby Well Addition	$0.340	2012
Kahuku 228 Reservoir No. 2 0.5 mgd	$4.860	2015
Total	**$11.435**	

Total Cost = Cost for Design + Land + Construction

APPENDIX G

NEIGHBORHOOD MEETING NO 29
MEETING NOTES ON
WINDWARD WATER

Kansas City, Missouri to study the new retrofitting sewer pump system and how that would be applicable to the Kahalu'u Sewer Pumping Station. Makapagal pointed out that during heavy rains, overflow from cesspools is headed to nearby beaches and suggested that a septic tank be built next to each house in the immediate area.

LeVasseur inquired about placing an Emergency Vehicle (Ambulance) Facility near the Kahalu'u Fire Station. Salvatore Lanzilotti, Director, Department of Emergency Services pointed out that Senate Bill 1504, appropriating funds for the Kahalu'u - Kaaawa rapid response units did not pass this legislative session. Lanzilotti noted that the fire department provides basic life support while the ambulance provides advanced life support for patients. He explained that the City contracts from the State to provide for ambulance vans and equipment. He suggested that area residents must lobby their legislators for support in placing a rapid response unit in the Kahalu'u - Kaaawa area. Costs for the ambulance vehicle are $100,000.

Mench inquired about the 42-inch water main route being built on Kahekili Highway. Clifford Jamile, Manager and Chief Engineer of the Board of Water Supply (BWS) stated that the new 42-inch water main will be built on the mauka shoulder of Kahekili Highway stretching from Ahuimanu Street to Haiku Road and added that there are no plans to pump and transfer additional water away from Windward Oahu. Jim Anthony commented that the proposed 42-inch water main is a part of BWS' design to enable service reliability and asked the Board for further deliberations on this and other related issues. Jamile replied that the existing water mains are likely to fail in the near future which makes it essential to build the new water mains soon. The cost of the project is $90 million. Chair Bender noted that the State Department of Transportation (DOT) is building a roundabout near the Hygienic Store in the intersection of Kamehameha and Kahekili Highways. Jamile replied that BWS will be coordinating with DOT on project schedules and the time line. George Okuda commented concern that construction of the 42-inch water main on the mauka shoulder of Ahuimanu and Haiku Road would result in erosion near the Valley of the Temples. Jamile pointed out that he was not aware of the project causing erosion. Jamile pointed out that through the Integrated Resource Planning (IRP) Program, water use and reuse would more efficient than pumping water from a high stream. Anthony commented that for the past year, Jamile has been honest with both a good heart and head in his capacity as Manager and Chief Engineer of the Board of Water Supply, everyone applauded.

Gilbert Silva expressed concern that a series of break-ins in the canoe facility have taken place where canoe ropes have been stolen, therefore is asking for increased police patrols. Lee stated that he will discuss the matter with Police Chief Lee Donohue. Mike Amii, Deputy Director, Department of Parks and Recreation along with Reppun suggested that continued reports to the police and installing surveillance cameras would help deter future vandalism.

The Mayor's Mini Team were thanked for their presentation. Chair Bender called for a recess at 9:00 p.m. and reconvened the meeting at 9:15 p.m.

Councilmember Steve Holmes: Councilmember Holmes distributed a written report with the following: Tuesday, July 25, 2000 will mark the last day for Mufi Hannemann and Donna Mercado Kim as Councilmembers. Both Hannemann and Kim are vacating their seats in order to run for Mayor and State Senator respectively. Both these vacant council seats will be filled in a winner-take-all special election where the top vote getter will fill out the remaining two years on the Council and will be sworn in October after the 20-day challenge period.

Discussion followed: Holmes joined with community leaders in a meeting with Nelson Billefield, an attorney representing Heeia Kea Incorporated, the landowner planning to evict the Kaluhiwa family. Holmes further stated that he and Lorrie Chee, Deputy Director of the Department of Planning and Permitting, discussed ways to extend time for the Kaluhiwa family while asking the property owner to act in good faith. Councilmember Holmes was thanked for his report.

Representative Iris Catalani: Representative Catalani distributed a written report with the following: The House plans not hold a special session unless two-thirds of the Senate are committed to correcting the problem of unequal senate terms. There being no questions, Representative Catalani was thanked for her report.

Representative Colleen Meyer: Representative Meyer distributed a written report with the following: (1) Expressed disappointment with Governor Cayetano's decision in vetoing $11.5 million of Capital Improvement Projects for schools such as Benjamin Parker Elementary. There being no questions, Representative Meyer was thanked for her report.

discussed in detail the past two months. The Punalu'u community discussed this issue the other night. They will hold a special meeting to further address this issue. She asked if it's prudent for the Board to discuss this item before Punalu'u does.

Questions, answers and comments followed: 1) Mattoon said many individuals who were at the Punalu'u meeting have formed an opinion on the BWS 36-inch transmission line project. Proper notification was not made to the community. 2) Moore said the expanded hours will affect all of Ko'olauloa because everyone uses Kamehameha Highway.

Cliff Jamile, Director, BWS, said the request for expanded hours is being made by the contractor and not BWS. If the Ko'olauloa Neighborhood Board does not support the proposal, then the BWS will deny the request. If the Board supports the proposal, then it goes before the Department of Health (DOH), who will attach certain provisions. After that, the State Department of Transportation (DOT) will set the hours of work. As the proposal goes along, the BWS will get involved. The contractor would have to make a proposal to BWS.

Additional questions, answers and comments followed: 3) Chair Long asked how long will the project take. Jamile answered approximately 720 calendar days (about two years). A 36-inch transmission line will be installed for 2.5 miles. There have been main breaks in the project area. His opinion is that there is no more water to explore taking from the Windward side. He's looking forward for the Integrated Resource Plan (IRP) to take place because it will answer a lot of questions. The BWS is proposing a reservoir in and around Kaneohe and Kailua. 4) Moore asked if the expanded hours will expedite the project. Jamile answered it is supposed to, but he doesn't know. The contractor could better answer the question. 5) Mattoon asked if it's less expensive to put a reservoir in Kaneohe and Kailua than to do this project. Jamile answered yes. 6) Mattoon said he's very pleased that the IRP was mentioned and that there isn't anymore water to explore taking from the windward side. 7) Langi asked what are the proposed hours of extension. Jamile answered it will be up to midnight, but it will be modified by the State. The contractor is restrictive for its starting time. 7) Kahana asked if there are incentives or penalties in the contract. Jamile answered the contract is for 720 days. BWS needs to explore that issue. If there are penalties or incentives, there has to be value to BWS. There are added costs for BWS: inspectors, monitors, cultural monitors and communications personnel. Herb Chock and Associates is the contractor, Martin Miller is the construction manager, and Ahi Logan is the cultural monitor. BWS job is to make sure everything goes according to plan. 8) Langi said part of Kamehameha Highway where construction has taken place is very bumpy. He asked if the contractor could use hot patch instead of cold patch. Jamile answered it's only a temporary patch. The permanent repaving will used at the end of the phase. Approximately 3,000 feet of the project has been completed. Permanent pave had been done on 2,000 feet. The road will never go back to its original condition. 9) Hurlbut made a point-of-order. He said discussion supposed to focus on the extended hours only. 10) Martin Miller said the extended hours could decrease the project by six months. They are asking DOH for a variance to expand the hours from Monday through Friday, from 8:30 a.m. to 3:00 p.m. and 6:00 p.m. to 12:00 midnight. Work in the non-residential area (Kahana Valley State Park to Makalii Point) will be from 8:30 a.m. to 3:30 p.m. and 6:00 p.m. to 7:00 a.m. The variance does not allow work on Saturday, but it does for Sunday. They are willing to discuss any input from the community. Currently, their working hours are 7:30 a.m. to 3:30 p.m. Once school begins, the starting time will resume at 8:30 a.m. 11) Chair Long asked if "how far sound will travel" will be addressed. Miller answered the DOH variance has a certain decibel limit. 12) Chair Long said if expanded hours were approved, DOT could rescind the permit if the community was not satisfied with the arrangement. 13) Langi said the tour buses leave the Polynesian Cultural Center (PCC) between 9:00 p.m. and 10:00 p.m. He asked if construction could stop at that time. Miller answered they will take a break from 9:00 p.m to 10:00 p.m.

Kahana moved and Mattoon seconded that the Ko'olauloa Neighborhood Board No. 28 solicit feedback from all the individual communities about the expanded work hours. Also, to put this item on September's agenda for action. Mattoon said the issue is the expanded hours, which will take place in Punalu'u. **The motion passed, 7-0-1.** Aye: Beaver, Foley, Kahana, Langi, Long, Mattoon, Moore. **Abstain**: Hurlbut. Discussion continued.

Mattoon made a point-of-order when a guest wanted to continue discussion. He said a decision has already been made on the issue.

APPENDIX H
UNRESOLVED ISSUES

H WORKING GROUP UNRESOLVED ISSUES

The Koʻolau Loa Watershed Management Plan Working Group (Working Group) would first like to recognize the willingness of the BWS and Group 70 to acknowledge the Working Group's concerns and incorporate as many of those concerns as they could through changes in the plan. Despite everyone's best efforts to resolve issues there are significant issues that are of concern to the Working Group that are not addressed adequately in the plan. The BWS on all of the Working Group's unresolved issues has provided their rationale for why these issues can not be addressed to the Working Group's satisfaction in the plan. The Working Group however feels strongly that these issues must be raised and made part of the document and BWS has agreed to allow us to place our unresolved issues in the plan. BWS has also committed to continue to work with us regarding resolution of these issues.

IMPLEMENTATION

The Working Group feels strongly that without an entity dedicated to implementing the plan the reality of timely and optimum implementation is very unlikely. In the view of the Working Group this entity would need to have:

- representation from the community, BWS and other county state and federal agencies involved in implementation;
- a budget and control over the allocation of that budget
- the ability to set and enforce timelines for project implementation
- the ability to add new projects should the entity see them as necessary and not identified at the time of the plan
- a degree of autonomy necessary to accomplish the timely implementation of the plan i.e. the ability to enter into contracts etc.

The entity should have a dedicated stream of funding which could be provided through the assessment of a fee on all water users in the area, or through another vehicle that has the support of all the agencies involved in the entity. This is a key element of the community's concern because the entity will not be able to implement the plan without adequate, dedicated funding.

AQUIFER PROTECTION

The Working Group notes that the State Water Resources Plan is considered by government entities to be the State's aquifer protection plan. The Working Group also notes that the Water Resources Plan is currently under revision. The Working Group feels strongly about aquifer protection and expresses its concern that if the Water Resources Plan is indeed the aquifer protection plan, then it must include meaningful consultation with concerned communities and not just a series of public meetings/hearings.

DEMAND BEING DRIVEN BY DEVELOPMENT

The Working Group feels strongly that any future water allocation granted for any non-agricultural use in the Koʻolau Loa must start from a baseline that includes the provision of water for full development of agricultural use of all agricultural lands in the area.

The Working Group also feels that the current planning and land use systems are not tied closely enough to the need to sustain watershed health, and that they tend to support the provision of water for development over concerns for the health of the watershed, for ecological needs, and for the potential need of future generations.

SUSTAINABLE YIELDS

The Working Group does not have the same faith as BWS faith in the methodology used for the establishment of sustainable yields nor does it feel that the concept of developing to sustainable yields adequately addresses the hydrological and ecological needs of the muliwai or the need to maintain an adequate reserve of water for presently unforeseen needs of future generations.

LEGAL DISCLAIMERS

Although these disclaimers are the result of input from the Corporation Counsel and the Deputy Attorney General they are troubling to the Working Group as they tend to water down the plan, take away any "teeth" it might have and hinder the goal of watershed protection that is the intent of the plan.

APPENDIX I

Neighborhood Board No. 28
Support of KLWMP
August 2007 Meeting Notes

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
THURSDAY, AUGUST 9, 2007
HAU'ULA COMMUNITY CENTER

CALL TO ORDER: Chair Dee Dee Letts called the meeting to order at 7:00 p.m. a quorum was present.

MEMBERS PRESENT: John Elkington, Kathryn Heath, Kelika Ishol, Barbara Kahana, Jimmy Leonardi, Dee Dee Letts, Creighton Mattoon, Junior Primacio.

MEMBERS ABSENT: Norman Kaluhiokalani, Les Steward, Dawn Wasson.

GUESTS: John Olszowka, Dee Dee Herron (Punaluu Community association), Fred Mencher (HME), Gerry Meade (KCHWC), Michelle Malufau (KCHWC), Chuck Braden (KCHWC), Dacey Kagawa, Jeff Overton (Group 70), Lea Albert (DOE), Ella Sirosicey (Kahuku Hospital), Amy Madsen (Marine Corps), Barry Usagawa (BWS), Sherry Wartner, Dawn Hoppe, Eric Takamura (Director of EVS), Captain Char (HFD), Fire Fighter Walsh (HFD), Lieutenant Robinson (HPD), Lieutenant Cheong (HPD), Keoki Miyamoto (Department of Facility Maintenance), Jacee Mikulanec (Councilmember Donovan Dela Cruz's Office) Leland S.M. Ribac (Neighborhood Commission Office Staff).

APPROVAL OF THE MEETING MINUTES OF JUNE 14, 2007: Mattoon moved and was seconded by Heath to approve the minutes, the motion was approved without objection by the Board with the following amendment:

- Page 5, under Public Input: Replace "A local community program" with Koolauloa Community Health & Wellness Center.

TREASURER'S REPORT: Chair Letts read the appropriations for Fiscal Year 2008; highlighting the Operating Account has $1,520, Publicity Account $1,081, and Refreshment Account at $120.

GOVERNMENT REPORTS:

HONOLULU FIRE DEPARTMENT (HFD): Captain Char of HFD reported the following information.

- Statistics for the month of July in the Ko`olauloa district: 12 fires; 37 medical calls; 2 search and rescues; and responded to 14 miscellaneous calls.
- Tip of the Month: As children will be returning to school this month, be cautious when driving near schools and crosswalks. Teach children street safety skills such as looking both ways before crossing the street, as well as to call 911 in case of emergencies.

No questions or concerns followed.

HONOLULU POLICE DEPARTMENT (HPD): Lieutenant Robison and Lieutenant Cheong reported the following:

- Lt. Robinson read the statistics for the month of July for the entire windward area; 0 manslaughter/murder, 4 rape, 4 robbery, 6 aggravated assaults, 61 burglaries, 168 thefts, 125 unauthorized entrance to motor vehicles (UEMV), 45 auto thefts.
- Between 10:00 p.m. and 6:00 a.m. HPD has been performing checks and sweeps at Lai`e point, resulting in the citing of 10 vehicles and the arrest of 8 persons.
- Prepare you families for hurricane season Flossie is the first of the season. Statistics show that if a category 3 hurricane was to hit, 85% of trees would be blown down.

Questions, comments and concerns:

- Leonardi questioned a new tower being built next to the Kahuku Police Station, and its proximity to the Kahuku High School. Lt. Robinson replied that it was his understanding that the new tower will replace the existing tower due to rust and structural problems. Chair Letts commented that if the new tower is to replace the old tower, why is it twice as high? Lt. Robinson has no exact answer.
- Ishol questioned of the 15 burglaries, which location experienced more? Lt. Robinson replied Punalu`u had eight of the 15 burglaries, and that the patrol is very good at identifying the thieves.

MAYOR'S REPRESENTATIVE: Keoki Miyamoto, Deputy Director of the City Department of Facility Maintenance, representing the Mayor, introduced himself and took any questions or requests.

Questions, comments and concerns:

- Leonardi questioned the cleaning of two streams located on the mauka sides of Kamehameha Highway, called Ki`i and Kahuku Bridges. Keoki to look into it.
- Chair Letts mentioned the Ka`a`awa Beach Park restrooms are still not operating and asked for a status report. Mr. Miyamoto had not information regarding the issue however Mikulanec from Council member Dela Cruz's office replied that the restrooms septic system had problems and needed to be redone in order to obtain approval from the Department of Health.
- A community member questioned if Patrick Kubota retired? Chair Letts replied that Kubota changed occupations and is at the Department of Hawaiian Home Lands.
- Primacio questioned the status of the Kahuku District Park play apparatus. The apparatus has been taken apart. Miyamoto to look into it.

COUNCILMEMBER DONOVAN DELA CRUZ: Jacce Mikulanec of Councilmember Dela Cruz's office reported the following:

- There was a great turn out at the past community clean ups events.
- In regards to the Ka`a`awa restrooms not being opened, the Department of Health is looking into it, the restrooms septic system did not meet standards.
- Several abandoned vehicles have been removed within the district.
- Councilmember Dela Cruz's newsletter was located in the back of the room, his website is up and running.
- It will soon be the time for CIP projects, such as play equipment for parks.

Questions, comments and concerns followed:

- A constituent questioned the real property tax exemption. Mikulanec replied that there have been several workshops and all details are in the back of the room.
- A constituent questioned the authorization of prisoners on the highway picking up trash, Mikulanec noted it was a State issue.
- Leonardi stated that on Kamehameha Highway near Kahuku High School, even with the two stop lights, when the school lets out there is a large traffic jam. Chair Letts replied that the highway belongs to the state and not the county so DOT should be contacted regarding this issue.
- Mencher questioned what should be done to recycle computer printers. Mikulanec to give contact information for disposing of the printers.

GOERVOR'S REPRESENTATIVE: Ben Henderson was not available, but provided Chair Letts a written as follows:

- DOT Highways will investigate the cleaning of two ditches mauka of Kamehameha Highway known as "hospital ditch". DOT Highway staff are currently engaged in assessing the condition of bridges on Oahu.
- With the start of school, be aware of children in crosswalks and playgrounds. There is a new law that calls for a $150 fine for motorists who fail to stop for pedestrians; second offense carries a $300 fine and three month license revocation; third offense $1,000 fine and six month license revocation.
- The Governor will be hosting the 4th Annual International Women's Leadership Conference on September 25th at the Sheraton Waikiki. Register at www.iwlc.org.

Questions, comments and concerns followed: Chair Letts recorded all concerns to be sent to Henderson.

- Leonardi asked whether turn lanes could be explored at Kahuku High School. When school is finished traffic is a big problem.
- Elkington questioned the completion date for the bridge in front of the State Park.
- A resident also added that there is a $75 fine for pedestrians that j-walk.

STATE LEGISLATORS: No State Legislators were available.

DEPARTMENT OF EDUCATION (DOE): Lea Albert representing the DOE reported the following:

- On Thursday, May 3, 2007 an overspray of chemicals prompted school officials to contact the Fire Department as well as the Department of Agriculture and Department of Health. The chemical over sprayed was Ornithine, used to kill slugs, and would take 24 hours to dissipate, said officials. The school was closed as of Friday the 4th of May, and reopened on the following Tuesday. Teachers claimed to feel ill, so school was again closed on Tuesday. The school was cleared of Ornithine the same day, but stayed closed until Wednesday. Ornithine has no long term affects.
- Several schools accomplished the Adequate Yearly Progress goals (AYP). Hau`ula did not make AYP in math, but did in reading.
- The district surpassed its current record of 44%, and reached 53%.

Questions, comments and concerns followed:

- Primacio questioned if the farmer was fined for the overspray, Albert replied yes.
- Chair Letts questioned a rumor that Ka`a`awa Elementary School would raise its grounds by five feet to accommodate a septic system. Albert noted that before changes occur they will go to the community first. To her understanding only a portion of the school would be raised, and DLNR will be working on this. Schools are being advised to upgrade systems.
- Herron heard that prisoners were on campus at Kahuku High School during operational hours. Albert responded that as soon as the Principal heard, prisoners were escorted back off the campus.
- Ishol questioned which schools did not make AYP? Albert noted that Hau`ula did not make AYP in math and, Kahuku High School did not make AYP.

BOARD OF WATER SUPPLY (BWS): Barry Usagawa of BWS reported the following information:

- There were no main breaks for the month of July.
- As of the first week of August 159 million gallons were being pumped on Oahu per day.
- Prepare adequate drinking water for the hurricane season, which is one gallon per person per day.
- Visit www.boardofwatersupply.com to view the new interactive Xeriscape plant page.

Questions, comments and concerns followed:

Mattoon mentioned that Usagawa was featured in an article in the Hawaiian Airlines magazine.

Board member Barbara Kahana joined the meeting at 7:40 p.m.

U.S. MARINES: Amy Madsen reported the following for the Marine Corps Base:

- In the last week of June, the Bay Fest went very well.
- On October 12, 13, and 14th, the Blue Angels along with others will be performing, so expect an increase in noise before and during the shows.
- There has been a change in command. Colonel Mark Duncan now commands the base.

Questions, comments and concerns followed:

- Heath explained that helicopter traffic comes out of the valley and directly above houses in the evening. Madsen will take the information back.
- Chair Letts noted that hospitals and care homes should be notified of the air show as the noise caused problems for patients last year. Madsen agreed.

- Primacio questioned the activity of the Army. Madsen was unsure, Chair Letts noted the Army and Marines are separate, and that the army should be at the next meeting.

UNFINISHED BUSINESS:

KO'OLAULOA WATERSHED MANAGEMENT PLAN: Barry Usagawa and Jeff Overton of Group 70 reported that the plan is in its pre-final draft stage, with thanks to the community. The plan started in 2004, and represents more than 4,000 hours of work. The plan is part of the Oahu Watershed Management Plan. The plan takes a holistic approach to the watershed, and encompasses the heath of as well as the water sources of the watershed. This is a plan for the entire Ko`olauloa area. The goal is to protect, preserve, and manage Oahu's watersheds, as well as provide a balance between sustainable groundwater and surface water use and development to serve present users and future generations. Several objectives are; to promote sustainable watersheds; protect and enhance water quality and quantity; protect native Hawaiian rights, traditional and customary practices; facilitate public participation, education, and project implementation; and to meet the water demands at reasonable costs. Overton also read a section of the plan's executive summary.

Questions, comments and concerns followed:

- Chair Letts noted that she appreciated the efforts of everyone involved, and read several unresolved issues, provided on a handout. Several issues involved implementation, aquifer protection, demand driven by development, sustainable yields, legal disclaimers, intermittent streams, and reasonable costs. She noted that these unresolved issues came from the planning committee and that BWS had agreed to include them in the document and continue to work with the community on the issues. Letts again thanked Barry and the consultant for their willingness to work with the community and incorporate their issues.
- Mattoon praised the plan, and asked what the next step was, if the Board endorses the plan. Usagawa noted that the plan would be presented to BWS, then the City's Department of Planning and Permitting, then go before the City Council where public hearings will be held. The plan then needs to be adopted by ordinance, then go before the Water Commission where public hearings are also held.
- Elkington questioned how many aha'pua'a were there in the area. Overton replied that there were 31-33. The longest water flows are located in Kahana, and Kaluanui.
- A constituent noted that it is good that the plan has grown, but questioned what will be done to ensure its implementation, and what if developers from town want to use the water. Overton explained that the water will be used to serve Windward residents. The plan itself will set the stage for water management.
- Elkington questioned if Lai`e was supported by its own water system, Usagawa replied yes, and the wells are not owned by the City. Chair Letts added that the plan included all well yields whether the wells were private or public.
- Mattoon noted that he enjoyed many "spirited" meetings. **Mattoon moved with Kahana seconding that the Ko`olauloa Neighborhood Board support the pre-final draft. Letts requested a friendly amendment that would require the Board to re-vote if any major changes in the plan occur. Mattoon accepted the friendly amendment, Kahana seconded. The motion carried unanimously by an 8-0-0 vote.**
- Primacio questioned the Kahuku water pumps. If it's electrically pumped, if there's no electricity, there's no water. Overton noted that this is also addressed in the draft. Primacio added that the last hurricane that hit the Windward side left Kahuku with no water for 23 days. Usagawa mentioned a generator could be used to pump the water.

KAHUKU HOSPITAL UPDATE: A Kahuku Hospital representative reported the following:

- The bankruptcy has taken longer than anticipated. As of July 1, 2007 HHSC will manage the hospital under a contract. A new Certificate of Need has already been submitted. The hospital will become a new entity called Kahuku Medical Center. Workers at the Medical Center will do their best to serve patients.
- Kahuku Medical Center has been aided by the Rural Health Administration, where a long range plan is being developed. Data has been requested to acquire additional equipment for the emergency room. A new Director of Nurses has been hired from Texas. The CEO of Kahuku Medical Center and HHSC are visiting all tenants on Kahuku Hospital property to see what they're providing.

Questions, comments and concerns followed:

- Primacio questioned if the land was owned by Continental Pacific. She replied that to her knowledge only a small parcel is not owned by the State, the flood zone.
- Elkington questioned if the State now owns the land. She was pretty sure, but noted that she would like to be kept on the agenda for more updates.

TRASH COLLECTION IN KAHUKU: Chair Letts read a written response from the Director of Environmental Services, Mr. Eric Takamura, stating that no door to door pick up will be done while the roads are dusty.

- Leonardi noted that he had met with several department representatives, but nothing was resolved. If the street is too dusty, no door to door service will be done. It would cost the association $8,000 to purchase trash bins, citizens were unhappy. Since 1970 trash has been collected door to door, and now they have stopped. Leonardi also noted that he is planning to meet with the Mayor.

Questions, comments and concerns followed:

- Heath questioned if the Union has been spoken to. Takamura replied that he had met with Union representatives in May and June. It was said that there is so much dust that workers are always covered in a layer of dust. Spraying oil on the road is not allowed due to federal environmental laws. Takamura noted that the decision to stop pick up completely was not handled well. Takamura has not been in contact with Miyamoto, but will be in contact from now.
- Primacio noted that the roads had been oiled down approximately three months ago. Takamura noted that that should have not been done.
- Chair Letts mentioned that the roads are too narrow for trucks to turn around for automated pickup. It was requested that Takamura stay in contact with Leonardi, and look into reimbursement to the community at the least for the $8,000 they have had to spend.
- A constituent voiced that no matter how many times residents water the dirt roads at any time of day, the roads will dry up before the trash pick up even occurs.

NEW BUSINESS:

KO'OLAULOA COMMUNITY HEALTH AND AWARNESS CENTER PRESENTATION (KCHWC): Chuck Braden of KCHWC shared a short DVD explaining what services including; family health care, physical exams, health screening, minor surgery, immunizations, and more.

Questions, comments and concerns followed:

Mattoon applauded KCHWC workers and noted that the center is a big part of the community.

BOARD VIDEOTAPING AND OLELO BROADCASTING: Primacio noted that no videographer was found so the issue of whether or not the board wanted to be taped by lelo is moot.

PUBLIC IMPUT:

- A constituent questioned a rumor that residents of the Senior Housing Project in Kahuku would be moved, to build condominiums. Information indicated that the rents were being raised from $870 to $990, and that section 8 would no longer be accepted. Plans are to build on top of the existing units. The land is owned by the City as Mikulanec will look for information.
- Primacio noted that he sits on the Housing Board and would like this item to be put on next months agenda. Chair Letts agreed.

CORRESPONDANCE: Chair Letts noted that the letter from Eric Takamura was received and read earlier.

COMMITTEE REPORTS:

CIP/PUBLIC WORKS- JUNIOR PRIMACIO: No report at that time.

CULTURAL AFFAIRS: No report at that time.

EDUCATION- JIMMY LEONARDI: Leonardi noted that Lea Albert reported earlier in the meeting.

HEALTH/ HUMAN SERVICES- KELIKA ISHOL: A community vision meeting is scheduled for August 25, 2007; this is the first of five meetings, which will meet every Saturday from 8:00 a.m. to 12 noon, to discuss Kahuku Hospital and the community vision for the Hospital, which will be sent to HHSC. If anyone knows of a child in need of healthcare please call 211 for information.

HOUSING- KATHRYN HEATH: Heath encouraged all home owners to apply for the one time tax exemption, the handout was located in the back of the room.

PARKS & RECREATION- NORMAN KALUHIOKALANI: No report at that time. Primacio noted that Kahuku Community association would like to get Kaluhioklani to spearhead the completion of Kahuku District Park. Chair Letts will follow up with Kaluhiokalani.

PLANNING & LAND USE- CREIGHTON MATTOON: Mattoon reminded everyone to attend the first of three community meetings in regards to the Sustainable Community Plan, on August 30, 2007 at Laie Elementary.

PUBLIC INFORMATION- LES STEWARD: No report at that time.

PUBLIC SAFETY/TRANSPORTATION- JOHN ELKINGTON: Elkington announced that there will be a meeting with State and Red Cross representatives, to discuss shelter exercises on September 26th. Primacio questioned Kamehameha Highway in Hau`ula, and how bumpy it is. The road is a State road and that this matter can be brought before the State DOT.

WATER- BABARA KAHANA: Kahana thanked board members that have been handling the drafting of the Sustainable Watershed Plan.

COMMUNITY REPORTS:

Lai'e- Elkington announced that a new BYU President has been chosen, he is a graduate of Stanford University.

Hau'ula- Ishol announced the Community Association meeting is scheduled for the 1st Tuesday of every month at 7:00 p.m. There is also a website being put together, a community swap meet is also being organized.

Ka'a'awa- Chair Letts announced that a T-Shirt design contest is ongoing with the schools, several fundraiser events are being planned jointly between the community association and the school. The restrooms at the park are still not open. The stream banks that were washed away are also being addressed.

ANNOUNCEMENTS: Chair Letts announced that there will be Sunshine Law Training, scheduled for August 14, 2007 at Mission Memorial Hall at 5:45 p.m.

ADJOURNMENT: At the completion of the agenda, Chair Letts called the meeting adjourned at 9:10 p.m.

Submitted by:

Leland S.M. Ribac
Neighborhood Assistant