‘EWA WATERSHED MANAGEMENT PLAN

PUBLIC REVIEW DRAFT

Prepared for:
Honolulu Board of Water Supply

Prepared by:
Townscape, Inc.

May 2017

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TABLE OF CONTENTS

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Table of Contents

Table of Contents (continued)

Appendices

Figures

Figures (continued)

Tables

Tables (continued)

Tables (continued)

Acronyms

AAB	Army Air Force Base
ADC	Agribusiness Development Corporation
ALISH	Agricultural Lands of Importance to the State of Hawai‘i
ASA	Aquifer Sector Area
ASR	Aquifer Storage and Recharge
ASYA	Aquifer System Area
AWUDP	Agricultural Water Use and Development Plan
BAT	Best Available Technology
BMP	Best Management Practice
BPNAS	Barbers Point Naval Air Station
BWS	(Honolulu) Board of Water Supply
CDD	Community Development District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFS	Cubic Feet per Second
CWA	Clean Water Act
CWB	Clean Water Branch (State of Hawai‘i DOH)
CWRM	Commission on Water Resource Management (State of Hawai‘i)
CY	Calendar Year
CZM	Coastal Zone Management
DAR	Division of Aquatic Resources (State DLNR)
DBCP	Dibromochloropropane
DBEDT	Department of Business, Economic Development and Tourism (State of Hawai‘i)
DDC	Department of Design and Construction (City & County of Honolulu)

Acronyms (continued)

DEM	Department of Emergency Management (City & County of Honolulu)
DFM	Department of Facility Maintenance (City & County of Honolulu)
DHHL	Department of Hawaiian Home Lands (State of Hawai‘i)
DLNR	Department of Land and Natural Resources (State of Hawai‘i)
DNL	Day-night average Noise Level
DOE	Department of Education (State of Hawai‘i)
DOFAW	Division of Forestry and Wildlife (State DLNR)
DOH	Department of Health (State of Hawai‘i)
DOT	Department of Transportation (State of Hawai‘i)
DP	Development Plan
DPP	Department of Planning and Permitting (City & County of Honolulu)
ED	Executive Director
ENV	Department of Environmental Services (City & County of Honolulu)
EPA	(U.S.) Environmental Protection Service
ESQD	Explosive Safety Quantity Distance
EWMP	‘Ewa Watershed Management Plan
FBI	Federal Bureau of Investigations
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAC	Granular Activated Carbon
GIS	Geographic Information Systems
GP	General Plan
GPCD	Gallons Per Capita Day

Acronyms (continued)

GPD	Gallons Per Day
HARC	Hawai‘i Agricultural Research Center
HART	Honolulu Authority for Rapid Transit
HCDA	Hawai‘i Community Development Authority
HECO	Hawaiian Electric Company
HISWAP	Hawai‘i Source Water Assessment Program
HNHP	Hawai‘i Natural Heritage Program
HRS	Hawai‘i Revised Statutes
HWP	Hawai‘i Water Plan
IAL	Important Agricultural Lands
IIFS	Interim Instream Flow Standard
IFS	Instream Flow Standard
IRP	Integrated Resource Planning
JBPHH	Joint Base Pearl Harbor-Hickam
KHP	Kalaeloa Heritage Park
LCC	Leeward Community College
LOS	Level of Service
LUO	Land Use Ordinance
MAV	Moving Average
MCAS	Marie Corps Air Station
MGD	Millions of Gallons per Day
MBR	Membrane Bioreactor
MCL	Maximum Contaminant Level

Acronyms (continued)

Mg/L	Milligrams per Liter
MLC	Mālama Learning Center
MSL	Mean Sea Level
MW	Megawatt
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Services
NSF	National Science Foundation
NTHP	National Trust for Historic Preservation
NWR	National Wildlife Refuge
O&M	Operations and Maintenance
OCCL	Office of Conservation and Coastal Lands (State of Hawai‘i DLNR)
OEQC	Office of Environmental Quality Control (State of Hawai‘i DOH)
OHA	Office of Hawaiian Affairs (State of Hawai‘i)
OP	Office of Planning (State DBEDT)
OSCo	O‘ahu Sugar Company
OTEC	Ocean Thermal Energy Conversion
OWMP	O‘ahu Water Management Plan
PCA	Potentially Contaminating Activity
PCB	Polychlorinated Biphenyls
PHNC	Pearl Harbor Naval Complex
PPM	Parts Per Million
PU	Permitted Use
PUC	Primary Urban Center

Acronyms (continued)

RCRA	Resource Conservation and Recovery Act
ROH	Revised Ordinances of Honolulu
SCP	Sustainable Communities Plan
SDWA	Safe Drinking Water Act
SHPD	State Historic Preservation Division (State of Hawai‘i DLNR)
SLUD	State Land Use District
SRF	State Revolving Fund
SSA	Sole Source Aquifer
SWAP	Source Water Assessment Program
SWPP	State Water Projects Plan
SY	Sustainable Yield
TAZ	Traffic Area Zone
TCP	1, 2, 3 Trichloropropane
TMK	Tax Map Key
TOD	Transit-Oriented Development
TNP	The Nature Conservancy
UH	University of Hawai‘i
UHWO	University of Hawai‘i at West O‘ahu
UIC	Underground Injection Control
UPC	Uniform Plumbing Code
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

Acronyms (continued)

WDIS	Waiāhole Ditch Irrigation System
WMP	Watershed Management Plan
WPOD	Wellhead Protection Overlay District
WQP	Water Quality Plan
WRF	Water Recycling Facility
WRPP	Water Resource Protection Plan
WUDP	Water Use and Development Plan
WUP	Water Use Permit
WWTP	Wastewater Treatment Plant

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EXECUTIVE SUMMARY

‘EWA WATERSHED MANAGEMENT PLAN

ES Executive Summary

ES.1 Purpose of the ‘Ewa Watershed Management Plan

The ‘EWA WATERSHED MANAGEMENT PLAN (EWMP) is a long-range plan to the year 2035 for the preservation, restoration, and balanced management of ground water, surface water, and related watershed resources in the ‘Ewa District, island of O‘ahu. The City and County of Honolulu Department of Planning and Permitting (DPP) and the Honolulu Board of Water Supply (BWS) have jointly prepared the EWMP, in accordance with the State Water Code, the Statewide Framework for Updating the Hawai‘i Water Plan, and the City’s Ordinance 90-62 that established the O‘ahu Water Management Plan. The EWMP is one of eight district-specific plans that together will form the updated O‘ahu Water Management Plan.

The PUBLIC REVIEW DRAFT of the EWMP is posted on the BWS website at www.hbws.org. After the public review period, support for the EWMP will requested from Neighborhood Board #23 (‘Ewa) and #34 (Makakilo/Kapolei). DPP and BWS will then finalize the EWMP and submit it for approval by the Honolulu City Council and for adoption by the State Commission on Water Resource Management (CWRM) .

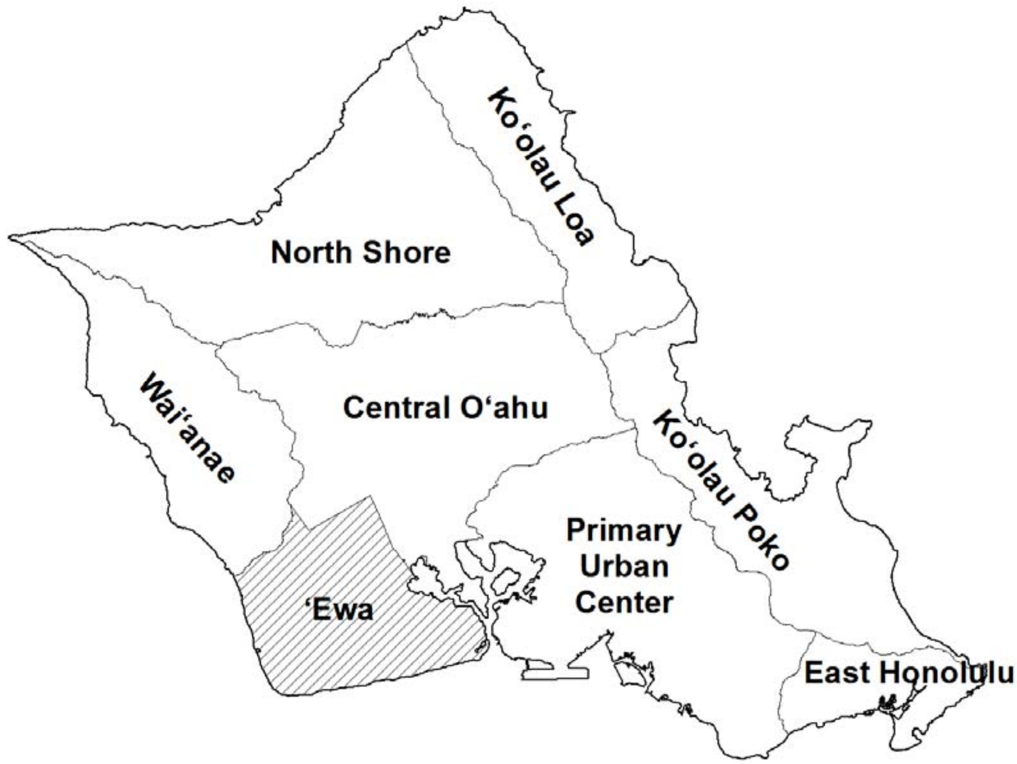


Figure ES-1 The Eight Districts of the O‘ahu Water Management Plan

This EXECUTIVE SUMMARY provides a brief synopsis of the planning process, major findings, and recommendations of the KPWMP.

The plan is presented in five chapters and a number of appendices:

Chapter 1	O‘ahu Water Management Plan Overview
Chapter 2	‘Ewa Watershed Profile
Chapter 3	Water Use and Projected Demand
Chapter 4	Plan Objectives, Water Supply and Watershed Management Projects and Strategies
Chapter 5	Implementation

ES.2 The ‘Ewa WMP and the ‘Ewa Development Plan

The State Water Code requires that the County water use and development plans be consistent with County land use plans and policies. Thus, throughout the planning process for the EWMP, BWS and DPP have been mindful of the policies and guidelines of the ‘Ewa Development Plan (‘Ewa DP), most recently updated in 2013.

The ‘Ewa DP envisions the district as a secondary growth area to urban Honolulu, with a “second city” in Kapolei, job centers in resort areas, industrial areas, and the University of Hawai‘i at West O‘ahu. Additionally, several master planned residential communities are expected to relieve housing pressures, while agriculture is preserved along Kunia Road and in the Navy’s Explosive Safety Quantity Distance arc at its Pearl Harbor West Loch Naval Munitions Command. This overarching vision for the district was used as the overall policy guide for the ‘Ewa WMP when projecting future water demands.

ES.3 The Planning Process

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

- Community-based
- Environmentally holistic
- Reflective of ahupua‘a management principles
- Action-oriented
- In alignment with State and City water and land use policies

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

1. **Technical research work:** including data collection and analysis, review of relevant plans and programs, creation of maps, charts and graphs, and statistical projections of future demands for potable and non-potable water;

2. **Stakeholder outreach and consultation**: individual interviews and small group meetings with community leaders, community groups and organizations, land owners, developers, public agencies, and elected officials; and general community meetings to provide a forum for the discussion of watershed issues and needed actions.

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

ES.4 Goals and Objectives of the ‘Ewa WMP

BWS and DPP established an overall GOAL and five supporting OBJECTIVES for all of the watershed management plans:

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

The five major OBJECTIVES which are common to all of the watershed management plans for O‘ahu are:

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 AND EDUCATION, AND PROJECT IMPLEMENTATION**

OBJECTIVE #5: **MEET FUTURE WATER DEMANDS AT REASONABLE COST**

Each of the Watershed Management Plans developed district-specific SUB-OBJECTIVES under each of the major OBJECTIVES. These Sub-Objectives were articulated based on the issues and values that emerged for the district from both the technical research work and the stakeholder consultation process. Water Supply and Watershed Management Projects and Strategies that would respond to and implement these Sub-Objectives were then researched and documented.

ES.5 Summary Profile of the District

‘Ewa is one of the eight planning districts of O‘ahu. This district is located on the southwestern portion of the island, and stretches from Wai‘anae to Waipahu, encompassing approximately 33,677 acres. In 2010, ‘Ewa’s resident population was 101,397 people, approximately 11% of O‘ahu’s population. Between 1980 and 2010, ‘Ewa’s population grew by 184% and is expected to continue to grow, as it is designated as the island’s growth center, along with urban Honolulu.

The urban center of ‘Ewa is Kapolei, designated as Honolulu’s “second city.” Residential neighborhoods include ‘Ewa Beach, ‘Ewa Gentry, ‘Ewa Villages, Honokai Hale, Kapolei, Makakilo, Ocean Pointe, and West Loch Estates, with residential master plans either developed or in the process of being implemented for much of the remaining areas within the district’s community growth boundary. Major job centers focus around business activities at Kapolei, resort development at Ko Olina, industrial activities at Campbell Industrial Park and Ko Olina Harbor, and education at the University of Hawai‘i at West O‘ahu.

Honouliuli is the only perennial stream in the district, although there are several gulches that while typically dry, carry high volumes of storm water during heavy rains. Peak stream flow for Honouliuli Stream was 35 cubic feet per second (October 2012-September 2013). Honouliuli Stream feeds into the West Loch of Pearl Harbor.

Low-lying areas of the ‘Ewa plain are subject to flooding during intense rainstorms. Detention basins have been built into several golf courses to alleviate flooding and gulches are protected to provide drainage and flood conveyance.

Three of the four Aquifer System Areas (ASYA) that comprise the Pearl Harbor Aquifer Sector Area are wholly or partially within the ‘Ewa district: Makaīwa, ‘Ewa-Kunia, and Waipahu-Waiawa. Much of ‘Ewa’s potable water comes from the ‘Ewa-Kunia ASYA, where 97% of its 16 million gallons per day (MGD) sustainable yield is allocated to ground water permits. Most of the Waipahu-Waiawa ASYA is located outside of the ‘Ewa District, but about 39 MGD of its 120 MGD sustainable yield is allocated to ground water sources in ‘Ewa. Additionally, there are three ASYAs in the ‘Ewa Caprock Aquifer Sector Area: Malakole, Kapolei, and Pu‘uloa. These aquifers provide brackish water for non-potable water uses.

ES.6 Water Use and Projected Demand

In the base year of 2010, most (approximately 45%) of ‘Ewa’s water demand was for domestic needs, including residential and non-residential (commercial, institutional, and other) uses. Industrial and agricultural uses each accounted for about 17% of water demands and golf course and other landscape irrigation accounted for 21% of demand.

Table ES-1 ‘Ewa Water Demand by CWRM Category (2010)

	Water Demand	
Water Demand Category	MGD	%
Domestic Residential	12.5	30%
Domestic Non-Residential	6.5	15%
Industrial [1, 2]	7.3	17%
Agriculture	7.0	17%
Irrigation[2]	8.6	21%
TOTAL	41.9	100%

1 Industrial water demands do not include demands supplied by salt water.

2 Industrial and irrigation demands include demands supplied by recycled and fresh and brackish ground water. Brackish water has chloride content ranging from just above drinking water limits to that nearly of seawater.

‘Ewa uses a combination of ground and recycled water sources to meet its water demands. In 2010, most of ‘Ewa’s water demand was met by in-district ground water sources, serving both potable and non-potable needs. Additionally, about 18% of water demand was supplied by ground water imported from Central O‘ahu. The Honolulu Board of Water Supply (BWS) provides for the majority of potable water needs, but the U.S. military provides additional potable water for their facilities at Kalaeloa and at Kapilina Beach Homes at Iroquois Point. Waiāhole Ditch provided 9% of the total water demand, serving agricultural water needs mauka of the H-1 Freeway. The Honouliuli Water Recycling Facility (WRF) provided approximately 20% of the total water demand, serving irrigation and industrial water needs.

Table ES-2 ‘Ewa Water Demand by Source (2010)

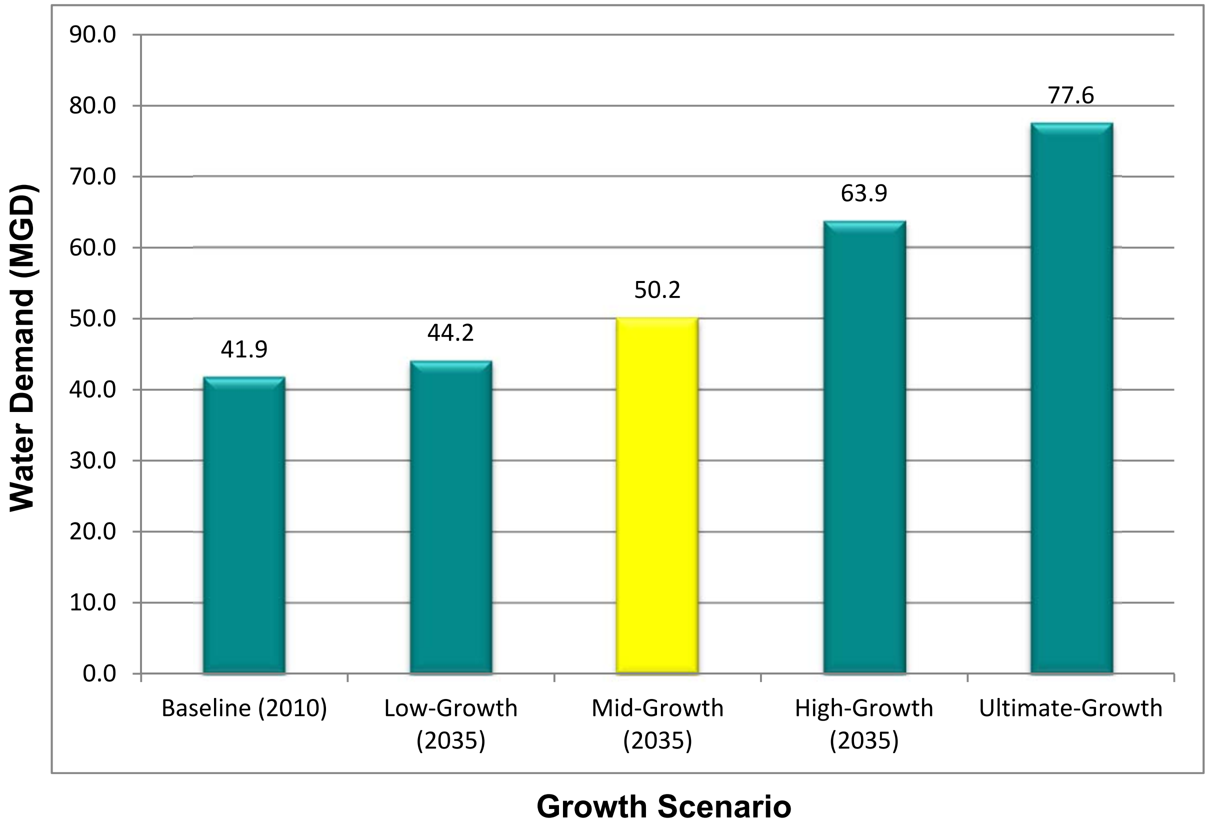
Water Source	Estimated Demand MGD	Estimated Demand %
Ground Water (Basal Aquifer)*	15.4	37%
Ground Water (Caprock Aquifer)	6.7	16%
Ground Water (BWS Import from Central O‘ahu)**	7.2	17%
Ground Water (U.S. Navy Import from Central O‘ahu)	0.6	1%
Waiāhole Ditch	3.6	9%
Surface Water	0.0	0%
Recycled Water (R-1)	7.0	17%
Recycled Water (R-O)	1.4	3%
TOTAL	41.9	100%

* BWS water demand is an average of demand over the five years from 2008 to 2012.
** Does not include 5.1 MGD that passes from Central O‘ahu through ‘Ewa to Wai‘anae.

Future water demands were projected in low-, mid-, and high-growth scenarios through the year 2035. The mid-growth scenario was selected as the most probable demand scenario, as it was based on the City’s socio-economic projections that reflect the growth policies in the ‘Ewa DP. The City’s population projections show ‘Ewa’s resident population increasing by 71% between 2010 and 2035.

An additional “Ultimate-Growth Scenario” was created to evaluate some point in the future where water demands approach the limits of natural water resources. In this scenario, urban development is “maxed out” and all residential units currently planned for development have been built. Additionally, climate change has decreased rainfall by 15% and raised temperatures and evaporation rates, increasing irrigation water needs for agriculture and landscaping. No time frame was associated with this scenario and it is not tied to City population projections.

Figure ES-2 ‘Ewa Water Demand by Growth Scenario



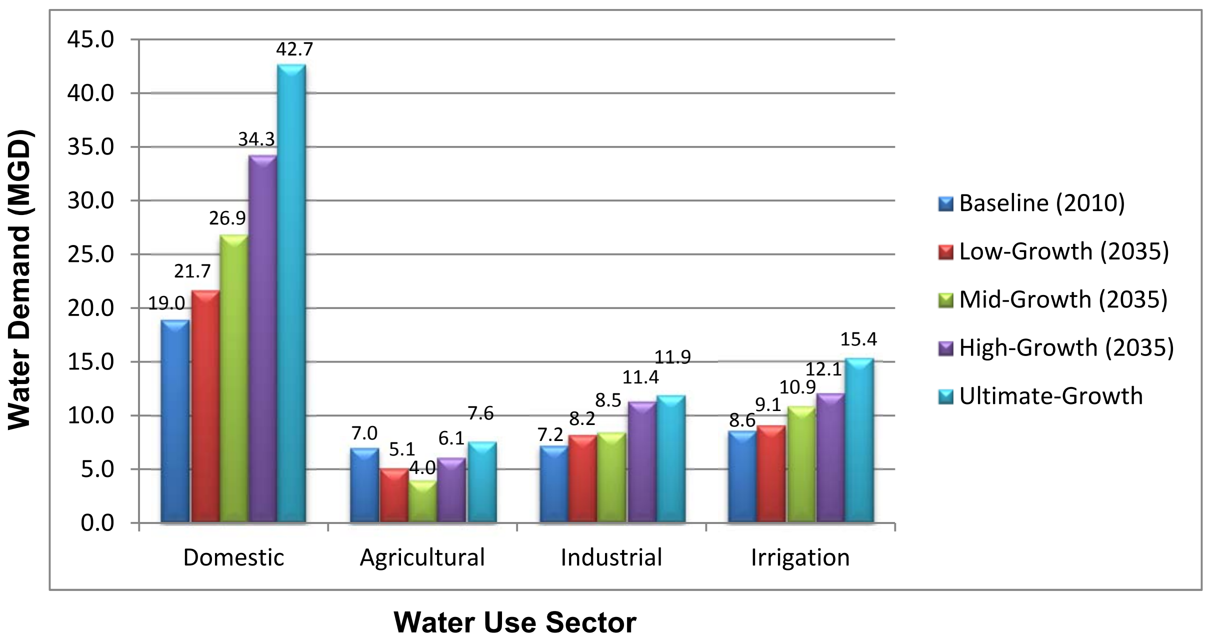
The most probable growth scenario (Mid-Growth) projects total water demand to increase by 8.3 MGD by 2035, a 20% increase over the baseline year of 2010. The “Ultimate-Growth” scenario projects water demand to increase by 35.8 MGD, or 86% over 2010 water demands.

Most of the increase in the Mid-Growth scenario occurs in the domestic water demand, which increases by 42%. More modest increases in industrial (17%) and golf course and other landscape irrigation (26%) water demands are expected. Agricultural water demand actually decreases in this scenario because urban land uses are projected to displace much of the existing agriculture within the community growth boundary.

Table ES-3 ‘Ewa Projected Water Demand by Water Use Sector

WATER USE SECTOR	2010 (MGD)	2035 (MGD) LOW-GROWTH	MID-GROWTH	HIGH-GROWTH	ULTIMATE-GROWTH
Domestic	19.0	21.7	26.9	34.3	42.7
Residential	12.5	14.8	18.5	23.4	29.0
Non-Residential	6.5	7.9	9.4	11.9	14.8
Agricultural	7.0	5.1	4.0	6.1	7.6
Industrial	7.2	8.2	8.5	11.4	11.9
Irrigation	8.6	9.1	10.9	12.1	15.4
Golf Course	7.5	7.5	7.5	8.3	9.5
Landscape	1.2	1.7	3.4	3.8	5.9
TOTAL	**41.9**	**44.2**	**50.2**	**63.9**	**77.6**
% increase 2010-2035		5%	20%	53%	85%

Figure ES-3 ‘Ewa Projected Water Demand by Water Use Sector



ES.7 Summary of Demand and Supply

Analysis of the ‘Ewa district and water demands and supplies identified the following:

- ‘Ewa has a limited supply of ground water available for potable uses
- ‘Ewa’s population is expected to increase as the City’s secondary growth area
- ‘Ewa has alternative water sources available to supplement traditional water sources

The EWMP thus provides an overall water resources management plan for the ‘Ewa District that emphasizes four important water principles and seven water policies:

WATER PRINCIPLES

1. Implement WATER CONSERVATION PROGRAMS at all levels of use: domestic, industrial, agricultural, and irrigation;
2. Continue to expand the production and use of RECYCLED WATER for industrial, irrigation, and agricultural uses;
3. USE POTABLE GROUND WATER WITH GREAT CARE - primarily for domestic water uses; and
4. SUPPLEMENT GROUND WATER WITH DESALINATED WATER to minimize the need for water transfers from Central O‘ahu, keeping ‘Ewa as self-sufficient as possible.

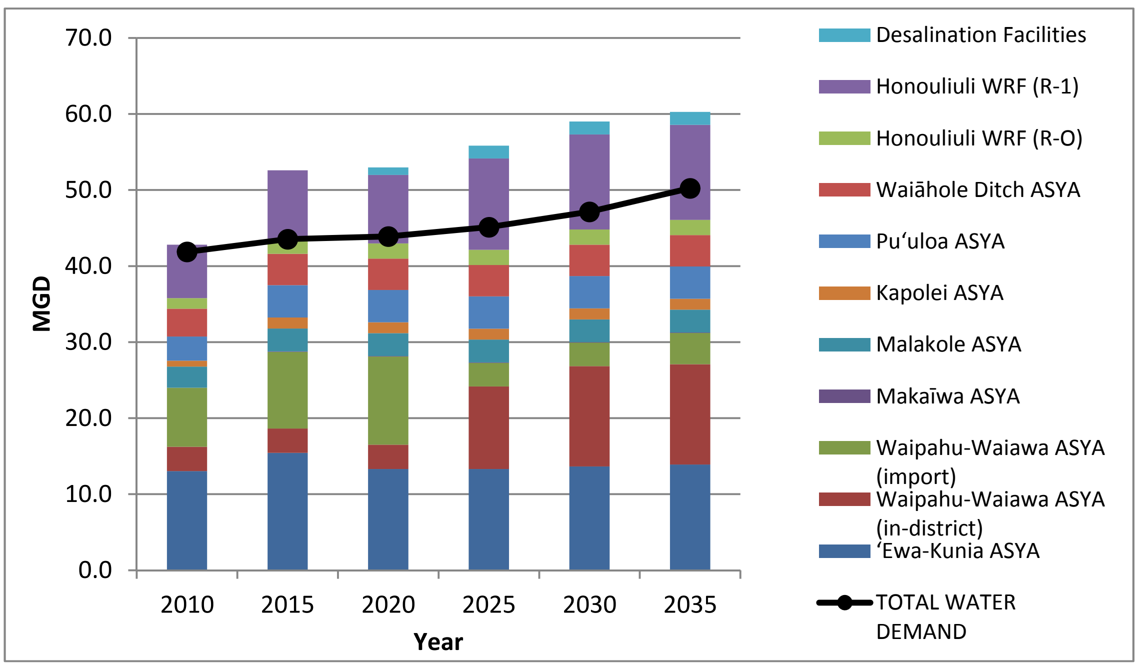
WATER POLICIES

‘Ewa Water Policy #1:	Continue to reduce ‘Ewa’s per capita water demand, to the amount feasible, by implementing water conservation programs at all levels of use: domestic, industrial, agricultural, and irrigation.
‘Ewa Water Policy #2:	Reserve potable water sources for potable needs.
‘Ewa Water Policy #3:	Incrementally convert non-potable uses that are currently using potable water to non-potable sources.
‘Ewa Water Policy #4:	Maximize the use of recycled water.
‘Ewa Water Policy #5:	Minimize the need for increased import of potable water from Central O‘ahu ground water aquifers.
‘Ewa Water Policy #6:	Replenish the ‘Ewa caprock aquifer and use this source for non-potable uses.
‘Ewa Water Policy #7:	Continue efforts to provide economically-competitive desalinated water.

A combination of water supply options may be used to adequately meet the projected 50.2 MGD of water demand projected for the year 2035 in the most probable demand scenario. Domestic water demand will mostly be met with increases in in-district ground water, desalination, and conversion of non-potable water demands to R-1 recycled water, allowing for reductions in the amount of water imported from Central O‘ahu. A currently planned desalination facility will help to reduce water imports from Central O‘ahu and to ensure that a reliable, drought-proof water source is available.

Agricultural, golf course, and landscape irrigation water demands will be met by existing ground water permitted use and increases in R-1 recycled water, requiring the Honouliuli Water Recycling Facility to increase its R-1 capacity from 10 MGD to at least 12.5 MGD. Industrial water demands are expected to be met by existing ground water permitted use and recycled water from the Honouliuli WRF.

Figure ES-4 ‘Ewa Most Probable Water Demand Scenario and Supply Options



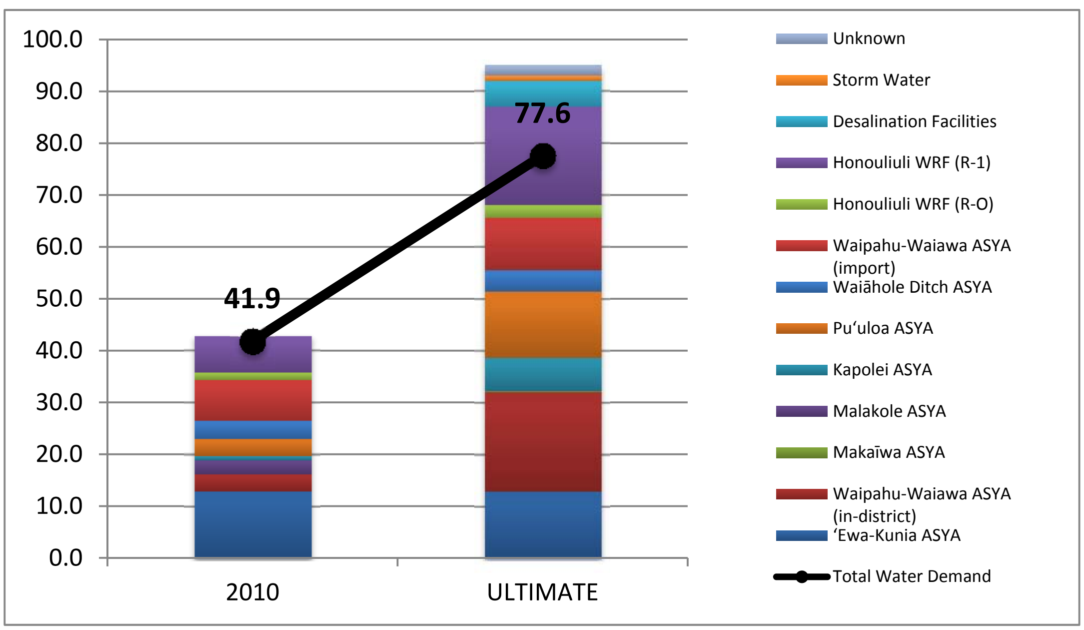
ES.8 Ultimate Demand Scenario and Supply

The Ultimate Growth Scenario projects that ‘Ewa will need 77.6 MGD of water sometime in the future when current land use plans have been developed, agriculture is maximized in the lands outside of the community growth boundary, and climate change requires a 15% increase in irrigation water demand due to reduced rainfall.

In a moderate application of ‘Ewa’s water principles, domestic water demand would need to be met with both an increase in-district ground water permitted use and an increase in ground water imports from Central O‘ahu. Desalination capacities would also need to be increased to 5 MGD and Kalaeloa Water System water demand would require an additional source, which is as yet undetermined, due to the limited available yield in the ‘Ewa-Kunia ASYA.

The modest increase in agricultural water demand is expected to be met with the existing Waiāhole Ditch and ground water sources, as well as additional R-1 recycled water. Storm water from Central O‘ahu could also supplement agricultural water supplies. Industrial water demands would be met with a combination of ground water and both R-O and R-1 recycled water. The expected large increases in irrigation water demand would be met with brackish ground water and R-1 recycled water.

Figure ES-5 ‘Ewa Ultimate-Growth Scenario Water Demand Scenario and Supply Options (Moderate Application on Water Principles)



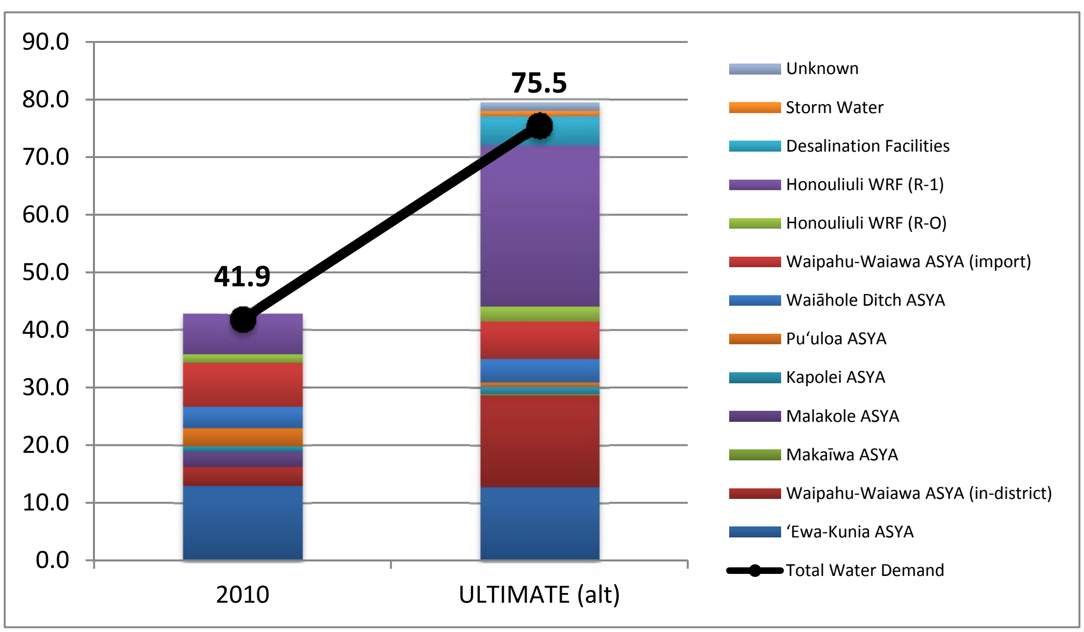
Thus it was concluded that water demands in the Ultimate-Growth Scenario can be met using a moderate approach to ‘Ewa water principles and policies, but will require a diversification of resources from primarily ground water to a greater reliance on recycled water and some new sources, such as desalinated water and possibly storm water. This, and increases in permitted use from in-district ground water sources, can moderate the demand for water to be imported from Central O‘ahu and eliminate the need for new sources to be developed, with the exception of the Kalaeloa Water System, which would still need to find a new source

AGGRESSIVE APPROACH TO ‘EWA WATER POLICIES

A more aggressive application of ‘Ewa’s water policies would increase the emphasis on water conservation programs, recycled water use, and dedicating ground water for potable domestic needs. Existing agricultural, golf course, and landscape irrigation water demands, currently supplied by the BWS potable water system, are converted to R-1 recycled water. This conversion would decrease the BWS ‘Ewa District per capita water demand, decreasing the total domestic water demand from the Ultimate-Growth scenario that was less aggressive in applying ‘Ewa’s water principles.

Use of recycled water is maximized to supply most agricultural, golf course, and landscape irrigation water demands, as well as non-potable industrial water demand that can use R-1 or R-O quality water. This frees up permitted use in ‘Ewa ground water aquifers, decreases the amount of water that would need to be imported from Central O‘ahu, and limits the need for additional desalinated water. This emphasis on recycled water would require expansion of the Honouliuli Water Recycling Facility for both R-O and R-1 water.

Figure ES-6 ‘Ewa Ultimate-Growth Scenario Water Demand Scenario and Supply Options (Aggressive Application on Water Principles)



ES.9 Projects and Strategies

The ‘Ewa WMP provides information on specific Water Supply and Watershed Management "**Projects with Champions**," and more general information on "**Watershed Management Strategies**." The Strategies are defined as important concepts that do not yet have champion entities that would organize and implement these concepts.

The Projects with Champions **are specific projects that are being planned and/or that are being implemented by a particular public agency or agencies or by a particular community group or non-profit entity**. There are several place-specific watershed management projects that are already ongoing in ‘Ewa, and the ‘Ewa WMP focuses on these real projects.

The ‘Ewa WMP presents information on the following 15 **WATERSHED MANAGEMENT PROJECTS WITH CHAMPIONS:**

1. Honouliuli Water Recycling Facility
2. Caprock Aquifer Storage and Recharge (ASR)
3. Brackish and Seawater Desalination
4. Waiāhole Ditch Water Loss Minimization
5. Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway
6. Water Infrastructure for Navy ESQD Zone
7. Kalaeloa Water System Improvements
8. Kalaeloa Heritage Park
9. Hoakalei Coastal Village Restoration
10. Mālama Learning Center
11. Anchialine Pool Restoration
12. Wai‘anae Mountains Watershed Partnership
13. Potable Source Water Protection (BWS "System-Wide" Project)
14. Assess Resiliency of Critical Water Infrastructure (BWS "System-Wide" Project)
15. BWS Infrastructure Renewal and Replacement Program (BWS "System-Wide" Project)

The ‘Ewa WMP also presents some basic information on 12 Watershed Management STRATEGIES. Strategies are defined here as potential actions that would serve to implement the overall goal, objectives, and sub-objectives of the ‘Ewa WMP, but that do not currently have a project champion. Many of these strategies could become “Projects” if/when an agency or organization decides to be the champion for that strategy.

DISTRICT-WIDE STRATEGIES

A Waiāhole Ditch Augmentation

B Brackish Well Development

C Industrial Cooling Using Seawater

D Grey Water Reuse

E Kalo‘i Gulch Regional Drainage Plan Evaluation

F Stormwater Retention/Detention – including golf course detention

G Renewable Energy Opportunities

H ‘Ewa Caprock District Cooling

I Convert Cesspools to Municipal Sewer System

J Integrate Planning for Land Use and Water Resources Management

K ‘Ewa Sustainability Dialogues

L Potable Source Water Protection

ES.10 Implementation of the ‘Ewa WMP

Implementation of the ‘Ewa Watershed Management Plan will be a long-term, ongoing process involving many project champions from public agencies, non-profit entities, community groups, and private land owners and businesses. Chapter 5 of the ‘Ewa WMP presents the details of the plan implementation agenda.

The Implementation chapter also provides a presentation and discussion of an identified PRIORITY WATERSHED and CATALYST PROJECT. A priority watershed is defined as a watershed that: (1) provides various opportunities to promote sustainable watersheds, and/or (2) needs protection or enhancement of water quality and quantity, and/or (3) provides many opportunities to protect Native Hawaiian rights and traditional customary practices, and/or (4) presents special opportunities for organizing and implementing important watershed management actions, and/or (5) provides significant ground water or surface water supplies to meet current and future demand.

A “catalyst project” is defined as a high priority project within a priority watershed that, when implemented, will provide energy, connectivity, information, and inspiration for other projects and programs within the watershed. The priority watershed for the ‘Ewa WMP is Honouliuli, which is the only watershed in ‘Ewa that has a perennial stream. Honouliuli watershed contains forest, agricultural, and urban land uses, and is planned for additional development in the near future. Several ground water sources are also located in this watershed, including ‘Ewa Shaft, which is planned as a major BWS water source. Additionally, Honouliuli Stream discharges into the West Loch of Pearl Harbor, which has been identified as a water quality limited segment by the State Department of Health. Honouliuli’s catalyst project is the Interagency Ground Water and Surface Water Quality Improvement Project, which proposes a partnership between BWS, DOH, and land owners to implement water quality best management practices on an ongoing basis.

The ‘Ewa WMP identifies a large number of “Projects with Champions” and “Watershed Management Strategies” that are important for water use and watershed health. These projects and strategies require various levels of manpower and funding, and can only be implemented to the extent that resources are available from the private and public sectors of the community. The Implementation chapter concludes with some thoughts on the need for a dedicated funding source that could provide ongoing financial resources for the implementation of important water supply and watershed management projects.

The proposed strategies and projects within this plan are the result of a comprehensive watershed analysis and stakeholder consultation process, and may involve various governmental agencies and non-governmental organizations. The implementation and funding of these projects are not the sole responsibility of the Board of Water Supply, City and County of Honolulu, or State of Hawai‘i. This Plan is intended to guide agencies and organizations in implementing the most important initiatives for the ‘Ewa District and water resources; however, implementation will depend on budgetary priorities, the availability of grants, and partnering efforts over the long term.

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CHAPTER 1

O‘AHU WATER MANAGEMENT PLAN OVERVIEW

‘EWA WATERSHED MANAGEMENT PLAN

1 O'AHU WATER MANAGEMENT PLAN OVERVIEW

1.1 AUTHORITY AND PURPOSE

The Watershed Management Plans (WMPs) for O'ahu have been prepared in accordance with the requirements of the State Water Code and Revised Ordinances of the City and County of Honolulu. The State Water Code, Hawai'i Revised Statues (HRS) Chapter 174C 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 County is responsible for preparing the water use and development plan for the City and County of Honolulu. In response, Revised Ordinances of Honolulu (ROH) Chapter 30 Water Management, established the *O'ahu Water Management Plan* (OWMP), which has evolved into a framework of regional WMPs by City development plan district to plan for the management of all water resources within each watershed (*Appendices A and B*). The development plan districts are shown in *Figure 1-1*.

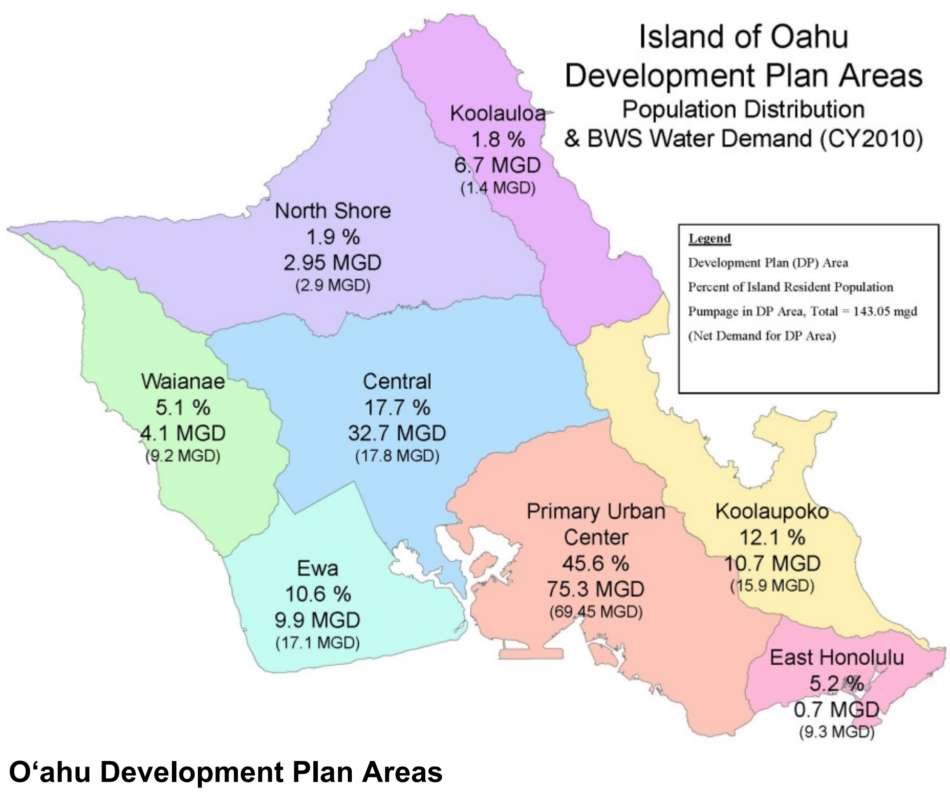


Figure 1-1 O'ahu Development Plan Areas

The State Water Code’s Declaration of Policy recognizes the need for comprehensive water resources planning and establishes the *Hawai‘i Water Plan* (HWP) as the guide for developing and implementing this policy (HRS §174C-2). The HWP is intended to serve as a continuing long-range guide for the Commission on Water Resource Management (CWRM) in executing its general powers, duties, and responsibilities assuring economic development, good municipal services, agricultural stability, and environmental protection.

The HWP currently consists of five major components (plans) identified as the: 1) Water Resource Protection Plan, 2) Water Quality Plan, 3) State Water Projects Plan, 4) Agricultural Water Use and Development Plan, and 5) County Water Use and Development Plans.

The Water Code recognizes that the HWP must be *“continually updated to remain useful and relevant and further specifies that each county shall update and modify its water use and development plans as necessary to maintain consistency with its zoning and land use policies”* HRS §174C-31(q).

WATER USE AND DEVELOPMENT PLAN (WUDP)

A separate WUDP is to be prepared by each of the four counties and adopted by ordinance. The objective of the WUDPs is to set forth the allocation of water to land use in that county. Hawai‘i Administrative Rule (HAR) §13-170-31 states that each WUDP shall include, but not be limited to:

(1) Status of county water and related land development including an inventory of existing water uses for domestic, municipal, and industrial users, agriculture, aquaculture, hydropower development, drainage, reuse, reclamation, recharge, and resulting problems and constraints;

(2) Future land uses and related water needs; and

(3) Regional plans for water developments including recommended and alternative plans, costs, adequacy of plans, and relationship to the water resource protection plan and water quality plan.

Additional guidelines for preparing the WUDPs are provided in Administrative Rule §13-170-32:

(4) Each water *use and development plan shall be consistent with the water resource protection plan and the water quality plan.*

(5) Each water use and development plan and the state water projects plan shall be consistent with the respective county land use plans and policies, including general plan and zoning as determined by each respective county.

(6) Each water use and development plan shall consider a twenty-year projection period for analysis purposes.

(7) The water use and development plan for each county shall also be consistent with the state land use classification and policies.

(8) The cost of maintaining the water use and development plan shall be borne by the counties; state water capital improvement funds appropriated to the counties shall be deemed to satisfy Article VIII, section 5 of the State Constitution.

STATEWIDE FRAMEWORK FOR UPDATING THE HAWAI‘I WATER PLAN

In February 2000, CWRM adopted the Statewide Framework for Updating the Hawai‘i Water Plan (Statewide Framework). The objectives of developing and outlining a statewide framework for the Hawai‘i Water Plan (HWP) are:

- To achieve integration of land use and water planning efforts that are undertaken by federal, state, county, and private entities so that a consistent and coordinated plan for the protection, conservation and management of our water resources is achieved;
- To recommend guidelines for the HWP update so that the plan and its component parts are useful to CWRM, other state agencies, the counties, and the general public;
- To develop a dynamic planning process that results in a “living document” for each component of the HWP which will provide county and state decision-makers with well formulated options and strategies for addressing future water resource management and development issues;
- To better define roles and responsibilities of all state and county agencies with respect to the development and updating of the HWP components;
- To describe and outline the techniques and methodologies of integrated resource planning as the basic approach that should be utilized in developing and updating the County WUDPs;
- To facilitate permitting and to identify potential critical resource areas where increased monitoring or baseline data gathering should proceed;
- To establish an overall schedule for phased updating of the HWP; and
- To outline an Implementation Plan for near-term and long-term actions.

The Statewide Framework includes the following recommended plan elements for the County WUDP update process:

- County-Specific WUDP Project Description
- Coordination with CWRM on Water Resource Management
- Stakeholder and Public Involvement
- Development of Policy Objectives and Evaluation Criteria
- Description of Water System Profiles
- Identification of Resource and Facility Options
- Development and Evaluation of Strategy Options
- Implementation Plan

The Statewide Framework further recommends integration of HWP components at the county level.

O‘AHU WATER MANAGEMENT PLAN: 1990 ADOPTION TO PRESENT

The initial HWP, including all component plans, was adopted by CWRM in 1990. In compliance with the State Water Code, the City and County of Honolulu enacted the O‘ahu Water Management Plan (OWMP) by Ordinance No. 90-62 and codified as Revised Ordinances of Honolulu (ROH) Chapter 30, Articles 1, 2 and 3, 1990, as amended. The OWMP serves as the WUDP for the City and County of Honolulu. The OWMP consists of policies and strategies, which guide the activities of the City and County of Honolulu and advises CWRM in the areas of planning, management, water development and use and allocation of O‘ahu’s natural water resources.

The 1990 OWMP described existing uses of water and contemplated future needs for the island of O‘ahu. The plan highlighted regional water problems and identified major water development projects. It also described the quality of water required for the contemplated uses. Informational needs and data gaps identified in the plan included surface water availability and use and agricultural water demand projections.

CWRM deferred adoption of the 1992 OWMP update pending additional refinement of plan components. Subsequent updates were complicated because of 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 1995.

In 1999, the Honolulu Board of Water Supply (BWS) began the integrated island-wide water planning effort to update the OWMP as recommended by CWRM. However, this approach was met with significant opposition by the public. One of the major concerns expressed by the public was that it is important to have equal focus on resource protection, conservation, and restoration as on water use and development. Communities also desired to be active participants in a community-based planning process. In addition, the communities consulted wanted assurance that there were sufficient water resources within their watersheds before island-wide regional water needs were discussed.

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 drew upon principles of the Public Trust Doctrine and the Precautionary Principle and have over time, identified four public trust uses of water that have priority over other water uses: 1) maintenance of waters in their natural state; 2) domestic water use; 3) the exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights and 4) reservations of water for Hawaiian Home Lands *(Appendix B.5)*. In response to these Supreme Court decisions, BWS decided to expand the water planning approach to include these principles through a holistic watershed-based approach modeled after the Hawaiian concept of ahupua'a encompassing environmental, economic and social/cultural values. A planning framework for watershed protection and water use and development was established for updating the OWMP that is inclusive of various legal and planning documents with extensive community participation that guide the plan. On March 17, 2004, CWRM approved the OWMP framework, scope of work and planning elements for regional watershed management plans as meeting the statutory and statewide framework provisions for updating the County WUDP.

The Ordinance further states that in conjunction with BWS, the City Department of Planning and Permitting (DPP) shall be responsible for the preparation of the regional watershed management plans for the OWMP. The regional WMPs shall be adopted by ordinance and then submitted to CWRM for adoption. Each regional WMP shall be updated, at a minimum, in tandem with the respective Development Plans/Sustainable Communities Plans. The Honolulu City Council adopted the Wai'anae and Ko'olau Loa WMPs on August 18, 2010, the Ko'olau Poko WMP on August 15, 2012, and the North Shore WMP on October 5, 2016. These regional watershed management plans will, together with island-wide water management policies and strategies in ROH Article 2 of Chapter 30, form the updated O'ahu Water Management Plan. In areas where a regional watershed plan has not been adopted, ROH Chapter 30, and the Technical Reference Document for the OWMP, dated March 1990, shall serve as the County WUDP.

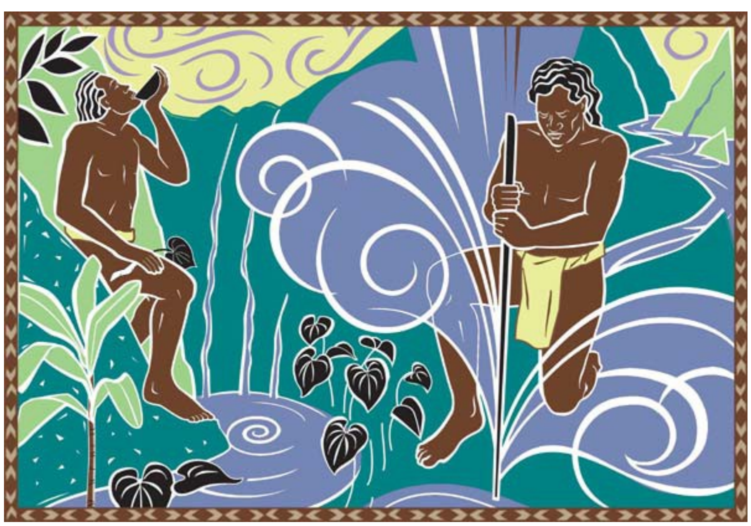
On March 16, 2011, CWRM adopted the Wai'anae and Ko'olau Loa WMPs into the Hawai'i Water Plan. The Ko'olau Poko WMP was adopted on September 19, 2012 and the North Shore WMP on December 20, 2016. CWRM has approved of the regional, watershed-based approach to water resource management as a viable methodology for the integration of HWP components within the County WUDP.

1.2 O‘AHU WATER MANAGEMENT PLAN FRAMEWORK

The OWMP consists of overall policies and strategies and regional watershed management plans, that will guide the activities of the City and County of Honolulu and will also provide advice to CWRM regarding the planning, management, conservation, use, development, and allocation of O‘ahu’s limited surface water and ground water resources for the next 20 years to 2035.

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
- State land use classifications and policies
- City and County of Honolulu Chapter 30, ROH establishing the OWMP island-wide polices and strategies and regional WMPs.
- General Plan for the City and County of Honolulu and Development Plans and Sustainable Communities Plans for O‘ahu’s eight land use districts
- City Zoning Designations
- BWS Mission of “Water for Life, Ka Wai Ola”



“Water for Life – Ka Wai Ola”

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 1-2*) 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 and the island overview chapter will provide a consolidating mechanism to place each of the regions into the proper 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 between land and water, Chapter 30 ROH now requires that each regional WMP shall be updated, at a minimum, in tandem with the respective Development Plans/Sustainable Communities Plans. With each iteration, land use and water planning will become increasingly integrated in vision, policies, goals, and objectives, so that resource protection and management and infrastructure development support a sustainable future.

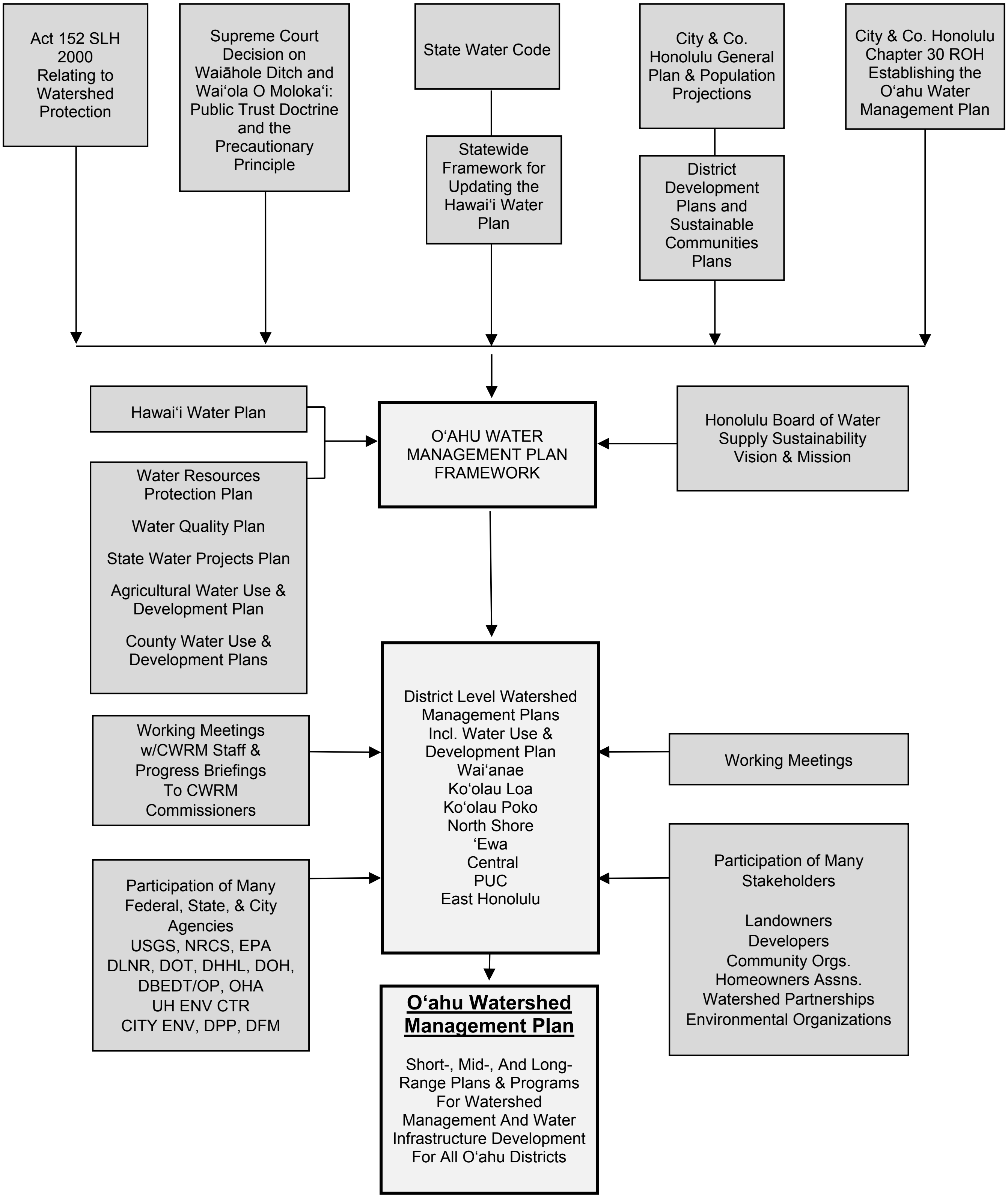


Figure 1-2 Watershed Management Plans for O‘ahu, County and State Level Planning Framework Diagram

Based on the planning principles and through a consultation process with community leaders, community groups, public agencies, landowners, 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 preservation, restoration and management of O‘ahu’s watersheds, and (2) sustainable ground water and surface water use and development to serve present users and future generations.

OBJECTIVES

(1) Promote sustainable watersheds.

(2) Protect and enhance water quality and quantity.

(3) Protect Native Hawaiian rights and traditional and customary practices.

(4) Facilitate public participation, education, and project implementation.

(5) Meet future water demands at reasonable costs.

The WMP objectives were derived from an extensive stakeholder consultation process and reflect their values and thinking about water resources. These values and thinking were then consolidated into broad goals and objectives that apply island-wide thus providing the overall guidance, balance, and consistency for each of the eight district level WMPs. Each of the eight plans will define more specific sub-objectives, policies, strategies, and actions that reflect specific district conditions, issues, and needs and provide a balance among all five plan objectives under the OWMP Framework.

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 interrelationship among watershed resources including geologic structures, soil characteristics, forest communities, endemic and indigenous animals, native and introduced species, ground water aquifers, streams and wetlands, reefs and near-shore waters, traditional and cultural practices, land use and land development. Healthy, sustainable watersheds should be the foundation for both land use and water resources management planning.

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

Objective 2. Protect and enhance water quality and quantity

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

Drinking water systems are regularly tested for compliance with EPA Safe Drinking Water Standards and BWS criteria for system operations and resource monitoring. Watershed protection projects and programs will ensure that aquifers and streams are healthy and sustainable. Source water protection programs and the monitoring of hydrologic indicators of rainfall, stream and spring flows, and aquifer water levels will ensure consistently high source water quality.

BWS ensures the health of the ground water aquifers by monitoring the island-wide index and deep monitor wells for water levels and chlorides at the top and mid-point of the fresh water/sea water transition zone. Source water quality can be affected by sea water intrusion or up-coning brackish water especially during extended drought. Monitoring also ensures sufficient aquifer recovery during post-drought periods.

BWS, CWRM, University of Hawai‘i and U.S. Geological Survey (USGS), are advancing research and analytical modeling tools to increase understanding of recharge and ground water aquifers and streams. The agencies work collaboratively to fund, construct and utilize 3-dimensional solute transport ground water modeling calibrated with new deep monitor wells in basal aquifers to:

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

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

Native Hawaiian water rights are set forth in the State Constitution, Section 221 of the Hawaiian Homes CWRM 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 fresh water into the nearshore water ecosystem.

The Hawai‘i Supreme Court held that title to water resources is held in trust by the State for the benefit of its people and 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, domestic water use, and reservation of water for Hawaiian Home Lands. 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 the availability of healthy and plentiful water resources.

Protecting Native Hawaiian rights and traditional and customary practices must be done in conjunction with setting measurable instream flow standards (IFS) for all perennial streams and stream segments, and 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 water for public trust purposes are also needed. Only after completing this evaluation of stream water can a determination of surface water availability for additional agricultural uses and urban nonpotable uses be accomplished.

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

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

Planning and managing our island’s water and related resources involves a variety of stakeholders including 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 of water resource issues can support collaboration with informed stakeholders. Directed water resource curriculum for schools will ensure that 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, 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, agriculture, 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 precautionary with respect to the resource and are well within established sustainable yields and instream flow standards, which protect the long-term viability of the water resource and do not detrimentally impact cultural uses and natural environments.

The allocation of water to land use considers a full range of alternative water sources. Water quality should be matched with appropriate use. Thus, high quality water is used for drinking and lower quality water, such as recycled water, is used for irrigation and industrial processes. New technology allows cost effective, diversified, drought-proof water systems that develop ground water, surface water, recycled and seawater resources that meet water demands while balancing other plan objectives.

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

<u>Water Conservation</u>

- 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 ditch systems and the renewal and replacement of water system facilities (pipelines, ditches, 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 affects 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 40 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 efficient operations of the existing water systems with sustainable aquifer pumpage levels.

Water System Reliability, Adequacy and Efficiency

- Water system reliability reflects the ability of the distribution system to consistently deliver water with minimal interruptions during normal and emergency conditions. Water systems are constantly improved to meet BWS Water System Standards providing standby pump capacity, infrastructure redundancy, treatment systems, enhanced security measures, drought mitigation, and disaster response.
- Adequate capacity reflects the ability to deliver an acceptable quantity and quality of water at a suitable pressure and overall responsiveness to customer needs and planned growth. As aging pipelines are replaced, capacity is added to improve fire protection, increase low pressure areas and reduce high pressure transients that could reduce pipeline design life. A diversified water supply system consisting of a combination of ground water, surface water, recycled water, desalinated water and seawater resources improves water system adequacy.

- Water System Efficiency reflects how well water is produced, delivered and used, and how energy is utilized. Efficiency is the ability to deliver water with a minimum of effort, expense or waste. 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 motors, variable frequency drives, 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 water demand and climate change adaptation.

1.3 O‘AHU WATER USE AND DEVELOPMENT PLAN UPDATE

The OWMP consists of island-wide water management policies and strategies and regional watershed management plans, which guide the activities of the City and County of Honolulu and advises the state CWRM in the areas of planning, management, water development and use and allocation of O‘ahu’s limited water resources. The island-wide policies and strategies listed in ROH, Article 2, Chapter 30, and restated below, apply to all City agencies *“in the performance of their powers, duties and functions as related to both public and private development.”* The implementation of the strategies will carry out the policies.

Policy 1. Facilities for the provision of water shall be based on the general plan population projections and the land use policies contained in the development plans and depicted on the development plan land use maps.

Policy 2. 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.

Policy 3. Close coordination shall be maintained between federal, state and county agencies which are involved in the provision or management of water to ensure optimal distribution of the available water supply.

Policy 4. 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.

Policy 5. The development and use of nonpotable water sources shall be maximized in a manner consistent with the protection of the ground water quality.

Policy 6. Water conservation shall be strongly encouraged.

Policy 7. Alternative water sources shall be developed wherever feasible to ensure an adequate supply of water for planned uses on O‘ahu.

Strategy 1. Develop water resources in consonance with the general plan population projections and the land use policies contained in the development plans and depicted on the development plan land use maps. Priority shall be given to affordable housing projects shown on the development plan land use maps or processed under HRS Chapter 201E.

Strategy 2. Continue to safely develop the remaining available ground water in accordance with the requirements of the state water code.

Strategy 3. Use surface water more effectively and efficiently.

Strategy 4. Continue to refine the near and long-term projections of agriculture on the island to more accurately project the future net release of water currently committed to agricultural use.

Strategy 5. Maintain an ongoing water conservation program through the board, using such approaches as pricing, public information, educational programs, water-saving devices, and use restrictions and allocations.

Strategy 6. Develop and use nonpotable water sources, wherever feasible, for the irrigation of agricultural crops, parks and golf courses, landscaping and for certain industrial uses.

Strategy 7. Continue efforts to develop economical methods of demineralizing brackish water and desalting seawater.

Article 2 further states that *"based on the findings and projections in the OWMP, provisions for an adequate supply of water to meet island-wide needs for at least twenty years shall be addressed. This shall be determined after evaluating the anticipated demand for water use from municipal, agricultural, military and private users; the available remaining ground water which can be safely developed; the planned and proposed water source development projects; and alternative water development projects under way."* The following update provides this basis.

Water use and development on O'ahu is guided by the City's General Plan and the Development Plans and Sustainable Communities 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 and rural development from 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 region-specific watershed management projects and strategies that enhance ground water and surface water supplies, improve land management with respect to water, protect traditional and cultural practices and facilitate plan implementation. Each regional WMP will consist of about 30 to 40 watershed management projects and strategies derived from stakeholder consultation and 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 eight regional WMPs. Together, the proposed regional watershed management plans update 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; State, federal, and private water systems; and prime and unique agricultural lands. In summary, BWS has evaluated the adequacy of the supply to meet future potable and nonpotable water needs, and through a combination of conservation, diversified water supply development and watershed protection strategies, the City can meet water demands through the 2035 planning period.

1.3.1 City and County of Honolulu Land Use Plans

The General Plan for the City and County of Honolulu 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 overarching policy document of a comprehensive planning system that addresses physical, social, economic and environmental concerns affecting O‘ahu. This planning system serves as the coordinating structure by which the City provides for the future growth on the island of O‘ahu. The General Plan provides objectives and policy statements which will help the City achieve a desirable and attainable residential population distribution among the eight land use regions, directing the bulk of new growth and supporting infrastructure to the primary and secondary urban centers and the ‘Ewa and Central O‘ahu urban fringe areas to relieve developmental pressures in the remaining urban fringe and rural areas and to meet housing needs.

The City established regional Development Plans (DP) and Sustainable Communities Plans (SCP) for each of the eight 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 the 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 six districts are “sustainable communities” plans, which are envisioned as relatively stable regions in which public programs will focus on supporting existing populations. Each land use district establishes a boundary to contain urban and rural development to protect agriculture and preservation zoned areas. These plans can be found on the City and County of Honolulu Department of Planning and Permitting’s website at http://www.honoluludpp.org/.

1.3.2 Population Forecasts and Municipal Water Demand

Population forecasts are provided by DPP's land use model utilizing US Census Bureau and State Department of Business Development and Tourism data, development master plans and subdivision information. DPP provides the forecasts by transportation analysis zones (TAZ) and census tracts, which provide more discrete land use coverage information within each land use district.

BWS applies its water use data to DPP's population forecast data to derive BWS served populations, gallon per capita demands and water demand forecasts by land use district for long range planning of source development and water system infrastructure sizing. Note that with all long-range forecasts, a range of variation will occur due to uncertainties in changing economic climate, jobs, tourism, zoning, development starts, population distribution and water conservation.

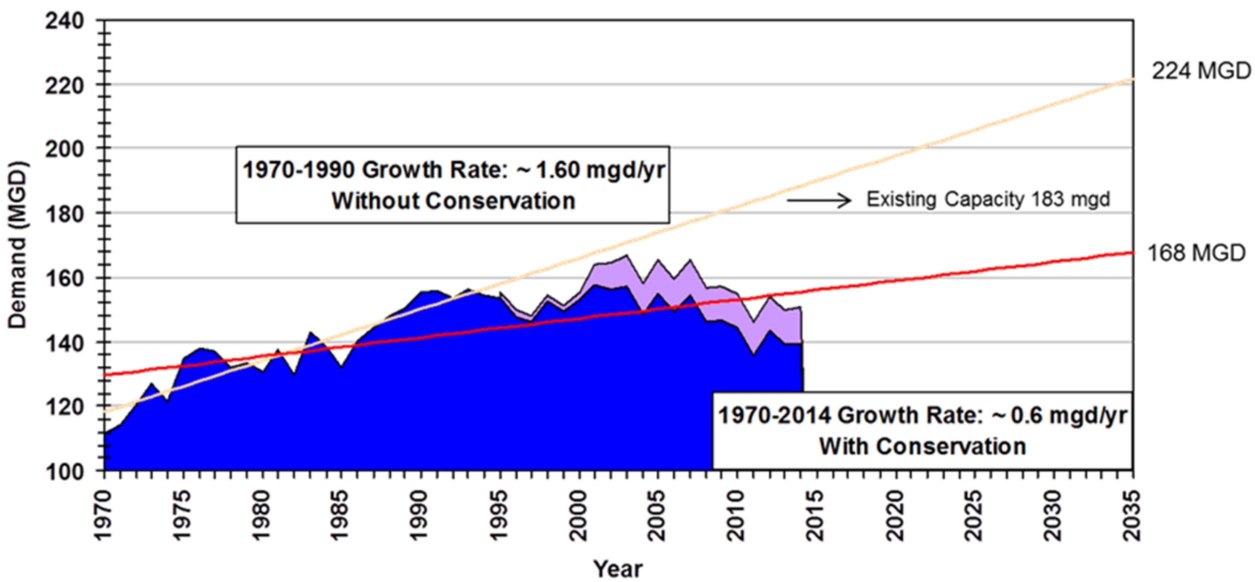


Figure 1-3 BWS Potable and Nonpotable Water Systems Demands: Actual 1970-2014 and Linear Projection to 2035

BWS water conservation programs starting in 1990 (in particular low flow toilets), Honouliuli recycled water in 2003 and the economic incentives associated with the increase in water and sewer rates over the last decade have significantly reduced potable water demand on O'ahu. In *Figure 1-3*, potable demand (blue) plateaued at about 155 MGD from 1990 to 2000 after steady growth from 1970 to 1990. Since 2004, potable water demand has decreased to 144.5 MGD in 2010 despite a resident population increase of over 115,000 people. Recycled and brackish nonpotable demands are shown in purple.

In *Figure 1-3*, potable demand growth rates are linearly projected to 2035 along two slopes of 1.60 MGD/year from 1970-1990 without conservation and 0.6 MGD/year from 1970-2014 with conservation amounting to 168 MGD in 2035. The trend with conservation can be considered as the BWS mid-growth scenario, while the 224 MGD trend without conservation will no longer be considered as a possible scenario. A trend line from 1990-2014 would show a decreasing trend to some future point, but is not provided because there is a saturation point at which additional conservation savings will only be realized at significant costs (see also *Figure 1-4)*.

BWS applies the per capita demand model to forecast future water demands because population forecasts using the DPP land use model as described above are readily available. In *Table 1-1*, the Per Capita Demand is derived by dividing BWS potable water demand, which includes water loss, by the BWS served population. The served population accounts for visitors present, residents absent and deducts military and private water systems. The per capita demand is then multiplied by the projected served population to derive the potable water demand forecast.

Table 1-1 O‘ahu Population and Water Demand 2010, By Development/Sustainable Communities Plan Area

DP Area	Resident Population	% Resident Population	Residents Absent	Visitors Present	Defacto Population	Private/ Military	BWS Population Served	DP area Demand (MGD)	Per Capita Demand (gpcd)
Wai‘anae	48,519	5%	2,667	1,349	47,201	6	47,195	9.244	196
‘Ewa	101,397	11%	5,575	2,993	98,815	6,757	92,058	17.072	185
Central O‘ahu	168,643	18%	9,271	493	159,865	18,822	141,043	17.761	126
PUC	435,118	46%	23,921	79,967	491,164	30,214	460,950	69.448	151
East Honolulu	49,914	5%	2,744	896	48,066	0	48,066	9.348	194
Ko‘olau Poko	115,164	12%	6,331	293	109,126	632	108,494	15.859	146
Ko‘olau Loa	16,732	2%	920	80	15,892	6,398	9,494	1.417	149
North Shore	17,720	2%	975	1,377	18,122	3,623	14,499	2.929	202
TOTAL	**953,207**	**100%**	**52,404**	**87,448**	**988,251**	**66,452**	**921,799**	**143.08**	

*Note: Population numbers are from DPP using 2010 census numbers.

Water conservation has a significant and beneficial effect on the per capita demand factors from 1990 to 2010 as shown in *Figure 1-4*. From 1990-2010, the per capita demand decreased 16.5% and through graphical trend analysis, BWS projects per capita demand to continue to decrease another 7.6% to 2040 as long as water conservation program goals are achieved.

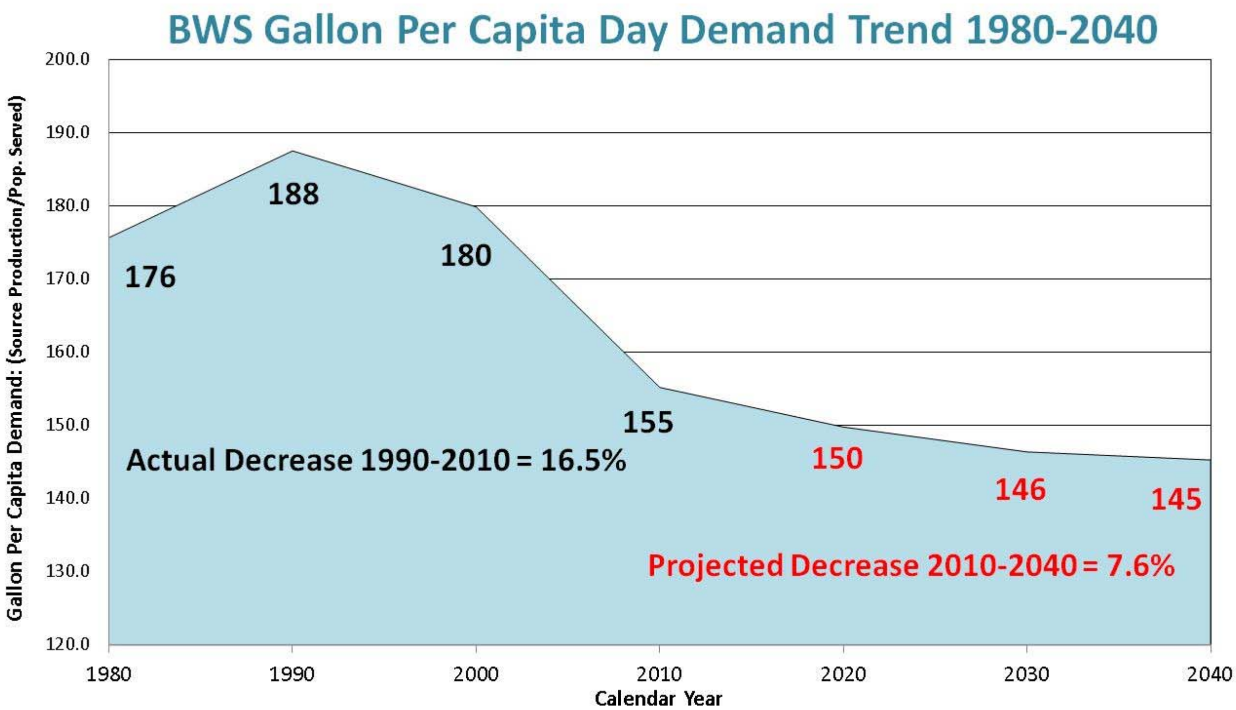


Figure 1-4 BWS Gallons per Capita Day Demand Trend 1980-2040

The following tables and descriptions highlight the BWS water demand forecasts by development plan districts for O‘ahu**.** BWS served population for O‘ahu in *Table 1-2* is forecasted to increase 12.1% from 921,799 in 2010 to 1,033,043 in 2035 with the majority of the increase occurring in the ‘Ewa, PUC, and Central O‘ahu districts. East Honolulu and Ko‘olau Poko populations are expected to decrease.

Table 1-2 BWS Served Population by Year and DP Area

BWS Served Population by Year & DP Area									
DP AREA	**1980**	**1990**	**2000**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
	Given Data (Served Pop.)				**Projected Data (Served Pop.)**				
Wai‘anae	32,724	37,801	41,731	47,195	48,044	48,892	49,741	50,590	51,439
‘Ewa	24,614	31,321	61,660	92,058	104,571	117,085	129,598	142,111	154,625
Central O‘ahu	77,354	105,917	124,455	141,043	144,981	148,920	152,858	156,797	160,735
PUC	435,671	466,297	447,114	460,950	465,875	470,800	475,725	480,649	485,574
East Honolulu	42,829	45,646	45,702	48,066	48,014	47,962	47,910	47,858	47,806
Ko‘olau Poko	107,667	116,803	113,256	108,494	108,029	107,565	107,100	106,635	106,171
Ko‘olau Loa	7,816	11,212	10,409	9,494	9,739	9,984	10,229	10,474	10,719
North Shore	11,798	14,725	14,438	14,499	14,794	15,090	15,385	15,680	15,976
TOTAL O‘ahu Population	**740,473**	**829,722**	**858,765**	**921,799**	**944,048**	**966,297**	**998,546**	**1,010,795**	**1,033,043**

BWS gallon per capita demand for potable water is forecasted to slow its downward trend to 6.5% from 2010 to 2035 as water conservation capacity approaches saturation, *Table 1-3.* ‘Ewa has the largest potential for water efficiency savings of 14% despite its dry climate because of the availability of recycled water for irrigation of large landscaped areas.

Table 1-3 BWS GPCD by Year and DP Area

BWS GPCD by Year & DP Area									
Calendar Year:	**1980**	**1990**	**2000**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
DP AREA	**Given Data (GPCD Rate)**				**Projected Data (GPCD rate)**				
Wai‘anae	235.30	239.40	223.79	195.87	197.16	191.19	185.40	179.79	174.34
‘Ewa	316.90	281.10	223.58	185.45	181.96	167.87	160.00	160.00	160.00
Central O‘ahu	148.70	141.80	155.96	125.93	125.00	125.00	123.00	123.00	121.00
PUC	177.00	190.00	170.98	150.66	150.14	145.38	140.77	140.00	140.00
East Honolulu	144.80	190.20	221.30	194.48	179.17	180.00	180.00	180.00	180.00
Ko‘olau Poko	148.60	151.20	173.17	146.17	145.00	145.00	145.00	145.00	145.00
Ko‘olau Loa	191.90	254.20	140.55	149.25	144.78	140.00	140.00	140.00	140.00
North Shore	194.90	216.60	194.97	202.01	202.73	202.83	202.93	203.03	203.14
TOTAL O‘ahu Gallon Per Capita	**175.70**	**187.57**	**179.91**	**155.22**	**153.85**	**149.80**	**146.11**	**145.57**	**145.09**

Assuming a continuation of conservation savings trends, the average day water demand, in *Table 1-4* is forecasted to increase by only less than 7 MGD from 143.08 MGD in 2010 to 149.88 MGD in 2035. The forecast which can be considered as the BWS low-growth demand scenario is a major reduction from the 52 MGD forecast from 2000. The largest water demand increase is expected in Ewa due to a population increase of about 62,500 people by 2035. Interestingly, PUC’s water demand is expected to be stable or even decrease despite an increase of 24,600 people because per capita demand is decreasing. High rise transit oriented development uses much less water than a townhouse or single family residence which will reduce the per capita water demand.

Table 1-4 BWS Demand by Year and DP Area

BWS Demand by Year & DP Area									
Calendar Year	**1980**	**1990**	**2000**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
DP AREA	**Given Data (Demand)**				**Projected Data (Demand)**				
Wai‘anae	7.7	9.05	9.34	9.24	9.47	9.35	9.22	9.10	8.97
‘Ewa	7.8	10.60	15.30	17.07	19.03	19.65	20.74	22.74	24.74
Central O‘ahu	11.5	15.02	19.41	17.76	18.12	18.61	18.80	19.29	19.45
PUC	77.1	88.58	76.45	69.45	69.94	68.44	66.97	67.29	67.98
East Honolulu	6.2	8.68	10.11	9.35	8.60	8.63	8.62	8.61	8.61
Ko‘olau Poko	16.0	17.66	19.61	15.86	15.66	15.60	15.53	15.46	15.39
Ko‘olau Loa	1.5	2.85	1.46	1.42	1.41	1.40	1.43	1.47	1.50
North Shore	2.3	3.19	2.82	2.93	3.00	3.06	3.12	3.18	3.25
TOTAL O‘ahu Demand	**130.10**	**155.63**	**154.50**	**143.08**	**145.24**	**144.75**	**144.44**	**147.14**	**149.88**

Table 1-5 shows O‘ahu’s ground water use as of 2010 totaling 229 MGD including the Waiāhole Ditch and the brackish ‘Ewa Caprock aquifer. Municipal ground water use constitutes 64% of the total, with military, agriculture and irrigation and other uses taking up the remainder. Agriculture ground water use includes private wells and the Waiāhole Ditch but overall agriculture ground water use has decreased post-plantation owing to the availability and use of surface water and the slow rate of diversified agriculture growth.

Table 1-5 O‘ahu’s Ground Water Use (2010)

Use Category	Water Used 12-Mo. MAV (MGD)	Percentage of Total Water Use
Municipal	146.4	63.8%
Military	23.2	10.1%
Agriculture*	23.1	10.1%
Irrigation**	16.7	7.3%
Domestic	0.5	0.2%
Industrial**	19.5	8.5%
Total	**229.4**	**100%**

* Includes Waiāhole Ditch
** Includes ‘Ewa Caprock Brackish aquifer

Table 1-6 summarizes Appendix C by listing O‘ahu’s largest permitted uses of fresh ground water by user including Waiāhole Ditch water uses but excluding saltwater and brackish caprock water uses in 2010.

Table 1-6 O‘ahu’s Top Fresh Ground Water Users by Permitted Use September 2010

Owner	Permitted Use (MGD)
1. Honolulu BWS	183.58
2. Waialua Sugar	33.48
3. US Navy	28.77
4. D.R. Horton/Schuler	7.97
5. US Army	7.29
6. Del Monte	5.04
7. Dillingham Ranch Aina	4.10
8. HRI/Laie Water Co.	3.69

Owner	Permitted Use (MGD)
9. Chevron USA, Inc.	3.60
10. Covanta Energy Corp.	3.34
11. Kalaeloa Partners, L.P.	3.17
12. US Fish and Wildlife	2.91
13. State of Hawai‘i	2.89
14. Monsanto Company	2.64
15. Robinson Kunia Land	2.49
16. Coral Creek	2.19

1.3.3 Department of Hawaiian Home Lands Demands

The Department of Hawaiian Home Lands (DHHL) owns lands in Mākaha, Wai‘anae, Lualualei, Nānākuli, Kalaeloa, Kapolei, Papakōlea, Mō‘ili‘ili, Waimānalo and Ha‘ikū as shown in *Figure 1-5*. DHHL is currently compiling their O‘ahu master plan and their findings will be incorporated in future WMP’s. DHHL projected water demands of 1.7 MGD (State Water Projects Plan 2003) are incorporated into the BWS municipal water demand forecasts using the population based per capita demand method. DHHL holds water reservations in the Waimānalo aquifer of 0.124 MGD and in the Waipahu-Waiawa aquifer of 1.358 MGD for their projects. DHHL will request that CWRM assign their reservations toward new or existing sources as their lands are developed. The State Water Projects Plan and DHHL demands are currently being updated by DLNR Engineering.

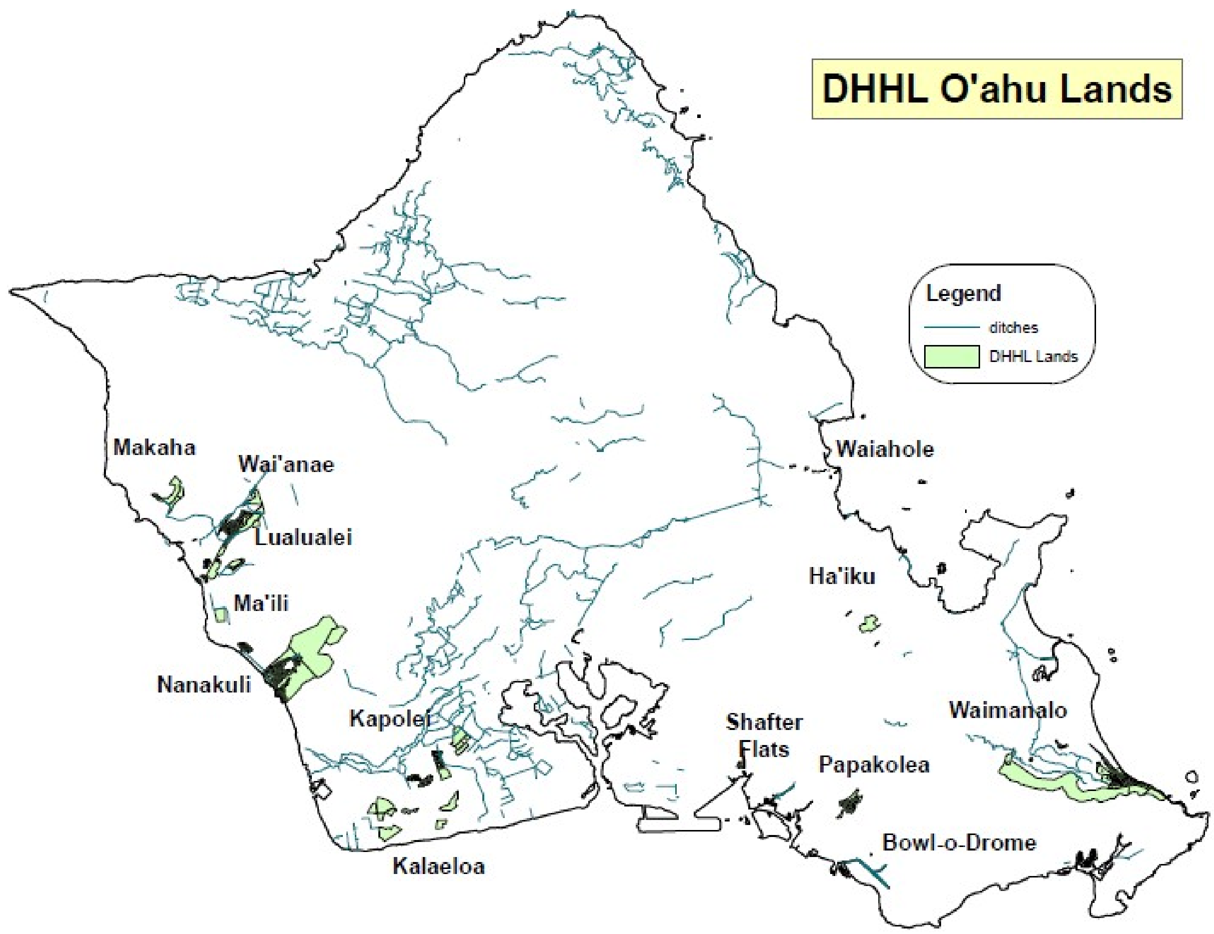


Figure 1-5 Department of Hawaiian Home Lands on O‘ahu

1.3.4 State Water Projects Plan Water Demands

The State Water Projects Plan (SWPP), 2003, identified a total of 24.5 MGD of water demand for housing, commercial, industrial, institutional, and agricultural uses for State agencies on O‘ahu to the year 2020. Approximately 51% of O‘ahu’s SWPP demand, or 12.5 MGD, is nonpotable use. The Department of Agriculture’s demand of 7.6 MGD, the Department of Business Economic Development and Tourism’s demand of 7.2 MGD and the University of Hawai‘i’s demand of 3.1 MGD comprise the largest water needs among State agencies.

The SWPP identified several water development strategies to meet their projected water demands including the use of existing State water system capacity; developing new water systems based on development master plans such as East Kapolei and Kalaeloa; utilizing existing BWS water credits from previous source development; and pursuing recycled and brackish water for nonpotable irrigation. These strategies constitute approximately 17.9 MGD or 73% of O‘ahu’s SWPP total. The remaining 6.7 MGD or 27% of State water demand can be obtained from BWS through the payment of Water System Facilities Charges. The BWS municipal water demand forecasts using the population based per capita demand method of assessing State and County land use plans can be assumed to incorporate most of the SWPP’s demands except for State owned water systems. An accounting tying specific source names to projected State agency demands would be helpful in the next SWPP update.

The SWPP update should add stronger water conservation and water loss reduction strategies, which were largely absent in the 2003 SWPP. Leak detection and repair projects in aging State water systems, such as agriculture, could reduce new source development, reduce operating and maintenance costs and provide more capacity for drought mitigation. The SWPP is currently being updated and their findings will be incorporated in future WMP’s.

1.3.5 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 growth boundaries in part to protect prime agricultural lands.

O‘ahu’s projected agricultural water demands have a wide variation and 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, climate, and number of acres in cultivation. The *State Agricultural Water Use and Development Plan* (AWUDP, 2004) estimated a worst and best case range of 7.6 MGD and 30.4 MGD, respectively, of additional water demand for O‘ahu based on population projections, partial replacement of imported produce with locally grown produce, and maintaining farm value growth in diversified agriculture.

Approximately 13 MGD of the projected best case agricultural demand was assumed to be assigned to private irrigation systems, with the remaining 17 MGD accommodated by the State’s Waiāhole Ditch and Waimānalo irrigation systems. The AWUDP focused on maintaining existing State 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 Wahiawā Irrigation System in Central O‘ahu and North Shore 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 gallons per day per acre (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. It should be noted, that 3,400 gpd/acre is considered a practical consumptive water use rate which does not include irrigation system water loss.

Figure 1-6 shows the agricultural zoned lands on O‘ahu with the four major irrigation systems: Waiāhole Ditch, Wahiawā, Waimānalo and Punalu‘u. Existing stream diversions and distribution systems should be inventoried, leaks and evaporation losses reduced to a reasonable goal 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. Improvements to existing ditch systems, such as lining or piping ditches, have the potential to reduce water loss and thereby provide water for the expansion of agriculture without adding new diversions. Cost and benefit considerations should be factored into the feasibility of these improvements and will affect implementation. Significant new surface water diversions require amendments to the IFS, but the studies and processes are cost prohibitive.

Kamehameha Schools has renovated their Punalu‘u and Kawailoa irrigation systems with cultural and eco-friendly stream diversion modifications and piped ditch systems to conserve and enhance the availability of stream water, *Figure 1-7*. The diversions include fish ladders on both stream banks and grated intakes to prevent debris and fish from entering the system. The ditch system was piped to reduce water loss and ditch maintenance and provide a pressurized irrigation system for farmers. The improvements keep unused water in the stream because as irrigation declines during the day or season, the pipe fills up to the intake and diverted flow reduces to zero.

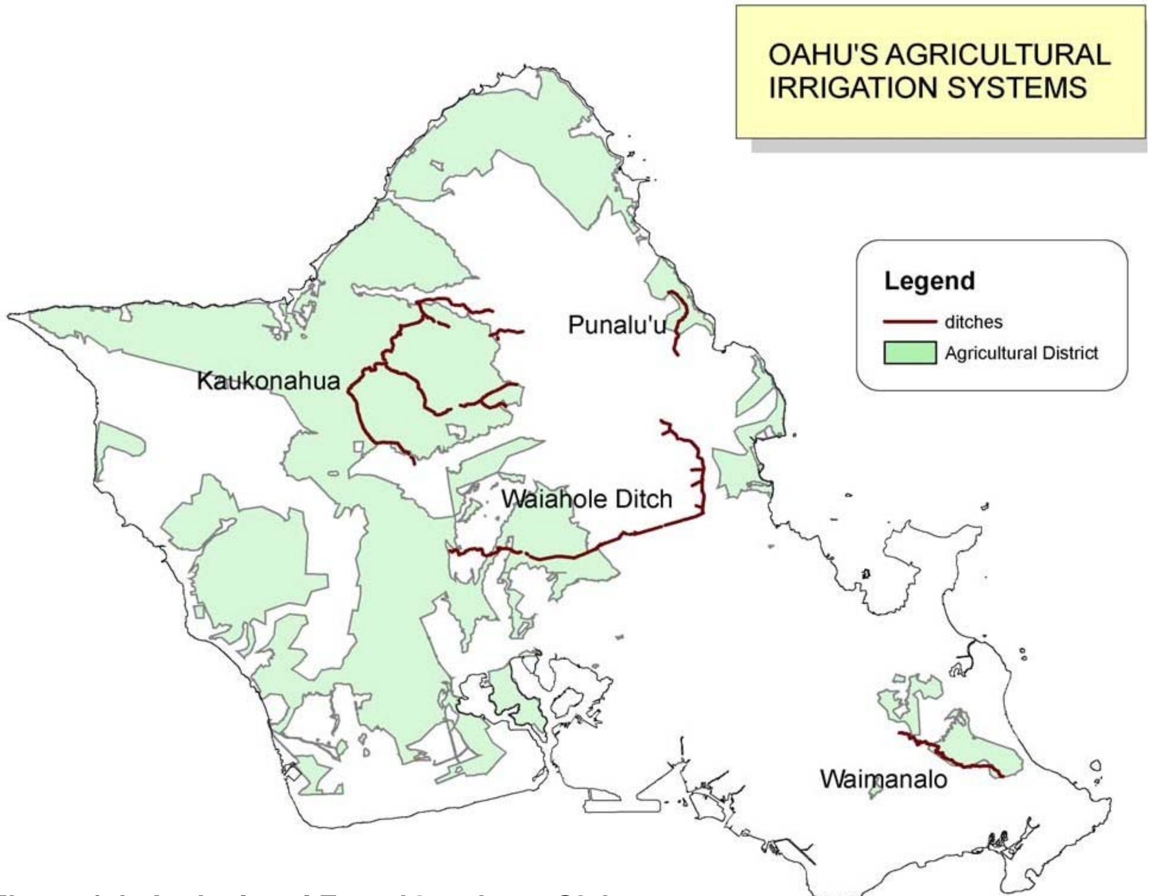


Figure 1-6 Agricultural Zoned Lands on O’ahu

Figure 1-7 Punalu‘u Stream Diversion and Piped Ditch

There are large tracts of agricultural lands in the ‘Ewa, Central O‘ahu, North Shore, Ko‘olau Loa and Ko‘olau Poko districts. The 2004 AWUDP estimated that of the 49,500 acres of prime agriculture lands on O‘ahu, 11,000 acres are in monocrop cultivation. The remaining 38,500 acres are idle and available for cultivation. *Table 1-7* lists the projected most probable water demands for each land use district compiled from the regional Watershed Management Plans and based on the projected use of agricultural lands within a 2030 and 2035 horizon.

Table 1-7 O‘ahu Agricultural Irrigation Water Demand

Land Use District	Existing Agricultural Irrigation Water Demand (MGD)	Projected Agricultural Irrigation Water Demand (MGD)*
North Shore	24.2	29.3
Central O‘ahu	15.8	15.7
‘Ewa	7.0	4.7
Ko‘olau Loa	14.5	17.4
Ko‘olau Poko	4.2	6.0
Wai‘anae	2.3	2.4
Total	**68.0**	**86.5**

* Agricultural water demands are the most probable demand scenarios for agriculture from Watershed Management Plans for Ko‘olau Loa (2030), Ko‘olau Poko (2030), Wai‘anae (2030) and North Shore (2035). Central O‘ahu (2035) and ‘Ewa (2035) are from calculations for watershed management plans under development. Lo‘i kalo water demand is not included.

The total agricultural lands water demand of 86.5 MGD utilize 3,400 gallons per day per acre (gpd/acre) from the State AWUDP for low rainfall areas and 2,500 gpd/acre for high rainfall areas. Studies indicate that water demands for diversified agriculture in high rainfall areas such as Punalu‘u, Waiāhole, Kahalu‘u and Kāne‘ohe, where rainfall exceeds 60 to 70 inches per year, requires less water and averaged 2,500 gpd/acre. Agricultural irrigation water demand is met with both ground and surface water supplies.

CWRM, in the Waiāhole Ditch contested case, allocated an average of 2,500 gpd/acre for large-tract Kunia farms allowing for some continuous proportions of fallow and cultivated lands. Small farms do not have the area to fallow their fields and will therefore have higher water demands per acre. Existing systems like the Waiāhole Ditch, Wahiawā, Kawailoa, Punalu‘u, Waimānalo and the ‘Ewa Plantation irrigation systems already provide a portion of this total. Additional potable ground water supplies in these aquifer system areas could provide supplemental agricultural water supply especially during drought. Diversified agricultural water demands in Wai‘anae, PUC, East Honolulu and a portion of North Shore are largely incorporated into the municipal demand forecasts. Agricultural water use constitutes only 3% of BWS potable metered water use. Ground water development is more costly for agriculture than gravity and surface water sources and may compete with urban uses.

Traditional wetland kalo occurs in almost all districts but according to various studies, the variability of water demands is large, and inflows can range from approximately 100,000 gpd/acre to 300,000 gpd/acre with temperature as one of the key factors to prevent rot. While net consumptive use (evapotranspiration and infiltration) averages approximately 50,000 gpd/acre (USGS, 2007), the additional water flow, which is returned to the stream, is needed to manage temperature and account for ditch losses. This plan therefore assumes 100,000 gpd/acre as the wetland kalo water demand estimate as presented in the Koʻolau Poko WMP in discussions with Waiāhole kalo farmers. Kalo’s high water use per acre and limited surface water supplies will limit the expansion and restoration of loʻi kalo but because it is important to preserve the remaining traditional kalo lands, the lower range of water demand will allow a greater amount of restoration. Water loss reduction strategies in ʻauwai and ditch systems (lining and piping) could provide additional water reducing the necessity of constructing additional stream diversions and potentially divert less stream water.

1.3.6 Ground Water Availability

The table of Sustainable Yield and Ground Water Use by Aquifer System Area was provided by CWRM and BWS for 2010 (*Table 1-8*). The table shows the seven aquifer sector areas and 26 aquifer system areas on Oʻahu with their associated revised sustainable yields adopted in August 2008 by CWRM, water use permits, water use in 2010 and the unallocated sustainable yields. CWRM reduced Oʻahu’s sustainable yields by 39 MGD in 2008 from 446 MGD to 407 MGD. A complete listing of Oʻahu Water Use Permit Index is provided in *Appendix C,* and additional information on sustainable yields is included in *Appendix D, Overview of Oʻahu’s Hydrogeology*.

Overall, there is available water on Oʻahu, in comparing permitted use that has been allocated and/or actual withdrawal to sustainable yield. 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. 2010 was a below normal rainfall year with the first half averaging 60% of normal rainfall. The 5-month moving average recovered to normal rainfall levels with heavy rains in November and December of 2010. Therefore, 2010 water use was higher than normal for both agriculture and urban sources. Ground water use increased by 4.5 MGD from 2009 to 2010, primarily due to the drier weather and some growth related increases in 2010.

Table 1-8 Sustainable Yield and Ground Water Use by Aquifer System Area (MGD)

Aquifer Sector	Aquifer System	Notes	Sustainable Yield (SY)	Water Use Permits Issued 2010	Unallocated Sustainable Yield	Water Use (2010)	SY Minus Water Use
Honolulu	Wai‘alae - East		2	0.79	1.21	0.124	1.876
	Wai‘alae - West		4	2.797	1.203	1.004	2.996
	Palolo		5	5.646	-0.646	6.289	-1.289
	Nu‘uanu	1	14	15.165	-1.165	15.232	-1.232
	Kalihi		9	8.761	0.239	5.424	3.576
	Moanalua	1	16	19.96	-3.96	17.143	-1.143
Total Honolulu			**50**	**53.119**	**-3.119**	**45.216**	**4.784**
Pearl Harbor	Waimalu		45	46.951	-1.951	35.524	9.476
	Waipahu-Waiawa		104	84.856	19.144	51.819	52.181
	‘Ewa-Kunia		16	15.457	0.543	12.143	3.857
	Makaiwa		0	na	na	0	0
Total Pearl Harbor			**165**	**147.264**	**17.736**	**99.486**	**65.514**
Central	Wahiawā		23	21.928	1.072	7.694	15.306
Total Central			**23**	**21.928**	**1.072**	**7.694**	**15.306**
Wai‘anae	Nānākuli	1,2,4	2	na	na	0	2
	Lualualei	1,2,4	4	na	na	0	4
	Wai‘anae	2	3	na	na	2.710	0.29
	Mākaha	1,2	3	na	na	1.956	1.044
	Kea‘au	2,4	4	na	na	0	4
Total Wai‘anae			**16**			**4.666**	**11.334**
North	Mokulē‘ia	1	8	8.025	-0.025	0.175	7.825
	Waialua	1	25	30.311	-5.311	3.276	21.724
	Kawailoa	1	29	1.614	27.386	0.425	28.575
Total North			**62**	**39.95**	**22.05**	**3.876**	**58.124**
Windward	Ko‘olau Loa	1	36	18.589	17.411	17.853	18.147
	Kahana	1,4	15	1.101	13.899	0.36	14.64
	Ko‘olau Poko	1,3,4	30	10.312	19.688	10.227	19.773
	Waimānalo	1,4	10	1.631	8.369	0.699	9.301
Total Windward			**91**	**31.633**	**59.367**	**29.139**	**61.861**
Total Aquifer Sector			**407**	**293.894**	**97.106**	**190.077**	**216.923**
‘Ewa Caprock	Malakole	5	1,000 mg/L		-	4.513	-
	Kapolei	5	1,000 mg/L		-	0.747	-
	Pu‘uloa	5	1,000 mg/L		-	1.374	-
Total ‘Ewa Caprock			**0**	**0**	**0**	**6.634**	**0**
Waiāhole Ditch			15	12.991	2.009	7.068	15
Grand Total Fresh and Brackish			**422**	**306.885**	**99.115**	**203.779**	**224.855**

1 2008 Water Resource Protection Plan updates on sustainable yield.

2 Wai‘anae is not a designated water management area; therefore, there is no permitted use.

3 Waihe‘e Tunnel & Waihe‘e Inclined Wells are not included under 2010 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 for irrigation wells.

Excluded salt water wells

Source: CWRM and BWS data. BWS footnotes.

Based on 2010 reported pumpage to CWRM.

In general, the Honolulu sector is fully allocated to the adopted sustainable yields. 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, Koʻolau Poko and Kahana) may interact with streams due to dike influences and therefore, availability may be subject to amendments of the interim IFS. Wai‘anae’s remaining water is small, in remote areas and also subject to interim IFS in dike areas.

Due to these land, economic, operational and environmental reasons, BWS has identified the concept of recoverable yield for its own municipal planning purposes. Recoverable yield is an estimate of the amount of ground water that could feasibly be developed for an aquifer system area and is slightly less than CWRM adopted sustainable yields. BWS has identified Waimānalo, Koʻolau Poko, Kahana, 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.

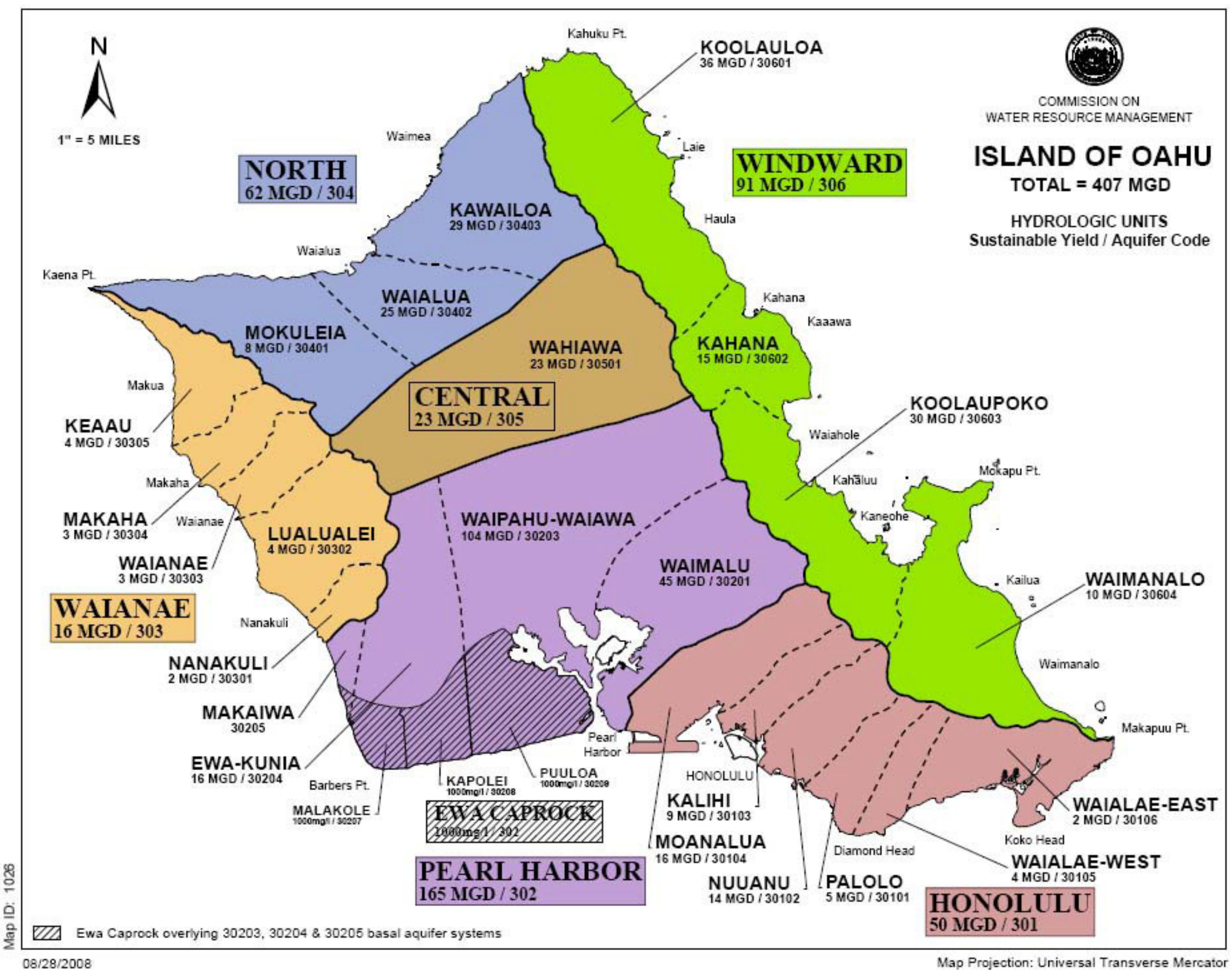


Figure 1-8 O‘ahu Aquifer System Areas

CWRM has adopted sustainable yields to protect ground water resources and regulate water use by water use permits. The following *Table 1-9* summarizes the available ground water by aquifer sector area accounting for the uncertainties of ground water/surface water interaction in dike formations in Windward and BWS operational experience in Wai‘anae.

Table 1-9 Summary of Available Ground Water by Aquifer Sector Area

Aquifer Sector	Sustainable Yield	Water Use Permits Issued (2010)	Unallocated Sustainable Yield (MGD)	Water Use 2010	SY minus Water Use
Honolulu	50	53	-3	45	5
Pearl Harbor	165	147	18	99	66
Central	23	22	1	8	15
Wai‘anae	16	---	--	5	1*
North	62	40	22	4	58
Windward	91	32	59	30	18**
Waiāhole Ditch	15	13	2	7	8
Total	**422**	**307**	**99**	**198**	**171**

* Adjusted: Based on pumping operations and BWS assessed recoverable yields. Wai‘anae & Mākaha systems: (6 MGD SY – 5 MGD use)

** Adjusted: Ko‘olau Loa system: (36 MGD SY – 18 MGD use). Excludes for planning purposes the balance of Kahana, Ko‘olau Poko & Waimānalo systems per CWRM ruling due to possible surface water interactions in dike formations.

On O‘ahu in 2010, a below normal rainfall year, about one-third or 109 MGD (307-198) of permitted use was unused. An estimate of available and recoverable ground water on O‘ahu is approximately 171 MGD, based on CWRM revised sustainable yields for O‘ahu minus water use in 2010, excluding the balance of the Kea‘au, Lualualei, Nānākuli, Kahana, Ko‘olau Poko and Waimānalo aquifer systems. Ground water use on O‘ahu increased by about 8 MGD from 2009 to 2010 primarily due to the dry weather and water use variability.

1.3.7 Surface Water Availability

Instream Flow Standards are similar to sustainable yields for ground water, in that their establishment provides a management system that protects instream and cultural uses while allowing for possible non-instream water use. CWRM is tasked with setting IFS for Hawai‘i’s streams in accordance with the State Water Code. The 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.”[i] These instream flow standards need to consider the best available information in assessing the range of present or potential instream and non-instream uses.

The current instream flow standards for O‘ahu streams are called interim instream flow standards (IIFS) 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.[ii] In the Waiāhole Contested Case Hearing, 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 instream flow standards is developed and an overall stream protection program put into place.”* The stream flows and diversions were not quantified in the standard; however, users of surface water and ground water were required to register their uses with CWRM.

CWRM amended the interim instream flow standards for four windward streams - Waiāhole, Waianu, Waikāne and Kahana have been established via the Waiāhole Ditch Combined Contested Case on July 13, 2006 *(Table 1-10)*.

Table 1-10 Amended O‘ahu Interim Instream Flow Standards

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

The State Water Resources Protection Plan (WRPP) established surface water hydrologic units and provided an inventory of basic data for O‘ahu’s streams. Table 3-22 of the WRPP lists 87 streams on O‘ahu, including the watershed area, number of diversions and stream gages. Diverted stream flows and their uses are not measured or reported and could not be included. The stream diversion inventory process continues and new information will be added to future WMPs. *Figure 1-9* shows O‘ahu’s surface water hydrologic units.

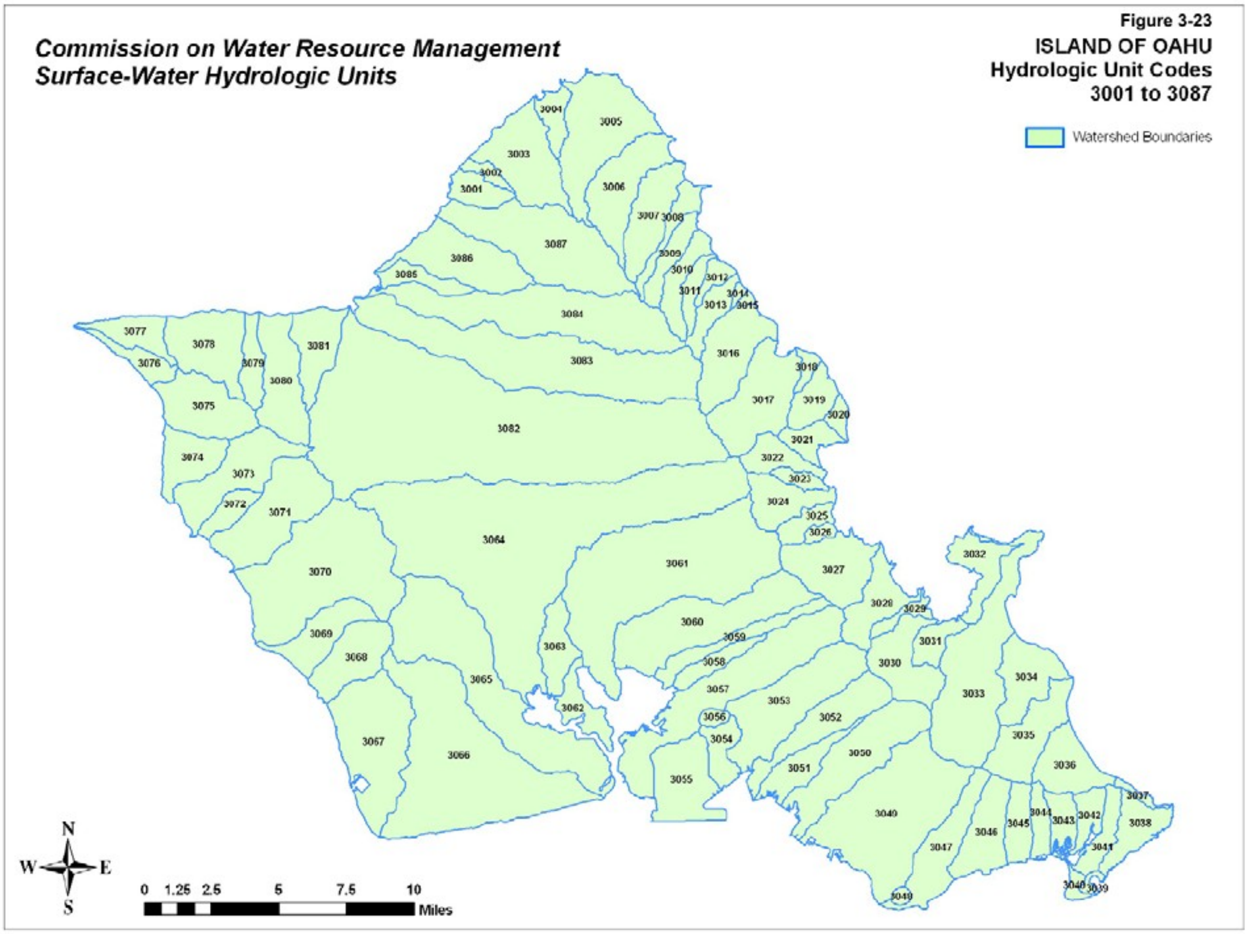


Figure 1-9 O‘ahu Surface Water Hydrologic Units

The hydrogeology appendix 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. Punalu‘u Stream and irrigation system studies have cost over $500,000, and therefore, new diversions, while permit-able, are not cost effective unless a simpler methodology for setting measurable IFS is proposed. The planning approach to surface water availability, 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. Significant new stream diversions will require amendments to IFS. In general, a starting point for surface water availability assumes 50% of Q70, stream flowing 70% of the time. *Table 1-11* lists some of O‘ahu’s largest perennial streams.

Table 1-11 O‘ahu’s Largest Streams and Mean Flows (2004 and 2010)

Stream Name	USGS Stream Gage no.	Mean Flow 2004 (CFS / MGD)	CFS Mean Flow 2010 (CFS / MGD)
Kaluanui	16304200	7.5 / 4.8	3.9 / 2.5
Punalu‘u (above ditch)	16301050		19.0 / 12.3
Kahana	16296500	53.5 / 34.6	28.1 / 18.1
Waikāne	16294900	19.1 / 12.3	7.9 / 5.1
Waiāhole (Kamehameha Hwy)	16294100	55.0 / 35.6	26.3 / 17.0
Waihe‘e	16284200	9.2 / 6.0	5.3 / 3.4
Kahalu‘u	16283200	5.1 / 3.2	1.6 / 1.1
Ha‘ikū	16275000	3.6 / 2.3	1.8 / 1.2
Kamo‘oali‘i - Kāne‘ohe	16272200	17.5 / 11.3	-- / --
Makawao – Kailua	16254000	7.2 / 4.7	3.2 / 2.1
Mānoa (Kānewai)	16240500	5.9 / 3.8	8.2 / 5.3
Kalihi	16229000	9.2 / 6.0	4.0 / 2.6
North Hālawa	16226200	9.9 / 6.4	2.8 / 1.8
Waiawa	16216000	50.0 / 32.3	-- / --
Waikele	16213000	53.7 / 34.7	24.5 / 15.8
Mākaha	16211600	2.2 / 1.4	0.5 / 0.3
N. Kaukonahua	16200000	19.2 / 12.4	10.4 / 6.7
S. Kaukonahua	16208000	29.6 / 19.1	15.1 / 9.7
‘Ōpae‘ula	16345000	18.8 / 12.2	11.9 / 7.7
Kamananui - Waimea	16330000	24.7 / 16.0	12.9 / 8.3
Total		**400.9 / 259.2**	**187.4 / 120.9**

Source: USGS Data. Several USGS gages have been discontinued due to cost considerations.

Note: Q70 is less than mean stream flow.

2004 was an above normal rainfall year while 2010 was a below normal rainfall year which accounts for the large difference in total gaged stream flow.

1.3.8 Planned Source Development

New sources recently completed or in various stages of construction and potential potable sources that will provide for future water demands are listed in *Table 1-12*. Alternative potable and nonpotable sources such as recycled water and desalination are listed in *Table 1-13*.

Table 1-12 Existing and Potential Ground Water Resources of Potable Water

New Ground Water Sources	Estimated Yield (MGD)	Additional Permitted Use Required (MGD)	CWRM Water Management Area	Potential Development Plan Area(s) Served
1. Kahuku Wells Pump 3	1.0	0.4	Koʻolau Loa	Koʻolau Loa
2. ʻŌpana Wells*	1.0	0.654	Koʻolau Loa	Koʻolau Loa
3. Kaipapaʻu or Wailele Well[1]	1.0		Koʻolau Loa	Koʻolau Poko
4. Kaluanui Wells* [1]	1.5		Koʻolau Loa	Koʻolau Poko
5. Maʻakua Wells* [1]	1.0		Koʻolau Loa	Koʻolau Poko
6. Kūʻou Well III*	0.5		Koʻolau Poko	Koʻolau Poko
7. Waimānalo Well III* ##	0.5	0.3	Waimānalo	Koʻolau Poko
8. ʻĀina Koa Well II	1.0		Waiʻalae-West	East Honolulu
9. Waiʻalae West Well	0.5	0.5	Waiʻalae-West	East Honolulu
10. Waiʻalae Nui Well*	0.7		Waiʻalae-West	East Honolulu
11. Nuʻuanu Tunnels MF Treatment Plant	0.2	Gravity Flow	Nuʻuanu	PUC
12. Wahiawā Well III	3.0	3.0	Wahiawā	Central
13. Waipiʻo Heights Wells III*	3.0	1.75	Waipahu-Waiawa	Central/PUC
14. Mililani Wells IV *	3.0	1.0	Waipahu-Waiawa	Central
15. Waiawa Wells I-I[2]	6.0	6.0	Waipahu-Waiawa	Central
16. Manana Well *	1.0	0.3	Waipahu-Waiawa	PUC
17. Kunia Wells III *	3.0		Waipahu-Waiawa	ʻEwa, Waiʻanae
18. Waipahu Wells II *	3.0	1.0	Waipahu-Waiawa	Central
19. Waipahu Wells III * #	3.0		Waipahu-Waiawa	PUC
20. Waipahu Wells IV*	3.0		Waipahu-Waiawa	ʻEwa, Waiʻanae
21. ʻEwa Shaft*	10.0	2.4	Waipahu-Waiawa	ʻEwa
22. Waipiʻo Heights II*	2.0	1.0	Waipahu-Waiawa	Central
Total Potable Resources	**48.9**	**18.3****		

Notes:

1 Potential transfer of existing permitted use from Punaluʻu Wells to optimize pumpage

2 Waiawa Water Master Plan, Revised Dec 14, 2004.

* Source already has an existing permitted use equal to or a portion of the estimated yield.

** Total does not include transfers of existing permitted use.

Includes 0.5 MGD water reservation for Department of Hawaiian Home Lands (DHHL)

0.124 MGD water reservation exists for DHHL in the Waimānalo WMA

Table 1-13 Existing and Potential Alternative Potable and Nonpotable Water Sources

Resource[1]		Minimum Estimate	Maximum Estimate	Development Plan Areas Served
Desalination (potable)				
1	Kapolei Brackish Desalination Plant	0.5	0.7	‘Ewa
2	Kalaeloa Seawater Desalination Plant	1.0	5.0	‘Ewa
Recycled Water				
4	Wahiawā WWTP[1]	1.6	2.0	Central (Galbraith)
5	Schofield WWTP	2.6	4.0	Central (Kunia)
5	Honouliuli Recycled Water	12.0	20.0	‘Ewa
6	Wai‘anae Recycled Water[2]	1.0	1.0	Wai‘anae
7	Kahuku, Turtle Bay, Lā‘ie Recycled Water	0.8	2.6	Ko‘olau Loa
8	Waimānalo Recycled Water	0.7	1.0	Ko‘olau Poko
9	Ala Wai Golf Course MBR	0.25	0.5	PUC
10	Mililani WWTP MBR	1.0	2.0	Central
Nonpotable Water				
9	Waiāhole Ditch[3]	15.0	15.0	‘Ewa, Central
10	Wahiawā Reservoir[4]	8.5	16.0	North Shore, Central
11	Kalauao Spring	0.5	3.3	PUC
12	‘Ewa Brackish Basal Wells[5]	4.0	5.0	‘Ewa
13	Ko‘olau Loa Agricultural Wells[6]	6.3	12.6	Ko‘olau Loa
14	Punalu‘u Stream Irrigation System[7]	2.0	7.0	Ko‘olau Loa
15	Maunawili Ditch/Waimānalo I	0.4	1.4	Ko‘olau Poko
16	Kawailoa Irrigation System[8]	8.0	8.0	North Shore
17	Glover Tunnel – Mākaha	0.55	0.55	Wai‘anae
18	Barbers Point NPW Well	1.0	1.0	Ewa
19	Waipio-Makalena NPW System	1.0	1.0	Central O‘ahu
	Total Alternative Resources	**68.7**	**109.1**	

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 = 2009 CWRM permitted use. 2.43 MGD remains unpermitted.

4 Kaukonahua Streams minimum average month = 8.5 MGD, 2004 mean flow = 31 MGD, 2010 mean flow = 16 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 Ground Water Withdrawal on Streamflow and Habitat, USGS Report 2006-5153.

8 Approximately 80% is surface water and 20% is ground water sources

The following table summarizes *Tables 1-12* and *1-13* of planned potable ground water sources and alternative potable and nonpotable sources.

Table 1-14 Planned Water Sources Summary

Resource	Quantity (MGD)
Ground Water – Potable	49
Desalination – Potable (minimum estimate)	1.5
Recycled Water (minimum estimate)	19.75
Ground Water – Nonpotable	36
Surface Water – Nonpotable	34
Total	140

Increases in potable and nonpotable demand are offset by water conservation, released agricultural ground water from the close of the sugar plantations, seawater desalination and the development of brackish and recycled irrigation water systems. Surface water is continuing to supply agriculture and although new stream diversions are not planned, additional water demands could be supplied by water loss control measures in ditch irrigation systems. Surface water will not be evaluated for municipal use until measurable IFS are set and water availability is determined.

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

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

- BWS has been operating the 12 MGD Honouliuli Water Recycling Facility for over a decade to supply irrigation and industrial process water for ‘Ewa. The recycled water distribution system can be supplemented with brackish water.
- The Army’s Schofield WWTP produces about 2.6 MGD of R-1 quality recycled water. With a planned distribution system within Schofield and to Kunia farms and back up storage, the water could be used for R-1 uses.
- The City’s Wahiawā WWTP has completed upgrades to produce 1.6 MGD of R-1 quality recycled water. With a water distribution system to State Agribusiness Development Corporation’s Galbraith Lands in Wahiawā and back up storage, the water can be used as R-1 water.

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

- The Kalaeloa Seawater Desalination Plant is currently planned for construction in the early 2020 timeframe and will bring an additional 1.0 MGD minimum of potable water supply to the ‘Ewa districts. The plant will be capable of further expansion as needed.
- The Kapolei brackish water desalination plant in Kapolei Business Park is currently being master planned adjacent to a new operations base yard. The brackish desalination plant is expected to produce approximately 0.7 MGD of potable water supply for Kapolei.

1.3.9 Adequacy of Supply and Future Demand and Population Distribution

The 171 MGD of unused ground water available on O‘ahu in 2010 (*Table 1-9*), adjusted for recoverability, and the existing large agricultural irrigation systems [Wahiawā Reservoir (16 MGD), Maunawili Ditch (1.4 MGD), Punalu‘u Stream (7.0 MGD), Kawailoa (8 MGD) and the Waiāhole Ditch (15 MGD)] totaling 47 MGD are available to meet future urban and agricultural water demands beyond the 2035 planning horizon.

Existing stream diversions will continue to provide for agricultural uses, including kalo, and reduce the need for potable ground water, although supplemental wells are recommended as a drought mitigation strategy. No new stream diversions are planned for non-instream uses until interim IFS are amended to protect and support appurtenant rights, traditional and customary rights in the stream, estuary and nearshore water environments. However, water efficiency improvements in the stream diversion and ditch systems should provide additional surface water for additional agricultural irrigation.

Recycled water is planned to supply a minimum of 20 MGD for urban irrigation. Future seawater desalination could supply approximately 2 MGD of potable water for ‘Ewa.

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 a total of 59% of O‘ahu’s population. Adding Central O‘ahu, the total General Plan population increases to 76% in these three districts. Therefore, natural and alternative water supplies, such as ground water, storm water, recycled water and desalination as well as advanced water conservation and watershed management to sustain the natural water resources must be fully integrated. In the remaining five sustainable communities of Wai‘anae, North Shore, Ko‘olau Loa, Ko‘olau Poko and East Honolulu, little change in BWS water demand is expected throughout the planning horizon. The existing sources and infrastructure in these sustainable areas are adequate, and therefore, additional transfers of water between these districts will be stable.

A summary graphic of O‘ahu’s population distribution based on the 2010 census, BWS potable water demand and water transfers is provided for the eight land use districts (*Figure 1-10*). This updated graphic from the 2000 graphic in previous WMP’s shows a reduction in BWS water demand of approximately 10 MGD from 155 MGD to 143 MGD. The 2010 water demand and distribution in the BWS system will be referenced in establishing future regional watershed management plan scenarios.

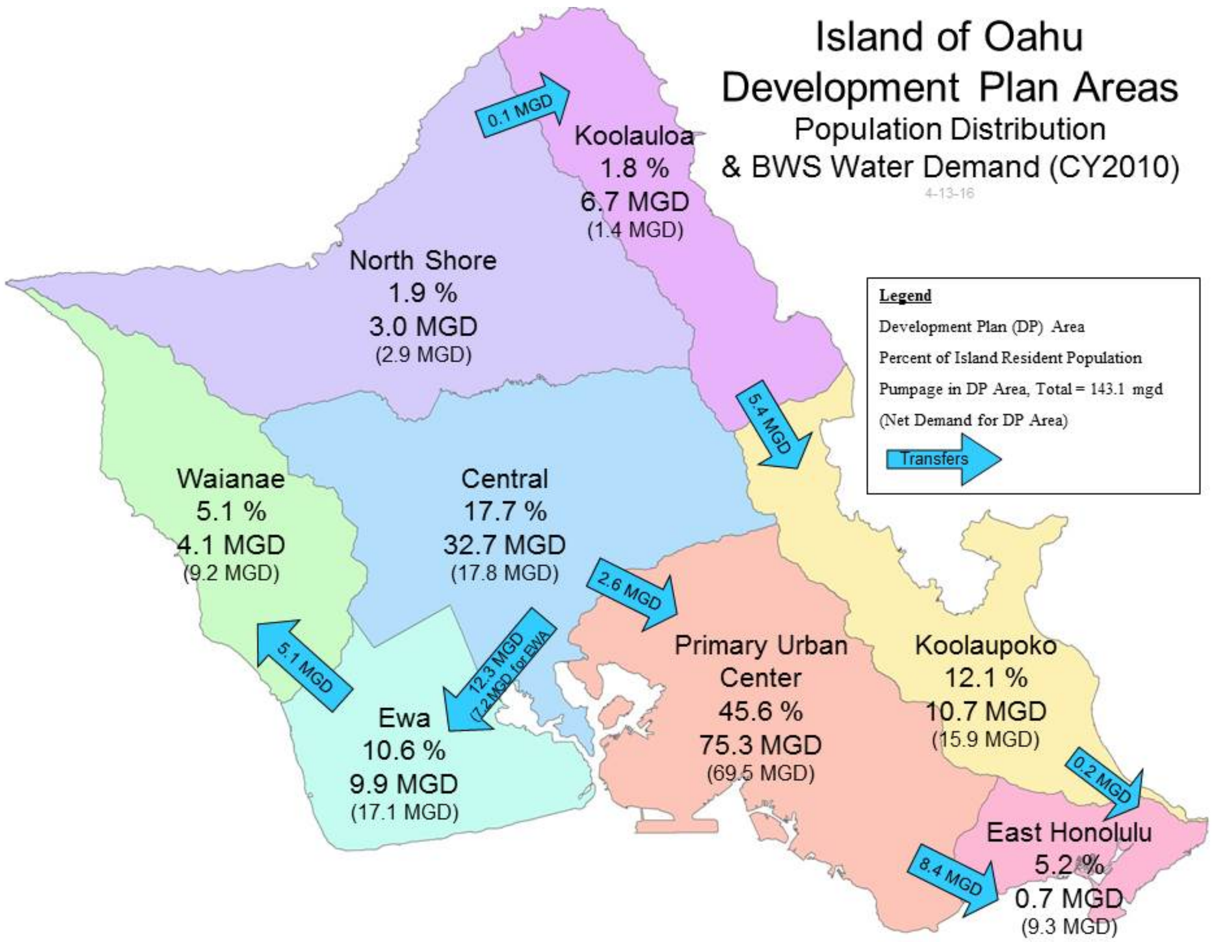


Figure 1-10 Population and Potable Water Demand Distribution 2010

A second summary graphic (*Figure 1-11*) of O‘ahu’s estimated population distribution and water demand based on DPP’s 2035 forecast is the BWS low-growth demand scenario. Potable water demand is increasing by only 7 MGD from 143 MGD in 2010 to 150 MGD in 2035, anticipating continued decreasing trends in per capita water use. Water transfers in 2035 between land use districts are expected to decrease accordingly except between Central O‘ahu and PUC. Desalination is included in the ‘Ewa district along with recycled water for irrigation that will be reducing the amount of additional potable water demand.

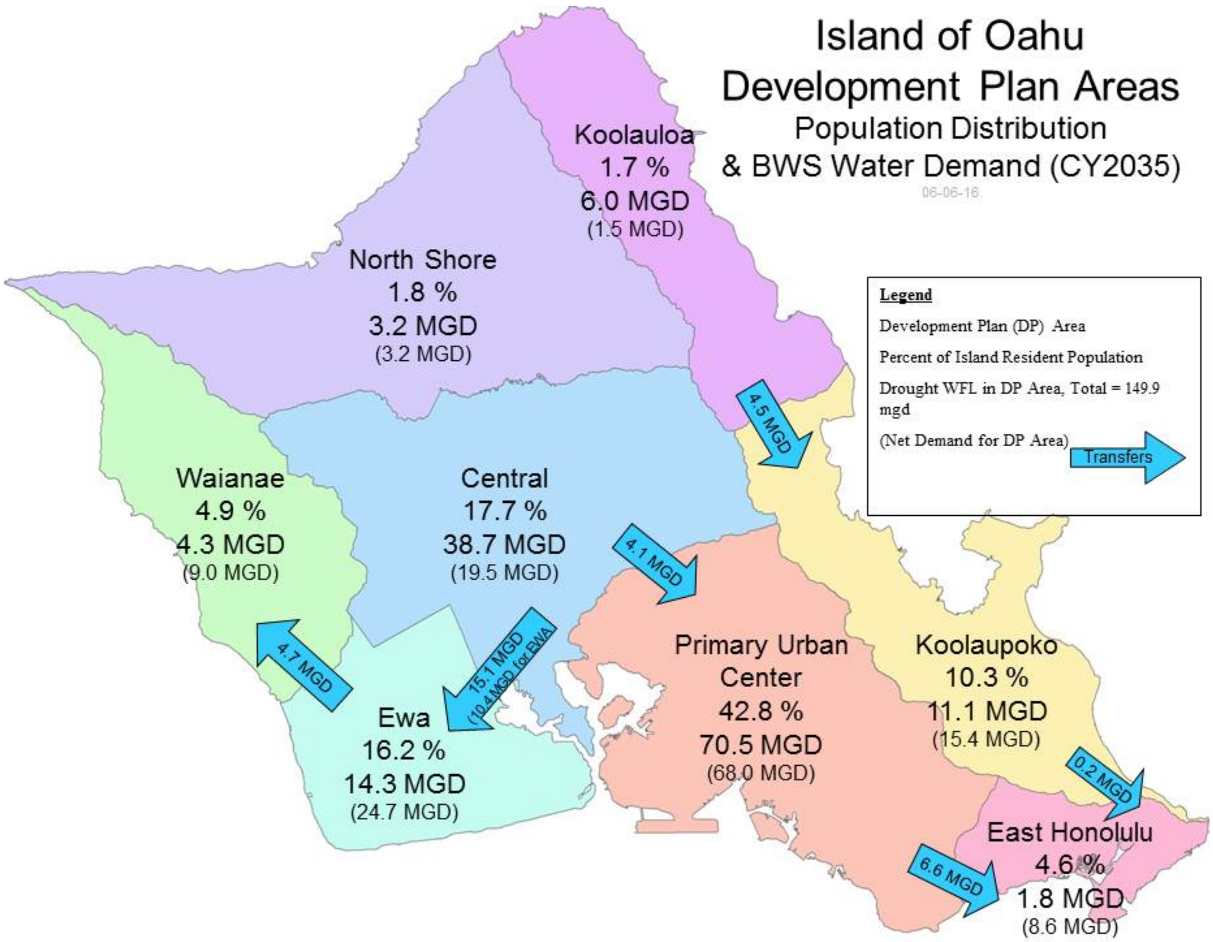


Figure 1-11 Estimated Population and Potable Water Demand Distribution 2035

The following findings summarize *Figures 1-10* and *1-11* Population Distribution and Potable Water Demand 2010 and 2035.

- The O‘ahu General Plan directs growth to South O‘ahu, (‘Ewa, Central O‘ahu and PUC). The directed growth policy allows the remaining districts of Wai‘anae, North Shore, Ko‘olau Loa, Ko‘olau Poko and East Honolulu to be sustainable communities with limited growth.
- Projected increase in water demand for O‘ahu’s eight land use districts of 8 MGD can be met with the current BWS water system. However, to realize this low forecasted demand, it is important that the following strategies be pursued:
    - o Continue to advance water conservation programs of water loss control in distribution systems and on-site plumbing/irrigation systems, high efficiency toilets and water fixtures, economic incentives and education, etc.

- Diversify water supplies through a combination of ground water, recycled water, storm water and desalination, which will preserve the natural ground water resource by providing drought proof water supplies and capture storm water to supplement irrigation. New potable ground water sources will be developed to distribute source withdrawals to reduce concentrated pumping in select large pump stations in anticipation of decreasing rainfall predicted by some climate change models. Brackish ‘Ewa Plantation wells will continue to be converted for urban irrigation in ‘Ewa to reduce potable ground water use. New distributed recycled water systems including membrane bioreactor (MBR) scalping plants are planned.
- Promote green infrastructure and low impact development standards that reduce water use. Consider new policies that utilize recycled water to irrigate single family lots and dual water systems for toilet flushing in new construction.
- Ensure watershed protection projects are adequately funded and implemented to preserve native species and water supplies in a climate change future so that existing source capacities can be maintained.

The BWS low-growth demand scenario of population and potable water distribution in 2035 is based on the best available estimates of supply and demand, analysis of decreasing water demand trends experienced since 1990 plus a significant commitment to advanced water conservation and alternative water development. New aquifer studies and climate change research will continue to refine estimates of sustainable yield and pumpage optimization plans will be adapted to avoid salinity and other water quality impacts.

The most conservative estimates of available remaining ground water sustainable yields, a reasonable accounting of uncertainties and climate change, planned ground water source projects, advanced water conservation and green infrastructure programs and alternative water source projects, such as recycled water, storm water and desalination, are used to accommodate future demands while also providing a comprehensive, watershed based suite of strategies, programs and projects to accommodate future growth and water demands within and beyond the 2035 planning horizon.

1.3.10 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 4: Plan Objectives, Water Supply and Watershed Management Projects and Strategies* and *Chapter 5: Implementation* incorporate contingencies designed to plan for uncertainties in supply and demand.

1.3.10.1 Ground Water Supply Uncertainties and Contingencies

Ground water supply uncertainties and contingencies are presented in this section and include the following topics:

- Estimating Sustainable Yield
- Recoverability of Sustainable Yield
- Climate Change
- Ground Water Contamination

The uncertainties are discussed followed by contingencies, or planning strategies to mitigate effects of the ground water 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.

Contingency for Estimating Sustainable Yield

- Periodically update information on rainfall, evapotranspiration, runoff, leakage and recharge to reflect current hydrologic trends due to climate change.
- Evaluate and account for aquifer boundary conditions recognizing separate geological formations such as dike, basal, alluvial and caprock aquifers within each aquifer system area.
- Construct deep monitor wells in important basal aquifers to provide the ability to monitor water levels, freshwater lens and transition zone thickness and trends in response to pumping.
- Develop advanced numerical ground water models to improve sustainable yield estimates. CWRM with BWS, USGS and UH participates in various efforts, dedicated to monitoring key hydrologic indicators such as rainfall, evapotranspiration, recharge, head, salinity, and transition zone trends, and to reaffirm the adopted sustainable yields in key aquifer systems. The USGS is constructing a 3-dimensional solute transport ground water model of the Pearl Harbor aquifer system calibrated to deep monitor wells.

Recoverability of Sustainable Yield

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

Contingency for Recoverability of Sustainable Yield

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

Climate Change

Climate change is expected to cause more severe droughts and floods, and as global temperatures increase, sea water levels are expected to rise affecting coastal environments, brackish aquifers and stream estuaries. Rainfall data from 1990 to 2010 show decreasing rainfall of 12% on O‘ahu (rain follows the forest). However, local climate models are mixed on the severity of future rainfall trends. The uncertainties introduced by climate change emphasize the importance of incorporating water system 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 to the uncertainty.”*[iii]

Contingency for Climate Change on Rising Sea Levels and Decreasing/Variable Rainfall

Rising sea levels and rainfall variability are global issues, which may have long-term impacts for Hawai‘i. A precautionary approach to adaptation and mitigating impacts of rising sea levels and rainfall variability is to 1) identify the water system’s most critical vulnerabilities; 2) suggest how climate variability and extremes might aggravate those vulnerabilities, and 3) design a range of solutions covering the climate uncertainty. The following contingencies could be evaluated:

- Sea level rise models by UH Sea Grant anticipate a likely sea level rise of 3 feet by 2100. At this level, coastal inundation, retreat/fill, hardening and infrastructure damage are predicted. BWS freshwater wells will not be impacted because of the overlying caprock formation preventing seawater from entering into the basal aquifer. Basically, if sea level rises by 3 feet, the freshwater lens due to density differences will rise 3 feet which will not detrimentally affect source yields. In areas of thin caprock above mean sea level, 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 Ground Water Replenishment System, recycled water hydraulic barrier injection system. However, the recycled water is treated by reverse osmosis to better than drinking water standards. In many systems in California, potable reuse has become the preferred strategy.
- Private brackish caprock wells near the coast may become more brackish or unusable increasing potable demand if converted and may need to be replaced with alternative supplies, such as recycled water.
- Recycled water and seawater desalination provide drought proof water supplies and watershed management projects will ensure healthier forests that will capture a larger percentage of less rainfall, stabilizing recharge fluctuations and maintaining current aquifer sustainable yields.
- BWS has engaged UH and the Water Research Foundation in climate change research projects to increase our understanding of climate change impacts to freshwater supplies.

Vulnerable water systems to severe drought and coastal inundation will be identified and resolved through the BWS capital improvement program.

- BWS is engaging UH in an aquifer storage and recovery study of storm water impoundment in Nu‘uanu Reservoir No. 4. Impounded storm water could be treated and injected into the Kalihi and Nu‘uanu aquifers to supplement natural recharge and sustain existing pumping stations down gradient.

Ground Water Contamination

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

Contingency for Impacts from Ground Water Contamination

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

1.3.10.2 Surface Water Supply Uncertainties

Surface water supply uncertainties and contingencies are presented in this section and include the following topics:

- Amending Interim Instream Flow Standards
- Quantifying Stream Flows, Diversions and Use
- Drought Impacts on Surface Water

The uncertainties are discussed followed by contingencies, or planning strategies to account for 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. 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.

Contingency for amending interim IFS

- CWRM identifies 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 has developed a standardized measurable IFS methodology emphasizing practicality and consistency.
- Until measurable IFS are established, new stream diversions are not recommended in this plan, other than for traditional and cultural practices, such as kalo cultivation. Other surface water users should work within the existing diverted flows, applying conservation and water loss prevention strategies to increase system efficiencies.

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 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 ground water use, non-instream water use must be reasonable and beneficial, conserved or returned to the stream.

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. BWS hydro-geologists are conducting field surveys using CWRM survey protocols of stream diversions to supplement CWRM efforts.
- The stream permitting process is being revised to improve the acquisition of pertinent information, and a surface water use reporting system will be established.

Drought Impacts on Surface Water

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

Contingency for Drought Impacts on Surface Water

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

A significant limitation to using surface water is its variability and lack of reliability especially during dry periods and drought. By increasing water storage, or by supplementing surface water with ground water, which is called conjunctive use, additional agricultural lands may be irrigated year-round cost effectively with minimal impact. *Figure 1-11* shows the seasonal relationship between surface water in conjunction with ground water for agricultural irrigation. During dry seasons and drought, when demand increases and limited stream water is available, ground water can supplement surface water, protecting instream uses. Surface water, which is more abundant during the wet season, can be economically used, allowing time for the ground water source to be replenished.

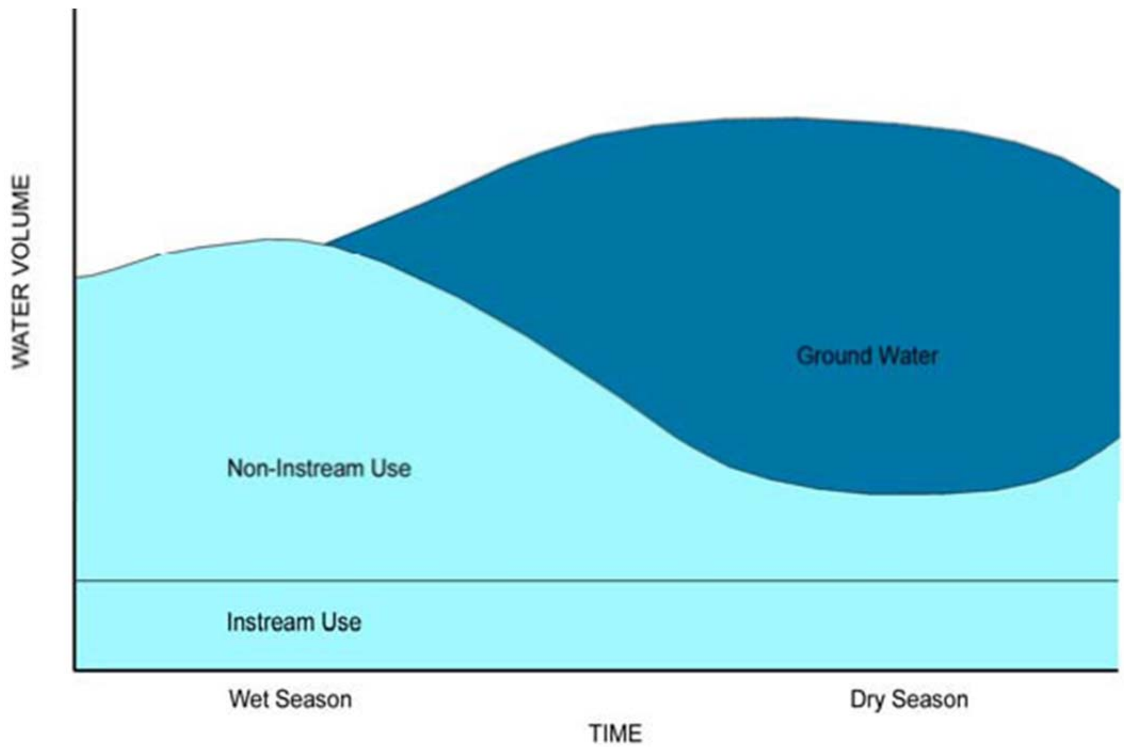


Figure 1-12 Seasonal Agricultural Water Use Supplementing Surface Water with Ground Water

1.3.10.3 Agricultural Water Demand Projection Uncertainties and Contingencies

Predicting agricultural water demands is challenging because of market uncertainties, variable regional crop type and associated water demand numbers, climate variability, etc. In addition, the general lack of metering agricultural water use severely hampers not only demand estimates but the protection and management of the water resource. Hawai‘i’s diversified agricultural production has increased in recent years.

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.

Contingency for Agricultural Water Demands

CWRM funded a UH study to develop a crop water demand model that is now used to provide discreet water demands by specific crop type, climate and soil condition. The model allows CWRM to tailor water allocations to specific lands thereby assuring reasonable and beneficial water use.

1.3.10.4 Urban Water Demands Uncertainties and Contingencies

Predicting population growth depends on public policies in the Development and Sustainable Communities Plans and the fluctuating economic trends affecting the pace of urban growth. The urban growth and rural community boundaries provide essential guidance on discreet limits to urban growth to protect agricultural and conservation lands. A significant uncertainty is estimating water demands associated with urban growth concurrently with decreasing unit water demands that masks the true effect of water conservation programs.

Contingency Plans for Demand Projection Uncertainties

The following strategies can mitigate the uncertainties in demand forecasting:

- Compiling trend data to analyze the extent, causes and effects of decreasing per capita water demand to develop reliable and accurate water demand forecasts. Improved conservation measures and economic forces have slowed both urban and agricultural water demand growth extending existing supplies.
- 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.
- With the integrated water resources strategies of watershed protection, advanced conservation, and sustainable diversified ground water and surface water supplies, and new technologies in recycled water and desalination using renewable energy sources, there should be sufficient water supply to accommodate variability in climate and domestic and agricultural water demand growth.

1.4 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 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 ground 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 ground water management areas. HRS 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 Improvement Program

The OWMP is the long-range strategic water resource plan for the City and informs and guides the BWS long-range capital program plan of source, storage, transmission, treatment infrastructure by providing a watershed based evaluation of available sources of supply and water demand forecasts. 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.

In 2013, BWS initiated the BWS Water Master Plan, a 30-year infrastructure plan that evaluates the entire water system, identifies improvements and balances needs and costs. The benefits are that infrastructure needs are anticipated so that water is available when and where it’s needed and capital projects are prioritized based on a comprehensive understanding of water resources from a holistic watershed perspective, most probable water demands accounting for conservation savings and the complexities of the water systems serving O‘ahu’s residents such that BWS can provide safe, dependable and affordable water supply now and into the future.

ENDNOTES

i State Water Code Section 174-C3

ii HAR Section 13-169-49 and 49.1

iii Miller, K. and Yates, D. 2006. *Climate Change and Water Resources: A Primer for Municipal Water Providers.* National Center for Atmospheric Research, American Waterworks Assoc. Research Foundation Publication

CHAPTER 2
‘EWA WATERSHED PROFILE

‘EWA WATERSHED MANAGEMENT PLAN

2 ‘EWA WATERSHED PROFILE

2.1 Overview of the ‘Ewa District

‘Ewa is located in the southwestern sector of the island of O‘ahu and is defined by the City and County of Honolulu’s ‘Ewa Development Plan District (Figure 2-1). It is bounded by the Wai‘anae and Central O‘ahu Planning Districts to the north, and by the Pacific Ocean and Pearl Harbor’s West Loch to the south. At approximately 33,677 acres (52.6 square miles) in size, [1] ‘Ewa is the second smallest of the City’s eight planning districts, but fastest growing in terms of population.

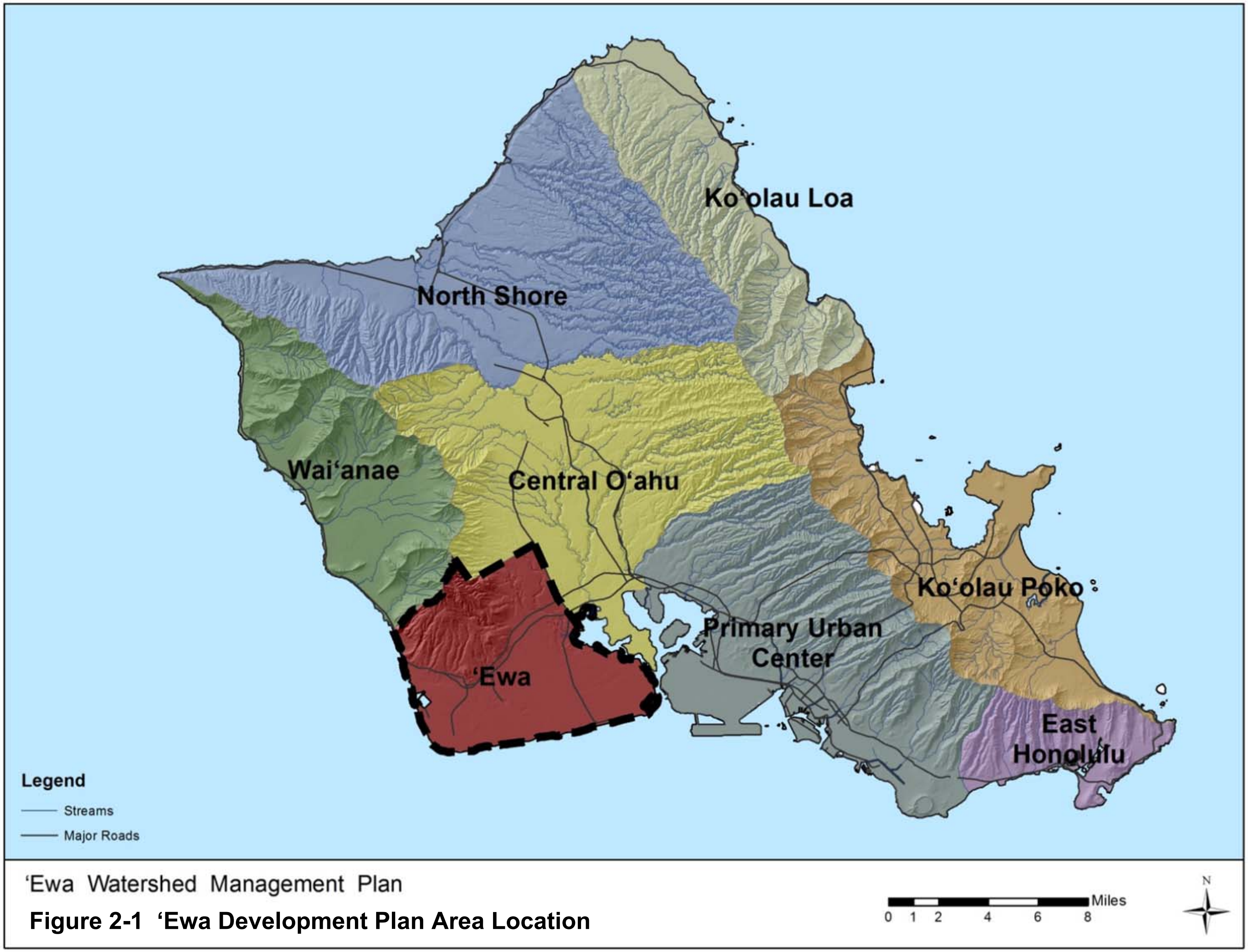
Key Implications for Water Resource Planning

- Limited extent – The ‘Ewa district does not include all of the upper watershed lands that contribute to its surface and ground water sources.

2.1.1 Climate

‘Ewa has a mild, subtropical climate, with temperatures typically ranging from 69° F to 91° F. Rainfall varies from approximately 20 inches per year in the Makaīwa, Kalo‘i, and Honouliuli areas to about 40 inches per year at Pālehua in the Wai‘anae Mountains, making ‘Ewa one of the drier areas of O‘ahu, where average rainfall can top 200 inches per year in the wettest areas.

[1] Personal communication, May 8, 2013, Department of Planning and Permitting, City and County of Honolulu.



'Ewa Watershed Management Plan

Figure 2-1 'Ewa Development Plan Area Location

The prevailing winds in ‘Ewa are tradewinds, from the northeast, occurring approximately 70% of the time. Kona winds from the south are also experienced. Average wind speed is 5-15 miles per hour. Evapotranspiration, water loss due to a combination of transpiration by plants and direct evaporation from plants, land, and water surfaces, is a major component of the hydrologic budget. Evaporation rates are high along the ‘Ewa coast, approximately 90 inches per year.

In 2007, Act 234 recognized that “climate change poses a serious threat to the economic well-being, public health, natural resources, and the environmental of Hawaii. The potential adverse effects of global warming include a rise in sea levels resulting in the displacement of businesses and residences and the inundation of Hawaii’s freshwater aquifers, damage to marine ecosystems and the natural environment, extended drought and loss of soil moisture,…and an increase in the severity of storms and severe weather events.” Indeed, climate change impacts have been recorded by NOAA as such:[2]

- “Average annual temperature has generally increased over the past 50-90 years. In Hawai‘i, high elevation stations have been warming faster than low elevation stations over the past 30 years;
- There has been a decline in northeast trade wind frequency in Hawai‘i since 1973;
- Precipitation has trended downward over the past 100 years in Hawai‘i;
- Hawai‘i has experienced a trend toward increasing drought during the winter rainy season.”

Additionally, probable future impacts of climate change on water resources have been predicted by a number of recent publications, notably the “National Water Program 2012 Strategy: Response to Climate Change” (EPA December 2012).

- Decrease in potable water supplies due to increased frequency, severity and duration of droughts; increase in evaporation; decrease in cloud cover and high level rainfall; decrease of fog drip at higher elevations, decrease in recharge of ground water aquifers, salt water intrusion into fresh and brackish water aquifers, and overall decrease in the sustainable yields of island aquifers;
- Increase in potable and non-potable water demand for municipal and agricultural uses due to increases in temperatures, increases in evapotranspiration and longer and more frequent droughts; “spikes” in Hawai‘i’s population growth due to migration from inundated Pacific islands;
- Decrease in the base flow of Hawai‘i streams due to decreases in rainfall and decreases in fair weather flows from springs and seeps from high level aquifers;

[2] NOAA. January 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 8. Climate of the Pacific Islands.

- Decrease in the health and diversity of nearshore aquatic ecosystems due to the increase in destructive coastal storm events and a decrease in the fair weather flow of fresh water into coastal waters;
- Impacts on water supply infrastructure due to more extreme weather events, including heavier precipitation from Kona storms and tropical cyclones, and associated inland and coastal flooding; increased corrosion of metallic pipelines resulting in more main breaks and higher repair and replacement costs;
- Increases in pollution of streams and nearshore waters due to warmer air and water temperatures and changes in precipitation patterns, causing an increase in “impaired” water bodies, with associated impacts on the health of people and of aquatic ecosystems;
- Collective and compounded impacts on coastal areas resulting from a combination of sea level rise, increased damage from storms and floods, coastal erosion, salt water intrusion into potable water aquifers, ground water inundation of low lying coastal communities, and increased temperature and acidification of the ocean;
- Indirect impacts due to unintended consequences of human responses to climate change, such as those resulting from armoring shorelines, which may in turn increase the erosion of nearby sand beaches; increased development pressures on inland agricultural lands as coastal communities “retreat” from no longer habitable coasts.
- Large increases in the costs of water supply infrastructure and flood mitigation measures due to this complex array of climate change impacts on the water systems of Hawai‘i.

These expected impacts of climate change on water resources will be particularly severe for a leeward area like ‘Ewa, with its relatively hot, dry climate and dependence on water resources from aquifers that lie in neighboring districts.

Key Climate Implications for Water Resource Planning

- ‘Ewa receives relatively low amounts of rainfall, has high temperatures, and experiences high evaporation rates, thus requiring more irrigation than other areas of the island.
- Decreasing rainfall and expected increases in drought conditions will increase water demand while decreasing water supplies, requiring more efficient use of water and diversification of water sources.
- Greater frequency and intensity of extreme weather may overwhelm water infrastructure and increase episodic pollution events from runoff.
- Sea level rise may impact water and other critical infrastructure and threaten low-lying freshwater sources.

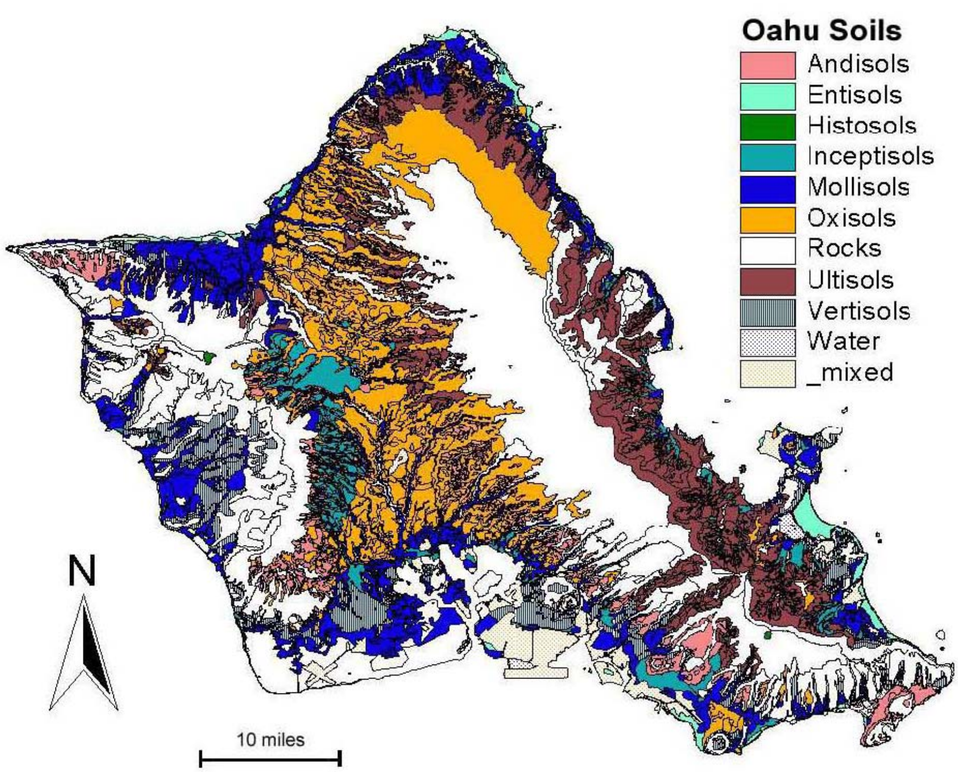
2.1.2 Geology and Soils

The island of O‘ahu was created by the Wai‘anae and Ko‘olau volcanoes. Soils in Hawai‘i have been mapped by the Soil Conservation Service (now called the Natural Resource Conservation Service) in the 1972. The highest classification of soils is the “order,” which groups soils by general characteristics and the soil-forming process. Of the 12 soil orders in the world, five, listed in Table 2-1 and mapped in Figure 2-2, are found in ‘Ewa.

Table 2-1 Soil Orders[3]

Soil Orders	Description
Andisols	Derived from volcanic ash. Fertility can range from highly productive to requiring lots of fertilizers for crop production.
Inceptisols	Minimal development of soil horizons.
Mollisols	Fertile soils with high organic content and high base saturation.
Oxisols	The most weathered soils of the tropics with low nutrient holding capacity and high iron and aluminum oxides.
Vertisols	Shrink when dry and swell when wet. They usually occur in valleys with poor drainage. They are fertile but pose severe limitations for roads, housing, and related uses.

Figure 2-2 Soil Orders on O‘ahu[4]



[3] Hue, N.V., G. Uehara, R.S. Yost, and M. Ortiz-Escobar. 2007. “Distribution of Soil Orders in Hawaii.”
[4] Hue, N.V., G. Uehara, R.S. Yost, and M. Ortiz-Escobar. 2007. “Distribution of Soil Orders in Hawaii.”

Soil associations are landscapes of distinct proportional patterns of soils. Associations normally consist of one or more major soils and at least one minor soil. There are three main soil associations in ‘Ewa (see Table 2-2). All are generally well-drained soils, suitable for various types of agriculture.

Table 2-2 Soil Associations[5]

Soil Association	Description
Lualualei-Fill land-Ewa	Deep, nearly level to moderately sloping, well-drained soils that have a fine-textured or moderately fine-textured subsoil or underlying material, and areas of fill land; on coastal plains. These soils are found from sea level to about the 400-foot elevation and can be used for agricultural purposes, livestock and pasture, urban development, and wildlife habitat. The fill land has primarily been used for commercial, industrial, and residential development. The natural vegetation consists of kiawe, koa haole, bristly foxtail, ‘uhaloa, and fingergrass.
Helemano-Wahiawa	Deep, nearly level to moderately sloping, well-drained soils that have a fine-textured subsoil; on uplands. Helemano-Wahiawa soils are found in broad areas with steep gulches between the 100 and 1,200-foot elevations. Vegetation commonly found are guava, koa haole, lantana, joee, and Bermuda grass. Helemano soils are used for pasture and Wahiawa soils are suitable for sugarcane and pineapple.
Tropohumults-Dystrandepts	Gently sloping to very steep, well-drained soils that are underlain by soft weathered rock, volcanic ash, or colluvium; on narrow ridges and steep slopes. Tropohumults-Dystrandepts soils are found on steep mountainous areas at elevations from 600 to 4,000 feet, making up much of the watershed recharge areas. Some of the minor soils are used for forest and pasture, agriculture including pineapple, sugarcane, and Japanese tea. Common plants found on these soils are lantana (tropical shrubs), yellow foxtail, and molasses grass at the lower elevations and ‘ōhi‘a, pukiawe, koa, ‘a‘ali‘i, and ferns at the upper elevations.

[5] USDA Soil Conservation Service. 1972. Soil survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. pp. 6-7.

The ‘Ewa Plain is also home to an interesting geological feature called karsts, which are formed when limestone bedrock is dissolved by the carbonic acid found in rainwater. The acidity in the flowing water eventually erodes enough limestone to cause the surface layer to collapse, creating a combination of sinkholes, caves, and underground channels. Within this region, water seeps and flows throughout these underground tunnels, caves, and streams.

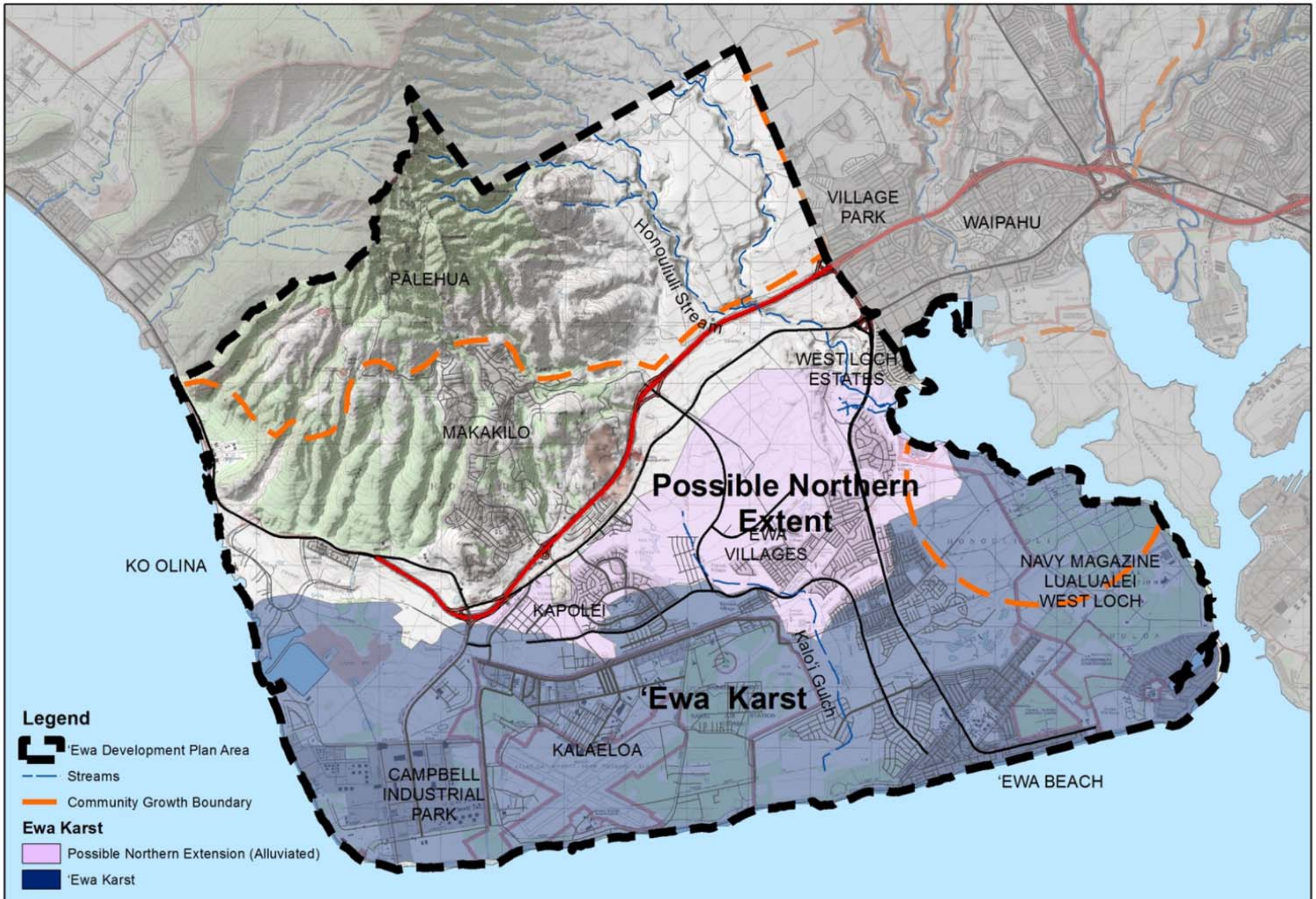
The ‘Ewa karst, covering about 31 square miles, is the largest network of karsts on O‘ahu. Some sinkholes are no more than four to five feet deep, while some are as deep as ten feet and extend to the water table.

Recent studies have found preserved remains of ancient plants and animals within the karst sinkholes, particularly shells, extinct birds, and two bats, one of which is new to science.[6] The U.S. Geological Survey ‘Ewa Quadrangle shows numerous sinking streams and closed depressions within the karst, some manmade. Most of the land surface of the karst has been developed.

Key Geology and Soils Implications for Water Resource Planning

- Much of the soils in ‘Ewa are well-drained and suitable for agriculture.
- The karst system is a unique geologic feature that needs protection for the biological and cultural resources associated with them.

[6] Association of Hawaiian Civic Clubs, “Resolution No. 01-3, Commending the Estate of James Campbell for their Protection of the Ewa Karst Sink Holes,” November 10, 2001, 42nd Annual Convention of the Association of Hawaiian Civic Clubs at Honolulu, Hawai`i, <http://www.aohcc.org/con2001/AoHCC_Resolutions_2001.php> (September 12, 2006).



'Ewa Watershed Management Plan

Figure 2-3 'Ewa Soil Associations and Karst Location

0 2,500 5,000 10,000 15,000 20,000 Feet

0 0.5 1 2 3 4 Miles

N

2.2 Natural Water Resources

2.2.1 Ground Water Resources

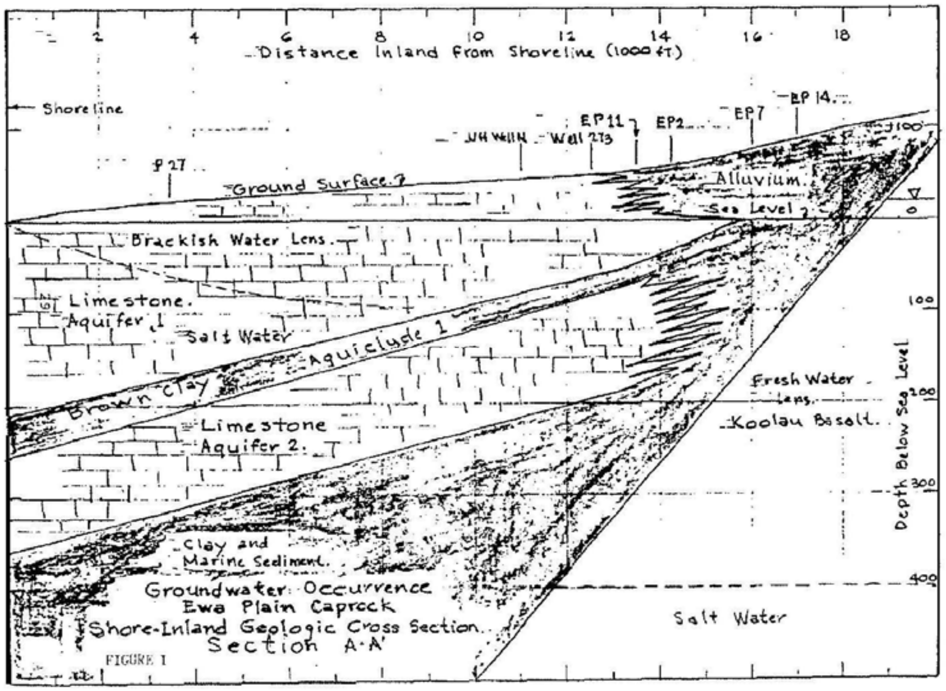
Ground water accumulates as rainfall and other types of precipitation percolate into the soil, saturating the soil and rock. The primary and most extensive type of ground water body is the basal fresh water lens that floats on denser sea water under much of Central O‘ahu and inland ‘Ewa. Water from the basaltic aquifers is relatively fresh (less than one percent saline), but as it moves towards the ocean, it mixes with sea water, forming a brackish transition zone. Recharge to the fresh water lens system is from infiltration of rainfall and discharge from upgradient ground water bodies, including dike-confined water in the Wai‘anae mountains and flow from Central O‘ahu. Agricultural irrigation was previously a significant source of recharge, but with the decline of the sugar industry, large volumes of irrigation water no longer enter this system to recharge the aquifer and ground water recharge from current agricultural irrigation is now assumed to be zero. Without supplemental irrigation, evaporation in ‘Ewa exceeds rainfall, resulting in no recharge to the fresh water aquifer, particularly since the mauka forest lands that capture ground and surface water lie outside the ‘Ewa district boundaries.

Near the coast, alternating layers of marine and terrestrial sediments deposited during sea level changes and subsidence events created the ‘Ewa plain. These sedimentary layers, or “caprock,” begin in the general vicinity of the H-1 Freeway and extend down to the coast, increasing in thickness like a wedge to a thickness of approximately 1,000 feet.[7] The caprock is highly impermeable, thus inhibiting the flow of ground water from the mauka basalt aquifers toward the ocean, thus allowing it to build up in large quantities. Caprock water is derived from local rainfall and leakage of basal water bodies. The aquifer was previously enhanced by sugar cane return irrigation, but after the O‘ahu Sugar Company closed, the brackish lens shrank to only a few feet thick.

Ground water in the upper layers of the caprock flow system is unconfined, but water in the lower caprock layers near the coast is confined or semi-confined by the overlying caprock. The caprock water found near the shore at Kalaeloa is brackish, and is in direct hydraulic connection with the Pacific Ocean.

[7] George A.L. Yuen and Associates, Inc., 1989. Report R-79), prepared for the Commission on Water Resource Management, p. 1.

Figure 2-4 Cross-Section of 'Ewa Caprock and Ground Water Occurrence[8]

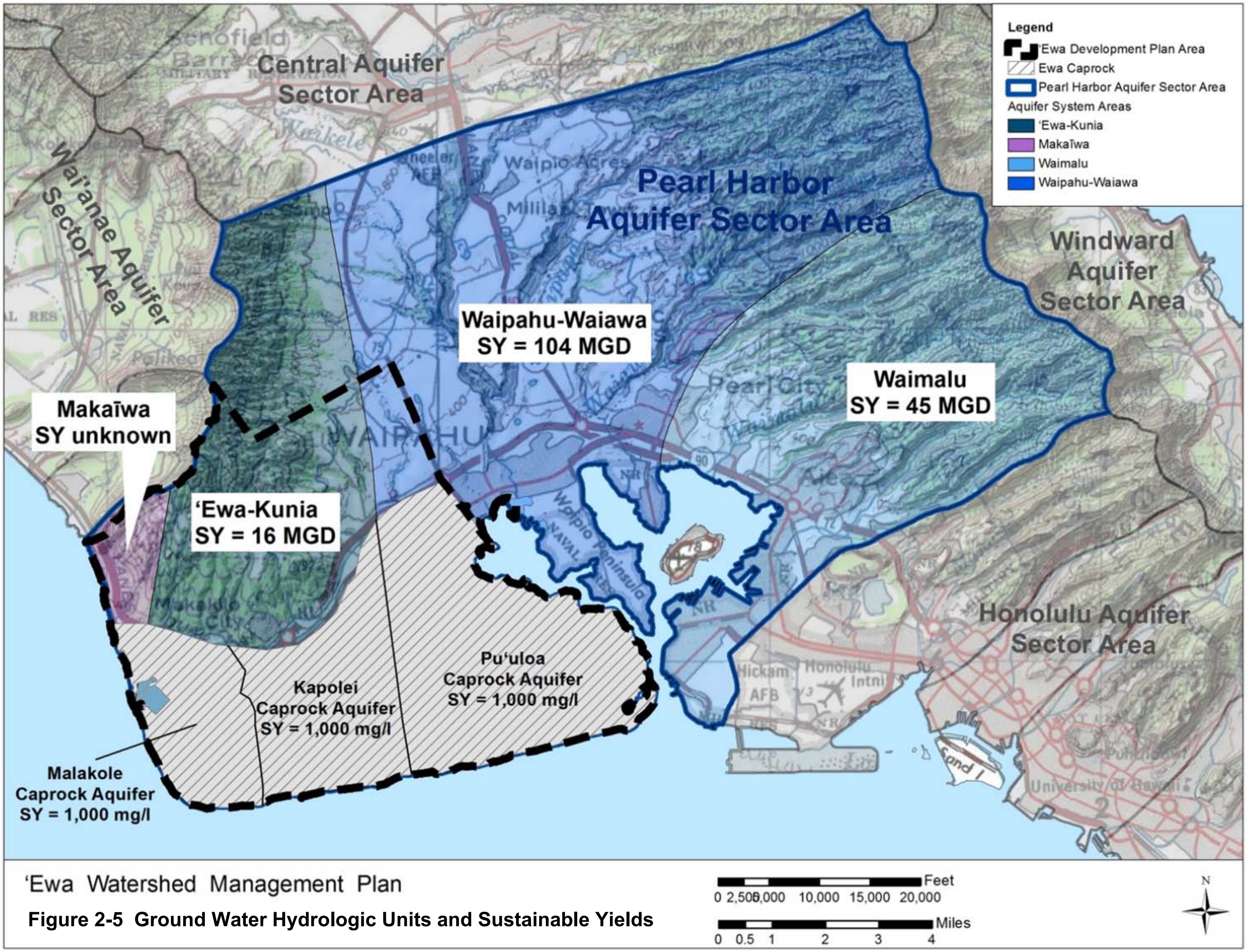


2.2.1.1 Aquifer System Areas

The State Commission on Water Resource Management (CWRM) defines seven hydrologic units, or Aquifer Sector Areas (ASA), across O'ahu, generally based on regional geology. These ASAs also serve as management boundaries for the regulation and allocation of ground water resources. The 'Ewa district covers apportion of the Pearl Harbor ASA that extends from Kahe in the west to Hālawa in the east. The 'Ewa Caprock ASA lies entirely within the 'Ewa district and extends over the makai portion of the district.

Aquifer sector areas are subdivided into aquifer system areas (ASYA), which are generally based on hydrogeology, although there may be movement of water between systems. Three of Pearl Harbor's four ASYAs are within, or partially within, the 'Ewa District (Figure 2-5). The Waipahu-Waiawa ASYA contains a basal lens in the Ko'olau volcanic series and the 'Ewa-Kunia System is in the Wai'anae volcanic series. Makaīwa ASYA was previously associated with the Wai'anae Sector due to differences in ground water behavior.[9] The 'Ewa Caprock Aquifer Sector Area includes three ASYAs: Malakole, Kapolei, and Pu'uloa.

[8] Mink. 1989. Groundwater Resources and Sustainable Yield Ewa Plain Caprock Aquifer, Oahu, Hawaii. State of Hawaii, Report R-79. P. 50.
[9] Commission on Water Resource Management. (August 2008). *Water Resource Protection Plan*. p. 3-71



'Ewa Watershed Management Plan

Figure 2-5 Ground Water Hydrologic Units and Sustainable Yields

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.”[10] The SYs for the aquifer system areas located within, or partially within, the ‘Ewa District are found in (Table 2-3).

Table 2-3 ‘Ewa Aquifer System Areas

AQUIFER SYSTEM AREA	SUSTAINABLE YIELD (MGD)[1]	PERMITTED USE (PU) IN CY 2010 (MGD)[2]	AVAILABLE YIELD (MGD)[4]	PERCENT ALLOCATED
PEARL HARBOR AQUIFER SECTOR AREA				
‘Ewa-Kunia	16	15.46	0.54	97%
Makaīwa	undetermined	0.072	N/A	N/A
Waipahu-Waiawa[3]	104	84.86 (total) 23.48 (PU in ‘Ewa)	19.14	23%
Total	**120**	**100.26 (total) 38.94 (PU in ‘Ewa)**	**19.68**	**84%**
‘EWA CAPROCK AQUIFER				
Malakole – ‘Ewa Caprock	1,000 mg/l	44.536	N/A	N/A
Kapolei – ‘Ewa Caprock	1,000 mg/l	2.333	N/A	N/A
Pu‘uloa – ‘Ewa Caprock	1,000 mg/l	11.924	N/A	N/A
Total	**N/A**	**58.793**	**N/A**	**N/A**

1 Source: Water Resources Protection Plan (August 2008). SY for the ‘Ewa caprock aquifer is set by a chloride limit of 1,000 milligrams per liter (mg/L) for irrigation.

2 Commission on Water Resource Management. May 21, 2012. Island Water Use Permit Index (Non-Salt Caprock).

3 Most of the Waipahu-Waiawa ASYA extends beyond the ‘Ewa District. Thus, much of the use is permitted outside of ‘Ewa.

4 Available yield = Sustainable Yield – Permitted Use

[10] Commission on Water Resource Management. (August 2008). *Water Resource Protection Plan*. p. 3-41.

Three of the aquifer systems, Malakole, Kapolei, and Pu‘uloa, are associated with the ‘Ewa Caprock brackish aquifer. Unlike the SY of the basal aquifer systems, the SY of the ‘Ewa caprock aquifer is set by a chloride limit of 1,000 milligrams per liter (mg/L). This chloride cap is used for several reasons: (1) the aquifer is very thin and vulnerable to saltwater intrusion thus making developable supply dependent upon well location, (2) ground water inflow from the basalt aquifer is uncertain, (3) tidal influences are equal to or greater than pumping influences, and (4) the unique hydrology warranted an alternative regulatory regime.[11] This SY is specific to irrigation wells because it is the maximum chloride level believed to be acceptable for irrigation.

2.2.1.2 Ground Water Management Areas

In September of 1979, the Board of Land and Natural Resources designated the ‘Ewa-Pearl Harbor Aquifer as the first Ground Water Control Area, now called a Ground Water Management Area (WMA). Designation as a WMA adds a layer of state oversight to water use by requiring CWRM-issued water use permits (WUP) for all water withdrawals, except for domestic consumption by individual users and catchment systems. The Pearl Harbor WMA includes the ‘Ewa-Kunia, Waipahu-Waiawa, and Waimalu Aquifer Management Systems.[12] Additionally, the ‘Ewa Caprock ASA, including the Malakole, Kapolei, and Pu‘uloa ASYAs, is also a Ground Water Management Area.

2.2.1.3 Ground Water Quality

Ground water quality in Hawai‘i is generally very good, but land uses may contaminate underlying aquifers as pollutants leach into the ground. Similarly, land uses may contaminate adjacent water bodies as water flows downgradient through gravity flow. Pesticides, herbicides, and other chemicals associated with agriculture and industry are common ground water pollutants. An increase in chlorides, an indication of salt water intrusion into the fresh water aquifer due to a thinning of the fresh water lens, is also considered an indicator of poor aquifer health.

When the sugar industry was at its peak, heavy irrigation of hundreds of acres of sugar cane supplemented ground water aquifers as excess irrigation percolated into the ground. Since the end of sugar production on O‘ahu in 1995, recharge of ground water from irrigation has subsided, resulting in fewer fertilizers leaching into the ground water from this source. In areas once fed primarily by irrigation, such as areas above the ‘Ewa Caprock Aquifer System Area, the lost input of fresh water has contributed to reduced sustainable yield and increased saltwater intrusion. Additionally, residual agricultural chemicals from pineapple cultivation, such as 1, 2, 3 trichloropropane (TCP) and dibromochloropropane (DBCP), are still detected in some wells, although within allowable levels for drinking water.

[11] Commission on Water Resource Management Staff Submittal, May 14, 1997.

[12] U.S. Geological Survey, Numerical Simulation of the Effects of Low-Permeability Valley-Fill Barriers and the Redistribution of Ground-Water Withdrawals in the Pearl Harbor Area, Oahu, Hawaii (U.S Department of the Interior, Prepared for: Honolulu Board of Water Supply; 2005).

Atrazine is an herbicide that was previously used by the sugar industry. On O‘ahu, the State Department of Health (DOH) found atrazine in wells in ‘Ewa, Central O‘ahu, and the North Shore, although at levels below Environmental Protection Agency (EPA) safety guidelines.[13] The Honolulu Board of Water Supply (BWS) has only found atrazine in its ‘Ewa Shaft, which is not yet on-line but already has Granular Activated Carbon (GAC) treatment that will remove atrazine and other volatile organic contaminants.

The City and State both protect ground water quality by identifying areas requiring special protection. In accordance with §3-301 of the BWS Rules and Regulations, BWS has delineated a “Pass/No Pass” line, which identifies where waste disposal sites are restricted. These restricted (“No Pass”) areas includes the portion of the ‘Ewa District that is mauka of the H-1 Freeway (Figure 2-6). Additionally, the DOH administers an Underground Injection Control (UIC) program in accordance with Hawaii Administrative Rules §11-23. Areas mauka of the UIC line are identified as potential drinking water aquifers that would be affected by the injection of fluids into the ground. Most of the ‘Ewa District is located mauka of the UIC line. Areas makai of the line include Ko Olina, Campbell Industrial Park, Kalaeloa, ‘Ewa Beach, and the Naval Reservation at West Loch (Figure 2-6).

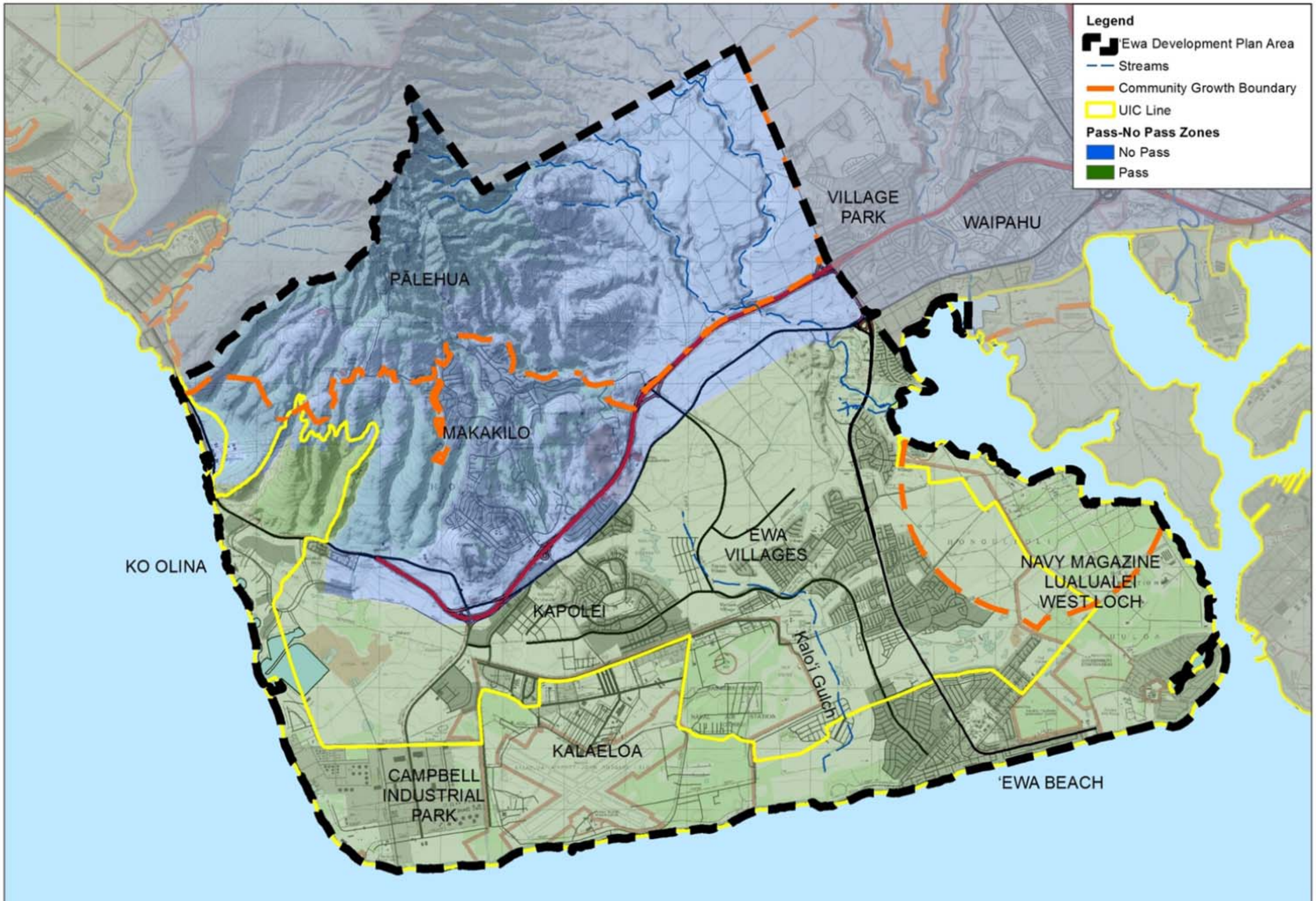
Additionally, the DOH developed the Hawaii Source Water Assessment Program (HISWAP) study, which was approved by EPA in November 1999. The HISWAP delineates drinking water source capture zones of two and 10 year travel times for each potable source. Potentially contaminating activities (PCAs) identified within these zones have to be mitigated or avoided.

On a scale of Very High, High, Medium, and Low, PCAs that the HISWAP ranked as Very High included RCRA (Resource Conservation and Recovery Act) sites, CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) sites, gas stations, historic landfills and dumps, cesspools, wastewater treatment plants, military installations, leaking underground storage tanks, pineapple cultivation, and power plants. Golf courses ranked High for potential contaminating activities in the HISWAP.

The HISWAP report scores wells based on PCAs and their proximity to the well. ‘Ewa wells had low scores in comparison with other wells on O‘ahu, indicating relatively few potential contaminating activities in close proximity to them. It should be noted that ‘Ewa Shaft is not yet in use and was not included in the HISWAP report. Barber’s Point Shaft, owned by the U.S. Navy, was also not included in the report.

PCAs within the capture zones of drinking water wells in the ‘Ewa District include agriculture, residential parcels, military installations, utility stations, major roads, sewer lines, septic tanks, and cesspools. Interestingly, although the Honouliuli Wastewater Treatment Plant (WWTP) is located within the District, portions of ‘Ewa do not have sewer systems. In these locations, individual wastewater systems are allowed, possibly affecting localized ground water quality.

[13] Safe Drinking Water Branch, 2005, Groundwater Contamination Maps, State of Hawaii Department of Health.



'Ewa Watershed Management Plan

Figure 2-6 UIC and Pass-No Pass Lines

Feet: 0, 2,500, 5,000, 10,000, 15,000, 20,000
Miles: 0, 0.5, 1, 2, 3, 4
N

BWS also conducted an inventory of inactive landfills on Oʻahu (URS, 2005). Three landfills were identified in the ʻEwa District: Puʻu Pālailai, Oʻahu Sugar Mill/Oʻahu Sugar Company, and Oʻahu Sugar Dump 2 (Table 2-4). A fourth inactive landfill, Oʻahu Sugar Dump 3, Village Park is located just outside of the eastern boundary of the ʻEwa District, mauka of the H-1 Freeway. Of the inactive landfills located in ʻEwa, Puʻu Pālailai and Oʻahu Sugar Dump 2 are located in the No-Pass zone. These two landfills in the No-Pass zone are listed as “Category 1,” meaning that they have the highest potential to impact drinking water wells. Oʻahu Sugar Mill was designated as a Category 3 landfill, with the lowest potential to impact drinking water wells.

None of the inactive landfills in ‘Ewa are considered lined and only Pu’u Pālailai is known to be capped. The three landfills accepted municipal and plantation wastes and were in operation at various times from the 1940s through the 1980s.

Table 2-4 Inactive Landfills[14]

Landfill	Pass/No-Pass	Category	Lined/ Unlined	Capped/ Uncapped	Landfill Type
Oʻahu Sugar Dump 2 (1940s-1950s)	No-Pass	1	No documentation	No documentation	Agricultural (plantation refuse)
Oʻahu Sugar Mill/Oʻahu Sugar Company Coral Wastepit (Pre-1970 through 1980)	Pass	3	Not specified	Not specified	Municipal (municipal solid waste, plantation industrial waste, empty pesticide drums, mixed waste from underground storage tanks, waste bunker fuel)
Puʻu Pālailai (1974-1988)	No-Pass	1	No[1]	Capped (1988)	Private (mixed municipal solid waste)

1 Eighteen inches of clay line the bottom of Puʻu Pālailai landfill but the State Department of Health does not consider it lined because quality assurance/quality control was not documented during installation of the liner.

There are no municipal wells downgradient of both the Oʻahu Sugar Mill and Puʻu Pālailai landfills, but BWS has wells downgradient of Oʻahu Sugar Dump 2. O’ahu Sugar Dump 2 was used to dispose of plantation refuse, but there are no records of where or when the landfill was in operation. Although the actual landfill was not found, the area where it is suspected to be is on undeveloped land within a gulch, surrounded by agricultural operations. This landfill was likely small and used for a burn and dump operation.

[14] URS. 2005. Oahu Inactive Landfills Relative Risk Evaluation (Draft). Prepared for the Honolulu Board of Water Supply.

As part of the 1999 closure of the former Barbers Point Naval Air Station (BPNAS), now called Kalaeloa, an environmental investigation found contaminants of concern, including the chemical additive Polychlorinated Biphenyls (PCB), heavy metals, petroleum products, pesticides and solvents. Due to the presence of highly permeable limestone bedrock and thin, poorly developed soils at BPNAS, any leachates or liquid wastes in the ground may readily migrate to the brackish caprock water table. Current operations at Kalaeloa include pollution prevention measures to prevent further contamination. There are no drinking water wells in Kalaeloa because the caprock aquifer is brackish.

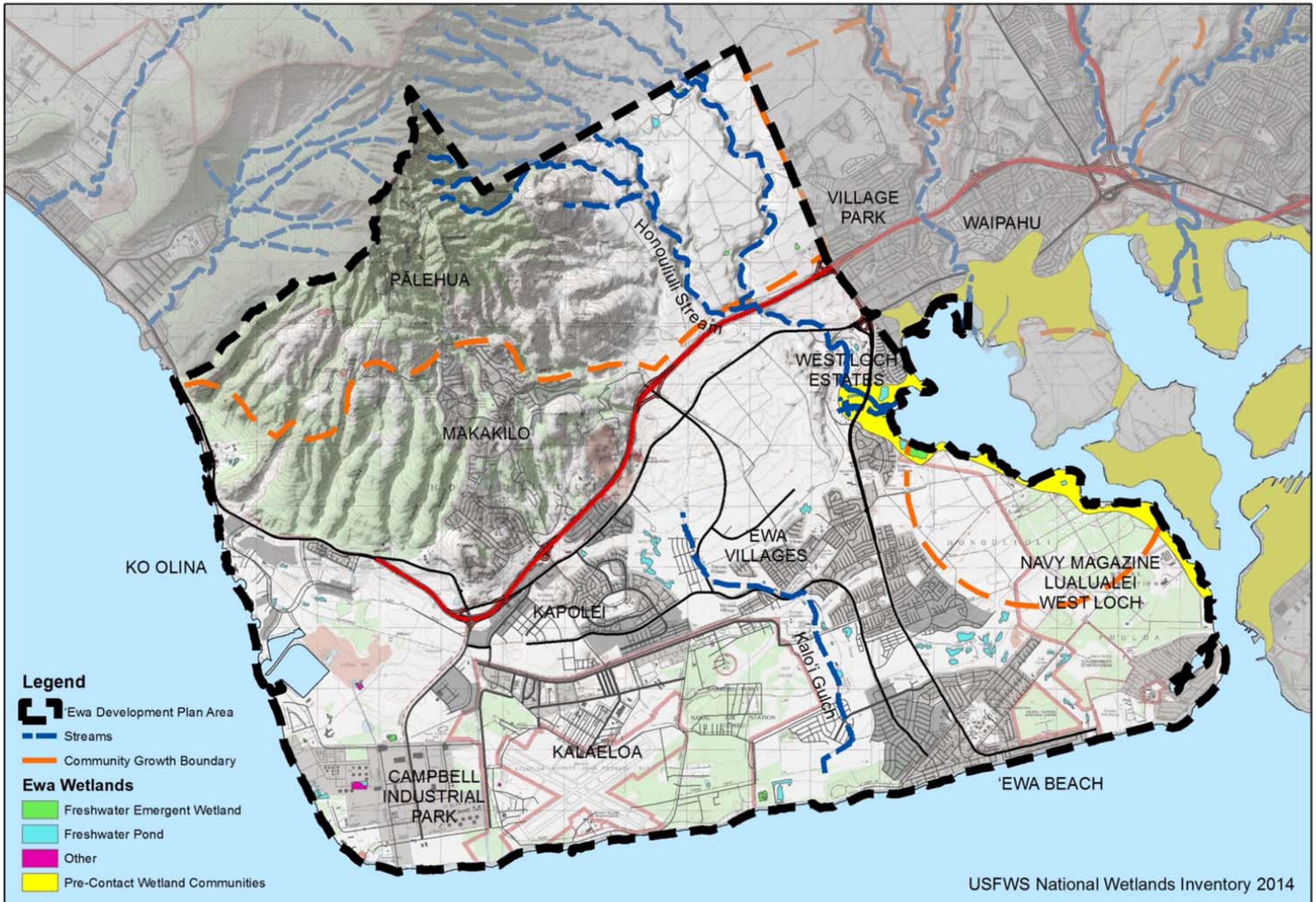
The Environmental Protection Agency’s (EPA) Sole Source Aquifer (SSA) Program was established under Section 1424(e) of the Safe Drinking Water Act (SDWA). Since 1977, it has been used by communities to help prevent contamination of ground water from federally funded projects and has increased public awareness of the vulnerability of ground water resources. The SSA program allows for EPA environmental review of any project that is financially assisted by Federal grants or Federal loan guarantees. These projects are evaluated to determine whether they have the potential to contaminate a sole source aquifer. To be a sole source, the aquifer must supply more than 50% of a community’s drinking water. The Oʻahu Sole Source Aquifer includes the ʻEwa District.

Key Ground Water Implications for Water Resource Planning

- Ground water available for human consumption is limited, but protected by various levels of regulations: SY, Ground Water Management Area, EPA Sole Source Aquifer status.
- Ground water quality is vulnerable to impacts from overlying land uses. Both the basal and brackish caprock aquifers may be impacted by land uses, which, if not planned wisely, could contaminate water sources for both drinking water needs (residential) and non-potable uses such as agriculture, landscape irrigation, and industry.
- There are some municipal water sources that have undetermined risks from overlying and surrounding land uses because they have not yet been assessed.

2.2.2 Surface Water Resources

Watersheds are defined as areas that drain to a common receiving body of water, such as a stream, or outlet, such as a lake or the ocean. Surface water within the ʻEwa District exists in streams and wetlands, although as a dry district, there is relatively little surface water in ʻEwa on a regular basis. Man-made agricultural ditches and ponds also carry and hold water and are described in Chapter 3. There are three watersheds in ʻEwa: Makaīwa, Kaloʻi, and Honouliuli.



'Ewa Watershed Management Plan

Figure 2-7 Surface Water Resources

2.2.2.1 Streams and Springs

The Hawai‘i Stream Assessment (1990) identifies Honouliuli (State Stream Identification No. 3-4-11) as the only perennial stream in the ‘Ewa District, however, there are several dry gulches that flow during or shortly after significant precipitation (Figure 2-7). Honouliuli Stream is intermittent in the mid-elevations and drains an area of about 11.5 square miles of the ‘Ewa plain and Wai‘anae Mountains. The stream is normally dry above Fort Weaver Road, with ground water input providing downstream flow.[15] In CY 2000, U.S. Geological Survey (USGS) testing of 105 sediment samples from Pearl Harbor (including offshore from the Honouliuli Stream) indicated that 148 of 252 chemicals of concern were present. Significant portions of these chemicals appear to originate from the watershed as agricultural or termiticide residue.

Table 2-5 Named Surface Waters

<table>
<tr><th>Shoreline</th><th>Watershed</th><th>Spring</th><th>Perennial Stream</th><th>Non-Perennial Stream</th><th>Dry Stream or Gulch</th></tr>
<tr><td rowspan="14">West Beach</td><td rowspan="8">Makaīwa</td><td rowspan="8">None</td><td rowspan="8">None</td><td rowspan="5">None</td><td>Pili o Kahe</td></tr>
<tr><td>Limaloa</td></tr>
<tr><td>Keone‘ō‘io</td></tr>
<tr><td>Waimanalo</td></tr>
<tr><td>Makaīwa</td></tr>
<tr><td>Barbers Point Canal</td><td>N/A</td></tr>
<tr><td rowspan="2">None</td><td>Pālailai</td></tr>
<tr><td>Awanui</td></tr>
<tr><td rowspan="6">Kalo‘i</td><td rowspan="6">None</td><td rowspan="6">None</td><td rowspan="6">None</td><td>Kalo‘i</td></tr>
<tr><td>Hunehune</td></tr>
<tr><td>Makalapa</td></tr>
<tr><td>Makakilo</td></tr>
<tr><td>Awanui</td></tr>
<tr><td>Palalai</td></tr>
<tr><td rowspan="3">West Loch</td><td rowspan="3">Honouliuli</td><td rowspan="3">None</td><td rowspan="3">Honouliuli</td><td rowspan="3">None</td><td>Honouliuli</td></tr>
<tr><td>Ka‘aikukui</td></tr>
<tr><td>Pālāwai</td></tr>
</table>

[15] T. Nance, Effect Of The Proposed Use Of The WP-18 Pump Station On Waikele Stream And West Loch (Tom Nance Water Resource Engineering; 1998); and E.I. Park, Pearl Harbor Brackish Water Study (BWS; 1983).

The USGS monitors stream flows and publishes the updated and historical flow data annually[16] and as a database on the internet.[17] The average flows for two gaged streams in ‘Ewa are provided in Table 2-6 below.

Table 2-6 Peak Stream Flow

Stream Name	Watershed Area (Square Miles Above Monitor)	Monitor Elevation (Feet)	Maximum Peak Discharge Water Year Oct 2012-Sep 2013 (CFS)	USGS Gauge Number
Kalo‘i	1.69	260	10	16212450
Honouliuli	11.09	65	35	16212500

Source: USGS National Water Information System: Web Interface, accessed September 10, 2014. (http://nwis.waterdata.usgs.gov/hi/nwis/current/?type=flow&group_key=county_cd)

Ground water flow into Pearl Harbor occurs as seeps and springs along the shore. While ground water flow estimates from the Pearl Harbor Springs are significant, the major springs are located outside of the ‘Ewa planning area.

2.2.2.2 Wetlands

The National Wetlands Inventory (1971) identifies several small wetlands on the ‘Ewa plain, possibly associated with agricultural irrigation features, but now under dense urban development. Results from a 2003 Hawai‘i Natural Heritage Program study of vegetation patterns before human contact determined that approximately 95% more wetland acreage was present in the Pearl Harbor region during pre-human times as compared to today.[18]

Honouliuli Wetland. Source: Starbulletin.com, Nov. 11, 2001: Gung-ho for Green by Jim Borg.

[16] U.S. Geological Survey (2001).
[17] U.S. Geological Survey, Surface-Water Data for Hawai‘i, <http://waterdata.usgs.gov/hi/nwis/sw> (June 3, 2005).
[18] S. Gon and D. Matsuwaki, “Native Ecosystems before Human Settlement and Remaining Native Ecosystems Today,” GIS Ecosystem Data Layers of the State of Hawai‘i (Hawai‘i Natural Heritage Program; 2003).

A series of biologically valuable fresh and brackish water wetlands encircle the Pearl Harbor shoreline. The United States Fish and Wildlife Service (USFWS) and State Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) established the Pearl Harbor National Wildlife Refuge (NWR) in 1976 to mitigate wetland loss brought about by construction of the Honolulu Airport Reef Runway and to provide habitat and protection for endangered Hawaiian waterfowl. The 37-acre Honouliuli Unit of the NWR borders the West Loch of Pearl Harbor (Figure 2-8) and is extensively managed for a variety of water birds, including the following endangered and migrant waterfowl:

- Hawaiian Duck, *Anas wyvilliana*
- Hawaiian Coot, *Fulica alai*
- Hawaiian Gallinule, *Gallinula chloropus sandvicensis*
- Hawaiian Stilt, *Himantopus mexicanus knudseni*

The Kalaeloa unit of the Pearl Harbor NWR is a 37-acre reserve created to help preserve karst/anchialine pool habitat (Figure 2-8). Some remaining sinkholes of the ʻEwa Karst are home for ʻōpae ʻula (*Halocaridina rubra*), a tiny brackish water shrimp. A natural sinkhole with these shrimp is found near Chevron's Rowland's Pond preserve. Two to three artificial ponds were dug by the Division of Aquatic Resources (DAR), two of which filled back up with water. DAR is waiting to see if this will provide the habitat that ʻōpae ʻula need. Native plants such as the endangered ʻakoko (*Chamaesyce skottsbergii var. kalaeloana*) and ʻEwa hinahina (*Achyranthes splendens var. rotundata*) are also protected by the reserve.

Key Surface Water Implications for Water Resource Planning

- There are few surface water resources from which water supply can be drawn. ʻEwa has only one perennial stream that only flows continuously in its lower reaches.
- ʻEwa has unique water resource features, including wetlands and Karst formations that hold both ecological and cultural significance, and should be protected.

2.2.3 Flooding and Drainage

Low-lying portions of the ʻEwa plain are subject to flooding during intense rainstorms. The relatively flat topography makes it difficult to drain large volumes of water when heavy rainfall events occur. With increased development, drainage problems have intensified through an increase in impermeable surfaces, channelization resulting in high velocity drainage ways, and alteration of natural water flow patterns. As an alternative to channelization, the *ʻEwa Development Plan* has developed policies for the preservation of gulches and drainage ways in their natural state to assist in flood control.

Detention basins are being used for both flood control and water quality improvement by providing temporary storage of excess stormwater and by allowing some percolation into the ground. Many detention basins used for flood control are integrated into golf courses, including the courses at West Loch, ‘Ewa Villages, Kapolei, Coral Creek, ‘Ewa by Gentry, and Hoakalei. There are also large detention basins in residential developments, such as ‘Ewa by Gentry, Royal Kunia, and Ocean Pointe in the ‘Ewa/Kapolei area. In addition to detention basins, the ‘Ewa Development Plan recommends the preservation of natural gulches for drainage and flood control, but with an emphasis on the recreational benefits of peripheral trails along the gulches.

Key Flooding and Drainage Implications for Water Resource Planning

- Portions of ‘Ewa are prone to flooding. Although dry for much of the year, flat topography and impervious urban land uses create conditions where heavy runoff does not drain quickly, causing major flooding.
- Detention basins may provide opportunities for storm water reuse and ground water recharge.

Flooding on Renton Road.
Source: Starbulletin.com, November 6, 1996. Deluge Floods Roads, Cuts Power.

2.2.4 Nearshore Resources

Near shore waters associated with the District are divided into two segments: (1) Pearl Harbor and (2) the ‘Ewa plain and Kahe shoreline east of Pearl Harbor. Pearl Harbor is the state's largest estuary. It consists of a system of drowned river valleys that have flooded and dried in response to glacier melting cycles. This cyclical sea level change has left the floor of the harbor with successive layers of mud, limestone, oyster beds, stream alluvium, and marine clays above the volcanic basalt. The harbor mouth and active areas of the harbor have been subject to dredging intermittently since the early 1900s and the bottom substrate is primarily mud. Corals and invertebrate habitats are typically located on vertical or near vertical surfaces not subject to heavy sediment loads.

The harbor is surrounded by the U.S. Navy installation with its associated shipyard, maintenance supply center, public works center, ammunition depot, 12 miles of docks, and four dry docks. The harbor consists of East Loch, Middle Loch, West Loch, Southeast Loch, and Ford Island, and has a water surface area of about eight square miles. The ‘Ewa District only borders the West Loch.

Satellite view of Pearl Harbor.
Source: http://en.wikipedia.org/wiki/
Image: PearlHarbor_Sm.jpg

The State identifies the entire harbor, out to a depth of 30 feet and extending up into the mouths of perennial streams, as a Water Quality Limited Segment. The pollutants determined to have exceeded State Standards by numeric assessment include total nitrogen, chlorophyll-a, turbidity, and total phosphorous. Nitrogen and phosphorous, presumably from application of fertilizers on agricultural lands, enter the harbor through ground water and stream flow.

Chlorophyll-a is a measure of phytoplankton growth and requires both high nutrient levels and a high residence time. High turbidity may arise either from high plankton concentrations or high concentrations of silt. The harbor acts as an effective sink for all urban and agriculturally derived pollutants entering with stream waters. Approximately 96,000 tons of sediment is estimated to enter the harbor annually from streams.[19] The Navy estimates that it removes 75,000 cubic yards of sediment per year from harbor operational areas, and 200,000 cubic yards of sediment per year from the main channels.[20] These dredging operations typically occur every five years.

Prior to designation of portions of the harbor as a Superfund site by the EPA in 1992, controls on pollutant sources and clean-up of existing pollutants were already being instituted. Control on the use and application of tri-butyl-tin bottom paints was instituted, selective dredging of contaminated sediments was conducted, and 40,000 cubic yards of PCB-contaminated sediments were removed and cleaned. Pearl Harbor Superfund site clean-up actions are still underway and may be monitored through the EPA web site.[21] Ongoing dredging operations within the harbor are attempting to deal with a variety of pollutant types and concentrations at different locations within the harbor.[22]

Even though it is known that many areas (particularly West Loch) contain contaminated sediments, a series of studies in the 1990s documented the occurrence of invertebrate species (including corals) not seen previously in the harbor.[23] More recent surveys by the Navy's Natural Resource Management Environmental Department continue to document the apparent recovery of benthic ecosystems.[24]

[19] Natural Resource Trustees, Final Restoration Plan and Environmental Assessment for the May 14 1996 Chevron Pipeline Oil Spill into Waiau Stream and Pearl Harbor, Oahu, Hawaiʻi, 1999, <http://www.darp.noaa.gov/southwest/chevron/ phfnleal.html>.

[20] U.S. Army Corps of Engineers, Long-Term Management Strategy for Dredged Material Disposal for Naval Facilities at Pearl Harbor Hawaii, Hawaii Phase II – Evaluation of Alternatives, ERDC/EL SR-00-4 (2000).

[21] “Superfund Site Report: Pearl Harbor Naval Complex,” Scorecard: The Pollution Information Site, <http://www.scorecard.org/env-releases/land/site.tcl?epa_id= HI4170090076#description> (May 30, 2006).

[22] U.S. Army Corps of Engineers, Long-Term Management Strategy for Dredged Material Disposal for Naval Facilities at Pearl Harbor Hawaii, Hawaii Phase II – Evaluation of Alternatives, ERDC/EL SR-00-4 (2000).

[23] S.L. Coles, R.C. DeFelice, L.G. Eldredge, and J.T. Carlton, Biodiversity Of Freshwater And Estuarine Communities In Lower Pearl Harbor, Oʻahu, Hawaiʻi With Observations On Introduced Species, Hawaiʻi Biological Survey Contribution No. 1997-014, Bishop Museum Technical Report No. 10 (Bernice Pauahi Bishop Museum; 1997).

[24] Steve Smith, Section Head, Environmental Department of the Natural Resources Management Group. Pearl Harbor, Hawaiʻi, personal communication.

Kahe shoreline
Photo credit: Shutterdo.com

The ‘Ewa and Kahe shorelines extend about 12 miles from the mouth of Pearl Harbor, west to Kalaeloa and north to Kahe Point. Recreational fishing vessels access this coastline primarily through Pearl Harbor and from the private Ko Olina Beach Marina adjacent to Barbers Point Harbor.

The near shore waters off the southern ‘Ewa plain increase in depth very gradually and much of the shore is protected by a series of narrow sand beaches. The benthic substrate is relatively flat pavement heavily colonized by macroalgae. Although individual coral colonies are interspersed across this wide shallow plain, nowhere do they approach concentrations sufficient to be termed a true reef.

This shallow shoreline was once prized for its abundance of native edible seaweed or limu. A decrease in the abundance of limu is likely a combined effect from decreased near shore nutrients and fresh water following the demise of sugar agriculture, increased harvesting, and increased competition from non-edible, non-indigenous algae species. The waters off of ‘Ewa Beach are designated by the State as the ‘Ewa Limu Management Area from the shoreline to 150 feet seaward. Picking, gathering, harvesting or otherwise taking of limu is not allowed without a permit.[25]

[25] Hawaii Revised Statutes 188-22.8

North of Kalaeloa, the width of the shallow near shore shelf is greatly decreased and the shoreline typically consists of an abrupt ledge of consolidated limestone. A mile-long channel dredged through the shallow sea floor allows deep draft ships to enter Kalaeloa (Barbers Point) Harbor and Ko Olina Marina. Although tidally influenced, the near shore currents are predominantly to the south and have fostered greater coral growth on the north side of the channel cut. North of the harbor, four artificial lagoons have been carved out of coastal lands to create swimming beaches for the Ko Olina Resort complex.

Key Nearshore Resources Implications for Water Resource Planning

- Pearl Harbor needs protection as an important native ecosystem, as well as a Navy installation. High sediment loads threaten not only navigation within the harbor, but also the habitat for native estuarine species and corals.
- Coastal ‘Ewa to Kahe waters need protection. Nearshore water quality should be maintained to protect resort, recreation, and subsistence activities.

2.3 Terrestrial Ecosystems

The Hawai‘i Natural Heritage Program (HNHP) compiled a likely picture of the natural ecosystem types that existed on O‘ahu before human contact.[26] Results from the HNHP show that before human contact, the ‘Ewa plain was likely covered by dry shrubland and grassland. Dry forest and shrubland were found throughout the Central Plateau, dominated by one or more trees, such as wiliwili (*Erythrina spp.*), lama (*Diospyros spp.*), and manele (*Sapindus spp.*). Mesic forest and shrubland, found above the 2,000-foot elevation, consisted of many potential dominant taxa and had increased plant diversity over the lower elevations, with the highest tree diversity of the ecosystem types at the time.[27] According to HNHP data, there are very few remaining native plant communities in the ‘Ewa District.

2.3.1 Protected Species and Critical Habitat

In December of 2001, the USFWS designated five units, 65,879 acres, of critical habitat for the O‘ahu ‘elepaio.[28] The ‘Ewa District overlaps a portion of the ‘elepaio critical habitat that is designated on the western slopes of the Wai‘anae Mountains (Figure 2-8). There are also critical habitats designated for various plant species in the southern parts of the Wai‘anae Mountains. While these habitats are not located within the ‘Ewa District, they are directly adjacent to the district boundaries.

Endangered O‘ahu ‘elepaio. Source: www.angelfire.com/hi/ecosystem2/

2.3.2 Management Activities

The Wai‘anae and Ko‘olau Mountain Ranges have management programs for the restoration of native forest habitat and protection of unique rare and endangered species. This requires controlling alien plant and animal species, locating and protecting populations of native species, re-introducing native species, conducting research, and public education.

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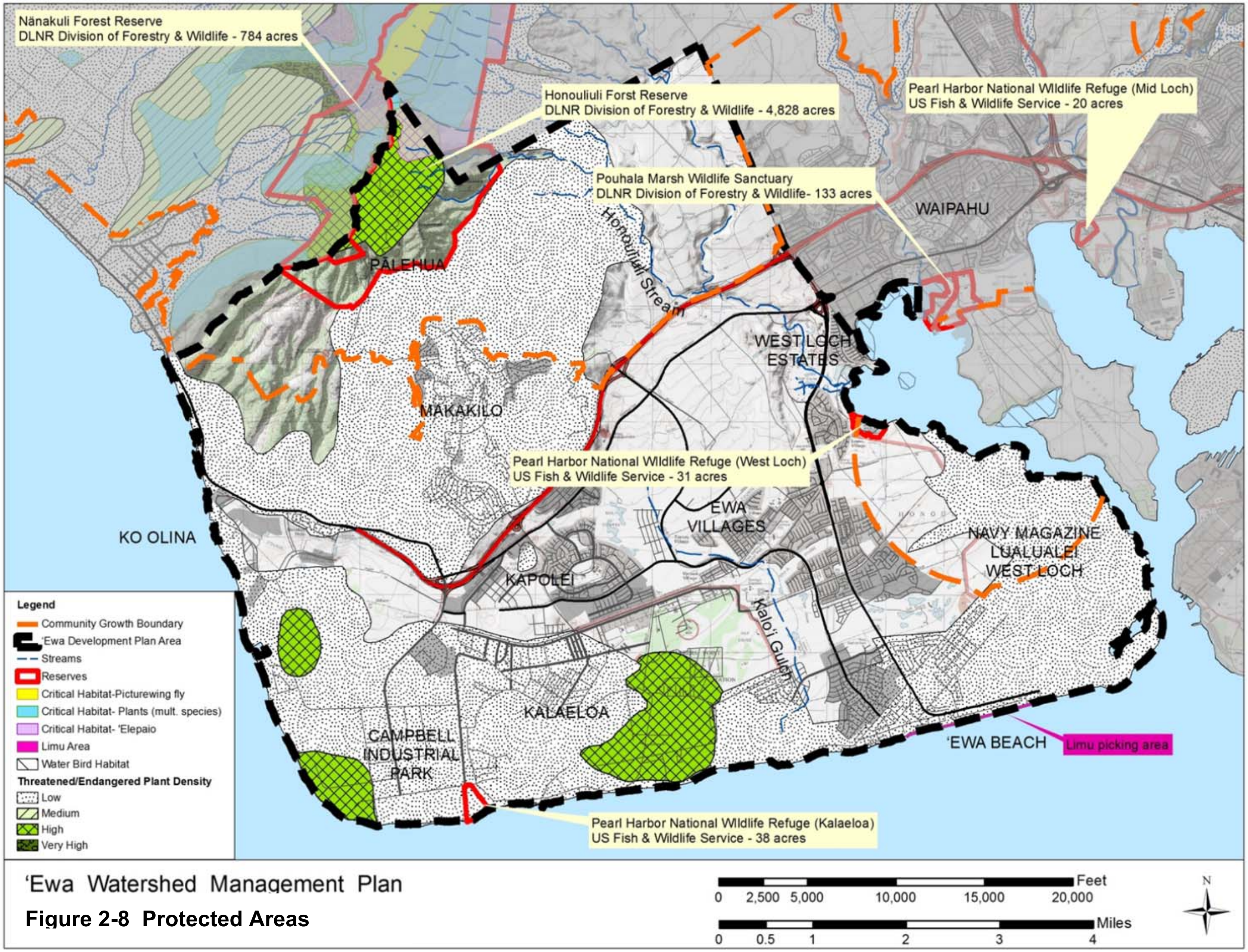
[26] HNHP recreated undisturbed native ecosystem ranges by expanding the current vegetation patterns into those areas devoid of native ecosystems, using clues from historical records. When there were no such sources, current rainfall patterns were overlaid on the island, and general moisture and presumed physical characteristics of the vegetation were assigned within the elevation and moisture zones.

[27] S. Gon and D. Matsuwaki, “Native Ecosystems Before Human Settlement and Remaining Native Ecosystems Today,” GIS Ecosystem Data Layers of the State of Hawaii (Hawai‘i Natural Heritage Program; 2003).

[28] U.S. Fish and Wildlife Service, Critical Habitat for the O‘ahu ‘Elepaio, [Online WWW]. Available URL: “http://www.fws.gov/pacificislands/CHRules/Elepaio_ch_final_fs.pdf,” [Accessed 5/3/06].



'Ewa Watershed Management Plan

Figure 2-8 Protected Areas

2.3.2.1 Pearl Harbor National Wildlife Refuge

National Wildlife Refuges are managed by the USFWS to protect native plants and animals and their habitats. The Pearl Harbor NWR is one of three refuges that make up the O‘ahu National Wildlife Refuge Complex. It was originally made up of two wetland units, Honouliuli and Waiawa, which protect endangered waterfowl. The Kalaeloa Unit, once a part of the former Barbers Point Naval Air Station (now referred to as Kalaeloa), was added to the Pearl Harbor NWR to protect the last remaining, ancient, coastal dry land plant communities once widespread throughout the ‘Ewa plain. USFWS manages this area under a cooperative agreement with the U.S. Navy.

2.3.2.2 U.S. Military Installations Integrated Natural Resource Management Plans

The U.S. military has developed Integrated Natural Resource Management Plans to document existing management actions for rare plants, animals, and ecosystems on Army training areas, and to recommend future management efforts. It covers most of the U.S. Navy installation areas at Pearl Harbor, with a focus on Pearl Harbor’s waters from the intertidal zone into Māmala Bay.

2.3.2.3 Honouliuli Forest Reserve

The Honouliuli Forest Reserve is a 3,582-acre reserve that was previously leased from the Campbell Estate by the Nature Conservancy (TNC) of Hawai‘i. When Campbell Estate decided to sell the land, the Trust for Public Land purchased it in 2009 and transferred the property to the State DOFAW in 2010. Located between the 1,200 and 3,100-foot elevations on the eastern slopes of the Wai‘anae Mountains, the reserve contains more than 90 different rare and endangered plants and animals. It specifically protects six native natural communities where 66 rare plants have been recorded, 20 of which had not been seen for 15 or more years, and 40 of which are listed as endangered.[29]

DOFAW staff manage the reserve, with a $345,000 endowment established by TNC, the Gill Family Trust, and the Edmund C. Olson Trust. The U.S. Army Garrison Hawai‘i also manages the reserve, investing more than $500,000 per year.

2.3.2.4 Watershed Partnerships

The Watershed Partnership Program began in in 1991 and is funded by the Natural Area Reserve Special fund. Eleven partnerships throughout the State bring together private landowners, public agencies, and most recently, community entities to work together to conserve watershed areas, thereby protecting fresh water and ecosystems.

[29] The Nature Conservancy, Honouliuli Preserve Master Plan, 2000-2005 (2000). p. 2; and Jay Feldman, “(Honouliuli):The Nature Conservancy’s Honouliuli Preserve,” OHE, April 6, 2000, <http://www.2.hawaii.edu/~turner/ohe/April00/4-6.html> (March 1, 2005).

The Wai‘anae Mountains Watershed Partnership was formed in 2010 to protect the biological, cultural, and economic resources of the Wai‘anae Mountains. Partners work together to make management decisions and implement management actions within the partnership area. Partners include DLNR; Gill-Olson Joint Venture; BWS; Ka‘ala Farm, Inc.; U.S. Army Garrison Hawai‘i; U.S. Navy Region Hawai‘i, and Wai‘anae Community Re-Development Corporation (MA‘O Organic Farms).

Key Terrestrial Ecosystem Implications for Water Resource Planning

- Critical forested watershed lands that provide recharge to ground water aquifers lie outside of the ‘Ewa District boundaries. Efforts to coordinate management outside of the district should be made to ensure continued source water protection.
- Critical forest ecosystems both within and adjacent to the ‘Ewa District boundaries provide habitat to federally listed species and must be protected.
- The various management activities that work to protect the terrestrial ecosystems in and around ‘Ewa should continue to coordinate their efforts.

2.4 Traditional Practices and Cultural Resources

Traditional and customary Native Hawaiian practices are dependent upon access to natural and cultural resources and the ability to use and care for the water, land, and air. These natural elements form the basis of subsistence, cultural and religious beliefs, customs, and practices. The following sections describe some important cultural places within the ‘Ewa District and their associated traditional Hawaiian practices. Understanding the significance of these places helps to gain insight when making management decisions that work with and for the land and waters, rather than try to manipulate them. References are from *Sites of O‘ahu* (Sterling and Summers, 1978), unless otherwise noted.

The ‘Ewa mokuoloko[30] extended from Honouliuli in the west to Hālawa in the east and was divided into the ahupua‘a[31] of Hālawa, ‘Aiea, Kalauao, Waimalu, Waiau, Mānana, Waimano, Waiawa, Waipi‘o, Waikele, Hō‘ae‘ae, and Honouliuli. Today’s ‘Ewa District only includes the ahupua‘a of Pu‘uloa and the makai portion of Honouliuli. The remaining ahupua‘a are in City’s Central O‘ahu Planning District.

Honouliuli and Pu‘uloa was known to be associated with gods and royalty. Stories tell of the goddess Hi‘iaka’s travels through ‘Ewa; Lanikuhonua on the west coast of ‘Ewa, was a known retreat for the chiefly class; and the Honouliuli plain is thought to be where souls wandered when they had no place to go. Trails ran through the district, allowing travel between Wai‘anae and Central O‘ahu and Honolulu and the many pu‘u provided waypoints.

2.4.1 Wahi Pana

Wahi pana are sacred sites, significant places such as heiau, shrines, churches, observation points; prominent pōhaku (stones); burial caves; geographic features; and natural features and phenomena associated with deities or significant events.[32] Wahi pana in ‘Ewa include:

- Limestone caves or pits (ana) may be found in the uplifted coral reef that makes up the ‘Ewa Plain in Kalaeloa. Legends describe these caves as the location where the hairless human beings (‘olohe) lived when they first landed on O‘ahu[33]
- Kapolei was one of three places in the island chain where Hawaiians would go to identify Hokule‘a, which is one of three stars that led to and from Tahiti[34]

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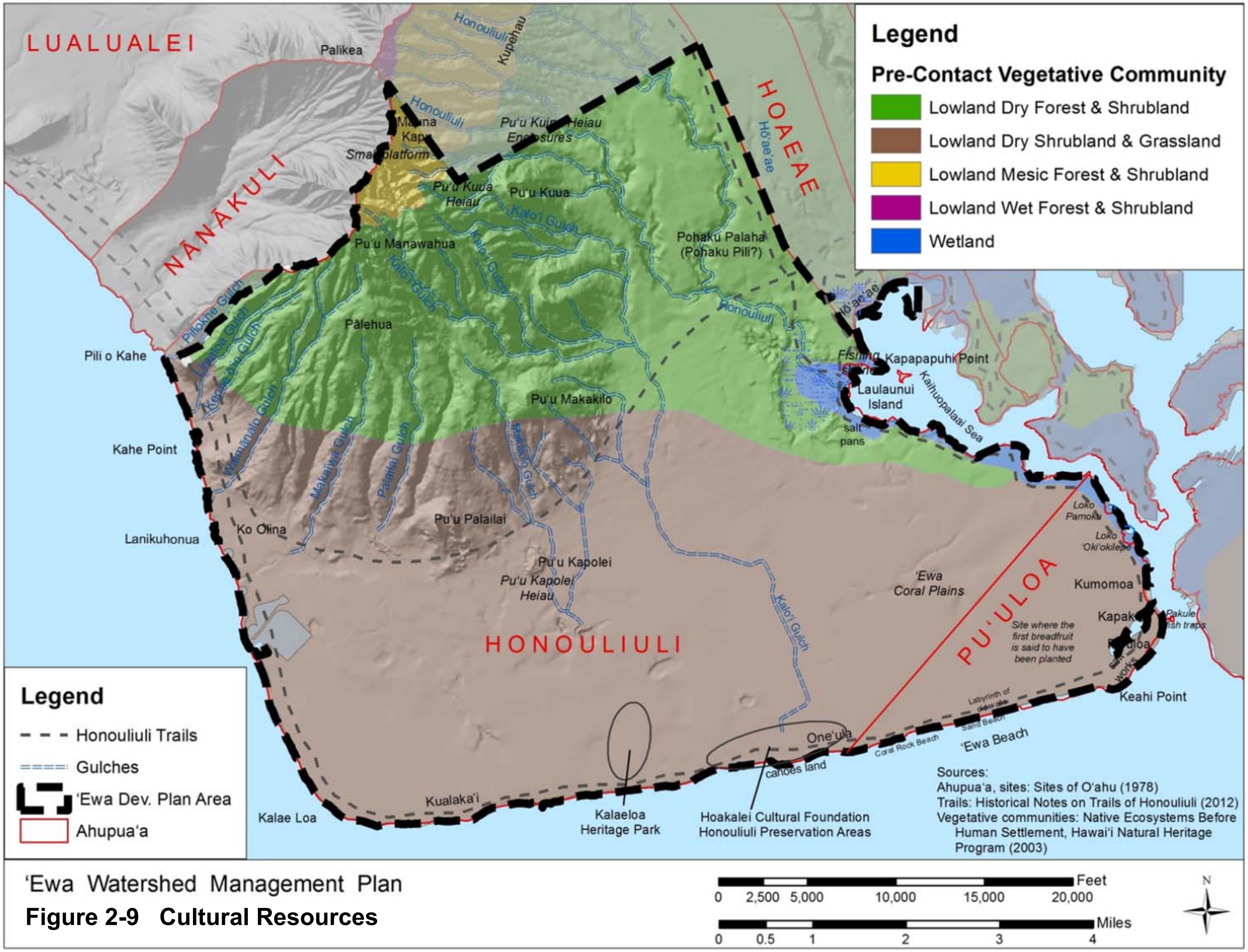
[30] *Moku o loko*, also known simply as *moku*, are land divisions, roughly the equivalent of a district. O‘ahu is divided into six *moku*: ‘Ewa, Kona, Ko‘olau Loa, Ko‘olau Poko, Waialua, and Wai‘anae.
[31] An *ahupua‘a* is a traditional Hawaiian land division that often extends from the mountain to the sea, thus including the resources necessary for self-sufficiency.
[32] HECO, Hawaii Externalities Workbook (July 1997), pp. 8-15.
[33] U.S. Fish and Wildlife Service, Kalaeloa Unit Pearl Harbor National Wildlife Refuge, < http://www2.hawaii.edu/~abrecken/Kalaeloa%20Brochure.doc> (April 3, 2007)
[34] Rod Ohira, “DHHL Focus on Kapolei,” Honolulu Advertiser, January 27, 2005, <http://the.honoluluadvertiser.com/article/2005/Jan/27/ln/ln40p.html> (March 15, 2005).



'Ewa Watershed Management Plan

Figure 2-9 Cultural Resources

- Kapolei was known as a “Leina Ka Uhane” or “conduit to the afterlife.” This is where kūpuna who have passed on wander until they are ready to cross over into the ao ʻaumakua, the realm of the gods.[35]
- Large pōhaku were markers for canoe travel, located at Kalaeloa and the airport side of Pearl Harbor. Stone markers also were used to locate artesian wells.[36]
- Kaʻahupahau, a guardian shark chiefess who guarded the entrance to Pearl Harbor, lived in an underwater cave in Honouliuli Lagoon (West Loch).[37]

2.4.2 Streams, Springs, and Ponds

Surface waters support habitat for native species of marine life, taro and other cultivation, domestic use, conducting cultural and spiritual customs, and recreation.

- Taro was found at the water of Kaʻaimalu, ʻEwa
- All streams of the area, including Honouliuli Stream
- Pahoehoe formations and karsts (limestone) where fresh water exists[38]

2.4.3 Shorelines, Reefs, Fishponds, and Nearshore Areas

Coastal areas were important for gathering food and medicine, practicing cultural and spiritual customs, and recreation. There were many salt pans along the south shore.

- Loko Laulaunui (Laulaunui Island), Loko Pamoku, Loko ʻOkiʻokiolepe (near Iroquois Point)
- Mullet at Kuhia loko (fishpond)
- Salt at Ninauele
- Fine seaweeds at Kuhia waho
- Limu (seaweed) at ʻEwa Beach - Limu was gathered here for food and medicinal purposes

[35] Department of Hawaiian Home Lands. November 2010. *Kapolei Regional Plan*. p. 9.
[36] Tesha Malama, Chair, ʻEwa Neighborhood Board #23, personal communication (March 23,2005).
[37] Dennis Kawaharada, Traditions of Oʻahu: Stories of an Ancient Island: Kaʻahupahau, 1999, <http://apdl.kcc.hawaii.edu/~oahu/stories/ewa/kaahupahau.htm> (June 12, 2006).
[38] Michael Lee, cultural practitioner (at ʻEwa Neighborhood Board meeting on 7/12/12 and as noted by Barry Usagawa)

2.4.4 Forests

The forests of Honouliuli[39] are where hunting pigs and animals; gathering plants used for medicine, food, hula/ceremonial adornments, and offerings; and cultural and spiritual customs took place.

2.4.5 Archaeological and Historic Sites

Man-made structures may include temples, shrines, agricultural sites, and sites for food production such as lo‘i, terraced slopes, ‘auwai, and fish ponds; sites with special functions may include trails, salt pans, hōlua slides, quarries, petroglyphs, gaming sites, and canoe landings. Clusters of these types of structures may be found in the following areas:

- Kalaeloa archaeological district
- One‘ula archaeological district

2.4.6 Areas of Cultivation

Cultivated areas can be described as a system with interrelated elements, such as fields, streams, and *‘auwai*. Other areas may include cultivation of plants used for food, medicine, adornment, ornament, implements, cooking, fuel, mulching, and ceremony.

- ‘Ewa was an extensive and fertile plain, the whole of which was in the highest state of cultivation. Every stream was carefully embanked, to supply water for the taro beds. Where there was no water, the land was under crops of yams and sweet potatoes.[40]
- Kalelealuaka’s father described to him the site of his former plantation at Keahumoe (or Keahumoa). This land is located in the general vicinity of Honouliuli / Waipahu. As Kalelealuaka and his father journeyed inland from Wai‘anae (through Pōhākea, or Kolekole Pass), they reached a plain of soft, whitish rock, where they refreshed themselves with food. Then they kept on ascending, until Keahumoe lay before them, dripping with moisture from the mist of the mountain. There they found bananas, upland kalo, sugar cane, and sweet potatoes.

[39] College of Tropical Agriculture and Human Resources, Hawaiian Native Plant Propagation Database, <http://www2.hawaii.edu/~eherring/hawnprop/not-lati.htm> (March 9, 2005).
[40] Archibald Campbell, “Voyage Round the World, May1809,” p. 145, Cited by E.P. Sterling, and C.C. Summers, Sites of Oahu (Bishop Museum Press, Honolulu; 1997), p. 3.

2.4.7 Circulation Networks, Including Trails and Dirt Roads

On land, these include trails and roads for lateral access and for mauka and makai access. Along the shore, these networks include landings, harbors, and piers.

- The ʻEwa Trail: A historical trail throughout and beyond the ʻEwa District. The ʻEwa Trail began at the lowland of Hālawa, and followed streams and taro patches through ‘Aiea, Kalauao, Waiau, Waimano, Mānana, and Waiawa, to the stream of Kukehi. Here the trail branched, one towards Waialua and the other to Honouliuli. At Honouliuli, the trail again branched into three trails, by Puʻu-o-Kapolei, Pōhākea, and Kolekole. The trail from Puʻu o Kapolei went by the sandy stretch to meet with the trail that led along the beach from Puʻuloa to Waimanalo. The trail at Pōhākea went up through Kunia and Honouliuli to meet up with a trail from Wahiawā and Waialua. The Kolekole trail passed over the Waiʻanae Range through Kalena (currently Schofield Barracks).

Key Traditional Practice and Cultural Resource Implications for Water Resource Planning

- Limestone caves provided water sources for drinking and agriculture.
- The few streams provided enough water for taro cultivation. Even where there were no streams, the ground was fertile enough for dryland crops.
- Limu and mullet suggest fresh water inputs in near shore areas.
- The mountains were wet.
- The ʻEwa District is full of cultural and historic sites and landscapes that should be protected and restored.

2.5 Settlement History

From fishing village to diversified agriculture, and master-planned communities to possibly the Technology Center of O‘ahu, ‘Ewa has had a varied history, and will perhaps have an equally colorful future. In ancient times, Hawaiians lived near the shore and streams to tend to fishing and food crops. Much can be learned about water management techniques for the ‘Ewa District by understanding traditional Hawaiian water management, and the how and why of settlement history in the area.

2.5.1 Settlement History Prior to Western Contact

Honouliuli could mean either blue harbor or dark harbor, for the waters of Pearl Harbor.[41] The coastline of coral outcroppings, mud flats, and shallow waters was ideal for fishing, and many fishponds were constructed along the banks of Pearl Harbor. Taro was grown along the streams, and dryland taro was planted along the banks of gulches that were not too steep. With the abundant food supply, the area around Pearl Harbor had the second highest density in population after Honolulu.[42]

2.5.2 Post Western-Contact Settlement

Western development in ‘Ewa began in the late 1800s[43] after the establishment of the Constitution of the Kingdom of Hawai‘i in 1840. Cattle grazing in the mauka forested regions had stripped the land of its vegetation, washing soil into the Pearl River lagoons, wiping out the oyster population. In 1877, James Campbell purchased the uplands and drove about 30,000 head of cattle out of the area.[44] In the 1930s, 1.5 million non-native trees were planted to halt erosion in the forests, and the Civilian Conservation Corps built roads and trails in the Honouliuli Preserve area.[45]

In the late 1800s to early 1900s, ‘Ewa was one of the large population centers on O‘ahu. With industry focused around sugar cane production the ‘Ewa Mill was a major employer that set up residential villages for the plantation. The introduction of the O‘ahu Rail and Land Company (OR&L) Railroad in 1889 by Benjamin Franklin Dillingham linked Leeward O‘ahu with Honolulu. These trains carried freight and passengers, providing more people with access to the leeward coast.

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[41] The Nature Conservancy, Honouliuli, <http://nature.org/wherewework/ northamerica/states/hawaii/preserves/art2350.html> (January 18, 2005)

[42] Edward D. Beechert, Waipahu Garden Park: A Research Report for Department of Recreation, City and County of Honolulu, Honolulu, HI, 1974, Cited in City and County of Honolulu Planning Department, Waipahu Town Plan Report: A Special Area Plan of the Central Oahu Development Plan (Wilson Okamoto & Associates, Inc.; 1995), p. 2-1.

[43] Amfac Property Development Corporation, Waikele Master Plan (2001), p. 2.

[44] Harold Morse, “Nature Conservancy Aims To Protect Honouliuli,” Honolulu Star-Bulletin, September 7, 2000, <http://starbulletin.com/2000/09/07/news/story6.html> (March 1, 2005).

[45] Harold Morse, “Nature Conservancy Aims To Protect Honouliuli,” Honolulu Star-Bulletin, September 7, 2000, <http://starbulletin.com/2000/09/07/news/story6.html> (March 1, 2005).

With the help of hydraulic engineers, Dillingham found an abundance of quality artesian water in ‘Ewa for irrigating planned sugar plantations. O‘ahu Sugar Company (OSCo) incorporated in 1897, harvested the first commercial crop of sugar in 1899. The OR&L Railroad brought raw sugar to the docks to be loaded onto the ships and then taken to other parts of the world.

The Waiāhole Ditch System, a network of tunnels and ditches, carries water from Windward O‘ahu to the island’s central plain and into ‘Ewa. Waiāhole Water Company, Ltd., a subsidiary of OSCo, built the main bore and smaller tunnels from 1913 to 1916 to provide water for expanding crops.

Between 1939 and 1944, about 3,000 acres of sugar cane lands on the coastal plain were converted to military use. World War II changed the face of the area, and Pearl Peninsula and its surrounding areas were converted to Pearl Harbor Military Base and Barbers Point Naval Air Station.[46]

After World War II and Hawaii’s admission to statehood in 1959, lands were quickly converted to urban uses. The population of the ‘Ewa District exploded during the 1960s. Growth in tourism and supporting businesses expanded at this time. The opening of Campbell Industrial Park in 1963 brought thousands of new job opportunities to the area with the opening of two petroleum refineries, a steel fabricating plant, cement plant, and many other industrial enterprises. With more jobs came more homes. In 1970, the ‘Ewa plantation merged with OSCo. Due to rising global competition, the sugar industry declined and sugar cane fields gradually receded and lands were converted to residential subdivisions.

In 1983 when production was no longer economically feasible, the cane fields were fallowed and subleased for ranching and pasture purposes.[47] With the closure of OSCo in 1995, future use and allocation of water between Leeward and Windward O‘ahu have become an issue. A large portion of the water that was used for sugar cane irrigation was diverted from the Windward to the Leeward side via the Waiāhole Ditch. Residents on the Windward side fought to see all of the water that was diverted for sugar production returned back to Windward streams. However, many on the Leeward side are still dependent on this water for diversified agriculture and other irrigation.

Key Settlement Implications for Water Resource Planning

- ‘Ewa’s agricultural history resulted in the development of water sources, including ground water and Waiāhole Ditch water.
- Sugar cultivation requires a lot of irrigation. With the replacement of sugar, new land uses may have lower water demands per acre.

[46] “Two Historic Towns Change With the Times,” HonoluluAdvertiser, <http://the.honoluluadvertiser.com/current/homes/zone12> (March 15, 2005).
[47] Gentry Homes, Ltd. and Kamehameha Schools Bishop Estate, Waiawa, O‘ahu, Hawaii Urban Design Plan Draft, (PBR Hawai‘i; 1998), p. 5.

2.6 Socio-Economic Conditions

2.6.1 Population

According to the U.S. Census, the population in the ‘Ewa District was 101,397 people in 2010. The total population increased by 164.7% over the previous thirty years, as ‘Ewa was designated as Honolulu’s “Second City” and City policy directed growth to the district.

Table 2-7 ‘Ewa Historic Population

Geographic Area	Historic Population				Change 1980-2010	Percent Change 1980-2010	Share of O‘ahu Change	Average Annual Change
	1980[1]	1990[1]	2000[1]	2010[2]				
‘Ewa DP Area	35,709	42,983	68,696	101,397	65,688	184.0%	34%	2,190
O‘ahu TOTAL	762,564	836,231	876,156	953,207	193,211	25.3%	100%	6,440

1 Source: ‘Ewa Development Plan Update (2011)
2 2010 ‘Ewa population from personal communication with City DPP, May 8, 2012.
2010 O‘ahu population from US Census 2010

‘Ewa’s population is expected to continue to increase over the next twenty-five years. The City Department of Planning and Permitting’s (DPP) socioeconomic projections (2009) are based on the land use policies set forth in the City’s General Plan, as well as by the ‘Ewa Development Plan (DP) Update. The General Plan (2002) calls for ‘Ewa to account for 13% of the total islandwide population by 2025, but the City’s projections estimate that ‘Ewa will account for almost 16% of O‘ahu’s population by 2035.

Table 2-8 ‘Ewa Projected Population by 2035

Geographic Area	2010 (Actual)		2035 (Projected)		Change 2010-2035	Percent Change 2010-2035	Share of Change	Average Annual Change
	Population	Percent of Total	Population	Percent of Total				
‘Ewa DP Area	101,397	11%	173,846	16%	72,449	71%	61%	2,898
O‘ahu TOTAL	953,207	100%	1,071,224	100%	118,017	12%	100%	4,721

Source: DPP Socio-Economic Projections (May 2014)

2.6.2 Demographic Characteristics

Based on the 2010 U.S. Census, the residents of ‘Ewa are generally younger than residents of the City and County of Honolulu as a whole, possibly due to the lower cost of housing. Additionally, ‘Ewa residents have larger household and family sizes. A large percentage of residents identify themselves as Asian (46%), comparable to the City as a whole, but only 7.5% of residents identify themselves as Native Hawaiian and other Pacific Islander, a smaller percentage than at the City level (8.9%).

Table 2-9 Demographic Characteristics[48]

Characteristics	‘Ewa	City-Wide
Median Age (Years)	31.2	35.7
Race		
One Race	75.8%	80.1%
White	18.4%	21.3%
Black or African American	2.3%	2.4%
American Indian and Alaska Native	0.2%	0.2%
Asian	46.0%	46.0%
Native Hawaiian and other Pacific Isl.	7.5%	8.9%
Other	1.3%	1.3%
Two or more Races	4.0%	19.9%
Gender		
Male	50.3%	50.3%
Female	49.7 %	49.7%
Average Persons per Household	3.61	2.95
Average Persons per Family	4.01	3.59

2.6.3 Economics

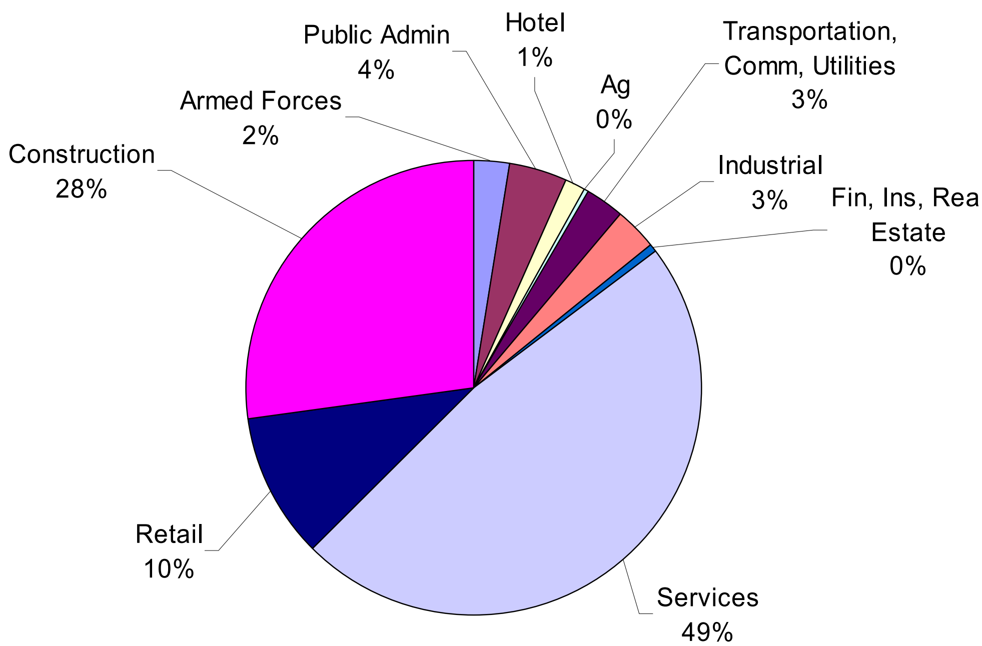
‘Ewa had a higher percentage (71%) of its working-age population (age 16 and older) in the labor force than O‘ahu as a whole (65%) in 2000. Of those employed, 92% were in civilian jobs vs. 8% in military jobs. Median household income in 2000 was approximately $60,811, higher than the O‘ahu median of $52,280. Correspondingly, 5.5% of the population in ‘Ewa was below the poverty line, a much lower percentage than O‘ahu as a whole (9.6%).

In 2000, the ‘Ewa District accounted for 4% of the total jobs on O‘ahu. The City’s socioeconomic projections (made in 2009) indicate that the number of jobs in ‘Ewa is expected to increase by 419% between 2000 and 2035, accounting for over 15% of O‘ahu’s jobs by the year 2035. These jobs are primarily in the service sector, with retail and construction also accounting for large percentages of jobs (Figure 2-11).

[48] Department of Planning and Permitting. General Demographic Characteristics: 2000, Ewa & Oahu. City and County of Honolulu.

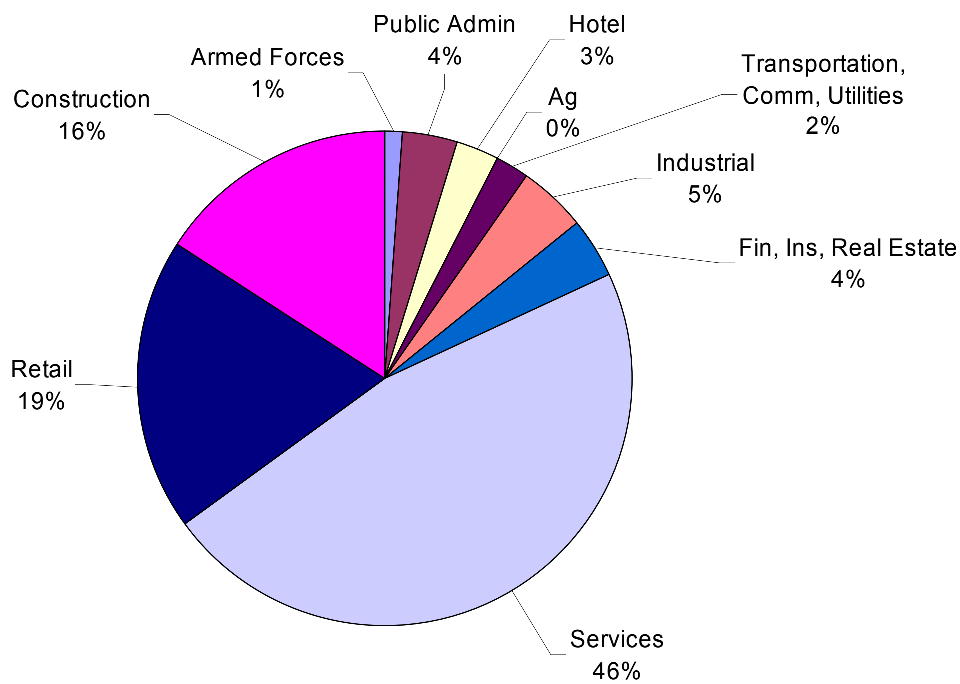
There are a variety of current and planned commercial opportunities for the ‘Ewa Development Plan area. The *General Plan* directs major economic activity and government services to the Primary Urban Center and the Second Urban Center at Kapolei, and permits the moderate growth of business centers in the urban-fringe areas. Several State and City and County offices have moved their headquarters from Honolulu to Kapolei, shifting to the Second Urban Center as the “Second Civic Center,” dominated by government buildings. In maintaining the viability of O‘ahu's visitor industry, the *General Plan* also permits the development of secondary resort areas in West Beach, namely the resort of Ko Olina.

Figure 2-10 ‘Ewa District Jobs by Employment Sector (2010) [49]



[49] Department of Planning and Permitting, September 2009, City and County of Honolulu Socioeconomic Projections.

Figure 2-11 ‘Ewa District Projected Jobs by Employment Sector (2035)[50]



Key Socioeconomic Condition Implications for Water Resource Planning

- Water demands will continue to increase as population has increased rapidly in ‘Ewa and is projected to continue to grow through 2035.
- Water demands will also continue to grow as the number of jobs increases.

[50] Department of Planning and Permitting, September 2009, City and County of Honolulu Socioeconomic Projections.

2.7 Land Use

All of the land in the State is classified into one of four designations: Conservation, Agriculture, Rural, or Urban. Over half of the land in the ‘Ewa District is classified as State Land Use “Urban,” in support of the City’s policy that identifies ‘Ewa as a growth area and “Second City.” Approximately one-third of the land is designated as “Agriculture,” and less than 4% is “Conservation” (Table 2-10). No lands are designated as “Rural.” The bulk of the agricultural and conservation land is located mauka of the H-1 Freeway (Figure 2-12).

Table 2-10 State Land Use Districts

Land Use District	Acres	Percent
Agriculture	9,820	29.2%
Urban	22,510	67.0%
Conservation	1,252	3.7%

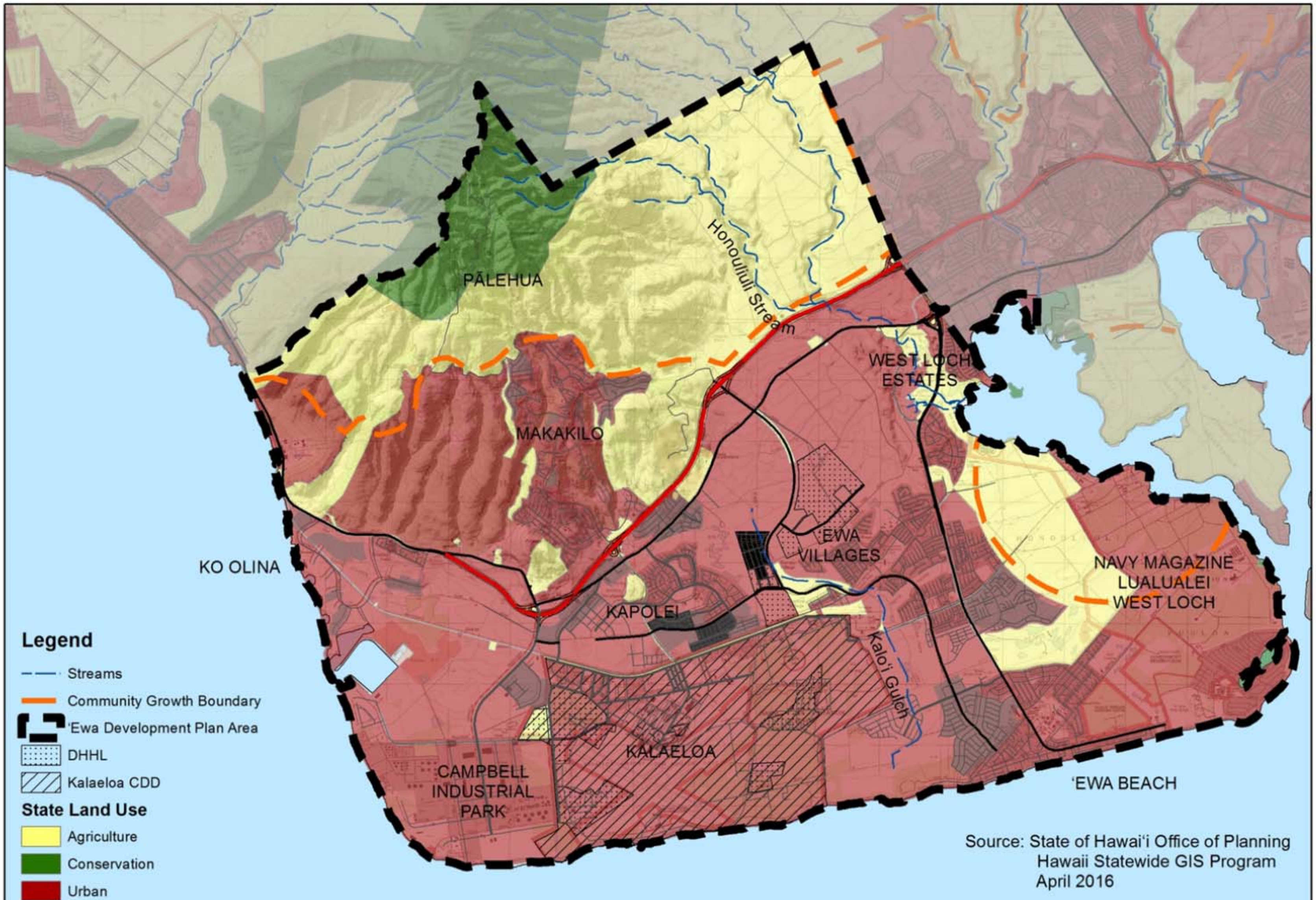
Source: Office of Planning, Department of Business, Economic Development, and Tourism, State of Hawai‘i, February 2016, State Land Use Districts GIS. http://planning.hawaii.gov/gis/download-gis-data/. Retrieved April 28, 2016.

The City Land Use Ordinance (LUO) defines land uses through zoning and regulates those uses in accordance with the City General Plan and Development Plan. Approximately one-third of the land area in ‘Ewa is zoned “agriculture.” Urban areas are further broken down into more specific uses, with the majority being “Federal and Military” and Kalaeloa Community Development District lands. Single Family Residential lands also make up a large portion of urban areas. Preservation lands account for approximately 12% of the area in ‘Ewa.

Table 2-11 City Zoning

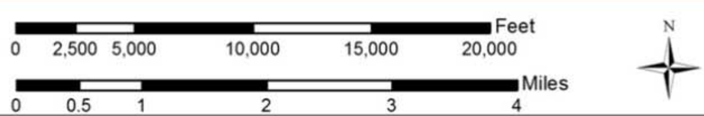
City Zoning	Acres	Percent
Apartment	1,841	5.8%
Apartment Mixed Use	463	1.4%
Agriculture	10,647	31.7%
Neighborhood/Community Business	527	1.6%
Community Business Mixed Use	836	2.5%
Country	65	0.2%
Federal and Military Preservation	7,066	21.0%
Industrial and Industrial Mixed Use	3,067	9.1%
Preservation	4,058	12.1%
Residential (single-family)	4,783	14.2%
Resort	128	0.4%

Source: Department of Planning and Permitting, City and County of Honolulu, February 22, 2016, Zoning Land Use Ordinance (LUO). ftp://gisftp.hicentral.com/layers/Zoning_Regulatory/. Retrieved April 28, 2016.



'Ewa Watershed Management Plan

Figure 2-12 State Land Use Districts



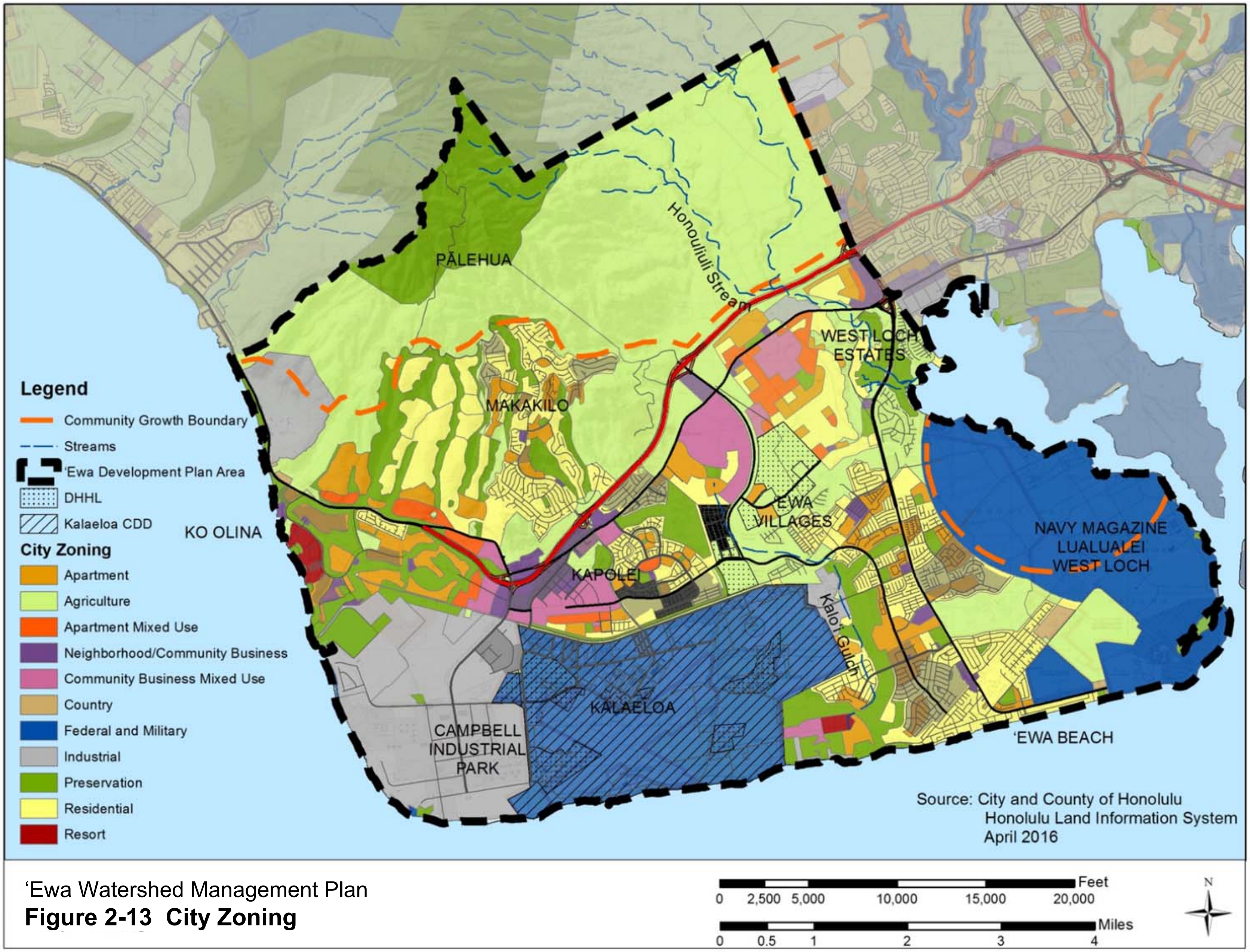
Despite the LUO, over 6,112 of the 33,677 acres (18%) of land in ‘Ewa could potentially be exempt from City zoning regulations because they are either owned by the Department of Hawaiian Home Lands (DHHL) or they are a Community Development District (CDD) governed by the Hawai‘i Community Development Authority (HCDA), which has developed rules that supersede City zoning (Figure 2-13). Affordable housing projects may also be exempt from zoning if certain conditions are met.

- DHHL (2,412 acres): Attorney General’s Opinion No. 72-21 (1972) stated that “where Hawaiian home lands are needed or required for the purposes of the Hawaiian Homes Commission Act, and zoning ordinance purporting to change the land use designation by the department of Hawaiian home lands or to impose restrictions on the use of such Hawaiian home lands would be outside the scope of any power granted to the counties.”
- HCDA Kalaeloa CDD (3,700 acres): Hawai‘i Revised Statutes (HRS) 206E-7 directs HCDA to develop rules for its community development districts that supersede all other ordinances and rules “relating to the use, zoning, planning, and development of land and construction thereon.”
- HRS 201H: Affordable housing projects may be granted exemptions from certain ordinances and rules, including zoning. In order for a project to be eligible for this exemption, at least 50% of its housing units must be affordable as determined by City rules and based on guidelines by the U.S. Department of Housing and Urban Development.

The ‘Ewa Development Plan identifies a Community Growth Boundary that provides space for urban development while protecting agricultural, conservation, and open space lands. The Community Growth Boundary in ‘Ewa generally restricts urban growth from the lands mauka of the H-1 Freeway and Makakilo and within the Navy’s Explosive Safety Quantity Distance (ESQD) zone adjacent to the West Loch of Pearl Harbor.

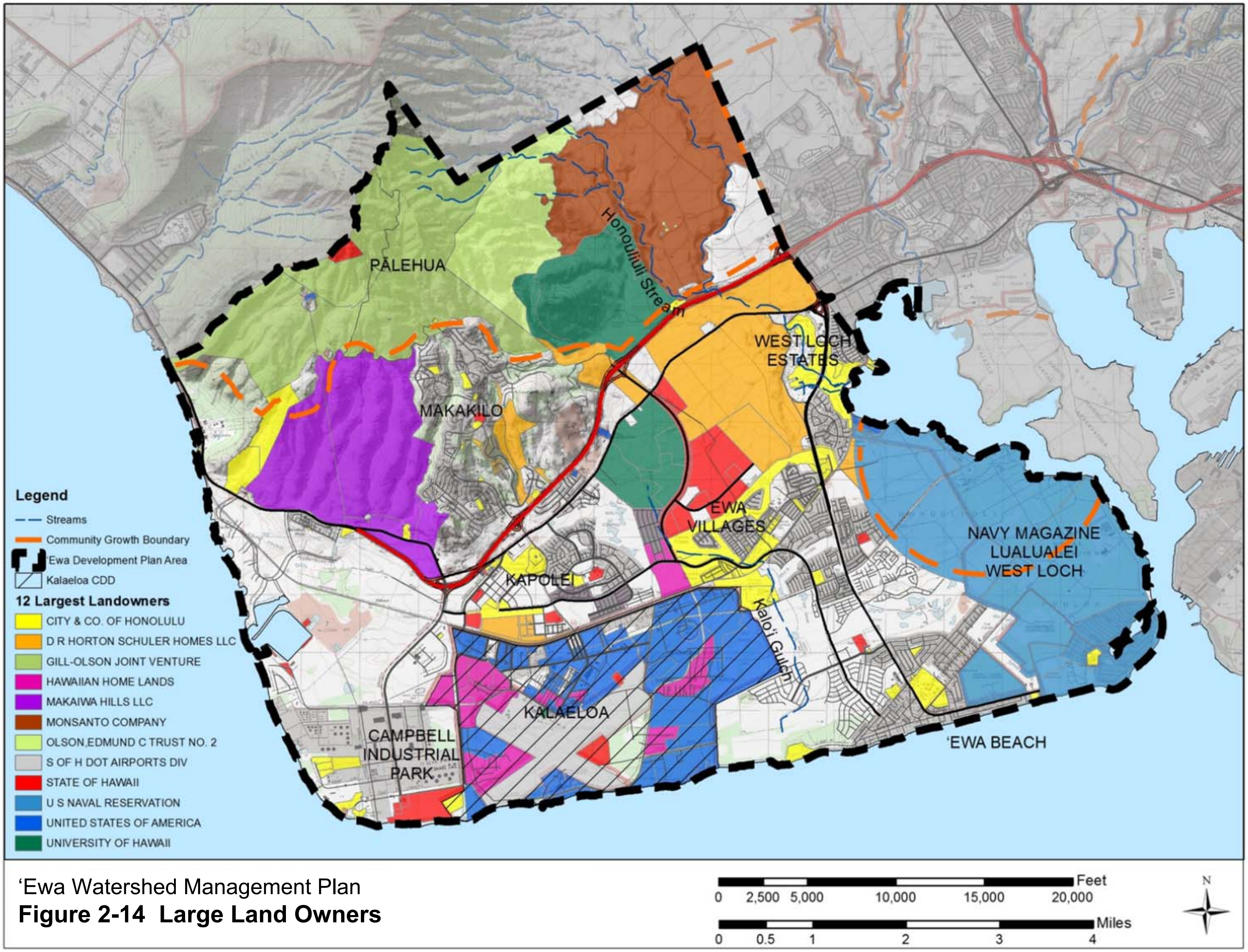
2.7.1 Land Ownership

The top ten land owners in ‘Ewa are diverse, including government entities, private corporations, private family trusts, and a non-profit organization. Collectively, they own approximately 37% of the land in the project area (Table 2-12). The land owned by the Navy is used for military purposes. The Monsanto Company and the Hawaii Agricultural Research Center (HARC) are involved in agriculture and related research. City and County of Honolulu lands are used for a variety of purposes including a golf course, landfill, wastewater treatment plant, parks, office buildings, and other civic purposes. The two Trusts manage portions of the Honouliuli Preserve, which protects valuable native forest habitat. The State Department of Transportation (DOT) owns and operates Kalaeloa Airport as a general aviation reliever for Honolulu International Airport. DHHL lands are used for office space, housing for its beneficiaries, and lands that are yet to be developed. Most of Hawaiian Electric Company’s (HECO) lands in the district are associated with its Kahe Generating Station.



'Ewa Watershed Management Plan

Figure 2-13 City Zoning



'Ewa Watershed Management Plan

Figure 2-14 Large Land Owners

Table 2-12 Large Land Owners in 'Ewa

Large Land Owner		Acres	Percentage
1	U.S. Naval Reservation	3,588	11%
2	Gill-Olson Joint Venture	2,665	8%
3	Monsanto Company	2,102	6%
4	DR Horton – Schuler Homes LLC	1,980	6%
5	Makaīwa Hills, LLC	1,850	5%
6	United States of America	1,840	5%
7	University of Hawai'i	1,489	4%
8	City and County of Honolulu	1,474	4%
9	Olson, Edmund C. Trust No.2	901	3%
10	State of Hawai'i	823	2%
11	Department of Hawaiian Home Lands (DHHL)	804	2%
12	State of Hawai'i Department of Transportation (DOT) Airports Division	752	2%

*The land area is calculated based on (2012) City and County of Honolulu GIS parcel data.

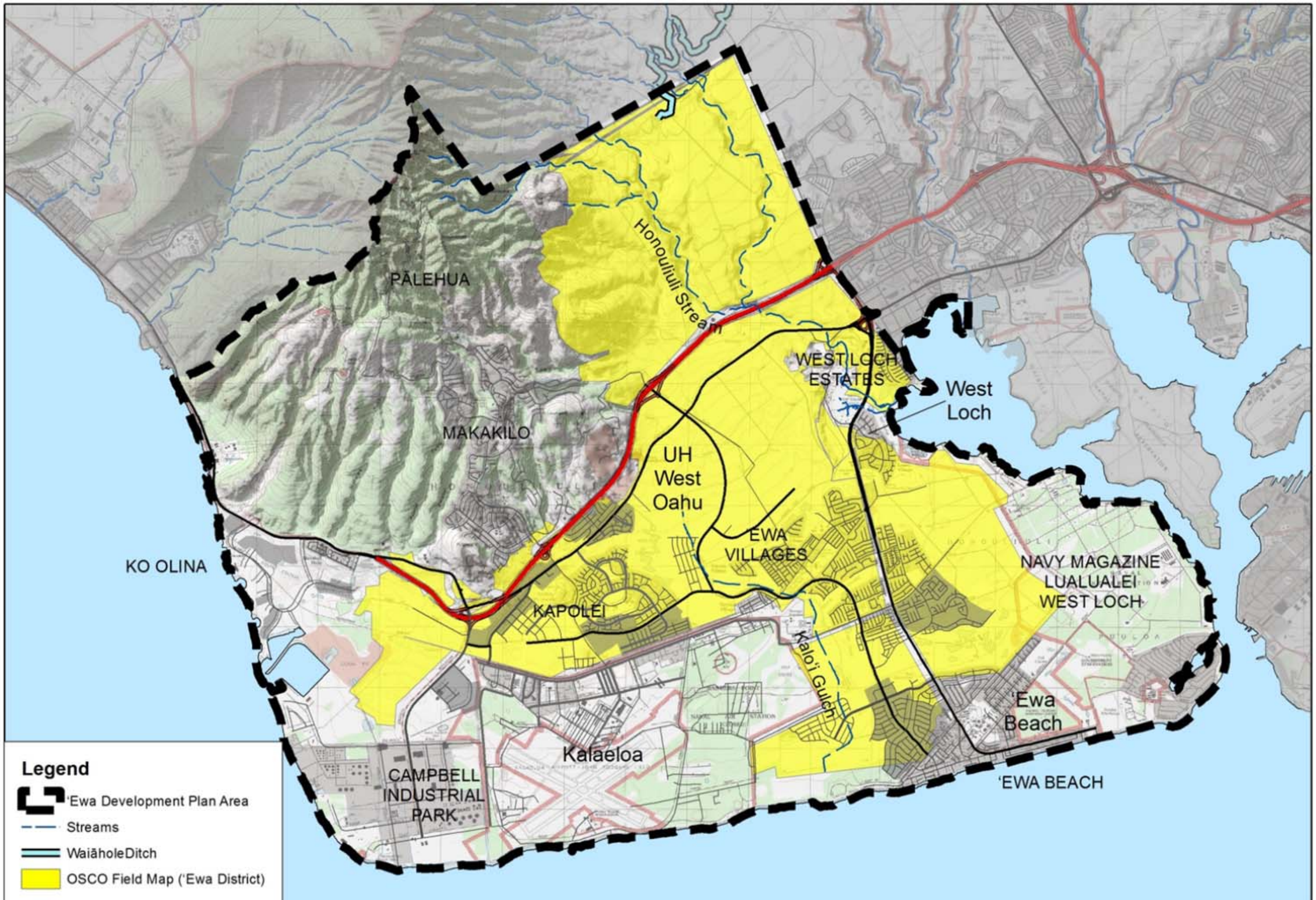
2.7.2 Agricultural Lands

Major, large-scale agriculture in 'Ewa began in the late 1890s when the 'Ewa plain was cultivated in sugar cane. The O'ahu Sugar Company (OSCO) was the largest of the sugar companies in the area, leasing 12,000 acres in 'Ewa and Central O'ahu (Figure 2-15). OSCO absorbed 'Ewa Plantation Company lands when they closed in 1970 and grew its plantation to over 15, 500 acres. Despite this, OSCO ceased operations after its 1995 harvest and the land once cultivated in sugar has since been converted to urban uses and diversified agriculture.

Through an aerial photo analysis,[51] it was determined that approximately 3,539 acres of land are being actively farmed in 'Ewa (Figure 2-16). Estimates of acres farmed only included land that appeared to be either in cultivation or fallow, but recently cultivated, and did not necessarily include the entire parcel. As of 2008, there were approximately 12,000 acres of land in cultivation on O'ahu.[52] Based on the aerial analysis of active agriculture, 'Ewa accounts for about 32% of this land.

[51] "Natural Color WorldView-2 (WV2) Orthosphoto Mosaic of the Island of Oahu, Hawaii" (State Office of Planning, Time Period of Information: January 11, 2011. Publication Date: March 02, 2011)

[52] Plasch Econ Pacific LLC. October 2011. *O'ahu Agriculture: Situation, Outlook and Issues*. Prepared for the City and County of Honolulu Department of Planning and Permitting.



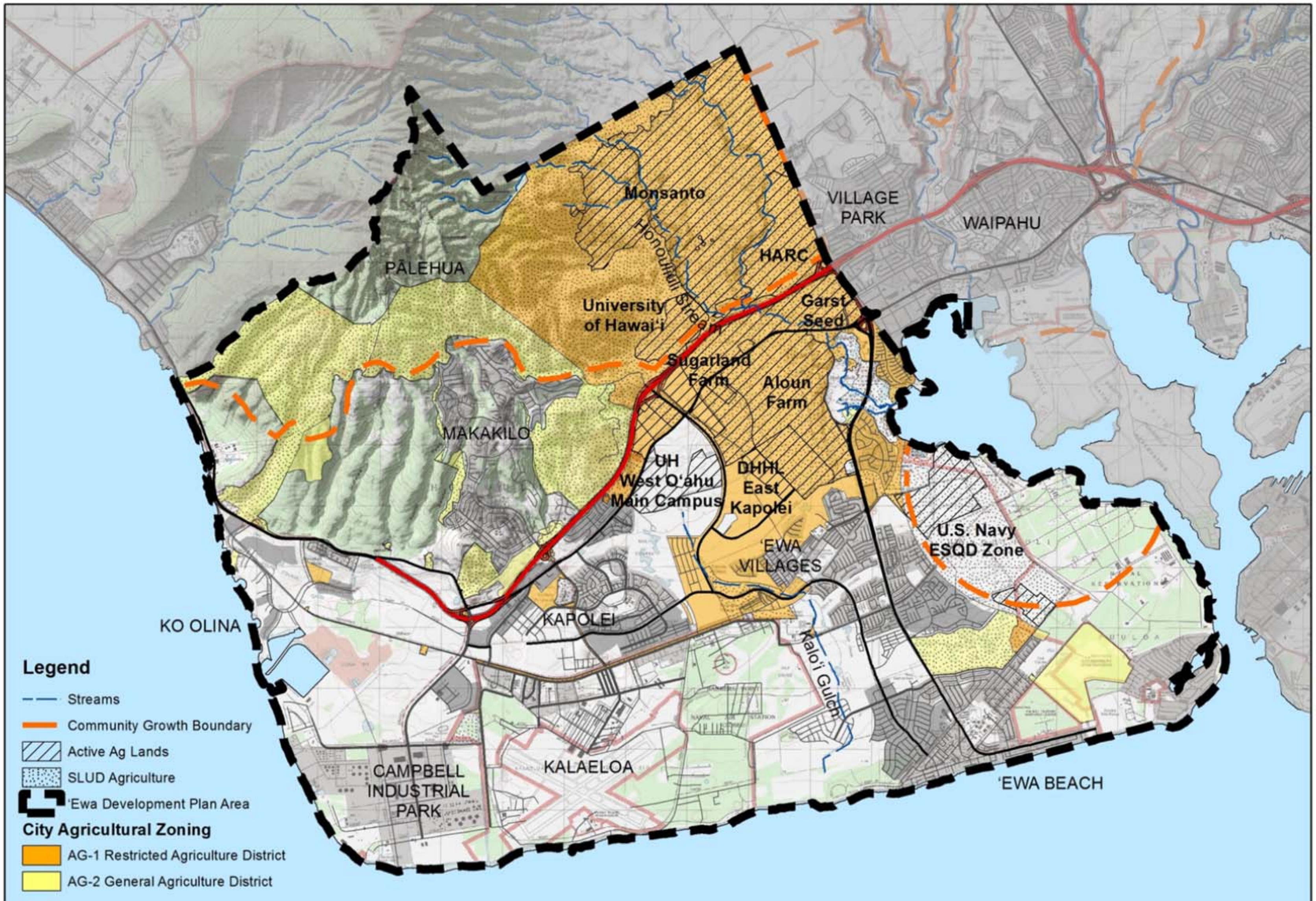
'Ewa Watershed Management Plan

Figure 2-15 O'ahu Sugar Company Field Map (1990)

Feet: 0, 2,500, 5,000, 10,000, 15,000, 20,000

Miles: 0, 0.5, 1, 2, 3, 4

N



'Ewa Watershed Management Plan

Figure 2-16 Active Agricultural Lands

‘Ewa provides many opportunities for farmers: plentiful sunlight, soil productivity, infrastructure, water availability, and access to local markets and export markets, and farms continue to grow seed crops, vegetables, and other diversified agriculture. The State Department of Agriculture operates the Kalaeloa Agricultural Park in the Campbell Industrial Park, which consists of 10 acres of land that is subdivided into two lots. The Navy also has 1,025 acres within its ESQD zone that it can lease for agriculture, although agricultural operations are limited by military safety restrictions and brackish water supply.[53]

Agricultural water needs have changed over time. When drip irrigation technology was introduced in the early 1970s to replace furrow irrigation, agricultural water needs decreased. By 1994, all irrigation to ‘Ewa sugar cane fields had ceased and almost all ‘Ewa Caprock wells stopped pumping, reducing withdrawals from the caprock aquifer in the Pu‘uloa area from 17 MGD to 3 MGD. The loss of irrigation recharge has shrunk the caprock aquifer and led to an increase in chlorides. Besides major changes such as caprock pumpage and loss of irrigation, reductions in irrigated acres may also have contribute to the increase in chlorides.

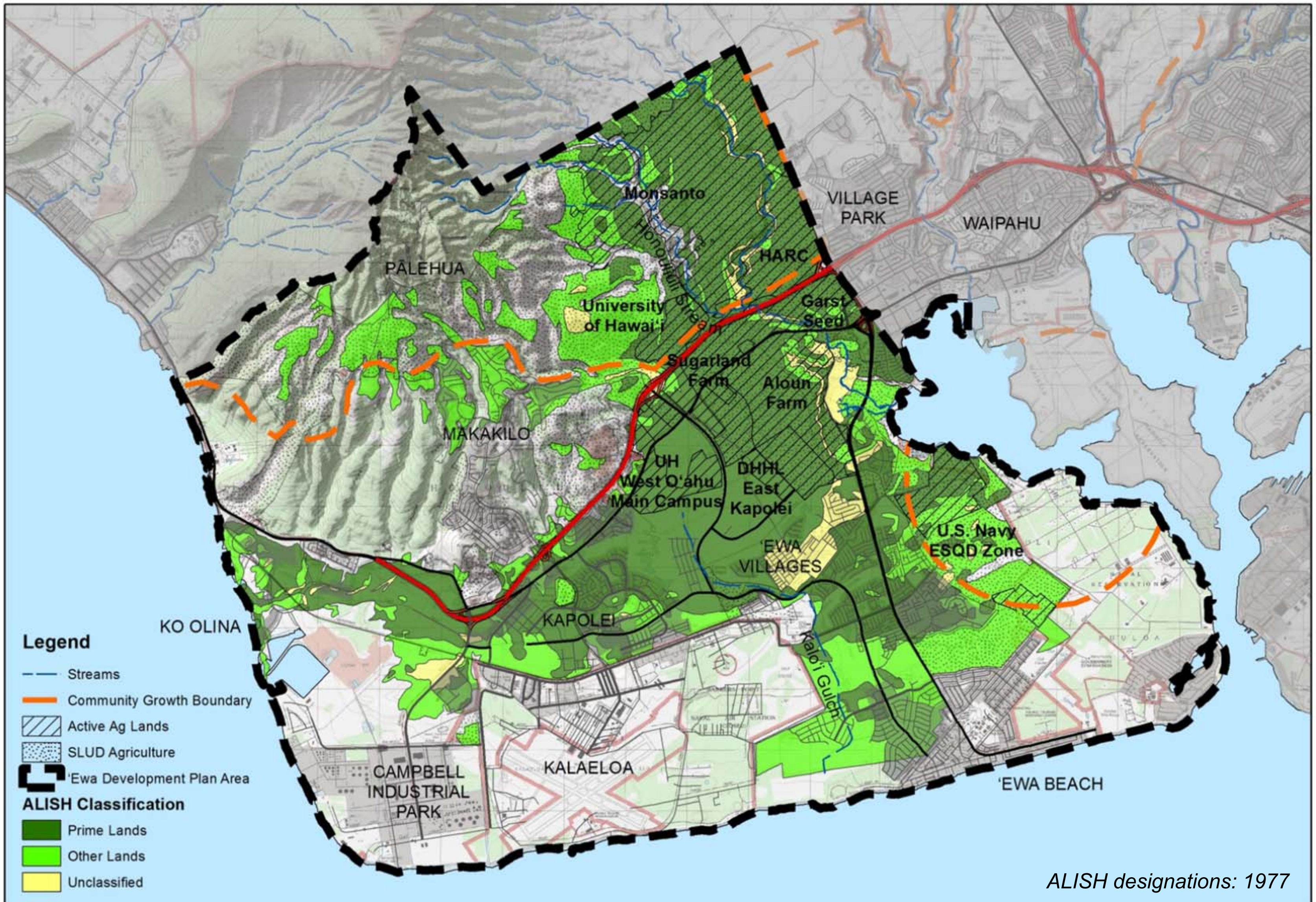
The State classifies agricultural soils into three categories using its Agricultural Lands of Importance to the State of Hawai‘i (ALISH) rating developed in 1977: Prime (best suited for the production of food, feed, forage, and fiber crops), Unique (non-Prime agricultural lands used for specific high-value crops), and Other (important to agricultural production, but have limiting factors that prevent them from being classified as Prime or Unique). Approximately 15,504 acres of land are designated as ALISH lands. Over half of those lands are designated as Prime Lands, about 38% of the ALISH lands are designated as Other Important Lands, and no lands are designated as Unique Lands in the ‘Ewa District (Table 2-13).

Table 2-13 ALISH Lands in ‘Ewa

ALISH Designation	Acres	Percent
Prime Lands	8,935	57.6%
Unique Lands	0	0.0%
Other Important Lands	5,812	37.5%
Unclassified Lands	757	4.9%
TOTA ALISH LANDS	15,504	100%

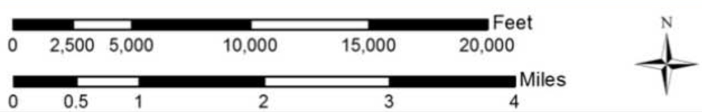
Source: State of Hawai‘i DBEDT GIS.
ALISH Designations created in 1977.

[53] Department of Planning and Permitting, City and County of Honolulu. May 2011. ‘Ewa Development Plan. p. 2-12



'Ewa Watershed Management Plan

Figure 2-17 ALISH Lands



It should be noted that although 46% of the land in ‘Ewa has some type of ALISH designation, much of it has already been developed or is proposed for development. The larger tracts of ALISH lands currently in cultivation within the Community Growth Boundary are all proposed for development including Ho‘opili (~983 acres lost), East Kapolei (~72 acres lost), and the UH West O‘ahu (UHWO) campus (~204 acres lost). Lands outside of the Community Growth Boundary, on the Wai‘anae side of Kunia Road and mauka of H-1 freeway, as well as within the Navy’s ESQD zone, will remain in agriculture, possibly even increasing cultivated acreage.

The City is also currently developing its inventory of Important Agricultural Lands (IAL), pursuant to a 2005 amendment to Chapter 205 of the Hawai‘i Revised Statues that calls for each county to identify lands within its jurisdiction that have the potential to be designated. Phase I was completed in April 2014 and provides background on the current state of the agricultural industry on O‘ahu and defines criteria by which IAL lands will be identified. The City’s Phase I report preliminarily identifies the portions of the ‘Ewa District mauka of the Community Growth Boundary as meeting a least one of the top three IAL criteria and the existing cultivated lands mauka of the H-1 Freeway as meeting all three top criteria.

Based on its history of agriculture and presence of natural resources, this district will continue to support agriculture in the future. However, because ‘Ewa is also designated as Honolulu’s secondary growth area, approximately 1,400 acres of agriculture is expected to be phased out of the Community Growth Boundary but will be preserved in those areas outside of the boundary.

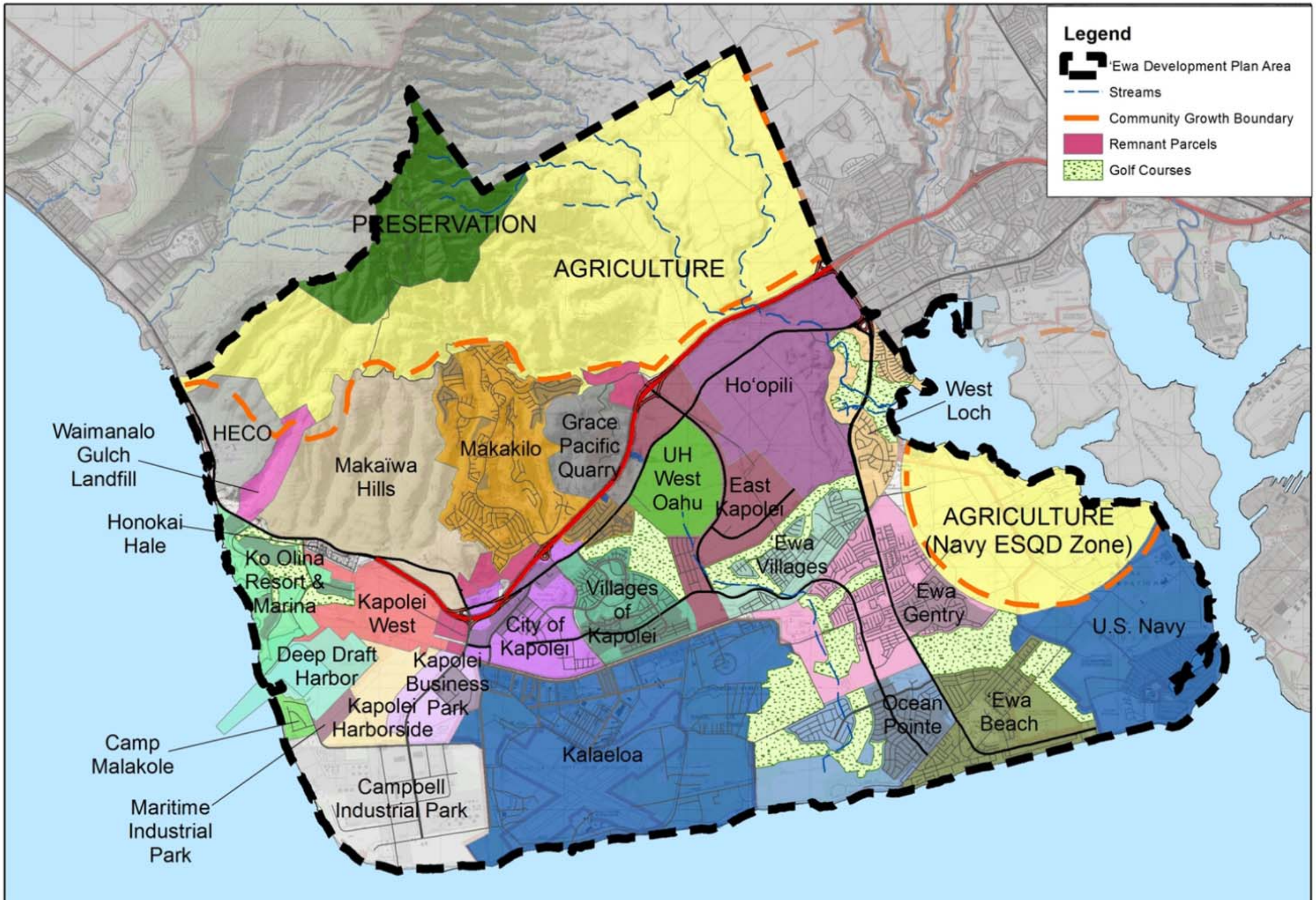
2.7.3 Residential Lands

According to the 2010 American Community Survey, the ‘Ewa District accounted for 9.1 percent of the housing units on O‘ahu. Most of the residential communities are located in the ‘Ewa Villages, ‘Ewa Gentry, and ‘Ewa Beach areas, with Kapolei growing as a residential area.

The ‘Ewa District is composed of 12 distinct communities: West Loch, Iroquois Point, ‘Ewa Beach, ‘Ewa Gentry, ‘Ewa Villages, Makakilo, Ocean Pointe, Villages of Kapolei, City of Kapolei, Honokai Hale, Ko Olina, with another three master planned developments proposed: Ho‘opili, East Kapolei, and Kalaeloa. These new developments are expected to increase the number of housing units by 15,618 between 2010 and 2035, increasing ‘Ewa’s share of O‘ahu’s housing inventory to 13%.

Table 2-14 Projected ‘Ewa District Housing Units (1980-2035)

	1980	1990	2000	2010	2020	2030	2035
‘Ewa DP Area	9,413	11,734	20,797	30,726	40,140	51,012	56,344
O‘ahu	232,038	281,683	315,988	337,030	372,256	402,321	416,347



'Ewa Watershed Management Plan

Figure 2-18 'Ewa Development Areas and Other Land Uses

Feet: 0, 2,500, 5,000, 10,000, 15,000, 20,000
Miles: 0, 0.5, 1, 2, 3, 4
N

2.7.4 Military Lands

F-1 Military and Federal Lands are primarily located at Barber’s Point/Kalaeloa and the Pearl Harbor area, and include diverse land uses such as housing and a firing range. Until July 1999 when it was formally closed, the 3,700-acre Barbers Point Naval Air Station was an active military field and a major staging area during every war since the Japanese attack on Pearl Harbor in 1941. As a part of the closure, the Navy retained control of 1,007 acres, 548 housing units, and a golf course, but the rest of the Kalaeloa property was turned over to the State. Much of the old Navy base is not currently utilized, except for a State of Hawaiʻi homeless shelter, the relocation of major elements of the Hawaiʻi Army and Air National Guard, a Coast Guard aerial operation,[54] and DOT use of the airfield for general aviation purposes.

The Pearl Harbor Naval Complex (PHNC) consists of these major facilities: Naval Shipyard, Naval Supply Center, Naval Station, Submarine Base, Public Works Center, Inactive Ships, and Navy Magazine Lualualei (West Loch Branch and Waipiʻo Peninsula). Land use within PHNC is primarily limited to operational and industrial activities, housing, and related administrative, training, and support facilities.[55] Naval Magazine Lualualei HQ, West Loch, located on the south shore of West Loch and Waipiʻo Peninsula, is the major ammunition storage area for all branches of the military in Hawaiʻi.

West Loch Branch of Naval Magazine Lualualei serves as a shipping and receiving facility and is bounded on the north and northwest by waters of the West Loch of Pearl Harbor and on the west by the communities of ʻEwa, ʻEwa Beach, and Kapolei. West Loch covers approximately 3,970 acres and has 118 above-ground magazines with a storage capacity of 20,830 short tons. Puʻuloa Rifle Range is located here.

The Explosive Safety Quantity Distance (ESQD) zone for the Pearl Harbor Naval Munitions Command at West Loch Naval Magazine allows for certain types of land uses such as agriculture, open-air recreation, or other uses that do not involve the construction of inhabited buildings or structures, within the outer 40 % of the hazard zone.[56] The Naval Base has first-line responsibility for implementing Regionalization and Claimant Consolidation for the Navy in Hawaiʻi. Both initiatives are closely linked together and are necessary for the Navy to gain service improvements in Shore Installation Management, including food service, supply, building maintenance, firefighting, public affairs, and data processing support.[57]

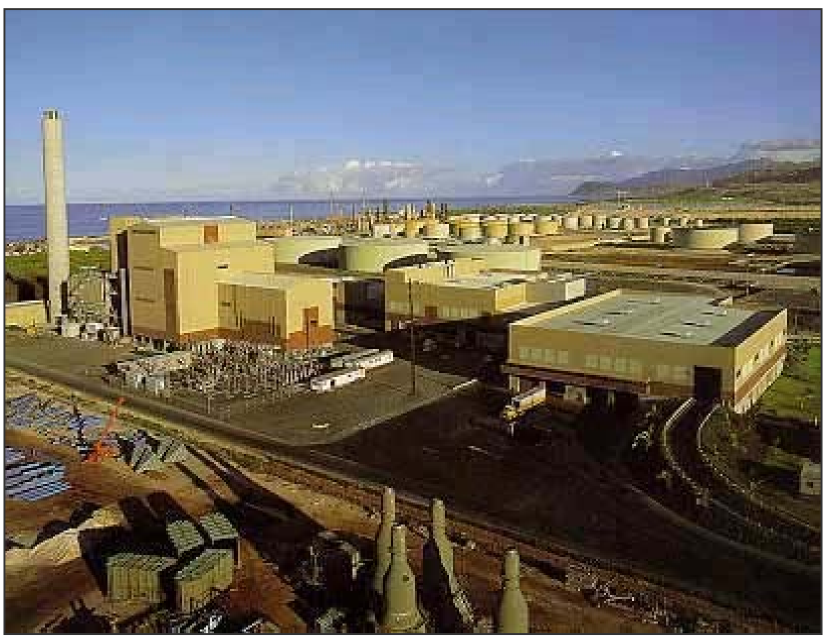
[54] Gregg K. Kakesako, “State Desires Aircraft Carrier at Pearl Harbor, Honolulu Star-Bulletin, June 19, 2003, <http://starbulletin.com/2003/06/19/news/story3.html> (May 10, 2005).
[55] U.S. Department of the Navy, Master Plan for Pearl Harbor Naval Complex. Pacific Division (Naval Facilities Engineering Command; 1984).
[56] City and County of Honolulu Planning Department, Waipahu Town Plan Report: A Special Area Plan of the Central Oahu Development Plan (Wilson Okamoto & Associates, Inc.; 1995), p 3-2.
[57] GlobalSecurity.org. Military, Pearl Harbor, <http://www.globalsecurity.org/military/facility/pearl_harbor.htm> (May 19, 2005).

Marine Corps Base Hawaii, Puʻuloa Training Facility provides an individual weapons training area for Marine, Navy, and Coast Guard personnel. The facility consists of one active 600-yard rifle range and another inactive 1,000-yard rifle range, two pistol ranges, and a small arms range.

The Coast Guard Air Station Barbers Point serves as the "Guardian of the Pacific" in their support of the Fourteenth Coast Guard District, the largest of all Coast Guard operating areas, protecting 14.2 million square miles of open ocean, atolls, and island nations. Air Station Barbers Point has long-range patrol and logistical support capabilities, as well as quick and versatile search and rescue response.

2.7.5 Industrial and Commercial Lands

Spread across 1,367 acres, Campbell Industrial Park is the state's largest industrial park and is known as a “regional industrial” center. Its tenants represent the industries of manufacturing, recycling, import/export, power generation, fuel storage, construction, warehouse and distribution. Campbell Industrial Park is a designated Foreign Trade Zone, designed to offset the customs advantages that overseas producers have over domestic producers. Therefore, special customs procedures are provided to US companies engaged in international trade. The industrial park is served by the adjacent Kalaeloa Barbers Point Deep Draft Harbor, the state's second busiest commercial harbor.[58] The Campbell Industrial Park/ Kalaeloa complex provides for over 7,000 jobs.



H-Power Plant at Campbell Industrial Park. http://www.iolani.honolulu.hi.us/Academics/UpperSchool/Science-Upper_School/Chemistry/ChemCom/VFT/HPOWERplant.html

Hawaii Independent Energy and Chevron are two oil companies with refineries in the park. The Hawaii Independent Energy facility can process 94,000 barrels per day and the Chevron refinery has a capacity of 54,000 barrels a day.[59]

[58] Enterprise Honolulu, Business Parks, Incubators and Technology Parks, <http://www.enterprisehonolulu.com/html/print.cfm?sid=29> (May 4, 2005).

[59] Honolulu Star Advertiser. “Tesoro Hawaii will lay off up to 200 people.” Retrieved on January 8, 2013. http://www.staradvertiser.com/news/breaking/20130108_Tesoro_to_shut_down_Oahu_refinery.html?id=186074191.

2.7.6 Resort Lands

The only resort area within the ‘Ewa district is at Ko Olina, located in the Makaīwa sub-watershed. It is one of five secondary resort designations identified in the November 2012 Draft County General Plan (others include Kuilima Resort, Hoakalei Resort at Ocean Pointe, Mākaha Valley, and Lā‘ie) that is intended to relieve growth pressures on Waikīkī.

Five hotels have already been constructed: Marriott’s Ko Olina Beach club, Aulani-A Disney Resort and Spa, JW Marriott Ihilani Resort and Spa at Ko Olina, Aulani Disney Vacation Club Villas, and Ko Olina Beach Villas Resort. Also within the 640-acre resort area are a golf course and clubhouse, four man-made lagoons, and the 43-acre Ko Olina Marina with 330 full-service slips. When fully developed, Ko Olina is expected to have at least 4,000 visitor units and 5,200 residential units.

2.7.7 Educational/Institutional Land

The ‘Ewa District area has 11 public elementary schools, 3 public middle schools, 2 public high schools, and 4 private schools, as of 2008.[60] Colleges include: University of Hawai‘i West O‘ahu Campus, Leeward Community College, and University of Phoenix Kapolei campus. The newest and largest educational complex in ‘Ewa is the UHWO campus. Originally opening in 1976 as the only four-year university on the Leeward Coast, the new campus opened in 2012, relocating from its former home at Leeward Community College. By the year 2025, UHWO is expected to have 7,600 students and 1,040 staff and faculty. [61]

Approximately 1,410 residential units are planned for the 202.3-acre UHWO campus. Additionally, approximately 2,631 residential units are planned on 298-acres of private development lands, adjacent to the campus.

2.7.8 Recreational Lands

The ‘Ewa District has many recreational and cultural areas. There are 29 existing parks and recreation centers with an additional 25 planned for development (Table 2-15). The proposed new parks would more than triple the existing park acreage in ‘Ewa.

[60] Department of Planning and Permitting, City and County of Honolulu. May 2011. ‘Ewa Development Plan. p. 4-34
[61] Department of Planning and Permitting, City and County of Honolulu. May 2011. ‘Ewa Development Plan. p. 2-4

Table 2-15 Existing and Planned Parks

Park Type	Number of Parks	Area (acres)
Existing Parks	29	395.5
Regional	1	69.4
District	1	25
Community	6	62.5
Neighborhood	4	17.7
Private	6	50
Beach	11	170.9
Planned Parks	25	847.5
Regional	2	505.7
District	4	135
Community	5	60.7
Neighborhood	10	112.9
Private	2	27
Beach	2	6.2
TOTAL	54	1,243

One'ula Beach Park

Nine golf courses are located in ‘Ewa: two municipal, one military, and six private courses (Table 2-16). West Loch, ‘Ewa Villages, Kapolei, Coral Creek, and Hoakalei golf courses also serve as flood retention basins for large storm events.

Table 2-16 Existing and Planned Golf Courses

Golf Course	Existing/Planned Area (acres)	Planned Area (acres)
City		
‘Ewa Villages Golf Course	235.0	N/A
West Loch Golf Club	187.0	N/A
Federal		
Barber’s Point Golf Course	145.0	N/A
Private		
Coral Creek Golf Course	195.0	N/A
‘Ewa Beach Golf Club	130.0	N/A
Hawai‘i Prince Golf Club	270.0	N/A
Hoakalei Country Club (Ocean Pointe)	189.0	N/A
Kapolei Golf Course	190.7	N/A
Kapolei West Golf Course	204.4	203.0
Ko Olina Golf Club	170.0	N/A
TOTAL	**1,916.1**	**203.0**

Ko Olina Hole 18.
Source: http://www. spiritofaloha.com/golf/0901/golf.html

In addition to these parks and golf courses, other recreational venues include Paradise Cove and Lanikuhonua Hawaiian Cultural Park, Hawaiian Waters Adventure Park in Kapolei, and a skate park in ‘Ewa Beach. There are no State Na Ala Hele program hiking trails in the ‘Ewa District, but the OR&L Railway has been converted into the Leeward Bikeway from Waipi‘o Point Access Road, across the ‘Ewa plain to the Wai‘anae Coast.

2.7.9 Conservation Land

Conservation lands are generally found within the Honouliuli Forest Reserve at the mauka portions of the ‘Ewa district and along some of the gulches, which aligns with the ‘Ewa Development Plan guidelines to preserve the natural gulches as part of the open space and drainage systems. Other than these locations, the lands in ‘Ewa are designated for other uses.

Key Land Use Implications for Water Resource Planning

- Directed for growth by the City, the ‘Ewa Development Plan designates urban, agricultural, industrial, and preservation uses. Diversified water sources are needed to supply these differing needs.
- Potable water demand will continue to increase as the number of housing units is expected to rise –Housing is expected to increase by over 15,000 units by 2035.
- As land is developed, large landscaped areas, including parks, golf courses, and roadway landscaping, will grow, increasing the demand for non-potable irrigation water.
- Agriculture could potentially be served by non-potable water sources, and as agriculture is being concentrated in discrete locations in ‘Ewa, non-potable water infrastructure could be directed to those sites.

2.8 Infrastructure and Utilities

2.8.1 Roads and Highways

There are several major roads and highways in ‘Ewa: the H-1 Freeway, Farrington Highway, Kapolei Parkway, and Franklin D. Roosevelt Avenue provide east-west access and Fort Weaver Road, Kualakai Parkway, and Makakilo Drive/Fort Barrette Road provide much of the access mauka to makai. Congestion is notoriously bad traveling into and out of ‘Ewa, particularly during the peak morning and afternoon rush hours when Level of Service (LOS)[62] was rated as D and F on some of these major roadways.[63]

Current and planned development continues to be an issue with residents concerned with its impacts on traffic congestion. In response to island-wide congestion, the Honolulu Authority for Rapid Transit (HART) began operations in 2011 to implement rail transit. Current plans identify three rail stations in ‘Ewa: East Kapolei, UH West O‘ahu, and Ho‘opili. Additional stations could be constructed if the rail is extended into Kapolei and Kalaeloa, as was previously discussed.

Honolulu Rail route. Source: www.honolulutransit.org

[62] Level of service characterizes the operating conditions as perceived by a driver of a roadway. LOS is rated from A through F, where LOS A represents ideal, congestion-free conditions and LOS F identifies extremely congested, over capacity conditions.

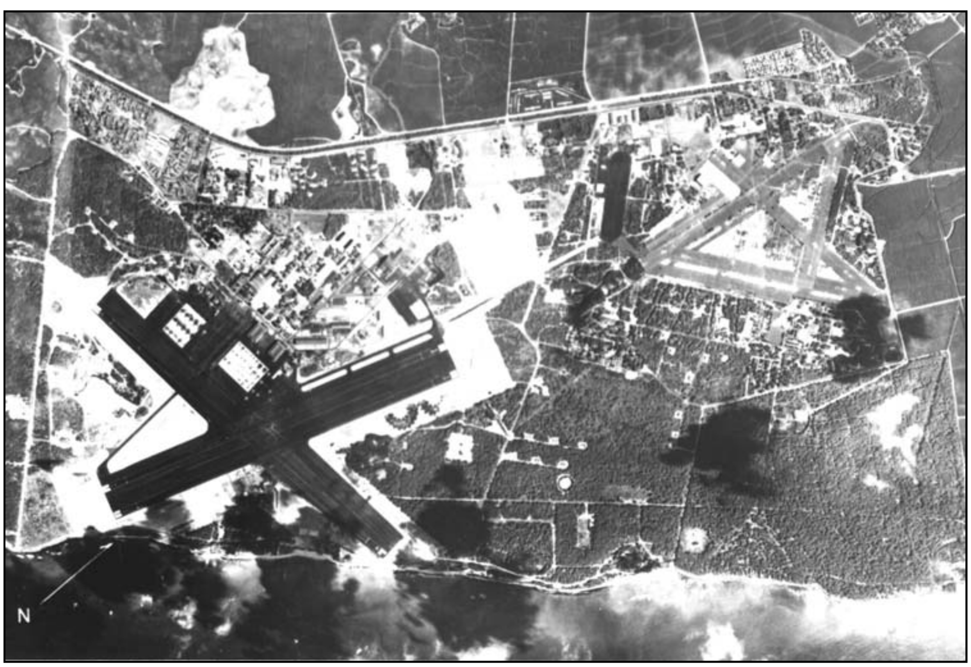
[63] Parsons Brinkerhoff. April 2011. ORTP 2035 Technical Report, Oahu Regional Transportation Plan 2035. Figure 3-9: 2007 AM Two-Hour Peak Period LOS – Islandwide.

2.8.2 Airports

Kalaeloa Airport is approximately 752 acres in size and is the only airport servicing the ‘Ewa region. The airfield was originally established as the much larger Barber’s Point Naval Air Station in 1942. The State DOT Airports Division took over ownership and operations of the airport in 1999 as a general aviation reliever for Honolulu International Airport. Regular users of the airport include the U.S. Coast Guard, Hawai‘i Community College Flight Program, Hawai‘i National Guard, and private users. Minimal facility improvements are currently planned.

Due to noise considerations from aircraft, the Federal Aviation Administration established compatibility criteria for determining acceptable land uses for various noise exposure levels. Day-night average noise level (DNL) are the accepted unit for quantifying human annoyance to general environmental noise with a general noise level of 65 DNL or lower considered acceptable for obtaining funding from Federal agencies. A 1989 noise study was used to develop the Air Installations Compatible Use Zones Noise Contours in Figure 18. Noise levels on the runway exceed 70 DNL but are generally below 65 DNL off of the airport property.

Another airfield, the ‘Ewa Marine Corps Air Station (MCAS), was completed in 1941. During the attack on Pearl Harbor in 1941, the airfield and a majority of its aircraft sustained heavy damage. The ‘Ewa MCAS was used by the Navy and Marine Corps to support efforts in the Pacific during World War II. The base was eventually closed in 1952 because its runways were too short for newer jet aircraft. While the air field has not been used since 1952, the air station has been protected by the Navy’s military reservation at BPNAS. Thus, most of the runways are still visible in aerial photos.



Barber’s Point NAS (left) and ‘Ewa Field (right) c. 1957.
Source: Hawaii Aviation Preservation Society
http://hiavps.com/Ewa%20MCAS.htm

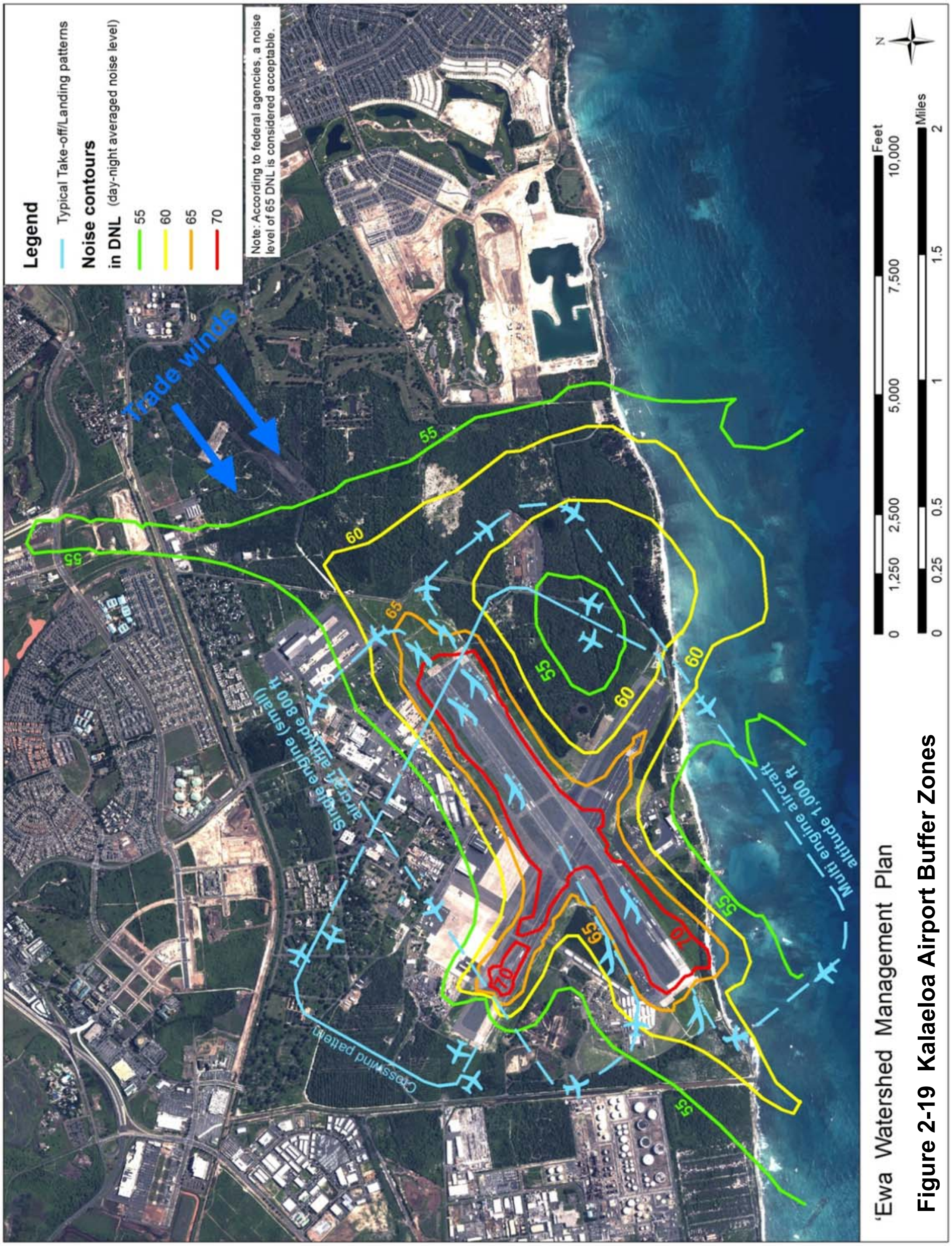


Figure 2-19 Kalaeloa Airport Buffer Zones

2.8.3 Harbors and Marinas

There is one State-owned harbor and one private marina in ʻEwa. Kalaeloa Barbers Point Harbor is operated by the State DOT Harbors Division for handling of specialized cargo such as certain dry-bulk and construction materials. Originally constructed in 1961, the harbor supplements the functions of Honolulu Harbor. A 2010 Environmental Assessment was produced to acquire 57 acres to expand the existing harbor.

The Ko Olina Marina is a private marina located within the Ko Olina Resort. Opened in 2000, the marina has 330 slips that can accommodate up to 200-foot vessels. Slips are available for recreational, commercial, and guest use. Thirty slips are also reserved for live-aboard use.

An additional marina was proposed by Haseko Hawaii Inc. as part of its Ocean Pointe/Hoakalei Resort community between White Plains Beach and Oneʻula Beach Park. While the marina has been dredged, it will instead be a recreational lagoon with no connection to the ocean.

Ko Olina Marina (left) and Kalaeloa Barber's Point Harbor (right).
Source: School of Ocean and Earth Science and Technology, University of Hawaiʻi
http://www.soest.hawaii.edu/coasts/data/oahu/oblique_leeward.xml

2.8.4 Electrical Power

The Hawaiian Electric Company, Inc. (HECO) provides electrical power to most of the residents of the City and County of Honolulu. Two of HECO's three power generating stations on Oʻahu are located in 'Ewa: HECO's Kahe Generating Station and the Campbell Industrial Park Generating Station. The Kahe station has six reheat steam turbine generator units that use oil to generate 650 megawatts (MW) of electricity.[64] The Campbell Industrial Park Generating Station is one of the largest commercial generators in the world fueled exclusively by biodiesel and has a 110 MW capacity.[65]

The City processes 2,000-3,000 tons of solid waste per day at its waste-to-energy H-POWER plant in Campbell Industrial Park. Beginning service in 1990, H-POWER produces up to 69 MW of energy, which it sells to HECO. Other independent power producers that sell energy to HECO include AES-Hawaii, which uses coal to produce 180 MW and Kalaeloa Partners, which uses oil to produce 208 MW.

The State has committed to achieving 100% clean energy by the year 2045. As a part of this effort, three solar farms have been constructed in 'Ewa: Kalaeloa Solar Farm (5 MW), Kalaeloa Renewable Energy Park (5 MW), and Kapolei Sustainable Energy Park (1.2 MW). Additionally, customer-sited solar power generation has been gaining popularity, with 272 MW generated island-wide.[66]

2.8.5 Solid Waste

'Ewa is home to the island's sole active municipal solid waste landfill at Waimanalo Gulch. The Waimanalo Gulch Sanitary Landfill is about 200 acres in size, with about half of the property permitted for landfilling and support operations. Approximately 300,000 tons of municipal solid waste and 100,000 tons of H-POWER ash are disposed of at the landfill annually.[67] Efforts to supplement or replace the Waimanalo Gulch Sanitary Landfill have been ongoing for several years, but no location has been selected yet.

[64] HECO About Us, History, Post-War Boom. http://www.heco.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=de685e658e0fc010VgnVCM1000008119fea9RCRD&vgnextchannel=575df2b154da9010VgnVCM10000053011bacRCRD&vgnextfmt=default&vgnextrefresh=1&level=0&ct=article [Retrieved on 3-22-13.]

[65] HECO Renewable Energy Sources, Biofuels. https://www.hawaiianelectric.com/clean-energy-hawaii/renewable-energy-sources/biofuels [Retrieved 3-10-16].

[66] HECO Power Facts. https://www.hawaiianelectric.com/about-us/power-facts [Retrieved 3-10-16].

[67] Waimanalo Gulch Sanitary Landfill Expansion Fact Sheet. http://www.opala.org/pdfs/solid_waste/WGSL_Factsheet.pdf [Retrieved 3-10-16]

2.8.6 Wastewater

The Honouliuli Wastewater Treatment Plant (WWTP) was built in 1978 and accepts wastewater from Makakilo and Barber’s Point to Hālawa and Mililani. It has a design capacity of 51 mgd and processes an average of 26 mgd of wastewater to advanced primary treatment. A secondary treatment facility produces 13 mgd of non-disinfected effluent, which is sent to the BWS Honouliuli Water Recycling Facility, where it receives tertiary treatment. Treated effluent from the WWTP is discharged through a deep ocean outfall 8,760 feet offshore by a depth of 200 feet. The City will convert Honouliuli WWTP to full secondary treatment by 2024.

Despite a large wastewater treatment plant located in the district, there are portions of ‘Ewa that are not serviced by centralized sewer systems and are instead on individual cesspools or septic systems. Those areas include Campbell Industrial Park and portions of ‘Ewa Beach.

2.8.7 Water Supply

Water is provided by several systems: the Honolulu Board of Water Supply, the U.S. Navy, and the Agribusiness Development Corporation (Waiāhole Ditch Irrigation System), as well as by owners of individual wells. Potable water is supplied by ground water wells while non-potable water is from ground water wells, seawater, and recycled water. There are no surface water diversions in ‘Ewa as there is only one perennial stream.

Recycled water is provided by the BWS Honouliuli Water Recycling Facility (WRF), which produces both R-1 (tertiary disinfected) and R-O quality water (demineralized using reverse osmosis) from water treated by the Honouliuli WWTP. The WRF can produce up to 12 mgd of recycled water, but planned expansions are expected to increase capacity to 26 mgd.

Table 2-17 Honouliuli WRF Capacity and Production in 2010

Water Quality	WRF Capacity	Production (2010)
R-1	10 mgd	7.01 mgd
R-O	2 mgd	1.39 mgd
Total	12 mgd	8.4 mgd

Key Infrastructure Implications for Water Resource Planning

- Additional roads and highways, including the City’s Rail Transit Project will allow for more development in ‘Ewa, increasing water demands for domestic and irrigation needs.
- Planned expansion of the Honouliuli WWTP and WRF will increase the recycled water available for non-potable uses.
- Renewable energy projects can reduce reliance on fossil fuels for water producing and water treatment facilities.
- Aging infrastructure provides opportunities for replacement with newer, more water and power-efficient technologies.

2.9 Relevant Land Use Plans

This section of the ‘Ewa Watershed Profile provides some excerpts and summaries from the following relevant public policy and regional plans:

- O‘ahu General Plan
- ‘Ewa Development Plan
- Kalaeloa Master Plan
- DHHL Regional Plan
- East Kapolei Neighborhood TOD Plan

The section provides some analysis of these plans, and a summary of implications for the ‘Ewa Watershed Management Plan.

2.9.1 O‘ahu General Plan, Amended October 3, 2002

The current in-progress update of the O‘ahu General Plan notes that recent growth trends are generally consistent with the City’s policies for population growth and distribution, but that job growth in the ‘Ewa District is lagging behind projections. Objectives and Policies from the October 3, 2002 version of the General Plan that are relevant to the EWMP are as follows:

Population
Objective B
To establish a pattern of population distribution that will allow the people of Oahu to live and work in harmony.

> *Policy 1*
> Facilitate the full development of the primary urban center.
>
> *Policy 2*
> Encourage development within the secondary urban center at Kapolei and the Ewa and Central Oahu urban-fringe areas to relieve developmental pressures in the remaining urban-fringe and rural areas and to meet housing needs not readily provided in the primary urban center.

Ewa District % Share of 2025 Islandwide Population: 13.0%.

II. Economic Activity
Objective C
To maintain the viability of agriculture on Oahu.

> *Policy 7*

Encourage the use of more efficient production practices by agriculture, including the efficient use of water.

Policy 8
Encourage the more efficient use of non-potable water for agricultural use.

Objective G
To bring about orderly economic growth on Oahu.

Policy 1
Direct major economic activity and government services to the primary urban center and the secondary urban center at Kapolei.

III. Natural Environment

Objective A
To protect and preserve the natural environment.

Policy 4
Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, water-recharge areas, distinctive land forms, and existing vegetation.

Objective B
To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.

Policy 1
Protect the Island’s well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and reefs and offshore islands.

V. Transportation & Utilities

Objective B
To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sound systems of waste disposal.

Policy 1
Develop and maintain an adequate supply of water for both residents and visitors.

Policy 2
Develop and maintain an adequate supply of water for agricultural and industrial needs.

Policy 3
Encourage the development of new technology which will reduce the cost of providing water and the cost of waste disposal.

Policy 4
Encourage a lowering of the per-capita consumption of water and the per-capita production of waste.

Policy 6
Support programs to recover resources from solid-waste and recycle wastewater.

VII. Physical Development and Urban Design

Objective A
To coordinate changes in the physical environment of Oahu to ensure that all new developments are timely, well-designed, and appropriate for the areas in which they will be located.

Policy 1
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.

Objective C
To develop a secondary urban center in Ewa with its nucleus in the Kapolei area.

Policy 1
Allocate funds from the City and County’s capital-improvement program for public projects that are needed to facilitate development of the secondary urban center at Kapolei.

Policy 2
Encourage the development of a major residential, commercial, and employment center within the secondary urban center at Kapolei.

Policy 3
Encourage the continuing development of Barbers Point as a major industrial center.

Policy 4
Coordinate plans for the development of the secondary urban center at Kapolei with the State and Federal governments and with the sugar industry.

Policy 5
Cooperate with the State and Federal governments in the development of a deep water harbor at Barbers Point.

Policy 6
Encourage the development of the Ewa Marina Community as a major residential and recreation area emphasizing recreational boating activities through the provision of a major marina and a related maritime commercial center containing light-industrial, commercial, and visitor accommodation uses.

Objective D
To maintain those development characteristics to the urban-fringe and rural areas which make them desirable places to live.

Policy 1
Develop and maintain urban-fringe areas as predominantly residential areas characterized by generally low rise, low density development which may include significant levels of retail and service commercial uses as well as satellite institutional and public uses geared to serving the needs of households.

Policy 3
Establish a green belt in the Ewa and Central Oahu areas of Oahu in the Development Plans.

2.9.2 ‘Ewa Development Plan, Updated October 2011

Executive Summary

‘Ewa’s Role in O‘ahu’s Development Pattern

- Provides a second urban center for O‘ahu with its nucleus in the City of Kapolei and job centers in resort areas, industrial areas, and the University of Hawai‘i West O‘ahu;
- Provides a wide range of master planned residential areas to relieve developmental pressures on O‘ahu’s rural areas and to provide housing types not readily provided in the Primary Urban Center (Kahala to Pearl City);
- Protects and promotes diversified agriculture on prime agricultural lands along Kunia Road and in the Explosive Safety Quantity Distance arc around the Pearl Harbor West Loch Naval Munitions Command; and
- Provides resort areas at Ko‘Olina and at Ocean Pointe.

The Vision to 2035

- Population growth from 68,700 in 2000 to over 164,000.
- Addition of over 35,000 new homes to the 20,800 homes in ‘Ewa in 2000;
- Job growth from 16,400 non-construction jobs in 2000 to over 87,000
- Growth of the City of Kapolei to include over 8,000 residents and provide almost 20,000 private and public non-construction jobs;
- Development of the University of Hawai‘i West O‘ahu campus to serve 7,600 students and employ 1,040 staff and faculty by 2025; and
- Resort development at Ko‘Olina and at Ocean Pointe to include over 7,200 visitor units.

SECTION 4.2 WATER ALLOCATION AND SYSTEM DEVELOPMENT

This section of the ‘Ewa DP provides some background information on water supply planning and sources of potable and non-potable water. General policies and guidelines for water allocation and water system development in ‘Ewa are then provided, as follows:

4.2.1 GENERAL POLICIES

Adequacy of Water Supply

- Before zoning approval is given for new residential or commercial development in ‘Ewa, the Board of Water Supply should:
- Report if adequate potable and nonpotable water is available, and
- If adequate potable and nonpotable water is not available, recommend conditions that should be included as part of the zone change approval in order to assure adequacy.
- Confirm adequacy of existing capacity at the time of land subdivision or building permit applications for existing lots.

Water Use Efficiency and Conservation

- Require developments to conserve water resources by implementing water conservation measures, such as low flow plumbing fixtures, drought tolerant landscaping, sub-metering and efficient irrigation systems with soil moisture sensors. Such requirements shall be determined during review of building permit applications.
- Encourage owners of existing plumbing systems to conduct regular water audits and effect repairs to reduce water loss.

- Dual Water Lines – Require developments with large landscaped areas (such as golf courses, parks, or schools), roadway landscaping, and industrial processes to have dual water lines to allow conservation of potable water and use of nonpotable water for irrigation and other appropriate uses. Such requirements shall be determined during review of project water master plans for new developments and approval of zoning applications and construction plans.
- Development and Allocation of Potable and Nonpotable Water – The State Commission on Water Resource Management has authority in all matters regarding administration of the State Water Code. By City Charter, the Board of Water Supply has the authority to manage, control and operated the water systems of the City, and therefore should coordinate the development and allocation of potable and nonpotable water sources and systems intended for municipal use on O‘ahu as guided by the City’s land use plans and the OWMP.

Use of Nonpotable Water

- Develop an adequate supply of nonpotable water for irrigation and other suitable uses on the ‘Ewa Plain in order to conserve the supply of potable water and to take advantage of dual water systems constructed by ‘Ewa developers.
- The Pearl Harbor aquifer is the most cost effective and accessible water resource of potable quality on O‘ahu, and it is needed to support the existing and future domestic potable water uses described in the development plans.
- To minimize the risk of impacts to potable water sources, the use of recycled water and brackish ground water as nonpotable irrigation sources should be given high priority.
- Significant demand exists for nonpotable water for golf courses, landscape irrigation, and industrial uses on the ‘Ewa Plain.
- In addition to the compatibility of the source to the demand in the area, the infrastructure to distribute the recycled water in that area is being planned and developed by the Board of Water Supply.
- Recycled water from the Honouliuli Water Recycling Facility and brackish water should, therefore, be used to meet demand in the ‘Ewa Plain where there are no adverse consequences to the drinking water resources.
- Require nonpotable water used for irrigation above Pearl Harbor aquifer to be low in chlorides and total dissolved solids to protect the quality of drinking water withdrawn from wells located down-gradient of the application. Experiences with increasing chloride, nitrate, and pesticide contamination of ground water indicate that activities on the surface of the land can have a detrimental effect on the quality of drinking water.

- Use of Waiāhole Ditch Water – Request that the State Commission on Water Resource Management consider all sources of water in making allocations.[68] A sufficient amount of water is needed to meet the diversified agricultural needs for ‘Ewa and Central O‘ahu along with providing for high quality recharge of the Pearl Harbor aquifer. Potential sources include caprock, surface water, spring waters, Waiāhole Ditch Water, and recycled water recovered from wastewater effluent. The amount of water available and the potential uses of each of these sources vary according to location.

Alternative Water Supplies

- Where practical, develop alternative water supplies using new technologies in water reclamation, membrane and distillation desalination and deep ocean water applications to ensure adequate supply for planned uses.
- Encourage use of technologies conserving water and using renewable energy that could support alternative water supplies, such as seawater air conditioning, photovoltaics, efficient plumbing and lighting fixtures, wave energy, and bio-fuels.

2.9.3 Kalaeloa Master Plan

Hawai‘i Community Development Authority, March 1, 2006

In 2003 the Hawai‘i State Legislature passed a bill that designated the Hawai‘i Community Development Authority (HCDA) as the planning and infrastructure development agency for 3,700 acres of land at Kalaeloa – formerly known as the Naval Air Station Barbers Point. In 2005, HCDA adopted a Strategic Plan for Kalaeloa, and then developed the Kalaeloa Master Plan.

The Kalaeloa Master Plan was completed in the Fall of 2005, and was adopted by the HCDA Board in early 2006. The Plan projects most of the future development for the upper/northern sector of Kalaeloa. Future development is projected to include:

- 6,352 Residential Dwelling Units
- 116,583 Square Feet of Retail Commercial Uses
- 725,028 Square Feet of Office Commercial Uses
- 1,819,388 Square Feet of Light Industrial Uses
- 470,436 Square Feet of Light Industrial Mixed Uses

The total estimated cost for this significant amount of development was $3,351,708,614.

It is interesting to note the detailed nature of these projections for the various development types and their ultimate costs.

[68] The Commission on Water Resource Management does currently consider all sources of water in their decision-making on water allocations. An analysis of alternatives is a requirement for proposed new uses of water.

These future uses are organized in 3 phases that were projected to be completed by the Year 2025. Phase 1 was planned to be developed during the period 2007 to 2015. To date, the only significant new development at Kalaeloa has been the construction of a 160,000 square foot building on 10 acres of land for the new offices for the Hawai‘i unit of the Federal Bureau of Investigation (FBI).

The Appendix to the Master Plan includes planning level cost estimates for the major infrastructure improvements, including “Potable Water System Construction Cost” of $35,534,200 and “Probable Irrigation System Construction Cost” of $4,663,200.

The Kalaeloa Master Plan assumes that adequate potable water sources for this development will be available from the BWS system, and that adequate non-potable water will be available for irrigation.

A related report, the “KALAELOA MASTER PLAN – INFRASTRUCTURE MASTER PLAN UPDATES October 2010 Draft” provides some further information on “NON-POTABLE IRRIGATION (R1), but does not address any further details for Kalaeloa potable water demand. The section on Kalaeloa non-potable water notes that “a new R1 system would need to be designed to BWS standards, constructed, and then dedicated to the BWS.” Some further details on proposed R1 improvements are provided in this chapter, together with a map that illustrates the proposed system. This section of the report states that “Tenants would need to pay monthly metered R1 fees at the prevailing R1 rate…”

2.9.4 DHHL East Kapolei Regional Plan

This plan is one of some 20 “Regional Plans” that the Department of Hawaiian Home Lands (DHHL) has recently developed for its lands throughout the state of Hawai‘i. For the “East Kapolei Region,” DHHL has already developed 403 homes and plans to construct an additional 1,457 homes over the next 5 to 10 years. In addition, DHHL has constructed their new Headquarters building in East Kapolei, and has leased land to a developer for the construction of a major, 1.5 million square feet commercial complex.

The DHHL East Kapolei Regional Plan briefly addresses the potable water systems that will be needed for the planned homes and the commercial center, including water mains and water reservoirs. The Plan also notes that DHHL’s water needs may be in the range of 12 MGD, “which is within the sustainable yield of the regional aquifer.” but the Plan does not provide any basis for this estimate. The Plan also does not take into account the water needs of other major developments in the ‘Ewa region, and does not address the feasibility of using non-potable water for irrigation of parks and landscaped areas.

Based on water demand estimates for other major master planned projects in the ‘Ewa region, this estimate seems to be very high. The total number of constructed and planned DHHL homes is 1,860 units. If we use the planning number of 500 gallons per unit per day, these homes would require about 930,000 gallons of water per day.

2.9.5 East Kapolei Neighborhood TOD Plan

(Public Review Draft – April 2010)

This draft Plan is one of seven “Neighborhood TOD Plans” that the City Department of Planning and Permitting is developing. “TOD – Transit-Oriented Development” generally refers to pedestrian-friendly mixed use development that occurs within about 1/4 of a mile from a rail transit station.

The East Kapolei Neighborhood TOD Plan Executive Summary begins with a “VISION” statement that reads, in part: *“The East Kapolei Neighborhood TOD (transit-oriented development) Plan presents a very unique opportunity to create a sustainable, responsible and integrated community for Oahu. Located along the proposed transit line that will connect downtown Honolulu with the East Kapolei region, Ho‘opili, University of Hawai‘i West Oahu (UHWO) and East Kapolei stations are each envisioned as transit-oriented development sites that provide a series of transportation options for residents, workers and visitors alike.”*

The “Summary of Recommendations” for the three station areas is as follows:

1. Ho‘opili Station

- Transit plazas at station
- Greenway beneath the elevated rail
- Integrate neighborhood mini parks
- Promote an active Main Street that connects the station to Campus Drive
- Medium, mixed-use development surrounding the station
- Lower, mixed-use developed on the periphery of the TOD area

2. UHWO Station

- Transit plazas on both sides of Kualakai Parkway
- Elevated pedestrian walkways crossing Kualakai Parkway (formerly North-South Road) and Campus Drive
- Greenway beneath elevated rail
- Active uses along Campus Drive on both sides of Kualakai Parkway
- New Main Street perpendicular to Campus Drive one block diamond head of station
- Bus transfer facility mauka of Campus Drive
- Park ‘n ride on both sides of Campus Drive
- Medium, mixed-use development adjacent to station

3. East Kapolei Station

- Greenway adjacent to Kualakai Parkway, beneath elevated rail
- Active uses west of East-West Road
- Bus transfer facility mauka of station
- Pedestrian walkways across Kualakai Parkway and East-West Road
- Medium density, mixed-use development west of Kualakai Parkway

This Draft TOD Plan does not address infrastructure needs of the recommended developments, and does not include details on plan implementation. Generally, the type of mixed use development recommended in this Plan would be somewhat more dense than the development that is planned for Hoʻopili, UHWO and East Kapolei, and would thus typically require more infrastructure, including potable and non-potable water, as compared to lower density development.

2.10 Summary of Some Stakeholder Issues

This summary of stakeholder issues is based on our initial meetings with community and public agency stakeholders, including:

- ‘Ewa Neighborhood Board
- Makakilo/Kapolei/Honokai Hale Neighborhood Board
- Tesha Malama, Manager, HCDA Kalaeloa Community Development District
- Shad Kane, cultural practitioner
- Pauline Sato, Malama Learning Center
- Gary Gill, DOH Division for Environmental Health
- Dr. Kioni Dudley, Save O`ahu Farmlands
- Leo Asuncion, Office of Planning, CZM Program
- Carty Chang and Staff, Chief, Planning Branch, DLNR Engineering Division
- Darrell Yagodich and Staff, Planning Office, Dept. of Hawaiian Home Lands
- Frances Rivero, ED ‘Ewa Beach Boys and Girls Club
- Aurora Winslade, Sustainability Manager, UH West O‘ahu
- Shirley Swinney, ‘Ewa kupuna
- James Nakatani, ED Agriculture Development Corporation
- Fred Nakaguma, retired Campbell HS teacher and limu researcher
- Kepa Maly, Hoakalei Cultural Foundation
- David Frankel, Native Hawaiian Legal Corporation
- Glenn Oyama, Hydrogeologist BWS
- Glenn Bauer, Hydrogeologist
- Gary Gill, Planning Committee, Gill-Olson Trust
- Stephanie Whalen, HARC
- Uncle Henry Chang Wo

Comments and issues heard from these meetings included:

1. “With all this growth and development – will there be enough water for ‘Ewa in the future?”
2. “All this growth and development is destroying the natural resources – we have exceeded the carrying capacity of our resources.”
3. “Polluted runoff has destroyed the natural limu beds of ‘Ewa Beach – or perhaps the demise of the sugar industry and its related nutrient rich runoff has led to the decline in limu here.”
4. “There are important natural and cultural sites and resources in ‘Ewa that we need to preserve and protect.”
5. “Cultural/natural resources education of the children must be a high priority.”
6. “There could/should be more use of greywater at the household level.”
7. “Climate change and sea level rise will result in higher salinity of brackish ground water.”
8. “How will the ‘Ewa WMP address non-point source pollution?”
9. “Families are struggling economically; there are a lot of foreclosures. ‘Affordable homes’ priced at $500,000 are NOT AFFORDABLE!”
10. “The new UH West O`ahu campus can provide opportunities for educational programs relating to natural resources management.”
11. “Are former sugar lands still full of chemicals that are getting into the public water supply?”
12. “Water conservation programs are very important. Developers and developments should help to pay for water conservation programs.”
13. “There are opportunities for capture, storage, transmission and use of stormwater runoff for irrigation of agricultural lands.”
14. “Flooding problems will continue to increase as ‘Ewa farm lands are converted to urban uses.”
15. “The ‘Ewa caprock aquifer is gradually becoming saltier. Could injection of reclaimed water into the caprock aquifer stabilize salinity?”
16. “The ‘Ewa WMP should look at ULTIMATE RESTORATION OF THE WATERSHEDS” – not just look at “ultimate build-out for development.” We cannot just look at extracting water; we need to protect and enhance the source! Restoration will take generations; long-term efforts and commitment are needed!”

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CHAPTER 3
WATER USE AND PROJECTED DEMAND

‘EWA WATERSHED MANAGEMENT PLAN

3 WATER USE AND PROJECTED DEMAND

3.1 Water Availability and Use in the ‘Ewa District

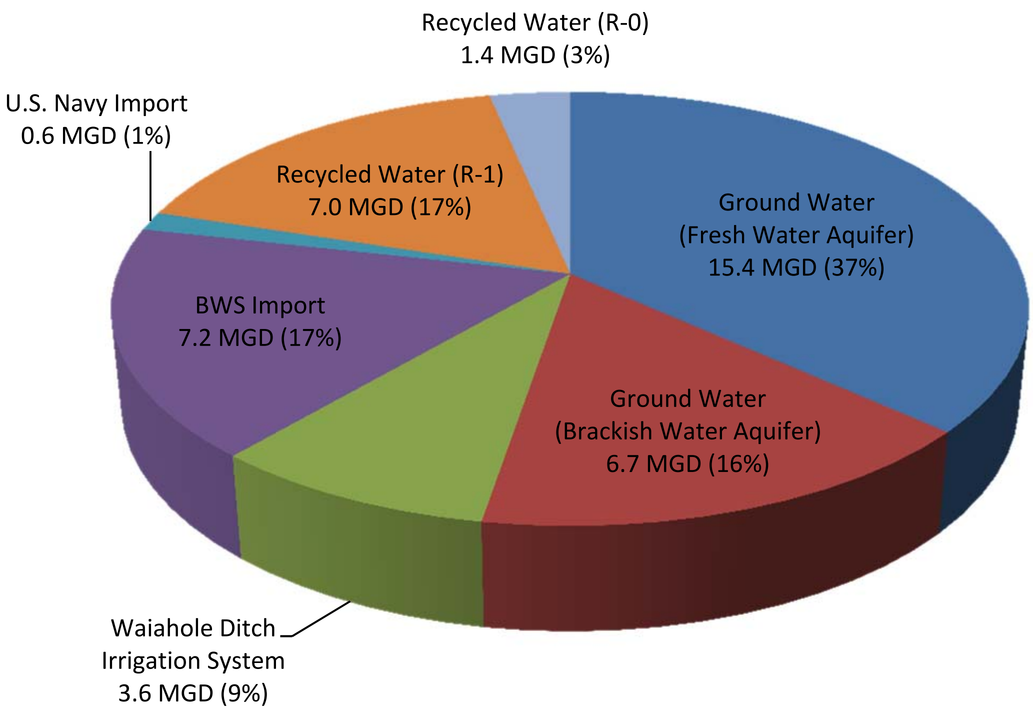
Water sources for ‘Ewa are more varied than for any other district on the island of O‘ahu. ‘Ewa’s water needs are supplied by a combination of fresh and brackish ground water, salt water, recycled water, and Waiāhole Ditch Irrigation System (WDIS) water. In general, ground water is used for agricultural; golf course, and landscape irrigation; and residential, commercial, and industrial uses. Salt water is used for industrial cooling purposes; recycled water is used for power generation, refining oil, golf course irrigation, and landscape irrigation; and WDIS water is used for agricultural irrigation. With a relatively dry climate, ‘Ewa has only one perennial stream, Honouliuli Stream, making surface water an unreliable source for this area. The following is a snapshot of ‘Ewa water demand for the base year of 2010.

Table 3-1 ‘Ewa Water Demand by Source (2010)

Water Source	Estimated Demand MGD	%
Ground Water (Basal Aquifer)*	15.4	37%
Ground Water (Caprock Aquifer)	6.7	16%
Ground Water (BWS Import from Central O‘ahu)**	7.2	17%
Ground Water (U.S. Navy Import from Central O‘ahu)	0.6	1%
Waiāhole Ditch	3.6	9%
Surface Water	0.0	0%
Recycled Water (R-1)	7.0	17%
Recycled Water (R-O)	1.4	3%
TOTAL	41.9	100%

* BWS water demand is an average of demand over the five years from 2008 to 2012.
** Does not include 5.1 MGD that passes from Central O‘ahu through ‘Ewa to Wai‘anae.

Figure 3-1 ‘Ewa District Water Sources (2010)



The Commission on Water Resource Management (CWRM) breaks down water consumption by type of use, including Domestic Residential (single family homes, multi-family homes, apartment buildings, etc.), Domestic Non-Residential (commercial, institutional, and other uses of potable water), Industrial, Agricultural, and Irrigation uses. The largest use of water in ‘Ewa is domestic residential use, which accounted for 30% of all water use in 2010. Domestic Residential uses require potable water and Domestic Non-Residential uses may or may not require potable water. Industrial, Agricultural, and Irrigation uses do not require potable water but may still be served by potable water.

Table 3-2 ‘Ewa Water Demand by CWRM Category (2010)

Water Demand Category	Water Demand MGD	Water Demand %
Domestic Residential	12.5	30%
Domestic Non-Residential	6.5	15%
Industrial [1, 2]	7.3	17%
Agriculture	7.0	17%
Irrigation[2]	8.6	21%
TOTAL	41.9	100%

1 Industrial water demands do not include demands supplied by salt water.

2 Industrial and irrigation demands include demands supplied by recycled and fresh and brackish ground water. Brackish water has chloride content ranging from just above drinking water limits to that nearly of seawater.

The Honolulu Board of Water Supply provides most of the potable water and all of the recycled water in ‘Ewa, while private ground water wells supply most of the non-potable water used for irrigation and industrial uses.

Table 3-3 ‘Ewa Water Demand by Producer (2010)

Water Purveyor	Water Demand MGD	%
BWS Potable	17.1	41%
BWS Recycled (R-1 + R-O)	8.4	20%
State	4.0	10%
Federal	2.2	5%
Private	10.2	24%
TOTAL	41.9	100%

1 Demand for private systems includes demand for brackish water, but does not include demands for salt water.

3.1.1 Basal Ground Water Availability and Use

Basal ground water aquifers are the primary source of fresh water for ‘Ewa. The ‘Ewa-Kunia Aquifer System Area (ASYA) has a sustainable yield (SY) of 16 MGD and 14.3 MGD (89%) of that is allocated to existing water use permits (Table 3-4). Pumpage records show that 76% of SY is actually being pumped, but this is a conservative number, as not all water use permit (WUP) holders report their use. CWRM has recently implemented a new on-line system to encourage water use reporting, but it is still too early to gage improvements in reporting.

The Waipahu-Waiawa ASYA has the largest SY on the island (104 MGD), and most of this aquifer lies in the Central O‘ahu Planning District. There are WUPs for 82% (84.9 MGD) of the aquifer’s SY throughout both the ‘Ewa and Central O‘ahu Districts (Table 3-4). Fifteen percent (15.8 MGD) of the permitted use is for wells located within the ‘Ewa District.

‘Ewa relies on potable ground water from both the ‘Ewa-Kunia and Waipahu-Waiawa ASYAs. Additionally, BWS imports 7.2 MGD from Waipahu-Waiawa ASYA wells located in Central O‘ahu, not including approximately 5.1 MGD that is further exported to Wai‘anae.

3.1.2 Caprock Water Availability and Use

The ‘Ewa caprock provides a significant brackish water resource for landscape and golf course irrigation, agriculture, and industrial cooling purposes at various developments, such as ‘Ewa by Gentry, Kapolei Villages, Campbell Industrial Park, and the Navy ESQD zone. Sustainable Yields for the caprock aquifers, Makaīwa, Malakole, Kapolei, and Pu‘uloa, are set by a chloride limit of 1,000 mg/L, rather than a rate of withdrawal (Table 3-5). This chloride limit was set as an irrigation standard because it is believed to be the maximum chloride level that is tolerable to vegetation.

Table 3-4 ‘Ewa District Basal Aquifer System Permitted Use, Pumpage, and Sustainable Yields (2010)

Aquifer System Area (ASYA)	BWS		State		Federal		Private		Sustainable Yield[3] (SY, MGD)	Total Permitted Use (MGD)	Available Yield[3, 4] (MGD)
	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)			
‘Ewa-Kunia	9.7	9.9[6]	0.5	0.0	2.3	1.3	1.8	0.9	16	14.3 (89% of SY)	1.7 (11% of SY)
Waipahu-Waiawa (‘Ewa District only)	7.7[7]	0.0	0.0	0.0	0.0	0.0	8.1	3.2	104	15.8 (15% of SY)	19.1 (18% of SY)
Waipahu-Waiawa (Entire ASYA including ‘Ewa)	54.8[3]	24.3[6]	1.4[3]	0.0	15.2[3]	0.0	13.6[3]	3.2		84.9[3] (82% of SY)	
TOTAL[5] (‘Ewa District only)	17.4	9.9	0.5	0.0	2.3	1.3	9.9	4.1	N/A	27.9	N/A
TOTAL (‘Ewa-Kunia ASYA and Entire Waipahu-Waiawa ASYA)	64.5	34.2	1.9	0.0	17.5	1.3	15.4	4.1	120	99.3 (83% of SY)	20.7 (17% of SY)

1 Permitted Use amounts are from the CWRM Water Use Permit Index as of September 2, 2010. Permitted uses account for fresh and brackish water withdrawals, but not salt water withdrawals.

2 Pumpage totals are from the CWRM file State Pumpage Monthly Totals 2000-2010, as of January 16, 2013. In some cases, there are no records for production. Where there was no data, attempts were made by CWRM to obtain the data, especially for those wells with high PU and/or those wells suspected of pumping large volumes of water. However, pumpage data was not obtained for some wells.

3 The SY and Available Yield for the Waipahu-Waiawa ASYA reflect the total SY and Available Yield for the entire ASYA, including Permitted Use for wells in the Central O‘ahu District.

4 Available yield equals sustainable yield minus permitted use under the Water Use Permit.

5 Only a portion of the Waipahu-Waiawa ASYA is located within the ‘Ewa District. Permitted use and pumpage as indicated in this row reflect permits and pumpage for wells that are physically located within the ‘Ewa-Kunia ASYA and Waipahu-Waiawa ASYA and are also within the ‘Ewa District. It DOES NOT include wells in the Waipahu-Waiawa ASYA that are located in the Central O‘ahu District.

6 BWS pumpage is an average of pumpage over the five years from 2008 to 2012.

7 BWS Well in Waipahu-Waiawa SY includes only ‘Ewa Shaft (Well No. 2202-21).

Table 3-5 ‘Ewa District Caprock Aquifer System Permitted Use, Pumpage, and Sustainable Yield (2010)

Aquifer System Area (ASYA)	BWS		Other City		State		Federal		Private		Sustainable Yield[3] (MGD)	Total Permitted Use	Total Pumpage[4] (MGD)
	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)	Permitted Use[1] (MGD)	Pumpage[2] (MGD)			
Makaīwa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.072	0.000	N/A	0.072	0.00
Malakole	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	6.511	2.76	N/A	7.011	2.76
Kapolei	0.30	0.00	0.00	0.00	0.73	0.34	0.00	0.00	1.30	0.41	N/A	2.333	0.75
Pu‘uloa	0.00	0.00	0.53	0.00	0.00	0.00	6.13	0.27	5.27	2.91	N/A	11.924	3.18
TOTAL	0.30	0.00	0.53	0.00	1.23	0.34	6.13	0.27	13.15	6.08	N/A	58.865	6.69

1 Permitted Use amounts are from the CWRM Water Use Permit Index as of May 21, 2010.

2 Pumpage totals are from the CWRM file State Pumpage Monthly Totals 2000-2010, as of January 16, 2013. In some cases, there are no records for production. Where there was no data, attempts were made by CWRM to obtain the data, especially for those wells with high PU and/or those wells suspected of pumping large volumes of water. However, pumpage data was not obtained for some wells.

3 Sustainable Yields for Makaīwa, Malakole, Kapolei, and Pu‘uloa ASYAs are set by a chloride limit of 1,000 mg/L, rather than a rate of withdrawal. Sustainable Yield is specific to irrigation wells because it is the maximum chloride levels believed to be acceptable for irrigation.

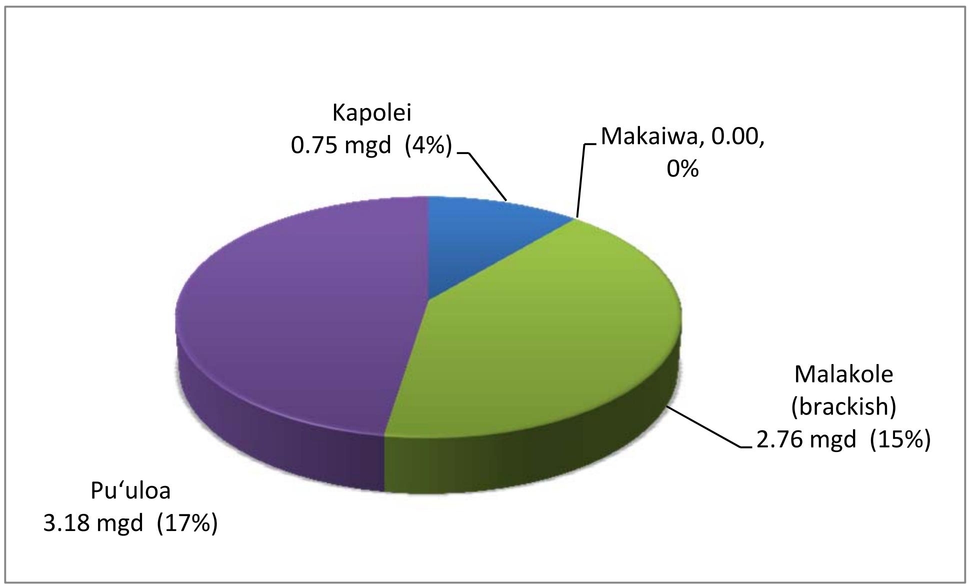


Figure 3-2 ‘Ewa District Brackish Aquifer Pumpage (2010)

3.1.3 Salt Water Availability and Use

CWRM regulates the pumping of salt water from wells in the ‘Ewa District. Approximately 37.5 MGD of salt water was permitted for industrial cooling in 2010, with pumpage reported at 12.2 MGD.

3.1.4 Waiāhole Ditch Irrigation System Water Availability and Use

The Waiāhole Ditch Irrigation System (WDIS) was initially constructed between 1913 and 1916 to transport water from the Windward side of O‘ahu to irrigate O‘ahu Sugar Company’s sugar cane fields in Central O‘ahu and ‘Ewa. The Waiāhole Ditch is approximately 25 miles long, extending from Kahana on the Windward side of O‘ahu to Honouliuli in the ‘Ewa district. Ground and surface water is collected from water tunnels in Kahana, Uwao, Waikāne, and Waiāhole, as well as from deep within the Ko‘olau Mountains as the Trans-Ko‘olau Tunnel transports water to the Leeward side of O‘ahu.

The WDIS emerges from the Ko‘olau Mountains above Waipi‘o at an elevation just over 700 feet. From this point, the ditch traverses through Waiawa, Waipi‘o, and Mililani and in a series of siphons across the Kīpapa and Waikele gulches. Along the eastern foot of the Wai‘anae Mountains, the ditch feeds a series of reservoirs and distribution channels leading to agricultural fields in Kunia, and terminates near Makakilo at an elevation of about 600 feet.

During past years (1951 to 1969), flow through this ditch averaged 27 MGD, but in 1993, O‘ahu Sugar Company announced the impending closure of its sugar plantation, triggering a heated controversy over the disposition of the Waiāhole Ditch Irrigation System. After a long legal battle over water rights, CWRM issued a Decision and Order in 2006 that returned 12 MGD of Waiāhole Ditch Water to windward streams (Table 3-7).[1] There is currently a SY of 15 MGD for offstream uses: 12.991 MGD (87% of the SY) is permitted to various State and private entities, leaving 2.009 MGD unallocated (Table 3-6). About 74% of the allocated water is for agricultural uses, with the rest used for landscape irrigation. In 2010, actual use of WDIS water in the ‘Ewa District (3.644 MGD) was less than permitted use (4.260 MGD) by 0.616 MGD.

[1] Commission on Water Resource Management (July 13, 2006). *Findings of Fact, Conclusions of Law and Decision and Order: In the Matter of Water Use Permit Applications, Petitions for Interim Instream Flow Standards Amendments and Petitions for Water Reservations for Waiāhole Ditch Combined Contested Case He*aring.

Table 3-6 ‘Ewa District Waiāhole Ditch Irrigation System Permitted Use and Production (2010)

WDIS End Users	BWS Permitted Use[1] (MGD)	BWS Production (MGD)	State Permitted Use[1] (MGD)	State Production (MGD)	Federal Permitted Use[1] (MGD)	Federal Production (MGD)	Private Permitted Use[1] (MGD)	Private Production (MGD)	Total Permitted Use (MGD)	Total Production (MGD)	Sustainable Yield (SY, MGD)	Available Yield[2] (MGD)
‘Ewa[3]	0.000	0.000	2.000[4]	0.119	0.000	0.000	10.701[5]	2.538	4.260	3.644	15	2.009
Central O‘ahu	0.000	0.000	0.150	0.029	0.000	0.000		4.051	8.731	3.093		
TOTAL	0.000	0.000	2.150	0.148	0.000	0.000	10.701	6.589	12.991	6.737	15	2.009

1 Permitted Use volumes are from CWRM Island Water Use Permit Index (total. as of (May 21, 2010)

2 Available yield equals sustainable yield minus permitted use under the Water Use Permit.

3 ‘Ewa end users include Pu‘u Makakilo, Edmund C. Olson Trust, Hawai‘i Agricultural Research Center (HARC), Monsanto Company, and Syngenta Hawai‘i LLC. Monsanto and Syngenta lands irrigated by Waiāhole Ditch extend outside of the ‘Ewa District.

4 2.000 MGD is allocated to the State ADC to account for water loss.

5 WUP 619 covers multiple users, one of which is in the ‘Ewa district, with the remainder in the Central O’ahu district. Therefore, PU cannot be separated by district.

Waiāhole Ditch, north portal
Photo credit: George F. Lee
Star-Bulletin, April 25, 1997

Table 3-7 Waiāhole Ditch Irrigation System Water Returned to Windward Streams

USE	ALLOCATION (MGD)
Water Returned to Windward Streams	12.0
Waiāhole Stream	4.8
Waianu Stream	3.0
Waikāne Stream	2.1
Kahana Stream	2.1
Permitted Offstream Uses (2010?)	12.991
Unallocated Water	2.009
TOTAL	27.0

3.1.5 Surface Water Availability and Use

The Hawai‘i Stream Assessment (1990) identifies Honouliuli as the only perennial stream in the ‘Ewa District. Although it flows continuously in its upper and lower reaches, it is intermittent in the mid-elevations. There are currently no stream diversions registered with CWRM in the ‘Ewa district.

Table 3-8 lists mean stream flow for a Honouliuli Stream tributary at about 629 feet above mean sea level (USGS Gage No. 16212480) and at Honouliuli Stream itself at about 145 feet above MSL (USGS Gage No. 16212490). Mean stream flow is very low and does not provide opportunities for reliable off-stream use.

Table 3-8 Mean Stream Flow (2013)

STREAM LOCATION	2013 MEAN FLOW (CFS)	(MGD)
Honouliuli Stream Tributary (USGS Gage No. 16212480)	0.106	0.069
Honouliuli Stream at H-1 Freeway (USGS Gage No. 16212490)	0.636*	0.411*

*Incomplete data were used for statistical calculation.

3.1.6 Recycled Water Availability and Use

Treatment of wastewater for non-potable use is becoming increasingly important in urbanized areas of Hawai`i, as well as for some resorts that are located in drier leeward areas where limited natural ground water resources are available for non-potable needs. Use of recycled water must conform to the DOH’s Reuse Guidelines. R-1 recycled water is tertiary disinfected and is the highest quality recycled water under the DOH guidelines. It is approved for a variety of irrigation uses, including spray irrigation of food crops. R-2 recycled water is secondary disinfected and may be used for limited purposes and is often used to irrigate landscaping. R-3 recycled water is secondary un-disinfected and can be used for limited industrial or agricultural uses under specific guidelines and controls. R-O recycled water has been demineralized using reverse osmosis technology. It is used for industrial processes to generate steam for power plants and oil refining processes.

DOH completed its update to *The Reuse Guidelines* in January 2016, particularly for irrigation and recycled water use zones that delineate areas where recycled water use is unrestricted, allowed with conditions, and restricted. Maps of these use zones identify the entire ‘Ewa caprock as unrestricted, with the exception of Pearl Harbor National Wildlife Refuge (West Loch), which is restricted. The areas mauka of the ‘Ewa caprock are conditional use areas, except those areas within the capture zones of ‘Ewa Shaft and Barber’s Point Shaft.

Recycled water has been available in ‘Ewa since 2003, when the City developed the Honouliuli Water Recycling Facility (WRF) adjacent to the Honouliuli Wastewater Treatment Plant (WWTP) site. Honouliuli WWTP currently treats approximately 26 MGD of wastewater to advanced primary treatment with a capacity of 38 MGD. The City under EPA Consent Decree is upgrading the WWTP to full secondary treatment by 2024. Effluent from the Honouliuli WWTP is discharged through the Barbers Point Deep Ocean Outfall.

The WRF has a current capacity of 12 MGD, 10 MGD of which can be treated to R-1 level standards for irrigation and industrial uses, and 2 MGD that can be treated to R-O standard for industrial use. The BWS is planning a more energy and process-efficient UV system and disk filter to replace the existing sand filter pre-treated process; and a photovoltaic system to help power some of the WRF’s systems. Approximately 4 MGD of R-1 capacity will be added. BWS will also continue the design and construction of the non-potable water backbone infrastructure system of pipes and reservoirs, expanding the areas with access to recycled water.

Table 3-9 Honouliuli Water Recycling Facility Capacity and Use (2010)

Recycled Water Classification	Capacity in 2010 (MGD)	Demand in 2010[1] (MGD)	Potential Future Capacity (MGD)	End Use
R-1	10	7.012	18[2]	Dust Control, Industrial, Golf Course and Landscape Irrigation
R-O	2	1.385	2.000	Industrial
TOTAL	12	8.397	20	

1 Recycled water demand data is from the BWS Recycled Water Use to 2012, R-1 and RO Users Summary dated April 4, 2012.

2 ‘Ewa Non-Potable Water Master Plan (2007) reported that an additional 8 MGD of R-1 capacity will be added.

The DOH defines gray water as wastewater from the following uses: showers and bathtubs; hand-washing lavatories; wastewater that has not contacted toilet waste; sinks not used for disposal of hazardous, toxic materials, food preparation, or food disposal; and clothes-washing machines excluding wash water with human excreta, e.g., diapers. As gray water is estimated to account for 50%-80% of the total wastewater generated by residential uses, it is increasingly being discussed both as a potential source of non-potable water and as a way to reduce the amount of wastewater that must be treated and disposed of at centralized WWTPs and individual wastewater systems. The DOH Guidelines for the Reuse of Gray Water (2009) provides information on acceptable uses of gray water and system requirements and design considerations, and maintenance. There are currently no known gray water users in the ‘Ewa District.

3.1.7 Desalinated Water Availability and Use

Seawater and some brackish water are too saline to be used for drinking or other purposes, such as irrigation. However, it is possible to remove the salt from water in order to make it more usable. Desalination of seawater and brackish water exists in many areas around the world and desalination technologies continue to improve. The most common desalination methods are reverse osmosis and ion exchange.

Many desalination facilities on O‘ahu are small and limited to demineralizing potable water for industrial boiler feed for power plants and refineries in Campbell Industrial Park. The BWS WRF also desalinates R-O recycled water for use in power plants and refineries in Campbell Industrial Park. There are at present no large-scale desalination facilities on O‘ahu for drinking water, but brackish water desalination exists at some resorts on the Kohala coast of the Big Island. Maui County is also planning a desalination facility.

3.1.8 Storm Water Availability and Use

Precipitation that falls over land either percolates into the ground, is taken up by plants, evaporates, or runs off as storm water. Urban development increases impervious surfaces that prevent percolation of water into the ground and increases runoff. It is estimated that one inch of rain that falls on a 1,000 square foot impervious surface will generate 600 gallons of storm water runoff.[2] Drainage retention basins have been required of large urban developments, including golf courses. These retention basins capture silt-laden runoff and allow settlement and percolation of water into the underlying aquifer and are often used as a means of non-point source pollution control. A portion of this storm water could be used for non-potable purposes, such as irrigation.

The *Hawai‘i Stormwater Reclamation Appraisal Report* (2005) identified the ‘Ewa plains as a potential location where storm water capture opportunities exist. The concept involves a deep infiltration trench to capture storm water and discharge it into the shallow brackish ground water aquifer. This would increase the quantity and improve the quality of the water available in the shallow brackish aquifer that could be extracted for irrigation and agriculture.[3] This opportunity ranked third out of nine storm water reclamation opportunities evaluated statewide and was the highest of the two O‘ahu-specific opportunities.

Additionally, the *Central Oahu Non-Potable Water Master Plan – Appraisal of Opportunities* (2013) suggests that storm water from Wheeler AAB may be available for use in Kunia and ‘Ewa. The feasibility of using stormwater from Wheeler AAB will need to consider the potential for untreated storm water to contain pollutants, thus impacting its ability to be used for certain purposes or on certain edible crops.

In ‘Ewa, stormwater capture is used in a limited capacity, as the district experiences low average rainfall (20-40 inches per year). When it does rain, golf courses such as West Loch, ‘Ewa Villages, Hawai‘i Prince, Kapolei, and ‘Ewa Beach, use ponds to capture runoff and store it for irrigation. Some golf courses, such as ‘Ewa Villages, are even designed as flood water retention basins to reduce flooding in ‘Ewa from runoff from surrounding mauka areas or Honouliuli.

Individual storm water capture technologies, such as rain barrels, are becoming popular as a way for homeowners to collect storm water before it runs off to and use it for non-potable water needs. While this preserves potable water for potable needs, rain barrels likely have limited use in this dry area.

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[2] Commission on Water Resource Management, December 2008, Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii, p. 1.

[3] CH2M Hill, 2005, Hawaii Stormwater Reclamation Appraisal Report, Prepared for the U.S. Department of the Interior Bureau of Reclamation Lower Colorado Region Resources Management Office, p.7-42 to 7-46.

3.2 Water Supply Systems

3.2.1 Drinking Water Systems

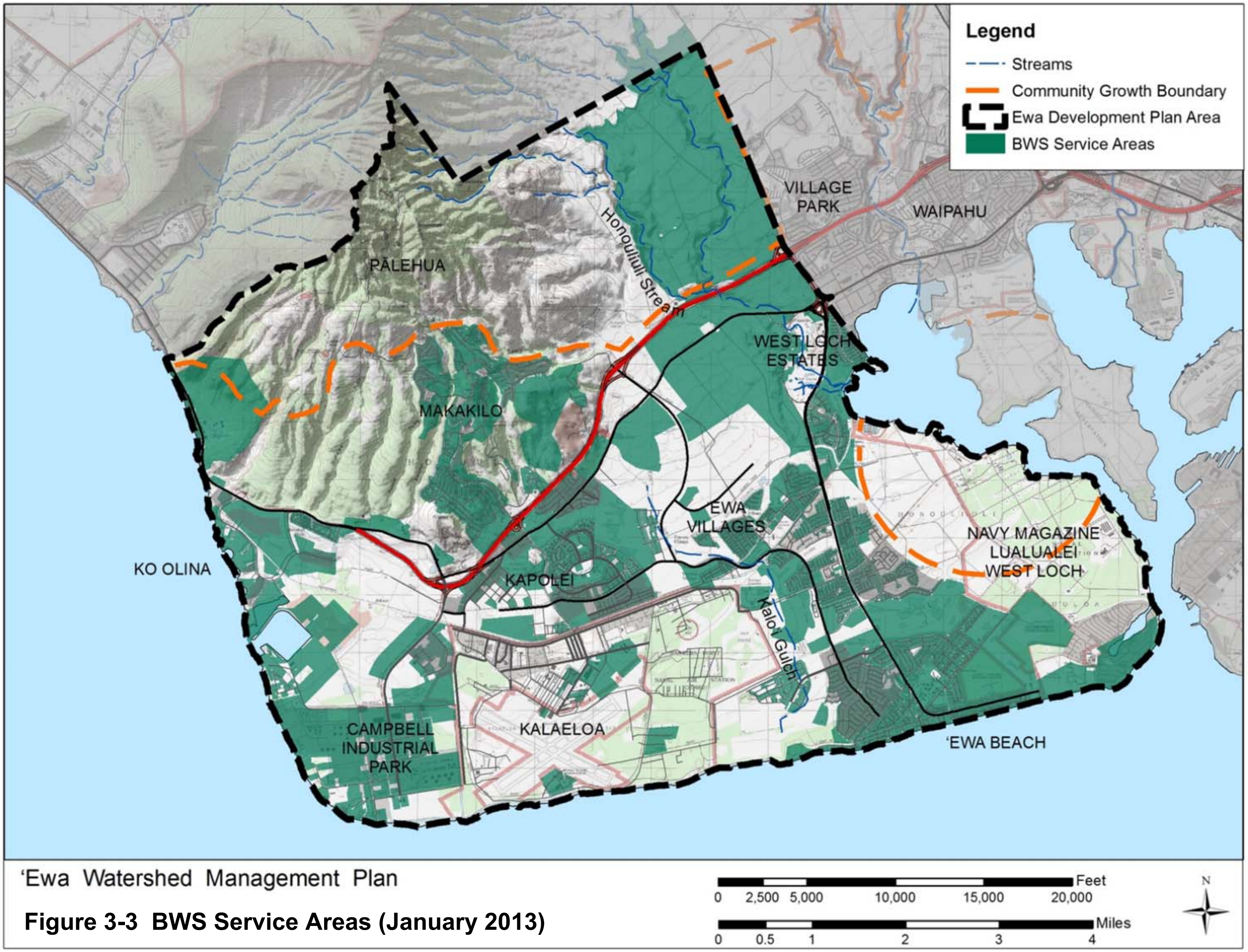
Drinking water is provided either by the Honolulu Board of Water Supply (BWS) and by the U.S. Navy. The Navy supplies water to its Kalaeloa lands and its facilities in Pu‘uloa, while the BWS provides drinking water to the remainder of the ‘Ewa district.

3.2.1.1 Honolulu Board of Water Supply Ground Water

The BWS provides most of the potable water needs for ‘Ewa’s residential, commercial, industrial, government, agricultural, and landscape irrigation uses. This system is organized by service zones that have service limits defined as 100 feet below the spillway of the controlling reservoir, which allow it to maintain a relatively constant water pressure for users. The low service zone ranges in elevation from sea level to 115 feet above MSL west of Kualakai Parkway and 128 feet above MSL east of Kualakai Parkway and includes the ‘Ewa plain and water pumped to Wai‘anae. Reservoirs in this service zone include the Waipahu, Kunia, and Honouliuli 228’ reservoirs and the Barber’s Point 215’ reservoir.

High service zones extend up in elevation from the service limits of the low service zones to the 340 foot elevation and include the Makakilo, East Kapolei and Honouliuli 440’ reservoir systems. Mountain service zones extend from the 340’ elevation to the mountain ridgelines. The Makakilo Ridge Service Zone extends up through 3 service zones to the 1230’ elevation.

BWS wells and shafts within the ‘Ewa District provide less than 10 MGD of potable water, requiring BWS to import water from Central O’ahu to satisfy demand. Additionally, 5 MGD of water is transported from Central O‘ahu through ‘Ewa to Wai‘anae to supplement their potable water supply.



'Ewa Watershed Management Plan

Figure 3-3 BWS Service Areas (January 2013)

Table 3-10 BWS Fresh Water Aquifer Permitted Use and Pumpage (2010)

BWS Source	Permitted Use (MGD)	Pumpage (MGD)
EWA-KUNIA ASYA	**8.2**	**9.9**
Honouliuli I (Well No. 2303-01 & 02)	2.2	2.4
Honouliuli II (Well No. 2303-03 through 06)	4.5	6.5
Makakilo (Well No. 2004-04)	1.5	1.0
WAIPAHU-WAIAWA ASYA (WITHIN THE 'EWA DISTRICT)	**7.7**	**0.0**
'Ewa Shaft (Well No. 2202-21) (Expected to come on-line in 2020)	7.7	0.0
WAIPAHU-WAIAWA ASYA (IMPORT FROM CENTRAL O'AHU)	**14.3**	**12.1**
Hoaeae (Well No. 2301-34 through 39) (portion to 'Ewa)	6.6	7.6
Kunia I (Well No. 2302-01 through 04)	5.0	2.6
Kunia II (Well No. 2402-01, 02, 03, & 05) (portion to 'Ewa)	2.7	1.9
SUB-TOTAL	**30.2**	**22.0**
EXPORT TO WAI'ANAE		5.1

Source: CWRM Water Use Permits BWS Pumpage Totals.

NOTE: BWS pumpage is an average of pumpage over the five years from 2008 to 2012

Figure 3-4 Sustainable Yields, BWS Water Use Permits, and BWS Ground Water Production in 'Ewa

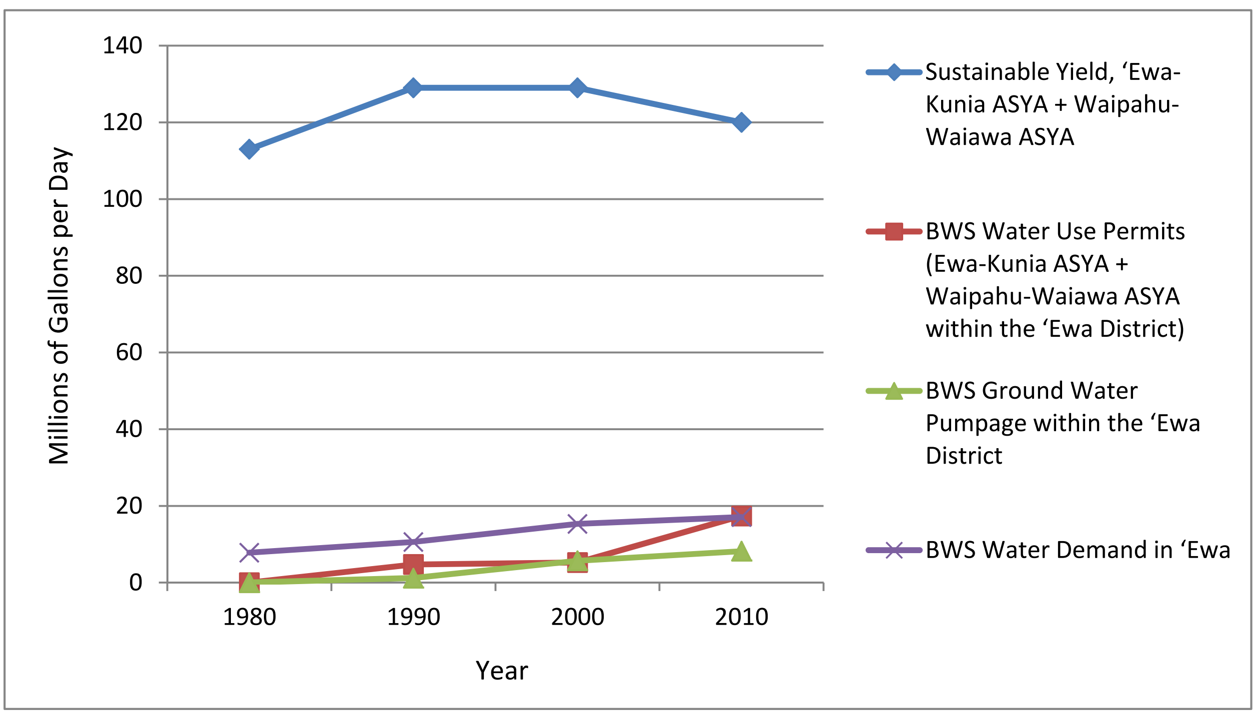
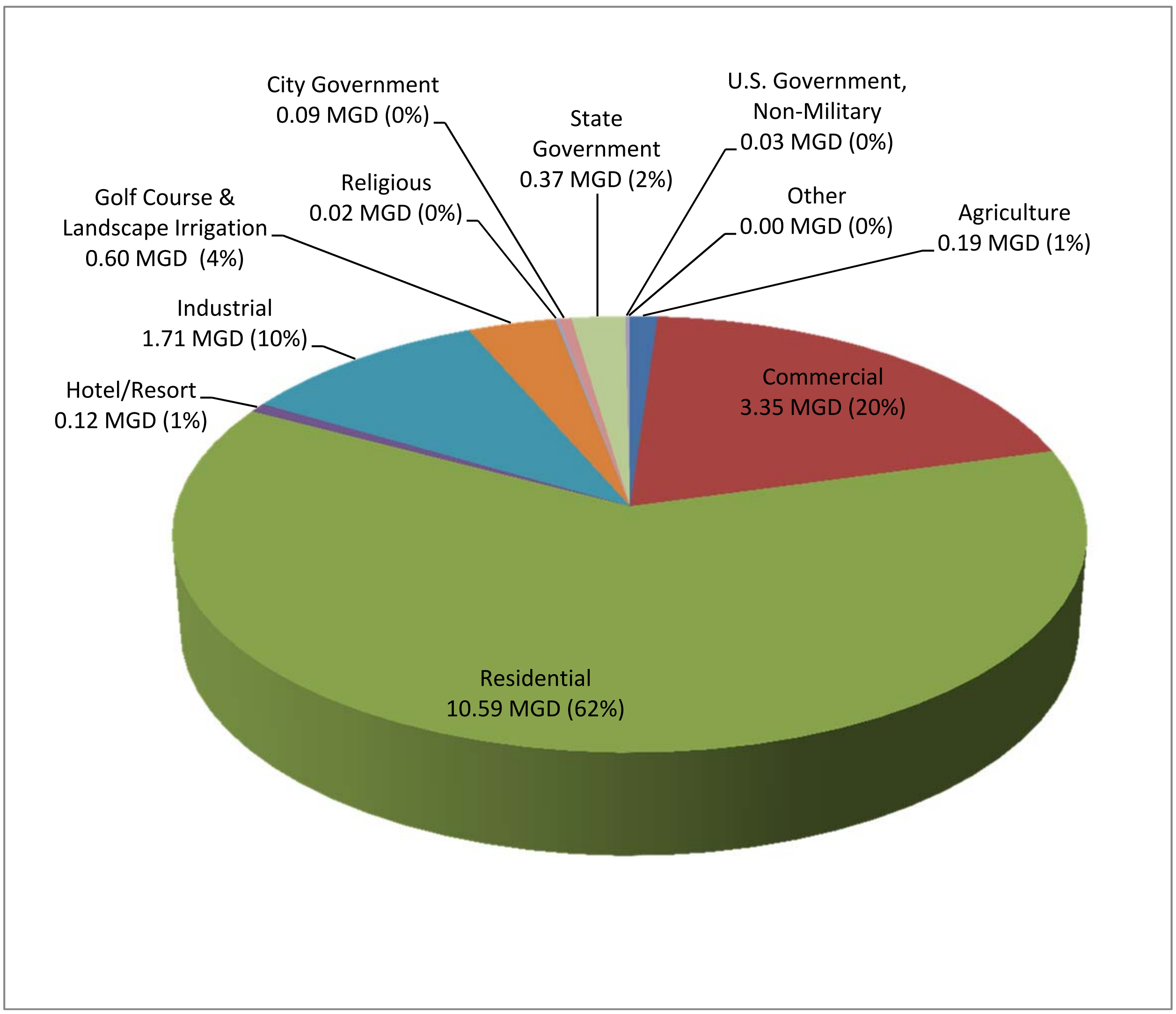


Figure 3-4 above illustrates BWS ground water production in 'Ewa between the years 1980 and 2010. While 'Ewa's water demand has increased over the last thirty years, it remains below the total amount of permitted use allocated to the BWS. BWS does not pump enough water from its 'Ewa sources to supply all of the 'Ewa demand and instead imports approximately 7.2 MGD of water from Central O'ahu.

BWS breaks down water demand by type of use. Residential water use, including single family, multi-family, and mixed residential uses, was by far the largest type of use, with demand totaling 10.6 MGD, 62% of the total BWS demand. Commercial use was the second highest type of demand with 3.3 MGD (20%), and Industrial use was third, with 1.7 MGD (10%). These water demands take into account district-wide water losses of 10.6%. This means that 10.6% of water is assumed to be lost during transmission between sources and end users. Therefore, 10.6% is added to metered consumption (the amount of water actually used by residences, businesses, etc.) to determine the actual volume of water that needs to be supplied.

Figure 3-5 'Ewa BWS Potable Water Demand by Use Type (Five Year Average, 2008-2012)



CWRM groups water uses into fewer categories: agriculture, domestic residential, domestic non-residential (including such uses as commercial, resort, institutional, etc.), industrial, irrigation, and other. In ‘Ewa, water supplied by BWS is mostly consumed by residential activities (62%), including single-family homes, multi-family dwellings, and mixed-use buildings. Roughly 23% of the water is consumed by domestic, non-residential activities, and 10% by industrial uses. The remaining 5% of total BWS water supplied to the ‘Ewa District is consumed by agricultural and landscape irrigation and other small uses.

Table 3-11 BWS ‘Ewa Water Demand by CWRM Categories (Five-Year Average 2008-2012)

CWRM Water Use Categories	Water Demand (MGD)	Percent
Agriculture	0.2	1%
Domestic Residential	10.6	62%
Domestic Non-Residential	4.0	23%
Industrial	1.7	10%
Irrigation	0.6	4%
Other	0.0	0%
TOTAL	**17.1**	**100%**

Table 3-12 Largest BWS Water Users in the ‘Ewa District (2010)

Water User	Average Daily Consumption (MGD)
Chevron, USA	1.3
Terraza-Corte Bella Association	0.2
Tesoro Hawaii Corporation	0.2
Marriot Vacation Club International	0.2
Westview at Makakilo Heights Phase II	0.1
Wet N'Wild Hawaii	0.1
Division of Park Maintenance & Recreation (Kapolei Regional Park)	0.1
Sunrise	0.1
Department of Education (Ilima Intermediate School)	0.1
HRRV (H-Power)	0.1

BWS Conservation Programs

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

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

The principal elements of these five program clusters are summarized in Table 3-13. Specific programs within each of these categories that have been major contributors to water conservation savings are summarized below.

Public Education and Outreach

The primary objective of the public education and outreach efforts is to influence consumer water use habits. A variety of programs target homes, schools, and businesses including Public Service Announcements, features in the newspaper, water saving tips on the internet, xeriscape demonstrations, detect-a-leak week, educational booths, a water waste hotline, and a water conservation poster and poetry contest that has been held for more than 35 years.

Large Water Users Programs

Large water user programs target organizations and businesses with high water consumption. These organizations often have the capacity to facilitate change from within the organization or agency. During droughts, BWS reminds the top 100 water users on their system to conserve water. Additionally, existing agreements with City and State agencies target parks, schools, golf courses, roadway landscaping, and other government facilities to be more efficient in their water use. In 2013, the State CWRM developed the Hawaiʻi Conservation Plan to facilitate water conservation by State agencies and others, and in 2014 released its Hawaiʻi Water Audits and Water Loss Control Manual.

Leak Detection, Repair, and Maintenance

Water loss audits are a measure of water distribution efficiency that can indicate potential targets for specific water conservation measures. BWS recently began a targeted conservation program by identifying and fixing system water losses to reduce water lost between production from the ground and delivery to homes. A portion of water loss is due to leakage; other causes of water loss can be from pipe, reservoir, and hydrant flushing, illegal unmetered water taps, and meters requiring calibration. On the mainland, municipal water loss averages between 10-15%. Here on Oʻahu, the island-wide BWS goal is to reduce water loss to less than 10%. Average ʻEwa water loss is estimated at 10.6% in 2010, near the target water loss percentage. BWS programs for leak detection repair, and maintenance is ongoing to continuously reduce water losses.

Table 3-13 BWS 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 –Hawai‘i State Science Fair • **Tours** –Fred Ohrt Museum –Hālawa Xeriscape Garden –Nu‘uanu Watershed –Water Reclamation Plant • **Water Conservation / Education Publications** • **Water Conservation Calendar** • **Video Library** • **Year Round Conservation Media Campaign** • **Speakers’ Bureau** • **Water Conservation Information/Complaints** • **Communications** –News Releases / Advisories on Water Emergencies / High Water Usage / Community Concerns / Public Meetings / News Conferences • **Landscape Water Conservation Classes** • **Special Events** –Detect-A-Leak Week –Water Conservation Week –Trade Shows/Exhibitions –Hālawa Xeriscape Garden Open House& Plant Sale –Community Events	• **Leak Detection and Repair** (within BWS distribution system and storage facilities) • **Pipeline Corrosion Protection Program** • **Flow Transmitter Maintenance** • **Repair and / or Replacement** of valves, fire hydrants, water distribution mains and service line leaks and fractures • **Enforcement** of unauthorized use of water • **Meter Maintenance Program** • **Maintenance / Repair and Replacement** of aging service laterals and hydrants • **Meter-Reading / Water Bill Monitoring** (Identify high water use due to undetected leakage; report seepages, leaks, or other signs of possible water leaks) • **Water Audits** and development of internal water use efficiency practices and programs • **Cathodic Protection** Monitoring and Maintenance -flow transmitter maintenance -pipeline corrosion programs	• **Visitor Industry** –Conservation Education –Linen Reuse Placard • **Government Agencies** –Conservation Partnership Projects • **Business / Commercial** –Conservation Education –Low-Flow Fixture Incentives –Restaurant placard, water served only upon request • **Irrigation System Submetering and Moisture Controllers**	• **BWS Low Ground Water (Drought) Plan** • **BWS Rules** –Governing wasteful water use practices (Empowering department to discontinue water service) –Use of nonpotable water for irrigation of large landscaped areas, golf courses, parks, highways, school playgrounds –Restaurant water service, water served only upon request –Restricted irrigation program (Applicable to periods of low rainfall and high consumption) • **County legislation** requiring low-flush toilets, and low-flow showerheads and faucet fixtures • **Conservation Rate Structure (Inverted Block Rate)** • **New Construction Regulations (Future)** –Dual Water Systems –Low-Flow Fixtures	• **Nonpotable Water System Standards and Master Plans** • **Residential Toilet Rebate Program** • **Nonpotable Source Development** –Caprock –Brackish –Surface Springs • **Wastewater Reuse** –Honouliuli Water Recycling Facility –Wahiawā/Central O‘ahu –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 Nonpotable Irrigation –Rebates for Water Efficient Appliances

3.2.1.2 Honolulu Board of Water Supply Desalination Facilities

BWS is pursuing desalination as a high-quality, sustainable, drought-proof water supply to meet the projected increase in demand for the ‘Ewa District. Desalinated water is an important source of freshwater supply for the following reasons:

- **Supports the City General Plan’s directed growth policy to ‘Ewa**. New sources of water supply are needed to support ‘Ewa’s future growth.
- **Drought mitigation supply**. use of desalinated water during periods of drought will allow a reduction in ground water pumpage at a time when ground water levels would be in a low ground water condition.
- **Climate Change resiliency**. Climate models indicate that dry areas will become even drier. Therefore, aquifer sustainable yields in ‘Ewa, Wai‘anae and the leeward section of Waipahu-Waiawa are expected to decrease. Desalination can offset the impacts of decreasing water supply in dry Leeward areas.
- **Stabilize inter-district water transfers**. Desalination provides a viable alternative water supply to inter-district transfers. Water could be moved from adjacent aquifers into ‘Ewa to compensate for decreased sustainable yields due to climate change. However, water will be needed in other Leeward areas as well to offset climate change impacts and provide for urban and agricultural demands. Desalination is an opportunity to build upon the ahupua‘a concept of sustainable watershed management within ‘Ewa before relying on transfers of additional water from adjacent watersheds.
- **Desalination costs are competitive with regional inter-district transfers**. BWS considered transferring water from North Shore to ‘Ewa, but this was discounted because desalination in ‘Ewa was more economically viable than developing new North Shore wells and a 17-mile transmission system. North Shore water is needed for North Shore agriculture.
- **Take advantage of ‘Ewa’s renewable solar energy resources**. Desalination has higher power requirements than pumping ground water, but ‘Ewa has the highest solar rating in the State, providing opportunities to couple desalination with photovoltaic power generation, leveraging the advantages of both technologies.
- **Land is available**. BWS owns 20 acres of land for the Kalaeloa seawater desalination plant and three acres for the Kapolei brackish desalination plant. Kalaeloa was acquired from the redevelopment of the Barber’s Point Naval Air Station and Kapolei was acquired from Campbell Estate. The lands were acquired at no cost to BWS, however, there are development stipulations including timeframes that must be met.
- **‘Ewa’s geology minimizes the impacts of an ocean intake and outfall**. ‘Ewa’s geology is unique in that a thick caprock formation overlays the basalt with a relatively impermeable sedimentary layer between the two formations. This allows for seawater to be extracted from the basalt and brine concentrate to be injected into the caprock in the same relative location without mixing.

3.2.1.3 Department of Hawaiian Home Lands Water Reservations

The State Water Code provides that “the planning for, regulation, management, and conservation of water resources in the State shall, to the extent applicable and consistent with other legal requirements and authority, incorporate and protect adequate reserves of water for current and foreseeable development and use of Hawaiian home lands as set forth in the section 221 of the Hawaiian Homes Commission Act.” In accordance with this provision, the Department of Hawaiian Home Lands may request water reservations to CWRM in support of their programs. DHHL currently has a water reservation for 1.358 MGD from the Waipahu-Waiawa ASYA. This reservation could be put toward BWS’s WUP permit allocation so it could provide that water to DHHL developments. BWS’s interconnected water system would allow for that reservation to support DHHL developments in ‘Ewa, Wai‘anae, Central O‘ahu, or the Primary Urban Center.

3.2.1.4 Federal Potable Water Systems

The United States government owns two water systems that are used for residential and other domestic needs: the Kalaeloa Water System, which draws its source water from Barber’s Point Shaft, and the Joint Base Pearl Harbor Hickam Water System that provides service to the Kapilina Beach Homes at Iroquois Point.

Kalaeloa Water System
Barber’s Point Shaft services the domestic water needs at the former 3,723-acre Naval Air Station Barber’s Point, now known as Kalaeloa. In 2011, the Navy named Pural Water Specialty Co., Inc. as the successful bidder for the purchase of the water distribution and wastewater collection systems at Kalaeloa. Hunt Companies, through its subsidiary, Hunt Kalaeloa Water LLC, is currently pursuing an application with the Public Utilities Commission to purchase the Kalaeloa Water System and have Pural manage and operate the system.

Table 3-14 Federal Fresh Water Aquifer Permitted Use and Pumpage (2010)

Federal Wells	Permitted Use (MGD)	Pumpage (MGD)
‘Ewa-Kunia ASYA		
Barber’s Point Shaft (Well No. 2103-03)	2.3	1.3

Joint Base Pearl Harbor-Hickam (JBPHH)
Information on water use that the JBPHH water system was not made available. In lieu of actual data, it was estimated that the 1,461 units in the Kapilina Beach Homes at Iroquois Point each use an average of 400 GPD of water, totaling approximately 0.58 MGD.

3.2.1.5 Private Potable Water Systems

The Pālehua Water System is owned by the Gill-Olson Joint Venture and services land uses mauka of Makakilo, including cattle ranches, residences, the Pālehua Solar Observatory, and Camp Pālehua. Water is pumped from BWS’s two-million gallon Makakilo reservoir to a 7,000 gallon, where it is treated with chlorine and pumped to a 50,000 gallon reservoir and into the distribution system. Average water use is estimated at 5,000 GPD.

3.2.2 Non-Potable Water Systems

3.2.2.1 BWS Non-Potable Ground Water

BWS pumped 1.1 MGD from Barber’s Point non-potable well (Well Numbers 2006-14 & 15), used for landscape irrigation at Ko Olina. BWS also provides non-potable ground water to the City of Kapolei for landscape irrigation.

Table 3-15 BWS Non-Potable Permitted Use and Pumpage (2010)

BWS Source	Permitted Use (MGD)	Pumpage (MGD)
‘EWA-KUNIA ASYA		
Barber’s Point NP1 (Well No. 2006-14 & 15)	1.0	0.9
KAPOLEI ASYA		
Kapolei Irrigation (Well No. 1905-08 & 10)	0.3	0.04
TOTAL	**1.3**	**0.9**

2010 pumpage from BWS records.

3.2.2.2 BWS Recycled Water

Since 1997, all ‘Ewa master plans requesting zone changes are required to include dual water lines to accommodate recycled water. Thus, recycled water demand is expected to increase over time. Additionally, dual water lines have been regularly required as part of water master plans and as conditions of subdivision approvals.

Consequently, the Hawai‘i Community Development Authority developed potable and non-potable water master plans for the incremental upgrade and replacement of aging pipelines in Kalaeloa with a dual water system that would allow for recycled water use for non-potable needs. The non-potable water system would obtain R-1 recycled water from the BWS WRF.

Similarly, another large development, Ho‘opili, has developed a non-potable water master plan that proposes a 215-foot 2.0 million gallon R-1 reservoir and recycled water pipeline distribution system.[4] The projected average daily recycled water demand is 2.1 MGD.[5]

[4] R.M. Towill Corp. August 4, 2015. Ho‘opili Water Master Plan, Honouliuli, Ewa, Oahu, Hawaii. Prepared for D.R. Horton-Schuler Division. P. 10.

Table 3-16 Recycled Water Users and Demand (2010)

Recycled Water Classification	User	Recycled Water Demand (MGD)[1]	Use
R-1	West Loch Golf Course	0.559	Golf Course irrigation
	‘Ewa Villages Golf Course	0.623	Golf Course irrigation
	Honouliuli Wastewater Treatment Plant	2.859	
	Coral Creek Golf Course	0.649	Golf Course irrigation
	Hawai‘i Prince Golf Course	0.717	Golf Course irrigation
	Kapolei Golf Course	0.343	Golf Course irrigation
	‘Ewa Beach Golf Course	0.455	Golf Course irrigation
	Barber’s Point Golf Course	0.429	Golf Course irrigation
	Fort Weaver Irrigation	0.052	Landscape irrigation
	Hoakalei Golf Course	0.310	Golf Course irrigation
	‘Ewa Makai Middle School	0.004[2]	Landscape irrigation
	City of Kapolei (Total)	0.000[3]	Landscape irrigation
	Goodfellow Brothers	0.007	Dust control and landscape irrigation
	D.R. Horton Mehana Tree Farm Irrigation	0.026	Landscape irrigation
	TOTAL	**7.033**	
R-O	Kalaeloa Cogen Power Plant	0.547	
	AES Hawaii Inc.	0.119	
	Citizen Gas	0.042	
	Tesoro Hawaii Corp.	0.215	
	Chevron	0.310	
	HECO (Kahe and Campbell)	0.144	
	H-Power	0.000[4]	
	HECO CIP	0.014	
	TOTAL	**1.392**	
TOTAL RECYCLED WATER USE		**8.424**	

1 Recycled water use and potential future capacity is from the BWS Recycled Water Use to 2012, R-1 and RO Users Summary dated April 4, 2012, with supplemental information from BWS.

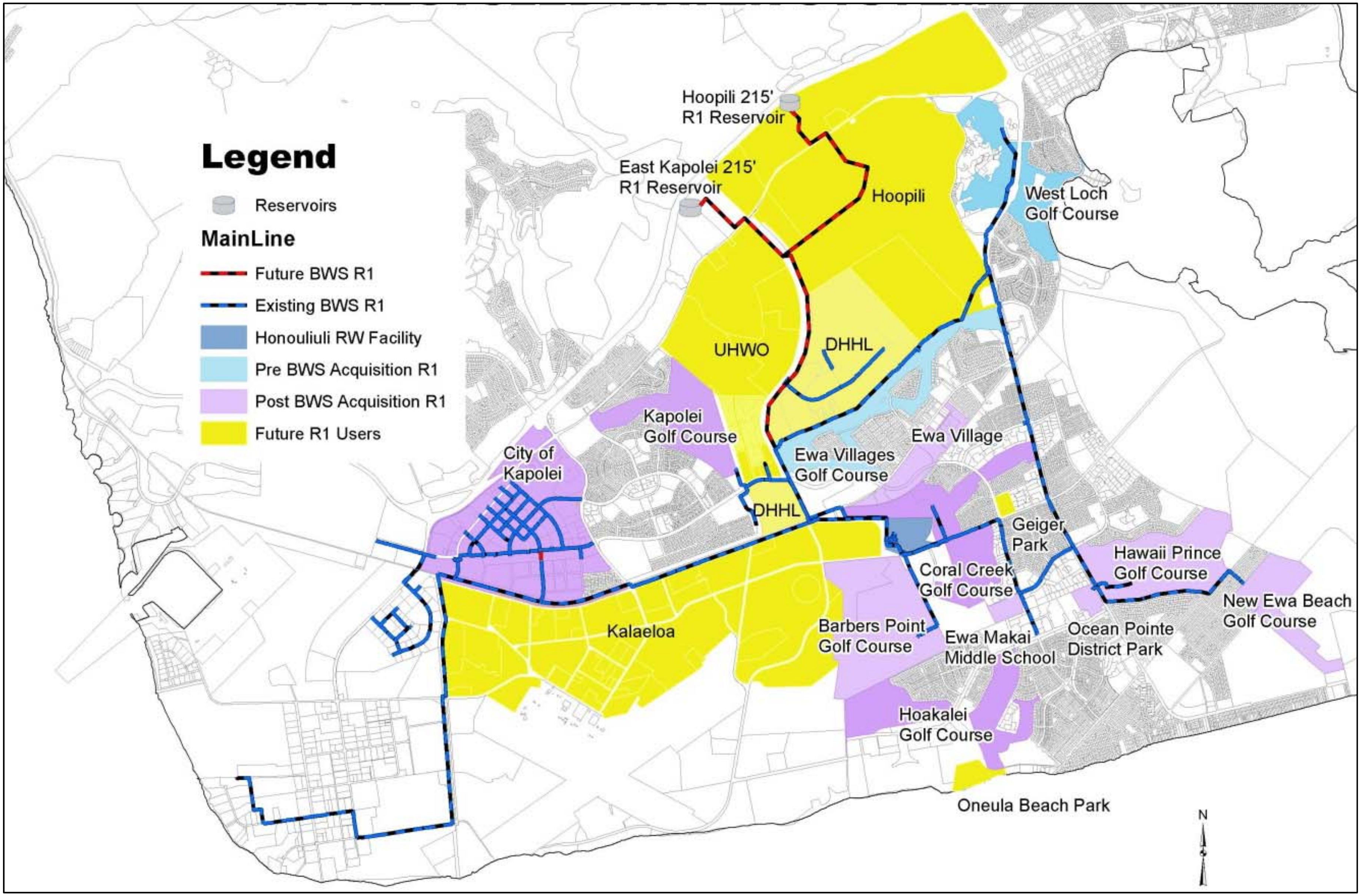
2 ‘Ewa Makai Middle School began using R-1 water in December 2010.

3 City of Kapolei began using R-1water for irrigation in September 2015 and uses approximately 50,000 GPD.

4 H-Power committed to using R-O water for its 3rd boiler, but to date has not begun using the R-O water.

[5] R.M. Towill Corp. August 4, 2015. P. 14.

Figure 3-6 BWS Recycled Water Systems



3.2.2.3 City Non-Potable Ground Water

In addition to the BWS water system, the City and County of Honolulu also owns a few non-potable wells in the Waipahu-Waiawa and Pu‘uloa ASYAs for landscape irrigation. No pumpage was reported for any of these wells in 2010.

Table 3-17 City Brackish Aquifer Permitted Use and Pumpage (2010)

City Wells	Permitted Use (MGD)	Pumpage (MGD)	Use
WAIPAHU-WAIAWA ASYA			
EP2 (Well No. 2201-03, 04, & 07)	0.00	0.00	Irrigation
PU‘ULOA ASYA			
Honouliuli STP 1 & 2 (Well No. 1901-03 &04)	0.50	No reported use	Industrial
Geiger Park (Well No. 2001-03)	0.03	No reported use	Irrigation
TOTAL	0.53	0.00	

3.2.2.4 State Non-Potable Ground Water Wells

The State of Hawai‘i holds water use permits for industrial and irrigation uses, but only one State well reported pumpage in calendar year 2010 for 0.34 MGD of non-potable landscape irrigation in Kapolei.

Table 3-18 State Brackish Aquifer Permitted Use and Pumpage (2010)

State Wells	Permitted Use (MGD)	Pumpage (MGD)	Use
MALAKOLE ASYA			
Ewa Caprock (Well No. 1905-05)	0.50	No reported use	Industrial
KAPOLEI ASYA			
Villages of Kapolei (Well No. 2003-04 & 07)	0.49	0.34	Irrigation
East Kapolei (Well No. 2003-08)	0.24	No reported use	Irrigation
TOTAL	1.23	0.34	

3.2.2.5 State Waiāhole Ditch Irrigation System

The Waiāhole Ditch Irrigation System collects water from the Windward side of O‘ahu, crosses through the Ko‘olau Mountains, extends through Central O‘ahu, and terminates in the ‘Ewa District. Of the 12.991 MGD of water that is permitted for offstream uses, 4.260 MGD is allocated to ‘Ewa users with most of that dedicated to agriculture (Table 3-6). Waiāhole Ditch is currently the sole water source for agricultural uses mauka of the H-1 Freeway, with only 0.002 MGD allocated for golf course use. In 2010, only 3.644 MGD of WDIS water was used in ‘Ewa.

Of WDIS’s 15 MGD sustainable yield, 2.009 MGD is currently unallocated. In 2010, only 6.737 MGD of the total 12.991 MGD permitted use was actually used, leaving roughly half (6.254 MGD) of the total permitted use unused. While this appears to show that WDIS water is underutilized, it should be noted that metered use is an annual average, while actual irrigation demands may be higher during certain months and that water flow needs to account for these peak demands.

3.2.2.6 Federal Non-Potable Water Systems

The United States government owns three ground water wells in the Pu‘uloa ASYA for agriculture and irrigation. Of the 6.13 MGD of permitted use, the federal government only reported pumping 0.27 MGD in 2010 for agricultural and landscape irrigation.

Table 3-19 Federal Brackish Aquifer Permitted Use and Pumpage (2010)

Federal Wells	Water Use Permit (MGD)	Pumpage (MGD)	Use
PU‘ULOA ASYA			
EP 23 (Well No. 2001-01)	5.89	0.19	Agricultural
Honouliuli Unit (Well No. 2101-14)	0.22	0.08	Irrigation
Pacific Tsunami (Well No. 1900-23)	0.02	No reported use	Irrigation
TOTAL	**6.13**	**0.27**	

3.2.2.7 Private Non-Potable Water Systems

Ground water is used by private entities and individuals for urban, industrial, agriculture, golf course, and landscape irrigation. Water drawn from the freshwater aquifers ('Ewa-Kunia and Waipahu-Waiawa) is used for agricultural and landscape irrigation and domestic purposes.

Table 3-20 Basal Aquifer Permitted Use and Pumpage for Large Private Users (2010)

Well Owner	Permitted Use (MGD)	Pumpage (MGD)	Use
WAIPAHU-WAIAWA ASYA			
D.R. Horton Schuler Homes (Well Nos. 2102-02, 04 through 22; 2202-03 through 20)	7.97	0.61	Agriculture
'EWA-KUNIA ASYA			
Aina Nui Corporation (Well No. 2006-01 through11)	0.96	0.09	Urban nonpotable
Del Monte Fresh Produce (Well No. 2703-01 & 02)	1.08	0.70	Agriculture
Ko Olina Co. (Well No. 2006-13)	0.70	0.63	Golf Course Irrigation
Grace Pacific, Inc. (Well No. 2104-01)	0.12	0.12	Industrial (Quarry)
TOTAL	**10.83**	**2.14**	

Table 3-21 Brackish Aquifer Permitted Use and Pumpage for Private Users (2010)

Well Owner	Permitted Use (MGD)	Pumpage (MGD)	Use
KAPOLEI			
Kapolei People's, Inc. (Well No. 2003-01, 02, 05)	1.00	0.41	Golf course
Kalaeloa Solar One (Well No. 1905-11)	0.30	No report	Industrial
MAKAĪWA			
Aulani Disney Resort (Well No. 2007-04)	0.07	No report	
MALAKOLE (Brackish)			
Kalaeloa Partners, L.P. (Well No. 1805-04 through 12)	3.17	1.33	Industrial
Chevron USA, Inc. (Well No. 1907-02)	0.00	No report	Industrial
VIP Sanitation (Well No. 1805-16)	0.003	No report	Industrial
Tesoro Hawaii Corp. (Well No. 1805-03, 17, 18)	0.00	No report	
Covanta Energy Corp. (H-Power) (Well No. 1806-09, 10)	3.34	1.43	Industrial

Table 3-21 Brackish Aquifer Permitted Use and Pumpage for Private Users (2010) Continued

Well Owner	Permitted Use (MGD)	Pumpage (MGD)	Use
MALAKOLE (Salt)	37.53	12.22	
AES Hawaii Inc. (Well No. 1806-11 through 18)	13.00	9.03	Industrial
Hawaiian Electric Co., Inc. (Well No. 1806-18)	14.40	0.005	Industrial
Chevron Products, Co. (Well No. 1807-01, 02)	1.50	1.06	Industrial
Chevron Products, Co. (Well No. 1807-03, 04)	0.10	0.003	Industrial
Chevron Products, Co. (Well No. 1806-20, 21)	2.00	2.12	Industrial
Ko Olina Intangibles, LLC (Well No. 1906-12)	6.53	No report	
PU‘ULOA	5.27	2.91	
Gentry Development Corp (Well No. 2001-02)	0.08	0.06	Irrigation
Hawaii Prince Golf Club (Well No. 1900-02, 17 through 20; 1901-03)	0.90	0.18	Golf course
Palm Villa I Association (Well No. 2001-06)	0.08	No report	Irrigation
Haseko (Ewa), Inc.	No entry	No report	Irrigation
YHB Ewa LLC (‘Ewa Beach GC) (Well No. 1900-22; 1959-09)	0.60	No report	Golf course
YHB Ewa LLC (‘Ewa Beach GC) (Well No. 1900-21)	0.10	0.00	Golf course
Hawaii Prince Golf Club (Well No. 1900-02, 17 through 20; 1901-03)	0.301	No report	Golf course
Palm Court Association (Well No. 2002-12)	0.04	No report	Irrigation
Palm Villa II Association (Well No. 2001-08)	0.05	No report	Irrigation
Arbors Association (Well No. 2001-07)	0.06	No report	Irrigation
Gentry Development Co. (Well No. 2001-04)	0.04	No report	Irrigation
Gentry Development Co. (Well No. 2001-09)	0.02	No report	Irrigation
Coral Creek Golf, Inc. (Well No. 2002-17)	0.50	No report	Golf course
Coral Creek Golf, Inc. (Well No. 2001-13)	0.80	No report	Golf course
Coral Creek Golf, Inc. (Well No. 2001-14, 15; 2002-17, 19)	0.89	2.16	Golf course
AOAO Suncrest/Shores(Well No. 2001-10)	0.02	0.03	Irrigation
Gentry Homes, Ltd. (Well No. 1908-08)	0.07	N report	Irrigation
Ewa by Gentry Community Assoc. (Well No. 2001-05)	0.20	0.04	Irrigation
Gentry Homes, Ltd. (Well No. 2001-12)	0.23	0.32	Irrigation
Gentry Homes, Ltd. (Well No. 1901-05)	0.04	0.12	Irrigation
Gentry Homes, Ltd. (Well No. 1900-24; 2000-06)	0.26	No report	Irrigation
TOTAL (BRACKISH/SALT)	**13.15/37.53**	**6.08/12.22**	

3.3 Projecting Future Water Demand

In order to plan for ‘Ewa’s future water needs, water demand was projected for all potable and non-potable systems - City, State, federal, and private - to the year 2035. These projections provide an estimate of how much water might be needed through 2035 and indicate when increased demand may require upgrades to infrastructure. The projections are also meant to provide guidance for responsible land and water use decisions in the future.

Where available, water use data for the year 2010 was used as the baseline for existing water demand, as it corresponds with the most recent U.S. Census long form report and thus, the most accurate population data.

3.3.1 Water Demand Scenario Descriptions

The Statewide Framework for Updating the Hawaii Water Plan (2000) recommends including “a range of forecasts of the amount of water required over the planning horizon…Among the scenarios are the base case scenario, a high-growth scenario and a low-growth scenario.” **The mid-growth scenario has been designated as the base-case scenario** because it is based on City policies as presented in the ‘Ewa Development Plan (approved by the City Council in 2013). A low-growth scenario will reflect slower growth in urban development and a high-growth scenario will reflect a faster rate of urban growth. Projections of the resident population for each of these scenarios may be found in Table 3-22.

Table 3-22 ‘Ewa Resident Population Projections

Scenario	2010	2015	2020	2025	2030	2035
Low-Growth[1]	101,397	110,091	118,785	127,479	136,173	144,866
% of O‘ahu Population[4]	11%	11%	12%	12%	13%	13%
Mid-Growth[2]	101,397	115,887	130,377	144,866	159,356	173,846
% of O‘ahu Population[4]	11%	12%	13%	14%	15%	16%
High-Growth[3]	101,397	125,547	149,696	173,846	197,996	222,145
% of O‘ahu Population[4]	11%	13%	15%	17%	19%	21%

1 Low-Growth Scenario: ‘Ewa’s population does not reach the Mid-Growth Scenario’s 2025 projection until 2035.

2 Mid-Growth Scenario: City and County of Honolulu Department of Planning and Permitting Socioeconomic Projections (May 2014)

3 High-Growth Scenario: ‘Ewa’s population reaches the Mid-Growth Scenario’s 2035 projection by 2025.

4 Source of O‘ahu population projections: City Department of Planning and Permitting, which were derived from DBEDT’s Population and Economic Projections for the State of Hawai‘i to 2040 http://dbedt.hawaii.gov/economic/economic-forecast/2040-long-range-forecast/

In addition to these three water demand scenarios, an “Ultimate-Growth” Scenario was created to identify a development scenario at some point in the future where the ‘Ewa District is “built out” and growth approaches the limits of natural water resources. It is at this point that land use and conservation policies and alternative water supply strategies become more critical to supplying expected demand. The Ultimate-Growth Scenario was not assigned a time frame. Rather, it assumed a built-out scenario sometime in the future, after all known projects have been development. The ‘Ewa resident population in the Ultimate-Growth Scenario was projected to be 256,938 people.

3.3.1.1 Low-Growth Scenario

In the Low-Growth Scenario, the number of jobs in the ‘Ewa district has not increased significantly by 2035 due to global economic downturns reminiscent of the one that began in 2008. Other than in the retail, service, and education sectors, the growth in jobs projected by the City has not occurred. Thus, most residents of the Wai‘anae, ‘Ewa, and Central O‘ahu districts continue to commute to the Primary Urban Center for employment.

The City’s rail project has been constructed and planned transit-oriented development (TOD) is very successful in Honolulu. This causes more people to choose to live in the PUC over ‘Ewa, reining in housing and population growth on the West Side of O‘ahu and causing ‘Ewa development projects to not be implemented at the rate previously anticipated.

3.3.1.2 Mid-Growth Scenario (Base-Case Scenario)

The Mid-Growth Scenario is based on the socio-economic projections for population and jobs for the ‘Ewa Planning District, as developed by the City and County of Honolulu in May 2014. This scenario is meant to reflect the ‘Ewa Development Plan vision, which identifies ‘Ewa as the Secondary Urban Center of O‘ahu, supported by residential master planned communities, resorts, the University of Hawai‘i at West O‘ahu campus, and office and commercial uses.

3.3.1.3 High-Growth Scenario

The High-Growth Scenario reflects a future where “the Second City of Kapolei has come into its own” by the year 2035. A resounding success, Kapolei has realized its potential as a job center, allowing residents of Wai‘anae, ‘Ewa, and Central O‘ahu to commute to work places in Kapolei, rather than travel to the PUC every day, thus lessening traffic congestion.

Additionally, the City’s high-capacity transit project (i.e., rail) has been constructed, including subsequent phases to Kapolei and Kalaeloa on the west end and UH Mānoa and Waikīkī on the east end. The three TOD projects in ‘Ewa at East Kapolei, UH West O‘ahu, and Ho‘opili are in various stages of development, providing additional housing and jobs.

In addition to the government, service, and retail jobs in Kapolei, HCDA is implementing its Kalaeloa Master Plan, providing research, eco-environmental, and aviation-related jobs, as well as schools and mixed-use neighborhoods.

3.3.1.4 Ultimate-Growth Scenario

The Ultimate-Growth Scenario was created to illustrate a development scenario for ‘Ewa at some point in the future where water approaches the limits of natural water resources. In this scenario, Kapolei and Kalaeloa have grown to be job centers rivaling Downtown Honolulu; development is “maxed out” and all residential units currently planned for development have been built. Additionally, climate change has decreased rainfall by 15% and raised temperatures and evaporation rates, increasing irrigation water needs for agriculture and landscaping.

This scenario allowed the planning team to pose the following questions: When all currently planned developments are built, will there be enough water to supply them? If so, what will those sources be? Will new technologies need to be implemented to satisfy demand? How does this tie in with the water demands of other districts within the integrated South O‘ahu water system, particularly Central O‘ahu and the PUC? While all of these questions cannot be answered here, the Ultimate-Growth Scenario at least recognizes this future situation where land use and more aggressive water conservation policies and alternative water supply strategies can be more definitively identifiable.

Limitations of the “Ultimate-Growth Scenario:” This Ultimate-Growth Scenario reflects a “full build-out” of developable land as identified by existing development plans and the community growth boundary. However, if the ‘Ewa District continues to be a desirable place to live, work, and play, redevelopment of older neighborhoods like ‘Ewa Beach will eventually occur, likely at higher densities. This would likely translate into greater demands for water and other resources, even though higher building densities decrease the average per capita water demand.

In still greater development scenarios, the community growth boundary may be moved to allow for additional urban development. However, moving the growth boundary would be a difficult undertaking, with a proposal to do so needing to be made through the City’s Development Plan Update process, which includes a community consultation and approval by both the City Planning Commission and the City Council, both of which have additional public comment requirements. To date, no community growth boundary in the City and County of Honolulu has been amended since they were first approved.

These more intense development scenarios would require strong development pressures such as exorbitant housing prices that are not expected in the near future and were thus not included in the “Ultimate-Growth Scenario” at this time. Future iterations of the ‘Ewa WMP may require these redevelopment and expansion possibilities to be incorporated into the projections.

3.3.2 Summary of Water Projection Scenarios

Table 3-23 provides a summary of the values and assumptions used in projecting future water demand for the various water use sectors: domestic, industrial, agriculture, golf course, and landscape irrigation under the four growth scenarios: Low, Mid, High, and Ultimate. Additionally, specific assumptions were sometimes used to project water demand for different water systems.

Table 3-23 ‘Ewa Water Demand Projection Scenario Assumptions

Sector	Baseline Data (2010)	2035 Growth Scenarios			Ultimate-Growth Scenario
		Low-Growth	Mid-Growth	High-Growth	
Domestic Honolulu Board of Water Supply[1]	‘Ewa BWS-Served Population: 92,058 Total ‘Ewa population: 101,397 people	‘Ewa BWS-Served Population: 129,598 (+37,540 people) Population growth will be slower than anticipated. ‘Ewa’s 2035 population will only reach the City’s population projection for the year 2025.	‘Ewa BWS-Served Population: 154,625 (+62,567 people) Water demand is based on the City’s population projections through 2035.	‘Ewa BWS-Served Population: 196,336 (+104,278 people) Population growth will accelerate faster than anticipated. Therefore, the City’s projected 2035 population will be reached by the year 2025.	‘Ewa BWS-Served Population: 243,341 (+151,283 people) All currently planned developments in ‘Ewa are built. The projected 2040 average household size (3.23 persons per household) was applied to the number of planned housing units to calculate the expected increase in population.
Domestic Kalaeloa Water System	Demand: 1.3 MGD	Demand: 1.4 MGD (+ 0.09 MGD) Phase I of the Kalaeloa Master Plan (Rev. Feb 2006) has been implemented by 2035.	Demand: 2.6 MGD (+ 1.24 MGD) Phases I & II of the Kalaeloa Master Plan (Rev. Feb 2006) has been implemented by 2035.	Demand: 3.3 MGD (+ 1.98 MGD) Phases I, II, & III of the Kalaeloa Master Plan (Rev. Feb 2006) have been implemented by 2035.	Demand: 4.2 MGD (+2.90 MGD) Phases I, II, III, & IV of the Kalaeloa Master Plan (Rev. Feb. 2006) have been implemented.

1 Population projections were obtained from DPP in May 2014.

Table 3-23 ‘Ewa Water Demand Projection Scenario Assumptions (Continued)

Sector	Baseline Data (2010)	2035 Growth Scenarios			Ultimate-Growth Scenario
		Low-Growth	Mid-Growth	High-Growth	
Domestic Pearl Harbor Water System (Iroquois Point)	Demand: 0.6 MGD	Demand: 0.6 MGD The Kapilina Beach Homes at Iroquois Point are not expected to add housing units.	Demand: 0.6 MGD The Kapilina Beach Homes at Iroquois Point are not expected to add housing units.	Demand: 0.6 MGD The Kapilina Beach Homes at Iroquois Point are not expected to add housing units.	Demand: 0.6 MGD The Kapilina Beach Homes at Iroquois Point are not expected to add housing units.
Industrial	Number of acres of industrial land use in ‘Ewa: 1,369	Industrial Acres: 1,369 (+ 0 acres) No change in industrial acreage.	Industrial Acres: 1,412 (+ 43 acres) Assumes growth in industrial acreages at Campbell Industrial Park and at Maritime Business Park.	Industrial Acres: 1,462 (+ 93 acres) Assumes growth in industrial acreages at Campbell Industrial Park and at Maritime Business Park over and above that seen in the Mid-Growth Scenario.	Industrial Acres: 1,671 (+ 302 acres) Assumes Campbell Industrial Park and Maritime Business Park are at full capacity and that proposed expansions at the Honouliuli WWTP and Kahe Valley are implemented.

Table 3-23 ‘Ewa Water Demand Projection Scenario Assumptions (Continued)

Sector	Baseline Data (2010)	2035 Growth Scenarios			Ultimate-Growth Scenario
		Low-Growth	Mid-Growth	High-Growth	
Agriculture	Number of acres in agriculture: 3,539	Agricultural Acres: 3,057 (- 481 acres) UH West O‘ahu and DHHL East Kapolei have displaced agriculture by the year 2035, but there are no changes to the number of acres of agriculture outside of the Community Growth Boundary.	Agricultural Acres: 1,997 (- 1,542 acres) All agricultural lands within the Community Growth Boundary have been converted to urban uses, except for the Ho‘opili development’s agricultural component (148 acres).[2] There are no changes in agricultural lands outside of the Community Growth Boundary.	Agricultural Acres: 2,988 (- 694 acres) All agricultural lands within the Community Growth Boundary have been converted to urban uses, except for the Ho‘opili development’s agricultural component (148 acres).[2] Outside of the Community Growth Boundary, there are no changes in agricultural lands mauka of the H-1 Freeway, but due to the high cost of shipping and the push for food security, all agricultural lands within the U.S. Navy ESQD zone are fully cultivated.	Agricultural Acres: 3,436 (- 166 acres) All agricultural lands within the Community Growth Boundary have been converted to urban uses, except for the Ho‘opili development’s agricultural component (148 acres).[2] Outside of the Community Growth Boundary all of the agricultural lands mauka of the H-1 Freeway, as well as those within in the U.S. Navy ESQD zone are fully cultivated.

2 - *Projected Non-Potable Water Demands*. Hoopili Water Master Plan. August 4, 2015.

Table 3-23 ‘Ewa Water Demand Projection Scenario Assumptions (Continued)

Sector	Baseline Data (2010)	2035 Growth Scenarios			Ultimate-Growth Scenario
		Low-Growth	Mid-Growth	High-Growth	
Golf Course Irrigation	Number of golf courses: 9	Number of golf courses: 9 (+ 0 golf courses) No change in the number or acres of golf courses in ‘Ewa.	Number of golf courses: 9 (+ 0 golf courses) No change in the number or acres of golf courses in ‘Ewa.	Number of golf courses: 10 (+ 1 golf course) Kapolei West Golf Course has been built as the tenth golf course in the ‘Ewa District.	Number of golf courses: 10 (+ 1 golf course) Climate change reduces rainfall and increases evapo-transpiration rates, thus increasing irrigation rates for the 10 golf courses by 15%.[3]
Landscape Irrigation	Number of housing units: 30,726 Residential housing units for 2010 from DPP existing Census data (May 2014).	Housing Units: (+ 13,212 housing units) Number of housing units is expected to increase by 43% over 2010 in the Low Demand Scenario, which is proportional to the projected increase in population.	Housing Units: (+ 26,083 housing units) DPP projects that there will be 56,809 housing units in the ‘Ewa District by 2035.	Housing Units: (+36,564 housing units) The number of housing units is expected to increase by 119% in the High Demand Scenario, which is proportional to the projected increase in population.	Housing Units: (+48,155 housing units) All planned developments are built. Based on development master plans, housing units increase by 157%. Climate change reduces rainfall and increases evapo-transpiration rates, thus increasing irrigation rates by 15%.[3]

3 Climate change is expected to decrease rainfall by approximately 15%. Thus, irrigation rates were increased by 15% to account for additional water needs.

3.3.3 Water Demand Methodology and Assumptions

Future water demand was projected for five different types of water uses, or sectors: domestic, industrial, agriculture, golf course irrigation, and landscape irrigation. The assumptions used in projecting water demand by each sector are described below.

3.3.3.1 BWS System Domestic Water Demand (2010-2035)

BWS provides the largest share of water demand in ‘Ewa, with domestic water use serving residential, commercial, industrial, irrigation, agriculture, government, and military water uses. Also included in the BWS water demand are some State uses identified in the State Water Projects Plan (SWPP, 2003), which identifies a 2020 ‘Ewa potable water demand of 9.7 MGD, an increase of 4.2 MGD over the projected 2010 water demand. All of the future State potable water demands identified in the SWPP are expected to be accommodated by the City BWS.

DLNR updated the SWPP for the Department of Hawaiian Home Lands in 2016. DHHL’s “medium” water demand projections for its Kapolei I and East Kapolei II developments totaled 1.0 MGD by 2031. Potable water will be obtained from the BWS system, which was determined to have sufficient capacity. Supply for DHHL’s water demand projection of 2.2 MGD for its Kalaeloa projects are split between the Kalaeloa Water System (see Section 3.3.3.2 below) and BWS (Water Use Zone 71841). Calculations for the BWS system incorporates some water demand from the DHHL Kalaeloa developments.

Additionally, the Pālehua Water System water demands are incorporated into the BWS projections, as potable water distributed by the private water system comes from the BWS Makakilo Reservoir.

A “per capita” (per person) approach was used to calculate domestic water demand, whereby the average water demand is divided by the population served (i.e., water demand per capita). Water demand includes water lost during transmission from the source to the user.

Total BWS Water Demand ÷ Population Served = Per Capita Water Demand

The BWS-served population takes into account the number of residents absent from ‘Ewa, as well as the number of visitors present. Populations served by non-BWS water systems, e.g., the U.S. Navy water system, are also subtracted out. The per capita demand is then applied to population projections through the planning horizon to estimate the future water demand.

Table 3-24 BWS Per Capita Water Demand in ‘Ewa (Base Year)

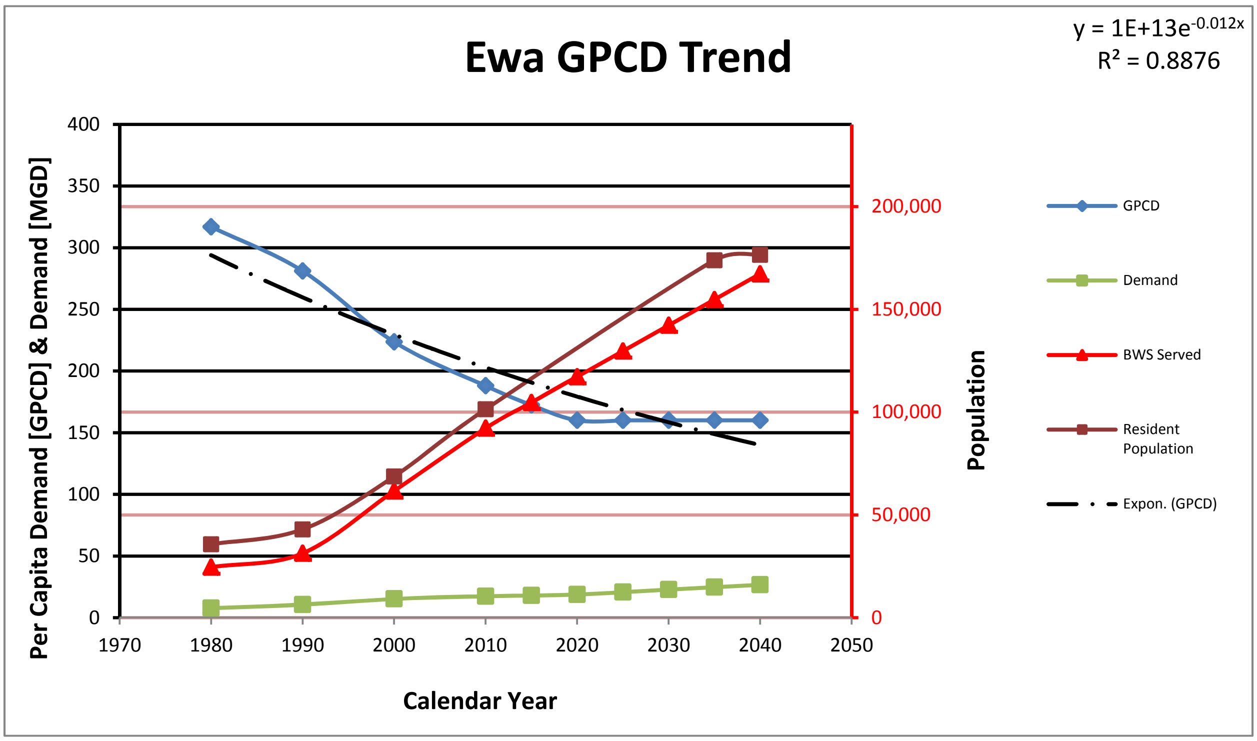
‘Ewa BWS-Served Population (number of people)	‘Ewa BWS-Served Water Demand (MGD)	Per Capita Demand (GPCD)
92,058	17.1[1]	185

1 The ‘Ewa water demand represents the five-year average water demand for the years 2008-2012.

It should be noted that 2010 (the base year) experienced lower rainfall than normal and thus would reflect conservatively high water demand for the existing conditions. To address this, the base year per capita demand is an average water demand for the years 2008-2012.

Figure 3-7 shows the trend in per capita water demand in Gallons Per Capita Day (GPCD) for ‘Ewa in comparison with resident and BWS-served population. The ‘Ewa per capita water demand has been decreasing over the last thirty years, from 317 Gallons Per Capita Day (GPCD) in 1980 to 185 GPCD in 2010, a decrease of 42%, even while the BWS-served population has increased, allowing the total water demand in ‘Ewa to increase at a much lower rate than the increase in population over the same time period.

Figure 3-7 ‘Ewa Per Capita Demand (1980-2040)



The high per capita demand in 1980 is attributed to the high proportion of industrial water use compared to the small BWS-served population before the sugar plantations closed. As ‘Ewa’s population and residential water demand increased with the City’s directed growth policy, the ratio of industrial and residential water use changed, dropping the per capita demand proportionately.

Leak detection and repair, conservation programs by the BWS, and the use of recycled water for non-potable water needs decreased the per capita water demand further. The downward trend in ‘Ewa’s per capita demand is expected to continue to decline until it reaches 160 GPCD around the year 2020, after which it is expected to remain stable. The per capita demand could decrease further if additional, more aggressive conservation strategies, such as the expansion of R-1 recycled water into residential developments, implementation of green building plumbing codes, rain catchment barrels, and grey water reuse for irrigation, are implemented.

Table 3-25 Per Capita Demand in ‘Ewa (2010-2035)

	2010	2015	2020	2025	2030	2035
GPCD	185	182	168	160	160	160

Ultimate-Growth Scenario: 160 GPCD

Projected domestic water demand for the BWS system was calculated by multiplying the projected BWS-served population by the per capita demand for that five-year increment.

Per Capita Demand X BWS-Served Population = Projected Water Demand

The BWS-served population (Table 3-26) takes into account the number of visitors present, the number of residents absent, and the population served by other water systems. Please see Table 3-23 for notes on how ‘Ewa population was projected through 2035.

Table 3-26 Projected BWS-Served Population in ‘Ewa (2010-2035)

Water Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth	92,058	99,566	107,074	114,582	122,090	129,598
Mid-Growth	92,058	104,571	117,085	129,598	142,111	154,625
High Growth	92,058	112,914	133,769	154,625	175,625	196,336

Ultimate-Growth Scenario BWS-Served Population: 243,341 people

Future potable water demand was calculated by multiplying the projected BWS-served population by the expected per-capita demand for each five-year increment and for the Ultimate-Growth Scenario (Table 3-27).

Table 3-27 BWS Domestic Water Demand Projections (2010-2035)

Water Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	17.1	18.1	18.0	17.3	18.5	19.7
Mid-Growth (MGD)	17.1	19.0	19.7	19.7	21.7	23.7
High Growth (MGD)	17.1	20.5	22.5	23.7	27.1	30.4

NOTE: Domestic potable water demands include irrigation water demand that is served by the BWS potable water system. An additional non-potable water system provides for irrigation of large landscaped areas and a separate recycled water system serves other large industrial and irrigation water needs.

Ultimate-Growth Scenario Water Demand: 37.9 MGD

3.3.3.2 Kalaeloa Water System Domestic Water Demand

Projected domestic water demand for the Kalaeloa Water System comes directly from the Kalaeloa Master Plan (2006), Technical Appendix B Engineering and Infrastructure, which breaks down implementation into four phases. Each growth scenario assumes than an additional phase of development has been implemented, increasing water demand accordingly. The Ultimate-Growth Scenario water demand reflects estimated water demand at full buildout, with Phases I-IV implemented.

The *State Water Projects Plan – DHHL Update* (2016) identified DHHL potable water demand in Kalaeloa as approximately 2.2 MGD by 2031, to be partially served by the Kalaeloa Water System. Therefore, Kalaeloa Water System demand includes some uses by DHHL. The remaining DHHL water demand will be served by the BWS water system.

Table 3-28 Kalaeloa System Domestic Water Demand Projections (2010-2035)

Water Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	1.3	1.3	1.4	1.4	1.4	1.4
Mid-Growth (MGD)	1.3	1.6	1.8	2.1	2.3	2.6
High Growth (MGD)	1.3	1.7	2.1	2.5	2.9	3.3

Ultimate-Growth Water Demand: 4.2 MGD

3.3.3.3 Joint Base Pearl Harbor Hickam Water System Demand Projections (2010-2035)

The JBPHH water system services the Kapilina Beach Homes at Iroquois Point. Information on existing and projected water demand was not available. The 1,461 housing units in the development were assumed to have an average water demand of 400 GPD, totaling 0.6 MGD. No expansion of the development was anticipated, because the surrounding land uses are either developed, are a part of the Naval Reservation at West Loch, or are part of the Navy’s explosives safety zone.

Table 3-29 JBPHH System Domestic Water Demand Projections (2010-2035)

Water Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	0.6	0.6	0.6	0.6	0.6	0.6
Mid-Growth (MGD)	0.6	0.6	0.6	0.6	0.6	0.6
High Growth (MGD)	0.6	0.6	0.6	0.6	0.6	0.6

Ultimate-Growth Water Demand: 0.6 MGD

3.3.3.4 Total Domestic Water Demand

Domestic water demand is served by BWS, Kalaeloa, and JBPPH water systems. Total domestic water demand for all tree water systems is expected to be 26.9 MGD by 2035 in the Mid-Growth Scenario.

Table 3-30 ‘Ewa Low-Growth Scenario Domestic Water Demand

Water System	2010	2015	2020	2025	2030	2035
Low-Growth Scenario (MGD)	19.0	20.0	19.9	19.3	20.5	21.7
Mid-Growth Scenario (MGD)	19.0	21.2	22.0	22.4	24.6	26.9
High-Growth Scenario (MGD)	19.0	22.8	25.1	26.8	30.6	34.3

Ultimate-Growth Water Demand: 42.7 MGD

3.3.3.5 Agricultural Water Demand

Agricultural water demand was calculated by applying an agricultural water use coefficient (an average daily water demand per acre of agriculture) to the number of acres of active agriculture. The current number of acres of active agriculture was estimated from analysis of aerial photos taken in January 2011. Future active agricultural acres were projected based on the following water demand scenarios. See Figures 3-8 through 3-11 for maps of where agricultural lands are projected to be located in each of the growth scenarios.

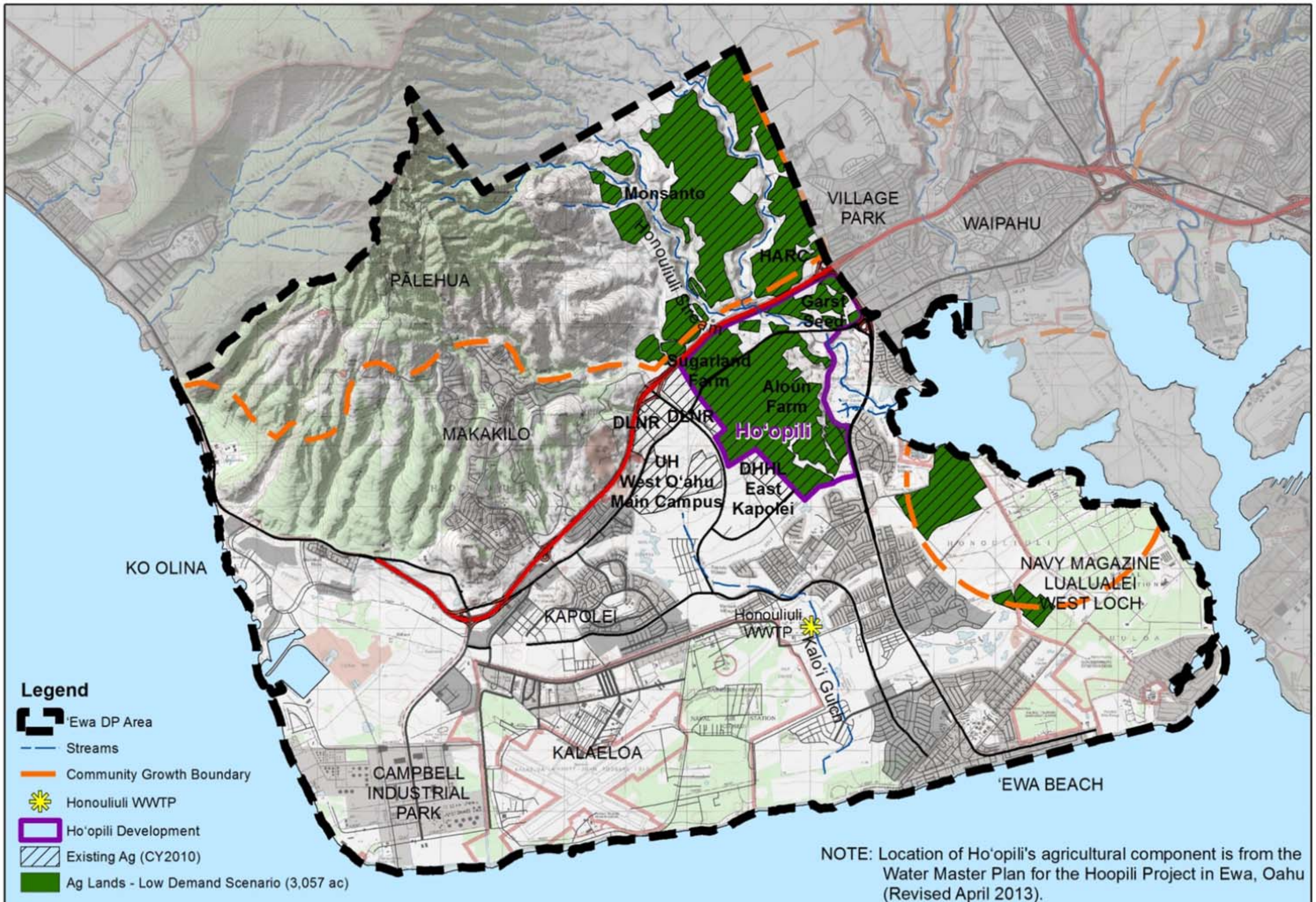
The Agricultural Water Use and Development Plan (AWUDP, 2004) only included the Waiāhole Ditch Irrigation System when projecting future agricultural water demand in the ‘Ewa District. Twenty-year projections (to approximately 2024) estimated a range in water demand from the WDIS from 6.1 MGD (worst case scenario) to 16.0 MGD MGD (best case scenario). Since then, a CWRM Decision and Order set the SY for offstream uses at 15 MGD. As the AWUDP does not conform to these newer restrictions, agricultural water demand from the WDIS has been projected per the methodology described below.

Low-Growth Scenario
All of the agricultural lands currently cultivated outside of the community growth boundary are still in active agriculture. Additionally, UH West O’ahu and DHHL’s East Kapolei developments (already partially constructed) have displaced the farms that were operating in those locations, but Ho‘opili, a planned development, has not yet been built. This leaves Ho‘opili as the last of the agricultural lands within the Community Growth Boundary.

Mid-Growth Scenario
All of the agricultural lands currently being cultivated outside of the community growth boundary are still cultivated at an intensity similar to that in 2010. However, it was assumed that all of the agricultural lands within the community growth boundary (UH West O‘ahu, DHHL East Kapolei, and Ho‘opili) have been converted to urban uses, with the exception of the commercial agriculture component of the Ho‘opili project (148 acres).[6] Even with the agricultural component of the Ho‘opili project preserved, the total number of cultivated acres will decrease by about 680 acres between 2010 and 2035.

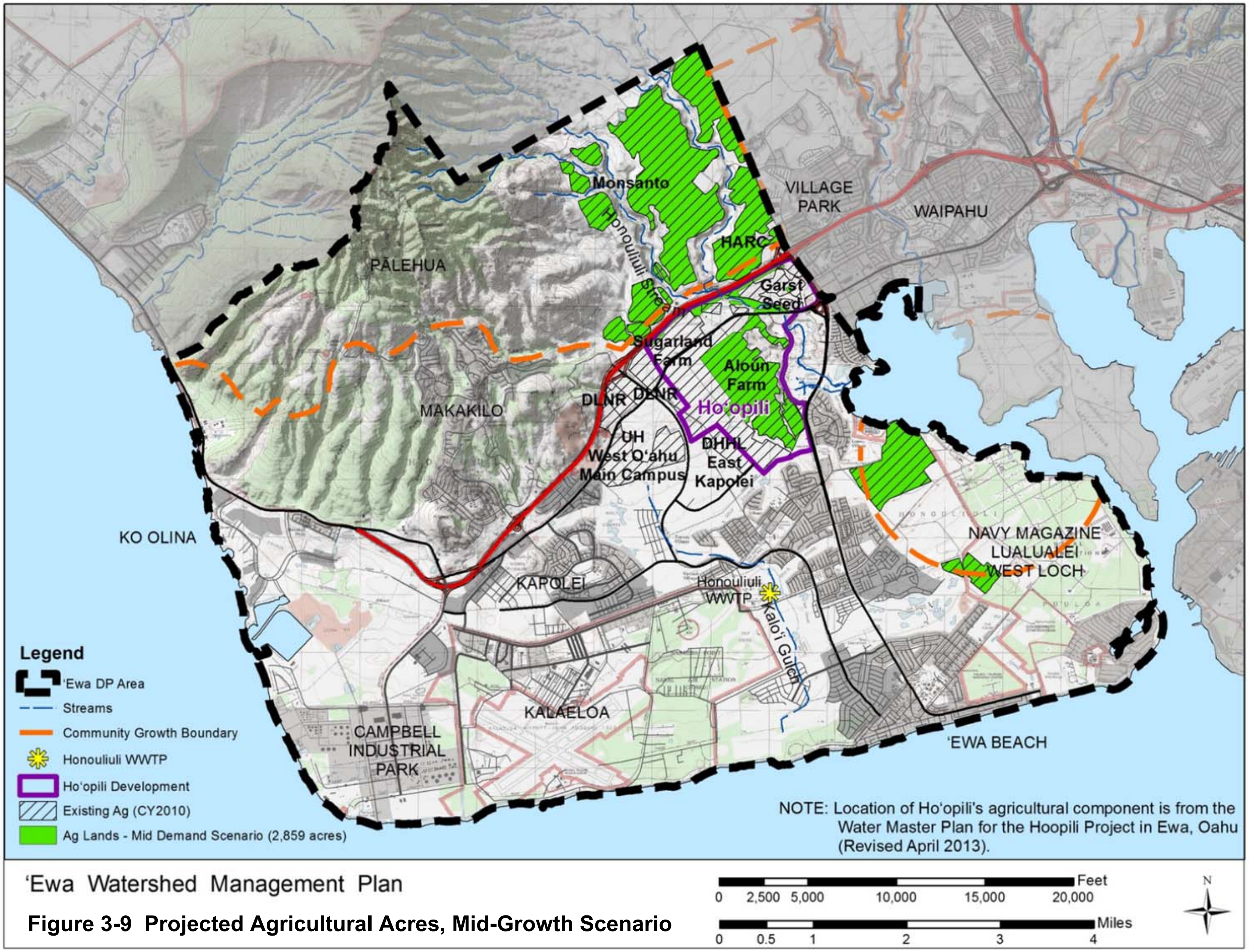
High Growth Scenario
As ‘Ewa is an urban growth planning district, all agricultural lands within the community growth boundary have been converted to urban uses, with the exception of Ho‘opili’s agricultural component (148 acres). However, due to the cost of shipping and the push for food security, all additional agricultural lands within in the U.S. Navy Explosive Safety Quantity Distance (ESQD) zone (+848 acres) are fully cultivated.

[6] *Projected Non-Potable Water Demands*. Hoopili Water Master Plan. August 4, 2015. p.11-13.



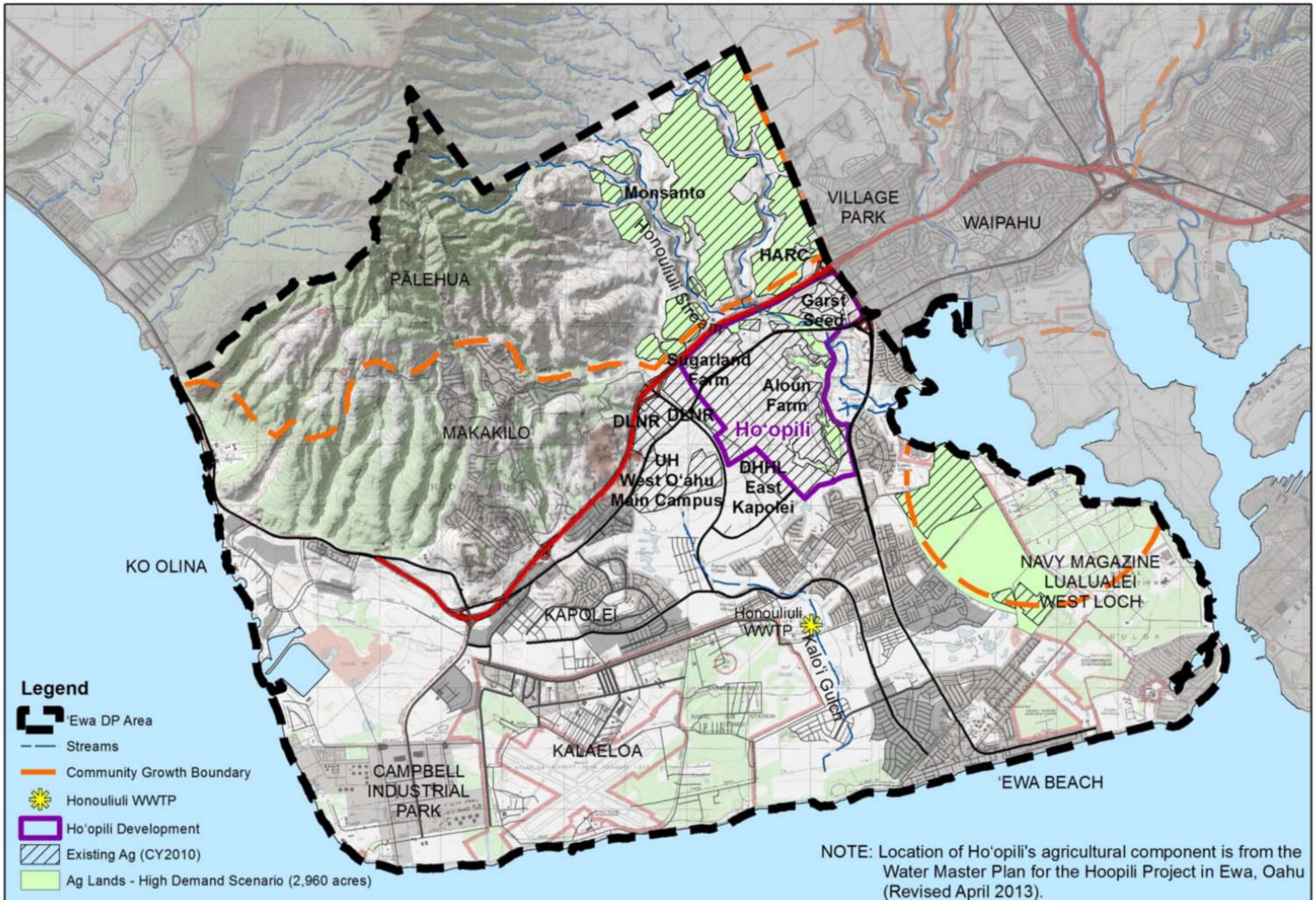
'Ewa Watershed Management Plan

Figure 3-8 Projected Agricultural Acres, Low-Growth Scenario



'Ewa Watershed Management Plan

Figure 3-9 Projected Agricultural Acres, Mid-Growth Scenario



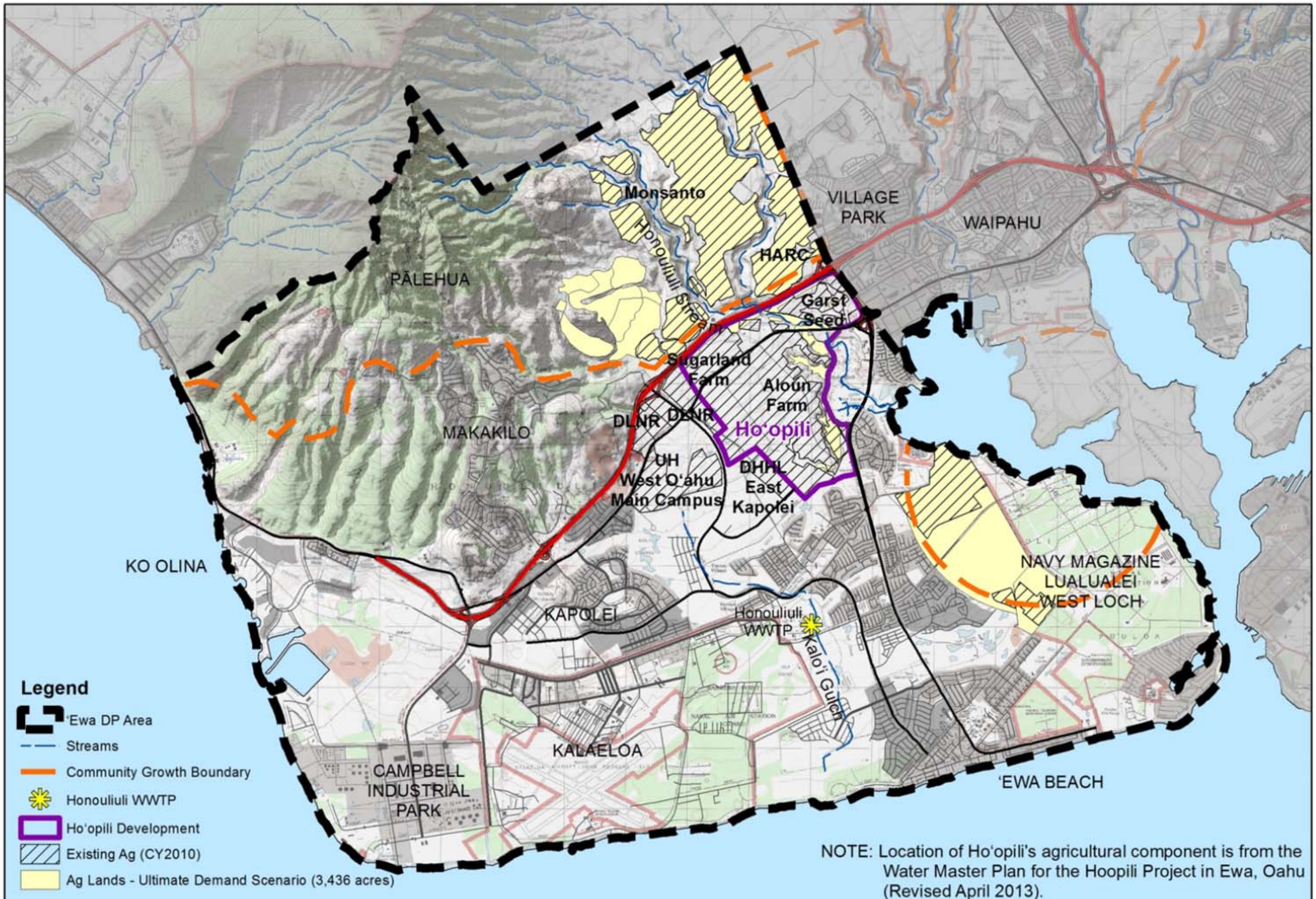
'Ewa Watershed Management Plan

Figure 3-10 Projected Agricultural Acres, High-Growth Scenario

Feet: 0 2,500 5,000 10,000 15,000 20,000

Miles: 0 0.5 1 2 3 4

N



'Ewa Watershed Management Plan

Figure 3-11 Projected Agricultural Acres, Ultimate-Growth Scenario

Ultimate-Growth Scenario

In addition to the cultivated acres in the High-Growth Scenario, all agricultural lands outside of the community growth boundary mauka of the H-1 Freeway, east of Makakilo are fully cultivated (+448 acres). Agricultural water needs will also be impacted by climate change, which is expected to cause a decline in rainfall and an increase in evapo-transpiration rates due to higher temperatures. It was assumed that irrigation rates for agriculture will increase by 15%, which is equal to the percentage that rainfall is expected to decline.

Table 3-31 Estimated Active Agricultural Acres (2010 – 2035)

Demand Scenario	2010[1]	2015	2020	2025	2030	2035
Low-Growth Scenario (acres)[2]	3,539	3,443	3,346	3,250	3,154	3,057
Mid-Growth Scenario (acres)[2]	3,539	3,539	2,830	2,830	1,930	1,997
High-Growth Scenario (acres)[2]	3,539	3,708	3,169	3,338	2,608	2,845

1 Existing acres (2010) based on aerial photo analysis of "Natural Color WorldView-2 (WV2) Orthophoto Mosaic of the Island of Oahu, Hawaii," January 11, 2011. Does not account for entire parcel, only active ag fields as drawn from aerial photo.

2 Changes in cultivated acres are evenly distributed amongst each five-year increment from 2010 – 2035, with the exception of the Ho‘opili development, which assumed that Phases 1A-1C would displace 700 acres of existing agriculture by 2020 and all of the existing agriculture by 2030 in the Mid-, High-, and Ultimate-Growth scenarios. Phases 1A-1C of the Ho‘opili project (68 acres of commercial agriculture) were assumed to be implemented by 2035 and all phases (148 acres of commercial agriculture) implemented in the Ultimate-Growth scenario.

Ultimate-Growth Scenario: 3,373 acres

Table 3-32 Existing Agricultural Acres in ‘Ewa (2010)

Land Owner	Acres[1]
HARC/Pioneer Hi-Bred	281.0
Monsanto	1,141.0
UH (West O‘ahu – mauka of Freeway)	152.9
DHHL (East Kapolei)	108.2
DLNR	131.3
DR Horton Schuler	1,166.0
UH (West O‘ahu main campus)	203.9
U.S. Navy (ESQD Zone)	354.7
TOTAL	**3,539**

1 Existing acres (2010) based on aerial photo analysis of "Natural Color WorldView-2 (WV2) Orthophoto Mosaic of the Island of Oahu, Hawaii," January 11, 2011. Does not account for entire parcel, only active agricultural fields as drawn from aerial photo.

Agricultural water demand coefficients (gallons per acre per day) were used to determine the change in agricultural water demand over the planning horizon. Table 3-33 provides the agricultural water demand factors and how they were applied.

Table 3-33 Agricultural Water Use Coefficients

Agricultural Water Use Coefficient (GPAD)	Source	Applied to
2,500	Water Master Plan for the Hoopili Project in Ewa, Oahu, Table 1 (Tom Nance Water Resource Engineering, Revised April 2013); Findings of Fact, Conclusions of Law, and Decision and Order *In the Matter of Water Use Permit Applications, Petitions for Interim Instream Flow Standards Amendments, and Petitions for Water Reservations for the Waiāhole Ditch Combined Contested Case Hearing* (December 1997)	Low-, Mid-, and High-Growth Scenarios
2,875	Mauka lands ag water demand factor + 15%. Climate change has decreased rainfall by 15% and increased evapotranspiration rates, increasing irrigation requirements	Ultimate-Growth Scenario

Agricultural water demand for 2035 was calculated by determining the change in active agricultural acres (between 2010 and 2035), calculating the water demand for those acres, and adding that to the 2010 agricultural water demand.

Agricultural Water Demand (2010) + Change in Agricultural Water Demand (2010 – 2035) = Agricultural Water Demand (2035)

The change in agricultural water demand was determined by applying a water use factor to the number of acres in active agriculture.

Water Demand Coefficient X Active Agricultural Acres = Agricultural Water Demand

The Hoʻopili development produced a water master plan (August 2015) that projected a non-potable water demand of 0.37 MGD for its commercial agriculture component. This 0.37 MGD was used to estimate the agricultural water demand for the Hoʻopili project in the Mid-, High-, and Ultimate-Growth scenarios, rather than using the above methodology. It was assumed that Phases 1A-1C would be developed by 2035 in the Mid- and High-Growth scenarios (0.17 MGD) and that the full commercial agriculture component would be built out in the Ultimate-Growth scenario (0.37 MGD).

Table 3-34 Agricultural Water Demand (2010-2035)

Demand Scenario	2010[1]	2015	2020	2025	2030	2035
Low-Growth Scenario (MGD)	7.0	6.8	6.6	6.3	6.1	5.8
Mid-Growth Scenario (MGD)	7.0	6.3	5.5	4.7	3.8	4.0
High-Growth Scenario (MGD)	7.0	6.8	6.6	6.4	5.5	6.1

1 Existing water demand was derived from (1) BWS Metered Consumption reports (“Ewa Watershed and DP Area MONCON – 2010” received from BWS on 12-17-12); (2) “Waiāhole Ditch Data_CXY 2010” received from ADC 5-15-13; and (3) “State Pumpage Monthly Totals 2000-2010” received from CWRM on 1-16-13.

Table 3-35 Ultimate Growth Scenario Agricultural Water Demand

	2010	Ultimate
Acres in Agriculture	3,539	3,373
Water Demand (MGD)	**7.0**	**7.6**

3.3.3.6 Industrial Water Demand

Industrial water needs are serviced by ground water provided by private sources and recycled water. The change in ‘Ewa’s industrial water demand was based on the projected growth in acres of industrial land uses in ‘Ewa, as described in Table 3-36, below. It was assumed that as the industrial sector grew, as represented by an increase in the number of industrial acres, then industrial water demand would grow proportionately. For notes on how the number of industrial acres in ‘Ewa was projected through 2035, please see Table 3-23.

Table 3-36 Projected Acres of Industrial Land Use (2010-2035)

Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth	1,369	1,369	1,369	1,369	1,369	1,369
Mid-Growth	1,369	1,378	1,386	1,395	1,403	1,412
High-Growth	1,369	1,388	1,406	1,425	1,444	1,462

Ultimate-Growth Scenario Acres of Industrial Land: 1,671

A water use coefficient of 5,289 GPAD was applied to the number of acres of industrial lands to get water demand. The water use coefficient for industrial demands was calculated by dividing the 2010 existing water demand for industrial purposes by the 2010 existing acres of industrial lands. It should be noted that this water demand only reflects industrial needs for non-potable water supplied by brackish water wells or recycled water. Industrial demand for potable water is factored into the calculations for BWS domestic water demand. Demands for salt water are not factored into these projections.

Table 3-37 Industrial Water Demand (2010-2035)

Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	7.2	7.2	7.2	8.2	8.2	8.2
Mid-Growth (MGD)	7.2	7.3	7.3	8.4	8.4	8.5
High-Growth (MGD)	7.2	7.9	8.5	10.1	10.7	11.4

Potable water demand for industrial uses is incorporated into the demand forecast for domestic water. Therefore, the above projections are for non-potable water (brackish water and recycled water, but NOT salt water).

Ultimate Water Demand: 11.9 MGD

3.3.3.7 Golf Course Irrigation Water Demand

Golf courses in ‘Ewa are irrigated by R-1 recycled water and by private brackish water sources. Several golf courses in ‘Ewa supplement their R-1 irrigation with on-site brackish caprock wells. There are currently nine golf courses in ‘Ewa, with one additional golf course (Kapolei West) proposed. It was assumed that no additional golf courses would be developed due to both a limitation in space and a saturation of the market. Kapolei West is anticipated to come on-line in the High-Growth Scenario around the year 2020, requiring 0.828 MGD of irrigation water (Kapolei Regional Non-Potable Water Master Plan, 2007). In the Ultimate Demand Scenario, it was assumed that climate change would increase irrigation needs by 15% over current demand due to an expected 15% decrease in rainfall.

Table 3-38 Golf Course Irrigation Water Demand (2010-2035)

Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	7.5	7.5	7.5	7.5	7.5	7.5
Mid-Growth (MGD)	7.5	7.5	7.5	7.5	7.5	7.5
High-Growth (MGD)	7.5	7.5	8.3	8.3	8.3	8.3

Ultimate Water Demand: 9.5 MGD

3.3.3.8 Other Landscape Irrigation Water Demand

Landscaped areas in ‘Ewa are irrigated by ground water from BWS, City, and private water systems, and by BWS recycled R-1 water. The increase in irrigation water demand was based on the increase in the number of housing units. A water use coefficient of 37.8 gallons per housing unit was derived by dividing the existing landscape irrigation water demand by the existing number of housing units. This water use coefficient was then applied to the projected number of housing units in the various growth scenarios.

Small landscaped areas associated with single family homes and commercial uses are already factored into the BWS domestic water demand, as they are supplied by BWS potable water. These irrigation demands are for large landscaped areas, such as parks and roadside landscaping, that are not on the BWS potable water system. In the Ultimate Demand Scenario, it was assumed that climate change would increase irrigation needs by 15% over current demand because rainfall is expected to decrease by 15%.

Table 3-39 Landscape Irrigation Water Demand (2010-2035)

Demand Scenario	2010	2015	2020	2025	2030	2035
Low-Growth (MGD)	1.2	1.3	1.4	1.5	1.6	1.7
Mid-Growth (MGD)	1.2	1.4	1.6	1.8	2.0	2.2
High-Growth (MGD)	1.2	1.4	1.7	20.	2.3	2.5

Ultimate Water Demand: 3.4 MGD

3.3.4 Summary of Water Demands

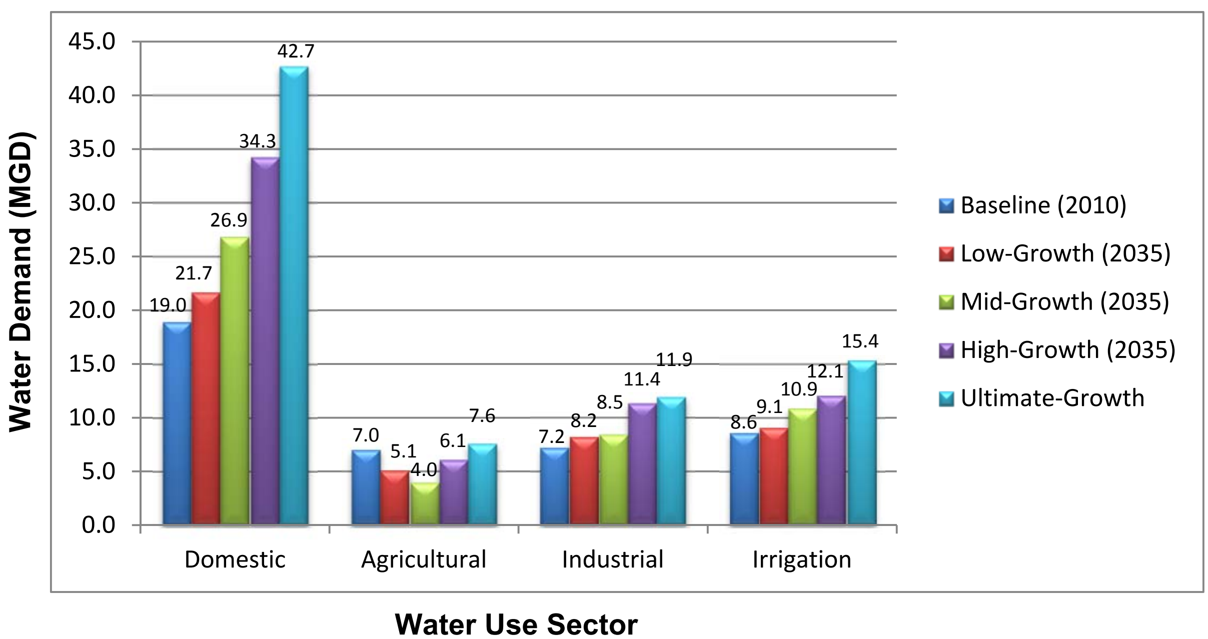
Table 3-40 and Figure 3-12 below display the projected 2035 water demand for the ‘Ewa District by water use sector in the Low, Mid High, and Ultimate-Growth scenarios. Domestic water demand is expected to increase significantly in all scenarios, ranging from an increase of 14% in the Low-Growth Scenario to 125% in the Ultimate-Growth Scenario. Irrigation water demand increases steadily over each scenario, but increases significantly in the Ultimate-Growth Scenario due to a high increase in housing units and climate change impacts. Industrial water demand increases very modestly in the Low and Mid-Growth scenarios, but increases by 57% in the High-Growth scenario and by 65% in the Ultimate-Growth scenario.

Agricultural water demand, on the other hand, decreases by 2035 in every scenario, as agricultural land is converted to urban uses within the Community Growth Boundary. The number of cultivated acres decreases by a lesser amount in the High- and Ultimate-Growth Scenarios than in the Low- and Mid-Growth scenarios as fallow lands outside of the Community Growth Boundary are converted to agricultural production. Still, the total number of cultivated acres decreases between 2010 and 2035, even in the High-Growth Scenario, resulting in a decrease in agricultural water demand. In the Ultimate Growth scenario, higher irrigation rates due to expected drier conditions result in an increase in agricultural water demand over 2010.

Table 3-40 ‘Ewa Projected Water Demand by Water Use Sector

		2035 (MGD)			
WATER USE SECTOR	**2010 (MGD)**	**LOW-GROWTH**	**MID-GROWTH**	**HIGH-GROWTH**	**ULTIMATE-GROWTH**
Domestic	19.0	21.7	26.9	34.3	42.7
Residential	12.5	14.8	18.5	23.4	29.0
Non-Residential	6.5	7.9	9.4	11.9	14.8
Agricultural	7.0	5.1	4.0	6.1	7.6
Industrial	7.2	8.2	8.5	11.4	11.9
Irrigation	8.6	9.1	10.9	12.1	15.4
Golf Course	7.5	7.5	7.5	8.3	9.5
Landscape	1.2	1.7	3.4	3.8	5.9
TOTAL	**41.9**	**44.2**	**50.2**	**63.9**	**77.6**
% increase 2010-2035		5%	20%	53%	85%

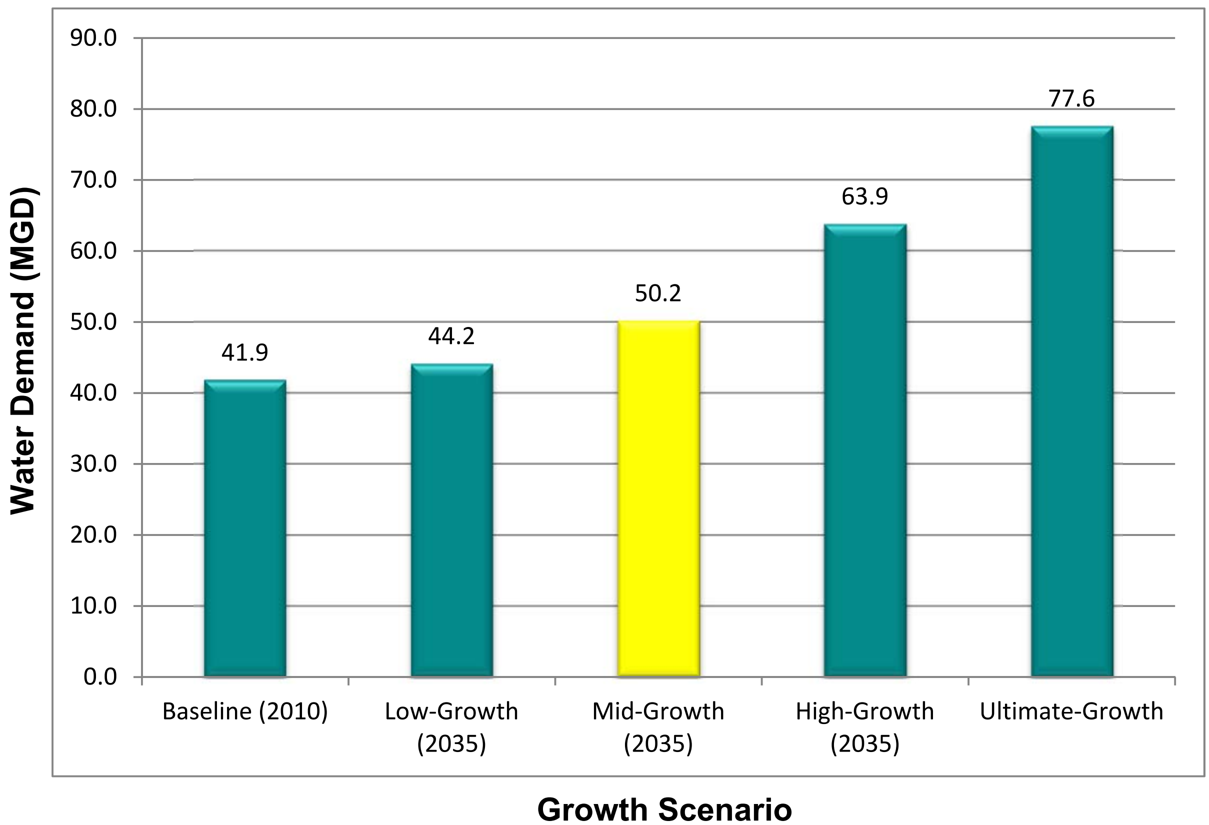
Figure 3-12 ‘Ewa Projected Water Demand by Water Use Sector



3.4 Most Probable Water Demand Scenario

The Statewide Framework for Updating the Hawaii Water Plan (2000) requires that each County Water Use and Development Plan identify a base case scenario which is assumed to be the most probable future scenario. For the ‘Ewa WMP, the **base case scenario will be the mid-growth scenario**, as it is based on City policies as presented in the ‘Ewa Development Plan (approved by the City Council in 2013).

Figure 3-13 ‘Ewa Water Demand by Growth Scenario



The base case scenario reflects domestic growth as projected by City policies and expected future development in the ‘Ewa District. Growth in industrial water demand mirrors the expected modest growth in proposed industrial parks. Landscape irrigation grows at a rate similar to the increase in housing units, as projected by the City DPP. Agriculture declines in the district, as urban uses displace farms within the Community Growth Boundary. Outside of the Community Growth Boundary, demand for agricultural lands in the mid-growth scenario is not high enough to put currently fallow lands in the Navy ESQD zone and at UH West O‘ahu into cultivation and consequently does not justify the infrastructure upgrades to supply water to these areas.

3.5 Adequacy of Supply to Meet Demand

‘Ewa’s base case (Mid-Growth) scenario projects domestic water demand to increase by 42% by 2035. Additionally, industrial water demand is expected to only increase by 17% and irrigation by 26%, while agricultural water demand is projected to decrease by 43%. In total, ‘Ewa’s water demand is expected to increase by 20% (~8 MGD). In order to meet these demands, there are two choices: continue to rely upon ground water for all potable and some non-potable water needs, or diversify sources.

Reliance upon ground water is theoretically feasible. The ‘Ewa-Kunia ASYA and Waipahu-Waiawa ASYA have a combined 20 MGD of unallocated (unpermitted) water. Additionally, the volume of water actually pumped is much less than what is permitted, with an estimated 70 MGD of water pumped out of a combined sustainable yield of 120 MGD. This would theoretically leave about 50 MGD of water, which could be used to supply the 11 MGD of additional water demand that ‘Ewa would require under the base case scenario.

However, this reliance only on ground water is not prudent in that it assumes that the sustainable yield will not change, but the State Commission on Water Resource Management regularly updates the aquifer sustainable yields and has changed SYs as recently as 2008 and is currently reevaluating further reductions in SYs. Additionally, climate change research indicates that annual rainfall will decrease in dry areas, likely decreasing sustainable yields in the future as less water percolates into the ground. ‘Ewa would also have to compete with other districts on O‘ahu that are supplied by the Waipahu-Waiawa ASYA: Wai‘anae, Central O‘ahu, and the Primary Urban Center. All of these factors make sole reliance upon ground water an ill-advised option for the future.

Instead, ‘Ewa has the opportunity to become a model for sustainable water use through water conservation and diversification of water sources. This opportunity allows for the application of ahupua‘a principals of self-sufficiency in a modern urban context by managing growth in water demand through advanced water conservation and the leveraging of a diverse suite of sustainable water supplies within the watershed, minimizing the need to transfer additional water from adjacent watersheds.

As proof of the efficacy of this model, previous applications of conservation and diversification of sources in the ‘Ewa district have resulted in an increase in BWS potable water demand of less than 125% over the last 30 years (1980-2010) while ‘Ewa’s population has increased by approximately 275% over the same time period. In a “Conservation and Diversification” strategy, ‘Ewa would pioneer recycled water as a viable, large-scale alternative to ground water for agricultural and landscape irrigation, as well as for industrial uses. Some industrial uses could continue to use fresh water and seawater for cooling purposes, where needed. Additionally, desalination would be an integral component of a diversified water source portfolio as a reliable option during drought and potential reductions in ground water availability, as an alternative water supply to inter-district transfers, and, paired with renewable energy projects, as a cost-competitive source for domestic water demands.

Stormwater reuse could also be considered as part of flood control measures that detain storm flows, although the regular use of surface water is still not a feasible option due to the unreliable nature of the one perennial stream in ‘Ewa. The following bullets describe how ‘Ewa could adopt a sustainable water supply strategy.

- **Water Conservation Practices and Programs** are expected to reduce ‘Ewa District per capita water use from 185 GPCD to 160 GPCD. In the Ultimate-Growth Scenario it is anticipated that regional build-out will result in almost 260,000 residents, with about 240,000 relying upon service from BWS. If ‘Ewa is able to reduce its per capita demand to 160 GPCD, BWS water demand would be 38.9 MGD, **6 MGD LESS than the estimated BWS municipal demand at 2010’s per capita demand of 185 GPCD.**
- **Potable water** would still be supplied from **ground water wells** within the ‘Ewa District and from the sources in Central O‘ahu that are currently serving ‘Ewa.
- BWS plans to supplement potable water from ‘Ewa aquifers with **up to 5 MGD of DESALINATED WATER** as regional build-out reduces the need for additional water imports from Central O‘ahu.
- Water for non-potable industrial and irrigation water uses could be provided by **15 MGD or more of RECYCLED WATER**. However, in order to adequately provide for a large increase in demand, BWS would have to upgrade the capacity of the existing Honouliuli WRF and install the transmission and storage infrastructure needed to expand service.

3.6 Climate Change

The BWS watershed management plans that have been adopted as of 2015 have not addressed the complex issues of climate change, sea level rise, and adaptation to climate change impacts. Research on climate change and sea level rise appear to be growing at an exponential rate – in the United States and in many other countries. There are, of course, skeptics who contend that climate change is not really happening or that climate change is a normal cyclic process that is unrelated to the increases in “greenhouse gases” caused by burning of fossil fuels.

While recognizing that there are skeptics, BWS has adopted a “precautionary” position on climate change impacts and issues. Thus the ‘Ewa Watershed Management Plan addresses climate change and adaptation to climate change from the position that these changes are real and require clear policy and planning responses.

The details of climate change in the Pacific Region are provided in other documents (see for example “Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 8. Climate of the Pacific Islands,” NOAA January 2013). For the purposes of the EWMP, we note the following excerpts from the NOAA report for the Pacific Region:

- “Average annual temperature has generally increased over the past 50-90 years. In Hawai‘i, high elevation stations have been warming faster than low elevation stations over the past 30 years;
- There has been a decline in northeast trade wind frequency in Hawai‘i since 1973;
- Precipitation has trended downward over the past 100 years in Hawai‘i;
- Hawai‘i has experienced a trend toward increasing drought during the winter rainy season.”

The focus here is on the probable impacts of climate change on Hawai‘i water resources, so “all” of the potential impacts are not summarized. What is documented are the impacts of climate change on water resources as identified in a number of recent publications, notably the “National Water Program 2012 Strategy: Response to Climate Change” (EPA December 2012).

- **Decrease in potable water supplies** due to increased frequency, severity and duration of droughts; increase in evaporation; decrease in cloud cover and high level rainfall; decrease of fog drip at higher elevations, decrease in recharge of ground water aquifers, salt water intrusion into fresh and brackish water aquifers, and overall decrease in the sustainable yields of island aquifers;

- **Increase in potable and non-potable water demand** for municipal and agricultural uses due to increases in temperatures, increases in evapotranspiration and longer and more frequent droughts; “spikes” in Hawai‘i’s population growth due to migration from inundated Pacific islands;
- **Decrease in the base flow of Hawai‘i streams** due to decreases in rainfall and decreases in fair weather flows from springs and seeps from high level aquifers;
- **Decrease in the health and diversity of nearshore aquatic ecosystems** due to the increase in destructive coastal storm events and a decrease in the fair weather flow of fresh water into coastal waters;
- **Impacts on infrastructure** due to more extreme weather events, including heavier precipitation from Kona storms and tropical cyclones, and associated inland and coastal flooding; increased corrosion of metallic pipelines resulting in more main breaks and higher repair and replacement costs;
- **Increases in pollution of streams and nearshore waters** due to warmer air and water temperatures and changes in precipitation patterns, causing an increase in “impaired” water bodies, with associated impacts on the health of people and of aquatic ecosystems;
- **Collective and compounded impacts on coastal areas** resulting from a combination of sea level rise, increased damage from storms and floods, coastal erosion, salt water intrusion into potable water aquifers, ground water inundation of low lying coastal communities, and increased temperature and acidification of the ocean;
- **Indirect impacts** due to unintended consequences of human responses to climate change, such as those resulting from armoring shorelines, which may in turn increase the erosion of nearby sand beaches; increased development pressures on inland agricultural lands as coastal communities “retreat” from no longer habitable coasts; and
- **Large increases in the costs of water supply infrastructure and flood mitigation measures** due to this complex array of climate change impacts on water systems.

These expected impacts of climate change on water resources will be particularly severe for a leeward area like ‘Ewa, with its relatively hot, dry climate and dependence on water resources from aquifers that lie in neighboring districts.

ADAPTATION to climate change has only recently begun to be an important focus for scientists and planners. The basic premise underlying strategies for adaptation to climate change is: “The climate IS CHANGING. Impacts from climate change ARE ALREADY BEING EXPERIENCED. The severity of these impacts WILL INCREASE in the future. Government and private sector entities have to find ways of ADAPTING their planning and development activities to these new climatic and environmental realities.” However, review of the available literature on adaptation to climate change has generally found broad statements of general strategies – “…leverage capital improvement funds to develop water and wastewater infrastructure designed to be resilient to the effects of climate change.” – and very few specifics.

Strategies for adaptation to climate change that may be particularly important for ‘Ewa include the following:

1. Assume and plan for steadily declining SUSTAINABLE YIELDS for ground water aquifers that provide potable water for the ‘Ewa community.
2. Recharge brackish water aquifers with recycled water and/or with treated stormwater so that brackish water aquifers can continue to provide water for non-potable water uses.
3. Incrementally increase the use of brackish water and recycled water in place of potable ground water for uses/users that do not require potable water, including the use of recycled water or grey water for non-potable domestic uses.
4. Continue and improve BWS water conservation programs so that per capita use of water – and especially per capita use of potable water – continues to decline, even as the ‘Ewa District continues to develop.
5. Develop designs for small scale desalination plants that can produce 1 to 3 MGD utilizing photovoltaic or other alternate energy technologies and non-polluting disposal of brine wastewater.
6. Use desalinated water as a drought-proof water source in order to reduce withdrawals from stressed ground water aquifers.
7. “The Rain Follows the Forest” – The BWS, together with major land owners and businesses in ‘Ewa and in other districts, should provide ongoing funding for the incremental restoration and improvement of important O‘ahu watersheds. This ongoing watershed improvement program will maintain and restore high elevation forests, potentially increasing, or at least maintaining, ground water supplies, stream flows, and the input of fresh water into nearshore ocean waters.
8. Long-range planning: 10 to 30 years out – plan for the REDUCTION of pumpage of dike aquifers such as in Ko‘olau Poko and Wai‘anae that are strongly related to base stream flows and/or critical fresh water flows to coastal waters.

The ‘EWA WATERSHED MANAGEMENT PLAN includes projections for water demands for the district at “full build-out”: approximately 78 million gallons per day. This projected water demand is 182% of the estimated 2010 ‘Ewa District water demand of 42 MGD.

The EWMP also presents strategies, opportunities and projects that will enable the BWS and other water purveyors in ‘Ewa to provide non-potable brackish and recycled water for much of ‘Ewa’s future water needs. Large population increases and the conversion of thousands of acres of agricultural land to urban uses, coupled with the impacts of climate change, will result in ever increasing stresses on regional water resources and water infrastructure. However, despite these severe stresses, the ‘Ewa District can serve as a model for balanced water resources planning and non-potable water use that can provide guidance to other urbanizing areas of Hawai‘i, including areas like Kona on Hawai‘i Island and Wailuku-Kahului on Maui.

Overall, the BWS will continue to partner with UH Mānoa and other organizations to research the impacts of climate change and to design adaptation strategies and projects that will support the BWS mission of providing safe and dependable water at affordable costs.

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CHAPTER 4

PLAN OBJECTIVES, WATER SUPPLY AND WATERSHED MANAGEMENT PROJECTS AND STRATEGIES

‘EWA WATERSHED MANAGEMENT PLAN

4 PLAN OBJECTIVES, WATER SUPPLY AND WATERSHED MANAGEMENT PROJECTS AND STRATEGIES

4.1 OVERALL GOAL, OBJECTIVES, AND SUB-OBJECTIVES OF THE EWMP

This Chapter presents three elements of the ‘Ewa Watershed Management Plan:

1. Overall GOAL, OBJECTIVES, and SUB-OBJECTIVES of the EWMP
2. Watershed Management Projects and Programs that have "Project Champions"
3. More general Watershed Management Strategies

In order to provide planning consistency, all of the O‘ahu Watershed Management Plans have the same general GOAL and the same five MAJOR OBJECTIVES. The overall GOAL and the major OBJECTIVES are based on the framing federal, state and city laws and policies and through a community involvement process that are listed in Chapter 1 of this plan. More detailed SUB-OBJECTIVES, derived from an analysis of watershed issues and stakeholder values, reflect the unique resources and needs of each planning district.

The overall GOAL of the O‘ahu Watershed Plans is:

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

The five MAJOR OBJECTIVES that are common to all of the Oahu Watershed Management Plans are:

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 cost

The ‘Ewa-specific SUB-OBJECTIVES then provide the planning framework for organizing specific water supply and watershed management PROJECTS and PROGRAMS, which are presented in detail in this chapter. The FIVE M AJOR OBJECTIVES and related SUB-OBJECTIVES are listed below. A brief description of the district-specific issues that were the basis for each SUB-OBJECTIVE is also provided.

OBJECTIVE #1: PROMOTE SUSTAINABLE WATERSHEDS

Sub-Objective 1.1 Maintain and restore the high elevation forests within the State Conservation District. The DLNR Division of Forestry and Wildlife (DOFAW), private conservation organizations like the Nature Conservancy and the Sierra Club and local environmental entities like the Wai‘anae Mountains Watershed Partnership and the Mālama Learning Center are strong advocates of conservation and restoration projects and activities in the mauka forest lands of ‘Ewa and other districts of O‘ahu. These forests have been degraded by feral pigs and goats and by non-native and invasive plants – to the point where the native dry and mesic forests have almost entirely disappeared. Degraded forests in turn have resulted in more erosion and storm runoff, less water infiltration and less ground water recharge, lower base flow of streams and less fresh water seepage into nearshore waters.

Sub-Objective 1.2 Protect native plant and wildlife habitat. In the Wai‘anae Mountains, natural habitats for native plants and animals have been almost totally destroyed. The U.S. Army Environmental Division has installed a number of “enclosure” fences in these mountains to protect small stands of endangered native plants. More extensive mapping and habitat restoration projects are needed.

Sub-Objective 1.3 Mitigate the impact of planned development within the Community Growth Boundary. Approximately 70% of the land area of the ‘Ewa District is within the “Community Growth Boundary,” and is thus already urbanized or is planned for development. Community members and organizations that are concerned with long-term sustainability and environmental health for ‘Ewa advocate standards and best management practices that will mitigate the environmental and social impact of urbanization.

Sub-Objective 1.4 Provide for agricultural water needs, taking into account the location of agricultural lands over either the potable or non-potable water aquifers. Agriculture within the Community Growth Boundary in ‘Ewa is expected to be almost entirely relocated within the next 20 years. Maximization of the remaining agricultural areas along Kunia Road and within the West Loch Naval Munitions Command should be supported to contribute toward Hawai’i’s food security. Kunia Road farms are located over potable aquifers, so irrigation water must be free of pollutants. Agricultural areas in the West Loch area are not located over potable aquifers, so there would be less concern about agricultural water quality in these areas.

Sub-Objective 1.5 Retain drainage ways as natural, rather than concrete channels. ‘Ewa has natural dry streambeds – or large gulches – that not only convey stormwater but also provide green corridors and open space connectivity from mauka to makai.

OBJECTIVE #2: PROTECT AND ENHANCE WATER QUALITY AND QUANTITY

Sub-Objective 2.1 Maximize ground water infiltration. Climate change may reduce average annual rainfall throughout the Hawaiian Islands, especially in leeward areas, thus shrinking ground water aquifers. To counter this climatic trend, programs and projects are needed that will improve mauka forest lands and thus increase the rate of natural ground water infiltration.

Sub-Objective 2.2 Conserve and reuse water to make the most efficient use of district water supplies and reduce the amount of effluent that is disposed of offshore. The ‘Ewa District has a limited supply of potable ground water within its boundaries. Thus, water conservation programs and water recycling/reuse are of special importance to ‘Ewa.

Sub-Objective 2.3 Implement regional drainage plans to mitigate flooding and reduce point and non-point source pollution of the ocean and Pearl Harbor. During heavy rains, flood waters sheet flow over the ‘Ewa plain, flooding lower lying areas and carrying pollutants into nearshore waters. Well-designed regional drainage/flood mitigation plans are needed to reduce these flooding and non-point source pollution risks.

Sub-Objective 2.4 Protect the quality of the potable water aquifers. Urban and agricultural uses can cause pollution of ‘Ewa’s very important potable water aquifers. Land uses within the ground water capture zones of potable water wells should be carefully planned.

Sub-Objective 2.5 Sustain the water quality of the brackish caprock aquifer. Wastewater from industrial and domestic sources is being injected or is leaking into the upper caprock aquifer, which is being used as a source of brackish irrigation water. This brackish water also eventually seeps into nearshore waters. Polluting uses should therefore be monitored and, where necessary, curtailed.

OBJECTIVE #3: PROTECT NATIVE HAWAIIAN RIGHTS AND TRADITIONAL AND CUSTOMARY PRACTICES

Sub-Objective 3.1 Preserve and provide access to sites and resources in ‘Ewa that are important to Native Hawaiian cultural practices. While ‘Ewa has been identified as the secondary growth district of O‘ahu, we must work to protect the important cultural sites and resources of the district, like the ancient Hawaiian villages at Kalaeloa and Hoakalei.

Sub-Objective 3.2 Protect the gathering of natural resources in the ‘Ewa coastal zone by understanding the roles that fresh water and land use play in the health of nearshore waters. The nearshore waters and reefs of ‘Ewa Beach were once renowned for their ocean resources, including limu and many species of fish. Recent intensive development of the ‘Ewa Plain is suspected of increasing non-point source pollution to nearshore waters, reducing the seepage of fresh water, and impacting the natural productivity of the ‘Ewa coastal zone. Measures are needed to understand the relationships between land uses and water flow and quality enabling the restoration of natural productivity to these waters.

OBJECTIVE #4: FACILITATE PUBLIC PARTICIPATION, EDUCATION, AND PROJECT IMPLEMENTATION

Sub-Objective 4.1 Provide opportunities for the community to participate in the management of ‘Ewa’s cultural and natural resources. Public education and community involvement are needed to protect and manage ‘Ewa’s land and water resources. ‘Ewa’s public schools, UH West Oahu and organizations like the Mālama Learning Center can be leaders in this important area of community education and involvement.

Sub-Objective 4.2 Provide opportunities for the community to learn about water resources and how to protect them. With a population projected to exceed 170,000 by the year 2035 – about equal to the 2010 population of the entire Island of Hawai‘i - the ‘Ewa District’s water demands by 2035 will be in the range of 50 MGD or more for domestic, industrial, irrigation, and agricultural water. Educating the community about the importance of water conservation and water resources protection will be of critical importance for all.

Sub-Objective 4.3 Collaborate amongst government agencies, non-profit entities and community organizations on issues relating to ‘Ewa’s long-term land and water resources future. All sectors of the ‘Ewa community will need to communicate and work together to understand natural resources and land use issues, and to agree on strategies and programs to shape a sustainable future for ‘Ewa.

OBJECTIVE #5: MEET PUBLIC WATER DEMANDS AT REASONABLE COST

Sub-Objective 5.1 Provide adequate and diverse water supplies for ‘Ewa’s urban and agricultural growth. Potable water aquifers within the ‘Ewa District have a limited sustainable yield. Other water sources, including recycled water, brackish water, grey water and desalinated water, as well as ongoing water conservation programs, will be needed for ‘Ewa to sustain future growth and economic development. BWS plans for their ‘Ewa water systems include bringing on line the 10 MGD ‘Ewa Shaft, increasing the capacity of their ‘Ewa Water Recycling Facility, and expanding the recycled water storage and distribution system.

Sub-Objective 5.2 Improve the efficiency of the water delivery system. System delivery efficiency is about energy efficiency; water loss control; reducing corrosion, settlement, and pressure spikes that cause main breaks; and demand side management programs that maximize ‘Ewa’s water supply reducing the need to import water from Central O‘ahu.

Sub-Objective 5.3 Research climate change impacts and pursue adaptation and infrastructure resiliency strategies. The many potential impacts of climate change, which may include drought, flooding and sea level rise, are not yet well understood. Public and private infrastructure managers – for roads, drainage, electrical power, potable water, non-potable water, agricultural water, wastewater – will need to develop adaptation strategies as climate change continues to unfold.

Sub-Objective 5.4 Incorporate renewable energy and energy efficiency strategies into all water systems. The production of electrical energy, except for photovoltaic systems, requires water; potable and non-potable water systems require electrical energy for extraction, storage and transmission. Renewable energy and energy efficiencies are thus critical for the future of public and private water systems in ‘Ewa.

Sub-Objective 5.5 Sustain the brackish caprock aquifer. The caprock aquifer is becoming more salty due to less rainfall and also due to the closure of the O‘ahu Sugar Company. Recharging of this aquifer with R-2 recycled water may be possible.

4.2 WATERSHED MANAGEMENT PROJECTS AND PROGRAMS WITH “PROJECT CHAMPIONS”

Several projects, programs, and strategies were identified to meet the objectives and sub-objectives of the ‘Ewa WMP. “Projects with Champions” are those that have an identified lead agency or organization that is proposing, planning, or already implementing the project. These projects are summarized in project descriptions that include the following:

- Issue
- Location
- Background
- Project Champion and Partners
- Project Goals
- Strategies
- Project Status
- Estimated Cost Range
- References

‘EWA WATERSHED MANAGEMENT PROJECTS WITH CHAMPIONS

1 Honouliuli Water Recycling Facility
2 Caprock Aquifer Storage and Recharge (ASR)
3 Brackish and Seawater Desalination
4 Waiāhole Ditch Water Loss Minimization
5 Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway
6 Water Infrastructure for Navy ESQD Zone
7 Kalaeloa Water System Improvements
8 Kalaeloa Heritage Park
9 Hoakalei Coastal Village Restoration
10 Mālama Learning Center
11 Anchialine Pool Restoration
12 Wai‘anae Mountains Watershed Partnership
13 Potable Source Water Protection (BWS “System-Wide” Project)
14 Assess Resiliency of Critical Water Infrastructure (BWS “System-Wide” Project)
15 BWS Infrastructure Renewal and Replacement Program (BWS “System-Wide” Project)

As distinct from “Projects with Champions,” the “Watershed Management Strategies” are defined as ideas for action that would help to implement EWMP objectives but that do not current time have a project champion.

‘EWA WATERSHED MANAGEMENT STRATEGIES

A Waiāhole Ditch Augmentation

B Brackish Well Development

C Industrial Cooling Using Seawater

D Grey Water Reuse

E Kalo‘i Gulch Regional Drainage Plan Evaluation

F Stormwater Retention/Detention – including golf course detention

G Renewable Energy Opportunities

H ‘Ewa Caprock District Cooling

I Convert Cesspools to Municipal Sewer System

J Integrate Planning for Land Use and Water Resources Management

K ‘Ewa Sustainability Dialogues

L Potable Source Water Protection

These projects, programs, and strategies are presented in the following tables and are organized by:

- The 5 MAJOR OBJECTIVES
- Important Community and Agency VALUES or ISSUES that were documented during the stakeholder consultation process;
- ‘Ewa-specific SUB-OBJECTIVES that flow from an understanding of these VALUES and ISSUES and reflect desired outcomes specific to ‘Ewa;
- PROJECTS and STRATEGIES that will implement specific SUB-OBJECTIVES. PROJECTS include ‘Ewa-specific projects and a number of “BWS system-wide” projects.

Several “Projects with Champions” and “Watershed Management Strategies” accomplish more than one sub-objective and are thus listed multiple times in the Table.

OBJECTIVE #1 Promote Sustainable Watersheds

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Growth and development is destroying our natural resources. Protect important natural and cultural sites and resources in ‘Ewa. Protect and enhance water at the source: watersheds.	1.1 Maintain and restore the high elevation forests within the State Conservation District	10 Mālama Learning Center 12 Waiʻanae Mountains Watershed Partnership
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Protect important natural and cultural sites and resources in ‘Ewa.	1.2 Protect native plant and wildlife habitat	10 Mālama Learning Center 12 Waiʻanae Mountains Watershed Partnership
Ensure that there will be enough water for ‘Ewa in the future. Prioritize water conservation. The ‘Ewa caprock aquifer is getting saltier.	1.3 Mitigate the impact of planned development within the Community Growth Boundary	1 Honouliuli Water Recycling Facility 3 Brackish and Seawater Desalination 14 BWS Infrastructure Renewal and Replacement Program D Grey Water Reuse L Potable Source Water Protection
Ensure that there will be enough water for ‘Ewa in the future. Protect the quality of potable water supplies from overlying land uses, including previous agricultural uses. Investigate stormwater runoff as a source of irrigation water.	1.4 Provide for agricultural water needs, taking into account the location of agricultural lands over either the potable or non-potable water aquifers	1 Honouliuli Water Recycling Facility 2 Caprock Aquifer Storage and Recharge 4 Waiāhole Ditch Water Loss Minimization 5 Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway 6 Water Infrastructure for Navy ESQD Zone B Brackish Well Development F Stormwater Retention/Detention

OBJECTIVE #1 Promote Sustainable Watersheds (Continued)

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Non-point source pollution is impacting water quality.	1.5 Retain drainage ways as natural, rather than concrete channels	E Kaloʻi Gulch Regional Drainage Plan Evaluation

OBJECTIVE #2 Protect and enhance water quality and quantity.

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
The ʻEwa caprock aquifer is getting saltier. Protect and enhance water at the source: watersheds.	2.1 Maximize ground water infiltration.	2 Caprock Aquifer Storage and Recharge
Growth and development is destroying our natural resources. Prioritize water conservation.	2.2 Conserve and reuse water to make the most efficient use of district water supplies and reduce the amount of effluent that is disposed of offshore.	1 Honouliuli Water Recycling Facility 2 Caprock Aquifer Storage and Recharge 6 Water Infrastructure for Navy ESQD Zone D Grey Water Reuse
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Non-point source pollution is impacting water quality. The urban lowlands continue to flood.	2.3 Implement regional drainage plans to mitigate flooding and reduce point and non-point source pollution of the ocean and Pearl Harbor.	E Kaloʻi Gulch Regional Drainage Plan Evaluation F Stormwater Retention/Detention – including golf course detention

OBJECTIVE #2 Protect and enhance water quality and quantity. (Continued)

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Growth and development is destroying our natural resources. Protect the quality of potable water supplies from overlying land uses, including previous agricultural uses.	2.4 Protect the quality of the potable water aquifers.	5 Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway I Convert Cesspools to Municipal Sewer System J Integrate Planning for Land Use and Water Resources Management L Potable Source Water Protection
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Prepare for climate change and sea level rise impacts on ground water. The ‘Ewa caprock aquifer is getting saltier.	2.5 Sustain the water quality of the brackish caprock aquifer.	2 Caprock Aquifer Storage and Recharge D Grey Water Reuse I Convert Cesspools to Municipal Sewer System J Integrate Planning for Land Use and Water Resources Management

OBJECTIVE #3 Protect native Hawaiian rights and traditional and customary practices.

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Growth and development is impacting our natural resources. The natural limu beds have been destroyed. Protect important natural and cultural sites and resources in ‘Ewa. Prioritize cultural and natural resources education for children. Non-point source pollution is impacting water quality.	3.1 Preserve and provide access to sites and resources in ‘Ewa that are important to Native Hawaiian cultural practices.	8 Kalaeloa Heritage Park 9 Hoakalei Coastal Village Restoration 10 Mālama Learning Center 11 Anchialine Pool Restoration
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Protect important natural and cultural sites and resources in ‘Ewa. Prioritize cultural and natural resources education for children. Non-point source pollution is impacting water quality.	3.2 Protect the gathering of natural resources in the ‘Ewa coastal zone by understanding the roles that fresh water and land use play in the health of nearshore waters.	2 Caprock Aquifer Storage and Recharge 9 Hoakalei Coastal Village Restoration 10 Mālama Learning Center 11 Anchialine Pool Restoration I Convert Cesspools to Municipal Sewer System J Integrate Planning for Land Use and Water Resources Management

OBJECTIVE #4 Facilitate public participation, education, and project implementation.

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Growth and development is destroying our natural resources. The natural limu beds have been destroyed. Protect important natural and cultural sites and resources in ‘Ewa. Prioritize cultural and natural resources education for children. Non-point source pollution is impacting water quality.	4.1 Provide opportunities for the community to participate in the management of ‘Ewa’s cultural and natural resources.	8 Kalaeloa Heritage Park 9 Hoakalei Coastal Village Restoration 10 Mālama Learning Center 11 Anchialine Pool Restoration K ‘Ewa Sustainability Dialogues
Growth and development is destroying our natural resources. Prioritize cultural and natural resources education for children. Non-point source pollution is impacting water quality.	4.2 Provide opportunities for the community to learn about water resources and how to protect them.	8 Kalaeloa Heritage Park 10 Mālama Learning Center 11 Anchialine Pool Restoration K ‘Ewa Sustainability Dialogues
The natural limu beds have been destroyed. Protect important natural and cultural sites and resources in ‘Ewa. Prioritize cultural and natural resources education for children. Non-point source pollution is impacting water quality.	4.3 Collaborate amongst government agencies, non-profit entities and community organizations on issues relating to ‘Ewa’s long-term land and water resources future.	10 Mālama Learning Center 11 Anchialine Pool Restoration 14 BWS Infrastructure Renewal and Replacement Program D Grey Water Reuse F Stormwater Retention/Detention J Integrate Planning for Land Use and Water Resources Management K ‘Ewa Sustainability Dialogues

OBJECTIVE #5 Meet public water demands at reasonable costs.

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Ensure that there will be enough water for ‘Ewa in the future. Increase greywater use at the household level. Investigate stormwater runoff as a source of irrigation water.	5.1 Provide adequate and diverse water supplies for ‘Ewa’s urban and agricultural growth.	1 Honouliuli Water Recycling Facility 2 Caprock Aquifer Storage and Recharge 3 Brackish and Seawater Desalination 4 Waiāhole Ditch Water Loss Minimization 5 Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway 6 Water Infrastructure for Navy ESQD Zone 7 Kalaeloa Water System Improvements A Waiāhole Ditch Augmentation B Brackish Well Development D Grey Water Reuse
Prioritize water conservation.	5.2 Improve the efficiency of the water delivery system.	4 Waiāhole Ditch Water Loss Minimization 14 BWS Infrastructure Renewal and Replacement Program
Ensure that there will be enough water for ‘Ewa in the future. Prepare for climate change and sea level rise impacts on ground water. Investigate stormwater runoff as a source of irrigation water. The ‘Ewa caprock aquifer is getting saltier.	5.3 Research climate change impacts and pursue adaptation and infrastructure resiliency strategies.	1 Honouliuli Water Recycling Facility 2 Caprock Aquifer Storage and Recharge 3 Brackish and Seawater Desalination 6 Water Infrastructure for Navy ESQD Zone 13 Assess Resiliency of Critical Water Infrastructure 14 BWS Infrastructure Renewal and Replacement Program A Waiāhole Ditch Augmentation C Industrial Cooling Using Seawater D Grey Water Reuse F Stormwater Retention/Detention – including golf course detention

OBJECTIVE #5 Meet public water demands at reasonable costs. (Continued)

Community or Agency Value or Issue	Sub-Objective (Policies)	Project/ Strategy
Water supply should consider energy efficiencies and renewable energy sources as means of minimizing costs and environmental impacts. Utilities should collaborate to maximize efficiencies in operations.	5.4 Incorporate renewable energy and energy efficiency strategies into all water systems.	1 Honouliuli Water Recycling Facility 3 Brackish and Seawater Desalination G Renewable Energy Opportunities H 'Ewa Caprock District Cooling
Prepare for climate change and sea level rise impacts on ground water. The 'Ewa caprock aquifer is getting saltier.	5.5 Sustain the brackish caprock aquifer.	2 Caprock Aquifer Storage and Recharge 6 Water Infrastructure for Navy ESQD Zone

PROJECT #01: Honouliuli Water Recycling Facility

Issue

As ‘Ewa continues to grow and develop, there will be an increased need for various kinds of non-potable water. The City will be upgrading its Honouliuli Wastewater Treatment Plant (WWTP) to full secondary treatment by 2024, potentially making the treated effluent available to the Honouliuli Water Recycling Facility (WRF) for production of Reverse Osmosis (R-O) and R-1 quality recycled water. Recycled water can be used for agriculture, irrigation of parks and golf courses, and industrial uses. The Honouliuli WWTP currently treats approximately 26 MGD of wastewater (*Update of the Hawaii Water Reuse Survey and Report, 2013*).

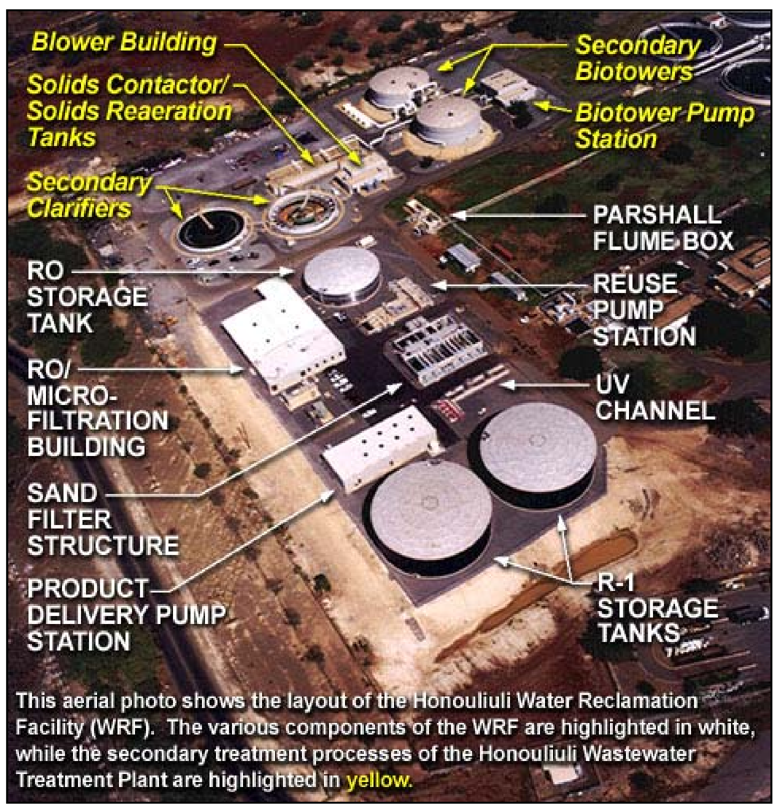
Location

The Honouliuli WRF is located on the site of the City’s Honouliuli WWTP on Geiger Road, about one mile west of the Geiger Road/Fort Weaver Road intersection.

Background

Recycled water is becoming increasingly important for urbanized areas of Hawai‘i, as well as for some resorts that are located in drier leeward areas with limited natural ground water resources. Use of recycled water must conform to the DOH’s *Reuse Guidelines* (2016). R-1 (tertiary disinfected) is the highest quality recycled water under the DOH guidelines and is approved for a variety of uses, including spray irrigation of food crops. R-2 (secondary disinfected) recycled water may be used for limited purposes and is usually applied using drip irrigation. R-O recycled water has been demineralized using reverse osmosis technology and is used for industrial process water for power plants and oil refineries.

DOH developed its original *Guidelines* in 1993 and updated them to stricter standards in 2002. The Honouliuli WRF was constructed in 2000 and complied with the 1993 DOH Guidelines. Therefore, the R-1 quality water produced at Honouliuli is unsuitable for some of the uses allowed under the 2002 Guidelines, for example, edible crops. Additional disinfection would be required to bring this water up to the 2002 standards for R-1 water.



Honouliuli Water Reclamation Facility

Currently, BWS operates the Honouliuli WRF, producing 2.0 MGD of R-O water and 10.0 MGD of R-1 water. The R-O water is pumped to Campbell Industrial Park. The R-1 water is pumped to users throughout ‘Ewa including West Loch Estates, Hoakalei Country Club, Campbell Industrial Park, and. As shown on the map, “Existing Recycled Water Infrastructure and Projects – Leeward O‘ahu,” there are a number of relatively new project areas that are planned to be added to this recycled water system. As ‘Ewa develops, there will be additional opportunities to design for recycled water use.

The existing Honouliuli WRF will need to be expanded as the demand for recycled water increases in the ‘Ewa District. According to the terms of the “2010 Global Consent Decree” between the U.S. EPA and the City, the Honouliuli WWTP is to be upgraded to full secondary treatment by 2024. The WWTP upgrade will produce higher quality effluent, which will increase the opportunity for expanded water reuse.

Project Champion and Partners

The Board of Water Supply will be the lead entity for the production and expansion of recycled water in the ‘Ewa District. The City’s Department of Environmental Management (ENV) is responsible for the upgrade of the Honouliuli WWTP to full secondary treatment. DOH streamlined and updated the *Reuse Guidelines* for recycled water in 2016. DPP will be adopting the 2012 UPC to allow for expansion of recycled water use.

Existing Recycled Water Infrastructure and Projects—Leeward O‘ahu

Project Goals

1. Preserve potable groundwater resources and recharge the ‘Ewa caprock with recycled water.
2. Expand R-1 capacity to meet ‘Ewa’s nonpotable water needs.
3. Improve R-1 quality for use on edible agricultural crops
4. Investigate and promote dual plumbing using recycled water in non-residential buildings
5. Identify and address existing barriers to recycled water use.
6. Provide at least 20% of ‘Ewa’s total water needs with recycled water at full build out.

Project Status

BWS is working to meet the recycled water project goals in the following areas:

1. Using $7 million in DOH State Revolving Funds loan program at an interest rate of 1% to construct a new UV disinfection and disk filter pretreatment system at Honouliuli WRF. The upgrade will increase R-1 capacity from 10 MGD to 14 MGD and reduce energy use by 60% from the current systems.
2. Adding photovoltaic systems to the Honouliuli WRF.
3. Planning for the new East Kapolei 215’ 3.0 million gallon recycled water reservoir to provide continuous pressurized R-1 irrigation water to areas along Kualakai Parkway, City of Kapolei and Campbell Industrial Park. Currently, R-1 water is not available when the distribution pumps are off.
4. Coordinating nonpotable water master plans with Kalaeloa and Hoʻopili developments to connect and utilize R-1 water for parks and roadway landscape irrigation. Hoʻopili is connecting to the R-1 system, adding R-1 distribution pipelines for irrigation and a 215’ R-1 reservoir.

Estimated Cost Range

BWS goal is that the recycled water systems must be economically self-sustaining and not subsidized through potable water revenues. Recycled water rates must be less than potable water rates to encourage expanded use, however, it must cover the cost of service, operations and maintenance, capital costs for infrastructure replacement. BWS will be revising its recycled water rates in their next financial plan and rate schedule update in 2017. The current estimate for future WRF system capital costs is $20,000,000.

References

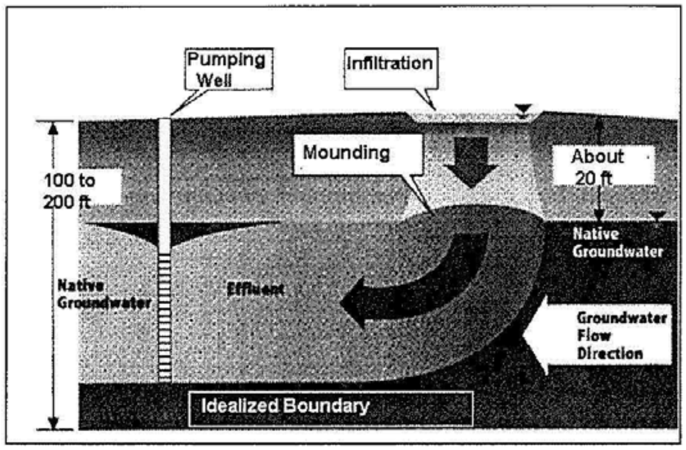
Hawaiʻi State Department of Health Wastewater Branch. January 2016. *Reuse Guidelines*.

Waiʻanae Watershed Management Plan, 2009.

PROJECT #02: Caprock Aquifer Storage and Recovery

Issue

The ‘Ewa caprock aquifer is getting saltier due to long-term pumping and less recharge than when the sugar plantations were irrigating and recharging it. With no mitigating action, the aquifer may become too salty to be used for irrigation.



Schematic of recharge-pumping scheme proposed for the ‘Ewa caprock

Location

The Pu‘uloa and Kapolei Aquifer System Areas (ASYA) are caprock aquifers with at least a portion of their areas located within a two-mile radius of the Honouliuli Water Recycling Facility (WRF). The Pu‘uloa and Kapolei ASYAs also have the second and third highest permitted use (PU) for brackish wells in ‘Ewa. The Malakole ASYA has the highest PU for these types of sources but users of this ASYA primarily pump high salinity brackish water for cooling and would not need fresher water sources.

Background

The ‘Ewa Caprock aquifer is recharged in part by leakage from the basal aquifer and irrigation over it. Sugar plantations began operations in the ‘Ewa plain in the late 1800s and early 1900s and were highly productive, thanks to irrigation from ground water wells. Basal wells were initially tapped for irrigation, followed by caprock wells, but over time, both basal and caprock wells became saltier. The caprock aquifer has shrunk and shown an increase in salinity since the sugar plantations closed and no longer irrigate the area. If nothing is done, the caprock aquifer will become saltier over time and may become unsuitable for irrigation at current pumping levels. The Water Commission through its water use permit system limits pumping levels by a chloride limit of 1,000 parts per million (ppm) which is considered the upper limit of salinity for tolerance by landscaping and certain agricultural crops.

Ground water in this area could be recharged and “freshened” using recycled water. The 2016 DOH “*Reuse Guidelines*” show that most of ‘Ewa is “unrestricted” in terms of recycled water use. Some municipalities on the U.S. mainland already use recycled water for aquifer storage and recharge (ASR) and some even use highly treated recycled water to recharge potable aquifers.

The Honouliuli WRF currently has the capacity to produce about 12 million gallons per day (MGD) of recycled water (two MGD of R-O water and 10 MGD of R-1 water). The City is required by a Global Consent Decree to upgrade wastewater treatment at the Honouliuli Wastewater Treatment Plant to full secondary treatment by 2024. This would make at least 26

MGD of secondary treated effluent available for recycling at the Honouliuli WRF, 16.5 MGD more than is currently being used. The City is planning for full secondary treatment with activated sludge process, which removes more nutrients than the current trickling filter process, resulting in lower levels of nutrient loading. This, along with natural filtration through the caprock formation, would result in is lower chances of algal blooms in nearshore waters from discharged WWTP effluent. Additionally, ground water modeling can establish thresholds for application of treated wastewater to account for maximum use of the recharge for irrigation prior to reaching the coast.

Project Champion and Partners

BWS owns the Honouliuli WRF and has an interest in sustaining existing non-potable ground water use in the Pu‘uloa and Kapolei aquifers, such as ‘Ewa Gentry and Kapolei Villages, in order to avoid costly recycled water distribution infrastructure to areas not currently served and will preserve potable ground water for potable uses. ENV would be a logical partner in this project in that they own the Honouliuli WWTP and would benefit from productive reuse of the treated effluent, rather than having to dispose of it through the existing offshore outfall. The Department of Health has regulatory oversight of the use of recycled water and should be consulted on appropriate design of the project.

Project Goals

- Augment ‘Ewa’s caprock aquifer to prevent salinity increases and maintain water quality over the long term for non-potable use, thus reducing the cost of additional recycled water distribution systems and freeing up potable ground water for drinking and domestic use.
- Recharge and store treated recycled water for future use by caprock aquifer users instead of discharging it offshore.

Strategies

Generate Supply

- Expand Honouliuli WRF to accept additional secondary treated wastewater from the Honouliuli WWTP (see Project 1).
- Add a UV disinfection process to treat secondary effluent to R-2 quality. Utilize renewable energy such as PV and methane power generation to reduce the energy cost associated with UV treatment.

Recharge Trenches

- Recharge trenches were planned in the 1990’s around the Honouliuli WWTP prior to and as an alternative to developing the Honouliuli WRF and could be re-evaluated. Trenches would take up less land area than large spreading basins to percolate recycled water into the caprock aquifer. The City ENV has acquired additional lands around the Honouliuli WWTP expanding the possible location of recharge trenches. Phase I: utilize an existing ‘Ewa caprock groundwater model previously constructed for the ‘Ewa Marina to model location of recharge trenches, application rates and withdrawal sites and rates. Application rates should not exceed withdrawal rates by a large margin to minimize leakage to nearshore waters.
- Phase II: Conduct a feasibility study of infrastructure and disinfection/treatment costs and benefits, financing, renewable energy options and develop an EIS. DOH Clean Water State Revolving Fund (SRF) low interest loan funding could be made available for green infrastructure projects. If feasible, proceed to design and construction.

Project Status

The Honouliuli WWTP will be upgraded to full secondary treatment by 2024, producing about 26-28 MGD of additional treated wastewater that could be recycled. Additionally, they will be converting to activated sludge to reduce nutrient loading. The Honouliuli WRF is being considered for expansion to accommodate future recycled water demand and to handle additional treated wastewater from the WWTP. Aquifer storage and recovery could substantially increase the amount of recycled water use in ‘Ewa.

Estimated Cost Range

[If pursued, a feasibility study would determine estimated costs]

References

Hawai‘i State Department of Health Wastewater Branch. January 2016. *Reuse Guidelines*.

Kumagai, James S., Ph.D., P.E. 1996. Final Report. Recommendation for Water Reclamation Nonpotable Water Plan for Oahu. Prepared for the Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawaii and The Department of Wastewater Management, City and County of Honolulu.

The Limtiaco Consulting Group. July 2013. *2013 Update of the Hawaii Water Reuse Survey and Report*. Prepared for the Department of Land and Natural Resources Commission on Water Resource Management.

PROJECT #03: Brackish and Seawater Desalinated Water for ‘Ewa

Issue

Climate models indicate that while wet areas of the islands will become wetter, the dry areas will become drier. Desalinated water may be needed to meet ‘Ewa’s projected water needs during droughts and to reduce water imports from Central O‘ahu, making the ‘Ewa District more source sustainable as ‘Ewa nears “full build-out.” However, given the relatively high capital and operating costs of desalination, the BWS strategy is to start small and prove the feasibility of producing desalinated water through the use of alternative energy technologies like photovoltaics.

Location

BWS owns two sites planned for desalination. A seawater desalination facility is planned on a 20-acre site located on Olai Street in Campbell Industrial Park TMK 9-1-031:028 and a brackish desalination facility on three acres in Kapolei on U‘u Place in Kapolei Business Park, TMK 9-1-75:53, the site of the State’s demonstration desalination facility.

Background

Desalination of seawater and brackish water through reverse osmosis exists in many areas around the world and desalination technology has advanced significantly in recent years. BWS acquired 20 acres of land from the Federal government through a public conveyance in early 2000 as part of the Barber’s Point naval base closure. BWS has to use this property for its intended use, a desalination facility by 2020, or later if another extension is granted, or face having to purchase the property. BWS conducted a successful feasibility study and EIS for the facility and has installed a source and an injection well for brine disposal and piloted a desalination process in the mid-2000’s.

In the 1990’s the State DLNR constructed and operated a 1.0 MGD brackish water desalination facility what is now the Kapolei Business Park. In the mid-2000’s BWS acquired the land and facility and plans on constructing a brackish desalination facility at this site in the future.

Most desalination facilities on O‘ahu are small and limited to demineralizing potable water for industrial boiler feed for power plants and refineries in Campbell Industrial Park. BWS uses R-O membranes to desalinate recycled water at Honouliuli WWTP to replace the potable water that would otherwise be used for these industrial uses. In 2006, 1.5 MGD of potable water was replaced with R-O recycled water for industrial use.

Some local bottled water companies use R-O membranes to further filter potable water for drinking and some home filtration systems employ R-O membranes. Desalinated water is of very high quality as the success of the bottled water industry indicates. There are at present no large-scale desalination facilities on O‘ahu for drinking water, but brackish water desalination exists at some resorts on the Kohala coast of the Big Island and Maui is planning a facility in South Maui.

BWS has selected seawater desalination as a long-range sustainable water supply option to meet the large increase in demand as the ‘Ewa District approaches full build-out. Desalinated water can also be an important drought mitigation strategy: use of desalinated water during periods of drought with a parallel reduction in ground water pumpage would allow ground water sources to stabilize and be conserved. The quality of the desalinated water will be controlled by a post-treatment process that will add back minerals to match the mineral content of existing ground water supplies to avoid water quality issues within the aging distribution system. There will also be no risk of contamination from pesticides or fuel releases.

Project Champion and Partners

BWS will be the lead entity for the planning, design, construction and operation of this facility.

Project Goals

- Provide high quality potable water to meet the water needs of the ‘Ewa District during periods of drought, reduce water transfers from Central Oahu to ‘Ewa and provide a sustainable supplemental water supply at full build-out.

Project Status

The final design and construction of the Kalaeloa seawater desalination plant has been deferred 17 years from 2003 to 2020 through a successful water conservation program that reduced per capita demand in ‘Ewa. However, urban growth continues to increase and is approaching the capacity of existing BWS wells in ‘Ewa. A post treatment study is on-going and is the last planning step before design is pursued, estimated in 2017.

A 1.0 MGD seawater R-O treatment plant is planned, downsized from previous plans, but will be scalable for future expansion. Since Campbell Industrial Park consumes about 3 MGD of potable water, desalinated water from the proposed Kalaeloa facility will be fully consumed within the park.

This facility will utilize R-O membrane filtration to filter high quality basal seawater from deep wells into fresh water. The brine concentrate will be injected into caprock wells below and not impacting the benthic environment of the nearshore, making ocean outfalls unnecessary. Some or all of the electrical power needed for the desalination process may be provided through photovoltaics or other alternative energy technologies.

Estimated Cost Range

A BWS engineering feasibility study conducted in 2000, estimated that a 5 MGD seawater R-O desalination plant would cost about $40 M or $8/gallon in capital costs. A downscaled 1.0 MGD facility may cost $10 million and will be determined in design. The facility could use 1,000 kilowatts per 1.0 MGD of processed water. BWS may pursue more cost effective alternative delivery methods such as the successful design-build-operate-maintain contract financed through State SRF low interest loans.

Desalination costs are comparable to the costs for new ground water development, for example in North Shore including the cost of a new transmission system through Central O‘ahu to ‘Ewa. North water is planned for agriculture and Central Oahu water is needed for agriculture and urban growth there and in the Primary Urban Center. Regulatory, environmental, agricultural, social and cultural issues for further ground water development can add many layers of cost and complexity.

As new desalination technology advances, capital and operation and maintenance costs will decrease. R-O membranes have already become less expensive and have greater efficiencies than 20+ years ago when the State demonstration desalination plant was constructed. Energy recovery technology has also advanced greatly. A smaller “off the grid” Renewable Energy Desalination Plant may also be possible.

References

Oceanit Laboratories, Inc. September 2008. *Proposed Kalaeloa Desalination Facility Final Environmental Impact Statement*. Prepared for Honolulu Board of Water Supply.

Wai‘anae Watershed Management Plan (2009), PROJECT 08: DESALINATED WATER – FROM BWS KALAELOA DESALINATION PLANT.

PROJECT #04: Waiāhole Ditch Water Loss Minimization

Issue

The Waiāhole Ditch Irrigation System (WDIS) was built nearly 100 years ago to provide irrigation water for agriculture in Central O‘ahu and ‘Ewa, but leaks and permeable ditch linings result in water losses. Reductions in these losses would mean that more water could be available for agricultural irrigation. Additionally, expected reductions in rainfall frequency due to climate change emphasize the need to conserve water in all water systems. Reductions in water system losses will also bring the WDIS into compliance with Commission on Water Resource Management mandates to reduce seepage loss.

Waiāhole Ditch

Location

Reservoir Number 155 is located in the ‘Ewa District on land owned by Monsanto Corporation. It is 3.13 acres with a capacity of 15 million gallons. Reservoir Number 225 is in Central O‘ahu and is owned by the Robinson Kunia Land LLC. It is 2.54 acres in size and has a capacity of 10 million gallons. Both reservoirs are earthen, unlined storage basins with diminished capacities due to sediment accumulation.

Background

The WDIS was built between 1913 and 1925 by the Waiāhole Water Company to irrigate Oahu Sugar Company’s (OSCO) plantation in Leeward O‘ahu. It runs 26.3 miles from Kahana, Waikāne, and Waiāhole valleys through the Ko‘olau Mountains to Central O‘ahu and ‘Ewa and includes six ground water tunnels.

In 1993 OSCO announced the closure of its sugar plantation and in 1999 the Agribusiness Development Corporation (ADC) purchased WDIS to maintain it as a water source for agriculture. ADC has a water use permit for 2.000 MGD to account for WDIS system losses, about 15% of the total permitted use. The Water Commission mandated ADC to reduce its system losses by 0.58 MGD by lining Reservoirs 155 and 225.

Project Champion and Partners

ADC is the owner of the WDIS and is the project champion. They are already partnering with the USACE in a cost-share agreement to design and implement improvements to the reservoirs. Landowners Monsanto Corporation (Reservoir 155) and Robinson Kunia Land LLC (Reservoir 225) have provided easements to ADC for work on the reservoirs.

Project Goals

- Bring ADC into compliance with Water Use Permit 862 that mandates a reduction in water loss of 0.58 MGD by lining both Reservoir 155 and Reservoir 225. ADC will then apply for a reduction in its current permitted use.
- Bring Reservoir 155 into compliance with dam safety regulations, which is particularly important given its “High Hazard” rating and potential for causing loss of life if it were to fail. Reservoir 225 is not under the same regulations as Reservoir 155, but will meet the same standards required of Reservoir 155.
- Minimize water losses to the extent practicable.

Strategies

Line reservoirs, conduct maintenance and improvements, and meet USACE and DLNR design criteria

- Remove sediment and debris buildup in the reservoirs;
- Line the reservoirs to eliminate seepage loss;
- Remove vegetation and repair deteriorating structures;
- Reduce size of Reservoir 155 to remove jurisdictional dam classification.

Minimize water losses

- Pipe the WDIS to reduce water loss through evaporation and operations and maintenance costs when foreign bodies clog the ditch.
- Install water meters at strategic locations to monitor use. Conduct regular water audits and identify potential losses, particularly as the system ages.

Estimated Cost Range

The latest estimate to improve Reservoir 155 and 225, including improvements to meet dam safety standards, was $7.5-$8 million in 2009 and will likely be higher in today’s dollars. The project requires a 65%-35% cost share between the Federal government and the State.

References

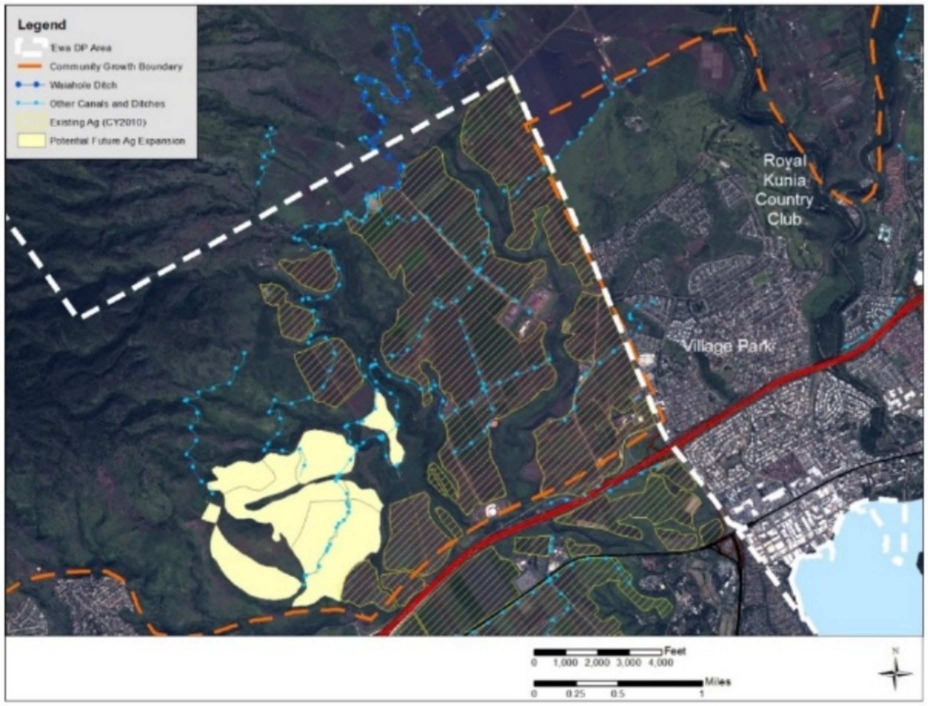
Request for Time Extension for Variable Water Use Permit for System Loss (WUP No. 851) for Waiāhole Ditch Irrigation System, Oahu, TMKs: (1) 9-2-001:001 and 9-4-003:001. Staff Submittal for the meeting of the Commission on Water Resource Management, May 21, 2008.

Application to Modify Water Use Permit for System Loss. Reduce System Loss Allocation to 2.000 MGD (WUP No. 862) and Request for Time Extension to Complete Reservoir Improvements to Further Reduce System Water Losses. Waiāhole Ditch Irrigation System, Oahu. Staff Submittal for the meeting of the Commission on Water Resource Management, May 021, 2009.

PROJECT #05: Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway

Issue

Expansion of agricultural lands mauka of the H-1 Freeway will require additional water sources, but cannot depend on the Waiāhole Ditch Irrigation System (WDIS), which has limited supply.



Agricultural Expansion Mauka of H-1 Freeway

Location

Abandoned reservoir and ditch systems used by the former sugar plantations mauka of the H-1 Freeway, particularly those that are on or adjacent to current and future areas of cultivation.

Background

The high cost of shipping and the movement for Hawai‘i to become increasingly food self-sufficient are expected to increase demand for farm land. In the ‘Ewa District, the area currently owned by the University of Hawai‘i at West O‘ahu (UHWO) is the only land outside of the Community Growth Boundary that could feasibly be returned to cultivation. The WDIS provides water to the active agricultural lands mauka of the H-1 Freeway, but any new request for a WUP will have to compete with agricultural uses in Central O‘ahu.

This land was previously cultivated in sugar, suggesting that it has somewhat fertile soils. The former plantations relied on reservoirs to store water from the extensive ditch system to irrigate their fields. Restoration of these reservoirs could provide storage for stormwater and unutilized WDIS water, thus supplying irrigation water for current and future agriculture in the ‘areas mauka of the H-1 Freeway.

Project Champion and Partners

ADC owns the WDIS and would have a major interest in this project, as part of its mission is, “to acquire, and manage in partnership with farmers, ranchers, and aquaculture groups, selected high-value lands, water systems, and infrastructure for commercial agricultural use…” Private landowners would be partners in this action that would benefit their lands.

Project Goals

Non-potable water sources are brought on-line to expand the cultivated area mauka of the H-1 Freeway, adding to the inventory of locally-grown produce and contributing to the island’s food self-sufficiency while preserving potable ground water for municipal uses. Historic agricultural reservoirs once used to irrigate this area are rehabilitated to hold stormwater and excess water from the WDIS during high-flow periods. The WDIS is extended to these reservoirs and a conveyance system of rehabilitated and/or new ditch systems is then used to irrigate crops using the water stored in the reservoirs.

Strategies

Extend the WDIS and rehabilitate old reservoirs

- Rehabilitate two historic reservoirs that once served the lands now owned by the UHWO. These reservoirs can also be used to capture stormwater to complement WDIS water.
- Restore the smaller irrigation ditches that previously transported water from WDIS to the sugarcane fields mauka of the H-1 Freeway.
- Pipe existing ditches to minimize water loss.

Recycled (R-1) Water

- If needed, pump R-1 water from the Honouliuli WRF to supplement WDIS and stormwater. If certain food crops are grown (with the exception of orchard crops), the Honouliuli WRF will need to be upgraded to meet current DOH Reuse Guidelines.
- R-1 irrigation within the capture zone of potable water sources must be avoided to prevent increasing their chloride content.

Ground Water

- If demand for recycled water increases, Waipahu WP 5, an existing, unused well that was previously used to irrigate sugarcane in the vicinity of the agricultural expansion area, could be rehabilitated. However, the ‘Ewa-Kunia aquifer is already 97% allocated. Significant use of Waipahu WP 5 would require revocation of existing permitted use.

Project Status

There is currently no initiative to restore the historic reservoirs and irrigation ditches. BWS already plans on pumping R-1 water to the vicinity of the H-1 Freeway to make it available for non-potable use over a wider area of ‘Ewa. Extending the availability of R-1 water to the potential agricultural expansion area projected in the “Ultimate Demand Scenario” would require a booster pump station and pipelines to the restored agricultural reservoirs in the area.

Estimated Cost Range

[If pursued, a feasibility study would determine estimated costs.]

PROJECT #06: Water Infrastructure for Agricultural Expansion in the Navy’s Explosives Safety Quantity Distance Zone

Issue

Expansion of agricultural lands in the Navy’s Explosives Safety Quantity Distance (ESQD) zone, approximately 1,202 acres of usable agricultural land, will require an additional water source and provides an opportunity to expand recycled water use.

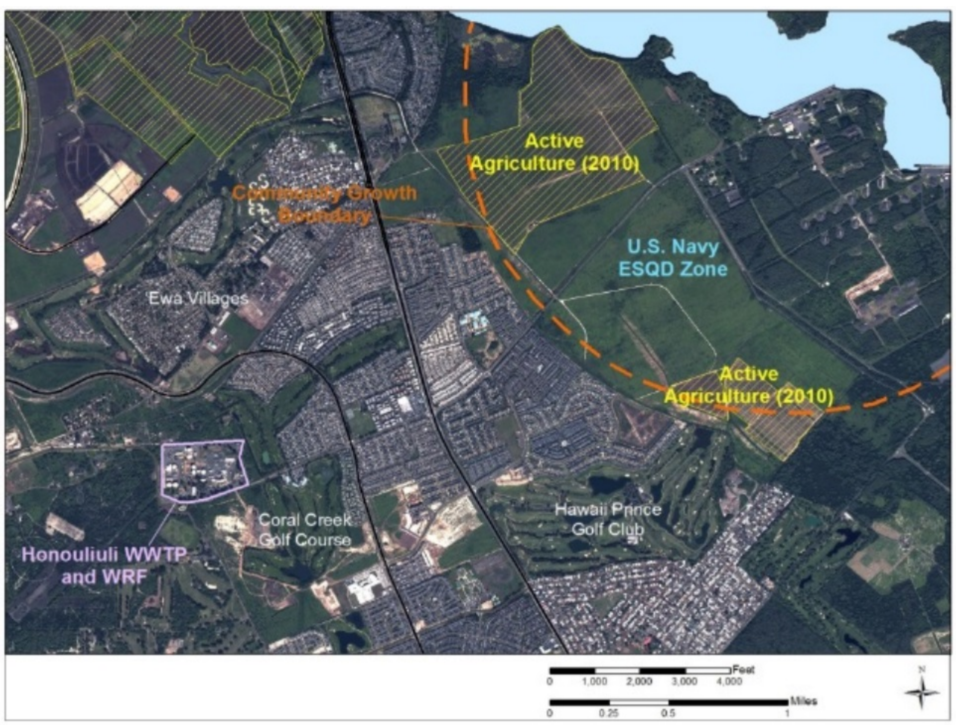
Location

The Navy’s ESQD zone within its Pearl Harbor Naval Complex, Navy Magazine Lualualei, West Loch Branch in Pu‘uloa.

Background

The high cost of shipping and the movement for Hawai‘i to become increasingly food self-sufficient is expected to increase demand for farm land. In the ‘Ewa District, there is limited space for agricultural expansion outside of the Community Growth Boundary. Makai of the H-1 Freeway, all agricultural land is expected to be converted to urban uses except for an agricultural component in the proposed Ho‘opili residential development project and land within the Navy’s ESQD zone.

The City is under a Global Consent Decree to achieve full secondary treatment of wastewater at its Honouliuli Wastewater Treatment Plant (WWTP) by 2024. The WWTP currently treats 26 MGD, which with the upgrades, could be available to the Honouliuli Water Recycling Facility (WRF) for production of either R-O or R-1 quality recycled water. This would potentially provide a large source of non-potable water as recycled water use in 2010 totaled 8.4 MGD (7.0 MGD of R-1 water and 1.4 MGD of R-O water).



Agricultural expansion area in proximity to Honouliuli WWTP

Project Champion and Partners

BWS owns the Honouliuli WRF, and would need to partner with the U.S. Navy to extend R-1 infrastructure into the ESQD and with the Navy’s lessee(s) who would purchase the R-1 water for crop irrigation. The Navy has existing abandoned fuel pipelines along Iroquois Road that could be converted for recycled water distribution at a lower cost than installing new pipelines. BWS R-1 recycled pipeline exists at Fort Weaver Road.

Project Goals

- All of the arable land within the Navy’s ESQD zone is cultivated, adding to the inventory of locally-grown produce and contributing to the island’s food self-sufficiency while preserving potable ground water for municipal uses.
- The City finds additional customers for some of the 26 MGD of recycled water to be available after the City comes into compliance with its current consent decree.
- Caprock water is left in the ground to eventually seep into the nearshore waters and maintain coastal ecosystems.

Strategies

Determine demand for R-1 water in the ESQD.

- Discuss with the U.S. Navy, their potential for increasing crop cultivation within the ESQD and their willingness to allow the installation of infrastructure for R-1 water.
- Discuss with the Navy’s agricultural lessee, the potential for increasing crop cultivation within the ESQD and their willingness to use and purchase R-1 water.

Determine the feasibility of selling R-1 water to ESQD agricultural tenant(s).

- Determine if the agricultural users are willing and able to pay the determined R-1water rate that is needed to offset the cost of infrastructure, operations, and maintenance, and eventual infrastructure replacement.

Expand the current capacity of the Honouliuli WRF to produce R-1 water.

- Upgrade the Honouliuli WRF to meet the current DOH Reuse Guidelines.
- If the arable land in the ESQD zone is fully cultivated, it would add 848 acres of farmed land and require an additional 2.1 MGD of water for irrigation.

Delivery

- Rehabilitate abandoned Navy fuel lines along Iroquois Road to distribute recycled water from the Honouliuli WRF to the Navy ESQD zone. Approximately 3,500 linear feet of 12” pipeline would be needed depending on the location of the on-site agricultural reservoir. BWS Honouliuli WRF pumps are adequate to pump water to the Navy ESQD zone to on-site reservoirs where agricultural booster pumps could re-pressurize the water to meet irrigation demand.

Project Status

There have been no recent discussions with either the Navy or its agricultural lessee to determine the long-term plans for agriculture within the EQSD zone and the potential demand for R-1 water.

The capacity of the WRF to add an additional UV system to add approximately 4 MGD of R-1 capacity is planned for 2016 and will meet the current DOH *Reuse Guidelines* for use on edible crops.

Estimated Cost Range

$2 million for 3,500 feet of new 12" pipeline

PROJECT #07: Kalaeloa Water System Improvements

Issue

The infrastructure of the 3,000+ acre KALAELOA COMMUNITY DEVELOPMENT DISTRICT – roads, drainage, sewer, water, electrical power and communications – is antiquated and substandard. Most of these systems, including the potable water system, need to be replaced with modern systems in order for the District to develop along the lines envisioned in the 2005 KALAELOA MASTER PLAN.

Location

The KALAELOA COMMUNITY DEVELOPMENT DISTRICT is located in the southwestern quadrant of the ‘Ewa District. These lands are bounded by the ocean to the south, Campbell Industrial Park to the west, and former sugar lands to the north and east that are now being developed for residential and commercial uses.

Background

The former BARBERS POINT NAVAL AIR STATION formally closed as a military base in 1999. By 2005 most of the land of the 3,000+ acre installation had been allocated to various federal, state and city agencies, including the US. Coast Guard, Department of Hawaiian Home Lands, the National Guard and the City Department of Parks and Recreation. The Navy retained title to a number of parcels, including the Barbers Point Golf Course, some coastal lands, and several brownfields sites.

In 2008, the Hawai‘i state legislature formally created the KALAELOA COMMUNITY DEVELOPMENT DISTRICT, and designated the Hawai‘i Community Development Authority (HCDA) as the management entity for the future planning, management, and development of Kalaeloa. Subsequent to that designation, HCDA has coordinated the development of an overall Master Plan for Kalaeloa and related long-range infrastructure plans. The first major new building at Kalaeloa, the Pacific Headquarters for the Federal Bureau of Investigation, opened for business in 2013.

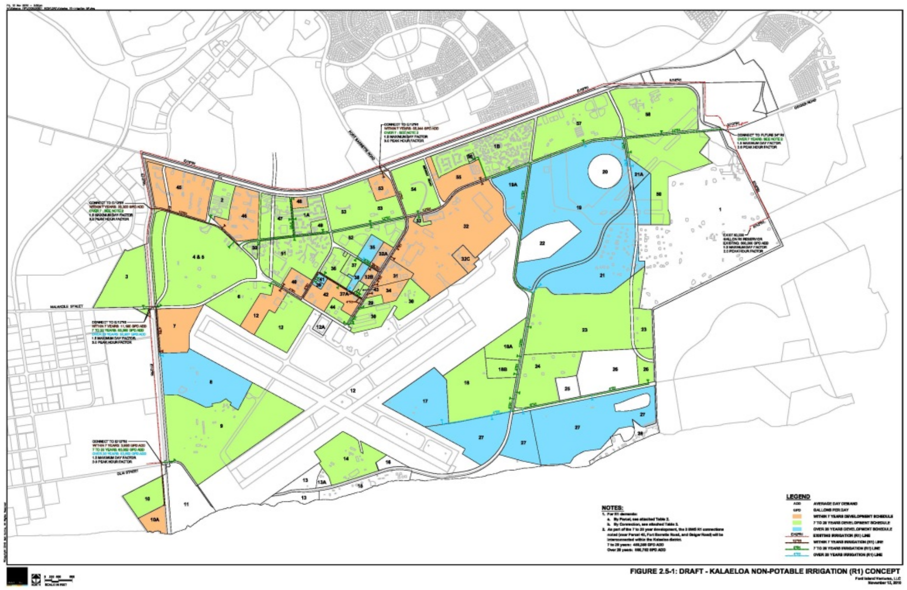
According to BWS analysis of the Kalaeloa Master Plan, at “build-out” the Kalaeloa Community Development District will require 3.4 MGD of potable water and 2.8 MGD of non-potable water. This build-out process may take 30 to 50 years to achieve.

Kalaeloa Master Plan Preferred Land Uses

Hunt Companies is pursuing control over the water and wastewater systems from Pural Water Specialty Companies. Hunt plans to develop 540 acres it acquired from the Navy and is proposing to have Pural continue to manage and operate the water and wastewater systems and make capital improvements. The Board of Water Supply will potentially install non-potable water lines and related infrastructure to serve Kalaeloa land owners and irrigation uses.

Project Champion and Partners

Should the transfer of control to Hunt Cos. go through, the new Hunt Kalaeloa Water LLC would be the lead entity for the design and upgrade of potable water and sewer systems. BWS is a potential partner to allow connection to the R-1 recycled water line along the railroad right of way. HCDA is providing overall planning and coordination for the upgrade of water, sewer and other infrastructure systems.



Draft—Kalaeloa Non-Potable Irrigation (R-1) Concept

Project Goals

Provide upgraded potable water and non-potable water infrastructure for all users and uses within the Kalaeloa Community Development District. Public agencies, private businesses, home owners and renters at Kalaeloa will eventually be able to enjoy safe and affordable potable and non-potable water supplies.

Project Status

The PUC is still considering Hunt Cos.’s December 2015 application to become the water and wastewater provider for Kalaeloa. BWS has included Kalaeloa in their plans for expanding the non-potable water infrastructure system in the ‘Ewa District.

Estimated Cost Range

Cost estimates for upgrading the water and wastewater infrastructure systems at Kalaeloa will need to be developed once ownership of the infrastructure is resolved.

References

Belt Collins, Hawaii Ltd. 2010. Kalaeloa Master Plan – Infrastructure Master Plan Updates.

Shimogawa, Duane. September 15, 2016. Pacific Business News. “Senator urging regulators to approve developer’s plan to buy town’s utilities.” [retrieved March 9, 2017].

PROJECT #08: Kalaeloa Heritage Park

C-shaped structure and kauhale (temporary visitor's center)

Issue

There is an opportunity to restore and learn from an historic Hawaiian settlement that made use of the unique karst ground water resources in Kalaeloa. Restoration of this site will also protect native plant ecosystems.

Location

Kalaeloa Community Development District, vicinity of Coral Sea Road

Background

When the Barbers Point Naval Air Station closed in 1999, approximately 3,700 acres of land was allocated to various Federal, State, and City Agencies. Approximately 77 of those acres, which are owned by the State Hawaii Community Development Authority (HCDA), are now being restored and managed as a cultural park: Kalaeloa Heritage Park (KHP). Most of the site is relatively undisturbed because the area was used as a military buffer zone within the former Naval Air Station.

Portions of the ‘Ewa region, including Kalaeloa, consist of a geology known as karst, where limestone bedrock is dissolved by the carbonic acid found in rainwater. The acidity in the rainwater eventually erodes enough limestone to cause areas of the surface layer to collapse, creating a combination of sinkholes, caves, and underground channels. Within this region, water seeps and flows through these underground tunnels, caves, and streams. The ‘Ewa Karst, covering about 31 square miles, is the largest network of karsts on O‘ahu. Numerous sinkholes are found in the ‘Ewa Plain, particularly in Kalaeloa. Some sinkholes are no more than four to five feet deep, while some are as deep as ten feet and extend to the water table.

Sinkholes served as a significant water resource for Native Hawaiians and were used for three general purposes: agriculture (including cultivation of banana, sugar cane, and ti), water source, and burials. Sinkholes that were used for their water resources have walls constructed around them to keep trash out and stone stairs within them to reach the water level.

Within KHP, there are numerous sinkholes, permanent and temporary habitation sites, C-shaped and L-shaped structures and heiau. The structures in the area are unique because they were built differently from the interlocking Hawaiian rock wall construction, but rather built in an upright Tahitian style—suggesting that the people who lived for hundreds of years at Kalaeloa were not just Hawaiians, but also included other Polynesian families. An ancient trail provided access to the shores and fishing grounds, and may have served as a regional trail from Kapolei.

Although water no longer flows through the sinkholes at KHP, there is still enough moisture in them to support plants, such as ti and maiapilo, that are found within them. Throughout the site, there are still some native plants such as wiliwili, naio, and coastal ‘iliahi, but invasive species including kiawe dominate most of the landscape.

Project Champion and Partners

Kalaeloa Heritage and Legacy Foundation; Hawaii Community Development Authority

Project Goals

- Steward and preserve Hawaiian cultural sites and the cultural landscape of Kalaeloa
- Restore and manage native plants and remove invasive species
- Implement and maintain an authentic Hawaiian presence in the Kalaeloa area.
- Educate the community on cultural traditions and practices, and advocate cultural awareness with minimal disturbance to the area through an interpretive trail and learning stations.

Project Status

In the summer of 2013, the construction of a traditional hale—consisting of stone, wood, and grass—was completed over six days with the help of at least 50 volunteers on each day. The gathering of the materials to build the kauhale, which serves as the gathering place for visitors to the KHP, took longer than its actual construction.

Of the 77 acres dedicated as the KHP, approximately three acres have been cleaned up and serve as the cultural village that features an interpretive trail area and learning stations. Native plants including ‘akoko, ‘Ewa hinahina, naio, maiapilo, wiliwili and ‘ulu have been planted. A section of the ancient trail has been uncovered and restored. Eleven cultural structures have been identified. However, more archaeological surveying is needed for the remaining areas of the KHP. Volunteers will continue to clean the area by removing invasive species and planting more native plants. A multi-purpose cultural center, including vehicle and bus parking, is planned for five acres of the KHP in the future.

Estimated Cost Range

Preliminary cost estimate for construction of a 16,300 sf multi-purpose cultural center and supporting facilities is approximately $9.5 million.

References

Personal communications with Shad Kane from the Kalaeloa Heritage and Legacy Foundation

Kalaeloa Heritage Park Conceptual Plan and Report Prepared for Hawai‘i Community Development Agency;

Draft Environmental Assessment for the Kalaeloa Heritage Park.

PROJECT #09: Hoakalei Coastal Village Restoration

Issue

There is an opportunity to reconnect residents with the land of ‘Ewa and to provide learning experiences on the natural and cultural heritage of the area.

Volunteers prepare nesting grounds for endangered birds at the Kauhale Wetland Preserve

Location

Honouliuli, ‘Ewa Beach

Background

The Hoakalei Cultural Foundation was established in 2006, following nearly 15 years of discussions with elder kamaʻāina of the ‘Ewa Beach region. The Hoakalei Cultural Foundation serves as the steward for nearly 30 acres of land, including a mile-long stretch of Honouliuli shoreline. The vision of the Hoakalei Cultural Foundation is to “enable future generations to understand, value and respect the spirit, natural resources and heritage of the ‘Ewa Plain.”

The stewardship program covers three cultural preservation areas: Kauhale, Ahu, and Kuapapa. These preservation areas include traditional Hawaiian house sites, shelters, dry-land agricultural features and walls, and historic structures. Intensive use of the land from the ranching and sugar plantation days and from military training operations has significantly impacted the land, and left some of the cultural sites looking like “rubble piles.”

The Kauhale Preservation Area is composed of approximately 22 acres, six of which are the remnants of a wetland that serves as the nesting ground for several endangered native water birds including aeʻo (Hawaiian stilt), ʻalae keʻokeʻo (Hawaiian coot), and koloa maoli (Hawaiian duck). Archaeological surveys provide documentation on the Kauhale Preservation Area which includes temporary and permanent habitation sites and dry land agricultural sites, along with other cultural features. Historical records indicate that crops such as ʻuala, ipu, kō, and hala were grown in the region. Many of the sites have been damaged by the overgrowth of introduced kiawe trees.

The Ahu Preserve contains the largest and best preserved site of the three preservation areas. A dry-stacked coral cobbles platform about 36 feet long, 32 feet wide, and four feet high is located within this preservation area. Archaeological work suggests that the platform was used either for ceremonial purposes or as a fisherman’s shrine. The Kuapapa Preserve consists of several sites for both temporary and permanent housing, dryland agricultural activities, workshop areas and other cultural features, as well as historic features such as the ruins of an old piggery.

Project Champion and Partners

Hoakalei Cultural Foundation

Project Goals

- Engage community youth and families in stewardship and cultural programs that enrich our lives through understanding the past.
- Encourage wise use of our natural and cultural resources and to pass the rich cultural legacy of the land on to future generations.
- Community members are engaged through place-based educational and stewardship programs to care for the cultural preservation areas.
- The Oneʻula-Kūalakaʻi shoreline is cleaned and restored.
- Native plants are cared for and restored, and invasive species are removed.

Project Status

In the summer of 2013, the Kauhale Heritage Trail, located within the Kauhale Preservation Area, was extended to a larger section of the traditional village site. The development of the Heritage Trail provides an opportunity for visitors to learn about the history of the land and resources. In several features within the Kauhale Preservation Area invasive species such as koa haole and kiawe have been replaced with native plants.

Hoakalei Cultural Foundation also hosts an annual wetland stewardship project where volunteers help to prepare the nesting grounds for the endangered Hawaiian water birds at the Kauhale Wetland Preserve. Volunteers help to clear introduced species and remove pickleweed in preparation for nesting season which runs from March through September. In addition, more than 100 tons of ʻōpala and debris have been removed along the Honouliuli shoreline between Oneʻula and White Plains Beach as part of the Oneʻula-Honouliuli Shoreline Service Project. Unique communities of endemic and indigenous plants are also being preserved along the shore line along with several extant cultural-historic sites.

References

Personal communications with Kepa Maly, Executive Director of Hoakalei Cultural Foundation

PROJECT #10: Mālama Learning Center (MLC)

Issue

Public education and community involvement are needed to protect ‘Ewa’s resources and to encourage wise water use.

Location

Kapolei, West O‘ahu

Background

The Mālama Learning Center was founded in 2004 with a mission to teach and inspire communities to create healthy living environments. MLC focuses on project- and place-based learning experiences by actively engaging with youth and adults. MLC works closely with Kapolei High school, and other West O‘ahu schools to integrate Hawaiian culture and traditions with technology and science.

Students from the Hawai'i Green Collar Institute visited the Pāhole Rare Plant Facility in the Wai‘anae Mountains, which harbors hundreds of rare and endangered Hawaiian plants.

The vision of MLC is to create a “place in West O‘ahu that brings art, science, conservation and culture together to promote sustainable living throughout Hawai‘i.” It strives to connect community with the land and sea by promoting a shared ethic of caring and conservation.

MLC offers numerous workshops and programs that promote healthy living and sustainability. The programs include:

- WithOut Walls: Hands-on sustainability workshops for community members;
- Hawai‘i Green Collar Institute: Training and workshops for students and teachers on environmental education and careers;
- Mālama ‘Āina Field School: Classroom and field-based learning for middle and high school students in Wai‘anae;
- School Sustainability Projects: Nurseries, gardens, and aquaponics projects at area schools;
- Site Restoration Projects: Native plant restoration projects working with public and private land owners in the region;
- Mākeke Kapolei: A weekly farmers’ market with Hawaiian cultural and sustainability demonstrations provided to the community at Kapolei High School; and
- Camp Pālehua: Partnership with Camp Pālehua (formerly Camp Timberline) to provide place-based environmental education focusing on gardening and forest restoration.

Project Champion and Partners

Mālama Learning Center, Leeward Community College’s Hālau ‘Ike O Pu‘uloa, UH West O‘ahu, Ka‘ala Farm, Kamehameha Schools, local public schools, and various funders

Project Goals

Goal: People of West O‘ahu adopt a lifelong commitment to practice mālama ‘āina.

Objectives:

- Increase youth and family participation in environmental & cultural stewardship
- Improve capacity of educators to employ effective environmental & cultural education techniques
- Improve community members’ ability to perpetuate environmentally & culturally sustaining actions
- Strengthen local environmental & cultural networks
-

Project Status

Since its inception in 2010, the Hawai‘i Green Collar Institute has held at least 25 sessions serving more than 400 people. Every session has been different, covering a variety of topics ranging from sustainable agriculture to watershed protection to marine biology. Some sessions have been as short as three days whereas others have been as long as a semester. In 2013, twenty-six educators from Leeward schools including Campbell High School in ‘Ewa participated in a three-part aquaponics course as part of the Hawai‘i Green Collar Institute. Educators were able to take an aquaponics system back to school as well as earn professional development credits. Each Hawai'i Green Collar Institute session includes individual follow-up with students or teachers for several months after the session concludes to deepen the impact of the program. Future seminars are planned for both students and educators, however funding from sponsors is critical for the continuation of this program.

Estimated Cost Range

Green Collar Institute: $15,000 - $20,000 per session serving approximately 20 - 25 people.

References

Personal communications with Pauline Sato, Executive and Program Director of Mālama Learning Center.

Mālama Learning Center Website (http://www.malamalearningcenter.org/)

PROJECT #11: Anchialine Pool Restoration

Issue

The rare anchialine pool system in Kalaeloa that provides habitat to native shrimp is being degraded by poor water quality, introduced species, trash, and neglect. These pools were also previously important to Hawaiian settlements in the area, providing water and areas for agriculture.

Anchialine pool

Location

Kalaeloa Community Development District, vicinity of Coral Sea Road between the end of the airport runway and the Campbell Industrial Park drainage channel.

Background

During the Base Realignment and Closure proceedings after the closing of the Barbers Point Naval Air Station in 1999, approximately 3,700 acres of land was turned over to various Federal, State and City agencies. Approximately 37.4 acres of land in the southwestern sector of Kalaeloa was conveyed to the U.S. Fish & Wildlife Service to be incorporated into the Pearl Harbor National Wildlife Refuge.

The Pearl Harbor National Wildlife Refuge (NWR) is comprised of three units: Waiawa, Honouliuli, and Kalaeloa. The Kalaeloa Unit was added to the Pearl Harbor NWR with the goals of (1) restoring and protecting the coastal coralline plain habitat, particularly for the endangered plants ‘Ewa hinahina and ‘akoko, and (2) restoring, protecting and maintaining anchialine pools.

Anchialine pools are typically found in geologically young lava fields and limestone bedrock. These pools are exposed sections of the ground water table that have a subsurface connection to the sea but no surface connection. Water levels within the anchialine pools fluctuate depending on the tide, thus salinity levels vary within the pools. Species are therefore tolerant to varying salinities. These brackish pools support unique insects, plants, and animals. Within the Kalaeloa Unit, two species of native shrimp are found in the anchialine pools: ‘ōpae‘ula (*Halocaridina rubra)* and the shrimp only known by its scientific name, *Metabetaeus lohena*, which is one of four shrimp species that have been identified as candidates for endangered species listing.

Threats to anchialine pools include poor water quality, introduction of alien species, and trash. Anchialine pools have been reported as one of the most threatened aquatic ecosystems in the State of Hawai‘i. In Kalaeloa, some of the area has previously been bulldozed and pools were filled with rubble, rocks, and debris by prior agricultural, military, residential and commercial activities. In addition to Kalaeloa, anchialine pools are found in Wai‘anae, Malaekahana, Kīpapa, and Kahuku on O‘ahu.

Project Champion and Partners

USFWS has done restoration work and educational programs for the Pearl Harbor NWR with Kapolei High School students, but no longer has funding to continue. They are currently looking for a community group to steward the area and do additional restoration. Some of the community partners that USFWS has worked with include Leeward Community College, University of Hawai‘i (UH) at Mānoa, UH Pacific Internship Programs for Exploring Science, UH Marine Option Program, and NALU Studies.

Program Goals

- Restore and protect coastal coralline plain habitat.
- Restore and protect natural habitat and flow within the anchialine pools.
- Protect and maintain the 14 existing anchialine pools and restore additional pools.

Project Status

Fourteen anchialine pools have been restored. Restoration efforts were successful in recruiting anchialine shrimp; at least six of the pools are now inhabited by two shrimp species. Fish and Wildlife Service staff and Kapolei High School students helped to excavate previously bulldozed anchialine pools to restore flow. They have also cleared some of the area by removing invasive plants, such as kiawe and koa haole, located near the pools. Some of the native plants found on-site included pā‘ū o hi‘iaka (morning glory), ma‘o (Hawaiian cotton), and hinahina ku kahakai (flower of Ni‘ihau). A trail system was developed to reduce disturbance to ground surface, protect plants, and improve visitor safety.

Future plans for the project include finding a community group to adopt and manage the area and to continue the programs; identifying, evaluating, and restoring an additional 15-30 anchialine pools; reintroducing pinao‘ula (damselfly) to the area; and creating an outdoor learning classroom.

Estimated Cost Range

$240,000-$300,000 for boundary fence and restoration of an additional 15-30 anchialine pools (from 2010 *National Wildlife Refuge Comprehensive Conservation Plan*)

References

Presentation by Lorena Wada, Assistant Field Supervisor USFWS and the Pearl Harbor O‘ahu National Wildlife Refuge Complex and USFWS Pacific Islands Planning Team. 2010. *National Wildlife Refuge Comprehensive Conservation Plan.*

PROJECT #12: Wai‘anae Mountains Watershed Partnership

Issue

Mauka forest lands capture moisture from precipitation and fog, feeding our streams and recharging the ground water aquifers that provide fresh water for drinking and irrigation. Native forests have multi-storied canopies that slow the velocity of rainfall, thus allowing for more water to infiltrate into the ground and reducing erosion caused by hard-hitting rain and high surface runoff. However, previous land uses degraded much of the native forests, which have been replaced by invasive plant species. These non-native tree canopies tend to be single-storied and are commonly viewed as inferior to native forests for promoting ground water infiltration and reducing runoff. Efforts to protect native forests and restore degraded forests is often difficult due to the large and sometimes inaccessible land areas, as well as fragmented land ownership.

Location

Forests in the ‘Ewa area are restricted to the mauka areas of the Wai‘anae Mountains, above farms and development. The Honouliuli Forest Reserve is a 4,828-acre reserve above the 1,200 foot elevation. A portion of the Reserve is within the ‘Ewa DP area, with the remaining acreage extending north into Central O’ahu.

Background

The Watershed Partnerships, started in 1991, are “voluntary alliances of public and private landowners committed to the common value of protecting forested watersheds for water recharge and other ecosystem services through collaborative management.” Partners work together to make management decisions and implement management actions within the partnership area.

The Wai‘anae Mountains Watershed Partnership was formed in 2010 to protect the biological, cultural, and economic resources of the Wai‘anae Mountains. Partners include DLNR; Gill-Olson Joint Venture; BWS; Ka‘ala Farm, Inc.; U.S. Army Garrison Hawai‘i; U.S. Navy Region Hawai‘i, and Wai‘anae Community Re-Development Corporation (MA‘O Organic Farms). The portion of the WMWP area that is in and around ‘Ewa is managed jointly by DLNR, the O’ahu Army Natural Resources Program, and the Gill and Olson family trusts.

WMWP Vision: “Working together to protect, restore, and enhance the Waianae Mountains watersheds while incorporating traditional, cultural and community values for future generations.”

WMWP Mission: “The overall goal of the Wai‘anae Mountains Watershed Partnership (WMWP) is to cooperatively develop and implement management strategies for the Wai‘anae Mountains, mauka to makai. The partnership will bring people together to responsibly manage watershed areas, native species and their habitats, and historical, cultural and socio-economic resources for all who benefit from the continued health of all of the Wai‘anae Mountains ahupua‘a.”

Project Champion and Partners

WMWP partners: Board of Water Supply, Department of Land and Natural Resources, Gill-Olson Joint Venture, MA‘O Organic Farms, US Army Garrison Hawaii, Navy Region Hawaii, and Ka‘ala Farms, Inc.

Native plant shade house at the WMWP baseyard.

Program Goals

- Fencing
- Invasive Species Control
- Survey of threats and resources
- Stabilize exposed soil areas
- Develop management strategies and policies
- Public education and outreach

Project Status

The WMWP has been in operation since 2010. Activities have included a native plant propagation and outplanting program, endangered species protection, predator control, fencing, and education and outreach.

Estimated Cost Range

$1,000,000/year

References

State of Hawai‘i Division of Forestry and Wildlife, Native Ecosystems Protection and Management. *About Watershed Partnerships*. http://dlnr.hawaii.gov/ecosystems/wpp/about/. Accessed 12/28/16.

Hawai‘i Association of Watershed Partnerships. *Wai‘anae Mountains Watershed Partnership.* http://hawp.org/partnerships/waianae-mountains-watershed/. Accessed 12/28/16.

BWS SYSTEM-WIDE PROJECT #13: Potable Source Water Protection

Issue

Protection of our potable water supplies is one of the Honolulu Board of Water Supply’s (BWS) most important goals. Most of our potable water is derived from ground water aquifers. Land uses affect the underlying ground water, so we must be thoughtful in what might impact drinking water for future generations.

Location

System-wide, particularly in those areas overlying the capture zones for ground water sources.

Background

Potable water on O‘ahu is supplied exclusively by ground water. Land uses overlying the potable aquifer and within the capture zones of potable sources may potentially contaminate them if pollutants seep into the ground or spill into unprotected wells.

Treatment of water for potable consumption is possible, and the BWS currently does treat all of the Central O‘ahu sources for pesticide contaminants. However, it is less costly to prevent contamination of a source than it is to treat it, thus lowering the cost to rate payers. Additionally, the U.S. Environmental Protection Agency and DOH has been lowering the maximum contaminant levels for particular contaminants in drinking water, making treatment progressively more expensive.

Above and beyond this, it should be the goal of the community to not allow our drinking water to become contaminated in the first place. It is the mission of the BWS to provide safe, dependable, affordable water, making water quality its number one priority.

Project Champion and Partners

Protection of potable ground water supplies relies heavily on management of the land uses above it and within their capture zones. This requires planning, policies, and regulation by the government agencies, such as DPP, that have jurisdiction over land use decisions.

The Department of Health has conducted a Source Water Assessment Program assessment identifying potable water sources and the potentially contaminating activities (PCAs) located within their capture zones. Data from this program should feed into any action to protect source waters.

The BWS and any other potable water purveyor should also be a partner in this process as they should have operational knowledge of their systems and on-the-ground understanding of how land uses affect the particular sources underlying them. This can help to prioritize areas and actions.

Project Goals

Potable water supplies comply with State and Federal standards for drinking water at minimal cost to the consumer.

Strategies

Education and Stewardship will inform decision-makers and the public on the importance of source water protection.

- Focus on the need for source water protection and why it is the best alternative for ensuring drinking water for today and future generations
- Education will encourage stewardship of water resources, particularly in urban areas where residents do not know where their water comes from

Prevention Measures will provide actions to prevent contamination of potable ground water sources.

- Develop a State statute authorizing counties to establish and implement source water protection ordinances that minimize PCAs within drinking water source capture zones
- Update the State’s Source Water Assessment Program
- Conduct on the ground surveys for potential contaminating activities in source capture zones and incorporate known previous land uses, such as BWS’s O‘ahu Inactive Landfills study, into the Source Water Assessment Program
- Identify incentives to prevent contamination, such as commercial and residential BMPs, and promote land uses that enhance ground water recharge
- Identify Best Management Practices (BMPs) within potable source water capture zones
- Identify allowable, prohibited, and conditional uses within source water capture zones
- Provide training for Department of Health regulators, County Planning Departments, County Water Departments, other potable water purveyors, and conditional-users within source water capture zones
- Develop a well-siting policy and program to avoid known water quality problems and to direct incompatible land uses away from the sites of future sources.
- Promote sustainable watersheds
    - Implement watershed partnership projects mauka of wells, like fencing the upland forested recharge areas, particularly those in capture zones.
    - If wells exist in this zone, apply advanced conservation measures to reduce withdrawals over time.
- Protect water quality and quantity by reducing ground water pumpage.
    - Implement conservation measures to reduce demand.
    - Meet irrigation demands with recycled water, desalination, and other resource augmentation technologies.
    - Recharge capture zones with stormwater, where appropriate

Monitoring will alert drinking water purveyors and the DOH of contamination

- Describe the water quality monitoring that is currently being conducted.
- Identify gaps in monitoring that need to be filled in order to protect drinking water sources.
- Recommend additional monitoring and implement programs.

Treatment will be used should there be a need after education and prevention measures are in place.

- Increased and enhanced monitoring will provide baseline conditions and will provide indications of water quality problems and the need for treatment.
- BWS and other potable water purveyors will treat potable water sources as necessary to meet State and Federal drinking water standards.
- Once a polluter is identified, they should be made accountable and be required to implement treatment and clean up measures to ensure safe drinking water.

Project Status

DOH conducted a source water assessment (2004) that identified potentially contaminating activities within source water capture zones. BWS has informed agricultural landowners of lands within source capture zones to implement best management practices to manage pesticide and fertilizer application to mitigate potential contaminating activities of the underlying groundwater as a source protection measure.

Maui County is working on a draft ordinance to create a Wellhead Protection Overlay District (WPOD) to regulate land uses within three zones around each drinking water source. The draft ordinance includes allowable, permitted, and prohibited uses within each zone; required BMPs, and design guidelines for land uses within each WPOD zone. Kaua‘i County is also in the process of developing a Wellhead Protection Program based on DOH’s SWAP.

Estimated Cost Range

[If pursued, various agencies would need to identify the roles and studies needed to determine estimated costs]

References

Whittier, Robert B., Kolja Rotzoll, Sushant Dhal, Aly I. El-Kadi, Chittaranjan Ray, Gordon Chen, and Daniel Chang. 2004. *Hawaii Source Water Protection Program Report*. Water Resources Research Center, University of Hawai‘i at Mānoa.

Maui County Draft Ordinance establishing a Wellhead Protection Overlay District

Maui Source Water Protection Project description

Wellhead Protection Project for Central O‘ahu description

BWS SYSTEM-WIDE PROJECT #14: Assess Resiliency of Critical Water Infrastructure

Issue

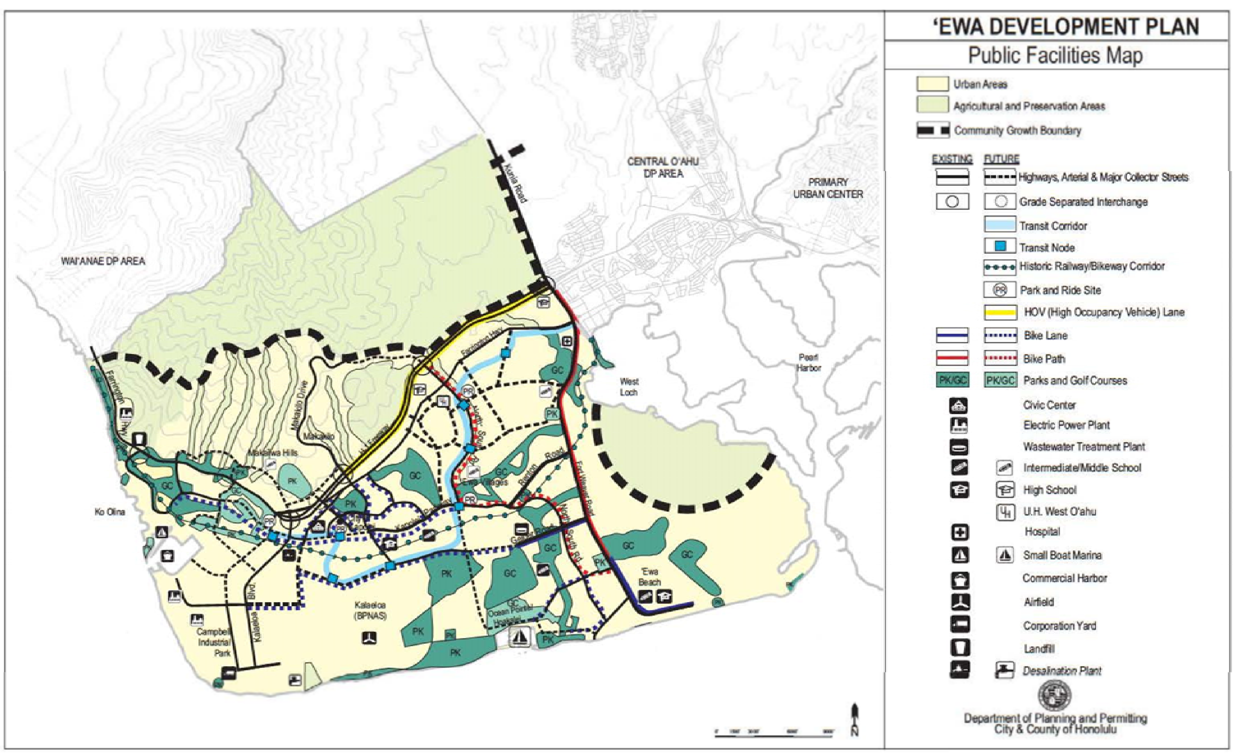
Some of the BWS’s critical water (and other) infrastructure may be vulnerable to significant damage or possibly even total loss from natural disasters like major hurricanes or tsunami and from the impacts of climate change. Community-wide recovery from natural disasters would be severely hampered by the loss of infrastructure systems that provide potable water and wastewater treatment.

Location

Water and wastewater infrastructure systems may be most at risk of damage from natural disasters like major hurricanes and tsunami from inundation and power outages if coastal power plants are damaged. Tele-communications are also at risk and may impact remote telemetry systems.

Background

Act 286 (2012), “Climate Change Adaptation Priority Guidelines,” requires adoption of a state-wide adaptation policy for addressing the impacts of climate change. FEMA Flood Maps and USACE regulatory planning guidelines have adopted a three-foot sea level rise criterion for coastal inundation by the year 2100.



Public Facilities Map from the ‘Ewa Development Plan

Public agencies that manage critical public infrastructure systems, including BWS, need to develop a better understanding of the ability of critical infrastructure such as wastewater treatment plants, wastewater pump stations, and potable and non-potable water systems to withstand the impacts of natural disasters (floods, earthquakes, tsunami, hurricanes, etc.) and climate change (increases in storm frequency and intensity, sea level rise, ground water level rise, etc.). Infrastructure agencies need to identify where the infrastructure vulnerabilities are and what the protective or adaptive strategies should be. What do nation-wide studies and guidelines tell us? What data do we need to make informed decisions? What do we know – and not know?

Emergency action plans have been developed to anticipate damage and disruptions of essential infrastructure services for most likely natural and man-made disasters. National Incident Management Systems protocols are followed and match Federal and military emergency response programs.

Project Champion and Partners

Many State and City agencies, including DLNR, DOH, DEM, BWS, DPP, ENV, DFM, DDC.

Project Goals

- Regularly update emergency response plans and protocols to mitigate the impacts of natural disasters and climate change on critical water infrastructure systems.
- BWS and other State and City agencies and departments are prepared to deal with major impacts on critical infrastructure systems from natural disasters and climate change.

Project Status

- Expand the inventory and deployment of permanent and mobile emergency generators.
- Harden essential pumping and maintenance facilities to withstand hurricanes.
- Design new facilities to updated building structural standards

Estimated Cost Range

Costs depends on the facility. Regularly budget hardening and emergency response equipment annually.

BWS SYSTEM-WIDE PROJECT #15: BWS Renewal and Replacement Plan

Issue

Preparing for Oahu’s water future, the BWS has developed a long-range Water Master Plan (WMP) to provide the data, analyses, projections, and basis for decisions necessary for the BWS to continue to provide safe, dependable, and affordable water service now and in the years ahead.

Water Master Plans are a Best Management Practice of water providers. Based on the complexity of Oahu’s water system, with components of the island’s water infrastructure nearing the end of their expected service life, combined with emerging challenges to water supply reliability, the BWS set its planning horizon to 30 years, a full generation, and longer than the forecast used by most WMPs. The BWS also incorporated an in-depth analysis of the physical condition and operating capabilities of the current water system, to gain a clear picture of what needs attention and the criticality.

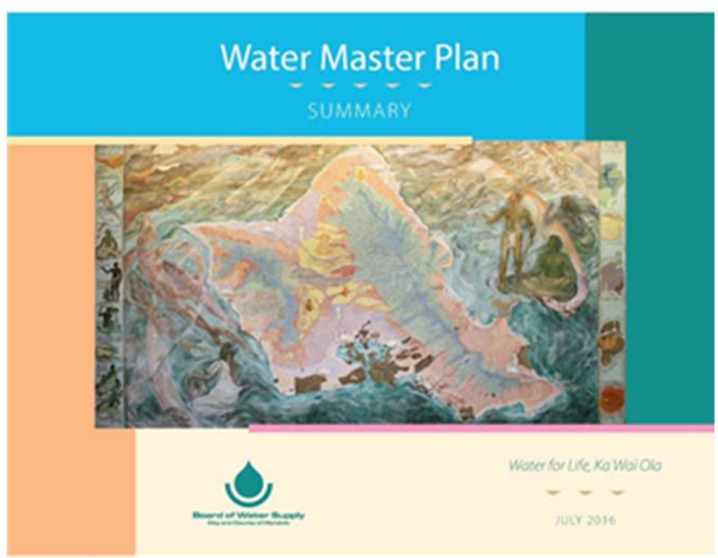
Location

The BWS municipal water system extends through all land use districts of Oahu.

Background

For decades, the BWS has built, operated, and maintained the vast and complex infrastructure that makes it possible to sustain natural water supplies and provide safe, dependable, and affordable service to customers.

Operating the water system on O‘ahu presents special challenges unique to this island setting. The water systems are aging. Many BWS facilities (particularly pipelines) are subject to high salinity groundwater, corrosive soils, and other conditions that can impact infrastructure lifespan. O‘ahu’s dramatic landscape requires that water supplies be elevated up steep mountainsides. The freshwater / seawater interface in the Island’s aquifers must be carefully monitored and balanced. Water is transferred throughout the island, from where it is most abundant to where water is needed.



The BWS Water Master Plan Public Draft was released in July 2016.

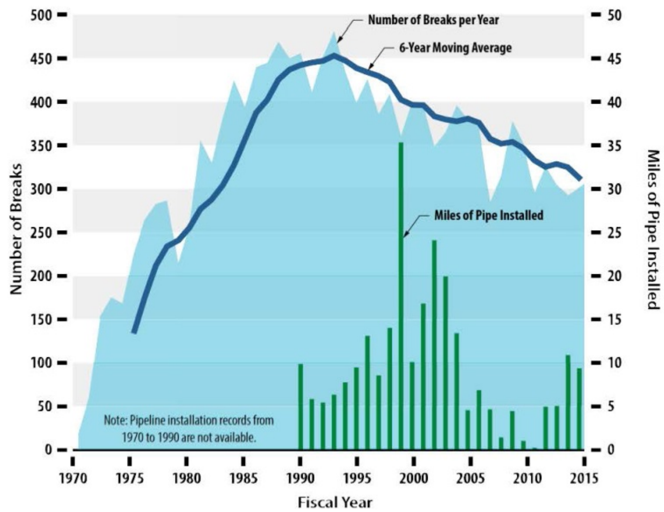
Project Champion and Partners

Honolulu Board of Water Supply

Project Goals

The WMP's recommendations are based on maintaining the health of the BWS water system. The Water Master Plan allows the BWS to:

- Increase reliability for residents, businesses, and visitors.
- Proactively care for water quality and delivery infrastructure, and reduce costly emergency repairs.
- Prioritize investment of limited resources in infrastructure based on benefits and risks.
- Spread investments and rate changes over time.
- Avoid unneeded replacement by physically assessing the condition of infrastructure.
- Improve design, construction, and maintenance practices so infrastructure lasts longer.



The number of water main breaks across the BWS System has been decreasing in recent years. [Source: BWS Water Master Plan]

Recommendations of the Water Master Plan reflect scientifically sound strategies and technologies to manage a range of challenges, from aging infrastructure to climate change adaptation. Implementation of these recommendations reflects the objectives of the Water Master Plan: Water Quality, Health, and Safety; System Reliability and Adequacy; Cost and Affordability; Water Conservation; and Water Resource Sustainability.

Thoughtful, proactive investment in infrastructure and maintenance of the water system supports the ability to better control rates over the long run. The Water Master Plan can be viewed at the following link:

http://www.boardofwatersupply.com/about-us/water-master-plan

Project Status

On-going

Estimated Cost Range

The BWS water system is valued at over $15 Billion with an existing Capital Improvement Program budget of $80 Million annually. Recommendations of the BWS Water Master Plan identify investments, actions, operational changes, and capital improvements to implement over the 30-year planning period. Actual implementation timeframes will depend upon available capital funding and on how uncertainties progress over time. The timing of projects to expand the water system will be tied to actual population growth and increases in demand. Specific projects, including locations, costs, and prioritization are described in the BWS 30-year Capital Improvement Program.

4.3 WATERSHED MANAGEMENT STRATEGIES

STRATEGY A: Waiāhole Ditch Augmentation

AUGMENT WAIĀHOLE DITCH USES WITH RECYCLED WATER. Leeward O‘ahu needs abundant, reliable and affordable water to support current and future agricultural activities. The recent emphasis on locally grown food would suggest an expansion in agricultural acreage in both the Central O‘ahu and ‘Ewa Districts, but water availability will likely be a limiting factor in this expansion. The Waiāhole Ditch Irrigation System (WDIS) has 15.0 MGD of water available for offstream uses through water use permits, with 12.991 MGD currently allocated. This leaves only 2.009 MGD for future expansion of uses.

It may be possible for the Mililani Golf Club, a current WDIS user, to convert to recycled water from the City’s Mililani WWTP, freeing up 0.25 MGD of WDIS permitted use for agriculture. In addition, the Mililani peninsula could also be converted to recycled water, a current WDIS user. An alternative would be to install a recycled water transmission pipe within the Ditch easement to provide recycled water for non-edible farm crops such as Kunia seed corn farms, as a supplement to WDIS water. Recycled water should not be added directly to the WDIS because of the potential for organic farms to use Ditch water. Possible Champions and/or Partners: DOA, CWRM, BWS, ‘Ewa Farmers.

STRATEGY B: Brackish Well Development

DEVELOP BRACKISH WELLS TO CONSERVE POTABLE WATER FOR MUNICIPAL NEEDS. The ‘Ewa caprock formation holds large volumes of brackish water that could potentially be used for small-scale non-potable water needs such as small landscape irrigation or small industrial uses. Increased use of brackish water for non-potable water needs would free up potable water for municipal uses and could be ideal in areas that are not serviced by recycled water systems. Water use and well construction permits would be needed and could be used to manage the brackish water aquifer, which will become saltier if pumped excessively. Possible Champions and/or Partners: CWRM, BWS, Private Sector.

STRATEGY C: Industrial Cooling Using Seawater

ENCOURAGE THE USE OF SEAWATER FOR INDUSTRIAL COOLING. CWRM data for Malakole Saltwater Wells (‘Ewa Caprock Aquifer Sector) as of November 9, 2012 list a total of fifteen saltwater wells belonging to Hawaiian Electric Company and others. Permitted use ranges from 0.1 to 14.4 MGD, and the total permitted use of the 15 wells is 123.325 MGD. Most of this saltwater is used in “industrial cooling” processes where it is pumped through cooling towers in the process used to generate electricity. Assuming future increase in the need for industrial cooling water, continued and expanded use of saltwater for this purpose should be the preferred option. This strategy would reserve other water sources – including potable and brackish ground water and reclaimed water – for other purposes.

Seawater could be obtained either through saltwater wells or through offshore pipes. Saltwater wells would require CWRM permits, but their use does not affect the freshwater sustainable yield, Possible Champions and/or Partners: CWRM, Industrial Water Users.

STRATEGY D: Grey Water Reuse

ENCOURAGE GRAY WATER REUSE TO REDUCE DEMAND FOR POTABLE WATER AND TO REDUCE THE AMOUNT OF WASTEWATER TO BE TREATED AND DISPOSED. There are opportunities to adopt on-site gray water reuse through plumbing modifications, particularly in new developments where dual plumbing systems could be installed during construction. Gray water can be used for small-scale non-potable water needs, such as residential landscape irrigation, but should be used on plants that are tolerant to alkaline conditions due to presence of soaps in the water.

In 2009, the DOH prepared “Guidelines for the Reuse of Gray Water.” DOH supports gray water reuse, provided public health is not compromised. Gray water is wastewater that is discharged from showers and bathtubs, hand-washing lavatories, washing machines, and sinks that are not used to dispose of food preparation matter or toxic materials, such as household cleaners, pesticides, fuels, or solvents. The DOH guidelines were prepared as an informational source for homeowners, contractors, and engineers on the use of gray water in Hawai‘i.

In addition to the DOH Guidelines, gray water systems must meet standards outlined in the Uniform Plumbing Code (UPC). The UPC is developed by the International Association of Plumbing and Mechanical Officials and governs the installation and inspection of plumbing systems, thus protecting public health, safety, and welfare. The current version of the UPC, adopted in 2012, discusses Alternate Water Sources for Non-Potable Application in Chapter 16. The City and County of Honolulu has not yet adopted the 2012 UPC but is moving to adopt voluntary plumbing standards for the installation of gray water systems.

The primary benefit of gray water reuse in the ‘Ewa District would be to reduce demand for potable water that is currently used for outdoor irrigation and to reduce wastewater flows to the regional wastewater treatment plant. Doing so would also reduce monthly consumption of potable water, thus lowering water and sewer bills. Possible Champions and/or Partners: DOH, BWS, ENV.

STRATEGY E: Kalo‘i Gulch Regional Drainage Plan Evaluation

EVALUATE THE KALO‘I GULCH REGIONAL DRAINAGE PLAN. There are few defined stream channels in the ‘Ewa plain, but the upper watersheds of the Wai‘anae Mountains collect enough rain to create large gulches that can overflow and flood adjacent lands. Development along these drainages can cause increased flooding in the plain, making it critical for stormwater to be addressed by every landowner. Large-scale developers in particular must take responsibility for the runoff from their lands. Addressing stormwater is not easy, as runoff inevitably flows from and to other properties and eventually into the ocean. Impacts to other properties, freshwater and nearshore ecosystems, and traditional and cultural practices dependent upon those properties and ecosystems must be taken into account, not only because it is the right thing to do, but because State law requires it and because failure to do so may result in contested cases and lawsuits that delay project implementation.

The effort to address stormwater from Kalo‘i Gulch is an example of and attempt by government and multiple landowners to address flooding in ‘Ewa with mixed results. Kalo‘i Gulch is a major drainage way in the ‘Ewa District. During heavy rains, stormwater runoff exceeds the capacity of the Gulch and adjacent lands are flooded. Government agencies partnered with some of the major private land owners to develop a comprehensive drainage/flood mitigation plan for Kalo‘i Gulch, including a system of on-site detention basins, channel improvements and a concrete-lined outlet to the ocean at ‘Ewa Beach. Some community members who were concerned about the cultural and environmental impact of the planned drainage outlet at ‘Ewa Beach requested and were granted a Contested Case Hearing for the project.

The Kalo‘i Gulch planning and permitting process should be evaluated for “lessons learned” that could be applied to future large-scale drainage plans. BMPs and the roles of private and public entities are of critical importance. Lessons learned from the Kalo‘i Gulch process could be applied to future plans for large-scale developments that must accommodate major drainageways, like Makaīwa, Kalaeloa, and West Kapolei. The proposed Ho‘opili development is also within the Kalo‘i Gulch catchment area. Possible Champions and/or Partners: DPP, DLNR, Major Private Land Owners.

STRATEGY F: Stormwater Retention/Detention—including golf course detention

RETAIN/DETAIN STORMWATER TO REDUCE FLOODING. The ‘Ewa Plain is relatively flat and heavy rains result in sheet flows from the mountains that can flood extensive areas, often with flood waters several feet deep. This sheet flow flooding - rather than the stream flooding experienced by most of the rest of O‘ahu - makes for unique challenges. Additionally, depending on the size and location of proposed residential and commercial development projects, the City’s permitting process does not always require on-site retention or detention of stormwater runoff.

Given the vulnerability of most of the ‘Ewa Plain to flooding, City DPP should consider establishing an ‘Ewa-specific set of standards for retention or detention of stormwater runoff for new development projects. The City’s recent Low Impact Development drainage standards are meant to address water quality issues, and thus do not significantly impact large storm events. ‘Ewa-specific stormwater standards should specifically address large-scale sheet flooding and provide both regional and individual benefits. Where possible, retention and detention works should be retrofitted into existing developments, including existing golf courses, parks, and greenways. Possible Champions and/or Partners: DPP, DLNR.

STRATEGY G: Renewable Energy Opportunities

TAKE ADVANTAGE OF RENEWABLE ENERGY OPPORTUNITIES TO REDUCE CONSUMPTION OF FOSSIL FUELS AND THE COST OF TREATING AND DELIVERING WATER. Ground water pumping, alternative technologies for potable water, and recycled water facilities, are high energy consumers. Renewable energy technologies could potentially reduce the energy costs associated with treating and delivering water over the long term. Additionally, renewable energy tends to be more environmentally friendly than conventional fossil fuel-based energy production.

Hawaiian Electric Company is continuing to increase the amount of its electrical power production that comes from solar and wind. The ‘Ewa District, with its high solar radiation, has been proposed for several solar farms to generate electricity. Additionally, the City’s H-POWER plant in Campbell Industrial Park burns municipal solid waste and produces electricity that is sold to the Hawaiian Electric Company. Water purveyors in ‘Ewa should develop small scale “off the grid” PV systems to power their pumps, desalination plants, and other facilities that have high energy requirements. Possible Champions and/or Partners: HECO, Renewable Energy Companies, BWS, U.S. Navy, Pural Water Specialty Company, Inc.

STRATEGY H: 'Ewa Caprock District Cooling

TEST THE FEASIBILITY OF USING COLD DEEP WELL WATER TO PROVIDE AIR CONDITIONING SERVICES IN THE 'EWA DISTRICT. Air conditioning for homes, businesses, offices, institutions and industrial uses requires large amounts of electrical energy – especially in relatively hot and dry regions like the 'Ewa District. A private company, HONOLULU SEAWATER COOLING, is planning to provide air conditioning services to downtown Honolulu office buildings through the use of deep, cold ocean water. A similar air conditioning project may be feasible for 'Ewa using cold water from deep basal seawater wells or deep ocean water. This project could result in a significant savings of electrical power. This project would be most feasible in the western portions of the 'Ewa District such as Kapolei, Campbell Industrial Park, and Ko'olina, due to their proximity to deep ocean water off the western coat of O'ahu. This alternate air conditioning system should become more feasible as the City of Kapolei continues to develop, with more offices, retail commercial and mid-rise and even high rise residential structures. Possible Champions and/or Partners: CWRM, HECO, Honolulu Seawater Cooling Company, Kapolei Business Association.

STRATEGY I: Convert Cesspools to Municipal Sewer System

PHASE OUT THE USE OF CESSPOOLS. Several residential neighborhoods in 'Ewa, including portions of 'Ewa Beach along North Road and Campbell Industrial Park, are not connected to the City's municipal wastewater collection and treatment system. A significant number of these older homes utilize cesspools to dispose of wastewater, and these outmoded systems may contribute to the contamination of surface runoff and ground water, and possibly contamination of nearshore waters because the wastewater is not treated. Contamination of ground water may also limit the use of wells that tap the brackish aquifer in areas with cesspools.

Homes in these neighborhoods should at least upgrade to septic systems, which provide some biological treatment, but eventual connection to the municipal wastewater collection system is the preferred long-term option. Funding for this kind of program could come from EPA grants, low interest loans, or through a City-created facilities improvement district. DOH is already administering a $10,000 tax credit that was passed by the Legislature in 2015 to replace priority cesspools. Possible Champions and/or Partners: ENV, DOH.

STRATEGY J: Integrate Planning for Land Use and Water Resources Management

Planning for both land use and water use is mandated by State statutes and City codes and ordinances, but to date there has been no significant attempt to integrate land use and water use planning. The question is often asked: “Does planning for water follow planning for land use or do limitations of water resources limit future land use?” A holistic answer to this question is: “Planning for land use and water use should be done in an integrated way such that the resulting plan provides for a balance of social, economic, transportation, land use, natural resources and water use and conservation for the planning area.” Going forward, as BWS completes and updates the Watershed Management Plans, and as DPP updates the Sustainable Communities Plans and Development Plans, there should be opportunities to integrate development and implementation of Land Use and Water Resources Management plans. Plans for Honolulu’s PRIMARY URBAN CENTER (PUC) may provide an opportunity for integrating land use and water use planning. Possible Champions and/or Partners: DPP, BWS.

STRATEGY K: ‘Ewa Sustainability Dialogues

ENGAGE KEY STAKEHOLDERS IN DIALOGUES ON CREATING A SUSTAINABLE ‘EWA. The ‘Ewa District was designated over thirty years ago as O‘ahu’s “Second City” and principal future growth and development region. As land development in ‘Ewa has progressed, there have been a growing number of community members and community leaders who are opposed to continued development. Perhaps the “pro-development vs. no development” debate needs to refocus on a more complex and holistic set of issues: “How can a developing region like ‘Ewa become more sustainable – socially, economically, culturally and ecologically?” This strategy suggests a process whereby community leaders, elected officials, key public agencies, non-profit organizations and educational institutions can engage in ongoing dialogues focused on developing programs toward a sustainable future for the ‘Ewa community.

The University of Hawai‘i at West O‘ahu aims to be a model of sustainability. Its Office of Sustainability has a mission to “make the University of Hawai‘i, West O‘ahu – in its teaching, research, operations, and public service – a model of sustainability that integrates the complementary values of caring for people and our ecosystems in economically viable ways.” It also strives to be “a place where sustainability practices are integrated in the development and operation of the campus and within the surrounding community.” Located in the middle of the ‘Ewa District, the UH West O‘ahu Office of Sustainability is in a unique position to coordinate regional sustainability efforts. Possible Champions and/or Partners: UH West O‘ahu Sustainability Coordinator, Mālama Learning Center, ‘Ewa Neighborhood Board, Kapolei/Makakilo/Honokai Hale Neighborhood Board, DPP, BWS, DHHL and others.

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CHAPTER 5
IMPLEMENTATION

‘EWA WATERSHED MANAGEMENT PLAN

5 Implementation

5.1 Introduction

The ‘Ewa District, together with the Primary Urban Center (PUC), is the designated “growth district” for the island of O‘ahu. The 1980 population of the ‘Ewa District was 35,709; in 1990: 42,983; 2000: 68,696; and 2010: 101,397. The City’s population projections (May 2014) show an ‘Ewa population of 144,866 by 2035 – an increase of 43,000+ people over a span of 25 years, or an average of about 1,700 people per year.

The ‘Ewa Watershed Management Plan is not a policy plan that directs future growth and development of the district, but it can present strategies for the wise use of water resources. The “big picture” potable water story for the ‘Ewa District is summarized as follows:

- Sustainable yield of potable aquifers lying wholly within the ‘Ewa District (‘Ewa-Kunia Aquifer System Area): 16.0 MGD
- ‘Ewa 2010 domestic water demand (including import): 19.0 MGD
- Projected 2035 ‘Ewa domestic water demand: 26.9 MGD (+7.9 MGD)
- Projected ‘Ewa “build-out” domestic water demand: 42.7 MGD (+23.7 MGD)
- Much of ‘Ewa’s water supplies are provided by the Waipahu-Waiawa ASYA, which has a large Sustainable Yield of 104 MGD. However, 95+ percent of this ASYA lies within the Central O‘ahu District.

The EWMP thus provides an overall water resources management plan for the ‘Ewa District that emphasizes four important water principles:

1. Implement WATER CONSERVATION PROGRAMS at all levels of use: domestic, industrial, agricultural, and irrigation;
2. Continue to expand the production and use of RECYCLED WATER for industrial, irrigation, and agricultural uses;

3. USE POTABLE GROUND WATER WITH GREAT CARE - primarily for domestic water uses; and
4. SUPPLEMENT GROUND WATER WITH DESALINATED WATER to minimize the need for water transfers from Central O‘ahu, keeping ‘Ewa as self-sufficient as possible.

The ‘Ewa District is a rapidly growing region that is already near its limits of natural water supplies. Thus, ‘Ewa can and should become a MODEL FOR WISE WATER USE FOR URBANIZING AREAS OF HAWAI‘I by building upon the ahupua‘a concept of sustainable watershed management within ‘Ewa before relying on the transfer of additional water from adjacent watersheds. Lessons learned in ‘Ewa may be applied to the already urbanized Primary Urban Center of O‘ahu, the “Urban Fringe” areas of O‘ahu, and urbanizing areas on the neighbor islands. This final chapter of the EWMP presents details on future water use for the ‘Ewa District that are based on the water principles summarized above.

5.1.1 Water Policies for the ‘Ewa District

The principles presented above can be further elaborated by the following WATER POLICIES based on the ahupua‘a concept for future water use and development in the ‘Ewa District:

‘Ewa Water Policy #1:	Continue to reduce ‘Ewa’s per capita water demand, to the amount feasible, by implementing water conservation programs at all levels of use: domestic, industrial, agricultural, and irrigation.
‘Ewa Water Policy #2:	Reserve potable water sources for potable needs.
‘Ewa Water Policy #3:	Incrementally convert non-potable uses that are currently using potable water to non-potable sources.
‘Ewa Water Policy #4:	Maximize the use of recycled water.
‘Ewa Water Policy #5:	Minimize the need for increased import of potable water from Central O‘ahu ground water aquifers.
‘Ewa Water Policy #6:	Replenish the ‘Ewa caprock aquifer and use this source for non-potable uses.
‘Ewa Water Policy #7:	Continue efforts to provide economically-competitive desalinated water.

BWS fully intends to apply these policies to use and development of BWS water supplies for the ‘Ewa District. BWS recognizes that it will need the cooperation of all water users and providers to successfully enact these policies and urges everyone to support these water use and development policies for the benefit of the people of the ‘Ewa District, and for the long-term wise use of the district’s limited water supplies.

5.2 Water Use and Development Plan

The “WATER USE AND DEVELOPMENT PLAN that is presented in the following pages is based on the ‘Ewa District profile presented in Chapter 2 and on the “WATER DEMAND PROJECTIONS” that are detailed in Chapter 3.

The WATER USE AND DEVELOPMENT PLAN thus includes:

- A table that summarizes WATER DEMANDS for potable and non-potable water and WATER SUPPLIES by water purveyor: for the base year 2010 and for the year 2035, for the Mid-Growth (“DPP Policy”) scenario and for an unspecified “future build-out” year for the “Ultimate-Growth” scenario for the ‘Ewa District;
- A narrative section that explains some of the key assumptions that underlie the tabular summary of WATER DEMANDS and WATER SUPPLIES.

5.2.1 Summary of Demand and Supply – Most Probable Demand Scenario (Mid-Growth)

Of the water demand scenarios evaluated in Chapter 3, Low-Growth, Mid-Growth, High-Growth, and Ultimate-Growth, the most probable water demand scenario is the Mid-Growth Scenario, which reflects the City’s population and housing projections based on the policies outlined in the ‘Ewa Development Plan. This Mid-Growth scenario projects domestic water demand to increase to a total of 26.9 MGD, an increase of 7.9 MGD by the year 2035. Non-potable water demand (serving agricultural, industrial, and irrigation needs) is projected to increase by 0.5 MGD over the same time period.

Projected increases in BWS domestic water demand will be met by an increase in in-district permitted use in the Waipahu-Waiawa ASYA, desalinated water, and conversion of non-potable water demands from the ‘Ewa-Kunia ASYA to R-1 recycled water. These sources will provide enough water to allow BWS to reduce ground water imports from Central O‘ahu, making the district more self-sustaining.

The Federal Kalaeloa Water System will also need to increase its permitted use in the ‘Ewa-Kunia ASYA by about 0.3 MGD by 2035. There is currently about 1.6 MGD of unpermitted use in the ‘Ewa-Kunia ASYA, accounting for 10% of the total sustainable yield.

Table 5-1 'Ewa Most Probable Growth Scenario Water Demand and Supply Options

DOMESTIC WATER	2010	2035
BWS Potable Water System Demand	17.1	23.7[a]
BWS Potable Water System Supply	17.1	24.4
'Ewa-Kunia ASYA	9.9	9.2
Waipahu-Waiawa ASYA ('Ewa District)	0.0	10.0
Waipahu-Waiawa ASYA Import (Central O'ahu District)	7.2	3.5
Desalination Facility Water Supply (Kalaeloa & Kapolei)	0.00	1.7
Federal Kalaeloa Water System Demand	1.3	2.6
'Ewa-Kunia ASYA Supply	1.3	2.6[b]
Federal Kapilina Homes Demand	0.6	0.6
Waipahu-Waiawa ASYA Import (Central O'ahu District)	0.6	0.6
TOTAL DOMESTIC WATER DEMAND	**19.0**	**26.9**
TOTAL DOMESTIC WATER SUPPLY	**19.0**	**27.3**
AGRICULTURAL WATER	**2010**	**2035**
Agricultural Water Demand (Mauka of H-1 Freeway)	3.6	3.6
Waiāhole Ditch Irrigation System Supply	3.6	4.1
Agricultural Water Demand (Ho'opili Area)	3.2	0.2
Waipahu-Waiawa ASYA ('Ewa District) Supply	3.2	3.2
Agricultural Water Demand (ESQD Area)	0.2	0.2
Pu'uloa ASYA Supply	0.2	0.5
TOTAL AGRICULTURAL WATER DEMAND	**7.0**	**4.0**
TOTAL AGRICULTURAL WATER SUPPLY	**7.0**	**7.8**
INDUSTRIAL WATER	**2010**	**2035**
Industrial Water Demand	7.2	8.5
BWS Honouliuli WRF (R-1) Supply	2.9	4.0[a]
BWS Honouliuli WRF (R-O) Supply	1.4	2.0
'Ewa-Kunia ASYA Supply	0.2	0.2
Malakole ASYA Supply	2.8	3.0
TOTAL INDUSTRIAL WATER DEMAND	**7.2**	**8.5**
TOTAL INDUSTRIAL WATER SUPPLY	**7.3**	**9.2**
GOLF COURSE IRRIGATION WATER	**2010**	**2035**
Golf Course Water Demand	7.5	7.5
BWS Honouliuli WRF (R-1) Supply	4.1	5.0
'Ewa-Kunia ASYA Supply	0.6	0.0[c]
Kapolei ASYA Supply	0.4	0.4
Pu'uloa ASYA Supply	2.3	2.4
TOTAL GOLF COURSE IRRIGATION DEMAND	**7.5**	**7.5**
TOTAL GOLF COURSE IRRIGATION SUPPLY	**7.5**	**7.8**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

a 1 MGD of Industrial water demand, currently supplied by the BWS potable water system, will be converted to R-1

b Kalaeloa Water System is supplied by Barber's Point Shaft, which has a PU of 2.34 MGD. Additional PU will need to be requested from the 'Ewa-Kunia ASYA to supply domestic water demands.

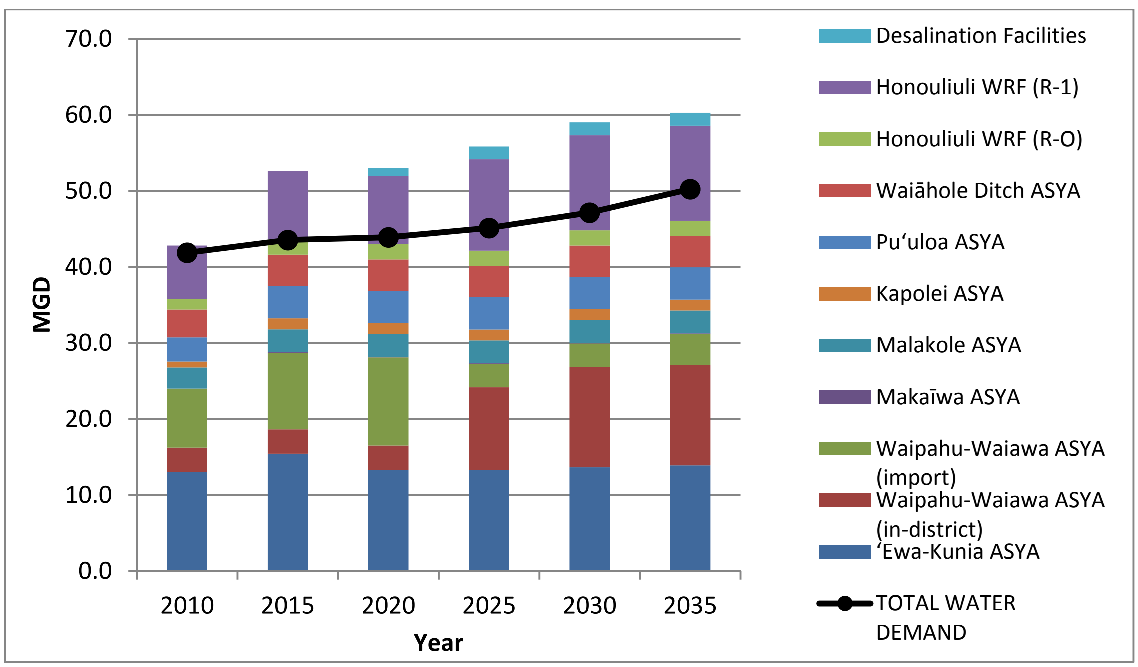
c Ground water supplies to be converted to R-1 recycled water, freeing up basal ground water for other uses.

Table 5-1 Summary of ‘Ewa Most Probable Growth Scenario Water Demand and Supply Options (Continued)

LANDSCAPE IRRIGATION WATER	2010	2035
Landscape Irrigation Water Demand	1.2	3.4
BWS Honouliuli WRF (R-1) Supply	0.1	3.5
‘Ewa-Kunia ASYA Supply	1.0	2.0
Kapolei ASYA Supply	0.4	1.0
Makaīwa ASYA Supply	0.0	0.1
Pu‘uloa ASYA Supply	0.7	1.4
TOTAL LANDSCAPE IRRIGATION DEMAND	**1.2**	**3.4**
TOTAL LANDSCAPE IRRIGATION SUPPLY	**2.1**	**8.0**
‘EWA WATER	**2010**	**2035**
TOTAL WATER DEMAND	**41.9**	**50.2**
TOTAL WATER SUPPLY	**42.8**	**60.3**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

Figure 5-1 ‘Ewa Most Probable Water Demand Scenario and Supply Options



Non-potable water needs increase very little in the Mid-Growth Scenario because of a decrease in agricultural water demands (3.0 MGD) as farms are converted to residential and other urban uses. Increases in landscape irrigation and industrial water demand were not enough to offset the decrease in agricultural water demand. Increases in landscape irrigation water demand can be met with existing permitted use and an increase in recycled water from the BWS Honouliuli Water Recycling Facility.

The capacity of the Honouliuli Water Recycling Facility to produce R-1 quality water will need to be increased from 10.0 MGD to 12.5 MGD by 2035 to account for the increase in irrigation demands that are projected. Planned conversion of 1 MGD of non-potable industrial water demands from the BWS potable system to recycled water will further reduce the need to import water, increasing ‘Ewa’s self-sufficiency. Additionally, the construction of a recycled water reservoir will allow for the Ho‘opili development to use R-1 water for irrigation of landscaped areas. Ko Olina Golf Club is also expected to convert from ground water to R-1 recycled water for irrigation, thus freeing up permitted use in the ‘Ewa-Kunia ASYA.

Table 5-2 Water Sources Needed to Supply the Most Probable Scenario

Source	Existing Capacity (MGD)	Future Capacity Needed (MGD)	Increase in Capacity Needed By (Year)	Increase Needed for (Use)
‘Ewa-Kunia ASYA	14.4	14.7[a]	2035	Domestic
Waipahu-Waiawa ASYA (In-District)	15.8	18.1[b]	2030	Domestic
Waipahu-Waiawa ASYA (import from Central O‘ahu)	7.8	4.1[c]	N/A	N/A
Makaīwa ASYA	0.07	0.07	N/A	N/A
Malakole ASYA	2.8	2.8	N/A	N/A
Kapolei ASYA	1.9	1.9	N/A	N/A
Pu‘uloa ASYA	10.1	10.1	N/A	N/A
Waiāhole Ditch ASYA	4.3	4.3	N/A	N/A
Honouliuli WRF (R-O)	2.0	2	N/A	N/A
Honouliuli WRF (R-1)	10.0	12.5[d]	2025	Industrial, Irrigation
Desalination Facilities	0.0	1.7[e]	2020-2025	Domestic

a Kalaeloa Water System increases PU by 0.3 MGD

b ‘Ewa Shaft increases PU by 2.3 MGD.

c BWS import decreases by 3.7 MGD.

d BWS needs in increase capacity by at least 2.5 MGD

e BWS needs to bring online at capacity of at least 1.7 MGD

Figure 5-2

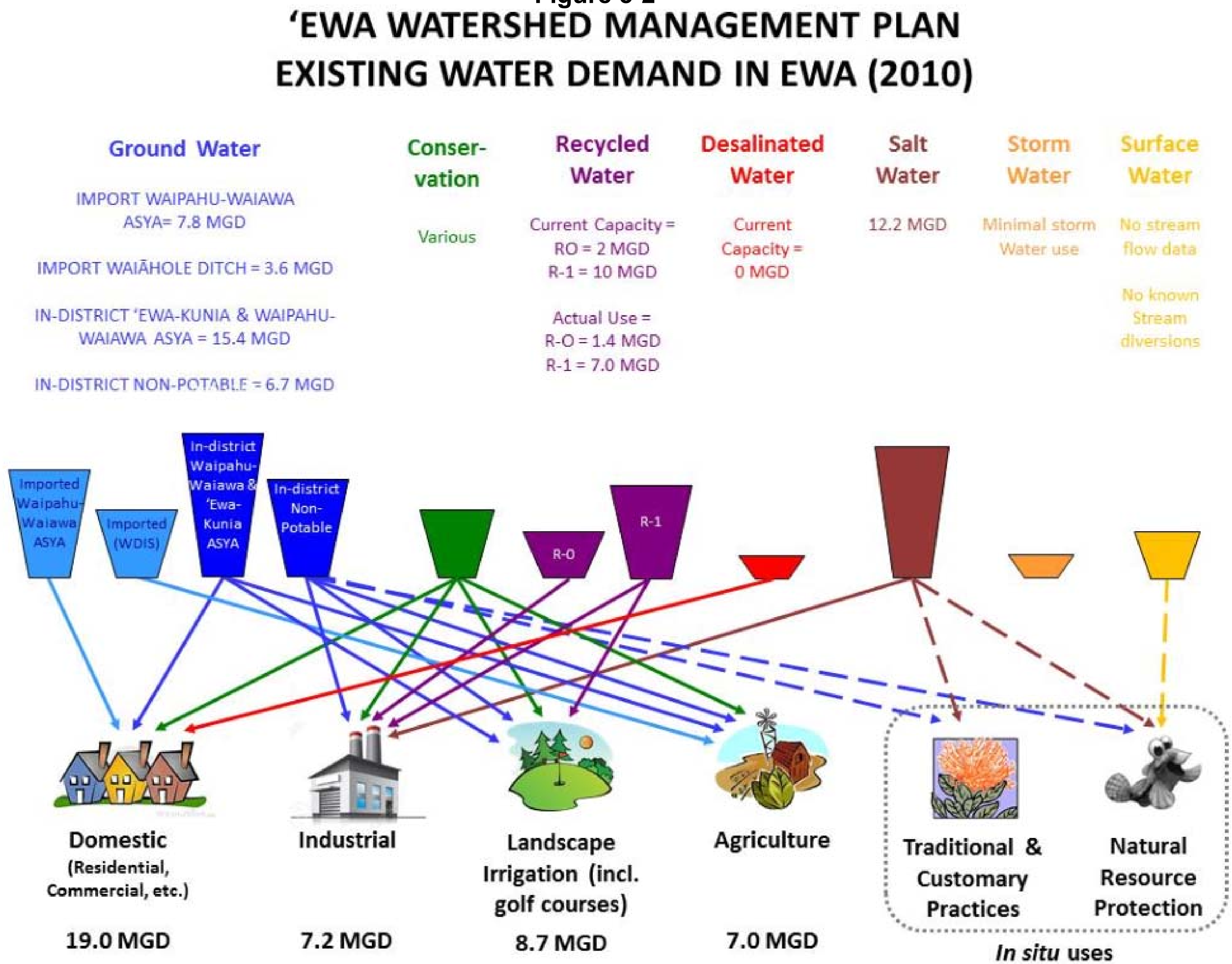
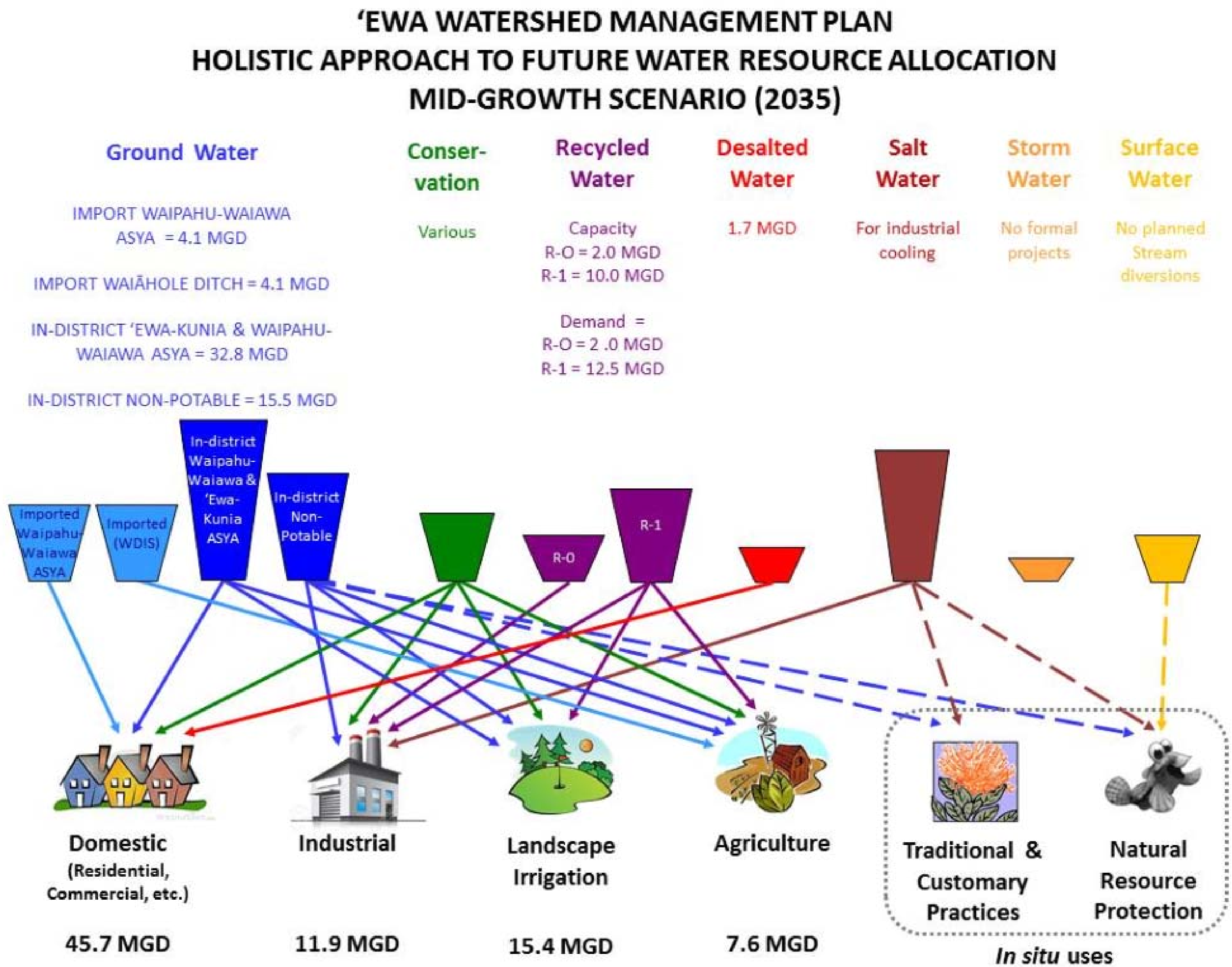

'EWA WATERSHED MANAGEMENT PLAN
EXISTING WATER DEMAND IN EWA (2010)
Ground Water
IMPORT WAIPAHU-WAIAWA ASYA= 7.8 MGD
IMPORT WAIĀHOLE DITCH = 3.6 MGD
IN-DISTRICT 'EWA-KUNIA & WAIPAHU-WAIAWA ASYA = 15.4 MGD
IN-DISTRICT NON-POTABLE = 6.7 MGD
Conser-vation
Various
Recycled Water
Current Capacity = RO = 2 MGD R-1 = 10 MGD
Actual Use = R-O = 1.4 MGD R-1 = 7.0 MGD
Desalinated Water
Current Capacity = 0 MGD
Salt Water
12.2 MGD
Storm Water
Minimal storm Water use
Surface Water
No stream flow data
No known Stream diversions
Imported Waipahu-Waiawa ASYA
Imported (WDIS)
In-district Waipahu-Waiawa & 'Ewa-Kunia ASYA
In-district Non-Potable
R-0
R-1
Domestic (Residential, Commercial, etc.)
19.0 MGD
Industrial
7.2 MGD
Landscape Irrigation (incl. golf courses)
8.7 MGD
Agriculture
7.0 MGD
Traditional & Customary Practices
Natural Resource Protection
In situ uses

Figure 5-3



'EWA WATERSHED MANAGEMENT PLAN
HOLISTIC APPROACH TO FUTURE WATER RESOURCE ALLOCATION
MID-GROWTH SCENARIO (2035)
Ground Water
IMPORT WAIPAHU-WAIAWA ASYA = 4.1 MGD
IMPORT WAIĀHOLE DITCH = 4.1 MGD
IN-DISTRICT 'EWA-KUNIA & WAIPAHU-WAIAWA ASYA = 32.8 MGD
IN-DISTRICT NON-POTABLE = 15.5 MGD
Conser-vation
Various
Recycled Water
Capacity
R-O = 2.0 MGD
R-1 = 10.0 MGD
Demand =
R-O = 2 .0 MGD
R-1 = 12.5 MGD
Desalted Water
1.7 MGD
Salt Water
For industrial cooling
Storm Water
No formal projects
Surface Water
No planned Stream diversions
Imported Waipahu-Waiawa ASYA
Imported (WDIS)
In-district Waipahu-Waiawa & 'Ewa-Kunia ASYA
In-district Non-Potable
R-O
R-1
Domestic
(Residential, Commercial, etc.)
45.7 MGD
Industrial
11.9 MGD
Landscape Irrigation
15.4 MGD
Agriculture
7.6 MGD
Traditional & Customary Practices
Natural Resource Protection
In situ uses

5.2.2 Summary of Demand and Supply – Ultimate-Growth Scenario

The Ultimate-Growth Water Demand Scenario was evaluated to test the limits of the available water supply by projecting water demands in a scenario where all proposed ‘Ewa developments have been built. Two Ultimate Growth Scenarios were assessed to demonstrate the impacts of moderate versus aggressive application of the water principles and policies for ‘Ewa described in Section 5.1.

5.2.2.1 Ultimate-Growth Scenario: Moderate Application of ‘Ewa WMP Water Principles and Policies

In the Ultimate-Growth scenario, agriculture within the Community Growth Boundary has been replaced by urban uses, but has increased outside of the Community Growth Boundary in areas where water infrastructure improvements could provide water to farms. Industry and golf course water needs increase modestly, while landscape irrigation water demands increase by 4.7 MGD, or by 400%. Irrigation water demands are further increased by 15% to account for anticipated decreases in rainfall and increases in evapotranspiration due to climate change.

In the Ultimate-Growth scenario, BWS domestic water demand increases by 20.9 MGD (approximately 120%) over 2010. If the policies described in Section 5.1 are applied modestly, BWS would need to increase permitted use and increase water transfers from Central O‘ahu. While some increase in PU and import from Central O‘ahu is reasonable, anticipated reductions in rainfall due to climate change are anticipated to lower sustainable yields on O‘ahu. Desalination is a source of reliable, drought-proof drinking water and can be provided at comparable costs to water imports, providing they are coupled with renewable energy technologies. Therefore in this scenario, BWS increases its desalination capacity to 5.0 MGD to reduce ‘Ewa’s reliance on imported water and eliminate the need to dedicate a new source in Central O‘ahu for use in ‘Ewa.

Additionally, the Federal domestic demand in Kalaeloa exceeds the current permitted use of the source for this system. A small increase in PU may be possible, as there is still unpermitted water in the ‘Ewa-Kunia ASYA, but about 2.0 MGD would still need to be served by an as yet unknown source.

Agricultural water demands would increase by 0.8 MGD between 2010 and in the Ultimate-Demand Scenario despite a modest overall decrease in agricultural acres. This occurs because the agricultural water rate (gallons per acre per day) is expected to increase by 15% to account for anticipated 15% declines in rainfall due to climate change.

Table 5-3 ‘Ewa Ultimate-Growth Scenario Water Demand and Supply Options (Moderate Application of Principles and Policies)

DOMESTIC WATER	2010	2035
BWS Potable Water System Demand	17.1	37.9[a]
BWS Potable Water System Supply	17.1	38.7
‘Ewa-Kunia ASYA	9.9	9.2
Waipahu-Waiawa ASYA (‘Ewa District)	0.0	15.0[b]
Waipahu-Waiawa ASYA Import (Central O‘ahu District)	7.2	9.5
Desalination Facility Water Supply (Kalaeloa & Kapolei)	0.0	5.0
Federal Kalaeloa Water System Demand	1.3	4.2
‘Ewa-Kunia ASYA Supply	1.3	2.6[c]
Source to be determined	0	2.0[c]
Federal Kapilina Homes Demand	0.6	0.6
Waipahu-Waiawa ASYA Import (Central O‘ahu District)	0.6	0.6
TOTAL DOMESTIC WATER DEMAND	**19.0**	**43.7**
TOTAL DOMESTIC WATER SUPPLY	**19.0**	**43.9**
AGRICULTURAL WATER	**2010**	**2035**
Agricultural Water Demand (Mauka of H-1 Freeway)	3.6	4.9
Waiāhole Ditch Irrigation System Supply	3.6	4.1
Waipahu-Waiawa ASYA (‘Ewa District)	0.0	1.0
Storm Water Capture	0.0	1.0
Agricultural Water Demand (Ho‘opili Area)	3.2	0.4
Waipahu-Waiawa ASYA (‘Ewa District) Supply	3.2	3.2
BWS Honouliuli WRF (R-1) Supply	0.0	0.0
Agricultural Water Demand (ESQD Area)	0.2	2.3
Pu‘uloa ASYA Supply	0.2	1.5
BWS Honouliuli WRF (R-1) Supply	0.0	1.5
TOTAL AGRICULTURAL WATER DEMAND	**7.0**	**7.6**
TOTAL AGRICULTURAL WATER SUPPLY	**7.0**	**12.3**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

a 1 MGD of Industrial water demand, currently supplied by the BWS potable water system, will be converted to R-1

b ‘Ewa Shaft will increase its PU from 7.66 MGD to 10 MGD. Well EP 10 is expected to be converted to potable use after Ko Olina Golf Course converts to recycled water.

c Kalaeloa Water System is supplied by Barber’s Point Shaft, which has a PU of 2.34 MGD. Some additional PU will need to be requested to supply domestic water demands, but there is not enough available yield to be able to supply all of Kalaeloa’s water demands. Additional source is as yet unknown.

Table 5-3 ‘Ewa Ultimate-Growth Scenario Water Demand and Supply Options (Moderate Application of Principles and Policies, Continued)

INDUSTRIAL WATER	2010	2035
Industrial Water Demand	7.2	11.9
BWS Honouliuli WRF (R-1) Supply	2.9	6.0
BWS Honouliuli WRF (R-O) Supply	1.4	2.5
‘Ewa-Kunia ASYA Supply	0.2	0.2
Malakole ASYA Supply	2.8	3.0
Pu‘uloa ASYA Supply	0.0	0.5
TOTAL INDUSTRIAL WATER DEMAND	**7.2**	**11.9**
TOTAL INDUSTRIAL WATER SUPPLY	**7.3**	**12.2**
GOLF COURSE IRRIGATION WATER	**2010**	**2035**
Golf Course Water Demand	7.5	9.5
BWS Honouliuli WRF (R-1) Supply	4.1	6.5
‘Ewa-Kunia ASYA Supply	0.6	0.0[d]
Kapolei ASYA Supply	0.4	1.5
Pu‘uloa ASYA Supply	2.3	5.1
TOTAL GOLF COURSE IRRIGATION DEMAND	**7.5**	**9.5**
TOTAL GOLF COURSE IRRIGATION SUPPLY	**7.5**	**13.1**
LANDSCAPE IRRIGATION WATER	**2010**	**2035**
Landscape Irrigation Water Demand	1.2	5.9
BWS Honouliuli WRF (R-1) Supply	0.1	5.0
‘Ewa-Kunia ASYA Supply	1.0	1.0
Kapolei ASYA Supply	0.3	2.0
Makaīwa ASYA Supply	0.0	0.1
Pu‘uloa ASYA Supply	0.7	5.5
TOTAL LANDSCAPE IRRIGATION DEMAND	**1.2**	**5.9**
TOTAL LANDSCAPE IRRIGATION SUPPLY	**2.1**	**13.6**
‘EWA WATER	**2010**	**2035**
TOTAL WATER DEMAND	**41.9**	**77.6**
TOTAL WATER SUPPLY	**42.8**	**95.1**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

d Ground water supplies to be converted to recycled water, freeing up basal ground water for other uses.

While agriculture is expected to decrease within the community growth boundary, it will expand in areas that are currently not in cultivation, thus requiring new sources of water. The area mauka of the H-1 Freeway was previously in sugar cultivation and old water infrastructure could be rehabilitated to accept water from the Waiāhole Ditch or storm water from Central O‘ahu. Some additional ground water may also be available. In the Navy ESQD zone, agriculture could be serviced by the Honouliuli Water Recycling Facility. Distribution lines from the WRF would need to be installed in order to provide R-1 recycled water to this area.

Increases in non-potable industrial water demand is expected to be met with modest increases in ground water and both R-O and R-1 recycled water. 1 MGD of industrial water currently served by the BWS potable water system will be converted to recycled R-1 water.

Supply of golf course irrigation water is expected to shift from brackish ground water to R-1 recycled water, as the recycled water service area is expanded. Ko Olina golf course will convert to recycled water as R-1 distribution infrastructure extends westward. This would allow well EP-10 to serve domestic water demands. Conversion of some irrigation demands from ground water to recycled water protects brackish ground water sources from over-pumping.

Landscape irrigation water demands will increase by almost 400% in the Ultimate-Growth Scenario. This growth will mostly be met by an increase in recycled R-1 water, supplemented by brackish ground water. No increases in permitted use are anticipated.

Water demands in the Ultimate-Growth Scenario can be met using a moderate approach to ‘Ewa water principles and policies, but will require a diversification of resources from primarily ground water to a greater reliance on recycled water and some new sources, such as desalinated water and possibly storm water. This, and increases in PU from in-district ground water sources, can moderate the demand for water to be imported from Central O‘ahu and eliminate the need for new sources to be developed, with the exception of the Kalaeloa Water System, which would still need to find a new source.

As development and climate change continues to increase water demands while potentially shrinking natural water supplies, demands for potable water could be decreased through greater emphasis on conservation, conversion to recycled water and gray water, and investment in storm water infrastructure. All of these options would decrease the per capita demand for potable water, thus stretching the available supply.

5.2.2.2 Ultimate-Growth Scenario: Aggressive Application of ‘Ewa WMP Water Principles and Policies

The previous section found that applying a moderate approach to ‘Ewa water principles and policies could provide enough water to meet demand in an Ultimate-Growth scenario, but that ground water imports from Central O‘ahu would need to be increased. A more aggressive application of ‘Ewa’s water policies would increase the emphasis on water conservation programs, recycled water use, and dedicating ground water for potable domestic needs. Existing agricultural, golf course, and landscape irrigation water demands, currently supplied by the BWS potable water system, are converted to R-1 recycled water. This conversion is expected to decrease the domestic BWS ‘Ewa District per capita water demand from 185 GPCD in 2010 to 150 GPCD in the future “Ultimate-Growth” scenario. This decreases the total domestic water demand by 2.4 MGD from the moderate Ultimate-Growth scenario that applied the water principles less aggressively, and had a per capita water demand of 160 GPCD.

Table 5-4 ‘Ewa Ultimate-Growth Scenario Water Demand and Supply Options (Aggressive Application of Principles and Policies)

DOMESTIC WATER	2010	ULTIMATE
BWS Potable Water System Demand	17.1	35.5[a]
BWS Potable Water System Supply	17.1	36.2
‘Ewa-Kunia ASYA	9.9	9.2
Waipahu-Waiawa ASYA (‘Ewa District)	0.0	16.0[b]
Waipahu-Waiawa ASYA Import (Central O‘ahu District)	7.2	6.0
Desalination Facility Water Supply (Kalaeloa & Kapolei)	0.0	5.0
Federal Kalaeloa Water System Demand	1.3	3.8
‘Ewa-Kunia ASYA Supply	1.3	2.6 [c]
Source to be determined	0	1.5 [c]
Federal Kapilina Homes Demand	0.6	0.6
Waipahu-Waiawa ASYA Import (Central O‘ahu District)	0.6	0.6
TOTAL DOMESTIC WATER DEMAND	**19.0**	**39.8**
TOTAL DOMESTIC WATER SUPPLY	**19.0**	**40.9**
AGRICULTURAL WATER	**2010**	**ULTIMATE**
Agricultural Water Demand (Mauka of H-1 Freeway)	3.6	4.9
Waiāhole Ditch Irrigation System Supply	3.6	4.1
Waipahu-Waiawa ASYA (‘Ewa District)	0.0	0.0
Storm Water Capture	0.0	1.0
Agricultural Water Demand (Ho‘opili Area)	3.2	0.4
Waipahu-Waiawa ASYA (‘Ewa District) Supply	3.2	0.0 [d, e]
BWS Honouliuli WRF (R-1) Supply	0.0	0.5[e]
Agricultural Water Demand (ESQD Area)	0.2	2.3
Pu‘uloa ASYA Supply	0.2	0.0 [d]
BWS Honouliuli WRF (R-1) Supply	0.0	3.5
Agricultural Water Demand (formerly on BWS potable system)	0.0	0.2
BWS Honouliuli WRF (R-1) Supply	0.0	0.2
TOTAL AGRICULTURAL WATER DEMAND	**7.0**	**7.8**
TOTAL AGRICULTURAL WATER SUPPLY	**7.0**	**9.4**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

a Existing agricultural, golf course, and landscape irrigation water demands, currently supplied by the BWS potable water system, are converted to R-1 recycled water.

b ‘Ewa Shaft will increase its PU from 7.66 MGD to 10 MGD. Well EP 10 is expected to be converted to potable use after Ko Olina Golf Course converts to recycled water.

c Kalaeloa Water System is supplied by Barber’s Point Shaft, which has a PU of 2.34 MGD. Some additional PU will need to be requested to supply domestic water demands, but there is not enough available yield to be able to supply all of Kalaeloa’s water demands. Additional source is as yet unknown.

d Ground water supplies to be converted to recycled water, freeing up basal ground water for other uses.

e Farm land is largely displaced by urban uses, reducing agricultural water demand. Commercial agriculture is converted from ground water to R-1 recycled water.

Table 5-4 ‘Ewa Ultimate-Growth Scenario Water Demand and Supply Options (Aggressive Application of Principles and Policies, Continued)

INDUSTRIAL WATER	2010	ULTIMATE
Industrial Water Demand	7.2	11.9
BWS Honouliuli WRF (R-1) Supply	2.9	9.0
BWS Honouliuli WRF (R-O) Supply	1.4	2.5
‘Ewa-Kunia ASYA Supply	0.2	0.0[d]
Malakole ASYA Supply	2.8	0.0[d]
Puʻuloa ASYA Supply	0.0	0.5[d]
TOTAL INDUSTRIAL WATER DEMAND	**7.2**	**11.9**
TOTAL INDUSTRIAL WATER SUPPLY	**7.3**	**12.0**
GOLF COURSE IRRIGATION WATER	**2010**	**ULTIMATE**
Golf Course Water Demand	7.5	9.5
BWS Honouliuli WRF (R-1) Supply	4.1	10.0
‘Ewa-Kunia ASYA Supply	0.6	0.0[d]
Kapolei ASYA Supply	0.4	0.0[d]
Puʻuloa ASYA Supply	2.3	0.0[d]
TOTAL GOLF COURSE IRRIGATION DEMAND	**7.5**	**9.5**
TOTAL GOLF COURSE IRRIGATION SUPPLY	**7.5**	**10.0**
LANDSCAPE IRRIGATION WATER	**2010**	**ULTIMATE**
Landscape Irrigation Water Demand	1.2	6.4
BWS Honouliuli WRF (R-1) Supply	0.1	4.7
‘Ewa-Kunia ASYA Supply	1.0	1.0
Kapolei ASYA Supply	0.3	1.3
Makaīwa ASYA Supply	0.0	0.1
Puʻuloa ASYA Supply	0.7	0.2
TOTAL LANDSCAPE IRRIGATION DEMAND	**1.2**	**6.4**
TOTAL LANDSCAPE IRRIGATION SUPPLY	**2.1**	**7.4**
‘EWA WATER	**2010**	**ULTIMATE**
TOTAL WATER DEMAND	**41.9**	**75.5**
TOTAL WATER SUPPLY	**42.8**	**79.6**

Projected future supply was based on capacity of the water source, i.e., the PU of a well or the capacity of a water supply facility.

d Ground water supplies to be converted to recycled water, freeing up basal ground water for other uses.

Use of recycled water is maximized to supply most agricultural, golf course, and landscape irrigation water demands, as well as non-potable industrial water demand that can use R-1 or R-O quality water. This frees up permitted use in all of the ground water aquifers in ‘Ewa. Wells that have their uses converted to recycled water could have their permitted use transferred to BWS for new wells further mauka in the ‘Ewa-Kunia ASYA, such as Ekahanui Well. This would decrease the amount of water that would need to be imported from Central Oʻahu.

Table 5-5 Recycled Water Demand in the Ultimate-Growth Scenario Addressed by Aggressive Reliance on In-District Water Sources

Water Use	R-1 Demand (MGD)	R-O Demand (MGD)
Agriculture	**4.2**	**N/A**
Ho‘opili	0.5	- - -
U.S. Navy ESQD Zone	3.5	- - -
Conversion from BWS Potable	0.2	- - -
Industrial	**9.0**	**2.5**
Existing and New Industrial	6.0	2.5
Conversion from Private Brackish Wells	3.0	- - -
Golf Course	**10.0**	**N/A**
Existing Golf Courses on R-1	5.5	- - -
New Golf Course	1.0	- - -
Conversion from Private Brackish Wells	3.5	- - -
Landscape Irrigation	**4.7**	**N/A**
Existing and New Landscaping	3.0	- - -
Conversion from Private Brackish Wells	1.7	- - -
TOTAL RECYCLED WATER DEMAND	**28.0**	**2.5**

Desalinated water would still be planned as another option in ‘Ewa’s diversified water source “toolkit.” Maximization of recycled water means that desalinated water does not have to increase beyond 5 MGD in this Ultimate-Growth Scenario. It also guards against unanticipated reductions in aquifer sustainable yields from climate change, increased competition for Waipahu-Waiawa ASYA water for other South O‘ahu districts, and unforeseen disasters, such as ground water contamination.

The emphasis on recycled water creates demand for approximately 28 MGD of R-1 water and 2.5 MGD of R-O water. The existing Honouliuli WWTP treats 26 MGD of wastewater to primary levels and would need to be expanded to provide enough water to the Honouliuli Water Recycling Facility for further treatment to R-1 and R-O standards. The City is currently under a consent decree to provide full secondary treatment at its Honouliuli WWTP by 2024. BWS would also need to upgrade the existing capacity of the Honouliuli WRF from 10 MGD of R-1 and 2.0 MGD of R-O water to at least 28 MGD of R-1 water and 2.5 MGD of R-O water.

BWS is already planning on expanding the Honouliuli WRF, but the aggressive application of ‘Ewa water principles and policies would require even larger and faster expansion, as well as distribution line to and storage facilities in new service areas. Costs for new infrastructure would also be borne upon private users, who currently have no requirement to use recycled water. Therefore, policies requiring recycled water use may have to be implemented, as well as programs to assist with infrastructure financing.

Although recycled water is the preferred source for agricultural irrigation, distributing R-1 water to the agricultural lands mauka of the H-1 Freeway is cost prohibitive. Additionally, if R-1 water with chloride contents of 300 mg/l percolated into the underlying ground water, it would increase the chloride content of BWS potable wells. Therefore, agriculture mauka of the H-1 Freeway is anticipated to continue to be irrigated by existing Waiāhole Ditch Irrigation System permits. Any additional agriculture in this area could be irrigated by a renovation of O‘ahu Sugar’s WP-5 water source in the ‘Ewa-Kunia ASYA, if SY is available, or new ground water wells in the Waipahu-Waiawa ASYA, if available. Unused Waiāhole Ditch water, previously used to irrigate fields in the area, and supplemented by storm water from Wahiawā as described in the Central O‘ahu Non-Potable Water Master Plan Phase 2 (2014), could also be used. Recycled water from the Schofield WWTP is expected to be used on Schofield and upper Kunia lands and not be made available to ‘Ewa.

Potable water demands could further decrease if more aggressive conservation and gray water projects, incentives, and requirements are pursued. If gray water were to be required for such uses and landscape irrigation or toilet flushing in commercial, residential, and hotel/resort water uses, ‘Ewa’s per capita demand could potentially be decreased to 140 GPCD or lower, further decreasing total domestic water demand.

5.3 Phasing and Funding of Projects with Champions

Projects with Champions, i.e., projects that have an identified lead agency or organization that is proposing, planning, or already implementing the action, are often complex, multi-year actions. Table 5-6 identifies the current status of each project, those actions of each project that are short-term (to begin implementation within 1-5 years), those actions that are long term (to begin implementation in 5 or more years), and potential funding sources.

Table 5-6 Watershed Management Project Phasing

Project	Current Status	Short-Term Actions (1-5 Years)	Long-Term Actions (5+ Years)	Potential Funding Sources
1 Honouliuli Water Recycling Facility	• Honouliuli WWTP treats 26 MGD of wastewater • 2010 Global Consent Decree requires WWTP upgrade to full secondary treatment by 2014 • Honouliuli WRF produces 2 MGD of R-O and 10 MGD of R-1 recycled water	• Upgrade Honouliuli WWTP to full secondary treatment • Prepare EA, plans, and specifications for and construct East Kapolei Recycled Water Reservoir	• Expand capacity of Honouliuli WRF	• BWS • ENV
2 Caprock Aquifer Storage and Recovery (ASR)	• CWRM regulates pumpage from the caprock aquifer, limiting the salinity of pumped water to 1,000 ppm	• Upgrade Honouliuli WWTP to full secondary treatment • Model location, application rates, and withdrawal locations and rates	• Add treatment capability to the Honouliuli WRF to produce R-2 quality water • Identify and secure lands in the Pu‘uloa and Kapolei ASYAs for application • Conduct feasibility study of treatment and infrastructure costs and benefits	• BWS • DOH Clean Water State Revolving Fund
3 Brackish and Seawater Desalination	• A Final EIS was accepted in September 2008 for the Kalaeloa Desalination Facility • A Draft EA for the Kapolei Baseyard and Brackish Desalination Plant was filed with OEQC in January 2017	Kalaeloa Desalination Facility: • Post-Treatment and Renewable Energy Study • Prepare plans and specifications for • Construct Kalaeloa Desalination Facility	• Design and construct Kapolei Baseyard and Brackish Desalination Plant	• BWS

Table 5-6 Watershed Management Project Phasing (continued)

Project	Current Status	Short-Term Actions (1-5 Years)	Long-Term Actions	Potential Partners
4 Waiāhole Ditch Water Loss Minimization	• Three deteriorated wooden siphons were replaced and other repairs made • A Draft EA for the Waiāhole Reservoir System Reservoirs 155 and 225 Improvements was filed with OEQC in January 2017	• Implement improvements to Reservoirs 155 and 255	• Continue to • Conduct water audits to identify water losses • Evaluate additional water loss minimization actions, such as piping	• ADC • USACE
5 Water Infrastructure for Agricultural Expansion Mauka of H-1 Freeway	• Irrigation water for the area is provided by the State WDIS • There are currently no plans for agricultural expansion on UHWO lands mauka of the H-1 Freeway	• Determine the potential for agricultural expansion with UHWO	• If feasible, rehabilitate historic reservoirs and irrigation ditches on UHWO lands • If needed and feasible, pump R-1 water uphill to service irrigation needs	• ADC • UHWO
6 Water Infrastructure for Navy ESQD Zone	• Irrigation water for the area is provided by the a Navy well • There are currently no plans for agricultural expansion on the Navy’s ESQD lands	• Upgrade the Honouliuli WWTP to full secondary treatment • Increase the R-1 capacity of the Honouliuli WRF to • Discuss with and obtain agreements with the Navy to allow for installation and use of R-1 infrastructure • Discuss with and obtain agreements with agricultural lessees to use R-1 water	• Develop or rehabilitate old lines for R-1 distribution to and throughout the farmed portions of the ESQD zone	• BWS • U.S. Navy
7 Kalaeloa Water System Improvements	• Water systems in Kalaeloa are undersized for proposed development and have high water loss	• Resolve ownership of Kalaeloa Water System • Design water system improvements	• Construct/ implement water system improvements	• Owner of Kalaeloa Water System • U.S. Navy

Table 5-6 Watershed Management Project Phasing (continued)

Project	Current Status	Short-Term Actions (1-5 Years)	Long-Term Actions	Potential Partners
8 Kalaeloa Heritage Park	• A small percentage of the Park has been cleared and operates for interpretive programs	• Remove invasive species • Plant native species • Archaeological surveys	• Construct a multi-purpose cultural center and visitor parking	• KHP • HCDA
9 Hoakalei Coastal Village Restoration	• Three preservation areas are being managed for native bird habitat and archaeological and cultural sites	• Build stewardship and cultural programs • Clean and restore the One‘ula-Kūalaka‘i shoreline	• Restore native plants • Community	• Hoakalei Cultural Foundation
10 Mālama Learning Center	• Runs/collaborates on seven programs to promote healthy living and sustainability, focusing on West O‘ahu schools	• Continue to grow the environmental, wellness, and cultural education programs in West O‘ahu schools	• Continue to support region-wide place-based environmental education	• State DOE • Leeward Community College • UH West O‘ahu • Wai‘anae Place-Based Wellness and Learning Alliance
11 Anchialine Pool Restoration	• Restored 14 ponds • Cleared invasive plants • Developed a trail system to minimize disturbance	• Identify a community group to steward the ponds	• Identify and restore an additional 15-30 pools • Reintroduce pinao‘ula • Create an outdoor leaning classroom	• USFWS • Kapolei High School • Leeward Community College • UH Mānoa
12 Wai‘anae Mountains Watershed Partnership	• Worked with schools and the community to develop firebreaks • Developed an outplanting and predator control programs • Collaborated on fencing projects	• Fencing of priority watersheds • Invasive weed control in priority watersheds • Feral goat control • Predator control • Native species outplanting	• Continued Education and outreach • Endangered species protection • Predator control • Fencing	• DLNR • O’ahu Army Natural Resources Program • Gill and Olson family trusts
13 Potable Source Water Protection (BWS “System-Wide” Project)	• Inventory of inactive landfills completed • Initial Source Water Assessment completed • Cesspool inventory completed	• Update inventories of PCAs • Monitor sources near PCAs	• Develop and implement source water protection strategies to minimize PCAs within source water capture zones	• BWS • DOH • DPP • CWRM

Table 5-6 Watershed Management Project Phasing (continued)

Project	Current Status	Short-Term Actions (1-5 Years)	Long-Term Actions	Potential Partners
14 Assess Resiliency of Critical Water Infrastructure (BWS “System-Wide” Project)	• BWS has identified existing infrastructure issues and priorities • BWS is funding a study of sea level rise and ground water inundation	• Identify facilities vulnerable to sea level rise and coastal erosion • Collaborate with other water-related agencies to collectively develop resiliency strategies	• Implement strategies to improve resiliency of existing infrastructure • Relocate facilities that are not able to be protected • Design new facilities to updated building standards	• BWS • DFM • ENV • DPP • UH • CZM
15 BWS Infrastructure Renewal and Replacement Program (BWS “System-Wide” Project)	• The BWS Water Master Plan was released in July 2016 • The system-wide Water Master Plan prioritized projects based on the likelihood and consequence of failure.	• Repair and replace high-priority pipelines • Repair and maintain existing reservoirs • Enhance the operations of existing pump stations • Maintain existing sources	• Extend the life of existing water infrastructure • Regularly assess the condition of pipelines and tunnels • Replace, repair, and upgrade reservoirs of concern in seismic events • Increase redundancy capacity • Add pumping capacity	• BWS

5.4 Watershed Management – Priority Watershed and Catalyst Project

In line with the five major objectives of the Oʻahu Water Management Plan, “critical watershed” is defined here as a watershed that: (1) provides various opportunities to promote sustainable watersheds, or (2) requires protection or enhancement of water quality and quantity, or (3) provides special opportunities to protect Native Hawaiian rights and traditional practices, or (4) presents special opportunities for organizing and implementing important watershed management actions, or (5) provides or may provide ground water or surface water supplies to meet current and future demand.

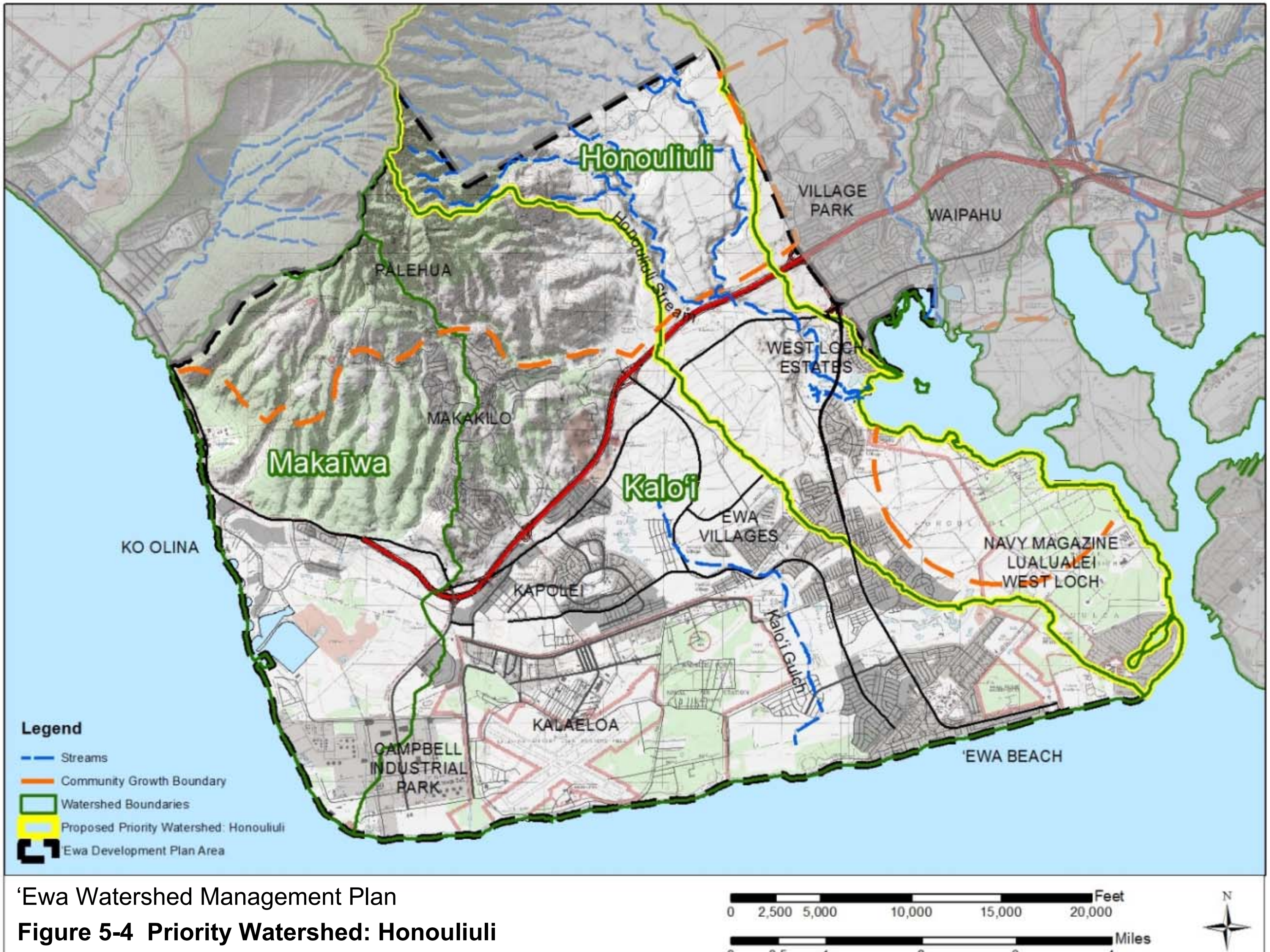
The HONOULIULI WATERSHED is designated as the critical watershed for the ‘Ewa district. Within this watershed, we have identified a comprehensive INTERAGENCY GROUND WATER AND SURFACE WATER QUALITY IMPROVEMENT PROGRAM as the “Catalyst Project.” A “Catalyst Project” is defined as a high priority project within the critical watershed that, when implemented, will provide energy, connectivity, information and inspiration for other projects and programs within the critical watershed. Thus, the project can be a CATALYST for positive action and change.

5.4.1 Brief Watershed Profile

HONOULIULI STREAM, an intermittent stream, is the only perennial stream in the ‘Ewa District. The District is otherwise drained by a network of gulches that are dry except during major rain events. The drainage area of Honouliuli Stream is 11.5 square miles of land in the Waiʻanae Mountains and the ‘Ewa Plain. Approximately two-thirds of the Honouliuli watershed lies within the ‘Ewa District; about one third is within the District of Central Oʻahu (Figure 5-1).

In the mauka section of this watershed, one dozen feeder streams originate in the Waiʻanae Mountains and in the plains of Central Oʻahu. These feeder streams flow together to form two main channels that meander through the northeastern sector of the ‘Ewa District. The two main channels join together just north of the H-1 Freeway, and thence flow for about two miles to the stream’s outlet into the West Loch of Pearl Harbor.

Current land uses within the Honouliuli watershed are mainly active agriculture and fallow agricultural land. In the near future, the lower reaches of the watershed will be developed as part of the planned community of Hoʻopili, which includes plans for 11,500 housing units, a shopping center, a light industrial park, a rail transit station, and land for farms. The City’s current ‘EWA DEVELOPMENT PLAN shows a “Community Development Boundary” Line that designates most of this watershed’s land north of the H-1 Freeway as “Agricultural” land, and lands south of the H-1 as “Urban Development.”



‘Ewa Watershed Management Plan

Figure 5-4 Priority Watershed: Honouliuli

5.4.2 Catalyst Project: Interagency Ground Water and Surface Water Quality Improvement Project

The quality of both ground water and surface water in the Honouliuli watershed are important because of: (a) BWS concerns for the quality of up to 10 MGD of ground water that will be drawn from the ‘EWA SHAFT in the near future to provide more potable water for ‘Ewa’s growing population; and (b) DOH Clean Water Branch’s (CWB) concerns for the water quality of West Loch and the nearshore waters associated with Pearl Harbor.

In 2012 the DOH CWB published a report entitled “Watershed Based Management Plan for Honouliuli Watershed: A Guide for Erosion and Sediment Control on Agricultural and Forest Reserve Lands.” The report provided an analysis of “Pollutant Causes and Sources” in the watershed and proposed a number of “Priority Activities and Management Practices.” Based on recent communications with a senior engineer in the Clean Water Branch, it appears that companies engaged in active agriculture within this watershed are generally following these best management practices (BMPs), which include measures to reduce pollutants and sediments from:

- Seed Corn farms
- Truck crop farms
- Grazing land
- Gulches
- Forest Reserve lands

BMPs include management measures such as vegetative cover of bare areas, vegetative barriers and filter strips to absorb runoff, grassed waterways, water and sediment control basins, low impact designs for farm roads, and fencing to protect Forest Reserve lands from feral pigs.

Given BWS concerns for ground water quality in this watershed and CWB concerns for surface water quality, there is an opportunity for BWS to partner with CWB to fund and oversee an ongoing program for the protection and improvement of surface water and ground water quality in the HONOULIULI WATERSHED.

Generally, BWS and CWB could partner to work with the major land owners in this watershed to form a WATERSHED ASSOCIATION whose members would implement various water quality BMPs on an ongoing basis. BWS and CWB could jointly fund a private, third party entity that would provide monitoring and technical assistance to land owners within the Honouliuli Watershed to ensure that appropriate water quality BMPs were being implemented in a consistent and ongoing manner.

5.5 Implementation & Funding: Sources and Strategies

5.5.1 Implementing Entities – Public and Private Sectors

The implementation of the many elements of the ‘Ewa WMP will depend on the future availability of resources – expertise, manpower, organization, and funding – from both the public and private sectors. A number of public agencies and private non-profit organizations have been named in this plan as possible implementers of specific projects and programs. These agencies and organizations include the following:

Public Agencies (Federal)

- Environmental Protection Agency (EPA)
- Federal Emergency Management Agency
  - National Flood Insurance Program
- National Oceanic and Atmospheric Agency (NOAA)
- National Science Foundation (NSF)
- National Trust for Historic Preservation (NTHP)
  - National Trust Preservation Fund
- U.S. Army Corps of Engineers (USACE)
- U.S. Army Garrison Hawai‘i
- U.S. Department of Agriculture
  - Farm Service Agency
  - Natural Resource Conservation Service (NRCS)
- U.S. Fish and Wildlife Service (USFWS)
  - Pearl Harbor National Wildlife Refuge
  - Partners for Fish and Wildlife
  - Pacific Islands Coastal Program
- U.S. Geological Survey
- U.S. Navy Region Hawai‘i

Public Agencies (State)

- Board of Land and Natural Resources

  Department of Agriculture (DOA)
  - Agribusiness Development Corporation (ADC)
- Department of Education (DOE)
- Department of Hawaiian Home Lands (DHHL)
- Department of Health (DOH)
  - Environmental Management Division
    - Wastewater Branch
    - Clean Water Branch
      - Clean Water Act Section 319 Grants
- Department of Land and Natural Resources (DLNR)
  - Commission on Water Resource Management (CWRM)
  - Department of Aquatic Resources (DAR)
  - Division of Conservation and Resource Enforcement (DOCARE)
  - Division of Forestry and Wildlife (DOFAW)
  - Engineering Division
  - State Historic Preservation Division (SHPD)
  - Office of Conservation and Coastal Lands (OCCL)
- Hawai‘i Community Development Authority (HCDA)
- Leeward Community College (LCC)
- Office of Hawaiian Affairs (OHA)
- Office of Planning (OP)
  - Hawai‘i Coastal Zone Management (CZM) Program
- University of Hawai‘i at Mānoa (UH)
- UH West O‘ahu

Public Agencies (City)

- Department of Design and Construction (DDC)
- Department of Emergency Management (DEM)
- Department of Environmental Management (ENV)
  - Wastewater Branch
- Department of Facility Maintenance (DFM)
- Department of Planning and Permitting (DPP)
- Honolulu Board of Water Supply (BWS)

Private and Non-Profit Organizations

- Hawaiʻi Agriculture Research Center (HARC)
- HECO
- Hoakalei Cultural Foundation
- Hunt Cos.
- Kaʻala Farm Inc.
- Kalaeloa Heritage and Legacy Foundation
- Kamehameha Schools
- Kapolei Business Association
- Mālama Learning Center
- MAʻO Organic Farms
- Monsanto

Many of the above-listed public agencies have one or more funding programs that could provide funds for water supply and/or watershed management projects. Private non-profit entities are also possible sources of funds or manpower for environmental improvement projects.

5.5.2 Dedicated Funding Sources for Watershed Management Projects

The EWMP provides policies, objectives, project descriptions and general strategies that collectively serve to guide future water resources management in the District. City and State agencies are not solely responsible for implementing the EWMP. CIP appropriations, Federal and private foundation grants, and the work of volunteers and non-profit organizations will all be needed to implement important elements of the Plan.

There has been some discussion over the years among advocates of good watershed management on the need for a "dedicated funding source" for important watershed projects – i.e., a funding source that would provide a fairly regular and significant revenue stream year after year.

An example of this concept is a bill that was proposed to the Twentieth State Legislature in 2000: House Bill No. 2835 – "A Bill for an Act Relating to Watershed Protection." Key excerpts from that Bill are as follows:

> "*The legislature finds that Hawaii's forests function as critical watersheds and are the primary source of fresh water for the islands.*"

"The purpose of this chapter is to establish a dedicated source of funds to protect, preserve, and enhance important watershed areas as essential and sustainable sources of fresh water."

"There is established within the state treasury a watershed protection trust fund to be administered by the commission on water resource management to implement the purposes of this part."

"The purpose of the trust fund is to fund public and private watershed management projects and activities benefiting water quality, water quantity, and general watershed values within designated watershed management areas."

"There shall be levied, assessed, and collected a watershed protection tax on the domestic use of water from municipal water systems at the rate of 5 cents per one thousand gallons of water used. The tax shall be collected by the county water agency as part of its regular billing to its customers."

In 2014, the State Legislature passed SB 2511, establishing a watershed initiatives program within DLNR "to plan, monitor, and execute watershed protection initiatives." This was in support of the State's "The Rain Follows the Forest," which sought to stabilize Hawaiʻi's water sources by doubling the acreage of protected watershed forests by 2021. SB 2062, appropriated $1 million to the natural area reserve fund in fiscal year 2014-15 for the "identification, establishment, and management of natural area reserves related to watershed protection and the acquisition of private lands for new natural area reserves related to watershed protection."

There has also been some public discussion on tapping other sources for watershed management action projects, including possibly using a percentage of the annual proceeds from the state's real estate conveyance tax. Others have proposed using a percentage of the Transient Accommodations Tax or the establishment of "Drainage Districts" that would be funded through special real property tax assessments. "Impact Fees" that would be paid by large federal, state, or private water systems have also been suggested. The fundamental issue for these funding concepts is: "who benefits and who pays?"

BWS, DPP, DLNR and CWRM could collaborate to develop a watershed projects funding Bill for consideration by the State Legislature – perhaps when the Oʻahu Water Management Plan has been completed. A new Bill could address some of the unresolved issues, including contributions to the "watershed protection trust fund" by significant public and private water users who are managing their own water sources.

It should be noted that HB 2835 focused on the importance of good management of Hawaiʻi watersheds because of their value in providing fresh water supplies. The Bill did not explicitly recognize other watershed values, including their value as storied places, scenic mountain landscapes, natural habitat for native animals, sources of medicinal and cultural plants, outdoor recreation, streams and wetlands, fish ponds and healthy nearshore waters. A future Bill might include recognition of these other important watershed values.

The proposed strategies and projects within this plan are the result of a comprehensive watershed analysis and stakeholder consultation process. The projects may involve various governmental agencies and non-governmental organizations. The implementation and funding of these projects are not the sole responsibility of the Board of Water Supply, City and County of Honolulu, or State of Hawai‘i. This Plan is intended to guide agencies and organizations in implementing the most important initiatives for ‘Ewa watersheds and water resources; however, implementation will depend on budgetary priorities, the availability of grants, and partnering efforts over the long term.

5.5.3 Implementation Challenges and Barriers

While protecting and providing for healthy watersheds and water supply are generally universally agreed upon goals, there are many challenges that may hinder their implementation:

- Public agencies often have limited legal and jurisdictional authorities, curbing their ability to comprehensively implement watershed management plans and projects;
- Watershed management projects often cross jurisdictional boundaries, requiring inter-agency and intergovernmental coordination;
- Lands that require management actions, or would reap the most benefit from such actions, are not under the control of agencies or non-profit organizations that would champion resource management or ecosystem restoration projects;
- Funding for both public and private sector projects is limited; and
- Decision makers and the general public are not aware of the complex interactions between land and water resources and uses, as well as the importance of those resources.

These challenges will not be overcome within the next 5 or 10 or even 20 years. However, there is a growing awareness among public agencies, elected officials, educators, and the general public of the critical importance of learning how to be good stewards of our precious land and water resources. Fresh water resources are limited by the rains that fall on island and careful stewardship of land and water resources is essential for a sustainable Hawai‘i. The O‘ahu Watershed Management Plan, and its District components, recognizes such links between land and water and our responsibility to care for these precious gifts.

APPENDIX A

O‘AHU WATERSHED MANAGEMENT PLAN FRAMEWORK

‘EWA WATERSHED MANAGEMENT PLAN

Oahu Water Management Plan Framework And Scope of Work for Wai`anae, Ko`olauloa and Ko`olaupoko Watershed Management Plans

Submitted to the State Commission on Water Resource Management in Compliance with the Statewide Framework for Updating the Hawaii Water Plan, Oahu County Water Use and Development Plan.

Attachment to BWS Transmittal Letter to CWRM, Dated February 20, 2004.

Table of Contents:

OWMP Framework Summary

The OWMP consists of policies and strategies, which guide the activities of the City and County of Honolulu and advises the State Commission on Water Resource Management (CWRM) in the areas of planning, management, water development and use and allocation of Oahu's natural water resources. The OWMP framework proposes regional plans entitled "watershed management plans" and shall be consistent with the following:

1. State Water Resource Protection Plan, State Water Quality Plan, State Water Projects Plan, State Agricultural Water Use and Development Plan and Department of Hawaiian Home Lands water plans as listed in Chapter 174C-31, Hawaii Water Plan, State Water Code.
2. The Statewide Framework for Updating the Hawaii Water Plan (Statewide Framework)
3. The General Plan for the City and County of Honolulu. The General Plan is a comprehensive statement of objectives and policies, which sets forth the long range aspirations of Oahu's residents and the strategies of actions to achieve them. It is the focal point of a comprehensive planning process that addresses physical, social, economic and environmental concerns affecting Oahu. This planning process serves as the coordinative means by which the City provides for the future growth of the metropolitan area of Honolulu. http://dev.honoluludpp.org/Planning/GeneralPlan.aspx
4. 8 Development Plan (DP) and Sustainable Community Plan (SCP) land use planning regions of Oahu. Each community oriented land use plan is intended to help guide public policy, investment, and decision making over the next 20 years. Each plan responds to specific conditions and community values of each region. Ewa and Primary Urban Center are "development plan" areas where growth and supporting facilities will be directed and be the policy guide for development decisions and actions needed to support that growth. The remaining 6 land use areas are "sustainable communities" plans, which are envisioned as relatively stable regions in which public programs will focus on supporting existing populations. The following table lists the 8 land use planning reports with links.

Oahu's Land Use Planning Regions	Web Page Links to the Plans
Waianae	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/WaianaePlan.aspx
Ko`olauloa	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/KoolauloaPlan.aspx
Ko`olaupoko	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/KoolaupokoPlan.aspx
North Shore	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/NorthShorePlan.aspx
Ewa	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/EwaPlan.aspx

Oahu's Land Use Planning Regions	Web Page Links to the Plans (Continued)
Central Oahu	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/CentralOahuPlan.aspx
East Honolulu	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/EastHonoluluPlan.aspx
Primary Urban Center	http://dev.honoluludpp.org/Planning/DevelopmentSustainableCommunitiesPlans/PrimaryUrbanCenter.aspx

5. City and County of Honolulu Ordinance 90-62, Water Management establishing the Oahu Water Management Plan establishing water management policies and strategies "for water use and development within each development plan area."
6. Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152, SLH 2000, Relating to Watershed Protection. The annual report set forth the development of a watershed master plan, including identifying protected watersheds areas, enhancement projects and an implementation plan.
7. Supreme Court Decision on Waiahole Ditch Contested Case applying the Public Trust Doctrine and the Precautionary Principle to water resource management.
8. BWS Sustainability Vision and Mission of "Water for Life" to enhance the quality of life of our community by providing world-class water services. Protecting the environment and supporting Oahu's economy while involving the community achieve BWS goals of sustainable water supplies for future generations. BWS accomplishes these goals with our watershed protection and water conservation partnership programs and diversifying our water supplies, both natural and alternative technologies, such as recycled water, seawater desalination and ocean resource development.

Background:

The Commission in 1990 formally adopted the initial Hawaii Water Plan, prepared by various state and county agencies. Further updates in 1992 were deferred pending additional refinement of plan components. In 1994, the City and County of Honolulu began their initial revision to the Oahu Water Management Plan. The draft OWMP update was completed in January 1998 and is the most current reference document. However, it was not submitted for adoption because Oahu's water situation was in a state of flux, with major changes in the agriculture industry, including the closing of the Oahu Sugar Company and the Waialua Sugar Company.

In 1999, the Honolulu Board of Water Supply (BWS) initiated the integrated resource planning process to update the Oahu Water Management Plan, Oahu's County Water Use and Development Plan. The integrated islandwide water planning effort was met with significant opposition, which surfaced in our public participation process. After almost two years of effort, we did not move beyond the public participation process and so before we started the water planning stage, we decided to stop and re-evaluate our approach. We summarize the main lessons learned as follows:

1. It is important to have equal focus on resource protection, conservation and restoration as on water use and development. There needs to be a reassurance that our natural resources are protected and our water supplies are sustainable before planning on water use and development can successfully occur.
2. It is important to elevate the community's knowledge about water related issues so the interested community can actively participate in a community-based planning process. It is equally important that the planning document is written so that it is easily understood.
3. The islandwide integrated approach elevated community concerns on growth limits and regional water transport. The integrated approach is more complex on Oahu because approximately ¾'s of Oahu's water systems are interconnected. The communities needed assurance that there were sufficient water resources within their watersheds before islandwide regional water needs were discussed.

In February 2000, CWRM adopted a framework for updating the Hawaii Water Plan to provide focus and additional guidance to each agency responsible for updating specific plan components. CWRM recognized the complexities in addressing water resource planning and views the plans as "living documents which over several plan iterations will result in a truly comprehensive water plan" (Statewide Framework page 1-2)

In August 2000,the Hawaii Supreme Court's decision on the Waiahole Ditch Contested Case, and the remand hearings, provided additional guidance for water resources planning, like the precautionary principle. In addition, three public trust uses of water were identified; domestic use, instream use and water for traditional and cultural practices. Commercial and agricultural water uses are in a lower category.

In 2001, BWS broadened its mission to "Water for Life", which strives for sustainability of all water supplies and to enhance the quality of life of our community by providing world-class water services.

The 2000 Act 152 Watershed Protection required the development of a watershed protection master plan that identified priority watersheds and protection projects for implementation. Act 152 renewed BWS investment in watershed protection recognizing the importance of watersheds for the sustainability of our groundwater supplies and streams. To date, about $1 million has been invested by BWS into Oahu's watersheds and aquifers. Noteworthy watershed protection projects are as follows:

- Ka`ala Bog Fencing to prevent feral animals from destroying the Mt. Ka`ala native habitat.
- Grant to the Oahu Invasive Species Committee to control invasive plant species within the Ko`olau watersheds
- Ala Wai Mauka Restoration Project for the Ko`olau Mountain Watershed Partnership
- BWS and Kamehameha Schools funded a USGS study to assess the hydrological and biological features and also funded the Punalu`u Agricultural Lands and Irrigation System Assessment to help set the in-stream flow standard for Punalu`u Stream.
- Waihe`e Valley Make a Difference Day invasive species removal
- Malama O Manoa "Kuleana Project" to change the residential practices of the Manoa Ahupua`a to increase awareness of water conservation and polluted runoff control.
- Watershed protection studies in Ala Wai, West Honolulu and Central Oahu.
- Ka`ala Farms and Mohala I Ka Wai educational awareness program
- Makaha Valley Restoration project
- Wai`anae and Ko`olauloa Watershed Management Plans

From 2001 to the present, several mountain and urban watershed partnerships have been established among BWS, agencies, organizations and community groups. Together, these partnerships have identified watershed protection projects and plans have been developed and funded. The following partnerships have been developed:

- Ko`olau Mountain Watershed Partnership
- Mohala I Ka Wai in Wai`anae
- Punalu`u Watershed Partnership
- Waihe`e Ahupua`a Initiative
- Ahupua`a Restoration Council of He`eia
- Malama O Manoa
- Wai`anae Kai Watershed Partnership
- University of Hawaii Manoa / BWS Water Conservation Partnership
- Hawaiian Electric Co. / BWS Energy and Water Conservation Partnership

Watershed Planning Approach:

The OWMP Framework proposes individual planning documents referred to as regional watershed management plans, which collectively will be the Oahu Water Management Plan. The regional watershed management plans will address the water needs, both present and future, for the 8 land use districts on Oahu. Rather than an islandwide approach brought down to each watershed, the watershed planning approach will start from the basic planning unit, each watershed or "ahupua`a" and expand it to the region or "moku". It is important that this watershed management plan allow equal focus on resource protection, conservation and restoration as well as on water use and development. The watershed approach is supported by the following references:

- The planning regions will be consistent with and support each of the 8 DP/SCP land use planning regions established in the General Plan. The State Water Code, Chapter 174C-31(b)(2), requires that "Each water use and development plan shall be consistent with the respective county land use plans and policies, including general plan and zoning".
- The Statewide Framework for Updating the Hawaii Water Plan, Page 3-26, Need for Flexibility, recognizes the need for appropriate flexibility in the county plans due to institutional and /or funding constraints, to encourage innovation as well as to accommodate unique and county-specific concerns.
- The Statewide Framework Page 3-19 also requires the preparation of "**regional plans** for water development including recommended and alternative plans, costs, adequacy of plans and relationship to water resource protection and quality plan." (Emphasis added).

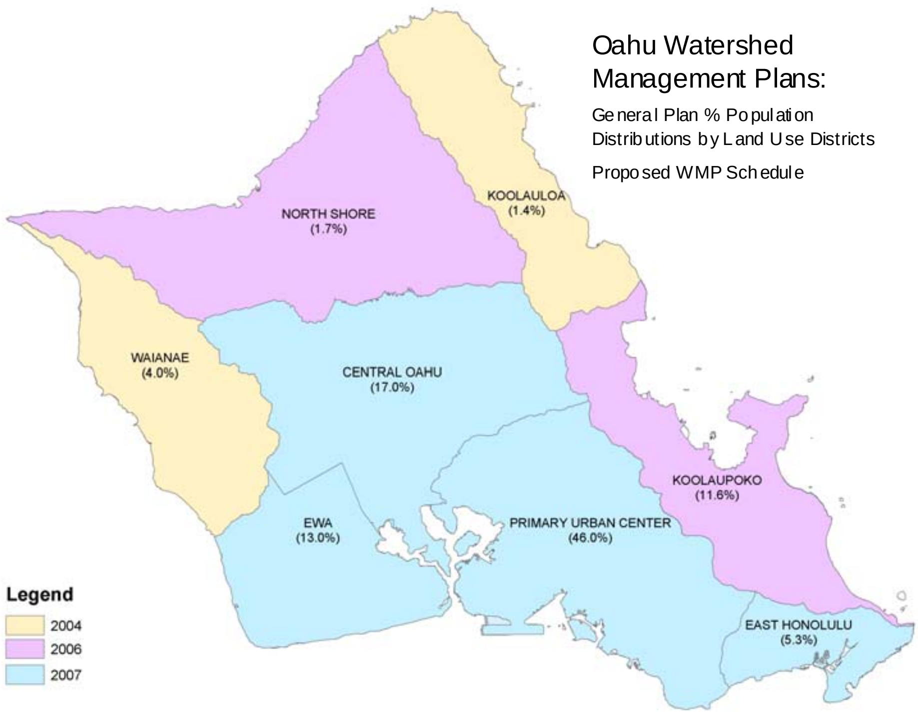
The watershed management plans will have the following key themes:

- Community-Based: In addition to public meetings, there will be many small group meetings with the community to educate, understand and apply the community's thinking and values about water resources. A wide-range of community meetings will be conducted including regional organizations such as Mohala I Ka Wai, Malama Ohana and the Neighborhood Boards, to local councils and associations, down to key individual meetings. The BWS watershed partnerships will be asked to provide representation for the community and key stakeholder groups.
- Environmentally Holistic: The watershed approach from mountains to the coral reefs recognizes the inter-dependence of water and land. The watershed management planning approach will not only address water use and development in the urban and agricultural zoned lands, but also describe protection strategies and enhancement projects for the forest reserves, conservation districts, streams and near-shore waters.
- Action-Oriented: The plan will describe specific watershed protection projects as well as natural and alternative water supply facilities that can be implemented by federal, state and city agencies and programs. The projects will be presented in a budgetary level format with information specific enough to support grant funding requests or an agency's capital improvement program.
- Alignment with State and County Water and Land Use Policies as stated above.
- Reflects Ahupua`a Management Principles: The watershed management plans will incorporate Ahupua`a principles in the plans. The community's help will be needed to identify their thinking and values about water. Living with Ahupua`a values and protocols is

very important to culturally intact communities, like Wai`anae and Ko`olauloa. Ahupua`a principles are not major factors in all districts, such as the urban metropolitan districts, however, these principles can still be used to guide water resource planning.

Proposed Schedule of Funding and Plan Approval:

The Oahu graphic below, shows the 8 land use areas on Oahu and the proposed funding schedule for the watershed management plans.



The following table lists the proposed funding schedules and anticipated target dates for submittal to CWRM for plan approval. The approval dates are based on an 18-month planning time frame and are only estimates and therefore subject to change.

Watershed Planning Areas	BWS Funding Schedule Fiscal Year	Target Dates for Submittal to CWRM for Plan Approval
Wai`anae, Ko`olauloa	FY 2004	1st Qtr FY 2006
North Shore, Ko`olaupoko	FY 2006	2nd Qtr FY 2007
South Oahu: (Ewa, Central Oahu, Primary Urban Center, East Honolulu)	FY 2007	2nd Qtr FY 2008

* BWS Fiscal Year is July 1 to June 30.

The four-year funding schedule is proposed due to the following reasons:

1. The Statewide Framework recognizes that implementation of the requirements and recommendations will need to be phased over the next several years and possibly over successive iterations of the updating process for the Hawaii Water Plan. (Statewide Framework Implementation Plan, Page 4-1)
2. BWS budgetary and staffing constraints.
3. As this watershed approach is new and unique, we are proposing an 18-month planning process to develop a baseline format and obtain the necessary approvals.
4. Wai`anae, Ko`olauloa, North Shore and Ko`olaupoko are designated as low growth, sustainable communities in the General Plan. The water demand projections for these areas show only marginal water demand increases through the planning horizon, currently 2025.
5. BWS is participating in active watershed partnerships in the Wai`anae and Ko`olauloa areas among others and these partnerships could assist in the public participation process.
6. South Oahu will be funded after the 4 rural districts for the following reasons:
    - To allow time for progress on the Section IV Framework Implementation Plan; Phase I Framework Adoption and Initial Updates to Hawaii Water Plan components, Phase II Development and Funding of New Framework Initiatives and Phase III Component Integration Phase of the Statewide Framework.
    - To allow time to complete the on-going products of the CWRM led Pearl Harbor Monitoring Group as part of the Milestone Framework for the Revised Pearl Harbor Sustainable Yields. Since 1998, BWS has funded over $4 million for the construction of deep monitor wells throughout Oahu and have committed staffing resources for the monitoring of these wells on a quarterly basis. These wells will be essential in the groundwater monitoring and modeling efforts currently underway to increase our understanding of the groundwater supply in the Pearl Harbor and Honolulu aquifers.
    - To allow time to complete the Board of Water Supply's 3-dimensional groundwater model of the Honolulu aquifers.
    - To allow time to incorporate state projects water demands and agricultural water needs. We understand that the State Water Projects Plan was recently completed and the State Agricultural Water Use and Development plan is now underway.
    - The watershed management plans for South Oahu will be funded in the same fiscal year and may be combined into a single plan to more easily address the integration of water resources.

    In calendar year 2000, South Oahu consumed about 78% of the islandwide municipal source pumpage of 154.6 mgd. We anticipate that the South Oahu watershed management plan(s) will fully utilize the IRP decision tools as described in the Statewide Framework for Updating the Hawaii Water Plan. The scope of work contemplated for the South Oahu regional watershed plan(s) will provide for compiling and developing water demand projections for domestic, commercial, industrial, agricultural, and nonpotable uses of municipal, state, federal and private water systems. It will also include assessment of environmental factors as part of the project objectives and evaluation criteria to be developed for the purpose of evaluating resource options and water management strategies.

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 Wai`anae and Ko`olauloa sustainable community plan areas are being submitted for CWRM review and approval (see attached). The draft scopes and planning approach were discussed with some of the community leaders and organizations in Wai`anae and Ko`olaupoko, and their feedback incorporated. The major project elements for the FY 2004 watershed management plans for Wai`anae and Ko`olauloa are:

1. Project Organization
2. Preliminary Watershed Analysis
3. Preliminary Stakeholders Consultations
4. Preliminary Watershed Management Strategies
5. 5-year Watershed Action Plan
6. Water Use and Development Plan
7. Draft Report
8. Final Report
9. Watershed Management Plan Approval

Summary of Current Water Distribution:

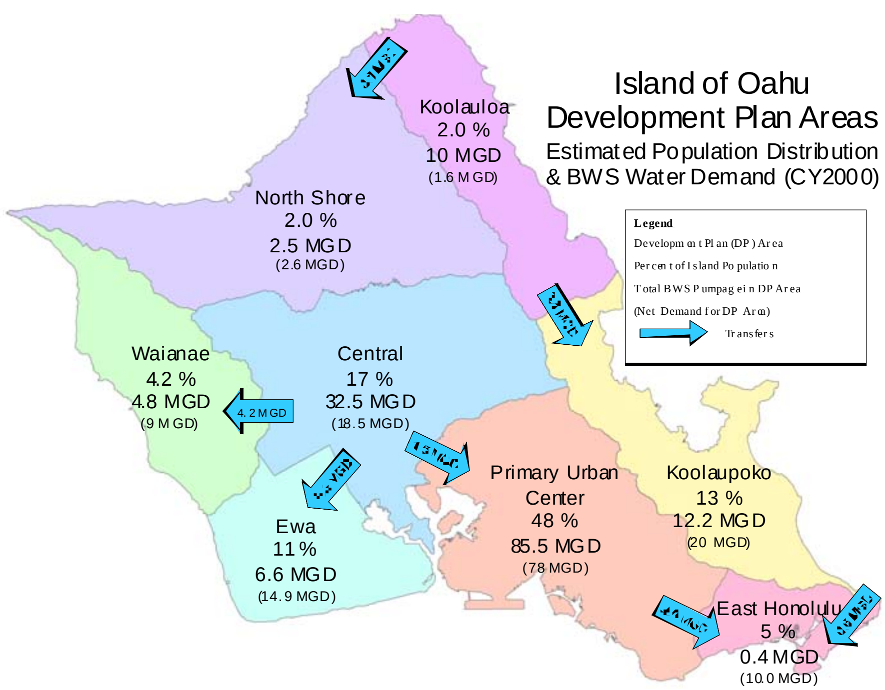
As part of the process of initiating the update of the OWMP and consistent with the guidelines set forth in the Statewide Framework for Updating the Hawaii Water Plan, we have compiled information on existing and projected water demands and sources of supply for the municipal system. BWS has evaluated the adequacy of the supply to meet the potable and nonpotable needs through ground water and recycled water sources. Water demand will be met with existing and funded source projects beyond the estimated 5-year planning period during the completion of all of the regional watershed management plans for Oahu.

The sustainable communities of Wai`anae, North Shore, Ko`olauloa and Ko`olaupoko have essentially the same water demand throughout the planning period. The existing sources and infrastructure in these areas are adequate to provide potable water service through the planning horizon and therefore, additional integration of water supplies between these regions will be limited.

In South Oahu, the water supplies, both natural and alternative, will be fully integrated and described in a future scope of work that once funded in FY 2007, will be submitted to CWRM for their review and approval. The following summarizes the main land use and water planning highlights in South Oahu.

- The City's General Plan directs the majority of the growth to South Oahu.
- Based on the City's growth forecast evaluating population, visitors, housing and employment factors, we forecast an increase in potable water demand for Oahu averaging about 1.1 million gallons per day per year, most of which will occur in South Oahu. In 5 years the BWS system demand is expected to increase by about 5.5 mgd, from 156 mgd in 2003 to 161.5 in 2008. New sources in the Waipahu-Waiawa Water Management Area, as identified in the City DP and SCP land use plans, will be able to provide adequate water supply.
- In addition, in that time period, recycled water facilities in Ewa and Central Oahu will be expanded to continue to off-set additional groundwater development.
    - In 2000, BWS acquired and now operates the 12 mgd Honouliuli Water Recycling Facility supplying irrigation and industrial process water for Ewa.
    - BWS has also funded the design of a delivery system to utilize approximately 3.0 mgd of Wahiawa recycled water in Central Oahu.
- The Kalaeloa seawater desalination plant is currently under design and will bring an additional 5.0 mgd of potable water supply to the second city of Kapolei.

For your information, a summary of Oahu's estimated population distribution based on the 2000 census, BWS potable water demand in calendar year 2000 and water distribution is provided among the 8 land use regions. The is essentially the base case of existing water demand and distribution in the BWS system, which will referenced in the watershed management plans.



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APPENDIX B
PLANS, POLICIES, GUIDELINES, AND CONTROLS

‘EWA WATERSHED MANAGEMENT PLAN

B PLANS, POLICIES, GUIDELINES, AND CONTROLS

B.1 OVERVIEW

The development of the Honolulu Board of Water Supply’s Watershed Management Plans (WMPs) is guided by various Federal, State, and County statutes, ordinances, plans, and controls with specific policies regarding the use and management of water. The critical water policies have been outlined in this section to ensure compliance with and adherence to the broader context under which this plan falls. The framework for developing the WMPs is provided by:

- State Water Code
- Statewide Framework for Updating the Hawai‘i Water Plan
- O‘ahu Water Management Plan Framework
- Act 44: An Act to Provide for the Encouragement and Protection of Agriculture, Horticulture, and Forestry
- Act 152: Relating to Watershed Protection, 2000 and the Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152.

Additionally, the O‘ahu Watershed Management Plan strives for consistency with:

- Federal Clean Water Act and Safe Drinking Water Act
- All of the Hawai‘i Water Plan components
- Department of Hawaiian Home Lands (DHHL) water plans as listed in the Hawai‘i Revised Statutes (HRS) Chapter 174C-31
- Hawai‘i 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.”[i] 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.[ii]

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.[iii]

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."[iv]

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.[v]

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.[vi]

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.[vii]

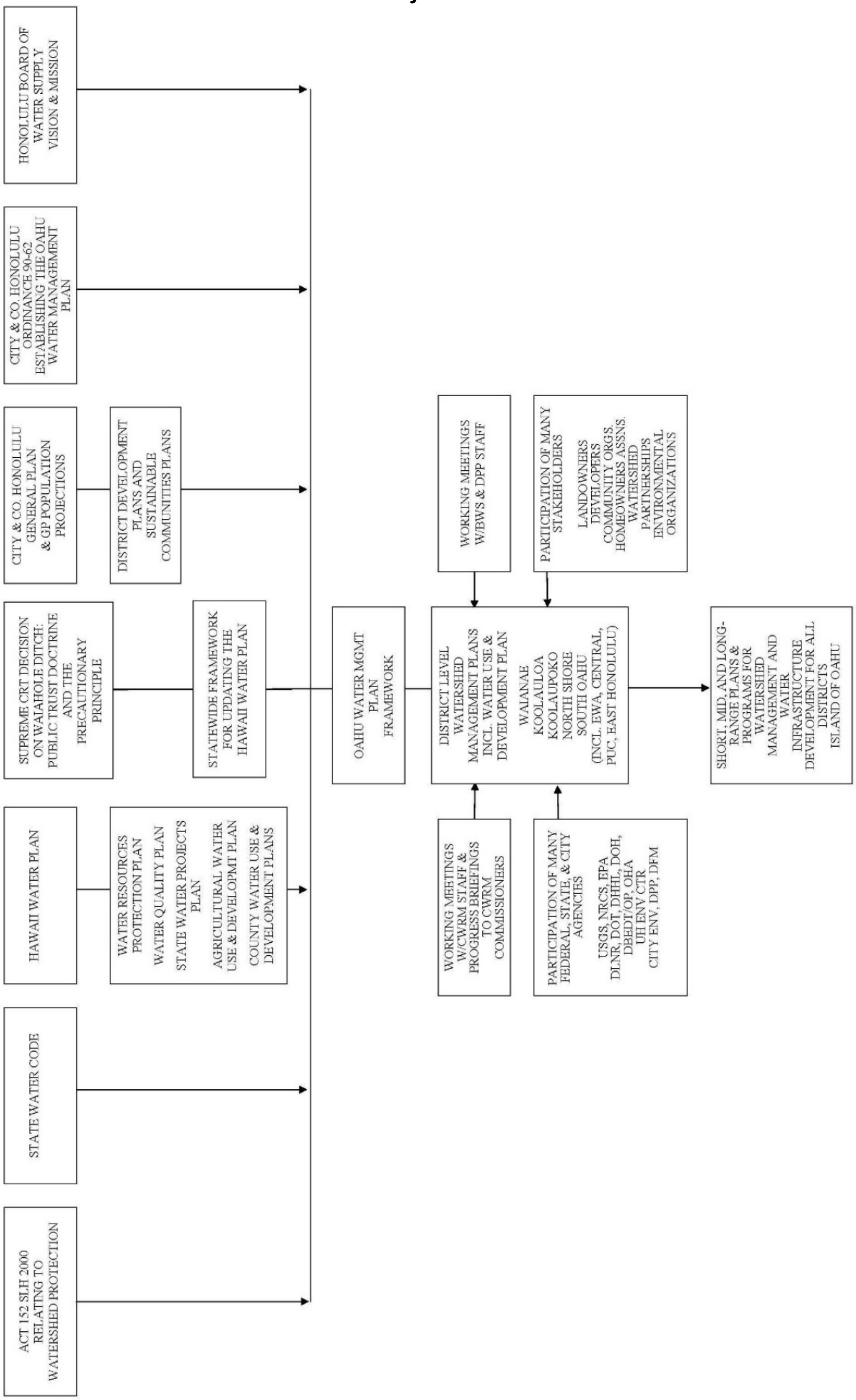

Figure B-1 O‘ahu Watershed Management Plan Framework Design

B.3.3 State Water Code

The State Water Code (Code) was enacted in 1987 as HRS Chapter 174C by the State Legislature to protect and manage Hawaii’s surface and ground water resources. The Code recognizes five general policies regarding water:

- Waters of the State are held for the benefit of the citizens of the State, who have a right to have the waters protected for their use.
- The Hawai‘i Water Plan is the guide for developing and implementing a program of comprehensive water resources planning to address the problems of supply and conservation of water.
- The Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic, aquaculture, irrigation and other agricultural, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of water of the State for municipal uses, public recreation, public water supply, agriculture, and navigation.
- The Code “shall be liberally interpreted to protect and improve the quality of waters of the State…. The people of Hawaii have an absolute interest in the prevention, abatement, and control of both new and existing water pollution and in the maintenance of high standards of water quality.”
- The State Water Code shall be liberally interpreted and applied to conform to the intentions and plans of the counties in terms of land use planning.[viii]

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.ix The complete text of the State Water Code may be viewed at: http://www.state.hi.us/dlnr/cwrm/regulations/Code174C.pdf.

B.3.4 Hawai‘i Water Plan

The State Water Code also mandates the development of the Hawai‘i 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 Hawai‘i Water Plan originally consisted of four parts: the Water Resource Protection Plan (WRPP), the Water Use and Development Plans (WUDP) for each county, the State Water Projects Plan (SWPP), and the Water Quality Plan (WQP). An Agricultural Water Use and Development Plan (AWUDP) was added through Act 101 by the 1998 State Legislature.

As of June 2009, the status of the HWP components was as reflected in the following table:

Table B-1 Status of the Hawai‘i Water Plan Components

HAWAI‘I WATER PLAN COMPONENTS	OFFICIAL DOCUMENT	STATUS
Water Quality Plan (WQP)	June 1990	Update in progress
State Water Projects Plan (SWPP) • Update of DHHL Projects	February 2003 May 2017	
Water Resource Protection Plan (WRPP)	June 2008	Update in progress
Agricultural Water Use and Development Plan (AWUDP)	December 2004	Update in progress
Hawai‘i County • Keauhou ASYA Update	August 2010 December 2016	
Kaua‘i County	1990	Update in progress
Maui County • Lāna‘i WUDP	1990 February 2011	Update in progress
O‘ahu County • Ko‘olau Loa • Wai‘anae • Ko‘olau Poko • North Shore • ‘Ewa • Central O‘ahu • Primary Urban Center • East Honolulu	1990 August 2009 August 2009 September 2012 June 2016	 Update in progress Update in progress Update in progress FY 2018

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.[x] 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.[xi]

B.3.5 Statewide Framework for Updating the Hawai‘i Water Plan

The Code calls for coordination between the Commission and other State and County agencies to formulate an integrated and coordinated program to develop and update the Hawai‘i Water Plan (HWP). To effectively implement these requirements, the Commission established a Statewide Framework in February 2000 to incorporate the techniques of Integrated Resources Planning.

The Statewide Framework established that the intent of the County WUDP was to ensure that future water needs of the County are met and to provide guidance to the Commission for decision-making on water uses and water reservation requests. Evaluation of the current HWP components, including the County WUDPs, noted several areas of improvement and planning complexities that need to be addressed. Implications of the Statewide Framework to the WUDPs are as follows:[xii]

- 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:[xiii]

- 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 Hawai'i, 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.”[xiv] 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.”[xv] 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 ‘Ewa 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.[xvi]
- The Ko‘olau forests are a primary water resource for the island of O‘ahu with an estimated sustained yield of over 133 billion gallons of water each year and are a habitat for several thousand native species and natural communities.[xvii]
- The Ko‘olau Mountains Watershed Partnership, consisting of major landowners within the watershed and associated non-landowner interests, is a valuable asset in the holistic, sustainable management of the watershed.[xviii]

B.4 WATER RIGHTS IN HAWAI‘I

Water rights and uses in Hawai‘i are governed by the State Water Code[xix] 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.[xx] 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.[xxi] 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,[xxii] 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.[xxiii]

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 awardees 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.[xxiv] 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.[xxv] Once established, future uses are not limited to the cultivation of traditional products approximating those utilized at the time of the Mahele,[xxvi] 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.[xxvii] 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.[xxviii] 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.”[xxix] 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).”[xxx] 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.”[xxxi] 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.[xxxii] As for ground water, two early cases (1884[xxxiii] and 1896[xxxiv]) 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,[xxxv] 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.[xxxvi] 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.[xxxvii]

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 ahupua‘a 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, ‘ōpae, ‘o‘opu, 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 Hawai‘i water law.

B.5.1 The Public Trust Doctrine

In its review of the Waiāhole Ditch Contested Case, the Hawai‘i 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 Hawai‘i Constitution adopted the public trust doctrine as a fundamental principle of constitutional law in Hawai‘i; 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.[xxxviii]

The Court has identified four trust purposes, three in the Waiāhole Ditch Contested Case, and a fourth in its 2004 decision, In the Matter of the Contested Case Hearing on Water Use, Well Construction, and Pump Installation Permit Applications, Filed by Wai‘ola o Moloka‘i, Inc. and Moloka‘i Ranch, Limited:

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights;[1] and
- Reservations of water for Hawaiian home lands.

The Court also identified the following principles for the water resources trust:[2]

- The state has both the authority and duty to preserve the rights of present and future generations in the waters of the state;
- This authority empowers the state to revisit prior diversions and allocations, even those made with due consideration of their effect on the public trust;

[1] Although the Court has not ruled specifically on the issue, the exercise of an appurtenant right presumably would have to be done in a traditional and customary manner if it is to be considered a public trust purpose. Otherwise, commercial uses of appurtenant rights would be a protected public trust use. Note, however, that unexercised appurtenant rights cannot be extinguished, and this also applies to commercial uses of appurtenant rights as long as that use is reasonable and beneficial.

[2] While these principles are directed at surface water resources, they apply equally to ground water resources.

- 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.

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 O‘ahu and (2) the broad policies which facilitate the attainment of the objectives of the plan.[xxxix] 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 needs to consider:

<u>Population</u>

Control population growth to the extent possible to avoid social, economic, and environmental disruptions, plan for future population growth, and establish a pattern of population distribution that will allow the people of O‘ahu 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 13 percent of the island-wide population to the ‘Ewa region by 2025.[xl]

<u>Economic Activity</u>

Provide, encourage, and promote economic opportunities and maintain the viability of agriculture. Maintain agricultural land along the Windward, North Shore, and Wai‘anae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.[xli]

<u>Natural Environment</u>

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 Hawai'i and the Island of O'ahu.
- 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.[xlii]

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.[xliii]

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.[xliv]

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.[xlv]

Health and Education

Coordinate county health codes and other regulations with State and Federal health codes to facilitate the enforcement of water pollution controls.[xlvi]

Government Operations and Fiscal Management

Ensure that government attitudes, actions, and services are sensitive to community needs and concerns.[xlvii]

B.6.2 Development Plans and Sustainable Communities Plans

The County Development Plans (DP) and Sustainable Communities Plans (SCP) for the eight land use districts established in the General Plan 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 ‘Ewa DP recognizes this district as a growth area, with a vision to create a “Second Civic Center.” Land use policies and guidelines from the ‘Ewa DP that have implications for the ‘Ewa Watershed Management Plan may be found in Section 2.9.2.

B.6.3 Revised Ordinances of Honolulu, Chapter 30: Water Management

The O‘ahu Water Management Plan (OWMP) was enacted by Ordinance No. 90-62 in 1990, and codified as Chapter 30, articles 1, 2, and 3, Revised Ordinances of Honolulu. The OWMP provides a long-range 20-year plan for the preservation, restoration, and balanced management of ground water, surface water, and related watershed resources for O‘ahu.

The State Water Code (HRS Chapter 174C) mandates the preparation and adoption of a water use and development plan by each county as part of the Hawai‘i Water Plan. In adopting the plan, the City and County of Honolulu recognizes that water is a limited resource, the development and use of which must be carefully planned. The Water Use and Development Plan for the City and County of Honolulu, which is called the OWMP, is intended to fulfill the requirements set forth by the State Water Code.

The OWMP consists of overall policies and strategies and regional watershed management plans, which guide the activities of the City and County of Honolulu and advises the State Commission on Water Resource Management in the areas of planning, management, water development and use, and allocation of O‘ahu’s limited water resources. In areas where a regional watershed plan has not been adopted, Articles 1, 2, and 3 of Chapter 30 and the Technical Reference Document for the OWMP, dated March 1990, shall serve as the water use and development plan.

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.[xlviii] The following policies recognize the vital role water plays in supporting land use activities and apply to all County agencies in their powers, duties, and functions and include the following:

- Facilities for the provision of water shall be based on the General Plan population projections and the land use policies contained in the DPs/SCPs and depicted on the DP and SCP Land Use Maps.
- System flexibility shall be maintained to facilitate the provision of an adequate supply of water consistent with planned land uses. The municipal water system shall be developed and operated substantially as an integrated island-wide water system.
- Close coordination shall be maintained between Federal, State, and County agencies involved in the provision or management of water to ensure optimal distribution of the available water supply.
- The quality and integrity of the water supply shall be maintained by providing for the monitoring and protection of the water supply in accordance with the requirements of the State Water Code.
- The development and use of non-potable water sources shall be maximized in a manner consistent with the protection of the ground water quality.
- Water conservation shall be strongly encouraged.
- Alternative water sources shall be developed wherever feasible to ensure an adequate supply of water for planned uses on O‘ahu.[xlix]

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 the eight regional watershed management plans for each of O‘ahu’s land use districts to comply with the Statewide Framework for Updating the Hawai‘i Water Plan. The Commission approved the OWMP Framework in 2003. The OWMP Framework of eight regional watershed management plans provides equal focus on resource protection, conservation, and restoration, as well as water use and development.

The watershed management plans are community-based, environmentally holistic, action-oriented, in alignment with State and County water and land use principles, and based on *ahupua‘a* management principles.

B.6.5 Honolulu Board of Water Supply (BWS) Mission

The BWS’ mission is “Water for Life, providing safe, dependable water supply now and into the future,” 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 provides safe and dependable water supply in the context of sustainability of all water resources and the environment.

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 ‘Ewa.

B.7.1 Wai‘anae Mountains Watershed Partnership

The Wai‘anae Mountains Watershed Partnership was created in 2010 to protect the biological, cultural, and economic resources of the Wai‘anae Mountains. Partners work together to make management decisions and implement management actions within the partnership area. Partners include DLNR; Gill-Olson Joint Venture; BWS; Ka‘ala Farm, Inc.; U.S. Army Garrison Hawai‘i; U.S. Navy Region Hawai‘i, and Wai‘anae Community Re-Development Corporation (MA‘O Organic Farms).

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APPENDIX C

O‘AHU WATER USE PERMIT INDEX

‘EWA WATERSHED MANAGEMENT PLAN

C O‘AHU WATER USE PERMIT INDEX

The State Commission on Water Resource Management maintains a database of permitted uses of water. The following table documents the owner, name, and identification number of wells, as well as the volume permitted for withdrawal by the water use permit and use of the water. The wells are further categorized by aquifer system area.

The permitted ground water uses are documented in the following table. Asterisks (*) in the “Use Description” column denote caprock or saltwater uses.

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
Aina Nui Corporation	EP 10 A to K	2006-01 to 11	0.957	Urban Nonpotable Use
Del Monte Fresh Produce	Kunia 1 & Basal Monitor	2703-01 & 02	1.075	Agriculture, irrigation for 2,595 acres pineapple; contaminant removal
Grace Pacific Corp.	Upper Quarry	2103-06	0.044	Industrial washing and dust control
Grace Pacific Corp.	Makakilo Lower Quarry	2104-01	0.124	Industrial washing and dust control
Honolulu BWS	BP Nonpotable 1 & 2	2006-14, 15	1.000	Municipal Nonpotable Irrigation Ko Olina Resort
Honolulu BWS	Honouliuli I - 1 & 2	2303-01, 02	2.240	Municipal Use
Honolulu BWS	Honouliuli II - 1 to 4	2303-03 to 06	4.480	Municipal Use
Honolulu BWS	Makakilo	2004-04	1.500	Municipal Use
Ko Olina Golf Course	Ko Olina	2006-13	0.700	Golf course irrigation
State DLNR DOWALD	Ewa Desalt Basal	1905-04	0.500	Supply brackish desalination plant
U.S. Navy	Barbers Point Shaft	2103-03	2.337	Military and State use at Kalaeloa
		Total WUP	**14.957**	
		Ewa-Kunia Sustainable Yield	**16**	
		Available	**1.043**	
		2010 Annual Pumpage	**12.143**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kahana Wells	3353-01, 02	0.600	Municipal Use
Division of State Parks	Kahana Artesian	3352-01	0.008	Kahana Valley Park system serving 16 residences
Kualoa Ranch, Inc.	Saito	3251-03	0.200	Irrigation of 50 acres of pasture
Kualoa Ranch, Inc.	Tomasu	3251-01	0.288	Irrigation for 46 acres of pasture & 4 acres of aquaculture
Kualoa Ranch, Inc.	Yamamoto	3351-04	0.005	Irrigate one acre of papaya
		Kahana Sustainable Yield	**15**	
		Total WUP	**1.101**	Remaining WUP's for salt water use
		Available	**13.899**	
		2010 Annual Pumpage	**0.360**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kalihi Pump Station	1952-06 to 08, 16 to 19, 22	6.948	Municipal Use
Honolulu BWS	Kapalama #1 & #2	2052-13, 14	1.500	Municipal Use
KS / Bishop Estate	Kamehameha Sch A & B	2051-01, 02	0.229	Domestic use for Kamehameha Schools
Oahu Country Club	OCC Irrigation	2050-01	0.060	Irrigation for 187-acre golf course
Palama Settlement	Palama Settlement	1952-15	0.024	Irrigation
		Kalihi Sustainable Yield	**9**	
		Total WUP	**8.761**	Remaining WUP's for salt water use
		Available	**0.239**	
		2010 Annual Pumpage	**5.424**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kapolei Irr 1 & Irr 2	1905-08, 10	0.302	City of Kapolei back-up irrigation for R-1 recycled water system
Kalaeloa Solar One	KS1	1905-11	0.300	
KPI	Kapolei Golf Course A,B&E	2003-01, 02, 05	1.000	Kapolei Golf Course irrigation supply
State HHFDC	Kapolei Irr C-1, D	2003-07, 04	0.494	Kapolei Village landscape irrigation and dust control
State HCDC	East Kapolei	2003-08	0.237	Kapolei Village landscape irrigation and dust control
		Kapolei Sustainable Yield		*Managed by chloride limit of 1,000 mg/l*
		Total WUP	**2.333**	
		2010 Annual Pumpage	**0.747**	

Well Owner	Well Name	Well No.	WUP	Use Description
Attractions Hawaii	Waimea Falls 1	3803-01	0.100	Currently Unused
Attractions Hawaii	Waimea Falls 2	3803-03	0.200	Currently Unused
Patricia L. Clark	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	Paniolo Ranch	3704-01	0.430	Livestock and irrigation of pasture land
Sean Ginella	Kawela Mauka	4100-06	0.102	Irrigation
Sean Ginella	Paumalu	3901-01	0.300	Livestock*
University of Hawaii	Waialee	4101-10	0.026	Dairy & piggery wash water
		Kawailoa Sustainable Yield	**29**	
		Total WUP	**1.614**	
		Available	**27.386**	
		2010 Annual Pumpage	**0.425**	

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
Campbell Estate	Sugarm Mill Pump	4057-11	0.028	Domestic & Irrigation of 40 acres of various crops
Serenity Park LLC	Kahuku P12 Batt	4057-07	0.300	Irrigation of ag parcel
Serenity Park LLC	Kahuku P3-1 & P3A-3	3957-01 & 03	1.244	Agriculture irrigation & domestic; truck farm (40 ac.) & taro (20 ac.)
Campbell Estate	Kahuku Pump 8	4057-06	0.670	Agriculture irrigation & domestic; truck farm (40 ac.) & taro (20 ac.)*
Hawaii Reserves Inc.	Kawananakoa	4056-01	0.576	Domestic & Irrigation for 135 acres of ranchland & cattle
U.S. Fish and Wildlife Service	Kii Wildlife 1 to 4	4157-05, 06, 07, 13	1.000	Habitat maintenance
U.S. Fish and Wildlife Service	Pump 15	4157-04	1.517	
Hawaii Reserves Inc.	Pump 12A Batt	4057-10	1.200	Aquaculture for 25 acres prawns
Director of Public Works	Kahuku TVWF 2011	4059-01	0.017	Military car wash*
Diversified Ag Promotions LLC	Kahuku Air Base	4158-12, 13	0.300	Aquaculture, Agriculture, Pasture, Residential
ELC 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.	Egg Farm	3956-05	0.001	Supply chicken and egg farm needs
Kapaka Farm	Kapaka Farm 1	3554-01	0.038	30 acres diversified fruits & vegetables
Kapaka Farm	Kapaka Farm 3	3654-03	0.190	Irrigation
Hawaii Reserves Inc.	Laie Maloo	3755-04	0.039	Agriculture
Hawaii Reserves Inc.	Prawn Farm	3856-07	0.171	Agricultural irrigation over 60 acres
Hawaii Reserves Inc.	Quarry D	3856-04	0.036	Irrigation for 51 acres bananas, papayas, grass
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
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 1 & 2	4057-15, 16	0.600	Municipal use
Honolulu BWS	Kaluanui Wells 1 to 3	3554-04 to 06	1.093	Municipal use
Honolulu BWS	Maakua	3655-02	0.667	Municipal use
Honolulu BWS	Punaluu I	3553-02	0.360	Municipal Use
Honolulu BWS	Punaluu II - 1 to 6	3553-03, 04, 06 to 08; 3554-03	4.618	Municipal Use
Honolulu BWS	Punaluu III - 1 & 2	3453-06, 07	1.327	Municipal Use
Polynesian Cultural Center	PCC Lagoon	3855-09	0.568	Supply lagoon's aquatic life, provide circulation
James Campbell Company LLC	Kahuku Pump 6	3957-07	0.026	Agriculture*
Hawaii Reserves Inc.	Malaekahana	3956-01	0.062	Domestic service to 33 homes, Malaekahana Park and ranch
Kaio, Jacob I. Sr	Kaio Artesian	3956-07	0.017	Irrigate 3 acres of taro, on choi, other
Kuilima	Opana 1 & 3	4100-04 & 05	0.346	Municipal, Individual Domestic, Industrial*
Laie Water Co.	BYU Campus, Quarry	3855-06 to 08; 3856-05 & 06	1.375	Municipal for 607 residential, BYUH, Commercial, Laie School
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
Ota G	Punaluu	3453-03	0.006	Irrigation of 2 acres of bananas and vegetables*
State DOA	Pump 1	4057-01	0.307	Domestic & Irrigation of 215 acres of various crops
Turtle Bay Resort LLC	Kuilima 1	4158-14	0.302	Golf course irrigation*
Turtle Bay Resort LLC	Pump 2 Bat, Kahuku Land	4159-01 & 02	1.075	Agriculture*
Turtle Bay Resort LLC	Turtle Bay GC	4100-01	0.017	Golf course irrigation*
White RE	Laie	3855-05	0.013	Irrigation of 9 acres of bananas and domestic use at 3 residences*
		Koolauloa Sustainable Yield	**36**	
		Total WUP	**18.589**	Remaining WUP's for salt water use
		Available	**17.411**	
		2010 Annual Pumpage	**17.853**	

Well Owner	Well Name	Well No.	WUP	Use Description
Chang DWA	Kahaluu	2750-09	0.002	Irrigation of 6 acres for heliconias & ginger
Honolulu BWS	Haiku Tunnel	2450-01	1.340	Municipal Use
Honolulu BWS	Haiku Well	2450-02	0.457	Municipal Use
Honolulu BWS	Iolekaa Well	2549-01	0.153	Municipal Use
Honolulu BWS	Kahaluu Tunnel	2651-01	2.128	Municipal Use
Honolulu BWS	Kahaluu Well	2651-03	0.927	Municipal Use
Honolulu BWS	Kuou I	2348-02, 03	2.696	Municipal Use
Honolulu BWS	Kuou II	2348-05	0.010	Municipal Use
Honolulu BWS	Kuou III	2348-06	0.196	Municipal Use
Honolulu BWS	Luluku Tunnel	2349-01	0.713	Municipal Use
Honolulu BWS	Luluku Well	2349-02	1.050	Municipal Use
Koolau Golf Partners LLC	Minami 1 & 2	2347-02, 03	0.150	100 Acres golf course, landscape, fire protection
Jean Paul Renoir and Kiiko N.	RL Montgomery	2751-08	0.036	Supply 2 homes, livestock, 12 acres fruits, vegetables
Hawaii State Hospital	HI State Hospital	2448-01	0.088	Domestic consumption; nursery irrigation 2,280 sq. ft.
State HCDC	Waiahole A and B	2853-04, 05	0.075	Serve 110 homes, 305 acres of bananas, papayas, etc.
Valley of the Temples, LLC	Heeia	2550-01	0.018	Irrigate 65 acres grass, Temple fish ponds, domestic
		Koolaupoko Sustainable Yield	**30**	
		Total WUP	**10.312**	
		Available	**19.688**	
		2010 Annual Pumpage	**10.227**	

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
C&C Facility Maint	Facility Maint 1 & 2	1806-09 & 10	3.340	Industrial: Power Plant
Kalaeloa Partners, L.P.	Kalaeloa PW 1 to 9	1805-04 to 12	3.168	Industrial cooling of cogeneration plant
State DLNR DOWALD	Ewa Caprock	1905-05	0.500	Supply brackish desalination plant
VIP Sanitation, Inc.	VIP Sanitation	1805-16	0.003	Irrigation, flush & clean portable toilets & trucks
		Malakole Sustainable Yield		*Managed by chloride limit of 1,000 mg/l.*
		Total WUP	***7.011***	Remaining WUP's for salt water use
		2010 Annual Pumpage	**4.513**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kalihi Shaft	2052-08	9.500	Municipal Use
Honolulu BWS	Moanalua 1 to 3	2153-10 to 12	3.790	Municipal Use
Honolulu Country Club	Honolulu Int CC	2154-01	0.346	Irrigate golf course
	Damon Estate	2153-02	0.021	Irrigate taro and fish pond, misc. uses
U.S. Navy	Halawa Red Hill	2254-01	4.659	Navy usage
U.S. Army	Fort Shafter	2053-11 & 13	1.035	Military use
U.S. Army	Tripler	2153-07, 08	0.609	Military use
		Moanalua Sustainable Yield	**16**	
		Total WUP	**19.960**	
		Available	**-3.960**	
		2010 Annual Pumpage	**17.143**	

Well Owner	Well Name	Well No.	WUP	Use Description
Waialua Sugar	Pump 5	3411-04, 06 to 11, 13	2.550	Irrigate 315 acres of sugar cane
Waialua Sugar	Pump 11	3409-13	0.530	Irrigate 133 acres of sugar, 75 gpm domestic
Hawaii Fish Co.	Hawaii Fish Co. 1	3412-04	0.576	Fish hatchery & farm
Mark Hamamoto	Hamamoto - 2006	3306-16	0.013	Domestic, 6-acre agriculture and domestic
North Shore Water Company LLC		3410-01	0.500	Domestic, irrigation of polo field, pasture
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
Mokuleia Aquafarm	MAF 1	3409-24	0.250	Aquaculture (2 acres fish and taro)*
Mokuleia Assoc.	Mokuleia Assoc.	3409-16	0.000	Well sealment planned*
Mokuleia Hmstd	Mokuleia Hmstds	3410-05	0.000	Stock watering*
Dillingham Ranch Aina LLC	Mokuleia Hmstds	3410-03	1.500	Domestic & irrigation for Mokuleia Homesteads
Stanhope Farms	Stanhope Farms	3308-02	0.056	Agriculture, Irrigation, domestic
Kaala Ranch	Mokuleia	3309-02	0.127	Cattle water, pasture & nursery irrigation
State DOT-Airports	Dillingham Airfield	3412-02	0.055	Supply airfield, Camp Erdman, and some residents
U.S. Air Force	USAF Kaena Pt.	3314-03	0.018	Currently Unused
Waialua High School	Waialua HS	3407-25	0.039	Irrigation of football, baseball and play fields*
		Mokuleia Sustainable Yield	**8**	
		Total WUP	**8.025**	
		Available	**-0.025**	
		2010 Annual Pumpage	**0.175**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Beretania P Station	1851-12,13,31,33 to 35,67,74,75	7.000	Municipal Use
Honolulu BWS	Manoa II	1948-01	0.700	Municipal Use
Honolulu BWS	Wilder Avenue Wells 1 to 4	1849-13 to 16	7.000	Municipal Use
Kawaiahao Church	Kawaiahao Church	1851-73	0.030	Domestic consumption & irrigation
McKinley HS	McKinley Aqua 1 & 2	1850-28, 29	0.085	10 Aquaculture tanks*
Pacific Club	Pacific Club	1851-07	0.040	Domestic and irrigation for private club
Pagoda Hotel	Ala Moana	1750-09	0.020	Industrial irrigation*
Punahou High School	Punahou School	1849-10	0.158	Drinking, pool, irrigation
Queens Medical Center	Queens Hospital	1851-54	0.237	Municipal use, air conditioning cooling, lawn
		Nuuanu Sustainable Yield	**14**	
		Total WUP	**15.165**	Remaining WUP's for salt water use
		Available	**-1.165**	
		2010 Annual Pumpage	**15.232**	

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kaimuki Pump Station	1748-03 to 10	4.000	Municipal Use
Honolulu BWS	Palolo	1847-01, 02	1.310	Municipal Use
Kokusai Kogyo	Kokusai, K.	1749-19	0.336	Supplies water to hotel, incl. drinking water
		Palolo Sustainable Yield	**5**	Remaining WUP's for salt water use
		Total WUP	**5.646**	
		Available	**-0.646**	
		2010 Annual Pumpage	**6.289**	

Well Owner	Well Name	Well No.	WUP	Use Description
Aoao Suncrest/Shores/Lombard/Avalon	Gentry Area 24	2001-10	0.022	Irrigation of 7.37 acres landscaped area and roadway
Arbors Association	Arbors GV 1	2001-07	0.063	Irrigation for Arbors & Golf Villa 1, Area 3
C&C Envir Serv	Honouliuli STP 1 and 2	1902-03, 04	0.500	WWTP in plant process water, emergency backup
C&C Parks & Rec	Geiger Park	2001-03	0.030	Irrigation of 10-acre Geiger Park
Coral Creek	Coral Creek 1, 10 & Lake A	2001-14, 2002-15,19	0.892	Backup golf course irrigation
Coral Creek	Coral Creek 2	2002-17	0.498	Water feature, backup golf course irrigation
Coral Creek	Coral Creek 4	2001-13	0.800	Water feature
Ewa by Gentry Comm. Assoc.	Gentry Entry Irr	2001-02	0.080	Irrigation for 20 acres of Gentry Entry Park
Ewa by Gentry Comm. Assoc.	Soda Creek III	2001-05	0.195	13.23 acres of park lawn & Roadway landscaping
Gentry Companies	Gentry Area 13	1901-05	0.037	Irrigation (common area & roadway)
Gentry Companies	Keaunui Area 30	2001-12	0.225	Irrigation (golf course, common area, park, roads)
Gentry Development Co.	Fort Weaver Apt.	2001-09	0.023	Irrigation of 7.8 acres of landscape and roadways
Gentry Development Co.	Sunrise Apt.	2001-04	0.040	Irrigation for 13 acres of lawn and road landscape
Gentry Homes, Ltd.	Gentry Area 35 #1 & #2	1900-24, 2000-06	0.255	Irrigation (common area & roadway)
Gentry Homes, Ltd.	Gentry Area 45	1901-08	0.066	Irrigation (common area & roadway)
Haseko (Ewa), Inc.	Ocean Pointe 4	1901-06	1.337	Dust control; golf course, roadway irrigation. Supplements R-1
Hawaii Prince Golf Club	EP 22, Wells 1 to 5	1900-02, 17-20	1.201	Golf Course Irrigation including lake evaporation
New Ewa Beach Golf Course	Dug C and D	1900-22, 1959-08	0.600	Irrigate golf course
New Ewa Beach Golf Course	New Ewa Intl G C	1900-21	0.100	Irrigate golf course
Palm Court Association	Palm Court 3	2002-12	0.040	Irrigation for 22 acres for Palm Court 2&3, Area 1C
Palm Villa I Association	Palm Villa 1	2001-06	0.080	Irrigation for 15 acres for Palm Villas 1, Area 1A
Palm Villa II Association	Palm Villa 2	2001-08	0.048	Irrigate 16 acres for Palm Villa 2, Area 4
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	Agriculture irrigation of Navy Blast Zone
		Puuloa Sustainable Yield		
		Total WUP	***13.261***	*Managed by chloride limit of 1,000 mg/l*
		Available		
		2010 Annual Pumpage	**1.374**	

Well Owner	Well Name	Well No.	WUP	Use Description
Kunia Water Association, Inc.	Del Monte Pump 3 & 4	2803-05, 07	3.960	Irrigate for 2480 acres pineapple; 150 residential @ Kunia Village
Alii Turf Co., LLC	Alii Turf	3001-01	0.115	Irrigation*
Brent Cullinan	Brent's	3104-03	0.029	Domestic, livestock, agriculture, and reservoir evaporation*
Galbraith Estate	Del Monte Pump 5	3103-01	2.000	Pineapple agriculture
Hawaiian Earth Products	HEP-1	3104-02	0.355	Industrial irrigation*
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, Inc.	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 Batt	2901-02, to 04, 10	5.648	Supply Schofield Base
U S Navy NAVFAC	NAVFAC Wahiawa Deep	3100-02	0.208	Potable supply for 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 Sustainable Yield	**23**	
		Total WUP	**21.928**	
		Available	**1.072**	
		2010 Annual Pumpage	**7.694**	

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Kuliouou Well	1843-01	0.300	Municipal Use
Honolulu BWS	Waialae Iki Well	1746-02	0.190	Municipal Use
Honolulu BWS	Wailupe Well	1745-01	0.300	Municipal Use
		Waialae-East Sustainable Yield	**2**	
		Total WUP	**0.790**	
		Available	**1.210**	
		2010 Annual Pumpage	**0.124**	

Well Owner	Well Name	Well No.	WUP	Use Description
Bishop Estate	Waialae C C	1646-01	0.460	Irrigation of the Waialae Golf Course
Honolulu BWS	Aina Koa	1746-01	0.480	Municipal Use
Honolulu BWS	Waialae Nui Ridge	1746-04	0.997	Municipal Use
Honolulu BWS	Waialae Nui	1747-03	0.700	Municipal Use
Honolulu BWS	Waialae West	1747-05	0.160	Municipal Use
		Waialae-West Sustainable Yield	**4**	
		Total WUP	**2.797**	Remaining WUP's for salt water use
		Available	**1.203**	
		2010 Annual Pumpage	**1.004**	

Well Owner	Well Name	Well No.	WUP	Use Description
Lopez Sons Inc	Haleiwa - Lopez 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
Mary Lou Gora	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	
Jewett, MJ & WF	Pump 9	3406-02	0.160	Diversified agriculture
NHAC	Lopez	3407-02	0.200	Domestic; irrigate 4.5 acres various crops; aquaculture
Poamoho Venture	Poamoho A	3205-02	0.600	Irrigation for 150 acres of diversified agriculture
Kamehameha Schools	Pump 3	3505-01 to 20	1.552	Irrigation for 2370 acres of diversified agriculture
Paradise Shrimp Farm	Paradise Shrimp	3407-38	0.576	Shrimp production*
Waialua Sugar	Pump 7B & 7C	3407-11, 12	2.930	Irrigate 440 acres of sugar cane, 125 gpm domestic
Waialua Sugar [02]	Pump 1	3407-04 to 06, 14, 15	2.330	Irrigate 367 acres of sugarcane
Waialua Sugar [02]	Pump 17	3404-01	8.630	Irrigate 990 acres of sugar cane, 300 gpm domestic
Waialua Sugar [02]	Waialua Pump 2 Batt	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 7D & 7E	3407-18, 19	0.180	
BP Bishop Estate Trust	Pump 8	3506-03, 04	1.660	Irrigate 136 acres of sugar cane, domestic
		Waialua Sustainable Yield	**25**	
		Total WUP	**30.311**	
		Available	**-5.311**	
		2010 Annual Pumpage	**3.276**	

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Aiea Gulch A & C	2355-03, 05	0.980	Municipal Use
Honolulu BWS	Aiea Wells A & B	2355-06, 07	1.300	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	Kaahumanu I #1 and #2	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 (piggery)
Pearl Country Club	Pearl Country Club	2356-54	0.330	Golf course irrigation (189 net acres)
State of Hawaii	Waimano Trng Sch	2557-01, 02	0.136	Supply for swimming pool, laundry plant
U.S. Navy	Aiea Halawa Shft	2255-32	0.697	Navy usage
		Waimalu Sustainable Yield	**45**	
		Total WUP	**46.951**	
		Available	**-1.951**	
		2010 Annual Pumpage	**35.524**	

O‘ahu Water Use Permit Index

Dated: May 21, 2012

Well Owner	Well Name	Well No.	WUP	Use Description
Honolulu BWS	Waimanalo Tunnel I to IV	2044-03, 04, 2045-03,05	0.700	Municipal Use
C&C Honolulu DES	Kailua WWTP	2545-01	0.025	Industrial use*
State of Hawaii DLNR-DOFAW	Kawainui 1 to 11	2245-02 to 11, 2345-04, 05	0.202	To serve 24 acres of ponds*
Honolulu BWS	Waimanalo I & II	2043-02, 1943-01	0.452	Municipal Use
Honolulu BWS	Waimanalo III	1942-01	0.200	Municipal Use
Roman Catholic Church in the State	SSDC-1	2146-04	0.010	Drinking water*
Royal Hawaiian CC	Wells 1, 2, 4, 6	2045-06, 2145-01, 02, 04	0.155	Irrigation for 176.4 acres for RHCC Golf Course
State DHHL	Reservation		0.124	Reservation via 11/17/93 rule 13-171-63 via CWRM
		Waimanalo Sustainable Yield	**10**	
		Total WUP	**1.631**	Remaining WUP's for salt water use
		Available	**8.369**	
		2010 Annual Pumpage	**0.699**	

Well Owner	Well Name	Well No.	WUP	Use Description
Abe, Tadahiro	Honouliuli	2202-02	0.009	Irrigation supply for 1.5 acre roses
D.R. Horton – Schuler Homes, LLC	EP 18 Battery	2102-02, 04 to 22; 2202-03 to 20	7.969	Diversified Ag
Gary Takiguchi	Honouliuli	2201-02	0.019	Domestic and irrigation (4.8 acres) for six (6) houses
Gentry Hawaii, Ltd. [06]	Waiawa 575-ft 1, 765-ft 2	2658-05, 03	0.000	Municipal use for Waiawa by Gentry, Phase I*
Waiawa Ridge Development LLC	Waiawa 575-ft 2	2659-04	0.300	Municipal use for Waiawa by Gentry, Phase I
Harris Rug CL	Harris Rug	2201-14	0.003	Industrial use for laundering or cleaning rugs
Hawaii Country Club	Haw Country Club	2603-01	0.400	Irrigation for Hawaii Country Club
Honolulu BWS	Ewa Shaft (EP 15,16)	2202-21	7.661	Municipal Use
Honolulu BWS	Hoaeae Wells 1-6	2301-34 to 39	6.610	Municipal Use
Honolulu BWS	Kunia I - P1 to P4	2302-01 to 04	5.000	Municipal Use
Honolulu BWS	Kunia II - P1 to P4	2402-01 to 03, 05	2.710	Municipal Use
Honolulu BWS	Kunia III - 1 to 3	2401-04 to 06	3.050	Municipal Use
Honolulu BWS	Manana	2458-05	0.700	Municipal Use
Honolulu BWS	Mililani I - P1 to P4	2800-01 to 04	2.670	Municipal Use
Honolulu BWS	Mililani II - P5 & P6	2859-01 to 02	1.590	Municipal Use
Honolulu BWS	Mililani III - 7 & 8	2600-03, 04	1.250	Municipal Use
Honolulu BWS	Mililani IV - 9 to 11	2858-01 to 04	2.022	Municipal Use
Honolulu BWS	Pearl City I - 1 & 2	2458-03, 04	1.150	Municipal Use
Honolulu BWS	Pearl City II - 1 to 3	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 P-1 & P-2	2459-19, 20	0.500	Municipal Use
Honolulu BWS	Waipio Hts. I - 1 & 2	2459-23, 24	0.500	Municipal Use
Honolulu BWS	Waipio Hts. II - 1 & 2	2500-01, 02	1.000	Municipal Use
Honolulu BWS	Waipio Hts. III - 1 & 2	2659-02, 03	1.250	Municipal Use
Roman Catholic Church - Hawaii	Honouliuli	2101-01	0.110	Supply for slaughter house
Kenneth Simon	Pearl City	2358-35, 44	0.040	Diversified agriculture
Kenneth Simon	Pearl City	2358-36	0.004	Domestic use for eight (8) residences
Kipapa Acres Assoc.of Owners	Kipapa Acres	2600-02	0.100	Supply residences, agricultural businesses, farm
Mark H. Ortiz	Ortiz	2202-01	0.003	Domestic supply for six (6) residences
Michael Watanabe	Watanabe, A.	2300-11	0.680	Irrigate watercress, onchoy, and taro farm
Michael Watanabe	Watanabe, A.	2300-20	0.400	Irrigate watercress, onchoy, and taro farm
Nazarene Church	Pearl City	2358-49	0.003	Supply Pastor's residence, church
Pearl City Community Church	Pearl City Comm Ch.	2359-10	0.005	Domestic for 10 residential units
Robinson Kunia Land, LLC	Robinson No. 1	2602-03	0.100	Agricultural food processing
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
TABA FARM, INC	Taba Farm	2358-21, 22, 26, 29	0.864	Agriculture
Tadao Abe	Honouliuli	2201-02	0.002	Domestic
U.S. Fish & Wildlife	PHNWR No. 1	2359-19	0.180	Habitat maintenance
U.S. Navy	Waiawa Shaft	2558-10	14.977	Navy usage
Waiawa Development, LLC	Gentry Waiawa 1	2658-07	0.524	Irrigation of 181-acre golf course
Waiawa Development, LLC	Gentry Waiawa 2	2658-08	0.458	Irrigation of 149-acre golf course
Waikele Country Club Inc.	Waipahu WP 1	2301-01 to 10	0.950	Waikele Golf Course irrigation
Yoshimura, D.	Waipahu	2459-21	0.006	Irrigate farm
		Waipahu-Waiawa Sustainable Yield	**104**	
		Total WUP	**84.856**	
		Available	**19.144**	
		2010 Annual Pumpage	**51.819**	

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APPENDIX D

OVERVIEW OF O‘AHU HYDROGEOLOGY

‘EWA WATERSHED MANAGEMENT PLAN

D OVERVIEW OF O‘AHU HYDROGEOLOGY

D.1 SETTING

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

D.2 CLIMATE

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

The contrast between O‘ahu’s lush green mountains and the arid lowland plains reflects extremely wide rainfall variations. Annual average rainfall on O‘ahu ranges from less than 20 inches on the leeward coast to almost 300 inches near the central crest of the Ko‘olau Range (Figure D-1). Such a marked difference over a distance of less than 15 miles has a significant effect upon water resources.

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

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

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

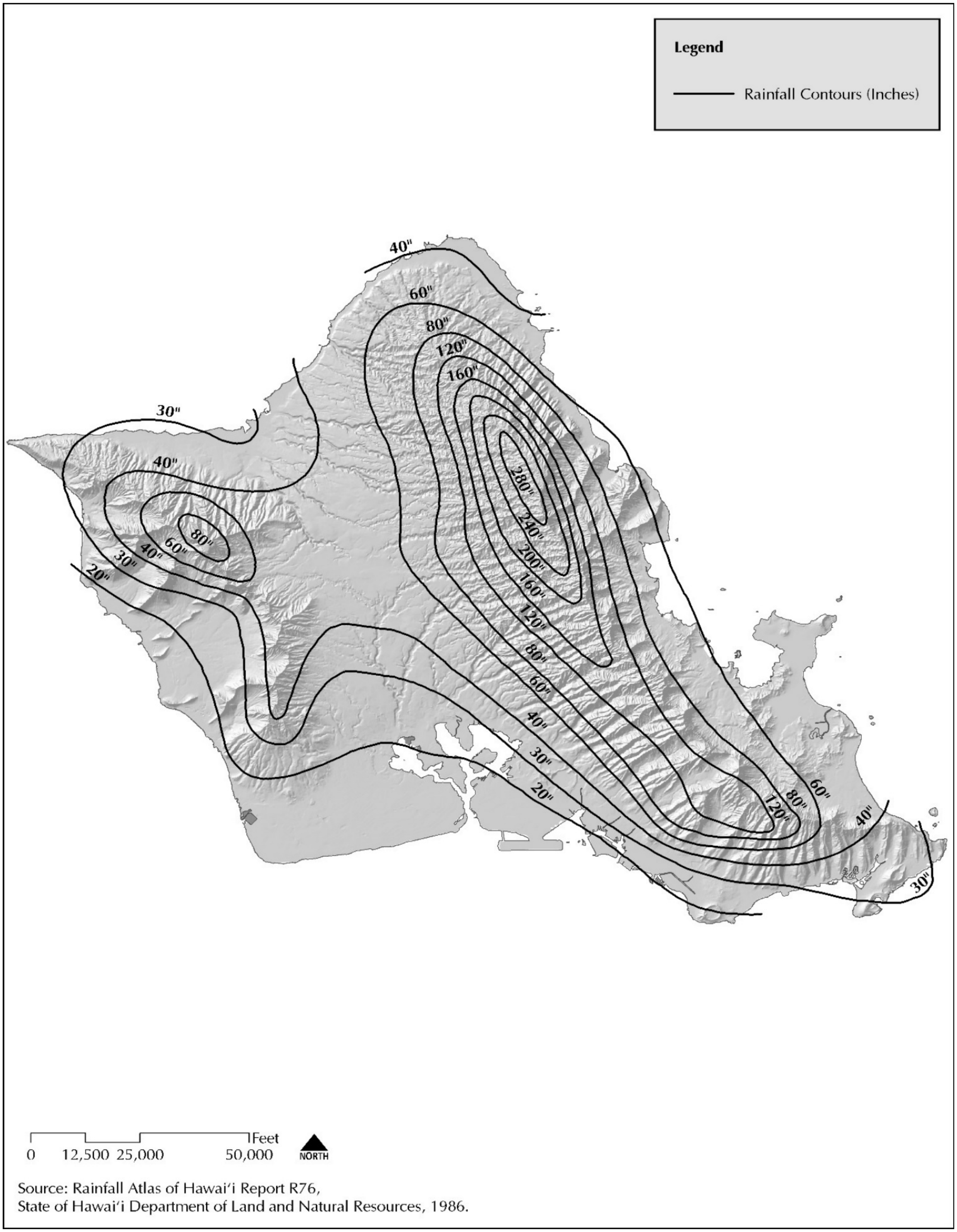


Figure D-1 O'ahu Annual Average Rainfall

Climate Change and Rising Sea Levels

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

- Global average temperatures have increased approximately 0.6 degrees Celsius over the past century and warming is expected to accelerate over the next century. The arctic areas have warmed more rapidly than other areas increasing glacial melt.
- Air pollution has changed the composition of the atmosphere.
- Global warming will change atmospheric and oceanic circulation and the hydrologic cycle leading to altered patterns of precipitation and runoff.
- Global average precipitation and evaporation will increase with warming because a warmer atmosphere can hold more moisture. However, this does not mean that it will get wetter everywhere and in all seasons. Some say average precipitation will tend to be less frequent but more intense. This implies unanticipated extremes, such as unprecedented droughts and floods.
- Climate variability affects the availability and quality of water resources. Long-term climatic trends could trigger vegetation changes that would alter a watershed’s water balance. Changes in the quantity of water percolating to ground water will result in changes to aquifer levels, in base flows entering streams and in seepage losses from streams to ground water.
- While artic areas are warming and glaciers are melting more rapidly, current climate models suggest that arctic and equatorial regions may have a tendency to become wetter and that subtropical regions may experience drying. Hawai‘i is within the tropical region defined as those areas between the Tropics of Cancer and Capricorn.
- Rising sea levels will introduce new stresses on physical and ecological systems, including aquifers, streams, forests and riparian zones as well as coastal and freshwater aquatic systems. Rising sea levels impact coastal environments in the following ways:
    - Lowland inundation and wetland displacement
    - Altered tidal range in rivers and bays
    - Changes in stream sedimentation patterns
    - Severe storm surge flooding
    - Saltwater intrusion into estuaries and freshwater aquifers
    - Increased wind and rainfall damage in regions prone to hurricanes

Sea level on O‘ahu has risen 10 inches over the last century and is expected to rise another 3 feet during this century[vii]. 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 sea levels to rise. Carbon dioxide also contributes to ocean acidification.

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.

D.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 D-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.

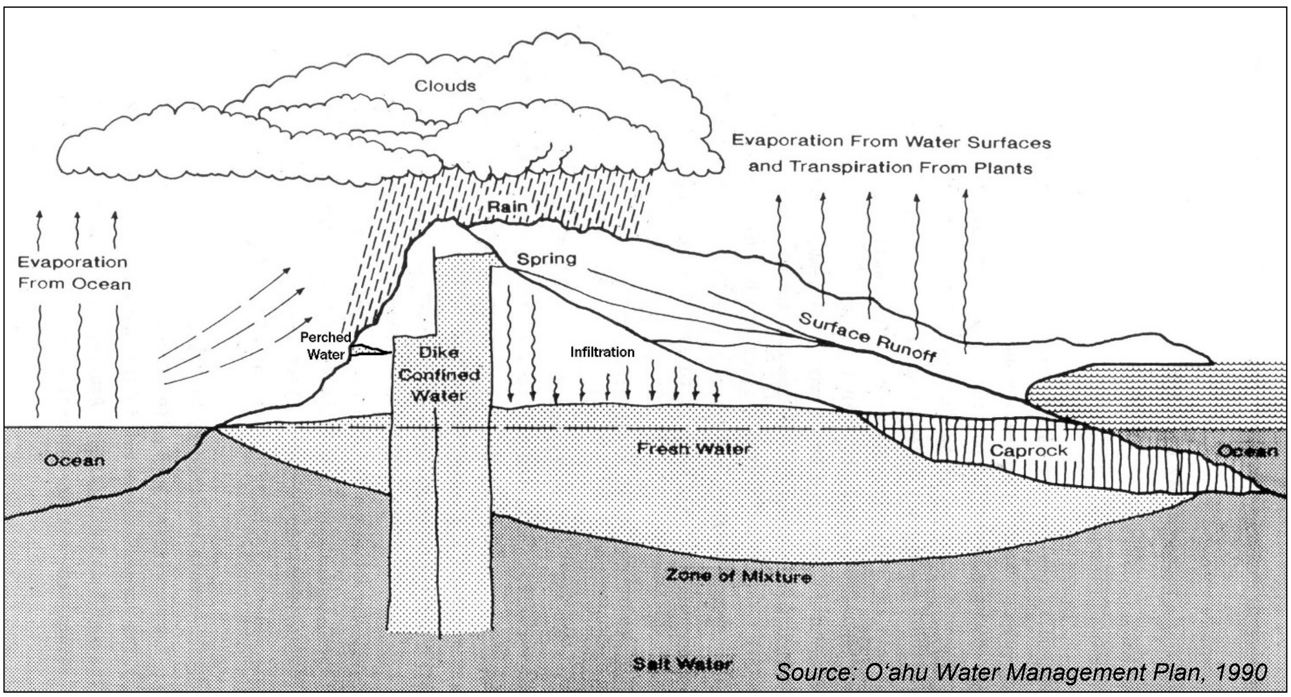


Figure D-2 Hydrologic Cycle

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

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

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

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

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

Leakage is the seaward flow of ground water to nearshore waters in the form of springs, seeps and underflow. Leakage is not easily quantifiable and varies in aquifers due to the amount of caprock or lack of sedimentary caprock. There are also freshwater losses to the aquifer transition zone or zone of mixture between freshwater and seawater.

Human activities can alter the components of the water cycle. For example, global warming and forest degradation can change evapotranspiration rates; agricultural and urban development can affect runoff patterns.

D.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.[viii] 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 debris avalanche 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 impounds the freshwater lens of ground water from flowing into the ocean. Under the caprock the freshwater lens thickens and is under pressure, a characteristic referred to as artesian, if the piezometric surface of the aquifer is higher than the land surface elevation.

D.5 HYDROGEOLOGY

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

D.5.1 Ground water

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

D.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 D-2).

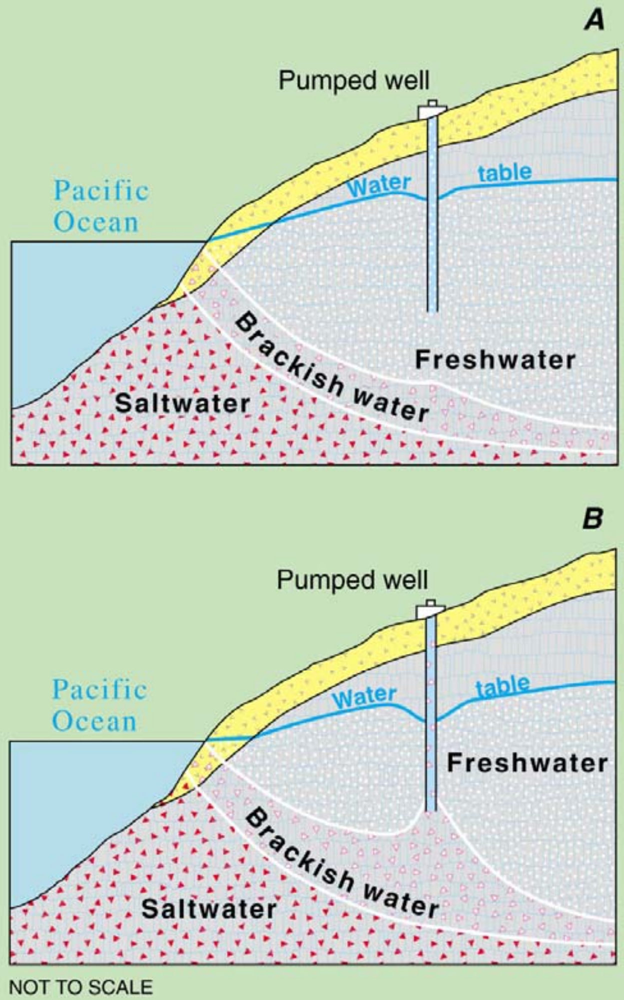
On O‘ahu, the Leeward basal aquifers are much larger than the Windward basal aquifers. On the Windward side of the island, the dike complex makes this a much smaller or truncated lens (Figure D-2).

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.[ix] 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 D-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.* *Source: USGS Ground Water in Hawai‘i*

Figure D-3 Salt Water Intrusion

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

D.5.1.3 Perched Water

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

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

D.5.1.4 Caprock Water

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

D.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.

D.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.

D.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 ground water as springs, especially in the Pearl Harbor area, maintains perennial streamflow near the shoreline. Figure D-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.

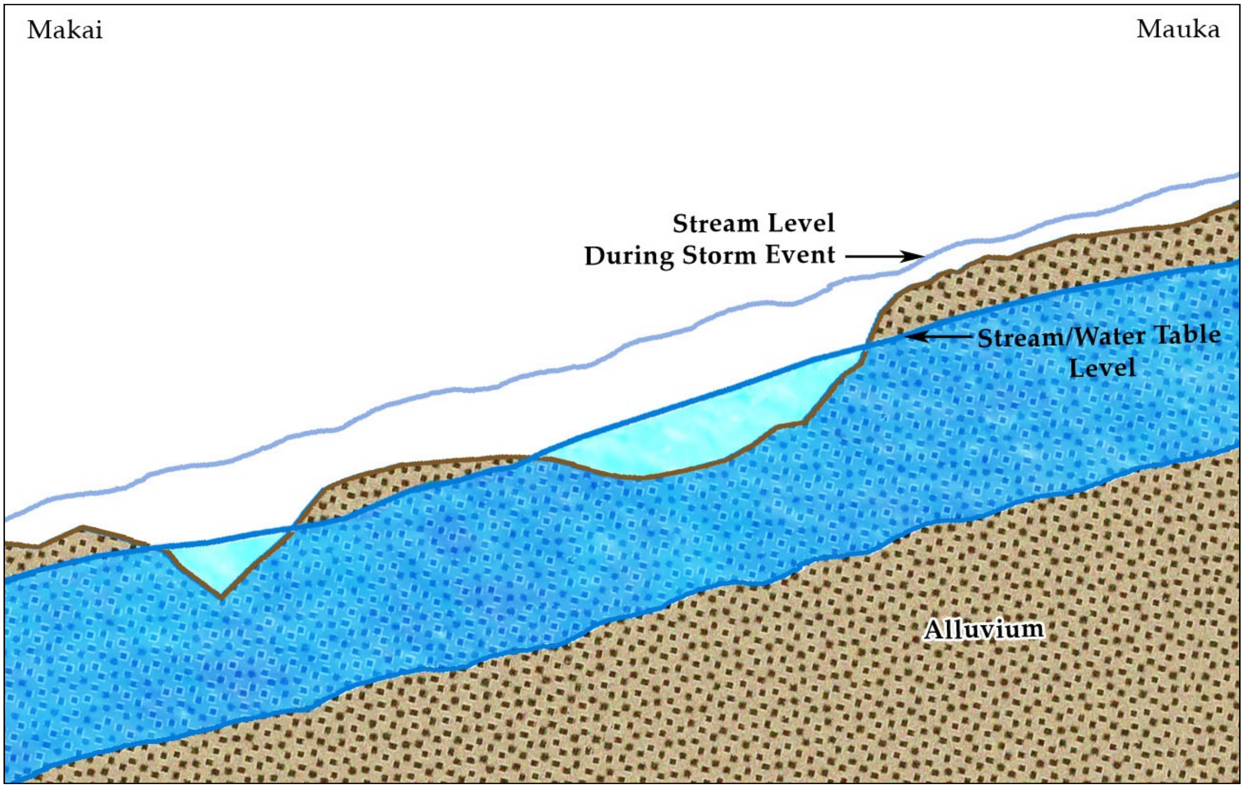


Figure D-4 Intermittent Streams During Wet and Dry Periods

D.5.3 The Relationship Between Ground and Surface Water

The aquifer systems in Windward O‘ahu consist of basal aquifers, high level dike aquifers and dike basal aquifers, which are a combination of the first two. Three of the windward aquifer system areas – Waimānalo, Ko‘olau Poko and Kahana – are generally considered to have a direct relationship between surface and ground water conditions. In Ko‘olau Loa, the upper elevations of these dike areas intersect with streams. At lower elevations, surface water may be hydraulically separated from the basal and dike basal aquifers by layers of thick sediments.[x] 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 D-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 D-6, (Location A). This is a gaining stream reach, where the dike water supplies water to the stream, and therefore ground water withdrawals affect streamflow. Also, where tunnels tap dikes for water supply, streams can be affected because dike water levels have been lowered.

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

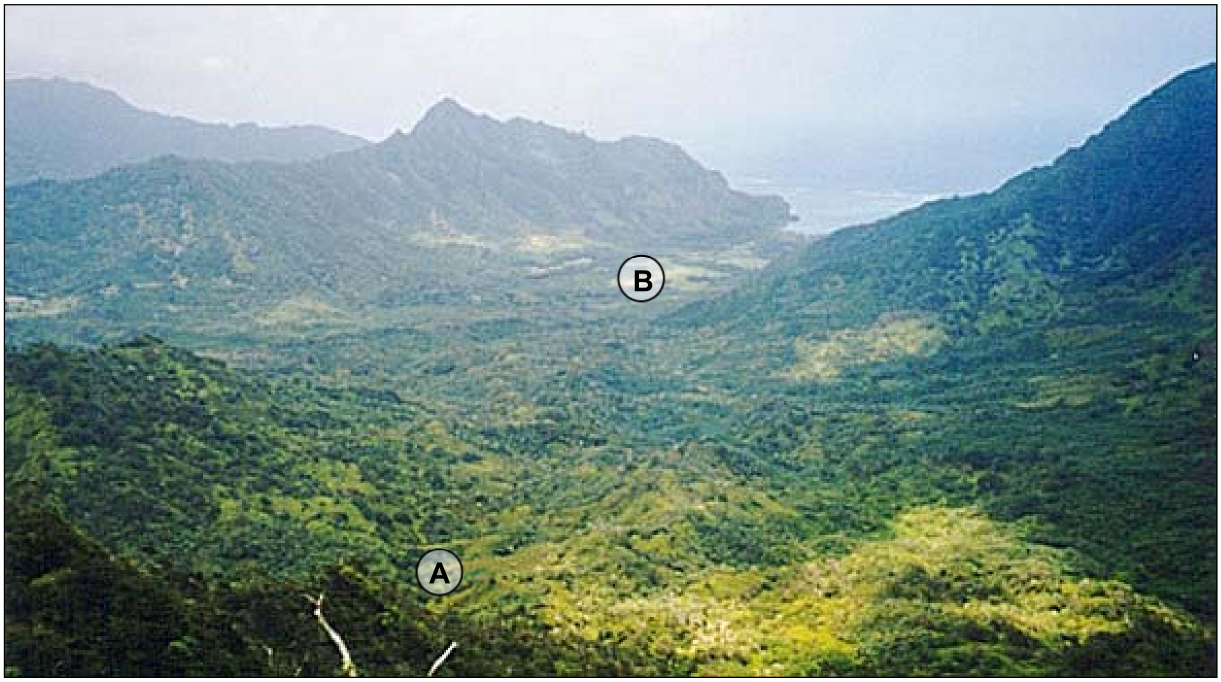


Figure D-5 Typical Windward Valley with Upper (A) and Lower (B) Elevation Stream Locations

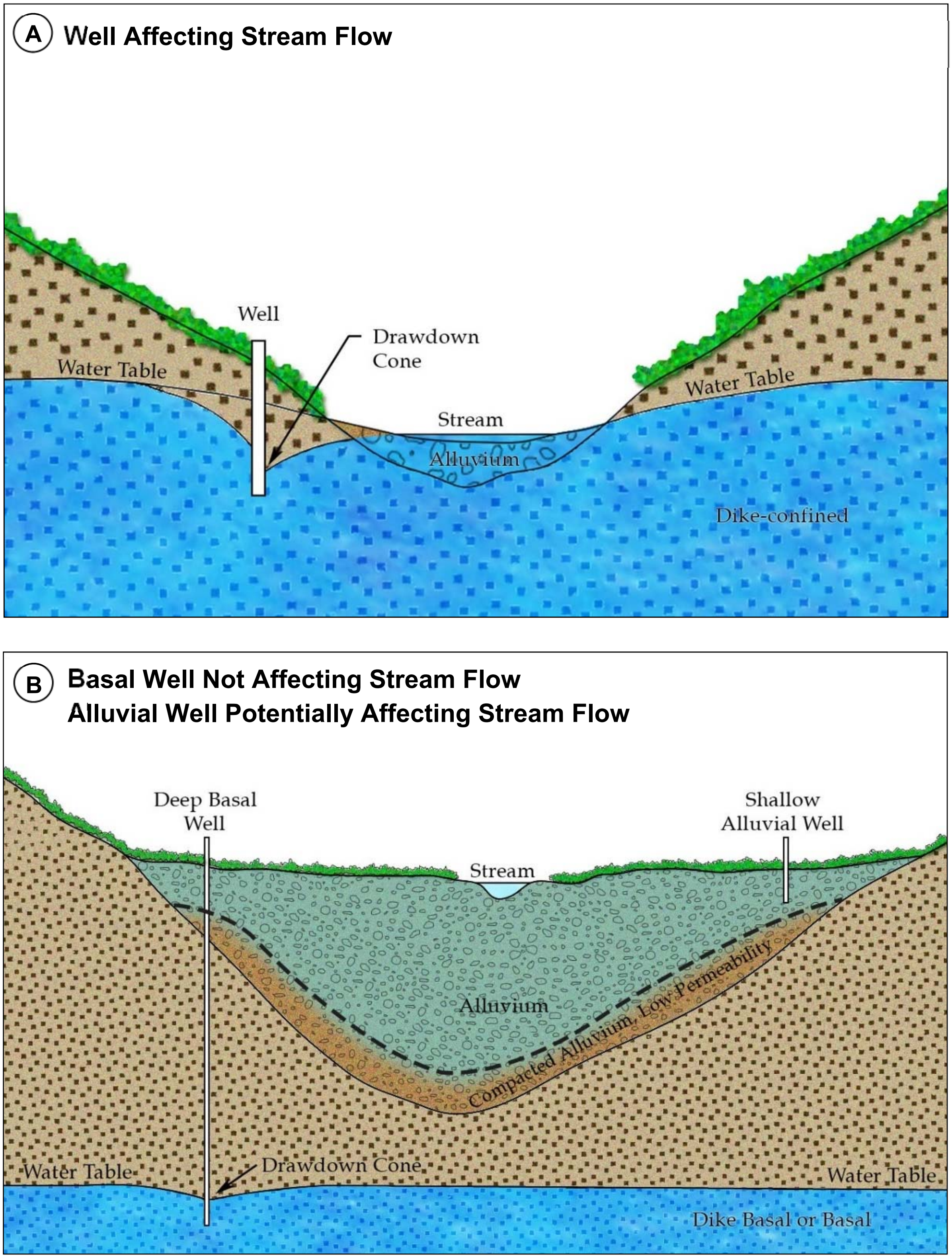


Figure D-6 Well/Ground Water Relationship

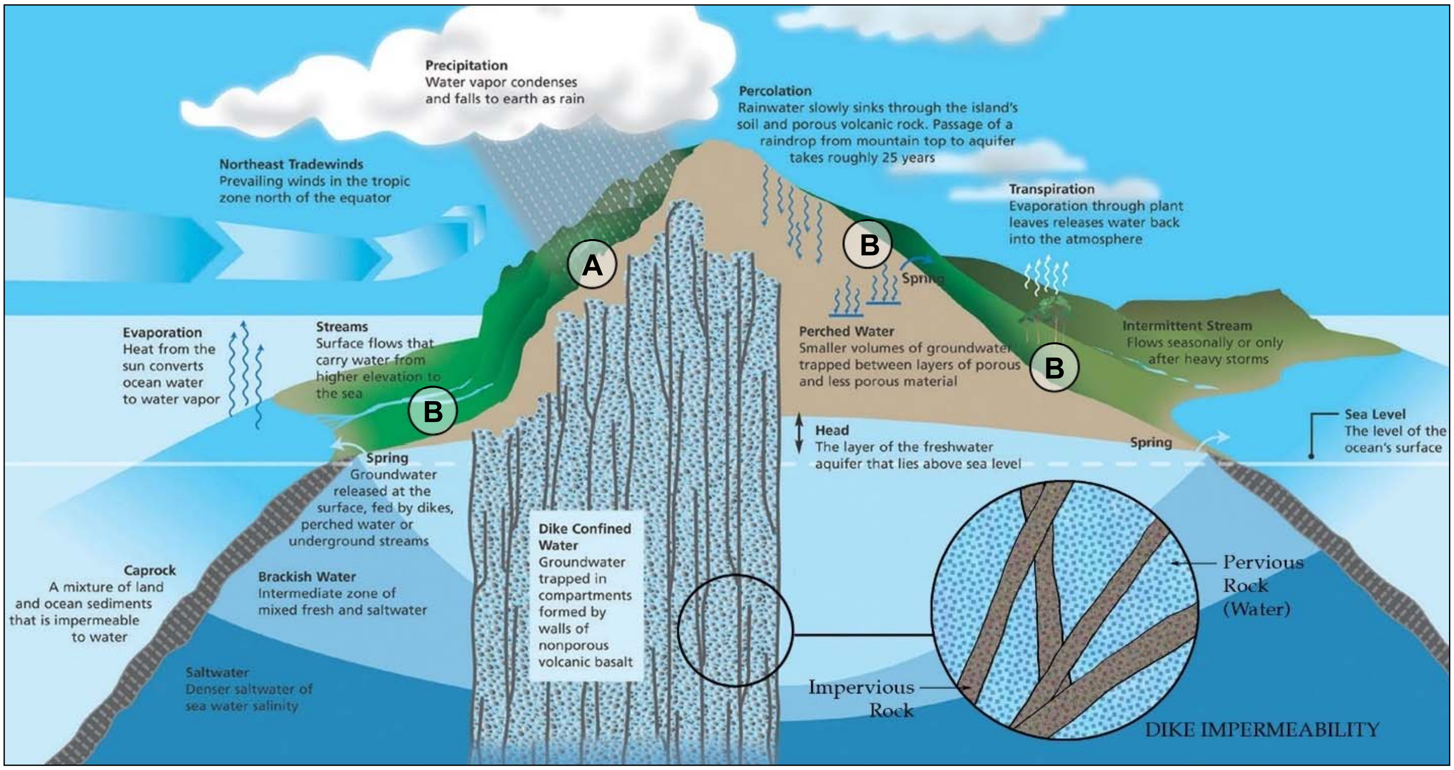


Figure D-7 Island Cross Section with Stream Type and Elevation Locations

D.6 SUSTAINABLE YIELD

Sustainable yields for all aquifer system areas have been adopted as part of the State Water Code's Water Resources Protection Plan (WRPP) and are used for resource management and protection. Sustainable yield is defined by the Hawai'i Administrative Rules as *the maximum rate at which water may be withdrawn from a water source without impairing the utility or quality of the water source as determined by the commission.*[xi] The island is divided up into Aquifer Sector and System Areas which are management tools that do not imply non-communication or separate independent aquifer bodies. Aquifer Sector Areas generally define large geological boundaries such as rift zones, unconformities or differences in water levels. Aquifer Sector Areas reflect broad hydrogeological similarities and are generally bounded geologic structures, which incorporate topographic divides, such as Honolulu and Pearl Harbor aquifer sectors. Aquifer System Areas such as Waipahu-Waiawa and Waimalu are more specifically defined by ground water hydraulic continuity.

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

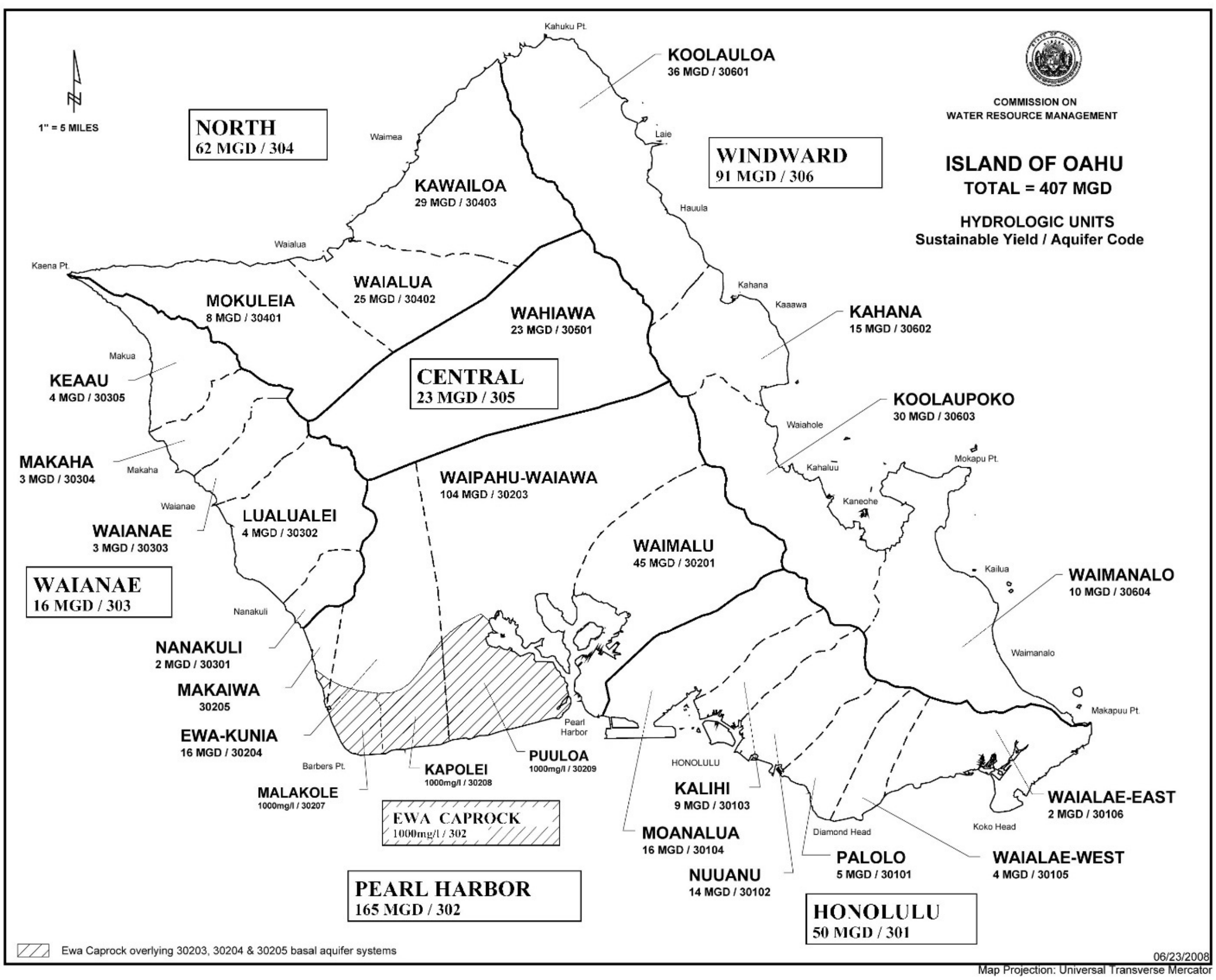


Figure D-8 Aquifer Sector and Aquifer System Area

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 ‘Ewa-Kunia, 1993 Wahiawā and Pearl Harbor, 1997 ‘Ewa Caprock, and 2000 Waipahu-Waiawa and ‘Ewa-Kunia).

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

D.6.1 Recoverability of Sustainable Yield

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

1. ***Well spacing and pump size optimization:*** In general, a higher level of recoverability can be achieved with many smaller wells spaced evenly throughout the aquifer system area, than fewer larger wells concentrated in a few locations. When pumping ground water, wells have an upconing effect where the saline water is drawn up toward the well (Figure D-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 D-9.

2. ***Surface and ground water 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 ground water interactions are more likely in dike formations. Ground water development in the basal formations usually does not have an effect on stream flows. Stream impacts from ground water development are evaluated on a case-by-case basis. Interim instream flow standards as well as appurtenant rights, riparian rights, and existing instream uses directly affect the availability of the portion of ground water interacting with surface water and require the approval of the CWRM.

3. ***Separate hydro-geological formations:*** The adopted sustainable yields provide a gross estimate for the entire aquifer system area assuming a single homogeneous geologic formation, and do not specifically account for the yields of each of the separate

hydro-geological formations within the aquifer system, such as dike, basal, alluvial or caprock formations. CWRM does not count caprock withdrawals against sustainable yields, but does count alluvial withdrawals. In the sustainable yield calculations, residual rainfall is assumed to recharge the 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 from some areas. The hydraulic interaction between these geologic formations is not fully understood, estimated or readily measurable and affect recoverability.

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

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

   a. ***Cost*** considerations limit the number of wells and length of connecting pipelines. Exploratory wells in dike and alluvial formations are risky due to potentially low yields and potential affects to IIFS.
   b. ***Land constraints*** such as steep terrain or urbanization can make potential well development infeasible due to high costs.
   c. In general, the higher the uncertainty from the factors noted above, the higher the **financial risk** and the less likely full recoverability will be achieved. However, water may be feasibly extracted through small on-site wells for private water systems.

D.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 D-9). Initial construction on the Waiāhole Ditch and Tunnel System (Waiāhole Ditch) took place between February 1913 and December 1915. During construction, large amounts of dike-impounded ground water were encountered at the high elevations (between approximately 700 to 800 feet elevation) at which the transmission tunnels were being bored, and subsequent extensions of the tunnel system during 1925 to 1933 and again in 1964, have resulted in a system that currently collects mostly dike-impounded ground water. Development of these dike-impounded waters that previously fed Waiāhole (and its tributary

Waianu), Waikāne and Kahana Streams through springs and seeps resulted in diminished flows in these streams.

The State CWRM has determined that the Waiāhole Ditch develops an average of 27 MGD, consisting of 23.3 MGD measured at the North Portal, which is directly underneath the crest of the 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. Twelve MGD of water was added to the Kahana, Waikāne, Waianu and Waiāhole Streams.[xii]

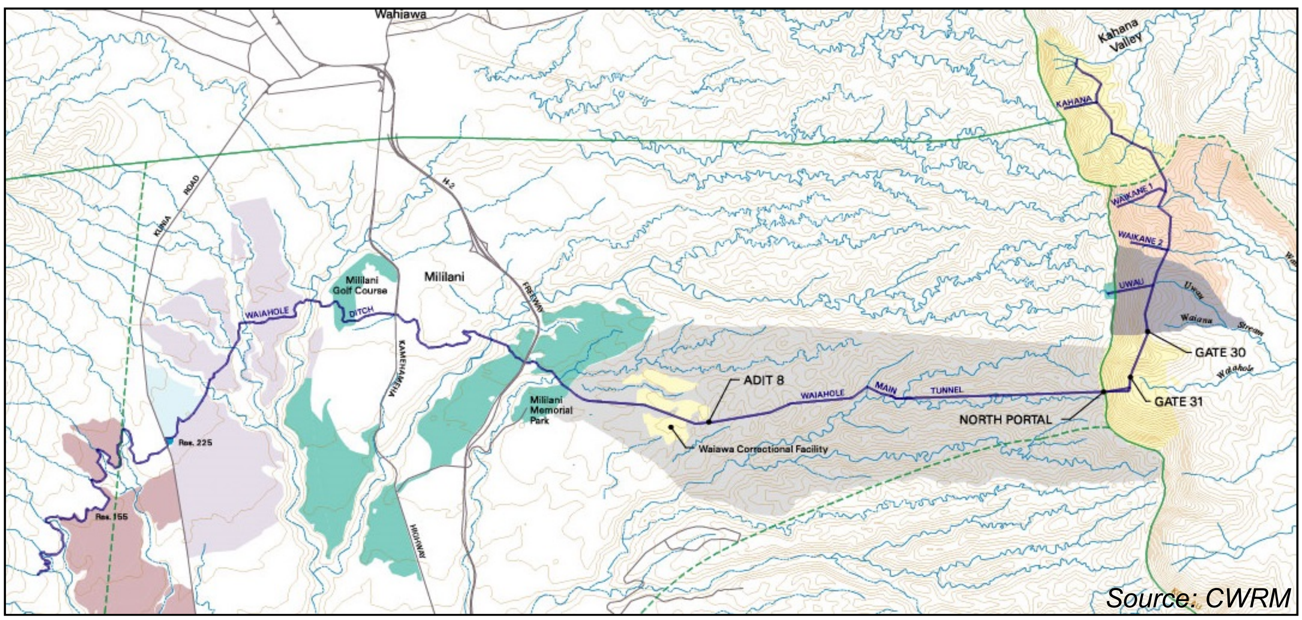
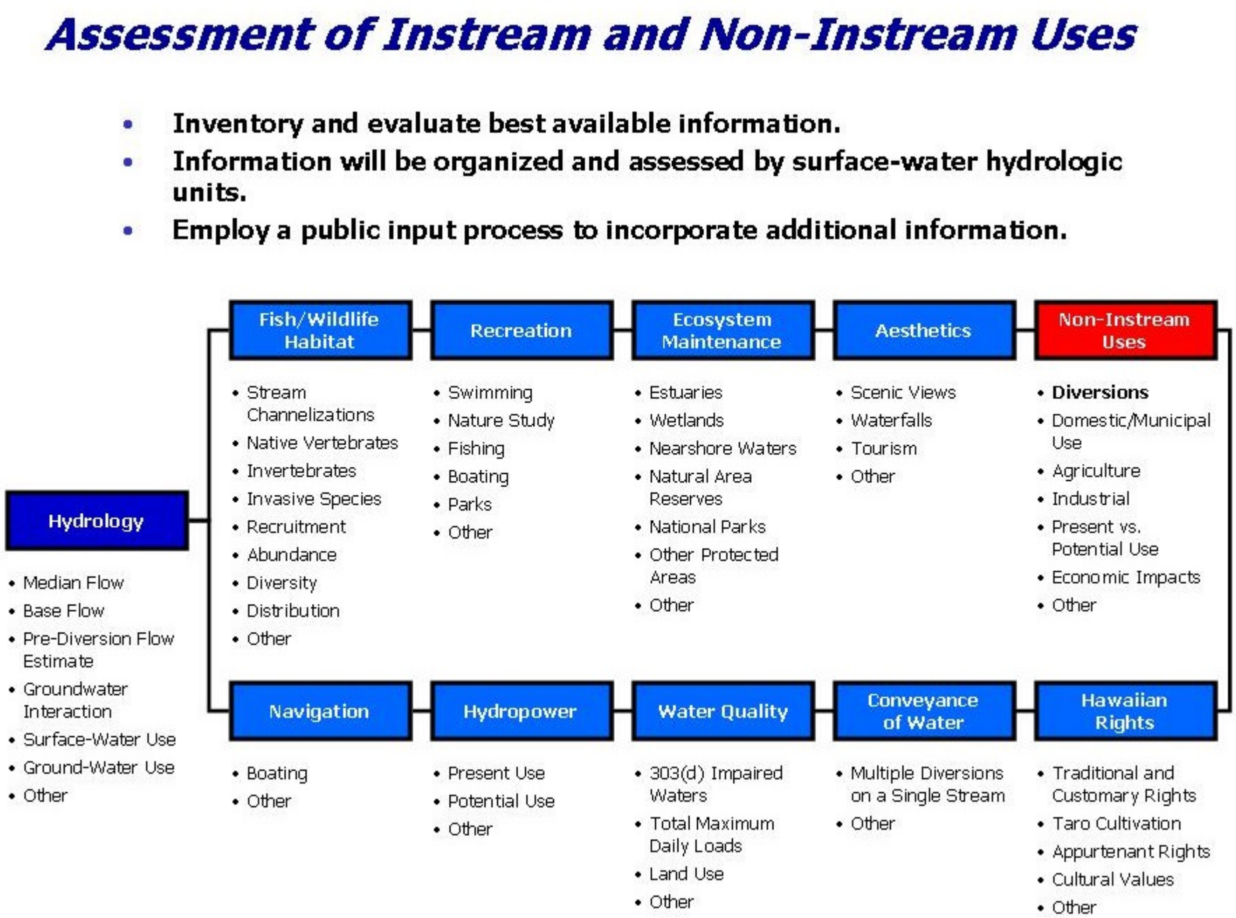


Figure D-9 Waiāhole Ditch System

D.7 INSTREAM FLOW STANDARDS

Instream flow standards (IFS) are similar to sustainable yields for ground water, in that their establishment provides a management system that protects the resource and cultural uses while allowing for possible non-instream water use. The State Water Code defines instream flow standards as *“the quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses.”*[xiii] 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 D-10). 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.



Source: CWRM Presentation to Water Commission, June 2006

Figure D-10 Information to Consider in Setting Measurable Interim Instream Flow Standards

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.[xiv] 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.”[xv] The stream flows and diversions were not quantified in the standard, however users of surface water and ground water were required to register their uses with CWRM.

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

Table D-1 Amended O‘ahu Interim Instream Flow Standards

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

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

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

ENDNOTES

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[i] Atlas of Hawai‘i, 1983

[ii] US Census, 2000

[iii] O‘ahu Water Management Plan Technical Reference Document, March 1990

[iv] Groundwater in Hawai‘i. USGS, FS 126-00

[v] State of Hawai‘i Agricultural Water Use and Development Plan, December 2003

[vi] 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

[vii] Rising Sea Levels, Sunny Lewis, Hawai‘i Public Radio, July 19, 2006

[viii] Atlas of Hawai‘i, Third Edition, 1998

[ix] Groundwater in Hawai‘i. USGS, FS 126-00

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

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

[xii] Waiāhole Ditch Contested Case

[xiii] State Water Code Section 174-C 3

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

[xv] Waiāhole Ditch Contested Case

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