

KAIKA BAY

WATERSHED-BASED PLAN

A watershed management plan to assess, protect, and improve water quality in the Kaiaka Bay Watersheds, O'ahu, Hawai'i

VOLUME 2: IMPLEMENTATION PLAN

APRIL 2018



Prepared for:

CITY & COUNTY OF HONOLULU
DEPARTMENT OF FACILITY MAINTENANCE

STATE DEPARTMENT OF HEALTH
CLEAN WATER BRANCH



Prepared by:



TOWNSCAPE, INC.
Environmental & Community Planning

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City & County of Honolulu – Department of Facility Maintenance &
Hawai'i State Department of Health – Clean Water Branch

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ACRONYMS

ADC	Agribusiness Development Corporation
BMP	Best Management Practice
BWS	Honolulu Board of Water Supply
City	City and County of Honolulu
CNPCP	Hawai'i Coastal Nonpoint Pollution Control Program
CPPE	Conservation Practice Physical Effects
CTAHR	College of Tropical Agriculture and Human Resources
CWB	Clean Water Branch
DAR	Hawai'i Department of Aquatic Resources
DBEDT	Hawai'i Department of Business, Economic Development and Tourism
DFM	City Department of Facility Maintenance
DLNR	Hawai'i Department of Land and Natural Resources
DOA	Hawai'i Department of Agriculture
DOD	Department of Defense
DOE	Hawai'i Department of Education
DOFAW	Division of Forestry and Wildlife
DOH	Hawai'i Department of Health
DOT-HWYS	Hawai'i Department of Transportation Highways Division
DPP	City Department of Planning and Permitting
DPW	Department of Public Works
ENV	City Department of Environmental Services
EPA	Environmental Protection Agency
FOTG	Field Office Technical Guide
Ft	Foot
GIS	Geographic Information Systems
HACD	Hawai'i Association of Conservation Districts
HRS	Hawai'i Revised Statutes
HWG	Hawai'i Watershed Guidance
HWMO	Hawai'i Wildfire Management Organization
ITAM	Integrated Training Area Management
JBPHH	Joint Base Pearl Harbor-Hickam
KMWP	Ko'olau Mountains Watershed Partnership
L	Liter
LA	Load Allocation
LID	Low Impact Development
mg	Milligram (1000 mg = 1 gram)
MGD	Millions of Gallons per Day
ml	Milliliter (1000 ml = 1 liter)
MOU	Memorandum of Understanding
MS4	Municipal Separate Storm Sewer System
NAR	Natural Area Reserve

ACRONYMS (CONTINUED)

NCTAMS-PAC	Naval Computer and Telecommunications Area Master Station Pacific
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
NSRWWAP	North Shore Regional Wastewater Alternatives Plan
OANRP	O'ahu Army Natural Resources Program
OHA	Office of Hawaiian Affairs
OISC	O'ahu Invasive Species Committee
OpenNSPECT	Open Nonpoint Source Pollution and Erosion Comparison Tool
ORC&D	O'ahu Resource Conservation and Development Council
OSDS	On-site Sewage Disposal System
PRC	Polluted Runoff Control
QA/QC	Quality Assurance / Quality Control
RFP	Request for Proposal
ROH	Revised Ordinances of Honolulu
SOP	Standard Operating Procedure
SWCD	Soil and Water Conservation District
SWMP	Storm Water Management Plan
TMDL	Total Maximum Daily Load
TSP	Technical Service Provider
TSS	Totals Suspended Solids
UH	University of Hawai'i
US	United States of America
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WBP	Watershed-Based Plan
WIS	Wahiawā Irrigation System
WLA	Waste Load Allocation
WMP	Watershed Management Plan
WMWP	Wai'anae Mountains Watershed Partnership
WWTP	Wastewater Treatment Plant

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EXECUTIVE SUMMARY

Land-based pollutants are one of the major factors impairing the health of Hawai'i's watersheds and coral reefs. On the North Shore of O'ahu, six watersheds that cover over 50,000 acres of land drain into Kaiaka Bay, located in the town of Waialua. Together, these watersheds are referred to in this plan as the "Kaiaka Bay Watersheds." Every waterbody in the Kaiaka Bay Watersheds is known to be polluted with one or more contaminants, including excessive nutrients, turbidity, sediments, fecal indicator bacteria (i.e. sewage), chemicals, chlorophyll *a*, and trash.

The goals of the Kaiaka Bay Watershed-Based Plan (WBP) are as follows:

- Improve existing regulations and programs related to watershed management and identify opportunities for new programs;
- Measurably reduce erosion and sediment loads from all land use types;
- Measurably reduce nutrient loads from all land use types;
- Address other types of pollutants (e.g. pesticides, hydrocarbons, pathogens, metals, etc.) as opportunities arise or as future needs indicate necessary; and
- Increase the education, understanding, and participation of major landowners and the local community regarding watershed stewardship and water quality monitoring activities.

The Kaiaka Bay WBP consists of two volumes: Volume 1: Watersheds Characterization, which describes the watersheds in terms of physical and natural features, land uses, water quality issues, and sources of pollution; and Volume 2: Implementation Plan (this document), which outlines the key actions and projects necessary to improve water quality in the watersheds, as well as provides guidelines for evaluating and monitoring progress.

Strategies for addressing thirteen key issues that pertain to existing policies, programs, and regulations related to watershed management are described in Chapter 2 of the *Implementation Plan*. These key issues were identified through research and consultations with various stakeholders, including government agencies, nonprofit organizations, landowners, and others. Each key issue is summarized and includes a description of how it is relevant to surface water quality. The issues are as follows (not presented in order of significance or priority):

1. New farmers and immigrants are not familiar with land use regulations
2. Need better record-keeping, follow-up, and enforcement of the City grading and grubbing exclusion
3. Agricultural conservation planning organizations are under-funded and short-staffed
4. Agricultural conservation plans and conservation practices are not consistently implemented
5. High priority watershed areas are threatened by invasive species
6. Wildfire prevention, response, and post-fire restoration efforts are under-funded
7. Cesspools impact water quality
8. Stormwater management programs/projects are under-funded
9. Property owners lack incentives to implement stormwater BMPs or low impact development practices
10. Water quality data are limited
11. There are few policies related to adapting to the effects of climate change
12. The State has obstacles in enforcing nonpoint source pollution regulations

13. Pollution regulations often lack an integrated watershed management approach

Strategies to address the key issues are presented in Table ES-1. Many of the strategies recommend additional funding for programs that are already working towards addressing an issue, while others encourage introducing new programs or revising existing policies. All recommended strategies should be reviewed and vetted by the relevant government branch.

Chapter 3, “Management Measures and Practices,” specifies management measures and practices that could/should be implemented to improve surface water quality and the nearshore ecosystem of Kaiaka Bay. To refine the discussion of pollutants and their control strategies, the six Kaiaka Bay Watersheds are categorized into four general land use types: (1) Forest Lands, (2) Agricultural Lands, (3) Developed Areas, and (4) Army Training Areas. The chapter is divided into five major sections: one section for each of the four land use types and a final section that summarizes the chapter and presents an overall prioritization of all the management measures to improve water quality. For each of the four land use types, relevant management measures are described and prioritized by watershed. In addition, any known opportunities for implementing specific projects in priority watersheds are described.

The overall prioritization of management measures for the entire project area builds on the prioritization of the management measures for each land use type but also incorporates additional information, including:

- Water quality data;
- Watershed modeling results (using OpenNSPECT);
- Goals and objectives from the “State Nonpoint Source Management Plan, 2015 – 2020” (DOH PRC, 2015);
- “Geomorphic Assessment of Poamoho Stream” (AECOM, 2016);
- Stakeholder consultation and feedback; and
- Professional judgment.

Of the nineteen management measures described in Chapter 3, nine were identified as overall priorities for implementation in certain watersheds (shown in **underlined bold** text in Table ES-2). These measures are as follows:

- Forest Lands Measure #1: Watershed Protection and Forest Management
- Agricultural Lands Measure #1: Erosion and Sediment Control from Actively Farmed Lands
- Agricultural Lands Measure #5: Livestock, Ranching, And Pasturelands Management
- Agricultural Lands Measure #6: Fire Prevention
- Agricultural Lands Measure #8: Field Access Road Management
- Developed Areas Measure #2: Nonpoint Source Wastewater Treatment
- Developed Areas Measure #3: Stormwater Management
- Army Training Areas Measure #1: Fire Prevention and Management
- Army Training Areas Measure #3: Erosion Management Along Roads, Trails, and Frequently Used Areas

It should be noted that the prioritization of specific measures in specific watersheds should not prohibit the procurement of funding to implement measures in watersheds that were not deemed “priority,” since implementing a practice in any applicable watershed will have positive effects on water quality.

Successful implementation of the *Kaiaka Bay WBP* is dependent on stakeholder awareness and involvement. Chapter 4 describes the existing context of education and outreach efforts in the Kaiaka Bay Watersheds and then presents eight different strategies to expand on those efforts. The goal is to empower, educate, and engage the public to effectively reduce nonpoint source pollution in the Kaiaka Bay Watersheds. Eight recommended education and outreach strategies are presented in Table ES-3.

Chapter 5, titled “Implementing the Kaiaka Bay Watershed-Based Plan,” describes implementation strategies that will help ensure that plans to implement measures and strategies identified in this WBP are developed with a solid foundation and necessary oversight to accomplish goals. One of the first strategies is to identify the entities who may be involved in implementation. In the Kaiaka Bay Watersheds, the City and County of Honolulu, the State Department of Transportation Highways Division, the U.S. Army, and the U.S. Navy operate systems that require permits for point source pollution; these agencies are required to comply with standards for pollutant loads and remediation strategies. Perhaps even more important for implementation is obtaining the cooperation of private parties, community organizations, local and state government, and other landowners to implement measures and strategies to reduce nonpoint sources of pollution.

When considering which strategies and management measures to implement, it should be remembered that there is no single, ideal management practice system for controlling a particular pollutant in all situations. Rather, the system should be designed based on the type of pollutant, the source of the pollutant, the local environmental conditions, the regulatory setting, the pollution reduction goals, the economic situation of the landowner/implementer, the experience of the system designers, and the willingness and ability of the landowner/implementer to maintain the practices. An important strategy for implementing management practices is to focus on priority pollutants within the same area or drainage system so that the practices function together to achieve the most significant reductions in pollutant loads.

The financial resources required to implement the strategies and practices outlined in this WBP vary considerably depending on the specific project, scale/size of the project, and location. It is important to note that the cost for implementing a project can sometimes appear to be relatively high compared with the potential pollutant load reduction, however, the cost to implement an individual project often decreases as the number of units installed increases, making the cost-benefit ratio more favorable. Costs to implement structural management practices can sometimes include engineering and permitting requirements, purchasing of materials, construction/installation, construction management, and operations and maintenance. For non-structural practices, implementation costs may include planning/consulting fees, site-specific testing, cost of materials, and maintenance.

Funding for implementation can come from a range of sources including federal, state, local, and private entities. Funding mechanisms can include contracts, private funds, local grants, cost-share agreements, and volunteer efforts.

The implementation timeline for the management measures and other strategies described in this WBP is contingent upon a number of factors, including the availability of funding, the extent of outreach to landowners and other stakeholders, the willingness of landowners/stakeholders to implement practices on their land, the regulatory permits and approvals, and the effectiveness of pollutant load reduction. While there are many unknown variables that will affect the overall implementation schedule, it is reasonable to state that each of the nine overall priority measures should be funded and implemented

in some locations within the next five years. The DOH expects to be able to issue a Request for Proposal in 2018 to implement projects in the Kaiaka Bay Watersheds using federal Clean Water Act Section 319 funding. The first project(s) would then be funded and implemented in 2019. It would be reasonable to expect that for every subsequent year another project will be funded.

The final chapter of *Volume 2*, “Evaluation and Monitoring,” outlines strategies for evaluating implementation progress and monitoring for improvements in water quality. A well-designed and comprehensive monitoring program is essential to evaluate how the Kaiaka Bay WBP is being implemented and to determine the level of progress achieved towards reducing pollutant loads. Two types of monitoring are recommended: implementation monitoring and trend monitoring. By tracking management measures and water quality simultaneously, managers will be able to evaluate the performance of the management measures implemented. It is a top priority to identify the entities responsible for monitoring, whether they be community-based volunteer groups, a nonprofit organization, the State DOH CWB, or a combination of various efforts. An “adaptive management” approach should be taken to continually assess and improve the management approach to be more efficient and effective. Due to the lack of complete information regarding the appropriate type, extent, and location of management measures and practices, it is highly likely that changes will be needed once aspects of the WBP are implemented.

Volume 1 of the Kaiaka Bay WBP characterizes the watershed conditions and *Volume 2* makes recommendations on how to reduce point source and nonpoint source pollutants. While this is an essential first step towards improving the health of the watersheds and the marine environment of Kaiaka Bay, a well-designed monitoring program is essential for an adaptive management approach to continually improve the plan. The *Kaiaka Bay Watershed-Based Plan* should be evaluated annually to determine progress and adapt implementation strategies and priority projects based on current knowledge.

TABLE ES-1. SUMMARY OF STRATEGIES RELATED TO POLICIES, PROGRAMS, AND REGULATIONS

STRATEGY	KEY ISSUE #	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/ CHAMPIONS	POTENTIAL SUPPORT/ FUNDING	TIMEFRAME TO IMPLEMENT
Require submittal of conservation plans used for exclusion to grading/grubbing permit (<i>Option A</i>)	1	Low	City DPP	City DPP	Short-term
Increased training for DPP and funding for enforcement of conservation plans (<i>Option A</i>)	1	Low	City DPP	DOH; DLNR; DOA; NRCS; EPA	Short-term
Formally define roles & responsibilities for SWCDs and DPP in the exclusion process (<i>Option A</i>)	1	Low	City DPP; West O'ahu SWCD	City DPP; West O'ahu SWCD	Mid-term
Create an agricultural watershed coordinator position (<i>Option A</i>)	1; 2	Low	West O'ahu SWCD; ORC&D; City DPP; City DFM	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Amend ROH Chapter 14 to specify that the grading/grubbing permit does not pertain to agricultural practices (<i>Option B</i>)	1	Unknown*	City	City	Long-term
Create a water quality protection fee for landowners in agricultural areas (<i>Option B</i>)	1	Unknown*	City	n/a	Long-term
Increase funding for agricultural outreach and education programs	2	Med	West O'ahu SWCD; ORC&D	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding for conservation planning organizations	3	Med	HACD; West O'ahu SWCD; ORC&D	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding opportunities to implement conservation plans and conservation practices	4	Med	Farmers	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding for watershed management programs and projects in high priority watersheds	5	Med/High	KMWP; WMWP; OISC; DLNR DOFAW	City; BWS; DOH; DLNR; NRCS; EPA; Army	Mid-term
Increase funding for projects and programs related to wildfire prevention, response, and post-fire restoration	6	Med	KMWP; WMWP; DLNR DOFAW	City; BWS; DOH; DLNR; NRCS; EPA; Army	Mid-term
Increase incentives to replace cesspools	7	Med/High	DOH; City	EPA; DOH; City	Mid-term
Establish a stormwater fee	8; 9	Med	City	n/a	Mid-term

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TABLE ES-1. SUMMARY OF STRATEGIES RELATED TO POLICIES, PROGRAMS, AND REGULATIONS (CONTINUED)

STRATEGY	KEY ISSUE #	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/ CHAMPIONS	POTENTIAL SUPPORT/ FUNDING	TIMEFRAME TO IMPLEMENT
Develop a framework for funding programs/projects related to water quality monitoring	10	Low	Third-party researchers; nonprofits; community organizations; City; DOH; DLNR; USGS	EPA; DOH; DLNR; City	Mid-term
The City's Office of Climate Change, Resilience, and Sustainability should recommend policies that protect water quality	11	Low/Med	City	EPA; DOH; City	Mid-term
DOH follow strategies outlined in "Hawai'i's Nonpoint Source Management Plan: 2015-2020" to enforce NPS pollution regulations	12	Low/Med	DOH	EPA; DOH	Short-term
Regulatory agencies should develop a framework for an integrated approach for permittees to meet permit requirements	13	Low	DOH; EPA	DOH; EPA	Mid-term

* The relative impact these strategies from Option B to address Key Issue #1 would have on pollutant load reduction is unknown, but they could result in reduced pollutant loads since there would be a strong incentive for farmers to get a conservation plan with the proposed new fee.

TABLE ES-2. OVERALL PRIORITY MANAGEMENT MEASURES BY WATERSHED

		Kī'iki'i Stream System			Paukauila Stream System		
		Kī'iki'i	Kaukonahua	Poamoho	Paukauila	Helemano	Ōpae'ula
FOREST LANDS	#1: <u>WATERSHED PROTECTION AND FOREST MANAGEMENT</u>		P*	P*		P*	P*
	#2: FIRE PREVENTION AND MANAGEMENT		P	P		X	X
	#3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS		P	P		X	
AGRICULTURAL LANDS	#1: <u>EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS</u>	P*	P*	P*	P*	X	X
	#2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS	X	X	P	X	X	X
	#3: PESTICIDE-USE MANAGEMENT	X	X	P	X	X	X
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	X	P	P	X	X	X
	#5: <u>LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT</u>	X	P*	X	X	P*	X
	#6: <u>FIRE PREVENTION</u>	X	P*	P*	X	X	X
	#7: IRRIGATION WATER USE	X	P	P	X	X	X
	#8: <u>FIELD ACCESS ROAD MANAGEMENT</u>	X	P*	P*	X	X	X
DEVELOPED AREAS	#1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING		P				
	#2: <u>NONPOINT SOURCE WASTEWATER TREATMENT</u>	P*	P*	X	P*	X	
	#3: <u>STORMWATER MANAGEMENT</u>	P*	P*	P*	P*		
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	P	P	X	P	X	
	#5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT	P	P	X	P	X	
ARMY TRAINING AREAS	#1: <u>FIRE PREVENTION AND MANAGEMENT</u>		P*				
	#2: PREVENTING THE SPREAD OF INVASIVE PLANTS		P				
	#3: <u>EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS</u>		P*				

Notes: 'P*' denotes the OVERALL PRIORITY management measures for the watershed

'P' denotes watersheds and management measures that are secondary priorities

'X' denotes watersheds that are applicable to the management measure

Shaded cells are watersheds in which the management measure is not applicable/recommended

TABLE ES-3. SUMMARY OF STRATEGIES RELATED TO EDUCATION AND OUTREACH

STRATEGY	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/CHAMPIONS	POTENTIAL SUPPORT/FUNDING
Multilingual agricultural outreach & education programs for farmers	Med	West O'ahu SWCD; ORC&D; City (related to Grading/Grubbing permit, stormwater regulations, and other local regulations)	City
"Hike Pono" program	Low	DOFAW; Hawai'i Tourism Authority	DOFAW; Hawai'i Tourism Authority
Public education on invasive species	Low	OISC; KMWP; WMWP; DOFAW	DOFAW; DOH
Community-based water quality monitoring programs	Low	DOH CWB; DLNR DAR; Surfrider Foundation; other community organizations	DOH CWB; DLNR DAR
Integrate lessons or projects related to water quality & watershed management into school curriculum & programs	Low	DOE; DOH; City DFM	DOE; DOH; City DFM
Expansion of public education related to stormwater	Med	City DFM; DOH	City DFM; DOH
Public education for replacement of cesspools	Med/High	City ENV; DOH	City ENV; DOH
Stream/beach clean-ups & restoration	Low/Med	DOH CWB; DLNR DAR; City DFM; Surfrider Foundation; other community organizations	DOH CWB; DLNR DAR

1 INTRODUCTION

The importance of clean water and healthy watersheds cannot be overstated. Hawai'i's watersheds provide us with many important natural and cultural resources, including (but not limited to) drinking water, agricultural lands, recreational opportunities, habitat for native plants and animals, and opportunities for traditional and customary Hawaiian practices. The six watersheds that flow into Kaiaka Bay on O'ahu's North Shore are no exception; these watersheds are referred to as the "Kaiaka Bay Watersheds" in this plan. However, every waterbody in the Kaiaka Bay Watersheds is known to be polluted with one or more contaminants, including excessive nutrients, turbidity, sediments, fecal indicator bacteria (i.e. sewage), chemicals, chlorophyll *a*, and trash. According to data from surveys conducted by the National Oceanic and Atmospheric Administration (NOAA), the coral reef ecosystem in Kaiaka Bay is not particularly healthy. The nearshore waters of the bay are heavily affected by the streams and the sediments and other pollutants they carry. Indeed, the word "Kaiaka" can be translated to mean "shadowy sea" in the Hawaiian language, which may be in reference to the turbidity of the water.

To address these water quality issues, the City and County of Honolulu Department of Facility Maintenance (DFM) and the State of Hawai'i Department of Health (DOH) Clean Water Branch (CWB) contracted with Townscape, Inc. and AECOM to develop a Watershed-Based Plan (WBP) for the Kaiaka Bay Watersheds. The *Kaiaka Bay WBP* will allow DFM and DOH CWB to better understand the major sources of pollution (point and nonpoint) in the watersheds and prioritize mitigation strategies. The WBP will also provide a greater context for DFM as they implement best management practices (BMPs) and other strategies/programs to comply with their Storm Water Management Plan (SWMP) and with the Waste Load Allocations (WLA) set in place for their Municipal Separate Storm Sewer System (MS4), operated under a National Pollutant Discharge Elimination System (NPDES) permit. An MS4 collects and transports stormwater runoff and discharges the runoff at discreet locations into watersheds without treatment. The WLAs were determined by the DOH in Total Maximum Daily Load (TMDL) calculations for pollution in the North and South Forks of Kaukonahua Stream, a major waterbody in the project area.

The goals of the *Kaiaka Bay Watershed-Based Plan* are to:

- Improve existing regulations and programs related to watershed management and identify opportunities for new programs;
- Measurably reduce erosion and sediment loads from all land use types;
- Measurably reduce nutrient loads from all land use types;
- Address other types of pollutants (e.g. pesticides, hydrocarbons, pathogens, metals, etc.) as opportunities arise or as future needs indicate necessary; and
- Increase the education, understanding, and participation of major landowners and the local community regarding watershed stewardship and water quality monitoring activities.

The WBP is composed of two volumes: *Volume 1: Watersheds Characterization* and *Volume 2: Kaiaka Bay Watersheds Implementation Plan*. *Volume 1* describes the six watersheds that drain into Kaiaka Bay in terms of physical and natural features, land uses, water quality issues, and sources of pollution. *Volume 2* (this document) outlines policy and education/outreach approaches that pertain to improving water quality and describes on-the-ground management measures that could be implemented to

improve water quality. Approaches for evaluating implementation and monitoring progress in improving water quality are also presented in the final section of *Volume 2*.

1.1 PROJECT LOCATION

The Kaiaka Bay Watersheds are comprised of approximately 51,454 acres of land situated between the ridgelines of the Wai'anae and Ko'olau mountain ranges and extending toward the North Shore, where the streams converge and flow into Kaiaka Bay, located in the beach town of Waialua (Figure 1). The Kaukonahua, Poamoho, and Ki'iki'i watersheds are part of the Ki'iki'i Stream System and the Helemano, 'Ōpae'ula, and Paukauila watersheds are part of the Paukauila Stream System. Together, the six Kaiaka Bay Watersheds make up approximately 13.5% of O'ahu's total land area.

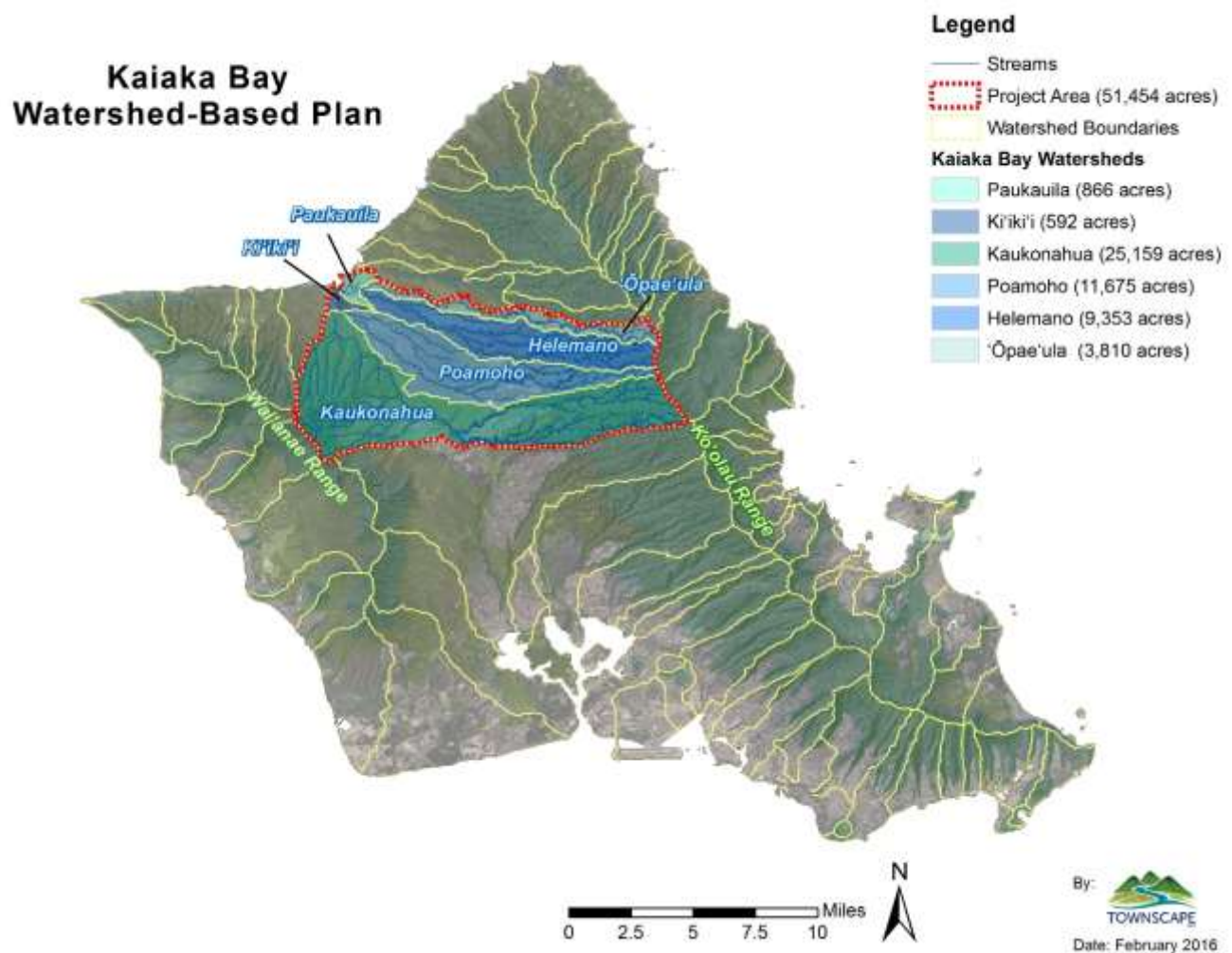


FIGURE 1. KAIKA BAY WATERSHEDS OVERVIEW

1.2 PLANNING PROCESS AND METHODOLOGY

1.2.1 BACKGROUND

This project was phased to meet funding restrictions and to prioritize tasks. In 2010, Phase I was completed by Townscape, Inc. for the watersheds that drain into both Kaiaka Bay and Waialua Bay (located just to the north of Kaiaka Bay). Phase I consisted of a preliminary watershed profile, initial stakeholder outreach with large landowners, hydrology calibration of a water quality model, water quality data collection, an initial assessment of water quality issues, and identification of preliminary BMPs and next steps. Since completion of Phase I, the project area was modified to no longer include the watershed that drains into Waialua Bay. This reduced the total area by approximately 11,763 acres.

1.2.2 WATERSHED PLANNING

1.2.2.1 NINE KEY ELEMENTS

The *Kaiaka Bay WBP* follows the guidelines for watershed planning outlined by the Environmental Protection Agency (EPA). The EPA guidelines refer to “nine key elements” of successful watershed projects. These guidelines require use of a holistic, watershed-based approach to identify sources of pollutants and the remedial actions necessary to reduce their loads to receiving waters (refer to *Volume 1*, section 1.3.1 for details on the nine key elements). Projects, strategies, and management measures that are outlined in this WBP will therefore be eligible for funding under section 319(h) of the federal Clean Water Act since it follows the EPA guidelines.

1.2.2.2 STAKEHOLDER OUTREACH

The EPA guidelines provide a framework for the public participation and stakeholder outreach process required for a WBP. In line with these guidelines, stakeholder outreach was conducted throughout the preparation of this *Implementation Plan*. See Chapter 6 of *Volume 1: Watersheds Characterization* for a review and summary of the stakeholder consultation process.

1.2.2.3 LITERATURE REVIEW & DATA COLLECTION

An essential component of the watershed planning process is review previous studies that have been conducted in the Kaiaka Watersheds and collect available water quality data. Additionally, literature review is required to develop a thorough understanding of relevant management measures and practices that can be used to address certain water quality issues. It is also essential to research various land uses that are occurring in the watersheds. Data and information from the literature review are incorporated throughout the plan and are cited where appropriate. See the “References” section for a complete list of sources.

1.2.2.4 FIELD WORK & GEOMORPHOLOGY ASSESSMENT

Field work was conducted to get an overview of the on-the-ground conditions, to verify the accuracy of geospatial data, and to assess possible problem areas identified by stakeholders and the overall planning process. Field activities conducted for *Volume 2: Implementation Plan* included multiple surveys by car of the project area and a few site visits to specific locations, including farms. Additionally, the

geomorphology fieldwork conducted by AECOM as part of the development of *Volume 1* resulted in a useful report, titled “Geomorphic Assessment of Poamoho Stream.” The report concluded that natural erosion processes that occur in mauka areas and in stream channels are a significant source of sediments and turbidity in the watersheds (AECOM, 2016; Appendix A).

1.2.2.5 GEOGRAPHIC INFORMATION SYSTEMS

GIS is a helpful tool used by planners and resource managers throughout the world to aid in analyzing and visualizing geographic areas and making management decisions. The majority of the work using GIS was conducted in the development of *Volume 1: Watersheds Characterization*; see section 1.3.4 of *Volume 1* for details.

1.2.2.6 MODELING NONPOINT SOURCE POLLUTION

A water quality model, called the Open Nonpoint Source Pollution and Erosion Comparison Tool (NSPECT), was used during the development of *Volume 1* to model nonpoint source pollution (sediments and nutrients). NSPECT is a watershed model based on Geographic Information Systems (GIS) that was developed by NOAA’s Office for Coastal Management. The results of the model were then analyzed by the four general land use types that exist in the Kaiaka Bay Watersheds: Forest Lands, Agricultural Lands, Developed Areas, and Army Training Areas. The results of the analysis are presented in section 7.3 of *Volume 1*.

1.2.2.7 POLLUTANT SOURCE ASSESSMENT

The pollutant source assessment presented in *Volume 1*, section 7.4 essentially synthesized the findings from the methods listed above. Table 1 provides a summary of the primary sources of pollutants in each of the four general land use types and identifies the priority watersheds for management actions to address specific pollutants. Prioritizing the watersheds by land use type provides a useful framework for recommending management measures (see Chapter 3 of this document).

TABLE 1. PRIORITY WATERSHEDS FOR MANAGING POLLUTANTS BY LAND USE TYPE

		Primary Factors That May Contribute Pollutants	Pollutants of Concern	Priority* Watersheds: Sediments	Priority* Watersheds: Nutrients	Priority* Watersheds: Other Pollutant Types**
GENERAL LAND USE TYPE	Forest Lands	<ul style="list-style-type: none"> Natural erosion processes Feral ungulates Nonnative & invasive plants Forest fires 	<ul style="list-style-type: none"> Sediments and turbidity Nutrients Bacteria (from animals and natural sources) 	<ul style="list-style-type: none"> Kaukonahua Poamoho Helemano ‘Ōpae‘ula 	<ul style="list-style-type: none"> Kaukonahua[†] Poamoho[†] Helemano[†] ‘Ōpae‘ula[†] <p>[†] Primarily the forests of the Ko‘olau range</p>	<p>None[‡]</p> <p>[‡] Not considered significant or feasible to address</p>
	Agricultural Lands	<ul style="list-style-type: none"> Natural erosion processes Grazing Nonnative & invasive plants Feral ungulates Fires Natural erosion processes Agriculture practices 	<ul style="list-style-type: none"> Sediments and turbidity Nutrients Chemical contaminants (e.g. pesticides transported in runoff) 	<ul style="list-style-type: none"> Kaukonahua Poamoho Paukauila Ki‘iki‘i 	<ul style="list-style-type: none"> Poamoho 	<ul style="list-style-type: none"> Poamoho (pesticides)
	Developed Areas	<ul style="list-style-type: none"> Wahiawā WWTP Wastewater injection wells (Pa‘ala‘a Kai WWTP) MS4s (City, DOT, Army, Navy) Cesspools and other OSDS Urban/roadway stormwater runoff Chemical use Hazardous waste sites 	<ul style="list-style-type: none"> Sediments & turbidity Nutrients Bacteria & other pathogens Chemical contaminants Trash 	<ul style="list-style-type: none"> Kaukonahua Poamoho Paukauila Ki‘iki‘i 	<ul style="list-style-type: none"> Kaukonahua Poamoho Paukauila Ki‘iki‘i 	<ul style="list-style-type: none"> Kaukonahua Paukauila Ki‘iki‘i (pollutants associated with urban stormwater runoff)
	Army Training	<ul style="list-style-type: none"> Natural erosion processes Feral ungulates Nonnative & invasive plants Army training activities Forest fires Controlled burns and other fires 	<ul style="list-style-type: none"> Sediments and turbidity Nutrients Bacteria (from animals and natural sources) 	<ul style="list-style-type: none"> Kaukonahua 	<ul style="list-style-type: none"> Kaukonahua 	<p>None[‡]</p> <p>[‡] Not considered significant or feasible to address</p>

* Watersheds are listed in no particular order.

** Other pollutants are considered secondary pollutants to sediments and nutrients. These pollutants are addressed opportunistically in this WBP.

Notes: DOT = State Department of Transportation; MS4 = Municipal Separate Storm Sewer System; WWTP = Wastewater Treatment Plant; OSDS = On-site Sewage Disposal System

1.2.2.8 PRIORITIZATION OF MANAGEMENT MEASURES

The rationale for the prioritization of management measures for each of the four general land use types is based on the pollutant source assessment (Table 1); the reasoning for the prioritization of each management measure in certain watersheds is discussed in the applicable sections of Chapter 3. The overall prioritization of all management measures builds on the prioritization of measures for each land use type, but also incorporates additional information and considerations, including:

- Water quality data;
- Watershed modeling results;
- Goals and objectives from the “State Nonpoint Source Management Plan, 2015 – 2020” (DOH PRC, 2015);
- The “Geomorphic Assessment of Poamoho Stream” (AECOM, 2016; Appendix A);
- Stakeholder consultation and feedback; and
- Professional judgment.

A discussion of the reasoning for prioritizing each of the nine management measures that were determined to be overall priorities for implementing to improve water quality is discussed in section 3.5.1.

1.2.2.9 SUMMARY OF PLANNING PROCESS

In Volume 1, various sources of data and information are assessed to ultimately prioritize the watersheds within four general land use types for pollutants of concern. In Volume 2, applicable management measures are assessed according to the prioritization of watersheds that occurred in the pollutant source assessment in Volume 1. The management measures are then assessed using additional criteria to determine the overall priority management measures. Figure 2 on the following page depicts this planning process.

1.3 IMPLEMENTATION PLAN OVERVIEW

Chapter 2 presents strategies that could be implemented to address key issues related to policies, programs, and regulations that pertain to water quality. Chapter 3 presents and prioritizes applicable management measures and practices for each of the four general land use types in the Kaiaka Bay Watersheds. The final section of Chapter 3 presents the nine overall priority management measures that should be implemented to improve water quality. Chapter 4 discusses education and outreach opportunities that could be funded/pursued to increase community awareness about water quality issues and involve the public in proactive activities. Implementation strategies and considerations are presented in Chapter 5. Lastly, the strategies for evaluating and monitoring progress are discussed in Chapter 6. Together with *Volume 1: Watersheds Characterization*, the *Implementation Plan* incorporates all nine of the key elements the EPA requires in a watershed-based plan.

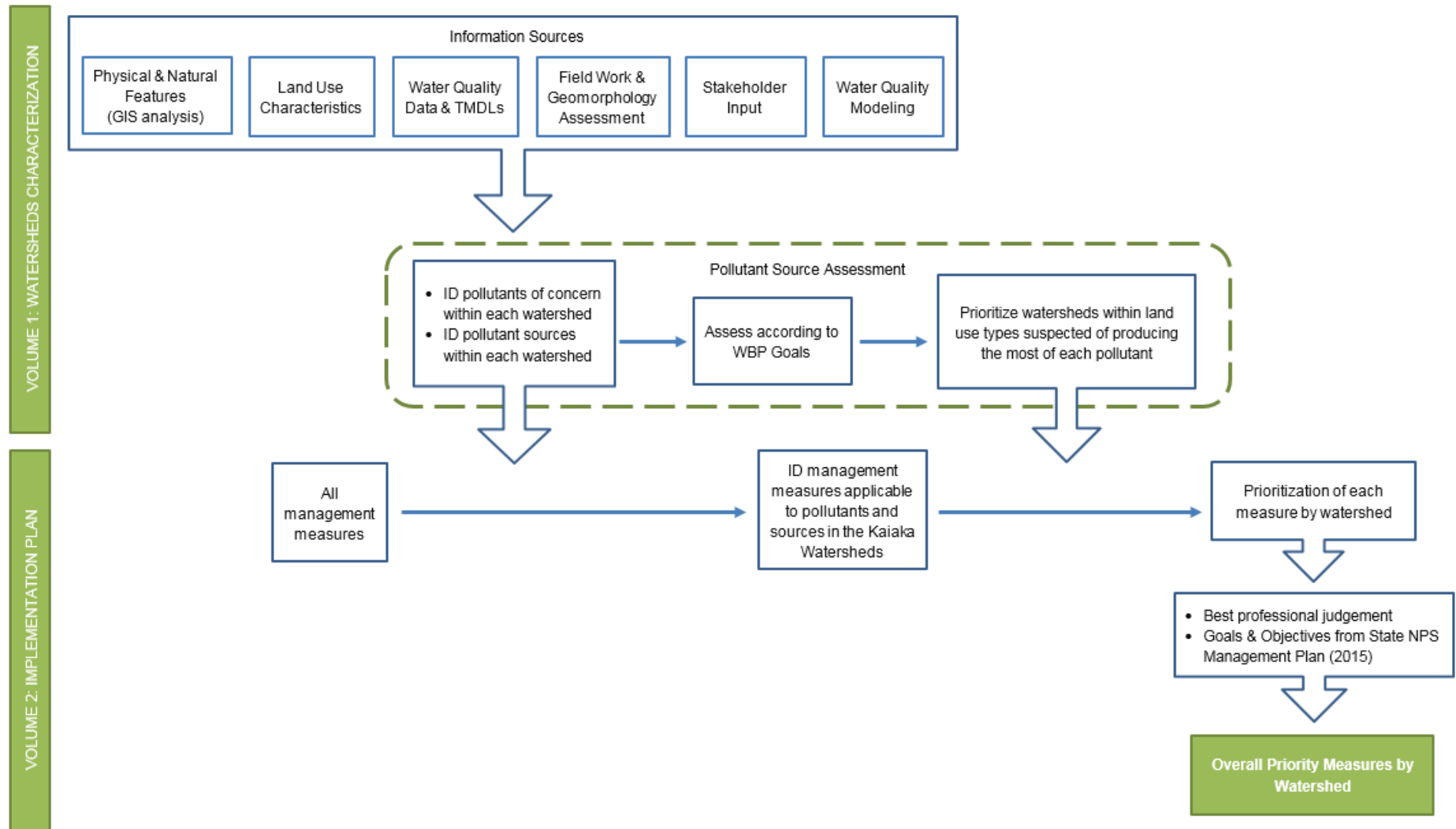


FIGURE 2. KAIKA BAY WBP PLANNING PROCESS

2 POLICIES, PROGRAMS, & REGULATIONS

Policies, programs, and regulations at federal, state, and county levels guide existing and proposed land uses to protect natural resources from impacts resultant from human activities. They play an important role in preventing pollution from occurring in the first place. They also lay the groundwork for affecting behavior changes through creating new requirements, incentives, and penalties. Many of the key policies relevant to protecting surface water quality and regulating sources of pollution are described in *Volume 1: Watersheds Characterization* (section 1.5). Enforcement and reporting programs are also important aspects of the regulatory framework. In addition, education and outreach programs are needed in concert with the policies; these opportunities are discussed in Chapter 4.

This chapter reviews some of the key issues that pertain to existing policies, programs, and regulations related to watershed management and water quality protection. For each of the key issues, potential strategies to address the key issues are described. The final section summarizes the strategies in a table format, with a qualitative and relative indication of how effective each recommended policy/program/regulation would be at reducing pollutant loads.

2.1 IDENTIFIED KEY ISSUES & PROPOSED STRATEGIES

Through research and consultations with various stakeholders, including government agencies, nonprofit organizations, landowners, and others, thirteen key issues that pertain to existing policies, programs, and regulations related to watershed management and water quality were identified. These issues are as follows (not presented in order of significance or priority):

1. Record-keeping, follow-up, and enforcement of the City grading and grubbing exclusion are lacking
2. New farmers and immigrants are not familiar with land use regulations
3. Agricultural conservation planning organizations are under-funded and short-staffed
4. Agricultural conservation plans and conservation practices are not consistently implemented
5. High priority watershed areas are threatened by invasive species
6. Wildfire prevention, response, and post-fire restoration efforts are under-funded
7. Cesspools impact water quality
8. Stormwater management programs/projects are under-funded
9. Property owners lack incentives to implement stormwater BMPs or low impact development practices
10. Water quality data are limited
11. There are few policies related to adapting to the effects of climate change
12. The State has obstacles in enforcing nonpoint source pollution regulations
13. Pollution regulations often lack an integrated watershed management approach

Each key issue is summarized below along with a description of how the issue is relevant to surface water quality. For each issue, strategies to address the issue are also described. All recommended measures should be reviewed and vetted by the relevant government branch.

Key Issue #1: City Grading & Grubbing Exclusion – Need for Better Record-Keeping, Follow-Up, & Enforcement

Description: The Revised Ordinances of Honolulu (ROH) Chapter 14 Article 13.5(d) requires that landowners obtain a permit for certain types of soil disturbing work (e.g. grading and grubbing), including activities for agricultural purposes. An exclusion to the permit requirement can be obtained if the farmer/land manager obtains a soil conservation plan that is approved by the applicable Soil and Water Conservation District (SWCD). A conservation plan addresses the key natural resource issues associated with the farming/ranching activities and outlines practices that should be implemented to address the key issues. It should be noted that a conservation plan does not exempt a farmer/land manager from other City/State regulations/permits. Even with an approved conservation plan, a farmer can still be cited by the City for illegal grading/grubbing should it extend beyond the plan parameters.

While the allowance for an exclusion to the permit creates a valuable incentive for farmers/land owners to obtain a conservation plan, one of the major issues is that there is no specified mechanism for follow-up or enforcement to ensure that conservation plans are implemented. The planning team for this WBP was informed that there is no entity that is responsible for proactive monitoring/enforcement of this law and there is typically little to no follow-up after the exclusion is granted to ensure that conservation practices in the plan have been implemented. Moreover, the City's Department of Planning and Permitting (DPP) does not keep records of land managers who have been granted exclusions to the grading/grubbing permit, even though the law states that conservation plans "shall be made available to the city and county." Since conservation plans are considered private documents, the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), O'ahu Resource Conservation & Development (ORC&D), and the West O'ahu SWCD cannot disclose whether a land manager has a plan.

DPP inspects a property when they receive a complaint that the farmer/land manager may not be in compliance with the grading/grubbing regulations. Upon inspection, DPP inquires whether or not a farmer has a conservation plan, at which point the farmer is required to supply DPP with a copy of the plan if they have one. Since the vast majority of DPP inspections are for construction projects, DPP inspectors are primarily trained in those types of BMPs and not necessarily in agricultural conservation practices. This is an issue because inspectors may not be able to determine whether agricultural conservation practices have been implemented in accordance with his or her conservation plan when they are inspecting a property.

Another issue is that the SWCDs cannot work with farmers that have an existing citation (nor do they approve plans for a farmer with a violation, even if the plan was prepared by another organization). If a farmer does not have the ability to pay the fine and resolve the violation (by either getting the grading/grubbing permit or by restoring the land back to its original condition), they will not be able to obtain a conservation plan and therefore cannot legally farm. This creates a system where once a farmer receives a citation, it can be very difficult for them to come into compliance.

Lastly, a major issue is that since the conservation plans used as an exemption to the grading/grubbing permit must be approved by the SWCDs, this creates a liability issue for the volunteer directors of the Districts who approve the plans.

Currently, many farmers/land managers operate as if they have a grading/grubbing permit exclusion without having a conservation plan because of these loopholes in record-keeping and enforcement.

Implications for Water Quality: Improved enforcement of the law regarding the grading/grubbing permit and exclusion process would mandate that farmers/land managers obtain and implement conservation plans on agricultural land. The increased use of conservation practices will reduce polluted runoff and protect the water quality of streams and other receiving waters.

Two Options for Strategies: *There are two alternative approaches that should be assessed to address these issues. Option A is the preferred alternative at this time since it provides strategies for improving the current system of allowing an exemption to the City grading/grubbing permit by getting a conservation plan. Option B should be considered a long-term alternative since it calls for an entirely new approach, consisting of revising ROH Chapter 14 Article 13.5(d) and suggesting a new approach to incentive farmers to obtain conservation plans.*

Option A: Improve the Current System (Preferred Alternative)

Strategy (Option A): Require Submittal of Conservation Plans Used for Exclusion to Grading/Grubbing Permit

Description: The law allows for the City to require that farmers seeking an exclusion to the grading/grubbing permit submit a copy of their conservation plan to the City to keep for their records: ROH Sec. 14-13.5(d) states “the conservation program ... shall be made available to the city and county...” The City could require that farmers submit a copy of their plan directly to DPP. ROH Sec. 14-13.5(d) could also be amended to specify that the conservation plans *must* be submitted to the City DPP. Regardless of an amendment to ROH Sec. 14-13.5(d), DPP should have a record-keeping system in place so that when farmers notify them that they have a conservation plan, there is a system for recording that information. Additionally, DPP inspectors or other staff should be sure to regularly attend the monthly SWCD meetings so they can keep their own records of who has received a new conservation plan.

If the City had their own records of who has and does not have an exclusion to the permit, the inspection process would be more efficient when complaints about a suspected violation are received. Additionally, if farmers knew that the City had a record of their conservation plan (and their address), it may encourage them to be in better compliance with their conservation plan.

Potential Participant/Champion: City DPP

Potential Funding: City DPP (although little additional funding would be required since the strategy only involves record-keeping)

Strategy (Option A): Increased Training for DPP and Funding for Enforcement of Conservation Plans

Description: DPP inspectors are primarily trained to inspect construction sites for compliance with City regulations; they are not trained on identifying conservation practices that have or have not been implemented in agricultural areas. Upon inspection of land in an agricultural area (after receiving a complaint), a DPP inspector should have the necessary training to identify whether or not conservation practices have been implemented and are maintained according to an approved conservation plan. If the farmer/land manager does have a conservation plan but is not adequately maintaining the required practices, the DPP inspector should record this as a violation. DPP could consider training one individual to be the designated inspector in agricultural areas.

Moreover, DPP should conduct or provide funding for other organizations to conduct regular inspections of agricultural areas with conservation plans used as exclusions to the grading/grubbing permit (regardless of whether or not there has been a complaint) to ensure that conservation practices have been implemented.

One of the major issues is that DPP does not currently have sufficient funding to expand their inspection program; additional funding should be pursued.

Potential Participant/Champion: City DPP

Potential Funding: Below is a list of some government agencies that could be potential funding sources for DPP to expand their inspection and enforcement of conservation plans:

- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources
- The State Department of Agriculture (DOA)
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency

DPP could allocate funding to an outside organization to conduct inspections on behalf of the City if an appropriate legal agreement were arranged (see next strategy).

Strategy (Option A): Formally Define Roles & Responsibilities for SWCDs and DPP in the Exclusion Process

Description: DPP and the SWCDs should work together to clearly define and formally agree on roles and responsibilities in the grading/grubbing exclusion process. This would require the City to assess how the current system is or is not meeting their needs to address nonpoint source pollution and how the system can be improved by specifying responsibilities in the relationship between the City and the SWCDs. This could be accomplished through an official agreement, such as a Memorandum of Understanding (MOU),

or through creating official Standard Operating Procedures (SOPs). Some issues that should be addressed include:

- The City's record keeping for farmers/land managers who obtain a conservation plan as an exclusion to the grading/grubbing permit.
 - The City should require the farmer/land owner submit their plan directly to them; this requirement *could* be communicated to farmers/managers by the District.
- The liability that the volunteer SWCD directors have when they authorize a conservation plan; the directors should not be held liable by the City.
- The responsibility of follow-up and enforcement to ensure conservation plans have been implemented when used as an exclusion to the grading/grubbing permit.
 - DPP should either do their own follow-up and enforcement or provide funding to a third-party entity to conduct monitoring and inspections after plans have been approved to ensure they are being implemented. With additional funding, the SWCD could have the capacity to conduct more follow-up with farmers after they receive conservation a plan to provide feedback and assist with implementation The SWCD can revoke a plan if the farmer is not in compliance with their agreement as a Cooperator with the SWCD which would cancel the farmer's exemption to the grading/grubbing permit, however, the SWCD cannot enforce the City's law, report violations, nor disclose whether or not a farmer has a valid conservation plan to the City. Moreover, there may appear to be a conflict of interest if the SWCD is expected to conduct inspections on behalf of the City.

Potential Participants/Champions: City DPP; West O'ahu SWCD

Potential Funding: City DPP; West O'ahu SWCD

Strategy (Option A): Create an Agricultural Watershed Coordinator Position*

Description: A new position could be created for an agricultural watershed coordinator who would work directly with farmers to communicate important information regarding relevant rules/regulations and how they can comply with the rules/resources. He/she would work with new farmers as well as existing farmers to help smooth and expedite the process for getting conservation plans and making sure they are in compliance with other regulations. The coordinator would have connections with the NRCS, ORC&D, SWCD, DOH, DOA, the State Agribusiness Development Corporation (ADC), and City departments such as DPP and DFM and would be able to direct farmers to the relevant agencies/organizations as needed.

The coordinator could be under contract with the City to keep records of farms that are in compliance with the grading/grubbing permit – to do so, the coordinator would need to have explicit agreements with the farms themselves and with the SWCD to keep records of farmers with conservation plans and share that information with DPP when necessary.

The coordinator could be employed by a third-party organization, such as ORC&D, with funding from various sources and agencies (see potential funding discussion below). The coordinator could also be employed by the City (DPP or DFM), on a funding-contingent basis. If public funds are used, there should

be clear and defined goals to be accomplished by the coordinator in a defined period of time with measurable metrics at six-month intervals. Performance reports should be made available to the public.

Potential Participants/Champions: West O‘ahu SWCD; ORC&D; City DPP; City DFM

Potential Funding: Below is a list of some government agencies that could be potential funding sources for an agricultural watershed coordinator:

- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources
- The State Department of Agriculture (DOA)
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency
- The City and County of Honolulu (DPP and/or DFM)

An alternative idea for funding is to create a new fee/tax for landowners in agricultural areas. The fee could be tied to property taxes and be used for water quality protection projects/programs in agricultural areas. Some of the funds from this fee could go towards funding a watershed coordinator position. See the second strategy listed for Option B (creating water quality protection fee) for more information about the fee idea.

** Recommendation for a Watershed Coordinator also discussed in relation to Issue #2.*

Option B: Replace the Current System with New System (Long-Term Alternative)

Strategy (Option B): Amend ROH Chapter 14 to Specify that the Grading/Grubbing Permit Does Not Pertain to Agricultural Practices

Chapter 14 of the Revised Ordinances of Hawai‘i could be amended to specify that landowners in areas that are zoned for agriculture and are actively farming or conducting other agricultural practices are exempt from the grading/grubbing permit for agricultural/farming activities. The law would have to clearly specify who is exempt from the permit and what constitutes “active farming.” The grading/grubbing permit would still apply for activities that are not directly related to agriculture/farming. This strategy would resolve the major issues that are related to the current system of exemption from the grading/grubbing permit, however, it should only be implemented with consideration for the impacts it would have on water quality.

If this strategy were to be implemented, it would also be imperative that new incentives for farmers to get conservation plans were created since the requirement to obtain a conservation plan would be removed; the water quality protection fee idea outlined in the following strategy would add the necessary incentive.

As an alternative to creating new incentives for farmers to get conservation plans, new DPP and/or DFM regulations could be created that target pollution coming from agricultural properties. Penalties for

noncompliance should be clearly specified. The key consideration in creating new regulations would be to determine who is responsible for inspecting agricultural areas and how the regulations will be enforced.

Potential Participant/Champion: City and County of Honolulu

Potential Funding: n/a

Strategy (Option B): Create a Water Quality Protection Fee for Landowners in Agricultural Areas

A new fee or tax for landowners in agricultural areas could be created to generate revenue for water quality protection projects/programs in agricultural areas. A portion of the fee could also go towards inspection and enforcement of existing regulations related to water quality and nonpoint source pollution. The fee could be tied to property taxes for landowners in areas zoned for agriculture. Landowners could receive a reduction or elimination of the fee if they either implement agricultural conservation practices that improve/protect water quality or if they submit a copy of their conservation plan to the City. The City may require proof of implementation such as date-stamped photographs of implemented practices. The revenue generated from the fee should go to a special fund that can only be used for specific purposes. To generate public support for the fee, the allowed specific uses of the funds should be clearly defined in advance and be beneficial to agriculture and/or natural resources. Some of the funds from this fee could go towards funding a watershed coordinator position.

Potential Participant/Champion: City and County of Honolulu

Potential Funding: n/a

Key Issue #2: New Farmers and Immigrants Are Not Familiar with Land Use Regulations

Description: Many new farmers/land managers are not familiar with local regulations that pertain to agriculture, including county, state, and federal regulations. Moreover, many new farmers are immigrants from other countries, which can add an additional obstacle due to language-barriers.

Implications for Water Quality: Farmers may not be aware of the regulations that are in place to protect natural resources and water quality, such as the City's grading/grubbing permit (and possible exclusion to the permit by obtaining a conservation plan) or local/federal regulations that pertain to nonpoint source pollution. They also may not be aware of proper fertilizer and pesticide use (storage and application) or regulations that pertain to their use.

Strategy: Increase Funding for Agricultural Outreach and Education Programs

Description: Funding for programs and organizations that conduct outreach to farmers should be increased to help spread awareness of important regulations and direct them to the appropriate resources to comply with the regulations. The ORC&D and the West O’ahu SWCD are two organizations that conduct outreach and work directly with farmers. For example, the West O’ahu SWCD launched a new program in December of 2016, called “Together We Farm,” to support immigrant and new farmers with the development, implementation, and monitoring of conservation plans. Language translation services are also part of the program.

Programs such as “Together We Farm” and organizations such as the West O’ahu SWCD and ORC&D should receive adequate funding to continue and expand their efforts.



Potential Participants/Champions:

ORC&D; West O’ahu SWCD

“Together We Farm” is a program run by the West O’ahu SWCD that provides services to new and immigrant farmers

Potential Funding: Below is a list of some government agencies that are either currently funding sources or are a potential funding source:

- The City and County of Honolulu
- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources
- The State Department of Agriculture
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency

In addition to government agencies, grants from various foundations and other private organizations may be available.

Strategy: Create an Agricultural Watershed Coordinator Position*

Description: The agricultural watershed coordinator, discussed in more detail under Option A for Issue #1, could help reach out to new and immigrant farmers in the Kaiaka Bay Watersheds to communicate important information regarding relevant rules/regulations and how they can comply with the rules/resources. He/she would work to provide translation services to immigrants when necessary.

Potential Participants/Champions: See discussion under Option A for Issue #1.

Potential Funding: See discussion under Option A for Issue #1.

* Recommendation for a Watershed Coordinator also discussed in relation to Issue #1, Option A.

Key Issue #3: Agricultural Conservation Planning Organizations Are Under-Funded and Short-Staffed

Description: There are currently only a few key organizations that prepare agricultural conservation plans on O‘ahu, including the Hawai‘i Association of Conservation Districts (HACD); funded by the Hawai‘i Department of Land and Natural Resources (DLNR), the ORC&D, and the NRCS. HACD and ORC&D both have very limited staff that are trained to prepare conservation plans. Additionally, the NRCS is required to be selective as to when they will work with a farmer; they will only work with a farmer to develop a conservation plan when the objective is to treat *existing* resource concerns and not to obtain an exclusion to the City’s grading/grubbing permit to begin farming activities. The latter scenario could result in the creation of new resource concerns that did not exist on the land prior to the initiation of farming activities (even with a conservation plan). The local NRCS office gives preference to federal Farm Bill applicants. The West O‘ahu SWCD does not currently develop conservation plans due to funding/staffing limitations, although the District directors approve qualified conservation plans prepared by other entities. While anyone can develop a conservation plan, if the plan is to be approved by the SWCD, it should be prepared by a Technical Service Provider (TSP), an individual with training and expertise on the subject and certified by the NRCS as a TSP.



ORC&D has a new online tool for farmers/land managers to develop their own conservation plan; see www.808planner.org.

In an effort to address this issue and increase the efficiency of conservation planning, the ORC&D has recently developed an online tool called the “808 Planner,” which increases opportunities for farms to access information about conservation practices and provides planning tools. The online tool will guide farmers in the development of their own conservation plan. The ORC&D would then “ground-truth” the plan to approve it. The website, www.808planner.org, went live in June 2017. On-going funding is needed.

An additional issue is that after a farmer receives an approved conservation plan, there is often little to no follow-up to ensure the conservation practices in the plan have been implemented or maintained. The reason for this is that the organizations that develop plans do not have adequate resources (i.e. staff time) to do the necessary follow-up. The ORC&D provides a monitoring service for land managers with existing conservation plans to determine the effectiveness of implemented practices, recommend new practices, and record progress in implementation. This service is provided for a fee.

Implications for Water Quality: The increased ability for organizations to develop conservation plans would allow more land managers to obtain conservation plans and implement conservation practices to protect natural resources, including water quality.

Strategy: Increase Funding for Conservation Planning Organizations

Description: Funding for conservation planners and organizations that do conservation planning should be increased. Increased funding would allow organizations like HACD, SWCD, and ORC&D to hire additional conservation planners. In addition to developing conservation plans, these organizations would have an improved ability to conduct outreach to farmers and to do more follow-up after plans are approved to ensure the conservation practices have been implemented. Funding for the ORC&D could also go towards supporting the development or maintenance of the online “808 Conservation Planner” tool.

Potential Participants/Champions: HACD; SWCD; ORC&D

Potential Funding: Below is a list of some government agencies that are either currently funding sources or are a potential funding source:

- The City and County of Honolulu *
- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources
- The State Department of Agriculture
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency

* The City and County of Honolulu currently does not provide any financial support to the SWCDs on O’ahu; all other counties in the state provide some funding to their respective SWCDs.

In addition to government agencies, grants from various foundations and other private organizations may be available.

Key Issue #4: Agricultural Conservation Plans and Conservation Practices Are Not Consistently Implemented

Description: Many farmers/land managers do not have the up-front capital required to implement conservation practices as a part of an approved conservation plan or otherwise. They may be interested in implementing different conservation practices on their land but lack the necessary resources to implement or maintain the practices.

Implications for Water Quality: The increased use of agricultural conservation practices, as part of an approved conservation plan or otherwise, would reduce pollutant generation and transport.

Strategy: Increase Funding Opportunities to Implement Conservation Plans and Conservation Practices

Description: The increased availability of funding to support farmers who want to implement conservation plans or implement/maintain certain conservation practices would improve resource management and prevent sediments, nutrients, and other pollutants from running off fields and entering waterbodies.

Potential Participants/Champions: Farmers

Potential Funding: Below is a list of some government agencies that are either currently funding sources or are a potential funding source:

- The City and County of Honolulu
- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources (possibly through the Conservation Reserve Enhancement Program)
- The State Department of Agriculture
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency

In addition to government agencies, grants from various foundations and other private organizations may be available.

Key Issue #5: High Priority Watershed Areas Are Threatened by Invasive Species

Description: Funding is needed to improve and expand protection of forested watershed areas, including invasive species control, conservation fencing, and wildfire management. To meet a statewide goal of protecting 30% of Hawai'i's priority watershed forests by 2030, currently protected priority watershed lands needs to be doubled. Achieving this goal would cost an estimated \$7.5 million per year; presently, the State spends \$1 million each year, not enough to reach the goal.

Implications for Water Quality: Protecting forested watershed areas can help to reduce pollutant loads in streams originating in forested areas by reducing erosion and sedimentation, as well as reducing sources of nutrients and bacteria.

Strategy: Increase Funding for Watershed Management Programs and Projects in High Priority Watersheds

Description: Increasing funding for agencies and organizations that implement watershed protection projects and/or conduct natural resource management will increase the capacity of those organizations to protect high priority watersheds. Funding for specific projects, such as constructing a fence to exclude feral ungulates in a priority area, would also improve/protect water quality.

Potential Participants/Champions: Koʻolau Mountains Watershed Partnership (KMWP); Waiʻanae Mountains Watershed Partnership (WMWP); Oʻahu Invasive Species Committee (OISC); DLNR Division of Forestry and Wildlife (DOFAW)

Potential Funding: Below is a list of some government agencies that are either currently funding sources or are a potential funding source:

- The City and County of Honolulu
- The Honolulu Board of Water Supply
- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency
- The U.S. Army Garrison Hawaiʻi

In addition to government agencies, grants from various foundations and other private organizations may be available.

Key Issue #6: Wildfire Prevention, Response, and Post-Fire Restoration Efforts Are Under-Funded

Description: Many of the key agencies/organizations that are involved in watershed protection and natural resource management do not have adequate/designated funding for projects that are specifically related to wildfire prevention, response, and post-fire restoration. When a wildfire is detected, these entities are often forced to use resources for other projects to respond, often collaborating to combine resources. Post-fire restoration efforts are often sporadic and small-scale (due to the lack of designated funding).

Implications for Water Quality: The prevention of wildfires would prevent the erosion and polluted runoff that often occurs after a fire. Improving fire management and response would reduce the duration and intensity of fires, thereby reducing post-fire runoff. Lastly, increasing post-fire restoration activities would speed up ecosystem recovery.

Strategy: Increase Funding for Projects and Programs Related to Wildfire Prevention, Response, and Post-Fire Restoration

Description: Funding for agencies and organizations that are or could be involved in wildfire prevention, response, or post-fire restoration activities should be increased. Prevention activities could include education and outreach to the public, vegetation management to reduce fuel loads, and other related practices (see Chapter 3: Forest Lands Measure #2, Agricultural Lands Measure #6, and/or Army Training Areas Measure #1). Improving fire response could include increasing firefighting training for staff and/or acquiring the necessary equipment. Post-fire restoration activities could include weed control to prevent undesirable species from colonizing burned areas and outplanting native plants. Funding could be used to establish a native plant seed bank and/or native plant nursery to grow plants for post-fire restoration projects.

In addition to agencies/organizations, private property owners could also apply for funding to conduct fire prevention practices, such as vegetation management to reduce fuel loads (e.g. mowing guinea grass on fallow agricultural lands).

Potential Participants/Champions: KMWP; WMWP; DLNR DOFAW

Potential Funding: Below is a list of some government agencies that are either currently funding sources or are a potential funding source:

- The City and County of Honolulu
- The Honolulu Board of Water Supply
- The State Department of Health (319 funds)
- The State Department of Land and Natural Resources (e.g. Wildland Urban Interface Grants)
- The Natural Resource Conservation Service
- The U.S. Environmental Protection Agency
- The U.S. Army Garrison Hawai'i

In addition to government agencies, grants from various foundations and other private organizations may be available.

Key Issue #7: Cesspools Impact Water Quality

Description: There are 722 cesspools in the Kaiaka Bay Watersheds, according to State DOH estimates (see section 7.2.9 of *Volume 1* of this WBP for details). These cesspools are estimated to leak nearly 300,000 gallons of untreated wastewater per day into the surrounding environment. Out of all 722 cesspools, only 79 qualify for a \$10,000 tax credit (HRS §123-16.5) available to property owners who upgrade to a better system (e.g. a sewer or septic system). Another 33 cesspools potentially qualify but

need to be verified for eligibility according to specific criteria. Since the cost of upgrading to a better system could be around \$20,000 and only 16% of the cesspools in the Kaiaka Bay Watersheds qualify or potentially qualify for the \$10,000 tax credit, there should be additional incentives to encourage property owners to replace their cesspools. The need for increased incentives is further supported by the passing of Act 125 in July 2017, which amends HRS Chapter 342D to require that every cesspool in the state must be either upgraded to a septic or aerobic system or connected to a sewage system (with certain exemptions) by 2050. Additionally, the Waialua area is categorized in a 2017 report to the legislature as a “Priority 3” area for the State’s prioritization of areas with cesspools that should be replaced (DOH, 2017). Priority 3 areas are described as having “potential impacts to sensitive waters.”

Implications for Water Quality: Cesspools are major sources of nutrients, bacteria, and other contaminants in O’ahu’s watersheds. Untreated wastewater can seep out of cesspools into groundwater, which can make its way to the ocean or seep up to surface waters. Moreover, many cesspools on the North Shore have been in service for over 50 years and are deteriorating. The 722 cesspools in the Kaiaka Bay Watersheds are estimated to discharge nearly 300,000 gallons of raw sewage per day (refer to section 7.2.9 of *Volume 1: Watersheds Characterization* for more information).

Strategy: Increase Incentives to Replace Cesspools

Description: To encourage more property owners to replace their cesspools, there are several different approaches that should be explored, including:

- Increasing the amount of the tax credit (HRS §123-16.5), especially since it does not cover the whole cost of cesspool replacement;
- Broadening the criteria for cesspools that qualify for the tax credit, since only 16% of the 722 cesspools in the Kaiaka Bay Watersheds potentially qualify; and/or
- Provide a rebate for property owners who replace their cesspools.

This strategy agrees with stated goals of the State Nonpoint Source Management Plan. Specifically, Strategy N of Goal 4, Objective 2, states, “Develop and implement a statewide effort to address cesspools” (DOH PRC, 2015). The plan says that the DOH CWB should develop a comprehensive strategy, through coordination with other agencies/organizations, to address runoff from cesspools and implement cesspool replacement projects. It further states that this effort could be “funded through a State Revolving Fund or through Section 319 Project Funds.” According to the plan, the DOH will complete the State’s strategy for addressing polluted runoff from cesspools in 2017.

Potential Participants/Champions: DOH; City ENV

Potential Funding: EPA; DOH; City & County of Honolulu

Key Issue #8: Stormwater Management Programs/Projects Are Under-Funded

Description: The City Department of Facilities Maintenance has a limited budget to implement programs/projects to comply with the requirements specified in their NPDES permit for their MS4. Consequently, there are limited funds available for additional projects that DFM would like to implement. Moreover, DFM anticipates new NPDES permit requirements in the future and needs to ensure an adequate source of funding to continue compliance.

Implications for Water Quality: Stormwater picks up pollutants as it runs off houses, driveways, and other impervious surfaces and eventually flows into a nearby water body or MS4. Implementing additional stormwater management programs/projects could reduce stormwater quantity, improve stormwater quality, and facilitate stormwater reuse for landscape irrigation or other purposes.

Strategy: Establish a Stormwater Fee*

Description: Generating revenue for the City DFM via a stormwater fee could provide additional funding for stormwater projects and low impact development (LID) features. The fee could be tied into property taxes and based on the percent of impervious surface on the property. Property owners that implement LID projects on site that provide retention or treatment of stormwater would receive a reduction in the amount of the fee.

Implementing this management measure would correspond to Strategy O, “Develop and implement a statewide effort to address urban runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015). The plan says that the DOH CWB, in coordination with other state and county agencies, will complete a statewide strategy to control urban runoff by 2018. By 2020, the DOH CWB Polluted Runoff Control (PRC) Program will implement the State’s strategy and invest Section 319 funds in at least one project aimed at reducing urban runoff.

Potential Participant/Champion: City & County of Honolulu

Potential Funding: n/a

* Recommendation for a Stormwater Fee also discussed in relation to Issue #9.

Key Issue #9: Property Owners Lack Incentives to Implement Stormwater BMPs or Low Impact Development Practices

Description: Property owners with existing development do not currently have many incentives to implement stormwater management practices or LID features on their land (not including NPDES permit holders or regulations requiring BMPs for construction). With little to no incentives, many property owners do not see the benefits implementing a LID feature and have no desire to do so.

Implications for Water Quality: Stormwater picks up pollutants as it runs off houses, driveways, and other impervious surfaces and eventually flows into a nearby water body or stormwater sewer system (MS4). If more home and property owners implemented LID features, stormwater could be reduced in quantity, improved in quality, and/or reused for landscape irrigation or other purposes.

Strategy: Establish a Stormwater Fee*

Description: A new stormwater fee, discussed in more detail in the strategy for Issue #8, would create incentives for property owners to implement LID features or other stormwater management practices on their property since they would receive a reduction in the fee.

Potential Participant/Champion: City & County of Honolulu

Potential Funding: n/a

** Recommendation for a Stormwater Fee also discussed in relation to Issue #8.*

Key Issue #10: Water Quality Data are Limited

Description: There is a lack of current and thorough water quality data for the six watersheds in the Kaiaka Bay drainage area. Although there have been a number of studies related to water quality over the years, the sampling locations are limited, and the reliability of the data is questionable in some cases depending on the age of the data or the sampling methodology that was used. There are three water quality gages run by the United States Geological Surveys (USGS) in the project area, yet they are all in the Kaukonahua Watershed. Additionally, the gages measure sediments in terms of suspended sediments, yet the State Water Quality Standards are in terms of Total Suspended Solids. The different units of measurement make it difficult to determine how the water body compares to the Water Quality Standards.

Implications for Water Quality: Increased water quality data would allow the City and the State to be better able to prioritize areas for projects that target specific pollutants or pollutant sources. Currently,

it is very difficult to determine which areas of each watershed should be prioritized for specific management measures due to the lack of data.

Strategy: Develop a Framework for Funding Programs/Projects Related to Water Quality Monitoring

Description: In order increase water quality data, a framework for funding water quality monitoring programs must be developed the that describes the critical criteria and requirements for the monitoring program to ensure that the water quality data can be used by the State DOH CWB.

The education and outreach chapter of this WBP (Chapter 4), describes a strategy to develop a community-based water quality monitoring program. The framework for funding such a program should be established.

This strategy is in accordance with Goal 1 in the State Nonpoint Source Management Plan: Objective 1 states, “Develop surface water quality assessment methods and monitoring plans to guide monitoring efforts,” and Objective 2 states, “Monitor and assess water quality to identify water quality impairments and improvements” (DOH PRC, 2015). To accomplish Objective 1, the plan says the CWB will first complete a standardized water quality assessment methodology for marine and inland waters (Strategy A). Next, the CWB will develop watershed-specific monitoring plans to guide monitoring efforts in priority watersheds (Strategy B). The plan states that the CWB will report on its recommendations for the regional monitoring program by 2019. To accomplish Objective 2, the CWB will collaborate with other agencies/organizations to conduct water quality monitoring.

Potential Participants/Champions: Third-party researchers (e.g. University of Hawai‘i); nonprofit organizations (e.g. Surfrider Foundation); other community-based organizations; City & County of Honolulu; DOH; DLNR; USGS

Potential Funding: EPA; DOH; DLNR; City & County of Honolulu

Key Issue #11: There Are Few Policies Related to Adapting to the Effects of Climate Change

Description: The effects of global climate change have already been detected in Hawai‘i and are predicted to increase over the coming decades (see sections 2.4 and 7.2.15 of *Volume 1: Watersheds Characterization* for more information). There are currently very few regulations in place that provide guidance for how to minimize the impacts of climate change, especially with regard to how climate change will impact surface water quality.

Implications for Water Quality: Some of the major effects of climate change related to water resources will be reduced base streamflow and groundwater recharge, increased erosion and polluted runoff into water bodies, and degraded marine ecosystems.

Strategy: The City's Office of Climate Change, Resilience, and Sustainability Should Recommend Policies That Protect Water Quality

Description: The City's new Office of Climate Change, Resilience, and Sustainability should ensure that the impacts climate change will have on surface water bodies are considered when developing policy recommendations for other branches of the City government.

Potential Participant/Champion: City & County of Honolulu

Potential Funding: EPA; DOH CWB; City & County of Honolulu

Key Issue #12: The State Has Obstacles in Enforcing Nonpoint Source Pollution Regulations

Description: Hawai'i Revised Statutes (HRS) §342D and HRS §342E allow the State DOH to enforce laws related to controlling sources of pollution (point source and nonpoint source). HRS §342E specifies that the DOH can fine nonpoint source (NPS) polluters up to \$10,000 for each offense (each day of each violation constitutes a separate offense). To enforce the law, a potential violation needs to be reported to the DOH. DOH follows up by inspecting of the property to confirm the NPS pollution. One obstacle to the enforcement of HRS §342E is that it is dependent on complaints from the public. Another key obstacle is that during inspection of a property, it is often difficult to determine the origin of NPS pollution. Moreover, the DOH does not currently have adequate resources and staff to develop their NPS enforcement program.

Implications for Water Quality: Enforcing NPS pollution regulations will help prevent or reduce pollutant loads in surface waters.

Strategy: DOH Follow Strategies Outlined in "Hawai'i's Nonpoint Source Management Plan: 2015-2020" to Enforce NPS Pollution Regulations

Description: One strategy outlined in the State's Nonpoint Source Management Plan (DOH PRC, 2015) describes how the DOH CWB aims to investigate opportunities for an NPS enforcement program ("Strategy T"). The first step is for the CWB to evaluate the technical, legal, and personnel resources required for an effective NPS enforcement program. The CWB Polluted Runoff Control Program will

receive enforcement training and participate in a complaint inspection with the CWB Enforcement and Compliance Section. The Plan states that the CWB will explore the possibility of enforcement of specific sources of NPS pollution or NPS enforcement in specific watersheds. According to the Plan, the CWB will report on the NPS enforcement opportunities in 2017.

Potential Participant/Champion: DOH CWB

Potential Funding: EPA; DOH

Key Issue #13: Pollution Regulations Often Lack an Integrated Watershed Management Approach

Description: The traditional approach for improving water quality involves regulating point sources of pollution using NPDES permits or other regulatory methods, as point sources are more easily identified and monitored than NPS pollution. However, since nonpoint source pollution is the most significant source of water quality impairment in the nation (EPA, 2008), regulations should be more flexible to allow for actions that reduce NPS pollution. Entities with NPDES permits and other types of permits are often required to meet standards that are very expensive to attain in the short-term (such as meeting WLAs identified through the development of TMDLs). Instead, funds could be spent on projects/practices that much more effectively reduce NPS pollution within the same watershed, thus achieving greater water quality benefits for similar costs.

Implications for Water Quality: With NPS pollution being the biggest threat to water quality, more regulatory emphasis on controlling NPS pollution would significantly improve water quality in the Kaiaka Bay Watersheds and in Kaiaka Bay.

Strategy: Regulatory Agencies Should Develop a Framework for an Integrated Watershed Approach for Permittees to Meet Permit Requirements

Description: EPA and DOH should develop a protocol for allowing NPDES permit holders (and other types of water-quality related permits) to identify NPS pollution control projects and programs within the same watershed that, if implemented, are credited toward the permit holder's requirements. Allowable outcomes of acceptable implementation of NPS pollution control projects and programs could include more flexibility in implementation deadlines for other projects or count toward meeting WLAs.

In line with this strategy, in 2015 the DOH CWB began collaborating with the Association of Clean Water Administrators to develop a water quality trading program in Hawai'i. Water quality trading has the potential to mitigate NPS pollution through NPS pollution reduction measures put in place to offset point source discharges (by permitted facilities) in the same watershed or waterbody. Trading may help improve water quality in situations in which compliance with permits under NPDES is difficult for a

discharger. Conditions to implement a trading program, such as BMPs to control NPS pollution to offset point source discharges, could be included in NPDES permits as part of this trading program. According to the State Nonpoint Source Management Plan (DOH PRC, 2015), the CWB has already set goals and a timeline for the development and implementation of the water quality trading program.

Potential Participants/Champions: DOH and EPA, with cooperation from NPDES permit holders (City and County of Honolulu, DOT-Highways, Army, and Navy)

Potential Funding: The development of the protocols would fall under DOH/EPA; NPDES permit holders would fund the associated projects

2.2 SUMMARY OF STRATEGIES & IMPLEMENTATION CONSIDERATIONS

The suggested strategies for policy measures, programs, and regulations that can help to improve water quality in the Kaiaka Bay Watersheds are summarized in Table 2. For each policy measure, the following information is provided:

- **Relative Impact on Pollutant Loads:** This is a rough order of magnitude estimate based on what area the strategy might impact and its degree of impact. Values are presented in terms of “Low,” “Med,” or “High.”
- **Potential Participants/Champions:** This listing should not be construed as agreement to implement or fund the proposed project/program, but rather a list of entities that might be able to implement or participate in the recommendation.
- **Potential Support/Funding:** Most of the strategies require some level of support such as funding or technical support. Possible supporting entities are listed not as commitments, but rather as possibilities. In some cases, the sources of support/funding are the exact same as the potential participants/champions. Support could also come from competitive grants.
- **Timeframe to Implement:** This is a rough indication of the ease of implementation as well as a consideration for the political support that might be needed. Short-term policy strategies could be implemented in less than a year, mid-term projects could be implemented in one to four years, and long-term projects would take five years or longer to implement.

Note that the priority policy measures should be reviewed and vetted by the relevant government branches.

TABLE 2. SUMMARY OF STRATEGIES RELATED TO POLICIES, PROGRAMS, AND REGULATIONS

STRATEGY	KEY ISSUE #	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/ CHAMPIONS	POTENTIAL SUPPORT/ FUNDING	TIMEFRAME TO IMPLEMENT
Require submittal of conservation plans used for exclusion to grading/grubbing permit (<i>Option A</i>)	1	Low	City DPP	City DPP	Short-term
Increased training for DPP and funding for enforcement of conservation plans (<i>Option A</i>)	1	Low	City DPP	DOH; DLNR; DOA; NRCS; EPA	Short-term
Formally define roles & responsibilities for SWCDs and DPP in the exclusion process (<i>Option A</i>)	1	Low	City DPP; West O'ahu SWCD	City DPP; West O'ahu SWCD	Mid-term
Create an agricultural watershed coordinator position (<i>Option A</i>)	1; 2	Low	West O'ahu SWCD; ORC&D; City DPP; City DFM	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Amend ROH Chapter 14 to specify that the grading/grubbing permit does not pertain to agricultural practices (<i>Option B</i>)	1	Unknown*	City	City	Long-term
Create a water quality protection fee for landowners in agricultural areas (<i>Option B</i>)	1	Unknown*	City	n/a	Long-term
Increase funding for agricultural outreach and education programs	2	Med	West O'ahu SWCD; ORC&D	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding for conservation planning organizations	3	Med	HACD; West O'ahu SWCD; ORC&D	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding opportunities to implement conservation plans and conservation practices	4	Med	Farmers	City; DOH; DLNR; DOA; NRCS; EPA	Mid-term
Increase funding for watershed management programs and projects in high priority watersheds	5	Med/High	KMWP; WMWP; OISC; DLNR DOFAW	City; BWS; DOH; DLNR; NRCS; EPA; Army	Mid-term
Increase funding for projects and programs related to wildfire prevention, response, and post-fire restoration	6	Med	KMWP; WMWP; DLNR DOFAW	City; BWS; DOH; DLNR; NRCS; EPA; Army	Mid-term
Increase incentives to replace cesspools	7	Med/High	DOH; City	EPA; DOH; City	Mid-term
Establish a stormwater fee	8; 9	Med	City	n/a	Mid-term

- Table continued on next page -

TABLE 2. SUMMARY OF STRATEGIES RELATED TO POLICIES, PROGRAMS, AND REGULATIONS (CONTINUED)

STRATEGY	KEY ISSUE #	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/ CHAMPIONS	POTENTIAL SUPPORT/ FUNDING	TIMEFRAME TO IMPLEMENT
Develop a framework for funding programs/projects related to water quality monitoring	10	Low	Third-party researchers; nonprofits; community organizations; City; DOH; DLNR; USGS	EPA; DOH; DLNR; City	Mid-term
The City's Office of Climate Change, Resilience, and Sustainability should recommend policies that protect water quality	11	Low/Med	City	EPA; DOH; City	Mid-term
DOH follow strategies outlined in "Hawai'i's Nonpoint Source Management Plan: 2015-2020" to enforce NPS pollution regulations	12	Low/Med	DOH	EPA; DOH	Short-term
Regulatory agencies should develop a framework for an integrated approach for permittees to meet permit requirements	13	Low	DOH; EPA	DOH; EPA	Mid-term

* The relative impact these strategies from Option B to address Key Issue #1 would have on pollutant load reduction is unknown, but they could result in reduced pollutant loads since there would be a strong incentive for farmers to get a conservation plan with the proposed new fee.

3 MANAGEMENT MEASURES AND PRACTICES

This chapter specifies management measures and management practices that could or should be implemented to improve surface water quality and the nearshore ecosystem of Kaiaka Bay. To accomplish this objective, the watersheds are categorized into four general land use types: (1) Forest Lands, (2) Agricultural Lands, (3) Developed Areas, and (4) Army Training Areas (Figure 3). The classification and description of each land use type is recognized to be a generalization for the purpose of recommending prioritized management measures for each land use type. The geographic coverage of the four land uses are depicted in Figure 3, however, the boundaries of the land use types should be regarded as rough approximations of actual land uses. Table 3 below shows the approximate number of acres in the Kaiaka Bay Watersheds for each of the four land use types. Table 4 summarizes some of the key characteristics for each of the land use types; refer to section 7.3.1 of *Volume 1: Watersheds Characterization* for more detailed descriptions.

TABLE 3. FOUR GENERAL LAND USE TYPES FOR IMPLEMENTATION PLAN

LAND USE TYPE	TOTAL ACRES	% OF PROJECT AREA
Forest Lands	17,437	34%
Agricultural Lands	23,956	47%
Developed/Urban Areas	3,763	7%
Army Training Areas	6,298	12%
Total	51,454	100%

TABLE 4. DESCRIPTIONS OF THE FOUR LAND USE TYPES

LAND USE TYPE	DESCRIPTION
FOREST LANDS	<ul style="list-style-type: none"> • Forested areas of the Koʻolau range & Waiʻanae range (Mt. Kaʻala) • Part of State Conservation District • Largely State-owned • Mixed native-nonnative forest (higher elevations are more native-dominated) • Includes multiple State reserves • Several fenced ungulate-free exclosures; on-going management in some areas
AGRICULTURAL LANDS	<ul style="list-style-type: none"> • Agricultural areas primarily used for crops, fallow fields, and grazing • Part of State Agricultural District • Dole Food, Co. and the State Agribusiness Development Corporation are two of the major landowners • Dominated by nonnative vegetation (scrubland/grassland)
DEVELOPED AREAS	<ul style="list-style-type: none"> • Includes the developed areas of Haleʻiwa, Waialua, Schofield Barracks, Wahiawā, JBPHH-Wahiawā Annex, Helemano Military Reservation, and the area immediately around the Dole Visitors' Center; also includes paved roadways (Drum Road, Kaukonahua Road, Kamehameha Highway) • Includes areas in the State Urban District and in the Agricultural District • The major landowners include the City and County of Honolulu and the Federal Government • Primarily consists of nonnative vegetation (scrubland/grassland) and impervious surfaces
ARMY TRAINING AREAS	<ul style="list-style-type: none"> • Includes the areas used by the Army primarily for training activities, namely Schofield Barracks East Range and Schofield Barracks West Range • Includes areas in the State Conservation District and in the Agricultural District • Owned by the Federal Government (Army) • Mixed native-nonnative forest (East Range) and nonnative scrubland/ grassland (West Range)

The chapter is divided into five major sections: one section for each of the four general land use types and a final section that summarizes the chapter and presents the overall priority management measures to improve water quality.

For each of the four land use types, there are four main subsections that present information about water quality issues and strategies to improve water quality. The first subsection summarizes the pollutants of concern and known/suspected pollutant sources in that land use type. Since measurably reducing sediments, erosion, and nutrients is an important goal of this plan, these pollutants are the primary focus. Other pollutants are discussed when information is available or when deemed important. Refer to *Volume 1: Watersheds Characterization* for further detail on water quality data and pollutant sources.

Second, the relevant management measures and applicable practices that address the water quality issues for that land use type are identified and briefly described (refer to text box on the following page for an explanation of management measures versus management practices). The management measures and associated practice types were derived from a variety of reputable sources, including the “Hawai’i Watershed Guidance” (HWG; Tetra Tech, 2010) multiple guides published by the EPA (cited in each relevant section), local management plans/projects, and NRCS conservation practices (also referred to as “standards”). NRCS standards provide information on nationally accepted management practices and are updated regularly for each state. Hawai’i-specific standards can be accessed via the NRCS Field Office Technical Guide (FOTG), available online at: <https://efotg.sc.egov.usda.gov/>. The management measures for each land use type are presented in no particular order and are numbered for reference purposes only; the numbering does not reflect prioritization. The list of examples of specific practices/NRCS standards for each type of management practice is not meant to be comprehensive; there may be other specific practices/BMPs that also apply. Moreover, not all practices may be applicable in all locations. For example, the NRCS standard called “terrace” that applies to Agricultural Lands may not be applicable in very flat terrains. Many of the practices listed apply to multiple management measures, however, they are listed under the measure that is most fitting. For example, in Agricultural Lands, a practice such as “filter strips” can help to achieve both a reduction in sediments as well as a reduction in nutrient-rich runoff. When information was available, a short description of how each practices type is currently implemented in the Kaiaka Bay Watersheds is also presented. It should be noted that this planning effort was not able to determine every location of an existing practice, therefore, there are undoubtedly more examples of existing practices that have been implemented in the Kaiaka Bay Watersheds that are not featured in this chapter.

The third subsection presents the relative effectiveness of each practice type at reducing pollutant loads, along with additional information such as relative cost, maintenance requirements, and other implementation considerations. Pollutant load reduction effectiveness is presented on a scale of “low,” “medium,” and “high;” these designations are based off the NRCS Conservation Practice Physical Effects (CPPE) documents in Section V of the NRCS FOTG as well as literature review¹. The actual pollutant load reduction depends on the extent of the practice, existing loading levels, and local features like soil and hydrology. Cost estimates are largely based off the NRCS cost spreadsheets for the Pacific Islands region

¹ The EPA’s *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* recommends identifying the effectiveness of each management practice in reducing pollutant loads using a scale of high, medium, or low (EPA, 2008).

as well as from communication with stakeholders. Additionally, the table indicates whether or not each practice has a beneficial side-effect on flooding or on groundwater conservation, since these issues are important community concerns but are not directly addressed in this WBP.

The fourth and final subsection under each land use type presents the prioritization of implementing the management measures in each of the six Kaiaka Bay Watersheds. The rationale for the prioritization of management measures for each land use type is described for each measure. It should be noted that the prioritization of specific measures in specific watersheds should not prohibit the procurement of funding to implement measures and their corresponding practices in watersheds that were not deemed “priority,” since implementing a practice in any applicable watershed will have positive effects on water quality. The subsection also identifies known opportunities for implementing practices/projects in priority watersheds. However, it was not possible to determine the location of every site that a practice could/should be implemented since the entire area of the Kaiaka Bay Watersheds is over 50,000 acres. Consequently, not all priority management measures have specific opportunities for implementation described in this section.

Section 3.5 presents the ultimate prioritization of all management measures that were identified for each of the four general land use types. The rationale for prioritization of each measure is presented along with a description of the land use or land type characteristics that are likely to generate/transport pollutants. The descriptions of these “hotspots” can help land managers identify ideal locations to implement the priority measures. The hotspots were identified and described in *Volume 1*.

Definitions of Management Measures and Management Practices

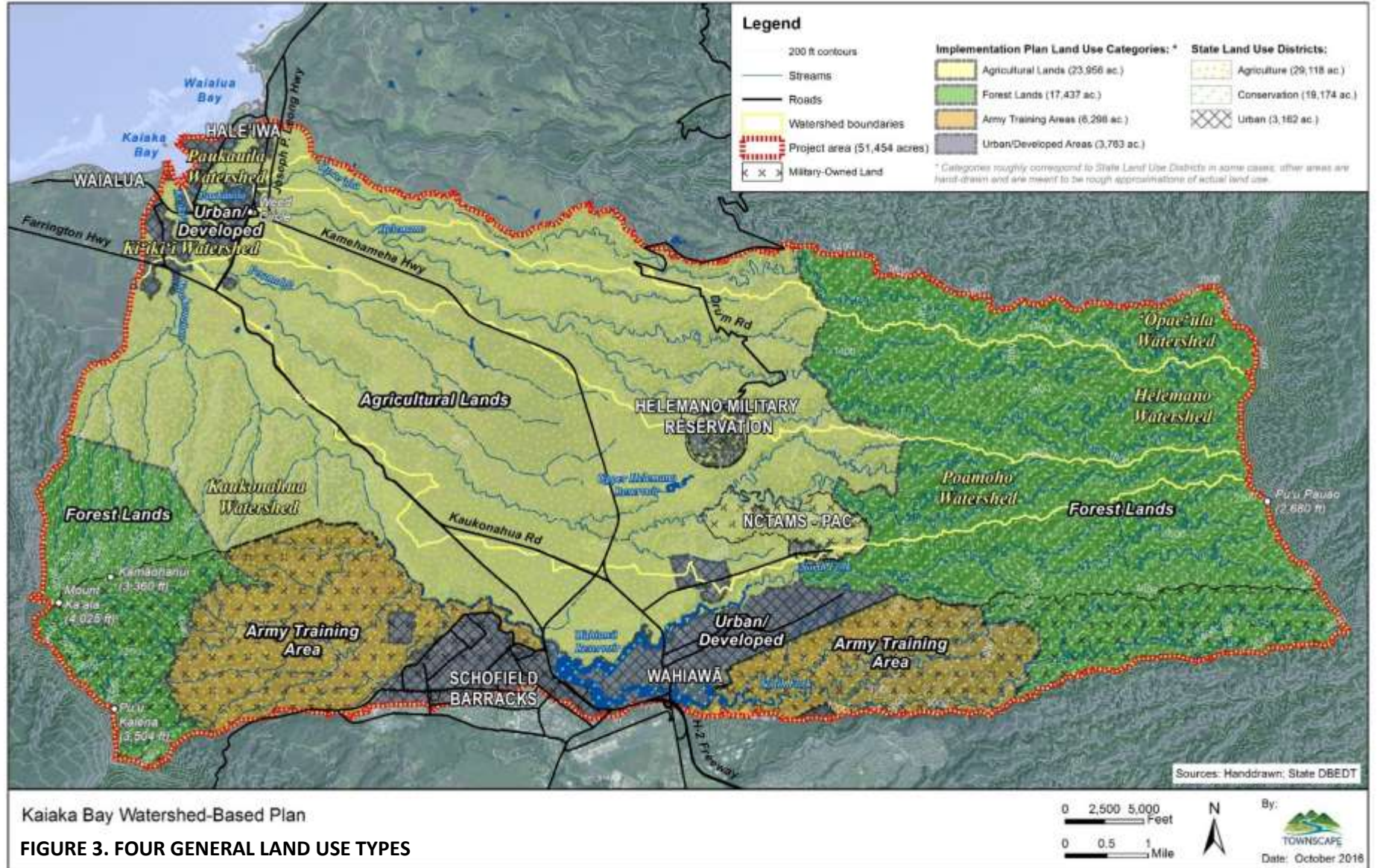
A **management measure** is essentially a group of economically feasible practices or projects that addresses a particular issue related to water quality². Management measures aim to improve water quality in receiving waters by:

- Preventing future pollutant sources
- Reducing existing pollutant sources (source reduction)
- Reducing pollutant loads entering streams

Management practices are specific, site-based projects that are used to achieve the measure. Management practices are often referred to as “Best Management Practices” (BMPs) or “Conservation Practices” (a term used most often by the NRCS).

Example: A management measure for agricultural lands could be to “reduce erosion and sediment transport.” An applicable practice to achieve the measure could be to install filter strips.

² The Federal Coastal Zone Act Reauthorization Amendments of 1990 defines management measures as “economically achievable measures for the control of ... nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives.”



3.1 FOREST LANDS

The Forest Lands land use type includes all forested and natural areas in the higher elevations of the watersheds (refer to Figure 3). Forest Lands make up approximately 34% of the total area in the Kaiaka Bay Watersheds (Table 5). Kaukonahua Watershed has the largest amount of Forest Lands (9,217 acres), followed by Helemano, Poamoho, and 'Ōpae'ula watersheds. Ki'iki'i and Paukaula watersheds do not have any land that is classified as Forest Lands. Refer to section 7.3.1 of *Volume 1: Watersheds Characterization* for a more detailed description of the Forest Lands land use type.

TABLE 5. FOREST LANDS AREA IN THE KAIKA BAY WATERSHEDS

	WATERSHED	ACRES	% OF WATERSHED	TOTAL ACRES
Ki'iki'i System	Ki'iki'i	0	0%	592
	Kaukonahua	9,217	37%	25,159
	Poamoho	2,016	17%	11,675
Paukaula System	Paukaula	0	0%	865
	Helemano	4,088	44%	9,353
	'Ōpae'ula	2,116	56%	3,810
	Total Acres	17,437	<i>n/a</i>	51,454
	% of Project Area	34%	<i>n/a</i>	100%

3.1.1 OVERVIEW OF POLLUTANTS & POLLUTANT SOURCES

While there is limited water quality data available for Forest Lands in the Kaiaka Bay Watersheds, it is known that sediments, nutrients, and pollutants such as bacteria are generated in Forest Lands and can be transported via surface water runoff into streams. The sources of pollutants are almost exclusively nonpoint, that is, they are results of landscape-level processes in the forested, mountainous environments. Known and suspected sources for these pollutants are briefly described below. For further details, please refer to *Volume 1: Watersheds Characterization*.

3.1.1.1 SEDIMENTS & TURBIDITY

Suspended sediments (as well other materials) are transported into streams via erosion and surface water runoff. Excessive amounts of suspended sediments in streams can cause high turbidity (low visibility in the water), which blocks sunlight from reaching aquatic life.

Water quality data for the Upper Kaukonahua subwatershed in the Ko'olau range, available from two different sources (DOH, 2009; USGS gage #162000000), indicate that turbidity is the water quality parameter of greatest concern. This information provides an indication that excessive turbidity is likely an issue in streams in the Forest Lands of other Kaiaka Bay Watersheds, including Poamoho, Helemano, and 'Ōpae'ula watersheds.

Upper Kaukonahua Stream, including the North Fork and South Fork of the stream, is listed on the State's 2014 303(d) list as being impaired with turbidity. TMDL calculations were developed for Upper Kaukonahua Stream and were approved in 2010 (refer to section 4.4 of *Volume 1: Watersheds Characterization*). Poamoho, Helemano, and 'Ōpae'ula streams are also listed as impaired with excessive turbidity.

The results of the modeling indicate that Forest Lands only produce 7% of the total sediments in the project area, however, it should be noted that the selected model (OpenNSPECT) does not model erosion caused by instream flow (which the geomorphology report conducted for this WBP found to be a significant source of sediments [AECOM, 2016; Appendix A]). Taken together, this information indicates that Forest Lands should not be overlooked as a significant source of sediments and turbidity in the Kaiaka Bay Watersheds.

SOURCES

Suspended sediments in streams coming out of Forest Lands can be a result of unstable stream embankments, shallow storm-induced landslides, and altered and denuded landscapes as influenced by fire, invasive plants, and invasive animals such as feral pigs. Fires are a major threat to Forest Lands in the Kaiaka Bay Watersheds; forest fires can cause soil loss and increased sediments in surface waters. Invasive plants are often more fire-prone than native species, which can increase the frequency and intensity of forest fires. Invasive plant species can also have negative effects on nutrient and water cycling, ultimately leading to degradation of water quality. Feral pigs are generally attributed with degrading water quality by contributing to erosion and soil



The habitat in the upper reaches of streams is dominated by native species (Helemano Stream pictured here), while the lower reaches are dominated by nonnative and invasive species

compaction. For example, pig diggings disturb plant communities, remove groundcover, and create wallows near streambanks, which contribute to erosion and sedimentation in streams. They also serve as vectors for invasive plant species by eating and dispersing seeds throughout the forest. In areas where there is high rainfall, steep slopes, and/or highly erodible soil types, there is typically more runoff generated and these factors can have even greater effects on water quality.

Natural erosion processes in the mountainous Forest Lands are known to be a significant source of sediments and turbidity in streams as well as areas that are degraded by invasive flora and fauna. The geomorphology report conducted for this WBP concluded that most suspended sediments in streams in the Kaiaka Bay Watersheds are likely coming from the stream channels themselves, especially from natural erosion processes that occur in the Forest Lands (AECOM, 2016; Appendix A). Indeed, many of the soil types that are found in the upper elevations of the watersheds are classified as highly erodible by water.

Major storm events have a significant impact on erosion processes in Hawai'i and result in large amounts of sediments being washed into drainages. Studies from other forested watersheds on O'ahu have shown that a single large storm event can produce 90 percent or more of the total annual sediment load in a stream (Izuka, 2012; Doty et al., 1981). Data from studies in the Kaiaka Bay Watersheds ('Ōpae'ula Stream) also indicate that storm events are major factors that significantly influence erosion and sediment loads in streams (Hoover, 2002; DeVito et al., 1995). These findings indicate that the clear majority of suspended-sediment transport occurs as a result of a few major storm events. They also indicate the great variability of suspended sediment yields in streams. Since Forest Lands are at the highest elevations in the Kaiaka Bay Watersheds, they receive the highest amount of rainfall and generate the most runoff, especially during storm events.

PRIORITY WATERSHEDS

Priority watersheds for controlling sediments in Forest Lands include all four of the applicable watersheds, since each watershed presents opportunities for implementing important management practices to address erosion/sedimentation. Therefore, the priority watersheds include:

- Kaukonahua Watershed;
- Poamoho Watershed;
- Helemano Watershed; and
- 'Ōpae'ula Watershed.

3.1.1.2 NUTRIENTS

Upper Kaukonahua Stream is listed on the State's 2014 303(d) list as being impaired with total nitrogen. TMDLs for Upper Kaukonahua Stream were developed and approved in 2010 (refer to section 4.4 of *Volume 1: Watersheds Characterization*). The 303(d) list also indicates that Poamoho, Helemano, and 'Ōpae'ula streams are impaired with excessive nutrients, including total nitrogen, nitrate/nitrite, and total phosphorus.

Analysis of the modeling results indicates that 99% of all nitrogen and 95% of all phosphorus in the Kaiaka Bay Watersheds originates from areas classified as Forest Lands in this WBP, however, it should be noted that while Forest Lands occur in both the Wai'anae range and the Ko'olau range, all or almost all of these nutrients originate on the Ko'olau side. Forest Lands in the Kaukonahua Watershed alone produce over 60% of all nitrogen and phosphorus.

SOURCES

The sources of excessive nutrients in streams in Forest Lands are largely the same as sources of sediments, since the processes that cause sediments to be transported in runoff into streams also cause nutrients to be transported in runoff. As with sediments, storms can significantly increase the transport of nutrients to streams. DeVito et al. (1995) found that concentrations of total phosphorus and nitrate significantly increased (along with total suspended sediments and turbidity) during storm events in 'Ōpae'ula Stream. In addition to the erosion caused by the digging activities of feral pigs, pigs contribute nutrients to the watersheds through their feces. Moreover, phosphorus is strongly adsorbed to silt and clay particles that are common in Hawaiian soils, therefore, total phosphorus concentrations generally increase with increasing suspended-sediment concentrations. This property amplifies the importance of erosion and sediment control in improving water quality.

Natural sources of nutrients in streams includes nitrogen from rainfall and fixation of atmospheric nitrogen by plants and other organisms. Phosphate may also be derived from the weathering of volcanic rocks and other soils.

PRIORITY WATERSHEDS

Priority watersheds for controlling nutrients in Forest Lands include all four of the applicable watersheds, since each watershed presents opportunities for implementing relevant management measures to address existing hotspots but also to protect native ecosystems and watershed functioning. Therefore, the priority watersheds include:

- Kaukonahua Watershed;
- Poamoho Watershed;
- Helemano Watershed; and
- 'Ōpae'ula Watershed.

3.1.1.3 OTHER POLLUTANTS

Bacteria (such as *E. coli*) and other pathogens are certainly present in Forest Lands, however, the extent of the impact these sources of pollutants make on downstream water quality is not well-understood or well-studied.

SOURCES

Soils in Hawai'i are a natural source of fecal indicator bacteria, including enterococci, total coliform, fecal coliform, *E. coli*, and fecal streptococci. Because soil is transported into streams during periods of rainfall, the soil represents a natural source of fecal indicator bacteria in streams. Feral pigs and other animals can introduce also bacteria and other microbes to ecosystems through their feces, however, the extent of the impact these sources of pollutants make on water quality is not well-understood.

PRIORITY WATERSHEDS

The goals of the WBP state that pollutants other than sediments and nutrients should be addressed opportunistically or as deemed necessary. Addressing the bacteria contributed through animal droppings is not a major priority for this WBP, especially since feral pig management in Forest Lands will be addressed in the management measures to reduce sediments and nutrients coming from those areas. The natural sources of bacteria (soils) are also not a priority for management since little can be done to reduce them.

Therefore, none of the Kaiaka Bay Watersheds are identified as a priority for addressing other types of pollutants coming from Forest Lands.

3.1.1.4 SUMMARY OF POLLUTANT SOURCES AND PRIORITY WATERSHEDS IN FOREST LANDS

Table 6 provides a summary of the pollutants of concern, the primary sources of the pollutants, and the priority watersheds for the pollutants of concern in Forest Lands.

TABLE 6. POLLUTANTS, POLLUTANT SOURCES, AND PRIORITY WATERSHEDS IN FOREST LANDS

Primary Factors That May Contribute Pollutants (all NPS)	Pollutants of Concern	Priority Watersheds: Sediments	Priority Watersheds: Nutrients	Priority Watersheds: Other Pollutants
<ul style="list-style-type: none"> • Natural erosion processes • Feral ungulates • Nonnative & invasive plants • Forest fires 	<ul style="list-style-type: none"> • Sediments and turbidity • Nutrients • Bacteria (from animals and natural sources) 	<ul style="list-style-type: none"> • Kaukonahua • Poamoho • Helemano • 'Ōpae'ula 	<ul style="list-style-type: none"> • Kaukonahua* • Poamoho* • Helemano* • 'Ōpae'ula* <p><i>* Primarily the forests of the Ko'olau range</i></p>	None

3.1.2 MANAGEMENT MEASURES & PRACTICES

This section describes some of the key management measures that could be implemented to reduce pollutant loads coming from the forested areas of the watersheds. In addition, to targeting known sources of pollutants, the “Hawai'i Watershed Guidance” points out that it is also important to implement management measures to ensure that the healthiest areas of the watershed remain healthy. Therefore, some of the management measures listed below are intended to help protect the healthiest areas of the watersheds, namely, the native-dominated high elevation forests in the Ko'olau range (the entire summit area) and in the Wai'anae range (Mt. Ka'ala). The results of implementing the associated practices can help to reduce erosion and sedimentation, thereby improving water quality in streams. In general, management practices that prevent soil disturbances will have the largest impacts on pollution abatement. The three management measures described below for Forest Lands are loosely based on the measures outlined for “Forestry” areas in the “Hawai'i Watershed Guidance,” as well as based on existing management priorities for organizations such as the Ko'olau Mountains Watershed Partnership.

For each management measure, several applicable management practices are listed that could help accomplish the objective of the measure. Where possible, references to any applicable NRCS FOTG standards (and associated three-digit code) and/or other documented practices are cited for further information.

FOREST MEASURE #1: WATERSHED PROTECTION AND FOREST MANAGEMENT




Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria

Objective: To reduce existing sources of pollution and prevent new sources by restoring and protecting watersheds.

Description: This management measure includes practices that aim to restore and protect forested ecosystems in the watersheds, including streams and riparian areas. The general intention is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Applicable watersheds include: Kaukonahua, Poamoho, 'Ōpae'ula, and Helemano.

Practices: There are three main types of management practices that apply to the “Watershed Protection and Forest Management” measure (Table 7). These practice types are based off a number of NRCS FOTG standards and practices from “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 10 (section 3.1.3).

TABLE 7. PRACTICES FOR FOREST MEASURE #1: WATERSHED PROTECTION AND FOREST MANAGEMENT

<i>Practice Type</i>		<i>Description</i>	<i>Example Image</i>	<i>Examples of Applicable Practices</i>
A	Fencing & Ungulate Control	Constructing fences to exclude feral ungulates (pigs); ungulate control occurs during/after fence construction to remove animals; ungulate control can also occur outside fenced areas to reduce populations	 <small>PHOTO CREDIT: DAVID CONCEPCION</small>	<u>DLNR (1996):</u> <ul style="list-style-type: none">• Fencing (pg. 22) <u>NRCS Standards:</u> <ul style="list-style-type: none">• Feral swine management (#297)• Fence (#382)
B	Weed Control	Killing/removing invasive plants that are known to have ecosystem-altering effects; a variety of techniques can be used	 <small>PHOTO CREDIT: QANRP</small>	<u>NRCS Standards:</u> <ul style="list-style-type: none">• Brush management (#314)• Herbaceous weed control (#315)• Forest stand improvement (#666)
C	Native Ecosystem Restoration	Increasing the presence of native forest species through outplanting and other ecosystem restoration activities to protect watersheds over the long term; priority areas include those that are threatened by invasive species and disturbed areas that are prone to erosion	 <small>PHOTO CREDIT: PLANTAWISH.ORG</small>	<u>NRCS Standards:</u> <ul style="list-style-type: none">• Conservation cover (#327)• Critical area planting (#342)• Tree/shrub establishment (#612)• Restoration and management of rare or declining habitats (#643)• Wetland wildlife habitat management (#644)• Upland wildlife habitat management (#645)

Identified Existing Activities for Each Practice Type:

A. Fencing & Ungulate Control

As of January 2017, there are approximately 930 acres of fenced area in Forest Lands in the Ko‘olau summit area, including area in ‘Ōpae‘ula, Helemano, and Poamoho watersheds. Pigs are eradicated from all fenced areas, with the exception of the newly constructed fence for the northern portion of the Poamoho Natural Area Reserve where there are on-going pig eradication efforts. Fences are currently being constructed along the Ko‘olau summit to enclose another 721 acres of land in the ‘Ōpae‘ula and Poamoho watersheds, and additional fences are proposed for a total of 1,049 acres located in the

Helemano, Poamoho, and Kaukonahua watersheds. The fences in the Koʻolau range are being maintained/constructed by a number of agencies and organizations, including DLNR DOFAW, the Koʻolau Mountains Watershed Partnership, and the U.S. Army (Oʻahu Army Natural Resources Program or OANRP). In the Kaukonahua Watershed in the Waiʻanae range, a total of 2,100 acres below Mt. Kaʻala have been fenced and are nearly pig-free (on-going pig eradication efforts). These fences were constructed and are maintained by the OANRP. Refer to section 3.3.2 of *Volume 1* of this WBP for more information and a map of the fenced areas.

In addition to the ungulate control that occurs inside the fenced areas, several different areas within the Kaiaka Bay Watersheds are open for hunting. There are three areas on Schofield Barracks East Range are open for hunting during the week when not in use for military training, with certain restrictions (DOH, 2009). The entire ʻEwa Forest Reserve, part of Oʻahu Hunting Unit C, is open to public hunting on weekends and state holidays only. The Mokulēʻia Forest Reserve, part of Oʻahu Hunting Unit E, is open to the public from February to October on weekends and state holidays. Hunting efforts can help to slow the growth of pig populations in Forest Lands.

DOFAW is in the process of finalizing management guidelines for State conservation lands. The guidelines help to prioritize management strategies for different areas according to different uses or conservation values. DOFAW’s draft management guidelines for State conservation lands include a category for “Native Species and Biodiversity Conservation Management.” The highest conservation value lands are prioritized for fencing and ungulate control. These areas are generally found along the Koʻolau summit, including the proposed Poamoho Natural Area Reserve (NAR).

B. Weed Control

There is a variety of organizations that participate in weed control efforts in Forest Lands of the Kaiaka Bay Watersheds, including KMWP, WMWP, DOFAW, OANRP and the Oʻahu Invasive Species Committee. These organizations work separately, collaboratively, or with volunteers from the public to target specific invasive plants. Weed control is primarily conducted inside fenced areas since those areas are protected from ungulates and have the most potential for ecosystem restoration.

In the Koʻolau range, invasive plants such as cane tibouchina (*Tibouchina herbacea*), manuka (*Leptospermum scoparium*), strawberry guava (*Psidium cattleianum*), mule’s foot fern (*Angiopteris evecta*), and Koster’s curse (*Clidemia hirta*) are targeted. In the Forest Lands of the Waiʻanae range, including Mt. Kaʻala and the slopes below Mt. Kaʻala, organizations such as OANRP and DOFAW target many different invasive species, such as grasses (*Anthoxanthum odoratum*; *Festuca arundinacea*), certain ornamental plants (*Crocosmia x crocosmiiflora*; *Dietes iridioides*), the vegetable fern (*Diplazium esculentum*), Kāhili ginger (*Hedychium gardnerianum*), a moss species (*Sphagnum palustre*), and many



Strawberry guava often grows in dense thickets, out-competing native species

others. Additionally, ecosystem-wide weed control targeting nonnative species occurs in many high priority areas (especially fenced areas) to improve habitat for native plants and animals. Per OANRP's 2016 yearly report, over 1,500 person-hours were spent by OANRP staff in 2016 conducting weed control for Army-managed Forest Lands (mainly on Mt. Ka'ala and in the fenced areas below Mt. Ka'ala).

DOFAW's draft management guidelines for State conservation lands include "Vegetation Management" as one of the categories of management guidelines. Vegetation management strategies vary according to the desired land uses and conservation values in specific areas.

C. Native Ecosystem Restoration

DOFAW and OANRP both have large greenhouses dedicated to growing threatened and endangered plants as well as common native plants for outplanting purposes. In the Kaiaka Bay Watersheds, the area that receives the most outplanting are the areas near Mt. Ka'ala and the fenced/managed areas on the slopes below Mt. Ka'ala in the Kaukonahua Watershed.



OANRP greenhouse with plants grown for outplanting

DOFAW's draft management guidelines for "Native Species and Biodiversity Conservation Management" in high value conservation areas includes restoring native species and native ecosystems, including reintroducing native plants, as one of the management strategies.

FOREST MEASURE #2: FIRE PREVENTION AND MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity)




Objective: Prevent fires to reduce post-fire erosion and runoff; improve fire management and response to reduce duration and intensity of fires thereby reducing post-fire runoff; increase post-fire restoration activities to speed up ecosystem recovery.

Description: This management measure includes practices that aim to prevent forest fires, improve fire management and response to fires, and increase post-fire restoration activities to speed up recovery of ecosystem. The general intention is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Applicable watersheds include: Kaukonahua, Poamoho, 'Ōpae'ula, and Helemano.

Practices: There are three main types of management practices that apply to the "Fire Prevention and Management" measure (Table 8). These practice types are based off NRCS FOTG standards and "Best

Management Practices for Maintaining Water Quality in Hawai'i" (DLNR, 1996) that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 10 (section 3.1.3).

TABLE 8. PRACTICES FOR FOREST MEASURE #2: FIRE PREVENTION AND MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Fuel Breaks & Vegetation Management	Reducing fire-prone vegetation to slow or stop fires from spreading; accomplished either by continued removal/maintenance or by replacing with less fire-prone vegetation		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Wildfire control and reclamation (pg. 22) • Fireline construction and maintenance (pg. 23) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Brush management (#314) • Fuel break (#383) • Fire break (#394) • Herbaceous weed control (#315) • Forest stand manipulation (#666) • Forest trails and landings (#655)
B Access Control	Controlling access to Forest Lands will help to prevent incidental wildfires that are accidentally started by hikers, hunters, or others; access to private property should be provided to key agencies (e.g. DOFAW) to respond to fires		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access control (#472) • Access road (#560) • Forest trails and landings (#655)
C Post-Fire Restoration	Practices that aim to restore groundcover and prevent the recruitment of fire-prone species, such as guinea grass; especially pertains to establishing native forest species suitable to the area		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Reforestation (pg. 24) • Wildfire damage control and reclamation (pg. 22) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Conservation cover (#327) • Critical area planting (#342) • Tree/shrub establishment (#612) • Restoration and management of rare or declining habitats (#643) • Upland wildlife habitat management (#645)

Identified Existing Activities for Each Practice Type:

A. Fuel Breaks & Vegetation Management

The Army maintains a firebreak road in the Kaukonahua Watershed that divides the Schofield Barracks West Range training area and the mauka, fenced forested area leading up to Mt. Ka'ala; this firebreak is further discussed in the Army Training Areas section (3.4.2). There are no other known fire or fuel breaks in Forest Lands.

Other than the weed control activities discussed under Forest Measure #1, the planning team for this WBP did not learn about any major efforts to conduct vegetation management specifically for the purpose of preventing fires in Forest Lands.

B. Access Control

There is fairly limited access to mauka areas in the Kaiaka Bay Watersheds since much of the land bordering the Forest Lands is either privately owned or owned or leased by the Army. However, there are a few different maintained access roads and trails, some of which require permits, including:

- Poamoho Trail and access road – The Poamoho Trail is located mauka of Helemano Military Reservation. A permit from DLNR DOFAW is required to gain access the area and trail use is limited to weekends and holidays.
- Schofield-Waikāne Trail – The Schofield-Waikāne Trail is located in the ‘Ewa Forest Reserve, above Wahiawā and is accessed via a four-wheel drive road located in Schofield Barracks East Range. It is only accessible on weekends from sunrise to sunset, with a letter of permission from the Army’s Directorate of Public Works as well as a permit from DLNR DOFAW.



The road to access the Poamoho trail is gated and locked to those without permits

There are many additional less-known/unmapped access points and trails as well that are used by hunters or local hikers, most of which are on trails that are not well maintained and possibly dangerous.

C. Post-Fire Restoration

Agencies and organizations that manage areas in Forest Lands, such as the Army, DOFAW, KMWP, and WMWP do not have funding or resources specifically designated for post-fire restoration projects. Since forest fires in Hawai‘i are unpredictable and sporadic, it is difficult to gather the resources necessary to quickly respond post-fire. In addition, limited access to forest fire sites can make restoration activities difficult and costly. Generally, DOFAW uses a “site-by-site” approach and determines what restoration activities are feasible as well as prudent. For example, after the large fire that burned approximately 500 acres of Forest Lands in the ‘Ewa Forest Reserve in August of 2015, DOFAW established three different sites within the burned area where they conducted restoration activities such as invasive weed control, outplanting native forest species, and constructing water catchments to water the outplantings. They would have liked to have done more, however, funding and resources on hand were major limitations.

FOREST MEASURE #3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS



Primary Pollutants Targeted: Sediments (including turbidity)

Objective: To reduce and prevent the generation and transport of pollutants from trails and roads into streams.

Description: This management measure includes practices that are guidelines for constructing and maintaining roads and trails in Forest Lands. It also includes practices to control access to ecologically sensitive areas. The general intention is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Applicable watersheds include: Kaukonahua, Poamoho, 'Ōpae'ula, and Helemano, although Kaukonahua and Poamoho watersheds have significantly more roads and trails in Forest Lands than the latter two watersheds.

Practices: There are two main types of management practices that apply to the "Construction and Maintenance of Roads and Trails" measure (Table 9). These practice types are based off NRCS FOTG standards and "Best Management Practices for Maintaining Water Quality in Hawai'i" (DLNR, 1996) that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. For example, the U. S. Fish and Wildlife Service (USFWS) and the EPA have co-funded a manual of procedures to enhance stability and maintain unpaved roads while reducing sedimentation and improving water quality, titled "Recommended Practices Manual: A Guideline for Maintenance and Service of Unpaved Roads" (CPYRWMA, 2000). This manual contains a comprehensive list of management practices that can also be helpful in providing additional guidance for how to best maintain unpaved forest roads. More information about implementing the practice types presented in the table below can be found in Table 10 (section 3.1.3).

TABLE 9. PRACTICES FOR FOREST MEASURE #3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS

Practice Type	Description	Example Image	Examples of Applicable Practices
A	Road/Trail Design & Maintenance	Forest roads and trails should be designed and maintained to minimize impacts to the watershed; includes BMPs to minimize, divert, and filter runoff from roads/trails	 <p>DLNR (1996):</p> <ul style="list-style-type: none"> • Forest roads – design (pg. 8), construction (pg. 9) • Forest roads – maintenance (pg. 11) • Streamside management zones (pg. 19) <p>NRCS Standards:</p> <ul style="list-style-type: none"> • Access road (#560) • Diversion (#362) • Filter strip (#393) • Forest trails and landings (#655) • Grassed waterway (#412) • Stream crossing (#578)
B	Access Control	Controlling and limiting access to Forest Lands will protect the watersheds and prevent erosion; access provided to motorized vehicles should be restricted and limited	 <p>NRCS Standards:</p> <ul style="list-style-type: none"> • Access control (#472)

Identified Existing Activities for Each Practice Type:

A. Road/Trail Design & Maintenance

DLNR DOFAW conducts maintenance on roads and trails once or twice a year, including the Poamoho Road and Poamoho Trail. BMPs that are sometimes implemented include water diversions, French drains, tree planting, revegetation, and filling holes with fabric or imported materials.

B. Limiting Access

There is currently limited access to mauka areas in the Kaiaka Bay Watersheds. There are no designated areas for recreational motorized vehicles. To protect the watersheds, the status quo should be maintained or improved. See “Access Control” for Forest Measure #2 for more information on current access.



A sign marks the end of the maintained portion of the Poamoho Trail

3.1.3 MANAGEMENT PRACTICE EFFECTIVENESS & IMPLEMENTATION CONSIDERATIONS

Table 10 presents qualitative assessments of the effectiveness each practice type has on specific pollutants. Pollutant load reduction effectiveness is presented on a scale of “low,” (L) “medium” (M) and “high” (H). Cost estimates for specific practices are presented when data was available. The information in the table is based on literature review (including the NRCS CPPE matrix and NRCS FOTG spreadsheets for the Pacific Islands region), consultation with service providers and stakeholders, and professional judgment. Additionally, the table indicates whether or not each practice also has a beneficial effect on flooding or on groundwater conservation, since these issues are important community concerns but are not directly addressed in this WBP.

TABLE 10. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR FOREST LANDS MANAGEMENT PRACTICES

Pollutant Reduction										Maintenance	Implementation Considerations
Sediments	Nutrients	Bacteria	Flooding*	Groundwater Conservation*	Cost						
FOREST MEASURE #1: WATERSHED PROTECTION AND FOREST MANAGEMENT											
Ungulate Control & Fencing	M	L	L	n/a	✓	\$50/acre (ungulate control); \$28/ft (fence)	M	Long-term watershed benefits expected			
Weed Control	L	L	n/a	n/a	✓	Varies: \$200-10,000/acre	H	Long-term watershed benefits expected			
Native Ecosystem Restoration	M	L	L	✓	✓	Varies: \$200-10,000/acre	M	Long-term watershed benefits expected			
FOREST MEASURE #2: FIRE PREVENTION AND MANAGEMENT											
Fuel Breaks & Vegetation Management	M/H	L	n/a	n/a	n/a	\$400-480/acre	M	Short-term negative effects; long-term effects may be significant			
Access Control	L/M	L	n/a	n/a	n/a	Varies – e.g. \$0.15/ft for signage; \$830 for a gate; \$44/acre for patrolling	L/M				
Post-Fire Restoration	M/H	M	L	✓	✓	Varies: \$200-10,000/acre	M				
FOREST MEASURE #3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS											
Road/Trail Design & Maintenance	M	L	n/a	n/a	n/a	\$18-27/ft	M				
Access Control	L/M	L	n/a	n/a	n/a	Varies – e.g. \$0.15/ft for signage; \$830 for a gate; \$44/acre for patrolling	L				

* Checked if practice has a beneficial effect on flooding/groundwater conservation

Notes: 'L' = Low; 'M' = Medium; 'H' = High

3.1.4 PRIORITY MANAGEMENT MEASURES BY WATERSHED

Table 11 presents the prioritization of the three Forest Lands management measures by watershed. The prioritization of watersheds for specific management measures was determined based off the priorities for managing pollutants that were presented in *Volume 1* of this WBP (Table ES-2 or Table 57). It should be noted that funding for implementing management measures in specific watersheds should not be limited to those that are indicated as “priority” in the table since implementing any management measure in any applicable watershed will have benefits on water quality.

TABLE 11. APPLICABILITY AND PRIORITIZATION OF FOREST LAND MANAGEMENT MEASURES BY WATERSHED

		<i>Ki'iki'i Stream System</i>			<i>Paukauila Stream System</i>		
		<i>Ki'iki'i</i>	<i>Kaukonohua</i>	<i>Poamoho</i>	<i>Paukauila</i>	<i>Helemano</i>	<i>Ōpae'ula</i>
FOREST LANDS MANAGEMENT MEASURES	#1: WATERSHED PROTECTION AND FOREST MANAGEMENT		P	P		P	P
	#2: FIRE PREVENTION AND MANAGEMENT		P	P		x	x
	#3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS		P	P		x	

Notes: 'P' denotes priority watersheds

'x' denotes applicable watersheds

Shaded cells are watersheds in which the management measure is not applicable/recommended

3.1.4.1 DESCRIPTION OF PRIORITIES

This section presents more information about the priority watersheds for each management measure, along with any known opportunities for implementing specific practices.

FOREST LANDS MEASURE #1: WATERSHED PROTECTION AND FOREST MANAGEMENT

Implementing practices that help achieve the “Watershed Protection and Forest Management” measure will help reduce existing sources of pollution and prevent new sources of pollution, primarily by reducing/preventing erosion and associated polluted runoff. Protecting native ecosystems in Forest Lands of the Kaiaka Bay Watersheds will also help achieve the Governor’s goal of protecting 30% (253,000 acres) of Hawai’i’s highest priority watershed forests by 2030 as part of the Sustainable Hawai’i Initiative. Twenty percent of all land in Hawai’i is identified as priority watershed forests, however, only 15% of these forests are currently protected. Implementation of this management measure could be increase if regulatory agencies developed an integrated watershed approach that would allow permit-holders to designate compliance funds towards watershed protection and forest management to reduce pollutant loads; this strategy is discussed in Chapter 2.

All four of the watersheds that are applicable to this management measure are determined to be priorities for implementing practices associated with watershed protection and forest management.

Opportunities for Implementation:

Kaukonahua

- On the Ko'olau side of the watershed, KMWP would like to see a fence constructed on Army-owned land that is bordered to the north by the southern portion of the newly constructed Poamoho NAR fence. The O'ahu Army Natural Resources Program has been planning to build a 95-acre fence in this area, however, plans for the fence have been postponed due to pending Section 7 consultations with the USFWS. The area is rarely used for on-the-ground Army training since access to the area is difficult and the terrain can be challenging. Funding to construct the fence would help to protect the watershed and the water quality in streams.
 - After the Army fence is complete and all ungulates are removed, control of invasive plants should begin inside the fence. Funding for organizations such as OISC, KMWP, and OANRP could support these weed control efforts.
- On the Wai'anae side of the watershed, additional fencing to protect more of the Ka'ala Natural Area Reserve from the damaging effects of feral pigs would be beneficial to protect and improve water quality in streams. The land is owned by the State of Hawai'i. The fence could abut the existing fences to the east (extending north from Pu'u Kamaohanui) and to the south (the large fenced area known as Lihu'e). The existing fences were constructed and are managed by the Army.
- Where possible and practical, increased opportunities for hunting in Forest Lands should be made available to the public to reduce pig populations outside of fenced areas and protect/improve water quality in streams.

Poamoho

- Invasive plants such as manuka, strawberry guava, and mule's foot fern are found in the forests of Poamoho. Funding to support OISC, KMWP, and DOFAW would aid in the on-going control of invasive plants found in Poamoho.
- Where possible and practical, increased opportunities for hunting in Forest Lands should be made available to the public to reduce pig populations outside of fenced areas and protect/improve water quality in streams.

Helemano

- KMWP would like to construct a fence along the Ko'olau summit that connects the Helemano/'Ōpae'ula fence to the north with the Poamoho NAR fence to the south, however, they currently lack adequate funding. Funding to construct the fence would help to protect the watershed and the water quality in streams.
- One of O'ahu's most invasive plants, cane tibouchina, has been found in Helemano Watershed, along with other invasive plants such as manuka and strawberry guava. Funding to support OISC, KMWP, and DOFAW would aid in the on-going control of invasive plants found in Helemano.
- Where possible and practical, increased opportunities for hunting in Forest Lands should be made available to the public to reduce pig populations outside of fenced areas and protect/improve water quality in streams.

'Ōpae'ula

- Invasive plants such as manuka, strawberry guava, and mule's foot fern are found in the forests of 'Ōpae'ula. Funding to support the OISC, KMWP, and DOFAW would aid in the on-going control of invasive plants found in 'Ōpae'ula.

- Where possible and practical, increased opportunities for hunting in Forest Lands should be made available to the public to reduce pig populations outside of fenced areas and protect/improve water quality in streams.

FOREST LANDS MEASURE #2: FIRE MANAGEMENT AND PREVENTION

Implementing practices that help achieve the “Fire Management and Prevention” measure will reduce the occurrence of wildfires as well as reduce the impacts on water quality after a fire due to restoration activities that can help to stabilize soils and reduce runoff. The priority watersheds for this management measure include Kaukonahua and Poamoho, since they have the most visitors and public access. Additionally, the Forest Lands in Kaukonahua Watershed on the slopes of Ka’ala are adjacent/mauka of the Army’s West Range Training Area where live-fire training is conducted; the proximity of the Army training increases the importance of fire prevention in this portion of the Kaukonahua Watershed.

Opportunities for Implementation:

Kaukonahua

- Areas in the Forest Lands of the Kaukonahua Watershed that border Army Training Areas should have adequate firebreaks to prevent the spread of fires. The Army maintains a firebreak road that divides the Schofield Barracks West Range training area and the mauka, fenced forested area leading up to Mt. Ka’ala; this firebreak is further discussed in the Army Training Areas section (3.4.2). It is a priority to maintain this firebreak as well as to consider creating additional firebreaks in the East Range training area.

Poamoho

- Areas in the Forest Lands of the Poamoho Watershed that border Agricultural Lands should have adequate firebreaks to prevent the spread of fires, especially since a lot of the Agricultural Lands are not actively farmed and are covered in invasive guinea grass, a very fire-prone and fast-growing plant.
- At major points of access, such as the Poamoho Road, informational signs about the risk of fires could be posted to inform the public of proper behaviors. The signs could also provide information about who to contact in case a fire is spotted.

FOREST LANDS MEASURE #3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS

Implementing practices that help achieve the “Construction and Maintenance of Roads and Trails” measure will help to minimize erosion and runoff, thereby reducing the transport of sediments and nutrients into streams. The priority watersheds for this management measure are Kaukonahua and Poamoho since they currently have the most roads and trails. Additionally, the sale of the Dole lands that are located in the Forest Lands of the Poamoho Watershed (as well as the Helemanohi Watershed) could open up the land to new uses, including increased public access. The State DLNR is one entity that is interested in these lands.

Opportunities for Implementation:Kaukonahua

- The planning team for this WBP was not able to determine any specific locations for practices for roads and trails in the Forest Lands of the Kaukonahua Watershed, although this does not indicate that none exist. It is likely that BMPs such as filter strips, grassed waterways, water bars, and streamside management zones would be applicable and beneficial in certain areas.

Poamoho

- To protect water quality, future land uses of the Dole parcels that are for sale should not be allowed to create new trails/roads in forested areas for the use of motorized recreation activities, especially in areas that are prone to erosion, near streams, or contain important natural/cultural resources.
- If new roads/trails are developed, they should be designed according to the practices outlined in this management measure. Additionally, public access to sensitive areas should be carefully considered and managed.
- The existing Poamoho Road and Trail should be maintained according to the practices outlined in this management measure.

3.2 AGRICULTURAL LANDS

The Agricultural Lands land use type includes land that is primarily used for growing crops, grazing, and fallow fields (formerly actively farmed). These areas are primarily located in the central portion of the project area (Kaukonahua, Poamoho, Helemano, and 'Ōpae'ula watersheds), however, Ki'iki'i and Paukaula watersheds also have Agricultural Lands (refer to Figure 3). Note that some areas that are part of the State Agriculture District are not included in this land use category since they are used primarily for Army training. Agricultural Lands cover approximately 47% of the total area in the Kaiaka Bay Watersheds (Table 12). Each of the six Kaiaka Bay Watersheds has some Agricultural Lands, however, Kaukonahua Watershed has more than twice as many acres as any other watershed (25,159 acres). Refer to section 7.3.1 of *Volume 1: Watersheds Characterization* for a more detailed description of the Agricultural Lands land use type.

TABLE 12. AGRICULTURAL LAND AREA IN THE KAIKA BAY WATERSHEDS

	WATERSHED	ACRES	% OF WATERSHED	TOTAL ACRES
Ki'iki'i System	Ki'iki'i	344	58%	592
	Kaukonahua	6,841	27%	25,159
	Poamoho	9,328	80%	11,675
Paukaula System	Paukaula	531	61%	865
	Helemano	5,225	56%	9,353
	'Ōpae'ula	1,687	44%	3,810
	Total Acres	23,956	<i>n/a</i>	51,454
	% of Project Area	47%	<i>n/a</i>	100%

3.2.1 OVERVIEW OF POLLUTANTS & POLLUTANT SOURCES

Runoff from Agricultural Lands is a nonpoint source type of pollution. Runoff from fields, orchards, and pastures can transport sediments, nutrients, and other pollutants (such as bacteria) into streams and other water bodies. Known and suspected sources for these pollutants are briefly described below. For further details, please refer to *Volume 1: Watersheds Characterization*.

3.2.1.1 SEDIMENTS & TURBIDITY

The State's 2014 303(d) list indicates that the lower portion of Kaukonahua Stream (which runs through Agricultural Lands) is impaired with excessive turbidity (noted to be two times the State Water Quality Standard). Poamoho, Helemano, and 'Ōpae'ula streams are also listed as impaired with excessive turbidity, along with Paukaula Estuary. The 303(d) list indicates that there is inadequate data to assess the water quality of Ki'iki'i Estuary, however, data from various studies indicate that waterbodies within the Ki'iki'i Watershed are impaired with excessive turbidity.

The USGS gages that were placed throughout the Kaukonahua Watershed as a result of the 2010 Waialua-Kaiaka Watershed Study also show elevated levels (i.e. exceeding water quality standards) of turbidity and sediments at each gage (refer to section 5.1.2 of *Volume 1* for details).

Agricultural areas have been found to be a major source of suspended sediments in watersheds on O'ahu. Izuka (2012) found that the vast majority of suspended sediments in streams in the Waikele Watershed on O'ahu come from agricultural areas (an order of magnitude higher than forests and two orders of magnitude higher than urban areas). In agreement with these findings, the results of the modeling indicate that Agricultural Lands are the main source of sediments in the Kaiaka Bay Watersheds, producing 85% of the total sediments and significantly more sediments per acre than the other land use types.

SOURCES

The effect of agriculture on increasing soil erosion is well known, although the effect differs by numerous factors including the amount and intensity of rainfall, soil condition, topography, crop type, cultivation method, field management practices, the number of field roads, and land use factors. Significant soil loss can occur during periods when a field is bare. It can also occur as a result of tilling, plowing, discing, or any other disturbance of the soil. Soil loss is also correlated with the



Exposed soil on fields is prone to erosion by wind and water, thus contributing to sediment loads in streams

proportion of unpaved access roads in a field. Pineapple fields are known to have a higher proportion of unpaved roads and longer periods of exposed fields during tillage and the early growth stage than other large scale-crops, which can result in increased soil loss (Oki and Brasher, 2003).

The grazing of cattle and other livestock can cause streambank erosion, soil compaction, and alter plant and animal communities, thereby increasing runoff and suspended sediment loads in streams (Dunkell, Bruland, Evensen, and Litton, 2011; G70, 2016). Cattle have been known to escape out of fenced areas into natural areas where they can degrade watersheds; this has occasionally been an issue in the past in the lower Kaukonahua Watershed.

Additional causes of erosion and sedimentation include wildfires, ecosystem degradation due to nonnative and invasive plants, and natural erosion processes (which are exacerbated when there are steep slopes, high rainfall, and/or highly erodible soil types). Major storm events have a significant impact on erosion processes in Agricultural Lands and result in large amounts of sediments being washed into drainages. Studies have found that the majority of annual suspended-sediment transport often occurs as a result of a few major storm events. Moreover, the geomorphology report conducted for this WBP concluded that most suspended sediments in streams in the Kaiaka Bay Watersheds are likely coming from natural erosion processes in the stream channels themselves and not necessarily from agricultural fields (AECOM, 2016; Appendix A).

Point sources of sediments include the State DOT-HWYS MS4 outfalls that are located along the highways that run through the Agricultural Lands, however, management measures that are applicable to MS4s are presented in section 3.3, under “Developed Areas Measure #3: Stormwater Management.”

PRIORITY WATERSHEDS

While all six watersheds have agricultural land, the analyses of the modeling results indicate that the priority watersheds for implementing management measures to reduce sediments in Agricultural Lands include:

- Poamoho Watershed;
- Kaukonahua Watershed;
- Paukauila Watershed; and
- Ki’iki’i Watershed.

3.2.1.2 NUTRIENTS

The State’s 2014 303(d) list indicates that the lower portion of Kaukonahua Stream is impaired with excessive nutrient concentrations (total nitrogen, nitrate/nitrite, and total phosphorus). The 303(d) list also indicates that Poamoho, Helemano, and ‘Ōpae’ula streams are impaired with excessive nutrients, including total nitrogen, nitrate/nitrite, and total phosphorus. Paukauila Estuary is impaired with excessive nitrogen concentrations (total nitrogen and nitrate/nitrite). The 303(d) list indicates that there is inadequate data to assess the water quality of Ki’iki’i Estuary, however, data from various studies indicate that waterbodies within the Ki’iki’i Watershed are also impaired with excessive nutrients.

Studies have shown that streams in agricultural areas on O’ahu generally have higher concentrations of dissolved nutrients than streams in undeveloped and urban areas, including total nitrogen, nitrate, and phosphorus (Anthony et al., 2004; Hoover, 2002). Accordingly, streams in Agricultural Lands in all six

waterbodies have been found to have excessive nutrients by various studies (refer to Chapter 5 of *Volume 1: Watersheds Characterization* for details).

Somewhat conversely, the results of the modeling indicated that Agricultural Lands contribute very little nitrogen and phosphorus (less than one percent of the total). However, Agricultural Lands should not be overlooked as a source of nutrients in the Kaiaka Bay Watersheds, especially since sedimentation is associated with nutrient transport and erosion is a significant natural resource issue in agricultural areas.

SOURCES

Fertilizers (a source of nutrients including nitrogen and phosphorus) can be washed off fields during rain events and flow into waterbodies. Runoff from pineapple fields has been shown to have higher total nitrogen concentrations than runoff from sugarcane fields (Anthony et al. 2004). Fertilizers can also seep into groundwater, which can then contaminate stream water since groundwater contributes to the base flow of streams.

The grazing of cattle and other livestock can also be a source of nutrients (via their waste), especially if the livestock are continually brought to a single area for watering each day, concentrating the waste.

As with sediments, storms can significantly increase the transport of nutrients to streams in agricultural areas. DeVito et al. (1995) found that concentrations of total phosphorus and nitrate significantly increased during storm events in 'Ōpae'ula Stream. Moreover, phosphorus is strongly adsorbed to silt and clay particles that are common in Hawaiian soils, therefore, total phosphorus concentrations generally increase with increasing suspended-sediment concentrations. This property amplifies the importance of erosion and sediment control in improving water quality.

Point sources of nutrients include the State DOT-HWYS MS4 outfalls that are located along the highways that run through the Agricultural Lands, however, management measures that are applicable to MS4s are presented in section 3.3, under "Developed Areas Measure #3: Stormwater Management."

PRIORITY WATERSHEDS

While all six watersheds have agricultural land, the analyses of the modeling results indicate that Agricultural Lands in the Poamoho Watershed contribute far more nutrients per acre than Agricultural Lands in the other watersheds. Therefore, Poamoho Watershed is priority watershed for implementing management measures to reduce nutrients in Agricultural Lands.

3.2.1.3 OTHER POLLUTANTS

In addition to sediments and nutrients, there are a number of other pollutant types that can be generated on Agricultural Lands. Traces of chemical contaminants derived from pesticides (e.g. herbicides, insecticides, fungicides, and nematicides) have been detected in both surface waters and ground waters in agricultural areas in the Kaiaka Bay Watersheds. Additionally, high concentrations of fecal indicator bacteria (*E. coli* and *Enterococcus*) have been found in streams in agricultural areas of the Kaiaka Bay Watersheds (Yost et al., 2009).

SOURCES

The agricultural use of pesticides represents the most significant use of pesticides among all other uses on O‘ahu. Many types of pesticides have been applied widely for agriculture in the Kaiaka Bay Watersheds, with pesticide use dating back to the 1950s. Annual application rates of herbicides on pineapple crops have been estimated to be as much as five times those of major temperate-region field crops (Hunt, 2004). Pesticides that are applied to manage crops can result in nonpoint source pollution when excessive amounts are applied or when rainfall occurs after application resulting in contaminated stormwater runoff. There is also a potential for chemical releases from abandoned farm sites and dumping areas, as dumping is a problem throughout Hawai‘i and often involves agricultural chemical storage.

Sources of bacteria in Agricultural Lands can come from animal waste, both from agricultural and feral animals, as well as naturally high levels of bacteria present in Hawaiian soils.

Point sources of other types of pollutants include the State DOT-HWYS MS4 outfalls that are located along the highways that run through the Agricultural Lands, however, management measures that are applicable to MS4s are presented in section 3.3, under “Developed Areas Measure #3: Stormwater Management.”

PRIORITY WATERSHEDS

The goals of the WBP state that pollutants other than sediments and nutrients should be addressed opportunistically or as deemed necessary. There are strong community concerns related to the excessive use of pesticides in agricultural areas. Since the Poamoho Watershed has the most area classified as Agricultural Lands in this WBP (as well as the highest percentage of its total area at 80%), it is the priority watershed for implementing measures to reduce pesticides entering waterbodies.

3.2.1.4 SUMMARY OF POLLUTANT SOURCES AND PRIORITY WATERSHEDS IN AGRICULTURAL LANDS

Table 13 provides a summary of the pollutants of concern, the primary sources of the pollutants, and the priority watersheds for the pollutants of concern in Agricultural Lands.

TABLE 13. POLLUTANTS, POLLUTANT SOURCES, AND PRIORITY WATERSHEDS IN AGRICULTURAL LANDS

Primary Factors That May Contribute Pollutants (PS and NPS)	Pollutants of Concern	Priority Watersheds: Sediments	Priority Watersheds: Nutrients	Priority Watersheds: Other Pollutants
<ul style="list-style-type: none"> Natural erosion processes <ul style="list-style-type: none"> Highly erodible soils Steep slopes (gulches) Grazing Nonnative & invasive plants Feral ungulates Fires Natural erosion processes Agriculture practices 	<ul style="list-style-type: none"> Sediments and turbidity Nutrients Chemical contaminants (e.g. pesticides transported in runoff) 	<ul style="list-style-type: none"> Kaukonahua Poamoho Paukauila Ki‘iki‘i 	<ul style="list-style-type: none"> Poamoho 	<ul style="list-style-type: none"> Poamoho (pesticides)

3.2.2 MANAGEMENT MEASURES & PRACTICES

This section describes some the key management measures that could be implemented to reduce pollutant loads coming from Agricultural Lands in the watersheds. The results of implementing the associated practices can help to improve water quality in streams. The EPA’s “National Management Measures to Control Nonpoint Source Pollution from Agriculture” (EPA, 2003) and the “Hawai‘i Watershed Guidance” list the same six management measures for agriculture, five of which are applicable to the Kaiaka Bay Watersheds. An additional three management measures are also described below to address other areas of concern in Agricultural Lands.

For each management measure, several applicable management practices are listed that could help accomplish the objective of the measure. Where possible, references to any applicable NRCS FOTG standards (and associated three-digit code) and/or other documented practices are cited for further information.

AGRICULTURE MEASURE #1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS




Primary Pollutants Targeted: Sediments (including turbidity)

Objective: To reduce erosion and the transport of sediments into waterbodies.

Description: This management measure includes practices that are designed to reduce erosion, runoff, and soil loss from actively farmed fields, thereby reducing pollutant transport into streams. In this plan, actively farmed areas include land that is under crop rotation or is temporarily fallow. While the primary pollutant targeted by these practices is sediment, other pollutants will also be reduced (including nutrients, pesticides, bacteria, and any other pollutant that can be transported via surface runoff). This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three major categories of management practices that apply to the “Erosion and Sediment Control from Actively Farmed Lands” measure (Table 14). The practices are intended to prevent erosion and the transport of sediments from fields or to route runoff from fields through practices that remove/filter sediments. These practice categories are based off consultations with relevant stakeholders and include groupings of applicable NRCS FOTG standards that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 14. PRACTICES FOR AGRICULTURE MEASURE #1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS

Practice Type	Description	Example Image	Examples of Applicable Practices
A Vegetative Practices	Establishing and maintaining vegetation in areas that are prone to wind/water erosion, including along/adjacent to actively farmed fields, fallow lands, and other critical areas; vegetation can reduce the transport of pollutants in runoff, prevent soil loss, and protect crops from wind and theft		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Alley cropping (#311) • Conservation cover (#327) • Cover crop (#340) * • Critical area planting (#342) • Field border (#386) • Filter strip (#393) • Grassed waterway (#412) • Vegetative barrier (#601) • Tree/shrub establishment (#612) • Windbreak/shelterbelt establishment (#380) • Windbreak/shelterbelt renovation (#650)
B Management-Related Practices	Practices that are implemented as part of crop management to protect natural resources and reduce runoff from fields; includes planting cover crops, rotating crops, mulching, minimal soil disturbance, and techniques for planting		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Conservation crop rotation (#328) • Contour farming (#330) • Contour orchard and other perennial crops (#331) • Cover crop (#340) * • Diversion (#362) * • Mulching (#484) • Residue and tillage management, no till/strip till/direct seed (#329) • Residue and tillage management, reduced till (#345) • Row arrangement (#557) • Strip cropping (#585) • Terrace (#600)
C Structural Practices	Permanent/structural practices designed to reduce field runoff and/or the transport of pollutants into waterbodies		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Diversion (#362) * • Lined waterway or outlet (#468) • Rock barrier (#555) • Sediment basin (#350) • Water and sediment control basin (#638)

* Listed in multiple locations since it applies to multiple types of management practices.

Identified Existing Activities for Each Practice Type:

A. Vegetative Practices

The planning team learned that some farmers/land managers in the Kaiaka Bay Watersheds do use vegetative buffers or filter strips, such as vetiver grass, along field borders and/or along field access roads to reduce runoff and trap potential pollutants from entering waterways. One large landowner allows naturally recruited vegetation to remain along field borders to act as a filter strip. Certain land managers use various forms of windbreaks on their property to reduce theft, protect their crops from wind damage, and reduce soil loss from wind erosion. Conservation cover is a commonly used practice in some areas to reduce soil loss, enrich soils, and prevent less desirable plants from colonizing a field.

B. Management-Related Practices

The planning team found that intentional cover crops are used in the Kaiaka Bay Watersheds in some areas but are not widely used. Cover crops that are intentionally planted include lablab, oats, and sunn hemp. Guinea grass, which grows uncontrolled in most agricultural areas in Hawai'i, is also considered a cover crop. Various landowners allow guinea grass to naturally grow in on rotated/fallow fields to provide cover for the soil.

One landowner mows the guinea grass every six weeks to maintain an even coverage. At least one landowner rotates cover crops to avoid a "mono-crop" of cover crops. The planning team was informed that it can be a challenge for farmers to embrace cover cropping, but once they adopt the practice they often realize its value and rely on cover crops to yield optimum results.

Crop rotation is becoming a more common practice, especially among the younger generation of farmers.

Most of the agricultural fields, including the pineapple fields, are generally planted on the contour, however, there are some areas that are not. See section 4.1 of AECOM's geomorphology report (Appendix A) for details.

Multiple land managers explained that they try to only till as much soil as they intend to plant. One landowner replants an area with a cover crop if they mistakenly till more than they need.

Diversions and berms to divert the flow of water are also used, although they are sometimes not ideally designed and should be assessed in terms of their impact to water quality.



Two examples of vegetative practices in the Kaiaka Bay Watersheds: Left - a filter strip on DuPont-Pioneer land (the plastic sheeting helps control weeds while the vetiver is establishing); Right - Norfolk pine trees are planted by Dole Foods along Kamehameha Hwy to serve as windbreaks to protect their crops and the soil



DuPont-Pioneer estimates that they save approximately \$300/acre per year by using cover crops such as sunn hemp (pictured) instead of chemically and mechanically maintaining bare fields; sunn hemp also has additional pest management benefits (see Measure #3)

C. Structural Practices

There are numerous sediment basins in agricultural areas in the Kaiaka Bay Watersheds. There are also drainage paths (diversions, berms) that have been created in some areas to direct field runoff from fields, although they are sometimes not ideally designed and should be assessed in terms of their impact to water quality.



One of the five small sediment basins on the DuPont-Pioneer property in Waialua. They prefer to use multiple small basins rather than one large one because small basins are easier to maintain.

AGRICULTURE MEASURE #2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS




Primary Pollutants Targeted: Nutrients

Objective: To reduce nutrient loads in waterbodies coming from actively farmed lands.

Description: This management measure includes practices that are intended to reduce the input of nutrients on actively farmed lands as well as practices to prevent or reduce the transport of existing nutrients into waterbodies. In this plan, actively farmed areas include land that is under crop rotation or is temporarily fallow. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three main types of management practices that apply to the “Nutrient Management” measure (Table 15). These practice types are largely based off NRCS FOTG standards, which can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 15. PRACTICES FOR AGRICULTURE MEASURE #2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS

Practice Type	Description	Example Image	Examples of Applicable Practices
A Managed/ Moderated Fertilizer Use & Application	Managing the amount (rate), source, application method, and timing of nutrient and soil amendment applications for efficient use by crops and reduced losses to the environment; also includes the proper handling/storage of fertilizers		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Agrichemical handling facility (#309) • Irrigation system, microirrigation (#441) (or “fertigation”) • Nutrient management (#590) *
B Agricultural Waste Management	The mechanical, chemical or biological treatment of agricultural waste to improve nutrient management and reduce losses to surface runoff		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Composting facility (#317) • Waste recycling (#633) • Waste separation facility (#632) • Waste storage facility (#313) • Waste transfer (#634) • Waste treatment (#629) • Waste treatment lagoon (#359) <i>Note: Improved composting areas would also qualify as an applicable practice</i>
C Runoff Prevention/ Treatment	Many practices listed for “Measure #1: Erosion and Sediment Control from Actively Farmed Lands” also apply to nutrient management since practices to filter out sediments in runoff typically also filter out nutrients		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Alley cropping (#311) † • Conservation cover (#327) † • Conservation crop rotation (#328) † • Cover crop (#340) † • Filter strip (#393) † • Hedgerow planting (#422) † • Sediment basin (#350) †

* See also the University of Hawai‘i College of Tropical Agriculture and Human Resources (CTAHR) publications on nutrient management:

<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/HF-4.pdf>;

http://www.ctahr.hawaii.edu/wq/publications/Final_FactSheets/NutrientMgmt590.pdf.

† Also listed under “Agriculture Measure #1: Erosion and Sediment Control from Actively Farmed Lands.”

Identified Existing Activities for Each Practice Type:

A. Managed/Moderated Fertilizer Use & Application

Multiple land managers/farmers explained that they only used the minimum amount of fertilizer necessary to yield maximum benefits.

B. Agricultural Waste Management

At least one land manager returns their plant waste to the field and tills it into the soil, composting it in the field. Another landowner supplies their harvested cover crops (such as oats or sunn hemp) to others who have a use for them. Most farmers have a general compost area, although many could benefit from improvements to the composting area and process.

C. Runoff Prevention/Treatment

See information for existing practices pertaining to Measure #1.

AGRICULTURE MEASURE #3: PESTICIDE-USE MANAGEMENT




Primary Pollutants Targeted: Pesticides

Objective: To reduce the amount of pesticides that are transported into waterbodies from actively farmed lands.

Description: This management measure includes practices that are intended to reduce the input of pesticides on Agricultural Lands as well as practices to prevent or reduce the transport of pesticides into waterbodies. In this plan, actively farmed areas include land that is under crop rotation or is temporarily fallow. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three main types of management practices that apply to the “Pesticide-Use Management” measure (Table 16). These practice types are based off a number of NRCS FOTG standards that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 16. PRACTICES FOR AGRICULTURE MEASURE #3: PESTICIDE-USE MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Integrated Pest Management (IPM)	A holistic system of pest management which utilizes a variety of techniques to achieve economic control of target pests while minimizing the impact on non-target organisms and the environment		NRCS Standards: <ul style="list-style-type: none"> • Conservation crop rotation (#328) † • Cover crop (#340) † • Integrated Pest Management (#595) * • Irrigation system, microirrigation (#441) (or “chemigation”)
B Proper Mixing & Storage	Pesticides should be mixed and stored according to the label in a facility that provides an environmentally safe area to do so		NRCS Standards: <ul style="list-style-type: none"> • Agrichemical Handling Facility (#309) *†
C Runoff & Wind Drift Prevention and/or Treatment	Many practices listed for “Agriculture Measure #1: Erosion and Sediment Control” and “Agriculture Measure #2: Nutrient Management” also apply to pesticide-use management since practices to filter out sediments and nutrients in runoff can also filter out pesticides		NRCS Standards: <ul style="list-style-type: none"> • Alley cropping (#311) † • Conservation cover (#327) † • Conservation crop rotation (#328) † • Cover crop (#340) † • Filter strip (#393) † • Hedgerow planting (#422) † • Sediment basin (#350) † • Windbreak/shelterbelt establishment (#380) † • Windbreak/shelterbelt renovation (#650) †

* See also CTAHR’s publications on pest management (the latter two links are specific to pineapple growers):

<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/HF-5.pdf>;

<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-29.pdf>;

<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-32.pdf>.

† Also listed under Agriculture Measure #1 and/or #2.

Identified Existing Activities for Each Practice Type:

A. Integrated Pest Management

One of the most essential aspects of IPM is to use and apply pesticides only according to their label; multiple landowners mentioned this aspect. They also strive to only use the amount of pesticides that are necessary to achieve maximum benefits. The planning team learned that sunn hemp is used in the Kaiaka Bay Watersheds as a method of biological control against one of the primary pests of corn, the corn earworm. The adult corn earworm is attracted to the yellow flowers of the



DuPont-Pioneer uses sunn hemp flower and seeds as part of an integrated pest management system for corn crops

plant and lays eggs on the flowers. A parasitic wasp, *Trichogramma*, is then drawn to the sunn hemp to parasitize the eggs. Increasing the natural predators of the corn earworm reduces the need for pesticides to control the corn earworm. Another method of IPM used in the Kaiaka Bay Watersheds is to let fields go fallow for a period of time to let pests die off naturally; this practice also reduces the need for pesticides.

B. Proper Mixing & Storage

The planning team confirmed that some of the larger land managers/farmers have facilities for pesticide storage and mixing that meet or exceed minimum standards/regulations. However, many small farmers do not have the funding or current capability to construct a proper facility/shelter for storing agrichemicals.

C. Runoff & Wind Drift Prevention and/or Treatment

See information for existing practices pertaining to Measure #1.




AGRICULTURE MEASURE #4: STREAM AND RIPARIAN AREA MANAGEMENT
Primary Pollutants Targeted: Sediments (including turbidity); nutrients

Objective: To prevent erosion of riparian areas and the transport of sediments, nutrients, and other organic material into streams.

Description: This management measure includes practices that aim to protect and improve riparian areas and streambanks to reduce/prevent erosion and runoff, thereby reducing pollutant transport into streams. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three main types of management practices that apply to the “Stream and Riparian Area Management” measure in Agricultural Lands (Table 17). These practice types are based off NRCS FOTG standards and “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996) that can be referenced for more information (the DLNR document is written for forestry lands but lists relevant practices for other undeveloped areas, such as Agricultural Lands). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 17. PRACTICES FOR AGRICULTURE MEASURE #4: STREAM AND RIPARIAN AREA MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A	Riparian Buffers & Vegetated Treatment Systems	Maintaining or establishing vegetation up-gradient of streams to serve as a buffer, slow runoff, and reduce sediments, organic material, and nutrients entering streams	 <ul style="list-style-type: none"> • Critical area planting (#342) * • Filter strip (#393) °§ • Grassed waterway (#412) ° • Riparian forest buffer (#391) ° • Riparian herbaceous cover (#390) ° • Streamside management zones (pg. 19) *^ • Tree/shrub establishment (#612) * ° • Vegetative barrier (#601) ° <p>See also “Management Practices for Protecting Wetlands and Riparian Areas” & “Management Practices for Vegetated Treatment Systems” ‡</p>
B	Streambank Protection & Stabilization	Practices to stabilize and protect banks of streams from erosion, including establishing non-invasive plants (preferably native) along eroding streambanks; note that the steep terrain and high rainfall may prohibit the implementation of certain practices	 <ul style="list-style-type: none"> • Critical area planting (#342) * ° • Wet detention pond (micropool) ‡ • Flow deflection techniques ‡§ • Flow diversion ‡§ • Grade control ‡§ • Hard bank stabilization methods ‡§ • Soft bank stabilization methods ‡§ • Streambank and shoreline protection (#580) ° • Streamside management zones (pg. 19) *^ • Stream channel stabilization ‡§ • Tree/shrub establishment (#612) ° <p>See also “Management Practices for Protecting Wetlands and Riparian Areas” ‡</p>
C	Stream Habitat Restoration	Improving the quality of the riparian ecosystem to provide habitat for native flora and fauna; protects water quality by preventing erosion and minimizing the harmful effects of invasive species	 <ul style="list-style-type: none"> • Herbaceous weed control (#315) ° • In-stream habitat enhancement ‡ • Stream habitat improvement and management (#395) ° • Tree/shrub establishment (#612) * ° • Wetland enhancement (#659) ° • Wetland restoration (#657) ° • Wetland wildlife habitat management (#644) ° <p>See also “Management Practices for Restoration of Wetlands and Riparian Areas” ‡</p>

* Listed in multiple locations since it applies to multiple types of management practices

° NRCS Conservation Standard (Standard No.)

^ “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996)

‡ “Urban Subwatershed Restoration Manual Series – Manual 4: Urban Stream Repair Practices” (Center for Watershed Protection, 2004)

‡ “National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (EPA, 2005)

§ “Streambank Stabilization Management Measures” (ADEQ, date unknown)

Identified Existing Activities for Each Practice Type:

A. Riparian Buffers & Vegetated Treatment Systems

No specific examples of riparian buffers or vegetative practices that pertain specifically to streams in Agricultural Lands were identified by the planning team; however, this does not indicate that none exist.

B. Streambank Protection & Stabilization

No specific examples of streambank protection/stabilization practices in the Agricultural Lands of the Kaiaka Bay Watersheds were identified in this planning effort; however, this does not indicate that none exist. Note that this practice type may not be applicable in many areas in the Agricultural Lands of the Kaiaka Watersheds due to steep slopes along streambanks and narrow stream canyons.

C. Stream Habitat Restoration

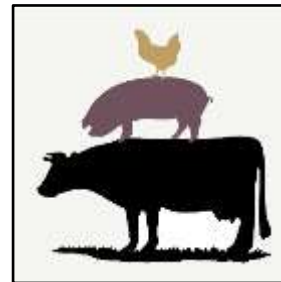
No specific examples of stream habitat restoration were identified in the Agricultural Lands of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

AGRICULTURE MEASURE #5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria

Objective: To reduce the transport of pollutants generated by livestock operations and ranching activities into waterbodies.

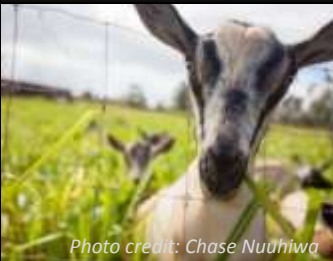
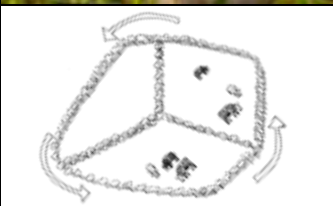



Description: This management measure includes practices that aim to reduce the physical disturbance and reduce direct loading of animal waste and sediment caused by rearing livestock and ranching, including cattle ranching, piggeries, goat farms, and chicken farms. Application of this management measure will reduce the physical disturbance to sensitive areas and reduce the discharge of sediment, animal waste, nutrients, and other pollutants to surface waters. This management measure is most applicable to the 'Ōpae'ula, Helemano, Poamoho, and Kaukonahua watersheds since existing/planned ranching and livestock operations have been identified in these watersheds.



Farms/ranches with chickens, goats, pigs, and/or cows can be found within the Kaiaka Bay Watersheds

Practices: There are five main types of management practices that apply to the “Livestock, Ranching, and Pasturelands Management” measure (Table 18). These practice types are largely based off a number of NRCS FOTG standards that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 18. PRACTICES FOR AGRICULTURE MEASURE #5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT

Practice Type		Description	Example Image	Examples of Applicable Practices
A	Livestock Access Limitation	Excluding livestock from an area not intended for grazing; exclusion may improve water quality by preventing livestock from accessing sensitive areas, reducing sediment and nutrient transport; Vegetation outside of a fenced area can also act as a filter strip when constructed near water channels	 <i>Photo credit: Chase Nuhiwa</i>	<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access control (#472) * • Fence (#382) *
B	Grazing Management	Grazing at an intensity and in a pattern that will maintain enough vegetative cover to protect the soil; increased vegetation slows erosion and runoff and acts as a filter for sediments and other pollutants		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Fence (#382) * • Prescribed grazing (#528)
C	Vegetative Stabilization	Improving vegetative cover in areas with exposed soil or undesirable vegetation to reduce erosion rates and the transport of pollutants to surface waters; includes the control of weeds and other undesirable plants to restore natural plant communities		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Critical area planting (#342) • Forage and biomass planting (#512) • Range planting (#550)
D	Streambank Protection	Includes practices to reduce the impact of livestock in riparian areas, such as fencing to restrict access to streams, providing alternative/additional sources of water (e.g. troughs, tanks, and pipelines), and stabilizing stream/waterway crossing areas		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access control (#472) * • Fence (#382) * • Livestock pipeline (#516) • Stream crossing (#578) • Watering facility (#614)
E	Waste Management	Practices to improve the handling and processing of animal waste to reduce the chances of nutrients and bacteria from the waste entering waterways; this practice type may only be relevant to a small number of operations/businesses		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Waste recycling (#633) • Waste separation facility (#632) • Waste storage facility (#313) • Waste transfer (#634) • Waste treatment (#629) • Waste treatment lagoon (#359)

* Listed in multiple locations since it applies to multiple types of management practices.

Identified Existing Activities for Each Practice Type:

A. Livestock Access Limitation

The planning team learned that there are ranches and livestock operations within the Kaiaka Bay Watersheds that do use fencing and other techniques to control/limit animal access to areas, however, fence maintenance is sometimes an issue; cattle have been known to escape out of fenced areas and roam into neighboring areas, including forested areas.

B. Grazing Management

No examples of specific grazing management practices were identified in the Agricultural Lands of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist. The planning team did learn that most of the cattle ranching operations in the region allow the cattle to roam over large areas, so the impacts of the cattle may not be as severe as in regions where cattle are restricted to small pens.

C. Vegetative Stabilization

No specific examples of vegetative stabilization practices in ranching/livestock areas were identified by the planning team; however, this does not indicate that none exist.

D. Streambank Protection

No specific examples of streambank protection methods utilized in ranching/livestock areas were identified in the development of this plan; however, this does not indicate that none exist.

E. Waste Management

No specific examples of animal waste management utilized in ranching/livestock areas were identified by the planning team, however, since the ranching/livestock operations in the area are relatively small and low-density, animal waste is not likely a major water quality issue in the Kaiaka Watersheds.



Sweet Land Farm, located on 86-acres near Waialua (Kaukonahua Watershed), raises goats to produce goat cheese; the image shows goats in a fenced area with plenty of room to roam and adequate vegetation

AGRICULTURE MEASURE #6: FIRE PREVENTION



Primary Pollutants Targeted: Sediments (including turbidity)

Objective: Prevent fires to reduce post-fire erosion and runoff.

Description: This management measure includes practices that aim to prevent wildfires on Agricultural Lands. The general intention is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are two main types of management practices that apply to the “Fire Prevention” measure (Table 19). These practice types are based off NRCS FOTG standards and “Best Management Practices for Maintaining Water Quality in Hawai’i” (DLNR, 1996) that can be referenced for more information (the DLNR document is written for forestry lands but lists relevant practices for other undeveloped areas, such as Agricultural Lands). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 19. PRACTICES FOR AGRICULTURE MEASURE #6: FIRE PREVENTION

Practice Type		Description	Example Image	Examples of Applicable Practices
A	Fire/Fuel Breaks	Creating strips or blocks of land where the vegetation, debris, and detritus have been reduced or modified to control/diminish the risk of fire crossing the area; design should minimize increases in erosion and divert the flow of water (refer to Agriculture Measure #8)		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Wildfire damage control and reclamation (pg. 22) • Fireline construction and maintenance (pg. 23) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Fuel break (#383) • Fire break (#394)
B	Vegetation Management	Reducing fire-prone vegetation to slow or stop fires from spreading; accomplished with continual maintenance using manual/mechanical methods or prescribed grazing; replacing with less fire-prone vegetation will yield longest term benefits		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Brush management (#314) • Forest stand manipulation (#666) • Herbaceous weed control (#315) • Prescribed grazing (#528) • Tree/shrub pruning (#660)

Identified Existing Activities for Each Practice Type:**A. Fire/Fuel Breaks**

A few of the larger landowners maintain firebreaks on vacant lands to prevent the spread of fires. The planning team was informed that firebreaks are not necessary when a field is actively farmed, since the crop itself would slow the spread of fire.

B. Vegetation Management

Information provided by the 2016 annual report for the O'ahu Army Natural Resources Program states that there is a landowner along Kaukonahua Road who voluntarily (and sporadically) mows a large swath of guinea grass on the western side of the road to prepare the land for sale. In past years, the OANRP has previously contracted this mowing and spraying work to reduce the fire fuel load in the area since in 2007 there was a devastating fire that burned almost a whole population of an endangered and rare species of hibiscus.

No other specific examples of vegetation management to prevent fires in Agricultural Lands were identified by the planning team; however, this does not indicate that none exist.

AGRICULTURE MEASURE #7: IRRIGATION WATER USE




Primary Pollutants Targeted: Sediments (including turbidity); nutrients; pesticides

Objective: To reduce polluted runoff from fields by increasing irrigation water use efficiency, including applying irrigation water based upon the capacity of the soil to hold water and the needs of the crop.

Description: This management measure includes practices that will reduce the waste of irrigation water, improve the water use efficiency, and reduce the total pollutant discharge from an irrigation system. By reducing the volume of water applied to agricultural lands, pollutant loads are also reduced. Less interaction between irrigation water and agricultural land will generally result in less pollutant transport from fields. Moreover, reducing use the use of irrigation water that is diverted from streams will allow more water to remain in streams for stream flow. If groundwater is the source of irrigation water, reducing overall use will maintain higher groundwater levels, which could help maintain the base flow of nearby streams. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three main types of management practices that apply to the “Irrigation Water Use” measure (Table 20). These practice types are based off a number of NRCS FOTG standards that can be referenced for more information. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 20. PRACTICES FOR AGRICULTURE MEASURE #7: IRRIGATION WATER USE

Practice Type	Description	Example Image	Examples of Applicable Practices
A Irrigation Water Management	A system that determines and controls the rate, amount, placement, and timing of irrigation water to reduce runoff and associated pollutants; irrigating according to the capacity of the soil to hold water and the needs of the crop.	 PHOTO CREDIT: TES.COM	<u>NRCS Standards:</u> <ul style="list-style-type: none">• Irrigation water management (#449)
B Efficient Transport/Delivery of Irrigation Water	Irrigation water transportation systems should be designed and managed in a manner that minimizes evaporation, seepage, and flow-through water losses from canals and ditches.	 PHOTO CREDIT: IRRIGATIONSERVICES.NET	<u>NRCS Standards:</u> <ul style="list-style-type: none">• Irrigation ditch lining (#428)• Irrigation pipeline (#430)• Irrigation system, microirrigation (#441)• Irrigation system, sprinkler (#442)• Structure for water control (#587)
C Sustainable Sources of Irrigation Water	Practices to facilitate the use of alternative sources of water (other than well water) for irrigation, specifically using catchment water or recycled wastewater (see <i>Developed Areas Measure #1</i>)	 PHOTO CREDIT: WWW.OC-BREEZE.COM	<u>NRCS Standards:</u> <ul style="list-style-type: none">• Dam (#402)• Irrigation reservoir (#436)• Irrigation system, tailwater recovery (#447)• Water harvesting catchment (#636) <i>See also "Central Oahu Non-Potable Water Master Plan – Appraisal of Opportunities Report" (Brown and Caldwell, 2013)</i>

Identified Existing Activities for Each Practice Type:

A. Irrigation Water Management

The planning team was not able to determine details about irrigation water management systems that are used in the Kaiaka Bay Watersheds, although, the planning team was informed that drip irrigation (or microirrigation) is a very efficient method of irrigating crops (see following discussion).

B. Efficient Transport/Delivery of Irrigation Water

Drip irrigation (microirrigation) is widely used in the Kaiaka Bay Watersheds; the planning team was informed that drip irrigation is an efficient method for irrigating crops (compared to other methods such as sprayers) since it reduces the quantity of water that is lost to wind and delivers the necessary amount of water directly to the soil. However, irrigation by other methods is used for some types of crops and by some farmers.

C. Sustainable Sources of Irrigation Water

The Wahiawā Wastewater Treatment Plant (WWTP) has been undergoing upgrades to produce effluent that can be officially classified by the DOH as R-1 (median fecal coliform limit of 2.2 per 100 ml). It should be noted, however, that in recent years the median fecal coliform quantity of the effluent has been within the requirements for R-1 water, but it is still rated as R-2 primarily because the WWTP lacks secondary containment. When the upgrades are complete, the effluent will be able to be officially classified as R-1, which will allow for increased use of the water in the Wahiawā Irrigation System (WIS) for irrigation purposes (the Schofield WWTP effluent is already classified as R-1). The ADC is currently developing plans to pipe the R-1 water from the Wahiawā WWTP to the former Galbraith Estate lands to be used for crop irrigation. During the 2017 legislative session, a Concurrent Resolution (SCR 174) was passed that requires the DLNR to assist the Office of Hawaiian Affairs (OHA) in providing an easement to the ADC for an R-1 pipeline that runs through land owned by OHA. See *Developed Areas Measure #1: Point Source Wastewater Treatment and Recycling* for more information about recycled wastewater.

AGRICULTURE MEASURE #8: FIELD ACCESS ROAD MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients




Objective: To reduce and prevent the generation and transport of pollutants from field access roads into streams.

Description: This management measure includes practices that are guidelines for constructing and maintaining field access roads in Agricultural Lands. The general intention is to reduce/prevent erosion of field roads and runoff thereby reducing pollutant transport into streams. This management measure is applicable to all six of the Kaiaka Bay Watersheds.

Practices: There are three main types of management practices that apply to the “Field Access Road Management” measure (Table 21). These practice types are based off a number of NRCS FOTG standards and practices from “Best Management Practices for Maintaining Water Quality in Hawai‘i”

(DLNR, 1996) that can be referenced for more information (the DLNR document is written for forestry lands but lists relevant practices for other undeveloped areas, such as Agricultural Lands). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. For example, the USFWS and the EPA have co-funded a manual of procedures to enhance stability and maintain unpaved roads while reducing sedimentation and improving water quality, titled “Recommended Practices Manual: A Guideline for Maintenance and Service of Unpaved Roads” (CPYRWMA, 2000). This manual contains a comprehensive list of management practices that can be helpful in providing additional guidance for how to best maintain unpaved roads. More information about implementing these practice types can be found in Table 22 (section 3.2.3).

TABLE 21. PRACTICES FOR AGRICULTURE MEASURE #8: FIELD ACCESS ROAD MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Road Design	Designing field roads to minimize soil loss and runoff, as well as to avoid waterways and sensitive areas		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Forest roads – design (pg. 8) • Construction (pg. 9) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access road (#560) * • Heavy use area protection (#561) • Stream crossing (#578) *
B Road Maintenance	Maintaining field roads to reduce soil loss and runoff; photo is a mulched road at DuPont-Pioneer in Waialua		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Forest roads – maintenance (pg. 11) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access control (#472) • Access road (#560) * • Dust control on unpaved roads and surfaces (#373) • Mulching (#484)
C Runoff Control	Practices to slow or divert the flow of runoff from roads; photo depicts a water bar in a field road on Maui		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Diversion (#362) • Filter strip (#393) • Grassed waterway (#412) • Vegetative barrier (#601) • Stormwater runoff control (#570) • Stream crossing (#578) *

* Listed in multiple locations since it applies to multiple types of management practices.

Identified Existing Activities for Each Practice Type:

A. Road Design

While there are many field roads that traverse relatively flat terrain in the central portion of the Kaiaka Bay Watersheds, there are numerous roads that run along the slopes of the Wai‘anae range in the Kaukonahua Watershed. Some roads have design characteristics that are not ideal, such as going against the contour and/or having excessively steep gradients.

B. Road Maintenance

One landowner sprays water on their field roads daily to reduce dust/erosion, while another informed the planning team that they wet the roads occasionally. One landowner explained that they strive to minimize and rotate travel on all field roads to reduce erosion. DuPont-Pioneer uses mulch made from crushed palates in frequently used areas to reduce erosion (depicted in photo in Table 21). They also place rocks/boulders at entries/exits to major field roads to avoid transporting soil onto paved roadways.

C. Runoff Control

Filter strips that were intentionally planted along field roads on one property were observed during the development of this plan. Additionally, the planning team was informed by another large landowner that although they do not intentionally plant vegetation along field roads, they allow naturally recruited vegetation to grow, which serves to slow/filter runoff. No other specific examples of runoff control practices from field roads in Agricultural Lands were identified by the planning team; however, this does not indicate that none exist.



A strip of boulders at the entry/exit point of a field road on the Waialua DuPont-Pioneer property removes excess soil from the tires of field machinery

3.2.3 MANAGEMENT PRACTICE EFFECTIVENESS & IMPLEMENTATION CONSIDERATIONS

Table 22 presents qualitative assessments of the effectiveness each practice type has on specific pollutants. Pollutant load reduction effectiveness is presented on a scale of “low,” (L) “medium” (M) and “high” (H). Cost estimates for specific practices are presented when data was available. The information in the table is based on literature review (including the NRCS CPPE matrix and NRCS FOTG spreadsheets for the Pacific Islands region), consultation with service providers and stakeholders, and professional judgment. Additionally, the table indicates whether or not each practice also has a beneficial effect on flooding or on groundwater conservation, since these issues are important community concerns but are not directly addressed in this WBP.

TABLE 22. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR AGRICULTURAL LANDS MANAGEMENT PRACTICES

Pollutant Reduction								
	Sediments	Nutrients	Pesticides	Flooding *	Groundwater Conservation *	Cost	Maintenance	Implementation Considerations
AGRICULTURE MEASURE #1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS								
Vegetative Practices	M/H	M/H	L/M	✓	n/a	Varies – e.g. \$300/acre (cover crop); \$8/ft (vegetative barrier)	L	
Management-Related Practices	M/H	L/M	L/M	✓	n/a	Varies	Varies	
Structural Practices	Varies	Varies	L	✓	n/a	Varies – e.g. \$40/cy (sediment basin); \$11-24/ft (diversion)	M	
AGRICULTURE MEASURE #2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS								
Managed/Moderated Fertilizer Use & Application	n/a	H	n/a	n/a	n/a	\$100/acre	L	
Agricultural Waste Management	L	M	n/a	n/a	n/a	≤\$28/sf (for facility)	L	
Runoff Prevention/Treatment	Varies	Varies	Varies	✓	n/a	Varies	L/M	
AGRICULTURE MEASURE #3: PESTICIDE-USE MANAGEMENT								
Integrated Pest Management	L	H	H	n/a	n/a	\$80/acre	L	Can reduce pesticide and herbicide usage by up to 90%
Proper Mixing & Storage	n/a	H	H	n/a	n/a	\$33/sf (for facility)	n/a	
Runoff & Wind Drift Prevention and/or Treatment	Varies	Varies	Varies	✓	n/a	Varies	L	

- Table continued on next page -

TABLE 22. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR AGRICULTURAL LANDS MANAGEMENT PRACTICES (CONTINUED)

Pollutant Reduction								
	Sediments	Nutrients	Pesticides	Flooding*	Groundwater Conservation*	Cost	Maintenance	Implementation Considerations
AGRICULTURE MEASURE #4: STREAM AND RIPARIAN AREA MANAGEMENT								
Riparian Buffers & Vegetated Treatment Systems	H	H	M	✓	n/a	\$30/ft (vetiver); \$1,900/acre	L	
Streambank Protection & Stabilization	M/H	L	L	✓	n/a	Varies	L/M	
Stream Habitat Restoration	M	L	L	✓	n/a	\$8/plant	M	
AGRICULTURE MEASURE #5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT								
Livestock Access Limitation	M	L	n/a	✓	n/a	\$2-10/ft (fence)	L	
Grazing Management	M/H	L	n/a	n/a	n/a	\$90/acre	L/M	
Vegetative Stabilization	M/H	L	n/a	n/a	n/a	\$330-1,000+/acre	M	
Streambank Protection	M	L/M	n/a	✓	n/a	Varies – e.g. \$1.20/ft (watering pipeline)	L	
Waste Management	L	M/H	n/a	n/a	n/a	\$33/sf (for facility)	L/M	
AGRICULTURE MEASURE #6: FIRE PREVENTION								
Fire/Fuel Breaks	M/H	L	n/a	n/a	n/a	\$400/acre	M	Short-term negative effects; long-term effects may be significant
Vegetation Management	M	L	n/a	n/a	n/a	\$480/acre	M	Short-term negative effects; long-term effects may be significant
AGRICULTURE MEASURE #7: IRRIGATION WATER USE								
Irrigation Water Management	L	L	L	n/a	✓	\$60/acre	L	
Efficient Transport/Delivery of Irrigation Water	L	L	n/a	n/a	✓	Varies	L	
Sustainable Sources of Irrigation Water	L	L	n/a	n/a	✓	Varies	L	
AGRICULTURE MEASURE #8: FIELD ACCESS ROAD MANAGEMENT								
Road Design	M	L	n/a	n/a	n/a	\$8-26/ft	n/a	
Road Maintenance	M	L	n/a	n/a	n/a	\$5-18/ft	M	
Runoff Control	M/H	M/H	L/M	✓	n/a	Varies – e.g. \$8/ft (vegetative barrier); \$11-24/ft (diversion)	L	

* Checked if practice has a beneficial effect on flooding/groundwater conservation

Notes: 'L' = Low; 'M' = Medium; 'H' = High

3.2.4 PRIORITY MANAGEMENT MEASURES BY WATERSHED

Table 23 presents the prioritization of the eight Agricultural Land management measures by watershed. The prioritization of watersheds for specific management measures was determined based off the priorities for managing pollutants that were presented in *Volume 1* of this WBP (Table ES-2 or Table 57). It should be noted that funding for implementing management measures in specific watersheds should not be limited to those that are indicated as “priority” in the table since implementing any management measure in an applicable watershed will have benefits on water quality.

TABLE 23. APPLICABILITY AND PRIORITIZATION OF AGRICULTURAL LAND MANAGEMENT MEASURES BY WATERSHED

		<i>Ki'iki'i Stream System</i>			<i>Paukauila Stream System</i>		
		<i>Ki'iki'i</i>	<i>Kaukonahua</i>	<i>Poamoho</i>	<i>Paukauila</i>	<i>Helemano</i>	<i>Ōpae'ula</i>
AGRICULTURAL LANDS MANAGEMENT MEASURES	#1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS	P	P	P	P	x	x
	#2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS	x	x	P	x	x	x
	#3: PESTICIDE-USE MANAGEMENT	x	x	P	x	x	x
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	x	P	P	x	x	x
	#5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT	x	P	x	x	P	x
	#6: FIRE PREVENTION	x	P	P	x	x	x
	#7: IRRIGATION WATER USE	x	P	P	x	x	x
	#8: FIELD ACCESS ROAD MANAGEMENT	x	P	P	x	x	x

Notes: 'P' denotes priority watersheds

'x' denotes applicable watersheds

Shaded cells are watersheds in which the management measure is not applicable/recommended

3.2.4.1 DESCRIPTION OF PRIORITIES

This section presents more information about the priority watersheds for each management measure, along with any known opportunities for implementing practices.

AGRICULTURAL LANDS MEASURE #1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS

Implementing practices that help achieve the “Erosion and Sediment Control” measure will reduce the transport of sediments from actively farmed fields into waterbodies. Other pollutants will also be reduced by implementing practices associated with this management measure, including nutrients,

pesticides, bacteria, and any other pollutant that can be transported via surface runoff. The priority watersheds for the “Erosion and Sediment Control” management measure include the actively farmed areas of Poamoho, Kaukonahua, Paukauila, and Ki’iki’i watersheds (in approximate order of priority). This prioritization is based off watershed modeling results, which are discussed in *Volume 1: Watersheds Characterization* (sections 7.3.2.1 and 7.3.3).

Opportunities for Implementation:

Poamoho

- The geomorphology report conducted for this WBP (AECOM, 2016; Appendix A) recommends the increased use of contour farming on pineapple fields. The report states that “although the contribution of sediment to the stream system generated by pineapple operations appear to be limited, altering the orientation of the crop rows can be effective in reducing sediment transport during large rainfall events.” AECOM estimated the spatial extent of pineapple crops that were planted on the contour and found that over 2,600 acres are planted on the contour while approximately 1,100 acres are not. They concluded that “converting the crop alignment to follow the contour has the potential to reduce sediment wash-off by 50% while encouraging water storage and infiltration.”
- The number of sediment basins and detention ponds in actively farmed areas of the Poamoho Watershed should be increased. Dole Foods expressed the need for additional detention basins on their lands.
- To minimize soil loss that can occur in the period after soil has been prepared for planting pineapple but before the actual planting occurs, practices to reduce wind and water erosion should be implemented, including windbreaks (temporary or permanent/vegetative) and covering the exposed soil with a mulch or other material. Additionally, plowing should not be conducted in rainy weather or before large storms are expected.
- Vegetative practices such as filter strips, vegetative barriers, grassed waterways, and critical area plantings are additional priorities to implement since they are low-cost, relatively easy to implement and maintain, and effective.

Kaukonahua

- The results of the modeling indicate a considerable amount of sediments originate in the agricultural area just to the north of Wahiawā and Schofield Barracks (refer to Figure 29 in section 7.3.2.1 of *Volume 1: Watersheds Characterization*). The land in this area is owned by the Office of Hawaiian Affairs and the State ADC (the former Galbraith Estate lands). In these areas, conservation practices associated with this management measure are especially important.
 - Vegetative practices such as filter strips, vegetative barriers, grassed waterways, and critical area plantings are priorities to implement since they are low-cost, relatively easy to implement and maintain, and effective.
 - Management-related practices are also important to implement; similar to vegetative practices, they are meant to *prevent* erosion (unlike most structural practices).

Paukauila

- The planning team was not able to determine any specific locations for practices for this management measure in the Agricultural Lands of the Paukauila Watershed, although this does not indicate that none exist.

- Vegetative practices such as filter strips, vegetative barriers, grassed waterways, and critical area plantings are priorities to implement since they are low-cost, relatively easy to implement and maintain, and effective.
- Management-related practices are also important to implement since they are meant to *prevent* erosion.

Ki'iki'i

- The planning team was not able to determine any specific locations for practices for this management measure in the Agricultural Lands of the Ki'iki'i Watershed, although this does not indicate that none exist.
 - Vegetative practices such as filter strips, vegetative barriers, grassed waterways, and critical area plantings are priorities to implement since they are low-cost, relatively easy to implement and maintain, and effective.
 - Management-related practices are also important to implement since they are meant to *prevent* erosion.

AGRICULTURAL LANDS MEASURE #2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS

Implementing practices that help achieve the “Nutrient Management” management measure will reduce the transport of nutrients from actively farmed fields into waterbodies. The actively farmed lands in the Poamoho Watershed are the priority for implementing practices associated with this measure. This prioritization is primarily based off watershed modeling results, which are discussed in *Volume 1* of this WBP (section 7.3.3). Additionally, the majority of the actively farmed lands are in the Poamoho Watershed, although each of the other five watersheds are also applicable and should not be discounted.

Opportunities for Implementation:

Poamoho

- The planning team was not able to determine any specific locations for nutrient management practices in the Agricultural Lands of the Poamoho Watershed, although this does not indicate that none exist.
 - Some of the smaller farms could benefit by having improved composting areas for their agricultural waste. Many of them are also in need of improved areas/facilities for handling and storing agrichemicals.
 - Vegetative practices or runoff/treatment practices are also important recommendations since they are low-cost, relatively easy to implement and maintain, and effective.

AGRICULTURAL LANDS MEASURE #3: PESTICIDE-USE MANAGEMENT

Implementing practices that help achieve the “Pesticide-Use Management” management measure will reduce the amount of pesticides that are transported into waterbodies from actively farmed areas. The actively farmed lands in the Poamoho Watershed are the priority for implementing practices associated with this measure. This prioritization is based on information discussed in *Volume 1* of this WBP (section 7.4.1.3). Additionally, the majority of the actively farmed lands are in the Poamoho Watershed, although each of the other watersheds are also applicable and should not be discounted.

Opportunities for Implementation:

Poamoho

- Integrated Pest Management could be used more extensively in the Poamoho Watershed. To help control nematodes (and reduce the use of fumigants), Dole could consider practices such as cover cropping with sunn hemp and solarization (see Wang and Sipes, 2009 and Hooks et al., 2006 for more information).
 - Wang and Sipes (2009) found that the cost of sunn hemp plus solarization is cheaper than a common type of fumigant used to control nematodes.
- Vegetative practices to reduce runoff and wind drift are also important recommendations since they are low-cost, relatively easy to implement and maintain, and effective.
- Many of the smaller farms are in need of improved areas/facilities for handling and storing agrichemicals.

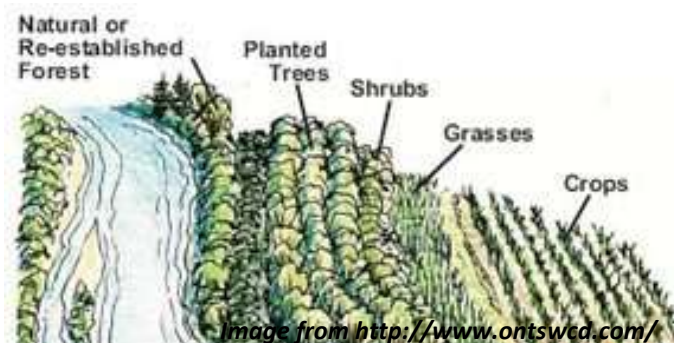
AGRICULTURAL LANDS MEASURE #4: STREAM AND RIPARIAN AREA MANAGEMENT

Implementing practices that help achieve the “Stream and Riparian Area Management” measure will prevent erosion of riparian areas and the transport of sediments, nutrients, and other organic material into streams. Kaukonahua and Poamoho watersheds are priorities for implementing stream and riparian area management practices. This prioritization is primarily determined based off watershed modeling results (discussed in section 7.3.2 of *Volume 1: Watersheds Characterization*). The modeling indicated that 21% and 44% of the total sediments that are transported by streams into Kaiaka Bay originate from Agricultural Lands in the Kaukonahua and Poamoho watersheds, respectively. Additionally, the geomorphology report prepared for this WBP concluded that most suspended sediments are likely coming from erosion processes in the stream channels themselves (AECOM, 2016; Appendix A).

Opportunities for Implementation:

Kaukonahua & Poamoho Watersheds

- While streambank erosion is considered a significant source of sediments in the watersheds, the planning team was unable to identify specific locations for stream and riparian area management practices in Agricultural Lands. The steep terrain and limited accessibility make many of the streams unsuitable for implementing many types of practices. Indeed, the field work associated with the geomorphology assessment revealed that Poamoho Stream is not well suited for structural streambank protection and stabilization practices. The geomorphology report states that attempting to control the natural sources of sediments in the streams “will likely have adverse consequences.” Instead, the report emphasizes the need for restoring the downstream floodplain and implementing agricultural practices such as contour farming to direct the flow of water (AECOM, 2016; Appendix A).



A vegetated buffer between actively farmed lands and streams would protect water quality by preventing erosion and filtering out contaminants.

- Nevertheless, there may be some areas where various types of streamflow deflectors can be used to redirect flow away from highly eroded banks (AECOM personal communication, 2016).
- It should also be noted that many of the practices listed under Agricultural Lands Measure #1 (Erosion and Sediment Control from Actively Farmed Lands) can help prevent/reduce sediments from flowing into streams. For example, creating/maintaining riparian buffers along the edges of fields that are adjacent to streams would be beneficial.

AGRICULTURAL LANDS MEASURE #5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT

Implementing practices that help achieve the “Livestock, Ranching, and Pasturelands Management” measure will reduce the transport of sediments, nutrients, and bacteria into waterbodies. The priority watersheds for this management measure include Kaukonahua and Helemano watersheds, since approximately 90% of the pastureland in the project area is located in those watersheds (approximately 2,489 acres out of 2,751 acres total; refer to Table 17 or Figure 24 in *Volume 1* of this WBP for details).

Opportunities for Implementation:

Kaukonahua

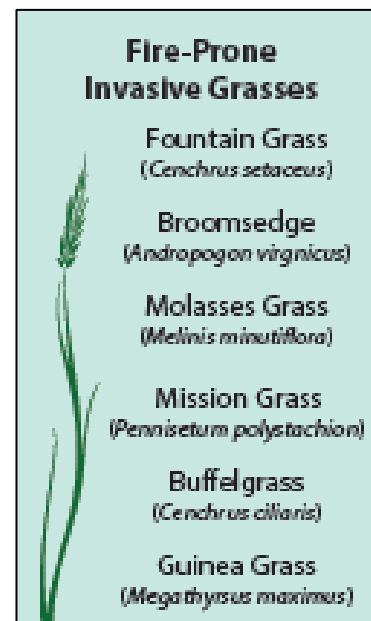
- A potential hotspot for erosion are the pasturelands/grasslands/scrublands on the slopes below the Forest Lands on Mt. Ka’ala (indicated as “highly erodible;” see Figure 9 in *Volume 1*). These areas are relatively steep and are difficult to access, however, vegetative stabilization practices and streambank protection practices should be implemented where possible. Additionally, livestock access limitation practices (e.g. building and repairing fences) are essential to keep livestock from escaping into adjacent forested areas.

Helemano

- The areas located mauka and makai of the Army’s Drum Road in the Helemano Watershed are used for pastureland, according to the 2015 State Agricultural Land Use Baseline Study (see Figure 24 in *Volume 1*). Practices such as fencing, prescribed grazing, vegetative stabilization, and streambank protection are priorities for the pasturelands in this area.

AGRICULTURAL LANDS MEASURE #6: FIRE PREVENTION

Implementing practices that help achieve the “Fire Prevention” management measure will reduce/prevent erosion and runoff caused by wildfires, thereby reducing pollutant transport into streams. Kaukonahua and Poamoho watersheds are priorities for implementing fire prevention practices in Agricultural Lands because the modeling results indicated that the majority of the sediments that flow into Kaiaka Bay originate from Agricultural Lands in those watersheds (65% of total sediments; see section 7.3.2 of *Volume 1: Watersheds Characterization*). These watersheds also have the most land that is classified as “alien grassland” according to the USGS GAP analysis (see Table 7 in *Volume 1* of this WBP for details). Agricultural Lands in the Kaukonahua and Poamoho watersheds also have the more public access than some of the other



Vegetation management to reduce fuel loads, such as fire-prone grasses, is an important practice for fire prevention

watersheds, increasing the potential for fires. Additionally, Kaukonahua and Poamoho watersheds have more acres of land categorized as Agricultural Land than any other watershed.

Opportunities for Implementation:

Kaukonahua

- The pasturelands/grasslands/scrublands on the slopes below the Forest Lands on Mt. Ka‘ala are dominated by guinea grass, a very fire-prone species. Since some of this land is already used for grazing, prescribed grazing for vegetation management to reduce fuel loads could be implemented.
 - In fact, according to www.pacificfireexchange.org, experimental trials in Hawai‘i indicate that the effects of grazing on fuel loads may last longer than chemical and mechanical treatments.
- Other types of vegetation management practices should also be implemented to reduce fuel loads.

Poamoho

- The planning team was not able to determine any specific locations for fire prevention management practices in the Agricultural Lands of the Poamoho Watershed, although this does not indicate that none exist. Undoubtedly, fire/fuel breaks and vegetation management practices would be beneficial in many different locations.

AGRICULTURAL LANDS MEASURE #7: IRRIGATION WATER USE

Implementing practices that help achieve the “Irrigation Water Use” measure will reduce polluted runoff from fields by increasing irrigation water use efficiency. The priority watersheds for this management measure are Kaukonahua and Poamoho, since the majority of the sediments that flow into Kaiaka Bay originate from Agricultural Lands in those watersheds (65% of total sediments; see section 7.3.2 of *Volume 1*). Additionally, Kaukonahua and Poamoho watersheds have more acres of land categorized as Agricultural Land than any other watershed, as well as some of the largest agricultural landowners, increasing the applicability/feasibility of implementing some of the potential management practices.

Opportunities for Implementation:

Kaukonahua

- When the effluent from the Wahiawā WWTP is officially classified as R-1 quality, the irrigation water in the Wahiawā Irrigation System will be able to be used on a wider variety of crops, becoming a sustainable source of irrigation water. Efforts to increase the use of recycled water should be supported. See *Developed Areas Measure #1: Point Source Wastewater Treatment and Recycling* for more information about recycled wastewater.

Poamoho

- Dole Foods operates the network of open irrigation ditches that make up the Wahiawā Irrigation System. Dole expressed the need to replace some of the open ditches with enclosed pipes to increase water transport efficiency. Several years ago, the Board of Water Supply supplied Dole with pipes to replace the ditches, but Dole lacks the funding to install the piping.

AGRICULTURAL LANDS MEASURE #8: FIELD ACCESS ROAD MANAGEMENT

Implementing practices that help achieve the “Field Access Road Management” measure will reduce and prevent the generation and transport of pollutants from field access roads into streams. The priority watersheds for this management measure are Kaukonahua and Poamoho, since the majority of the sediments that flow into Kaiaka Bay originate from Agricultural Lands in those watersheds (65% of total sediments; see section 7.3.2 of *Volume 1*). Kaukonahua and Poamoho watersheds have more acres of land categorized as Agricultural Land than any other watershed; they also have more acres of field roads in Agricultural Lands according to GIS analysis (indicated as impervious surfaces by the NOAA C-CAP dataset in Agricultural Lands). The Kaukonahua Watershed has approximately 149 acres of field roads in Agricultural Lands and the Poamoho Watershed has approximately 261 acres; the other watersheds each have fewer than 100 acres of field roads in Agricultural Lands. Additionally, Kaukonahua and Poamoho watersheds have some of the largest agricultural landowners, increasing the applicability/feasibility of implementing some of the potential management practices.

Opportunities for Implementation:

Kaukonahua

- The planning team was not able to determine any specific locations for field access road management practices in the Agricultural Lands of the Poamoho Watershed, although this does not indicate that none exist. It is likely that implementing practices such as filter strips, grassed waterways, mulching, dust control, stream crossing, and heavy use area protection would be applicable and beneficial in certain areas.

Poamoho

- The planning team was not able to determine any specific locations for field access road management practices in the Agricultural Lands of the Poamoho Watershed, although this does not indicate that none exist. It is likely that implementing practices such as filter strips, grassed waterways, mulching, dust control, stream crossing, and heavy use area protection would be applicable and beneficial in certain areas.

3.3 DEVELOPED AREAS

Developed Areas, as classified in this WBP, are primarily located along the coast and in the “saddle” between the Wai’anae and Ko’olau mountain ranges. These areas include the developed portions of Hale’iwa, Waialua, Schofield Barracks, Wahiawā (including the Wahiawā Reservoir), the Army’s Helemano Military Reservation, the Navy’s Joint Base Pearl Harbor-Hickam (JBPHH)-Wahiawā Annex (or Naval Computer and Telecommunications Area Master Station Pacific ([NCTAMS-PAC])), and the area immediately around the Dole Visitors’ Center (refer to Figure 3). Paved roads that traverse various land use types, including Kaukonahua Road, Kamehameha Highway, and the Army’s Drum Road, are also applicable to the management measures and practices for Developed Areas. While Developed Areas account for a relatively small proportion of the total area in the Kaiaka Bay Watersheds (approximately 7% of the total; Table 24), these areas can have important impacts on water quality. Each of the six Kaiaka Bay Watersheds has some land in this land use type, however, Kaukonahua Watershed has eight times more land classified as Developed Areas than any other watershed (2,603 acres). Ki’iki’i and Paukaula watersheds have the highest percent of their total area classified as Developed Areas, at 42%

and 39%, respectively. Refer to section 7.3.1 of *Volume 1: Watersheds Characterization* for a more detailed description of the Developed Areas land use type.

TABLE 24. DEVELOPED LAND AREA IN THE KAIKA BAY WATERSHEDS

	WATERSHED	ACRES	% OF WATERSHED	TOTAL ACRES
Ki'iki'i System	Ki'iki'i	248	42%	592
	Kaukonahua	2,803	11%	25,159
	Poamoho	331	3%	11,675
Paukauila System	Paukauila	334	39%	865
	Helemano	40	0%	9,353
	Ōpae'ula	7	0%	3,810
	Total Acres	3,763	<i>n/a</i>	51,454
	% of Project Area	7%	<i>n/a</i>	100%

3.3.1 OVERVIEW OF POLLUTANTS & POLLUTANT SOURCES

There are many factors that contribute to degradation of water quality in surface waters found in Developed Areas of the Kaiaka Bay Watersheds. Sources of pollution in this land use type include both point sources and nonpoint sources. Known and suspected sources for these pollutants are briefly described below. For further details, please refer to *Volume 1: Watersheds Characterization*.

3.3.1.1 SEDIMENTS & TURBIDITY

The State's 2014 303(d) list indicates Kaukonahua, Poamoho, Helemano, and Ōpae'ula streams are impaired with excessive turbidity, along with Paukauila Estuary and Kaiaka Bay. The 303(d) list indicates that there is inadequate data to assess the water quality of Ki'iki'i Estuary, however, data from various studies indicate that waterbodies within the Ki'iki'i Watershed are impaired with excessive turbidity.

A number of other studies have also found that waterbodies in close proximity to Developed Areas, such as the Wahiawā Reservoir, Kaukonahua Stream, and Kaiaka Bay, have excessive turbidity and suspended sediments (refer to Chapter 5 of *Volume 1: Watersheds Characterization* for details).

However, analysis of the modeling results for sediments shows that



Murky and muddy Helemano Stream near Kamehameha Highway in Hale'iwa

Developed Areas in the Kaiaka Bay Watersheds are not a major source of sediments (contributing 1% of the total sediments); however, it should be noted that the model (OpenNSPECT) can only model the effects of rill and sheet erosion and therefore may overlook other significant sources of sediments in urban areas, such as stream channel erosion caused by instream flows, or the effects of stormwater drainage systems, stream diversions, and other man-made hydrological alterations.

SOURCES

It is well documented that stormwater runoff in urban areas can transport sediments from areas with exposed soils such as landscaping projects or constructions sites as well as from roadways and other impervious surfaces into nearby waterways. Point sources of sediments in the Developed Areas of the Kaiaka Bay Watersheds include the City MS4, State DOT-HWYS MS4, the Navy's MS4, and the Army's MS4. Additionally, the Wahiawā WWTP and, to a lesser degree, the Schofield WWTP are also potential point sources of sediments and turbidity (effluent from the latter does not typically enter a surface waterbody directly).

PRIORITY WATERSHEDS

Since the modeling results did not show any dramatic differences in sediment output from Developed Areas between the six watersheds, the priority watersheds for controlling sediments in Developed Areas are the watersheds that have the most land area in this land use class. Therefore, the priority watersheds for controlling sediments in Developed Areas include:

- Kaukonahua Watershed;
- Paukauila Watershed;
- Poamoho Watershed; and
- Ki'iki'i Watershed.

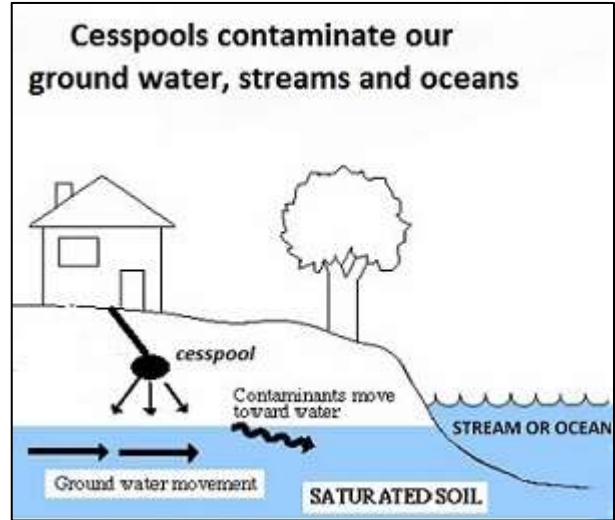
3.3.1.2 NUTRIENTS

The State's 2014 303(d) list indicates that Kaukonahua, Poamoho, Helemano, and 'Ōpae'ula streams are impaired with excessive nutrient concentrations (total nitrogen, nitrate/nitrite, and total phosphorus). Paukauila Estuary and Kaiaka Bay are also impaired with excessive nitrogen concentrations (total nitrogen and nitrate/nitrite). The 303(d) list indicates that there is inadequate data to assess the water quality of Ki'iki'i Estuary, however, data from various studies indicate that waterbodies within the Ki'iki'i Watershed are also impaired with excessive nutrients. Kaiaka Bay has also been found to have excessive levels of nutrients (nitrate/nitrite ammonia, and total phosphorus). Refer to Chapter 5 of *Volume 1: Watersheds Characterization* for more information on past studies and water quality data.

The results of the model indicated Developed Areas produce a 1% of all nitrogen and 3% of all phosphorus. Given that the model could not account for nutrient input from any wastewater system (including all on-site sewage disposal systems [OSDSs] and WWTPs) nor could it account for nutrients transported and deposited in MS4s, Developed Areas should not be overlooked as a source of nutrients in the Kaiaka Bay Watersheds.

SOURCES

Nonpoint sources of nutrients in Developed Areas in the Kaiaka Bay Watersheds can be generated from on-site sewage disposal systems (e.g. cesspools), use of fertilizers, improper disposal/containment of vegetative debris, landfills, and other waste sites. Areas with impervious surfaces can accelerate the transport of nutrients and other pollutants into nearby waterbodies. Point sources in the Developed Areas include the Wahiawā WWTP and, to a lesser degree, the Schofield WWTP (effluent from the latter does not typically enter a surface waterbody directly). In addition, the City MS4, State DOT-HWYS MS4, the Navy's MS4, and the Army's MS4 are also point sources of nutrients to waterbodies in Developed Areas.



Cesspools are one source of nutrients in the Kaiaka Bay Watersheds; Image from Hawai'i Department of Health, Wastewater Branch

PRIORITY WATERSHEDS

The priority watersheds for controlling nutrients in Developed Areas are the watersheds that have the most land area or have the largest percentage of their total area in this land use class, as well as the watersheds with the most OSDs. Additionally, the results of the model indicate that Developed Areas in the Poamoho Watershed contribute the most nutrients per acre out of any other watershed. Therefore, the priority watersheds to reduce many types of urban pollutants are:

Therefore, the priority watersheds for controlling nutrients in Developed Areas include:

- Kaukonahua Watershed;
- Ki'iki'i Watershed;
- Paukauila Watershed; and
- Poamoho Watershed.

3.3.1.3 OTHER POLLUTANTS

Kaiaka Bay is listed on the 303(d) list as impaired with enterococci and alpha-chlorophyll (a measure of algal presence or "bloom"). Multiple data sources have found that waterbodies in the Kaiaka Bay Watersheds are polluted with bacteria and other potentially toxic chemicals; refer to Chapter 5 of *Volume 1: Watersheds Characterization* for more information on past studies and water quality data.

In addition to sediments and nutrients, developed and urban areas are known to be sources of many other types nonpoint source pollutants, including oil and grease from automobiles and roadways, pesticides, bacteria and other pathogens, polycyclic aromatic hydrocarbons, metals, and other household chemicals.

SOURCES

Stormwater runoff from parking lots and roadways can rapidly transport these pollutants along with carelessly discarded trash into waterbodies. Leaking cesspools and other OSDs are a potential nonpoint source of fecal indicator bacteria and other pathogens.

Point sources of many types of pollutants in the Developed Areas of the Kaiaka Bay Watersheds include the City MS4, State DOT-HWYS MS4, the Navy's MS4, the Army's MS4, the Wahiawā WWTP, and the Schofield WWTP (however, effluent from the latter does not typically enter a surface waterbody directly).

PRIORITY WATERSHEDS

The goals of the WBP state that pollutants other than sediments and nutrients should be addressed opportunistically or as deemed necessary. It is important to address contaminants in stormwater runoff, especially since a strategy outlined in the State Nonpoint Source Management Plan is to "Develop and implement a statewide effort to address urban runoff" (Goal 4, Objective 2; DOH PRC, 2015). Regarding pathogens and bacteria sourced from cesspools, professional judgment deems OSDs to be an important water quality issue. Moreover, the State Nonpoint Source Management Plan specifies a strategy to "Develop and implement a statewide effort to address cesspools" (Goal 4, Objective 2; DOH PRC, 2015).

The priority watersheds for reducing most of these pollutant types are those with the highest percentages of impervious surfaces, since impervious surfaces facilitate the transport of pollutants into waterbodies. Additionally, the watersheds with the most OSDs are also priorities. Therefore, the priority watersheds to reduce many types of urban pollutants are:

- Kaukonahua Watershed (Schofield Barracks and Wahiawā);
- Ki'iki'i Watershed (Waialua); and
- Paukaula Watershed (Hale'iwa).

3.3.1.4 SUMMARY OF POLLUTANT SOURCES AND PRIORITY WATERSHEDS IN DEVELOPED AREAS

Table 25 provides a summary of the pollutants of concern, the primary sources of the pollutants, and the priority watersheds for the pollutants of concern in Developed Areas.

TABLE 25. POLLUTANTS, POLLUTANT SOURCES, AND PRIORITY WATERSHEDS IN DEVELOPED AREAS

Primary Factors That May Contribute Pollutants (PS and NPS)	Pollutants of Concern	Priority Watersheds: Sediments	Priority Watersheds: Nutrients	Priority Watersheds: Other Pollutants
<ul style="list-style-type: none"> • MS4s (City, DOT, Army, Navy) • Wahiawā WWTP • Wastewater injection wells (Pa‘ala‘a Kai WWTP) • Cesspools and other OSDS • Hazardous waste sites • Chemical use • Urban/roadway stormwater runoff 	<ul style="list-style-type: none"> • Sediments & turbidity • Nutrients • Bacteria & other pathogens • Chemical contaminants • Trash 	<ul style="list-style-type: none"> • Kaukonahua • Poamoho • Paukauila • Ki‘iki‘i 	<ul style="list-style-type: none"> • Kaukonahua • Poamoho • Paukauila • Ki‘iki‘i 	<ul style="list-style-type: none"> • Kaukonahua • Paukauila • Ki‘iki‘i

3.3.2 MANAGEMENT MEASURES & PRACTICES

This section describes some of the key management measures that could be implemented to reduce pollutant loads coming from Developed Areas in the Kaiaka Bay Watersheds. The results of implementing the associated practices can help to improve water quality in streams.

For each management measure, several applicable management practices are listed that could help accomplish the objective of the measure. The measures and practices presented below are derived from a variety of sources, including:

- “Hawai‘i Watershed Guidance” (Tetra Tech, 2010);
- NRCS “Field Office Technical Guide” – conservation standards for the Pacific Islands Area;
- “Storm Water Permanent Best Management Practices Manual” (DOT-HWYS, 2007);
- “The Use of Best Management Practices (BMPs) in Urban Watersheds” (EPA, 2004);
- “Chapter 4: Management Measures for Urban Areas” in *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1993);
- “Urban Subwatershed Restoration Manual Series” (Center for Watershed Protection, 2004); and
- Specific local plans such as the “North Shore Regional Wastewater Alternatives Plan” (Brown and Caldwell, 2012), along with others (cited in text).

Where possible, references to any applicable NRCS FOTG standards (and associated three-digit code) and/or other documented practices are cited for further information.

DEVELOPED AREAS MEASURE #1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING



Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria/pathogens

Objective: To reduce the quantity and improve the quality of pollutants generated by wastewater treatment plants with NPDES permits to discharge into waterbodies.

Description: The objective of this management measure is to improve the quality of effluent from the Wahiawā Wastewater Treatment Plant. Additionally, it aims to reduce the quantity of treated wastewater that is discharged into waterbodies. Kaukonahua Watershed is the only applicable to this management measure.

Practices: There are two management practice types that apply to the “Point Source Wastewater Treatment and Recycling” measure (Table 26). These practice types are based off several documents, plans, and on-going initiatives. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 31 (section 3.3.3).

TABLE 26. PRACTICES FOR DEVELOPED AREAS MEASURE #1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING

Practice Type	Description	Example Image	Examples of Applicable Documents/Plans/Practices
A Complete Upgrades to Wahiawā WWTP to Produce R-1 Effluent	Complete renovations so that the WWTP effluent will be classified as R-1 quality, which can then be used for irrigation of a wider variety of crops than the current effluent		<ul style="list-style-type: none"> • See “Final Environmental Assessment for the Wahiawā Wastewater Treatment Plant Modifications” (Limtiaco, 2008)
B Discontinue Effluent Discharge into Wahiawā Reservoir	Effluent discharge into the Reservoir from the Wahiawā WWTP should eventually be discontinued; either by pumping effluent to a water recycling facility for irrigation and/or by some other means, including considering the use of a constructed wetland to further treat the wastewater		<ul style="list-style-type: none"> • See “Final Environmental Assessment for the Wahiawā Wastewater Treatment Plant Modifications” (Limtiaco, 2008) • See “Central Oahu Non-Potable Water Master Plan – Appraisal of Opportunities Report” (Brown and Caldwell, 2013) <u>NRCS Standards:</u> • Constructed wetland (#656)

* Listed in multiple locations since it applies to multiple types of management practices.

Identified Existing Activities for Each Practice Type:

A. Complete Upgrades to Wahiawā WWTP to Produce R-1 Effluent

The Wahiawā WWTP, owned and operated by the City, is currently undergoing renovations that will allow the final effluent will receive an official R-1 classification from the DOH (median fecal coliform limit

of 2.2 per 100 ml). It should be noted, however, that in recent years the median fecal coliform quantity of the effluent has been within the requirements for R-1 water, but it is still rated as R-2 primarily because the WWTP lacks secondary containment. When the upgrades are complete, the effluent will be able to be officially classified as R-1, which will allow for increased use of the water in the Wahiawā Irrigation System for irrigation purposes (the Schofield WWTP effluent is already classified as R-1). The R-1 water can then be sold and used for the irrigation of a wide variety of crops, including vegetables. Piping from a new R-1 storage tank at the WWTP will also be installed to transport the R-1 water for future irrigation use. It has been noted that water quality in the Wahiawā Reservoir may improve once the upgrades to the WWTP are completed.

B. Discontinue Effluent Discharge into Wahiawā Reservoir

When the upgrades to the Wahiawā WWTP are completed, the R-1 quality effluent can be used for a wider variety of irrigation purposes. The State Agribusiness Development Corporation is already planning on using the R-1 water for irrigating crops on the former Galbraith Estate lands in Wahiawā, as are other producers throughout the North Shore. If the demand for R-1 water is high enough, it may be possible to discontinue discharge of the effluent into the Wahiawā Reservoir.

An alternate option is to discharge the excess effluent into a natural wastewater treatment system that is designed to further treat the water. In the past, there was an effort to examine the feasibility of creating a constructed wetland near the WWTP to improve the water quality of the Wahiawā Reservoir. The project never moved past a feasibility study that was conducted in 2006/2007 by the Sustainable Resources Group International, Inc. on behalf of the University of Hawai‘i’s Center for Conservation Research and Training.

This practice will actually be mandated by law in 2027, as newly adopted Act 248 requires that there shall be no wastewater discharged into any water body by the end of 2026, except when used to create energy.

DEVELOPED AREAS MEASURE #2: NONPOINT SOURCE WASTEWATER TREATMENT

Primary Pollutants Targeted: Nutrients; bacteria/pathogens

Objective: To reduce pollutants in waterbodies that are associated with private on-site sewage disposal systems and wastewater injection wells.



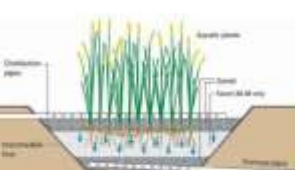
Description: The objective of this management measure is to improve the treatment of wastewater in areas that are not served by the Wahiawā or Schofield WWTPs and/or to upgrade OSDs. This management measure includes underground wastewater injection wells, since they can be considered a nonpoint source of pollution. Nutrients, bacteria, and other pathogens are the targeted pollutants. The significance of this management measure is supported by the passing of Act 125 in July 2017, which amends HRS Chapter 342D to require that every cesspool in the state must be either upgraded to a septic or aerobic system or connected to a sewage system (with certain exemptions) by 2050.

The watersheds that are most applicable to this measure are Ki'iki'i, Paukaula, and Kaukonahua since they have the largest populations of people that are not served by the major WWTPs and consequently have the most OSDs. However, Poamoho, Ōpae'ula, and Helemano watersheds also have several OSDs (see Figure 27 of *Volume 1*) and should not be ignored.

Practices: There are three main types of management practices that apply to the “Nonpoint Source Wastewater Treatment” measure (Table 27). These practice types are largely based off recommendations from the 2012 North Shore Regional Wastewater Alternatives Plan (NSRWWAP; Brown and Caldwell, 2012). The purpose of the NSRWWAP was to evaluate alternatives for wastewater collection, treatment, and disposal for the North Shore region within the next 20 years, including the areas in and around Hale'iwa and Waialua within the Kaiaka Watersheds. The planning effort sought to understand the values and long-term vision of the North Shore community by consulting with residents, business owners, and other important stakeholders. Various alternatives were assessed and prioritized for specific areas. The recommended alternatives for the Waialua and Hale'iwa sub-districts are presented in under practice type “B” in Table 27.

In addition to the NSRWWAP, a number of NRCS conservation standards are also applicable to this management measure. It should be noted that the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 31 (section 3.3.3).

TABLE 27. PRACTICES FOR DEVELOPED AREAS MEASURE #2: NONPOINT SOURCE WASTEWATER TREATMENT

Practice Type		Description	Example Image	Examples of Applicable Practices
A	Upgrade Cesspools to a Better Wastewater System	Property owners could utilize a \$10,000 tax credit towards the cost of upgrading or converting a qualified* cesspool to a septic tank system or an aerobic treatment unit system (or connecting to a sewer system)	 A Conventional Septic System includes: a Septic Tank, a Distribution Box and a Septic Drain Field.	<u>NSRWWAP:</u> <ul style="list-style-type: none"> • Upgrade Cesspool Systems with Septic Tank Addition ‡ • Upgrade onsite systems with gray water separation **
B	Implement the 2012 North Shore Regional Wastewater Alternatives Plan (NSRWWAP)	Recommends alternatives for wastewater treatment for different areas on the North Shore; all are “decentralized” wastewater treatment methods (versus a large municipal facility)	 <i>Waialua Sub-District Recommendations</i>	<u>NSRWWAP Recommendations (in addition to upgrading cesspools):</u> <ul style="list-style-type: none"> • Form an onsite maintenance district† • Neighborhood cluster systems with reuse †‡ • Upgrade existing private/municipal wastewater treatment (i.e. City Pa‘ala‘a Kai WWTP) ‡ • Sewer commercial/residential areas for treatment/water reuse †‡ • Neighborhood cluster systems with injection well disposal • Upgrade onsite systems with gray water separation **
C	Natural Wastewater Treatment Systems	Property owners with on-site sewage could consider using a natural wastewater treatment system		<ul style="list-style-type: none"> • See “Management Practices for Vegetated Treatment Systems” (EPA, 2005) <u>NSRWWAP & NRCS:</u> <ul style="list-style-type: none"> • Ponds (#378) • Constructed wetland (#656)

* *Qualified cesspools are those located within 200 feet of a shoreline, perennial stream, wetland; within a source water assessment program area (two-year time of travel to a public drinking water source); shown to impact drinking water supplies or recreational waters; a residential large-capacity cesspool; or can be connected to an existing sewer system.*

** *Listed for two of the above practice types since it applies to both.*

† *Specifically recommended for the Waialua Sub-District.*

‡ *Specifically recommended for the Hale‘iwa Sub-District.*

Identified Existing Activities for Each Practice Type:

A. Upgrade Cesspools to a Better Wastewater System

A state law (HRS §123-16.5) allows a \$10,000 tax credit to be awarded to qualified homeowners who upgrade to a better system (e.g. a sewer or septic system). Of the 772 cesspools in the Kaiaka Bay Watersheds, 79 qualify for the \$10,000 tax credit for upgrading to a better system qualify and another 33 potentially qualify (verification is required). Additionally, the Waialua area is categorized in a 2017 report to the legislature as a “Priority 3” area for the State’s prioritization of areas with cesspools that should be replaced (DOH, 2017). Priority 3 areas are described as having “potential impacts to sensitive waters.”

B. Implement the 2012 North Shore Regional Wastewater Alternatives Plan

No progress towards implementing any strategies or projects described in the NSRWWAP was identified by the planning team.

C. Natural Wastewater Treatment Systems

No specific examples of natural wastewater treatment systems were identified in the Developed Areas of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; chemical contaminants; trash






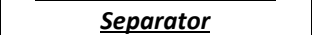
Objective: To reduce the transport of pollutants commonly found in urban stormwater runoff into waterbodies.

Description: This management measure includes practices that are designed to decrease stormwater runoff volumes and velocities as well as improve the water quality of the runoff. The practices are applicable to nonpoint sources of stormwater runoff (e.g. impervious surfaces) as well as point sources (i.e. stormwater systems or MS4s). Many types of pollutants (including sediments, nutrients, bacteria/pathogens, pesticides, hydrocarbons, and miscellaneous chemical contaminants) are reduced by implementing stormwater management practices. The watersheds that are applicable to this management measure include Kaukonahua, Poamoho, Paukauila, and Ki'iki'i.

Description: This management measure includes practices that are designed to reduce the impact of development on natural hydrological systems, including surface water and groundwater. The primary pollutants targeted by this measure are those that are common in urban runoff, (oil/grease/fluids from automobiles, pesticides, polycyclic aromatic hydrocarbons, household chemicals, and metals such as lead, cadmium, copper, and zinc).



Practices: There are four major categories of management practices that apply to the “Stormwater Management” measure (Table 28). These practice types are based off consultations with relevant stakeholders as well as from multiple sources that are referenced in a key below the table; the sources should be referenced for additional information about specific practices. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing stormwater management practices can be found in Table 31 (section 3.3.3).

TABLE 28. PRACTICES FOR DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Temporary BMPs	Practices that can be implemented in the short-term to produce immediate effects on improving stormwater quality or reducing the quantity of runoff; a permanent BMP should be planned to replace the temporary practice <i>NOTE: Nonnative and unusual plants have been found growing on erosion control blankets/mats; care should be taken to avoid spreading weeds</i>		<ul style="list-style-type: none"> • Erosion control blankets/mats/mulch †‡ • Diversion/swales † • Fiber rolls/sandbag barrier/bio-sock † • Misc. construction BMPs †‡ • Retaining walls † • Silt fence † • Storm drain inlet protection † • Stormwater runoff control (#570) ° • Wind erosion controls †
B Permanent/ Structural BMPs (including Low Impact Development practices)	Any practice that is considered a long-term solution/approach to improving the quality of stormwater and/or to reduce the quantity of runoff that leaves the site; includes filtration BMPs, infiltration BMPs, detention BMPs, other LID practices, and proprietary filtration/treatment devices for storm drains/inlets <i>NOTE: Care should be taken when sourcing seeds/plants to ensure no new nonnative species are introduced to an area</i>	     <p><u>Continuous Deflective Separator</u></p>	<p><u>Vegetative BMPs</u></p> <ul style="list-style-type: none"> • Seeding/critical area planting (#342) °‡ • Filter strips (#393) °‡‡§ • Grassed swales (wet, dry) * ‡ • Grassed waterway (#412) °‡ • Vegetative barrier (#601) °‡§ <p><u>Infiltration BMPs</u></p> <ul style="list-style-type: none"> • Constructed wetlands* °‡‡§ • Infiltration trench/basin* ‡‡ • Permeable pavement* † • Stormwater ponds* †‡§ <p><u>Filtering BMPs</u></p> <ul style="list-style-type: none"> • Bioretention (rain garden) *‡ • Sand filters* ‡ • Underground vault sand filter‡ <p><u>Structural/Proprietary Devices</u></p> <ul style="list-style-type: none"> • Baffle boxes§ • Catch basin inserts*‡§ • Grate inlets*‡ • Hydrodynamic separators*‡§ • Misc. inlet/outlet/culvert devices/structures § • Multi chambered treatment trains* • Sediment basin/trap † • Oil/grit separators*‡ • Water quality inlets*‡§ <p><u>Other/General</u></p> <ul style="list-style-type: none"> • Stormwater runoff control (#570) ° • Other permanent BMPs‡ • Other post construction BMPs †

- Table continued on next page -

TABLE 28. PRACTICES FOR DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT (CONTINUED)

Practice Type	Description	Example Image	Examples of Applicable Practices
C Behavioral/ Action-Based Practices: Good Housekeeping, Landscape Maintenance, & Discharge Prevention	Practices to reduce the potential for the discharge of pollutants to the storm drainage system or receiving waters through good housekeeping, proper landscape maintenance, and other practices to reduce/prevent discharge		<ul style="list-style-type: none"> • Alternative product substitution*† • Good housekeeping practices*† • Household hazardous waste collection*†§ • Integrated pest management (#595) ° • Landscaping and lawn care (including on-site recycling/composting) *† • Nutrient management (#590) ° • Pet waste collection*† • Pest control* • Reducing illegal dumping/discharge*† • Roof runoff structure (#558) ° • Spill prevention and cleanup* • Street sweeping* • Storm drain stenciling*†§ • Trash reduction/litter control † • Vehicle washing* • Water harvesting catchment (#636) °
D Infrastructure/ BMP Inspection & Maintenance	Infrastructure such as roadways, bridges, culverts, MS4 inlets/outfalls, and other drainage features should be inspected and properly maintained; stormwater BMPs should also be inspected and maintained		<ul style="list-style-type: none"> • BMP inspection and maintenance*‡ • Culvert replacement*† • Roadway and bridge maintenance *§ • Storm system inspection and maintenance *§ • Stream crossing (#578) °

Sources:

* "The Use of Best Management Practices (BMPs) in Urban Watersheds" (EPA, 2004)

° NRCS Standard (Standard No.)

† "Chapter 4: Management Measures for Urban Areas" (EPA, 1993)

‡ "Storm Water Permanent Best Management Practices Manual" (DOT-HWYS, 2007)

§ "Storm Drainage Best Management Plans in the Vicinity of Wahiawā Reservoir" (Oceanit, 2008)

Identified Existing Activities for Each Practice Type:**A. Temporary BMPs**

Temporary BMPs in the Kaiaka Bay Watersheds are largely implemented by NPDES permit holders as part of their permit requirements. These BMPs can be found at construction sites as well as around inlets and outfalls that are part of an MS4. The City, the State DOT Highways Division, the Army, and the Navy all operate MS4s under different NPDES permits. Each agency has a Storm Water Management Plan in compliance with their permit. A section of each SWMP identifies and addresses erosional issues that pertain to their MS4 and stormwater drainage. Temporary BMPs are installed while the agency

plans for installing permanent/structural BMPs to address the issue. Many different types of temporary BMPs have been installed by various parties in the Kaiaka Bay Watersheds.

B. Permanent/Structural BMPs

There are many examples of permanent stormwater BMPs within the Kaiaka Bay Watersheds, however, many additional opportunities exist. Permanent BMPs have been installed by the City, the Army, and the State DOT-HWYS in compliance with their NPDES permits. The Navy is currently in the process of identifying priority areas for permanent BMPs. Each agency's SWMP outlines the major erosional issues and the plan/timeline to implement permanent BMPs to address the issues. The SWMPs also require that "Action Plans" for retrofitting the existing MS4 with structural BMPs are developed and submitted to the DOH. The "Action Plans" identify specific locations for implementing structural BMPs that will improve the quality of the stormwater that enters their MS4. The plans provide an explanation on why certain sites were selected and include an implementation schedule. Examples of permanent/structural BMPs that have been implemented by various parties include reseeded, stormwater detention basins, vegetated swales, filter strips, erosion control matting, permeable pavement, and "proprietary" devices such as storm drain inlet grates/filters and hydrodynamic separators.

Other permanent BMPs have been installed by private parties in commercial or residential areas within the Kaiaka Bay Watersheds. Some popular examples include LID features such as biofiltration/rain gardens and vegetated swales/barriers.



These barriers ("bio-socks") are a temporary BMP placed along Kaukonahua Road help prevent the transport of sediments and other pollutants that are common in runoff from roadways



The City MS4 in Wahiawā has filters at some of the stormwater inlets to prevent debris and other pollutants from entering the system

C. Behavioral/Action-Based Practices: Good Housekeeping, Landscape Maintenance, & Discharge Prevention

The SWMPs for the City, the State DOT-HWYS, the Navy, and the Army all have various sections that address the importance of good housekeeping, landscape maintenance (included integrated pest management), and discharge prevention to protect water quality. Each of the SWMPs includes a schedule for street sweeping in specific areas as well as a "Trash Reduction Plan." To comply with the WLAs determined by the TMDL for Upper Kaukonahua (see section 4.4 of *Volume 1: Watersheds*



Stenciling at storm drain inlets informs the public not to dump anything down the drain

Characterization), the City does additional landscape maintenance at their facility/baseyard in Wahiawā to prevent debris from entering their MS4. At a dog park at the JBPHH-Wahiawā Annex, the Navy has signage and provides bags for pet waste. Each of the SWMPs also address how to detect and prevent/reduce illegal dumping into storm drains, including regular inspections of outfalls to look for signs of unusual dumping and installing signage at stormwater inlets to inform the public not to discharge into the drain because it eventually drains to the ocean. The signage used by the Army, the City, the Navy, and the State DOT-HWYS varies, but is either stenciling or a placard.

The City, the DOT-HWYS, the Navy, and the Army all have different outreach programs that aim to educate the public on stormwater and how they can help to protect water quality. For more information about the outreach programs, see Chapter 4 of this document.

D. Infrastructure Inspection & Maintenance

The SWMPs for the City, the State DOT-HWYS, and the Army all include details that pertain to inspection schedules and maintenance of their drainage systems. Other infrastructure, such as roadways, bridges, etc., that fall under their jurisdiction are inspected and projects are prioritized to address issues related to stormwater. The City and DOT-HWYS also inspect commercial/industrial facilities that have the potential to discharge into their respective MS4s. The Navy’s SWMP states that they are in the process of mapping the storm drain system which will allow them to contract a system-wide cleaning for the drains and pipes.

DEVELOPED AREAS MEASURE #4: STREAM, RIPARIAN, AND WETLAND MANAGEMENT

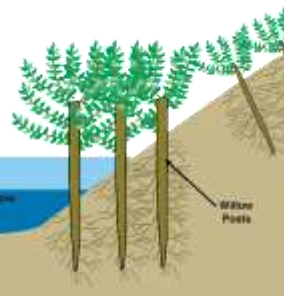



Primary Pollutants Targeted: Sediments (including turbidity); nutrients

Objectives: To prevent erosion of riparian areas and reduce the transport of sediments, nutrients, and other organic material into streams; to improve water quality by removing trash and restoring the habitat.

Description: This management measure includes practices that aim protect and improve riparian areas and streambanks to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. The primary pollutants targeted by these practices are sediments and nutrients. The watersheds with “Developed Areas” that are applicable to this management measure include Kaukonahua, Poamoho, Paukaula, and Ki’iki’i.

Practices: There are four main types of management practices that apply to the “Stream, Riparian, and Wetland Management” measure in Developed Areas (Table 29). These practice types are based off multiple sources that are referenced in a key below the table; the sources should be referenced for additional information about specific practices. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 31 (section 3.3.3).

TABLE 29. PRACTICES FOR DEVELOPED AREAS MEASURE #4: STREAM, RIPARIAN, AND WETLAND MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Streambank Protection & Stabilization	Practices to stabilize and protect banks of streams from erosion, including establishing non-invasive plants (preferably native) along eroding streambanks		<ul style="list-style-type: none"> • Critical area planting (#342) [◊] • Flow deflection techniques [†]§ • Flow diversion [†]§ • Grade control [†]§ • Hard bank stabilization methods [†]§ • Soft bank stabilization methods [†]§ • Streambank and shoreline protection (#580) [◊] • Stream channel stabilization [†]§ • Tree/shrub establishment (#612) [◊] <p>See also “Management Practices for Protecting Wetlands and Riparian Areas” [‡]</p>
B Stream Habitat Restoration	Improving the quality of the riparian ecosystem to provide habitat for native flora and fauna; protects water quality by preventing erosion and minimizing the harmful effects of invasive species		<ul style="list-style-type: none"> • In-stream habitat enhancement [†] • Herbaceous weed control (#315) [◊] • Restoration and management of rare or declining habitats (#643) [◊] • Stream habitat improvement and management (#395) [◊] • Wetland enhancement (#659) [◊] • Wetland restoration (#657) [◊] • Wetland wildlife habitat management (#644) [◊] <p>See also “Management Practices for Restoration of Wetlands and Riparian Areas” [‡]</p>
C Vegetated Treatment Systems	Maintaining or establishing vegetation up-gradient of streams to serve as a buffer; slows runoff and reduces sediments, organic material, and nutrients entering streams		<ul style="list-style-type: none"> • Filter strip (#393) [◊]§ • Grassed waterway (#412) [◊] • Kalo lo’i [^] • Riparian forest buffer (#391) [◊] • Riparian herbaceous cover (#390) [◊] • Stormwater runoff control (#570) [◊] • Tree/shrub establishment (#612) [◊] • Vegetative barrier (#601) [◊] <p>See also “Management Practices for Protecting Wetlands and Riparian Areas” & “Management Practices for Vegetated Treatment Systems” [‡]</p>
D Stream Cleanups	Stream cleanups enhance the appearance of a stream, improve the flow of water, and prevent pollutants from being released by removing trash, litter, and other debris		<ul style="list-style-type: none"> • Stream cleanups [†] • Adopt-a-stream ^{*†}

Sources:

* “The Use of Best Management Practices (BMPs) in Urban Watersheds” (EPA, 2004)

◊ NRCS Conservation Standard (Standard No.)

† “Urban Subwatershed Restoration Manual Series – Manual 4: Urban Stream Repair Practices” (Center for Watershed Protection, 2004);

‡ “National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (EPA, 2005).

§ “Streambank Stabilization Management Measures” (ADEQ, date unknown)

^ “West Maui Watershed Plan: Kahana, Honokahua & Honolua Watersheds Strategies and Implementation Report” (G70, 2015)

Identified Existing Activities for Each Practice Type:

A. Streambank Protection & Stabilization

No specific examples of streambank protection/stabilization practices were identified in the Developed Areas of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

B. Stream Habitat Restoration

No specific examples of stream habitat restoration practices were identified in the Developed Areas of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

C. Vegetated Treatment Systems

No specific examples of vegetated treatment systems were identified in the Developed Areas of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

D. Stream Cleanups

The Army’s SWMP specifies that they will coordinate an annual stream cleanup day; Kaukonahua and Helemano streams are two of the potential streams for the cleanup day. The Army and the City both have volunteer Adopt-a-Stream programs that aim to involve and educate people about polluted stormwater runoff and stream degradation.

DEVELOPED AREAS MEASURE #5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria/pathogens; chemical contaminants

Objective: To protect natural hydrological cycles, thereby reducing urban runoff and the transport of common urban pollutants into waterbodies.

Description: This management measure includes practices that are designed to reduce the impact of development on natural hydrological systems, including surface water and groundwater. The primary pollutants targeted by this measure are those that are common in urban runoff, including sediments, nutrients, bacteria/pathogens, and miscellaneous chemical contaminants (oil/grease/fluids from automobiles, pesticides, polycyclic aromatic hydrocarbons, household chemicals, and metals such as lead, cadmium, copper, and zinc). The watersheds with “Developed Areas” that are applicable to this management measure include Kaukonahua, Poamoho, Paukauila, and Ki’iki’i.

Practices: There are two main types of management practices that apply to the “Planning New Development and Retrofitting Existing Development” measure (Table 30). These practice types are based off multiple sources that are referenced in a key below the table; the sources should be referenced for additional information about specific practices. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type

and objective potentially qualifies. More information about implementing these practice types can be found in Table 31 (section 3.3.3).

TABLE 30. PRACTICES FOR DEVELOPED AREAS MEASURE #5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Land use & Development Design	practices to reduce pollutant loads, conserve natural areas, economic benefits... accomplish three goals: (i) reduce the amount of impervious cover; (ii) protect existing natural lands; and, (iii) use pervious areas for stormwater treatment		<ul style="list-style-type: none"> • Better site design strategies*†‡ <p><i>Including:</i></p> <ul style="list-style-type: none"> – Conserve natural areas* – Limit impervious surfaces*†
B Low-Impact Development Strategies	Low-Impact Development refers to strategies concerned with maintaining or restoring the natural hydrologic functions of a site; reduces off-site storm water runoff and removes pollutants from runoff		<ul style="list-style-type: none"> • Bioretention/rain gardens* • Constructed wetlands (#656) °† • Green roofs*† • Infiltration basins/trenches† • Permeable pavements*† • Rain barrels/cisterns* • Roof runoff structure (#558) ° • Sand filters and sand/peat filters† • Vegetated filter strips (#393) *°† • Vegetated swales and channels*†‡ • Water harvesting catchment (#636) ° • Xeriscaping‡

Sources:

* "The Use of Best Management Practices (BMPs) in Urban Watersheds" (EPA, 2004)

° NRCS Conservation Standard (Standard No.)

† "Chapter 4: Management Measures for Urban Areas" (EPA, 1993)

‡ "Urban Stormwater Management in the United States" (National Research Council of the National Academies, 2008)

Identified Existing Activities for Each Practice Type:

A. Land use & Development Design

No specific examples of better land use and development design were identified in the Developed Areas of the Kaiaka Bay Watersheds in this planning effort; however, this does not indicate that none exist.

B. Low-Impact Development Practices

There are two relatively new regulations that require the use of Low-Impact Development. Effective August 2017, the City's new Water Quality Rules require LID BMPs for all new development and redevelopment projects greater than one acre (DPP Administrative Rules Title 20). The second new regulation related to LID requires the Army to implement LID BMPs for development projects of 5,000 square feet or larger. There are many different types of LID features in Developed Areas of the Kaiaka Bay Watersheds, including pervious pavement, vegetated swales, and rain barrels. For example, as part

of the City's "Action Plan for Retrofitting the Existing MS4 with Structural BMPs," several LID projects are planned, including installing grass swales at the Wahiawā Police Station. With the relatively new regulations in place, there will undoubtedly be more LID features in the Developed Areas of the Kaiaka Bay Watersheds.

3.3.3 MANAGEMENT PRACTICE EFFECTIVENESS & IMPLEMENTATION CONSIDERATIONS

Table 31 presents qualitative assessments of the effectiveness each practice type has on specific pollutants. Pollutant load reduction effectiveness is presented on a scale of "low," (L) "medium" (M) and "high" (H). Cost estimates for specific practices are presented when data was available. The information in the table is based on literature review (including the NRCS CPPE matrix and NRCS FOTG spreadsheets for the Pacific Islands region), consultation with service providers and stakeholders, and professional judgment. Additionally, the table indicates whether or not each practice also has a beneficial effect on flooding or on groundwater conservation, since these issues are important community concerns but are not directly addressed in this WBP.

TABLE 31. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR DEVELOPED AREAS MANAGEMENT PRACTICES

	Pollutant Reduction						Cost	Maintenance	Implementation Considerations
	Sediments	Nutrients	Bacteria	Other	Flooding *	Groundwater Conservation *			
DEVELOPED AREAS MEASURE #1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING									
Complete Upgrades to Wahiawā WWTP to Produce R-1 Effluent	L	L	L	L	n/a	✓	Unknown – Work in progress	n/a	Upgrades/construction in progress
Discontinue Effluent Discharge into Wahiawā Reservoir	M	H	M/H	L	✓	✓	Varies	n/a	Would be implemented by City ENV
DEVELOPED AREAS MEASURE #2: NONPOINT SOURCE WASTEWATER TREATMENT AND RECYCLING									
Upgrade Cesspools to a Better Wastewater System	L	M/H	M/H	L	n/a	✓	Up to \$30,000/1,000 gallons	L	Implemented by private property owners
Implement the 2012 NSRWWAP	L	M/H	M/H	L	n/a	✓	Varies	Varies	Would be implemented by gov't agencies: City ENV, State DOH
Natural Wastewater Treatment Systems	L	M/H	M/H	M/H	n/a	n/a	Varies – \$3,000-30,000 per acre treated	L	Could be implemented by gov't agencies (see above) and/or private property owners
DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT									
Temporary BMPs	M	L	L	L	✓	n/a	Varies	L	Primarily implemented by gov't agencies: City DFM, State DOT-HWYS, Army, Navy

- Table continued on next page -

TABLE 31. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR DEVELOPED AREAS MANAGEMENT PRACTICES (CONTINUED)

	<i>Pollutant Reduction</i>						<i>Cost</i>	<i>Maintenance</i>	<i>Implementation Considerations</i>
	<i>Sediments</i>	<i>Nutrients</i>	<i>Bacteria</i>	<i>Other</i>	<i>Flooding*</i>	<i>Groundwater Conservation*</i>			
Permanent/ Structural BMPs	M/H	L/M	Varies	L	✓	n/a	Varies	Varies	Primarily implemented by gov't agencies (see above); also can be implemented by property owners
Behavioral/ Action-Based Practices: Good Housekeeping, Landscape Maintenance, & Discharge Prevention	M	L	L	L	n/a	n/a	n/a	Varies	Applicable to gov't agencies as well as private property owners
Infrastructure Inspection & Maintenance	M	L	L	L	✓	n/a	Varies	M	Conducted by gov't agencies: City DFM, State DOT-HWYS, Army, Navy
DEVELOPED AREAS MEASURE #4: STREAM, RIPARIAN, AND WETLAND MANAGEMENT									
Streambank Protection & Stabilization	H	L	L	L	✓	n/a	Varies	Varies	
Stream Habitat Restoration	M	L	L	L	✓	n/a	Varies – \$200-10,000/acre	M	Could be community project; see Ch. 4
Vegetated Treatment Systems	M	L	L	L	✓	n/a	Varies – e.g. \$8/ft (vegetative barrier); \$1,200/acre (riparian forest buffer)	L	
Stream Cleanups	L	L	L	L	n/a	n/a	n/a	L	Could be community project; see Ch. 4
DEVELOPED AREAS MEASURE #5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT									
Development Design	M	M	M	M	✓	n/a	Varies	L	
Low-Impact Development Practices	M	M	M	M	✓	✓	Varies	L/M	Required for projects over 1 acre

* Checked if practice has a beneficial effect on flooding/groundwater conservation;

Notes: 'L' = Low; 'M' = Medium; 'H' = High

3.3.4 PRIORITY MANAGEMENT MEASURES BY WATERSHED

Table 32 presents the prioritization of the five management measures for Developed Areas by watershed. The prioritization of watersheds for specific management measures was determined based off the priorities for managing pollutants that were presented in *Volume 1* of this WBP (Table ES-2 or Table 57). It should be noted that funding for implementing management measures in specific watersheds should not be limited to those that are indicated as “priority” in the table since implementing any management measure in any applicable watershed will have benefits on water quality.

TABLE 32. APPLICABILITY AND PRIORITIZATION OF DEVELOPED AREAS MANAGEMENT MEASURES BY WATERSHED

		<i>Ki'iki'i Stream System</i>			<i>Paukauila Stream System</i>		
		<i>Ki'iki'i</i>	<i>Kaukonahua</i>	<i>Poamoho</i>	<i>Paukauila</i>	<i>Helemano</i>	<i>Ōpae'ula</i>
DEVELOPED AREAS MANAGEMENT MEASURES	#1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING		P				
	#2: NONPOINT SOURCE WASTEWATER TREATMENT	P	P	x	P	x	
	#3: STORMWATER MANAGEMENT	P	P	P	P		
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	P	P	x	P	x	
	#5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT	P	P	x	P	x	

Notes: 'P' denotes priority watersheds

'x' denotes applicable watersheds

Shaded cells are watersheds in which the management measure is not applicable/recommended

3.3.4.1 DESCRIPTION OF PRIORITIES

This section presents more information about the priority watersheds for each management measure, along with any known opportunities for implementing practices.

DEVELOPED AREAS MEASURE #1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING

Implementing practices that help achieve the “Point Source Wastewater Treatment and Recycling” management measure will reduce the quantity and improve the quality of pollutants generated by wastewater treatment plants with NPDES permits to discharge into waterbodies. Kaukonahua Watershed is the only applicable watershed (and also the priority) for implementing practices associated with this measure.

Opportunities for Implementation:

Kaukonahua

- While the quality of the effluent from the Wahiawā WWTP already meets R-1 standards (median fecal coliform limit of 2.2 per 100 ml), the WWTP should complete the necessary upgrades in order to meet all State standards for R-1 water (i.e. constructing a secondary containment system). Once the R-1 classification is determined, the water in the Wahiawā Reservoir and the Wahiawā Irrigation System can then be used for irrigation of a wider variety of crops than currently allowed water. Efforts to increase the use of the recycled water from the WWTP for irrigation purposes should be supported.
- If the demand for R-1 water for irrigation is high enough, it may be possible to discontinue discharge of the effluent from the Wahiawā WWTP into the reservoir (plans are currently underway to develop a pipeline to transport the R-1 water to the former Galbraith Estate lands for irrigation).

DEVELOPED AREAS MEASURE #2: NONPOINT SOURCE WASTEWATER TREATMENT AND RECYCLING

Implementing practices that help achieve the “Nonpoint Source Wastewater Treatment and Recycling” management measure will reduce pollutants in waterbodies that are associated with private on-site sewage disposal systems and wastewater injection wells, including nutrients, bacteria, and other pathogens. Ki’iki’i, Kaukonahua, and Paukauila watersheds are priorities for implementing practices associated with this measure because they have the largest populations of people that are not served by the major WWTPs and consequently have the most cesspools and other types of OSDs.

Opportunities for Implementation:

Ki’iki’i

- According to data from the DOH, out of the 220 cesspools that are in the Ki’iki’i Watershed, only one cesspool potentially qualifies for the tax credit (eligibility certification required). There should be increased incentives for other property owners in the Ki’iki’i Watershed to upgrade their cesspools (refer to Ch. 2 for more on this topic).
- Some of the recommended alternatives to the current wastewater treatment practices in the Waialua area that were recommended in the 2012 NSRWWAP include:
 - Forming a on onsite maintenance district;
 - Developing neighborhood cluster systems with reuse; and
 - Sewering commercial/residential areas for treatment/water reuse.These alternatives should be considered.

Kaukonahua

- There are 196 cesspools in the Kaukonahua Watershed, 77 of which are eligible for the tax credit and 12 of which are potentially eligible (certification required). There should be increased incentives for other property owners in the Kaukonahua Watershed to upgrade their cesspools (see Ch. 2).

Paukauila

- There are 207 cesspools in the Paukauila Watershed, 20 of which are potentially eligible for the tax credit (certification required). There should be increased incentives for other property owners in the Paukauila Watershed to upgrade their cesspools (see Ch. 2).

- Some of the recommended alternatives to the current wastewater treatment practices in the Haleʻiwa area that were recommended in the 2012 NSRWWAP include:
 - Upgrading cesspool systems to septic systems;
 - Developing neighborhood cluster systems with reuse;
 - Upgrade existing private/commercial wastewater treatment systems; and
 - Sewering commercial/residential areas for treatment/water reuse.

These alternatives should be considered.

DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT

Implementing practices that help achieve the “Stormwater Management” measure will reduce many types of pollutants that are transported in stormwater runoff, including sediments, nutrients, pesticides, bacteria, hydrocarbons, and many others. Kiʻikiʻi, Kaukonahua, and Paukaula watersheds are priorities for implementing practices associated with this measure because they contain the most populated areas, including the towns of Waialua, Haleʻiwa, Wahiawā, and Schofield Barracks. The Poamoho Watershed is also a priority because the Developed Areas within the watershed were found by the model to produce the most nitrogen and phosphorus than Developed Areas within the other watersheds (see section 7.3.2 of *Volume 1*). These four watersheds also had the most acres of impervious surfaces in the project area (see section 2.6, Table 9 in *Volume 1*). Note that with the new City and Army regulations that require LID for certain projects, there will be an increase in LID features (permanent BMPs).

Opportunities for Implementation:

Kiʻikiʻi

- The planning team was not able to determine any specific locations for stormwater management practices in the Kiʻikiʻi Watershed, although this does not indicate that none exist. It is likely that all four of the main types of stormwater practices presented in Table 28 would be applicable and beneficial in certain areas.

Kaukonahua

- There are numerous potential projects in listed for the Kaukonahua Watershed in the City’s “Action Plan for Retrofitting the Existing MS4 with Structural BMPs,” including several BMPs at the Wahiawā Fire Station and the Wahiawā Police Station (trench drain filters, drain inlet filters, seepage wells, replanting vegetation, and grass swales) and roadway shoulder improvement projects to control erosion at three locations in Wahiawā.
- The Army’s 2015 Annual Stormwater Report identified a number of sites in the developed areas of Schofield Barracks that require permanent erosion control BMPs; the Army Department of Public Works (DPW) is seeking funding to implement all necessary projects.
- The planning team was not able to determine any specific locations for many of the other types of stormwater management practices in the Kaukonahua Watershed, although this does not indicate that none exist. It is likely that all four of the main types of stormwater practices presented in Table 28 would be applicable and beneficial in certain areas.

Poamoho

- According to the Navy’s 2016 Storm Water Annual Report, additional erosion control BMPs could be implemented at the Navy’s JBPHH-Wahiawā Annex to lower turbidity loads in

stormwater as it flows towards the North Fork of Upper Kaukonahua Stream (to aid in compliance with the WLAs set in place by the Upper Kaukonahua TMDL study). Examples of suitable BMPs include revegetating poorly vegetated areas and installing geotextile fabric material to reduce erosion.

- No other specific locations for stormwater management practices to be implemented in the Poamoho Watershed were determined, although this does not indicate that none exist. It is likely that all four of the main types of stormwater practices presented in Table 28 would be applicable and beneficial in certain areas. Developed Areas in the Poamoho Watershed include the Helemano Military Reservation, the JBPHH-Wahiawā Annex, and the area around the Dole Visitors' Center.

Paukauila

- The City's "Action Plan for Retrofitting the Existing MS4 with Structural BMPs" indicates a potential BMP retrofit project (installing 23 trench drain filters) at the Waialua fire station.
- The planning team was not able to determine any specific locations for many of the other types of stormwater management practices in the Paukauila Watershed, although this does not indicate that none exist. It is likely that all four of the main types of stormwater practices presented in Table 28 would be applicable and beneficial in certain areas.

DEVELOPED AREAS MEASURE #4: STREAM AND RIPARIAN AREA MANAGEMENT

Implementing practices that help achieve the "Stream and Riparian Area" management measure will prevent erosion of riparian areas and reduce the transport of sediments, nutrients, and other organic material into streams. Ki'iki'i, Kaukonahua, and Paukauila watersheds are priorities for implementing practices associated with this measure because they contain the most populated areas and have streams that run right through those areas.

Opportunities for Implementation:

Ki'iki'i, Kaukonahua & Paukauila Watersheds

- The planning team was not able to determine any specific locations for stream and riparian area management practices in Developed Areas of the watersheds.
- However, each of the practice types listed in Table 29 (streambank protection/stabilization, habitat restoration, vegetative treatment systems, and stream cleanups) would certainly be applicable/feasible in some areas.



The lower reaches of the streams in the Kaiaka Bay Watersheds are visibly polluted with excessive turbidity, sediments, and other pollutants. Pictured here is 'Ōpae'ula Stream in Hale'iwa (Paukauila Watershed); notice the erosion taking place along the streambank and lack of a vegetative buffer between the parking area and the stream. This location may be a potential location for implementing one or more practices (e.g. a vegetated treatment system such as a riparian buffer).

DEVELOPED AREAS MEASURE #5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT

Implementing practices that help achieve the “Planning New Development and Retrofitting Existing Development” measure will reduce pollutants that are common in urban runoff, including sediments, nutrients, bacteria/pathogens, and miscellaneous chemical contaminants. Ki’iki’i, Kaukonahua, and Paukaula watersheds are priorities for implementing practices associated with this measure because they contain the most populated areas (Waialua, Hale’iwa Wahiawā, and Schofield Barracks), which are also the areas where the most development will occur. Note that with the new City and Army regulations that require LID for certain projects, there will be an increase in LID.

Opportunities for Implementation:

Ki’iki’i

- The planning team was not able to determine any specific locations for practices related to new development or retrofitting existing development in the Ki’iki’i Watershed, although this does not indicate that none exist. Both practice types listed in Table 30 would certainly be applicable/feasible in some areas.

Kaukonahua

- The planning team was not able to determine any specific locations for practices related to new development or retrofitting existing development in the Kaukonahua Watershed, although this does not indicate that none exist. Both practice types listed in Table 30 would certainly be applicable/feasible in some areas.

Paukaula

- As described in *Volume 1* of this WBP (section 3.3.4), there are several proposed development projects for the Hale’iwa area; these projects most likely have opportunities to implement practices applicable to this management measure.
- The planning team was not able to additional locations for practices related to this management measure in the Paukaula Watershed, although this does not indicate that none exist. Both practice types listed in Table 30 would certainly be applicable/feasible in some areas.

3.4 ARMY TRAINING AREAS

Army Training Areas, as classified in this WBP, include the U. S. Army’s Schofield Barracks West Range and East Range in the Kaukonahua Watershed (refer to Figure 3). These areas are used for live fire (West Range only) and maneuver training to accomplish the Army’s training objectives. This land use type is part of two different State Land Use Districts: The Agriculture District and the Conservation District. Army Training Areas account for approximately 12% of the total area in the Kaiaka Bay Watersheds (Table 33). Kaukonahua Watershed is the only watershed with this land use type (6,298 acres). Refer to section 7.3.1 of *Volume 1: Watersheds Characterization* for a more detailed description of the Army Training Areas land use type.

TABLE 33. ARMY TRAINING AREAS IN THE KAIKA BAY WATERSHEDS

	WATERSHED	ACRES	% OF WATERSHED	TOTAL ACRES
Ki'iki'i System	Ki'iki'i	0	0%	592
	Kaukonahua	6,298	25%	25,159
	Poamoho	0	0%	11,675
Paukauila System	Paukauila	0	0%	865
	Helemano	0	0%	9,353
	'Ōpae'ula	0	0%	3,810
	Total Acres	6,298	<i>n/a</i>	51,454
	% of Project Area	12%	<i>n/a</i>	100%

3.4.1 OVERVIEW OF POLLUTANTS & POLLUTANT SOURCES

There is little water quality data available for waterbodies in or near the areas classified as Army Training Areas in this WBP, however, it is known that sediments, nutrients, and other pollutants can be generated as a result of land use and training activities. Known and suspected nonpoint sources of these pollutants are briefly described below. For further details, please refer to *Volume 1: Watersheds Characterization*.

3.4.1.1 SEDIMENTS & TURBIDITY

While water quality data for water bodies in Army Training Areas is limited, the State's 2014 303(d) list indicates that Upper Kaukonahua Stream, including the North Fork and South Fork of the stream, is impaired with excessive turbidity. TMDLs were developed for Upper Kaukonahua Stream and were approved in 2010 (refer to section 4.4 of *Volume 1: Watersheds Characterization*). The stream runs through Schofield Barracks East Range, located in lower elevation forests of the Ko'olau range.

Analysis of the modeling results for sediments shows that areas classified in this WBP as Army Training Areas contributing 7% of the total sediments for the project area. A large portion of the sediments generated in Army Training Areas are likely coming from areas of exposed soil. An area of land classified as "bare ground" by the C-CAP dataset used in the model is located in Schofield Barracks West Range, in the Kaukonahua Watershed. The Kaukonahua Watershed has the most area classified as "bare ground" out of any other watershed, most of which is located in the Army Training Area.

SOURCES

Disturbance from Army training activities can alter drainage patterns and stream hydraulics, thereby increasing soil erosion and transport to nearby streams (DOH, 2009). In the forests of the East Range, the Army conducts "jungle training" as well as other maneuver training (no live-fire permitted in East Range). These training activities likely accelerate erosion in some places due to the combination of steep slopes, easily erodible soils (Helemano series), and disturbing the land cover or surface drainage. In the West Range, the Army conducts live-fire training as well as other types of training activities. These land

uses may also increase erosion rates in some places (e.g. along roads). In addition, the Army conducts prescribed burns to maintain West Range as well as to reduce fuel-loads and the chances of incidental fires. After prescribed burns, there may be exposed soils may

The Integrated Training Area Management (ITAM) program at Schofield Barracks is currently identifying and classifying erosion hot spots in order to support the selection and implementation of management practices in priority areas.

PRIORITY WATERSHEDS

There is only one watershed with land that is classified in the Army Training Area land type, therefore, the priority watershed for reducing sediments in this land use type is Kaukonahua Watershed

3.4.1.2 NUTRIENTS

Upper Kaukonahua Stream, which runs through Schofield Barracks East Range, is listed on the State's 2014 303(d) list as being impaired with total nitrogen. TMDLs for Upper Kaukonahua Stream were developed and approved in 2010 (refer to section 4.4 of *Volume 1: Watersheds Characterization*). There is little other data available regarding nutrient levels in waterbodies in Army Training Areas.

Analysis of the modeling results for nutrients shows that Army Training Areas contributing less than 1% of the total nitrogen and less than 1% of the total phosphorus for the whole project area.

SOURCES

A large portion of the nutrients generated in Army Training Areas are likely coming from areas with steeper slopes and higher rainfall, such as in Schofield Barracks East Range. Additionally, areas with exposed soil (e.g. from training activities, after prescribed burns, or along roads/trails) are likely sources of nutrients since erosion of soils is closely associated with the transport of nutrients.

PRIORITY WATERSHEDS

There is only one watershed with land that is classified in the Army Training Area land type, therefore, the priority watershed for reducing nutrients in this land use type is the Kaukonahua Watershed.

3.4.1.3 OTHER POLLUTANTS

The Army Training Areas may be a source of pesticides and other chemical pollutants. These chemicals could include petroleum hydrocarbon fuels, lubricants, spills from vehicles, or legacy pollutants from past training activities.

SOURCES

Pesticides are applied occasionally in select areas for range management as a pre-treatment to prescribed burn areas to improve the effectiveness of the burn. Other chemical pollutants could be generated from past or current training activities in Schofield Barracks East Range or West Range, from tactical vehicles used for training purposes, or from historic waste sites.

PRIORITY WATERSHEDS

The goals of the WBP state that pollutants other than sediments and nutrients should be addressed opportunistically or as deemed necessary. Pesticide use in Army Training Areas is not considered a significant issue and therefore is not a priority to address in this plan. Furthermore, it is not a focus of this plan to address specific training strategies or historic land uses, therefore, no watershed is identified as a priority in this WBP.

3.4.1.4 SUMMARY OF POLLUTANT SOURCES AND PRIORITY WATERSHEDS IN ARMY TRAINING AREAS

Table 34 provides a summary of the pollutants of concern, the primary sources of the pollutants, and the priority watersheds for the pollutants of concern in Army Training Areas.

TABLE 34. POLLUTANTS, POLLUTANT SOURCES, AND PRIORITY WATERSHEDS IN ARMY TRAINING AREAS

Primary Factors That May Contribute Pollutants (all NPS)	Pollutants of Concern	Priority Watersheds: Sediments	Priority Watersheds: Nutrients	Priority Watersheds: Other Pollutants
<ul style="list-style-type: none"> • Natural erosion processes • Feral ungulates • Nonnative & invasive plants • Army training activities • Forest fires • Controlled burns and other fires 	<ul style="list-style-type: none"> • Sediments and turbidity • Nutrients • Bacteria (from animals and natural sources) 	<ul style="list-style-type: none"> • Kaukonahua 	<ul style="list-style-type: none"> • Kaukonahua 	None

3.4.2 MANAGEMENT MEASURES & PRACTICES

This section describes some the key management measures that could be implemented to reduce pollutant loads coming from Army Training Areas in the Kaiaka Bay Watersheds. The results of implementing the associated practices can help to improve water quality in streams.

For each management measure, several applicable management practices are listed that could help accomplish the objective of the measure. The measures and practices presented below are derived from a variety of sources, including:

- NRCS FOTG conservation standards for the Pacific Islands Area;
- Information and materials provided by the OANRP, under the Army Department of Public Works Environmental Division;
- Publicly available Army Standing Operating Procedures;
- “Chapter 4: Management Measures for Urban Areas” in *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1993);
- “Storm Water Permanent Best Management Practices Manual” (DOT-HWYS, 2007)
- Personal communication with various individuals; and

- Practices from “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996).

For each management measure, several applicable management practices are listed that could help accomplish the objective of the measure. Where possible, references to any applicable NRCS FOTG standards (and associated three-digit code) and/or other documented practices are cited for further information.

ARMY TRAINING AREAS MEASURE #1: FIRE PREVENTION AND MANAGEMENT




Primary Pollutants Targeted: Sediments (including turbidity)

Objective: Prevent fires to reduce post-fire erosion and runoff; improve fire management and response to reduce duration and intensity of fires thereby reducing post-fire runoff; increase post-fire restoration activities to speed up ecosystem recovery.

Description: This management measure includes practices that aim to prevent wildfires in the Army’s training areas (Schofield Barracks East Range and West Range), improve fire management and response to fires, and increase post-fire restoration activities to speed up recovery of ecosystem. The general intention of this management measure is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Fire ignition has been identified as one of the two most important threats that face natural resources in the area that could be impacted by Army training activities (U. S. Army Garrison Hawai‘i, 2010). Kaukonahua is the only applicable watershed for this management measure.

Practices: There are three main types of management practices that apply to the “Fire Prevention and Management” measure in Army Training Areas (Table 35). These practice types are based off NRCS FOTG standards and “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996) that can be referenced for more information (the DLNR document is written for forestry lands but lists relevant practices for other undeveloped areas, such as Army Training Areas). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 38 (section 3.4.3).

TABLE 35. PRACTICES FOR ARMY TRAINING AREAS MEASURE #1: FIRE PREVENTION AND MANAGEMENT

Practice Type	Description	Example Image	Examples of Applicable Practices
A Fire/Fuel Breaks	Creating strips or blocks of land where the vegetation, debris, and detritus have been reduced or modified to control/diminish the risk of fire crossing the area		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Wildfire damage control and reclamation (pg. 22) • Fireline construction and maintenance (pg. 23) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Fire break (#394) • Forest trails and landings (#655) • Fuel break (#383)
B Prescribed Burns & Vegetation Management	Reducing fire-prone vegetation to slow or stop fires from spreading; accomplished by prescribed burns, continued removal/ maintenance, or replacing with less fire-prone vegetation		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Prescribed burn (pg. 24) <u>NRCS Standards:</u> <ul style="list-style-type: none"> • Brush management (#314) • Herbaceous weed control (#315)
C Post-Fire Restoration	Practices that aim to restore groundcover and prevent the recruitment of fire-prone species, such as guinea grass; especially pertains to establishing native forest species suitable to the area		<u>DLNR (1996):</u> <ul style="list-style-type: none"> • Reforestation (pg. 24) • Wildfire damage control and reclamation (pg. 22)

Identified Existing Activities for Each Practice Type:

A. Fire/Fuel Breaks

The Army maintains a road that serves as a fire break between West Range and the forested areas mauka of West Range (the slopes of Mt. Ka'ala). The Army strives to design and construct their firebreaks in a manner that minimizes any negative environmental effects to the extent feasible.

B. Prescribed Burns and Vegetation Management

The Army's Wildland Fire program under the Directorate of Emergency Services typically conducts a prescribed burn every May at Schofield Barracks West Range to prevent



An aerial view of the firebreak road located at Schofield Barracks West Range; the grassy area to the left is typically part of the annual prescribed burn.

accidental fires by reducing fuel loads. The prescribed fires typically burn between 1,200 and 1,600 acres of land in West Range. During the prescribed burn, Army firefighters monitor the burn and ensure that no fires are spread above the firebreak road that divides West Range and forested areas mauka of it and they also monitor to ensure that the fire does not spread into neighboring areas. The fire typically burns out after a few days once the fuel loads are depleted. It has been estimated that prescribed burns at Schofield can reduce wildfire outbreaks by as much as 75 percent over the year (U. S. Army Garrison-Hawai'i Public Affairs, 2015). One Army firefighter informed the planning team that he has not observed a significant increase in erosion after the fires and does not believe the prescribed burns have long-term negative effects on surface water quality.



Invasive grasses, such as guinea grass, can be managed using prescribed burns or herbicide. Image courtesy of K. Kawelo; Army Environmental Division.

Occasionally, the Environmental Division will conduct an aerial herbicide spray in West Range (below the firebreak road) using a boom sprayer on a helicopter to reduce fuel loads. This is sometimes done prior to a planned prescribed burn to improve the efficacy of the fire, however, in recent years there has not been an aerial spray at Schofield. To reduce the risk of contaminating waterbodies, herbicide application is not conducted during rainfall and the minimum amount of herbicide that is necessary is applied. Additionally, selected herbicides have a high rate of breakdown in the environment (U. S. Army Garrison-Hawai'i, 2010).

C. Post-Fire Restoration

The Army's fire program does not typically conduct restoration activities after fires, however, they may do a post-fire analysis survey depending on the fire's location and the vegetation damaged. If a survey is deemed necessary, the fire crew coordinates with the Environmental Division (e.g. OANRP) and/or personnel from the Integrated Training Area Management office.

If any important natural resources have been affected by a wildfire, the O'ahu Army Natural Resources Program may respond by conducting restoration projects such as outplanting or weed control, depending on factors such as the extent of the damage, the species affected, and the location of the fire. See "Forest Lands Measure #2: Fire Prevention and Management" for a discussion of fire management and post-fire restoration in Forest Lands.

ARMY TRAINING AREAS MEASURE #2: PREVENTING THE SPREAD OF INVASIVE PLANTS




Primary Pollutants Targeted: Sediments (including turbidity)

Objective: To protect ecosystems from the harmful effects of invasive plants, including preventing erosion and maintaining hydrological functions to reduce sediment-laden runoff.

Description: This management measure includes practices that are designed to prevent or reduce the spread of invasive plants in and between Army Training Areas. The introduction of nonnative and invasive species, such as weeds and pest animals, has been identified as one of the two most important threats that face natural resources in the area that could be impacted by Army training activities (U. S. Army Garrison Hawai'i, 2010). The primary pollutant targeted by this management measure is sediment, however, there may be other benefits if erosion and excessive runoff is prevented (e.g. nutrients and bacteria). Kaukonahua is the only applicable watershed for this management measure.

Practices: There are three main types of management practices that apply to the “Preventing the Spread of Invasive Plants” management measure (Table 36). These practice types are based off official Army SOPs, practices recommended by the O’ahu Invasive Species Committee, and NRCS FOTG standards. However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. More information about implementing these practice types can be found in Table 38 (section 3.4.3).

TABLE 36. PRACTICES FOR ARMY TRAINING AREAS MEASURE #2: PREVENTING THE SPREAD OF INVASIVE PLANTS

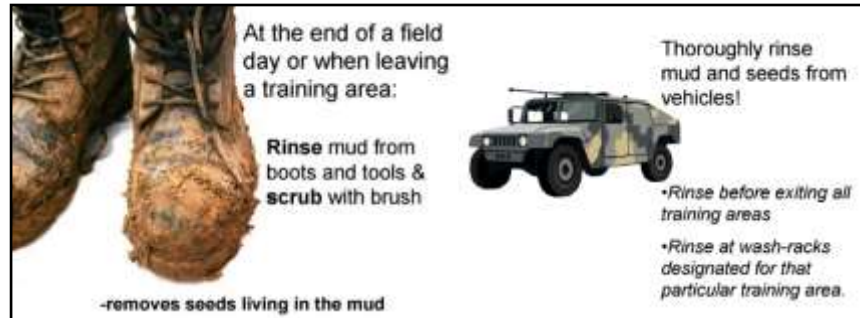
Practice Type	Description	Example Image	Examples of Applicable Practices
A Boot, Gear, & Vehicle Cleaning	Mud and debris on field gear and vehicles can contain seeds and other materials from invasive plants; cleaning gear and vehicles can help to prevent the spread of invasive plants	 Image: Heidi Howard	n/a – Note: Army personnel receive regular trainings and briefings on these practices; participation is required and there can be consequences if rules not followed
B Access Control	Restricting access to ecologically sensitive areas and areas that are known to have highly invasive species present		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Access control (#472) Note: Army personnel receive regular trainings and briefings on the subject; participation is required and there can be consequences if rules not followed
C Monitoring & Controlling	Surveying vegetation to detect invasive species; killing/removing invasive species when found (using herbicide or manual removal techniques)		<u>NRCS Standards:</u> <ul style="list-style-type: none"> • Brush management (#314) • Herbaceous weed control (#315) • Forest stand improvement (#666)

Identified Existing Activities for Each Practice Type:

A. Boot, Gear, and Vehicle Cleaning

Soldiers and other military personnel are required to clean their boots and field gear after exiting training areas. It is also a requirement that vehicles be washed at wash racks upon exiting the training areas. If applicable rules are not followed, soldiers can lose access to training ranges. Soldiers are given “Field Cards” that provide information on proper range usage, including emphasizing the importance of cleaning gear and vehicles.

There are two vehicle wash racks at Schofield Barracks: The Central Vehicle Wash Facility and the East Range wash rack. Equipment used in East Range must be washed at the East Range wash rack before being used at another training area, however, it is ideal if the equipment just stays at East Range.



Outreach material used to inform Army personnel about how they are required to do their part to prevent the spread of invasive plants; Images courtesy of OANRP, Army Environmental Division.

B. Access Control

When Army Environmental (i.e. OANRP) discovers an area that has an infestation of an incipient invasive species, the area is marked with Siebert stakes (an “incipient” invasive species is one that is not yet widespread but has the potential to spread quickly and degrade ecosystems). OANRP regularly briefs the Army on specific sites in East Range and West Range that ideally would be avoided by soldiers and maintenance personnel; these briefings are required for certain Army personnel. While these sites are not officially excluded from training, there is an agreement that sites marked with signs and cones will generally be avoided.

Signs that say, “No Mowing,” are also placed in areas where there is the risk of landscaping/maintenance personnel inadvertently spreading invasive species. OANRP coordinates vegetation management needs with ITAM in these situations.



Image courtesy of OANRP, Army Environmental
A “No Mowing” sign placed in East Range to prevent the spread of invasive plants.

Additionally, when new projects or training activities are proposed in the ranges, Army Environmental/OANRP is consulted beforehand.

C. Monitor & Control

OANRP staff spend hundreds of hours each year surveying and controlling for incipient weeds in Army Training Areas. Range access roads are surveyed annually to monitor for incipient weeds. East Range requires the most attention since a diverse array of weeds not found on other Army lands have been found there. In 2016, OANRP spent 349 person-hours in East Range alone controlling incipient weeds (OANRP, 2016). The majority of the hours went toward the control of *Schizachrium condensatum*, an invasive grass.

ARMY TRAINING AREAS MEASURE #3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS




Primary Pollutants Targeted: Sediments (including turbidity)

Objective: To reduce and prevent the generation and transport of pollutants from roads, trails, and other frequently used areas in Army Training Lands into streams.

Description: This management measure includes practices that are guidelines for constructing and maintaining roads and trails in Army Training Areas. It also includes practices to control access to ecologically sensitive areas, such as areas with excessive erosion or areas near waterways. The general intention is to reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Kaukonahua is the only applicable watershed for this management measure.

Practices: There are three main types of management practices that apply to the “Erosion Management Along Roads, Trails, and Frequently Used Areas” measure in Army Training Areas (Table 37). These practice types are based off NRCS FOTG standards and “Best Management Practices for Maintaining Water Quality in Hawai‘i” (DLNR, 1996) that can be referenced for more information (the DLNR document is written for forestry lands but lists relevant practices for other undeveloped areas, such as Army Training Areas). However, the applicable practices should not be limited to only the standards/practices listed; any practice that fits into the general practice type and objective potentially qualifies. For example, the USFWS and the EPA have co-funded a manual of procedures to enhance stability and maintain unpaved roads while reducing sedimentation and improving water quality, titled “Recommended Practices Manual: A Guideline for Maintenance and Service of Unpaved Roads” (CPYRWMA, 2000). This manual contains a comprehensive list of management practices that can be helpful in providing additional guidance for how to best maintain unpaved roads. More information about implementing practice types in the table below can be found in Table 38 (section 3.4.3).

TABLE 37. PRACTICES FOR ARMY TRAINING AREAS MEASURE #3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS

Practice Type	Description	Example Image	Examples of Applicable Practices
A	Road/Trail Design & Maintenance	Forest roads and trails should be designed and maintained to minimize impacts to the watershed; includes BMPs to minimize, divert, and filter runoff from roads/trails as well as other frequently used areas	 <ul style="list-style-type: none"> • Access road (#560)[◊] • Diversion (#362)[◊] • Filter strip (#393)[◊] • Forest roads – design (pg. 8), construction (pg. 9) * • Forest roads – maintenance (pg. 11) * • Forest trails and landings (#655)[◊] • Grassed waterway (#412)[◊] • Stream crossing (#578)[◊] • Streamside management zones (pg. 19) * • Stormwater runoff control (#570)[◊]
B	Prevent/Address Erosion During & Post Training	Implement temporary and/or permanent BMPs to prevent/address erosion along roads, trails, and other frequently used areas	 <p><u>Temporary BMPs:</u></p> <ul style="list-style-type: none"> • Erosion control blankets/mats/mulch*†‡ • Diversion/swales/water bar *† • Fiber rolls/sandbag barrier/bio-sock † • Retaining walls † • Silt fence† • Wind erosion controls† <p><u>Permanent BMPs:</u></p> <ul style="list-style-type: none"> • Filter strips (#393)[◊]†‡ • Grassed swales (wet, dry) ‡ • Grassed waterway (#412)[◊]‡ • Infiltration trench/basin†‡ • Seeding/hydromulch/critical area planting (#342) *◊‡ • Sediment basin (#350)[◊] • Vegetative barrier (#601)[◊]‡ • Other permanent BMPs ‡ <p><u>Other/General:</u></p> <ul style="list-style-type: none"> • Misc. construction/post-construction BMPs†‡ • Stormwater runoff control (#570)[◊]
C	Limit Access to Eroding Areas	Restrict access to areas with excessive erosion or areas prone to erosion near waterways	 <ul style="list-style-type: none"> • Access control (#472)[◊]

Sources:

* "Best Management Practices for Maintaining Water Quality in Hawai'i" (DLNR, 1996)

◊ NRCS Standard (Standard No.)

† "Chapter 4: Management Measures for Urban Areas" (EPA, 1993)

‡ "Storm Water Permanent Best Management Practices Manual" (DOT-HWYS, 2007)

Identified Existing Activities for Each Practice Type:

A. Road/Trail Design & Maintenance

Roads in the Army Training Areas are managed either by the Army's Department of Public Works or by ITAM, which is part of the Army's Range Division. DPW is responsible for overall land maintenance on the ranges, including the main roads within the ranges, while ITAM is responsible for maintaining the smaller "maneuver trails" that are spur roads off the main roads in the East Range training area. ITAM also maintains the land in East Range as it pertains to impacts from "maneuver training." West Range does not have on-the-ground training since it is a live fire training range; soldiers stand at a firing point and shoot at targets (no maneuver training). In managing the small "maneuver trails" (roads) in East Range, ITAM uses best management practices such as:

- Using take-off channels to direct the flow of storm water off the road via aggregate channels to stable vegetated areas;
- Hardening and shaping road surfaces to mitigate storm water erosion; and
- Hydroseeding bare ground along roads utilizing flexible growth medium (hydroseeding refers to seeds that are broadcast in a flexible growth medium slurry).



Two examples of practices implemented in Schofield Barracks East Range: Sediment pit (top); Broad-based dip for channeling and directing stormwater (bottom)

B. Prevent/Address Erosion During and Post Training

ITAM conducts annual surveys of areas that are frequently used in East Range (e.g. helicopter landing zones and open fields that are utilized for training) to identify areas that need maintenance. Maintenance may involve back filling, grading, and/or recontouring, followed by hydroseeding.

ITAM is currently conducting a thorough, on-the-ground assessment of issues and identifying "hot spots" for management. For every location, characteristics about the site are recorded so that ITAM can later prioritize management. The information recorded includes observations about the surrounding vegetation types, the canopy cover, the topography, and proximity to water bodies. The hot spots are GPS'd and mapped using GIS. The last time ITAM did this kind of thorough assessment was in 2010/2011.

C. Limit Access to Eroding Areas

No specific examples of how access to eroding areas is restricted/limited in Army Training Lands were identified by the planning team, however, this does not necessarily indicate that none exist.

3.4.3 MANAGEMENT PRACTICE EFFECTIVENESS & IMPLEMENTATION CONSIDERATIONS

Table 38 presents qualitative assessments of the effectiveness each practice type has on specific pollutants. Pollutant load reduction effectiveness is presented on a scale of “low,” (L) “medium” (M) and “high” (H). Cost estimates for specific practices are presented when data was available. The information in the table is based on literature review (including the NRCS CPPE matrix and NRCS FOTG spreadsheets for the Pacific Islands region), consultation with service providers and stakeholders, and professional judgment. Additionally, the table indicates whether or not each practice also has a beneficial effect on flooding or on groundwater conservation, since these issues are important community concerns but are not directly addressed in this WBP.

TABLE 38. EFFECTIVENESS, RELATIVE COST, AND IMPLEMENTATION CONSIDERATIONS FOR ARMY TRAINING AREAS MANAGEMENT PRACTICES

	Pollutant Reduction				Cost	Maintenance	Implementation Considerations
	Sediments	Nutrients	Flooding*	Groundwater Conservation*			
ARMY TRAINING AREAS MEASURE #1: FIRE PREVENTION AND MANAGEMENT							
Fire/Fuel Breaks	M/H	L	n/a	n/a	\$400/acre	M	Short-term negative effects; long-term effects may be significant
Prescribed Burns & Vegetation Management	M	L	n/a	n/a	Varies	M	Short-term negative effects; long-term effects may be significant
Post-Fire Restoration	M/H	M	n/a	✓	Varies: \$200-10,000/acre	M	
ARMY TRAINING AREAS MEASURE #2: PREVENTING THE SPREAD OF INVASIVE PLANTS							
Boot, Gear, & Vehicle Cleaning	L	L	n/a	n/a	n/a	M	Already required; more emphasis needed
Access Control	L/M	L	n/a	n/a	Varies – e.g. \$0.15/ft for signage; \$830 for a gate	L/M	Army ENV (OANRP) conducts this practice
Monitoring & Controlling	L	L	n/a	n/a	Varies: \$200-10,000/acre	M/H	Army ENV (OANRP) conducts this practice
ARMY TRAINING AREAS MEASURE #3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS							
Road/Trail Design & Maintenance	M	L	n/a	n/a	\$18-27/ft	M	
Prevent/Address Erosion During & Post Training	M/H	L	n/a	n/a	n/a	n/a	Army ITAM personnel conduct this practice in East Range; West Range may have opportunities (DPW would implement)
Limit Access to Eroding Areas	M	L	✓	n/a	Varies – e.g. \$0.15/ft for signage; \$830 for a gate	M	

* Checked if practice has a beneficial effect on flooding/groundwater conservation

Notes: ‘L’ = Low; ‘M’ = Medium; ‘H’ = High

3.4.4 PRIORITY MANAGEMENT MEASURES BY WATERSHED

Table 39 presents the prioritization of the three management measures for Army Training Areas by watershed. The prioritization of watersheds for specific management measures was determined based off the priorities for managing pollutants that were presented in *Volume 1* of this WBP (Table ES-2 or Table 57). It should be noted that funding for implementing management measures in specific watersheds should not be limited to those that are indicated as “priority” in the table since implementing any management measure in any applicable watershed will have benefits on water quality.

TABLE 39. APPLICABILITY AND PRIORITIZATION OF ARMY TRAINING AREAS MANAGEMENT MEASURES BY WATERSHED

		<i>Ki'iki'i Stream System</i>			<i>Paukauila Stream System</i>		
		<i>Ki'iki'i</i>	<i>Kaukonahua</i>	<i>Poamoho</i>	<i>Paukauila</i>	<i>Helemano</i>	<i>'Ōpae'ula</i>
ARMY TRAINING AREAS MANAGEMENT MEASURES	#1: FIRE PREVENTION AND MANAGEMENT		P				
	#2: PREVENTING THE SPREAD OF INVASIVE PLANTS		P				
	#3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS		P				

Notes: 'P' denotes priority watersheds

'x' denotes applicable watersheds

Shaded cells are watersheds in which the management measure is not applicable/recommended

3.4.4.1 DESCRIPTION OF PRIORITIES

This section presents more information about the priority watersheds for each management measure, along with any known opportunities for implementing practices.

ARMY TRAINING AREAS MEASURE #1: FIRE PREVENTION AND MANAGEMENT

Implementing practices that help achieve the “Fire Prevention and Management” measure will reduce/prevent erosion and runoff thereby reducing pollutant transport into streams. Kaukonahua Watershed is the only applicable watershed (and also the priority) for implementing practices associated with this measure. GIS analysis indicates that about 20% of the land classified as Army Training Areas is classified as “alien grassland” according to the USGS GAP landcover dataset (approximately 1,271 acres). These areas are scattered throughout West Range and East Range (refer to Figure 11 in *Volume 1* of this WBP for a map of the landcover types in the watersheds). The commonly found grass species are typically very fire-prone, such as guinea grass.

Opportunities for Implementation:

Kaukonahua

- The West Range firebreak road should continue to be maintained.
- The forests in and above the East Range training area could be protected from accidental fire by creating a firebreak.
- The Army should continue to conduct prescribed burns in West Range, however, they should also conduct post-prescribed burn restoration or reseeding in critical areas, such as along drainage ways.
- The Army should reduce fuel loads in other areas by mowing guinea grass and/or replacing fire-prone vegetation with alternative species.
- The Army should also conduct post-fire restoration activities after wildfires or other incidental fires.

ARMY TRAINING AREAS MEASURE #2: PREVENTING THE SPREAD OF INVASIVE PLANTS

Implementing practices that help achieve the “Preventing the Spread of Invasive Plants” in Army Training Areas will help to prevent erosion and reduce sediment-laden runoff. Kaukonahua Watershed is the only applicable watershed (and also the priority) for implementing practices associated with this measure.

Opportunities for Implementation:

Kaukonahua

- The planning team was not able to determine any specific locations for practices related to this management measure, however, the planning team was informed that the Army could improve in its “self-policing” to ensure that new species are not being introduced to the island. “Self-policing” primarily refers the first type of practice listed in Table 36 (inspecting/cleaning gear and vehicles).

ARMY TRAINING AREAS MEASURE #3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS

Implementing practices that help achieve the “Erosion Management Along Roads, Trails, and Frequently Used Areas” management measure will reduce and prevent the generation and transport of pollutants from these areas into streams. Kaukonahua Watershed is the only applicable watershed (and also the priority) for implementing practices associated with this measure.

Opportunities for Implementation:

Kaukonahua

- The planning team was not able to determine any specific locations for implementing this measure, although it is visually apparent that areas of West Range have exposed soils and could benefit from hydroseeding or other permanent BMPs. In fact, there is a large area that is classified as “bare ground” by the dataset used for the watershed modeling in West Range. Additionally, ITAM has been conducting an assessment of erosional areas and will be addressing priority areas.



Schofield Barracks West Range is dominated by nonnative grasses and has noticeably eroding areas

3.5 OVERALL PRIORITIZATION OF MANAGEMENT MEASURES BY WATERSHED

This section presents the overall prioritization of all management measures that were identified for each of the four general land use types in the Kaiaka Bay Watersheds. The overall prioritization builds on the prioritization of individual management measures for each land use type (presented in the previous four sections). In addition, it incorporates additional criteria and sources of information, including:

- **Water Quality Data:** Sources of data include the State 303d list and other sources; see Chapter 5 of *Volume 1: Watersheds Characterization* for details. It should be noted that the water quality data did not provide much information that was used for the overall prioritization since all six watersheds are polluted with excessive nutrients and turbidity (sediments).
- **Watershed Modeling Results:** The planning team used OpenNSPECT to model nonpoint source pollution in the Kaiaka Bay Watersheds; key findings from the modeling are presented in section 7.3.2 of *Volume 1*. The key findings were very useful in providing criteria for the overall prioritization.
- **Goals and Objectives from the State Nonpoint Source Management Plan, 2015 – 2020:** The State NPS plan (DOH PRC, 2015) lists several goals with objectives that are applicable to specific management measures in this WBP. These goals/objectives provided guidance for the overall prioritization.

- **Geomorphic Assessment of Poamoho Stream:** The geomorphology report conducted for this WBP (AECOM, 2016; Appendix A) presented some key findings about sources of sediments/turbidity in the watersheds. The findings and recommendations for improving water quality were incorporated into the prioritization of management measures.
- **Stakeholder Consultation and Feedback:** A variety of different stakeholders were consulted throughout the development of the WBP; important issues and potential solutions were discussed. The prioritization takes into account the findings from the stakeholder consultation process; see Chapter 6 of *Volume 1: Watersheds Characterization* for more information.
- **Professional Judgment:** Includes considerations related to feasibility of implementation, effectiveness of the measure, and other information that has been garnered through the development of this plan. Many management measures were not deemed overall priorities due to these considerations. For example, one reason that the Agricultural Lands Measure #4 (Stream and Riparian Area Management) was not ultimately prioritized for any watershed is because implementing many of the associated practices would be very difficult and efforts are better spent on other measures for Agricultural Lands.

Each measure was assessed independently according to the criteria; they were not evaluated against each other in terms of relative importance.

Using this methodology, nine overall priority measures were identified (shown in **underlined bold** text in Table 40 on the next page). The rationale for prioritizing each of the nine measures is discussed in the following section along with a description of the land use or land type characteristics that are likely to generate/transport pollutants. The descriptions of these “hotspots” can help land managers identify ideal locations to implement the overall priority measures (in addition to the known opportunities for implementation previously described for each measure). The hotspots for specific pollutants in the four land use types were identified and described in *Volume 1: Watersheds Characterization* (Pollutant Source Assessment).

TABLE 40. OVERALL PRIORITIZATION OF MANAGEMENT MEASURES BY WATERSHED

		Ki'iki'i Stream System			Paukauila Stream System		
		Ki'iki'i	Kaukonahua	Poamoho	Paukauila	Helemano	Ōpae'ula
FOREST LANDS	#1: <u>WATERSHED PROTECTION AND FOREST MANAGEMENT</u>		P*	P*		P*	P*
	#2: FIRE PREVENTION AND MANAGEMENT		P	P		x	x
	#3: CONSTRUCTION AND MAINTENANCE OF ROADS AND TRAILS		P	P		x	
AGRICULTURAL LANDS	#1: <u>EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS</u>	P*	P*	P*	P*	x	x
	#2: NUTRIENT MANAGEMENT ON ACTIVELY FARMED LANDS	x	x	P	x	x	x
	#3: PESTICIDE-USE MANAGEMENT	x	x	P	x	x	x
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	x	P	P	x	x	x
	#5: <u>LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT</u>	x	P*	x	x	P*	x
	#6: <u>FIRE PREVENTION</u>	x	P*	P*	x	x	x
	#7: IRRIGATION WATER USE	x	P	P	x	x	x
	#8: <u>FIELD ACCESS ROAD MANAGEMENT</u>	x	P*	P*	x	x	x
DEVELOPED AREAS	#1: POINT SOURCE WASTEWATER TREATMENT AND RECYCLING		P				
	#2: <u>NONPOINT SOURCE WASTEWATER TREATMENT</u>	P*	P*	x	P*	x	
	#3: <u>STORMWATER MANAGEMENT</u>	P*	P*	P*	P*		
	#4: STREAM AND RIPARIAN AREA MANAGEMENT	P	P	x	P	x	
	#5: PLANNING NEW DEVELOPMENT AND RETROFITTING EXISTING DEVELOPMENT	P	P	x	P	x	
ARMY TRAINING AREAS	#1: <u>FIRE PREVENTION AND MANAGEMENT</u>		P*				
	#2: PREVENTING THE SPREAD OF INVASIVE PLANTS		P				
	#3: <u>EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS</u>		P*				

Notes: 'P*' denotes the OVERALL PRIORITY management measures for the watershed

'P' denotes watersheds and management measures that are secondary priorities

'x' denotes watersheds that are applicable to the management measure

Shaded cells are watersheds in which the management measure is not applicable/recommended

3.5.1 NINE OVERALL PRIORITY MANAGEMENT MEASURES

Rationale for Overall Prioritization

FOREST MEASURE #1: WATERSHED PROTECTION AND FOREST MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria

Priority Watersheds: Kaukonahua; Poamoho; Helemano; ‘Ōpae‘ula (*not listed in any particular order for control of sediments; Kaukonahua Watershed is the top priority for nutrient reduction*)

Prioritization Rationale: *Regarding sediments/turbidity* – Data collected at the three USGS water quality gages located in the Kaukonahua Watershed indicate high sediment loads coming out of Forest Lands (in comparison with sediment loads at locations downstream). It is likely that this trend exists in the other three watersheds as well, given that the forest composition, geology, rainfall, and topography are similar for all four watersheds. In support of these findings, the Geomorphology Report concluded that a significant amount of suspended sediments in the streams comes from the mauka, forested areas in each of the watersheds and from the stream channels themselves. Furthermore, the results of the modeling showed that areas classified as “bare ground” produce 43 times more sediments than areas classified as “evergreen forest,” therefore, areas in Forest Lands where soils have been exposed due to human/animal activity or natural causes are more prone to erosion and should be managed.

Regarding nutrients – The results of the watershed modeling indicated that over 95% of the total nitrogen and phosphorus in the Kaiaka Bay Watersheds originate in Forest Lands in the Ko‘olau range. Consequently, one of the key findings from the modeling calls for the protection and management of the forests of the Ko‘olau range to prevent increased nutrient-rich runoff. Kaukonahua Watershed was found to be the top priority, followed by the other three applicable watersheds.

Hotspots for Implementation:

- Areas with little to no ground cover (exposed soils) as a result of human or feral pig activity;
- Degraded ecosystems that are especially susceptible to erosion and/or wildfire (e.g. areas that are dominated by nonnative species and experience high rainfall, have highly erodible soils, and/or steep slopes); or
- Areas with high densities of feral pigs and other invasive species.

Note that in addition to implementing practices in the hotspots described above, it is it is perhaps equally important to protect the most native-dominated ecosystems from further degradation and erosion. These “healthy” areas of the watersheds include the native-dominated high elevation forests in the Ko‘olau range (the entire summit area) and the Mt. Ka‘ala in the Wai‘anae range.

Known Opportunities for Implementation (refer to section 3.1.4.1 for more information):

- Kaukonahua Watershed – Construct a fenced enclosure to protect the forested area on the Ko’olau side of the watershed (Army-owned lands).
- Helemano Watershed – Construct a fenced enclosure that connects the Helemano/‘Ōpae’ula fence to the north with the Poamoho NAR fence to the south.
- Kaukonahua, Poamoho, Helemano, and ‘Ōpae’ula watersheds – Continue and expand efforts to control invasive species.

AGRICULTURE MEASURE #1: EROSION AND SEDIMENT CONTROL FROM ACTIVELY FARMED LANDS

Primary Pollutants Targeted: Sediments (including turbidity)

Priority Watersheds: Poamoho; Kaukonahua; Paukauila; Ki’iki’i (*in approximate order of priority*)

Prioritization Rationale: The results of the watershed modeling indicated that Agricultural Lands are the main source of sediments in the Kaiaka Bay Watersheds, producing 85% of the total sediments and considerably more sediments per acre than the other three land use types. The model also showed that areas classified as “bare ground” produce three times more sediments per acre than areas classified as “cultivated land” and 11 times more than areas classified as “grasslands,” therefore, the highest priority hotspots within Agricultural Lands are large areas with exposed soil, including fields with recently disturbed soils. Poamoho Watershed had the most area classified as “bare ground” within Agricultural Lands. While nutrients are not the primary pollutant targeted by this management measure, implementing practices associated with the measure will also reduce the transport of nutrients into waterbodies. The modeling indicated that Agricultural Lands in the Poamoho Watershed contribute far more nutrients per acre than Agricultural Lands in the other watersheds, therefore, Poamoho Watershed is also the priority for implementing management measures to reduce nutrients in Agricultural Lands.

Implementing this management measure would correspond to Strategy P, “Develop and implement a statewide effort to address agricultural runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Areas with a significant amount of bare/exposed soil;
- Areas without adequate existing practices to control erosion and runoff;
- Fields adjacent to or containing waterways/streams; or
- Areas that are dominated by nonnative species and have highly erodible soils or steep slopes.

Known Opportunities for Implementation (refer to section 3.2.4.1 for more information):

- Kaukonahua Watershed – Implement vegetative practices and management-related practices on OHA/ADC lands (the modeling results indicated this area as a significant source of sediments and there are opportunities for implementing practices since the area is under new management).
- Poamoho – Construct additional sediment basins and detention ponds on Dole lands (Dole expressed the need for more). Implement vegetative management practices.

AGRICULTURE MEASURE #5: LIVESTOCK, RANCHING, AND PASTURELANDS MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; bacteria

Priority Watersheds: Kaukonahua; Helemano (*not listed in any particular order*)

Prioritization Rationale: The reasoning for prioritizing this measure is essentially the same as for Agricultural Lands Measure #1: the modeling indicated that Agricultural Lands are the main source of sediments in the Kaiaka Bay Watersheds. Therefore, reducing erosion and preventing sedimentation in agricultural areas is very important to improve overall water quality.

Implementing this management measure would correspond to Strategy P, “Develop and implement a statewide effort to address agricultural runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Areas with a significant amount of bare/exposed soil;
- Areas without adequate existing practices to control erosion and runoff;
- Areas that are dominated by nonnative species and have highly erodible soils or steep slopes; or
- Areas adjacent to or containing waterways/streams.

Known Opportunities for Implementation (refer to section 3.2.4.1 for more information):

- Kaukonahua Watershed – The slopes below the Forest Lands on Mt. Ka’ala (indicated as “highly erodible;” see Figure 9 in *Volume 1*).
- Helemano Watershed – Pasturelands located mauka and makai of the Army’s Drum Road.

AGRICULTURE MEASURE #6: FIRE PREVENTION

Primary Pollutants Targeted: Sediments (including turbidity)

Priority Watersheds: Kaukonahua; Poamoho (*not listed in any particular order*)

Prioritization Rationale: Since the modeling indicated that Agricultural Lands are the main source of sediments in the Kaiaka Bay Watersheds and much of the land that is not actively being cultivated is covered in nonnative grasses (such as the fire-prone guinea grass), preventing fires will prevent erosion and sediment-laden runoff that occurs after fires. Additionally, preventing fires in Agricultural Lands will also prevent the spread of fires into Forest Lands.

Implementing this management measure roughly corresponds to Strategy P, “Develop and implement a statewide effort to address agricultural runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Areas that are dominated by nonnative species that are especially susceptible to wildfire (e.g. areas dominated by nonnative grasses); or
- Areas that are dominated by nonnative species and have highly erodible soils or steep slopes;

Known Opportunities for Implementation (refer to section 3.2.4.1 for more information):

- Kaukonahua Watershed – Vegetation management to reduce fuel loads should be conducted on the slopes below Mt. Ka’ala on the Wai’anae side of the watershed.

AGRICULTURE MEASURE #8: FIELD ACCESS ROAD MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients

Priority Watersheds: Kaukonahua; Poamoho (*not listed in any particular order*)

Prioritization Rationale: The modeling indicated that Agricultural Lands are the main source of sediments in the Kaiaka Bay Watersheds – especially areas that are classified as “bare ground.” Areas classified as “bare ground” produce three times more sediments per acre than areas classified as “cultivated land” and 11 times more than areas classified as “grasslands,” therefore, the highest priority hotspots within Agricultural Lands are areas with exposed soil, including field access roads.

Implementing this management measure would correspond to Strategy P, “Develop and implement a statewide effort to address agricultural runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Field access roads with steep topographical grades;
- Field access roads that cross over or run adjacent to drainages;
- Field access roads with eroding shoulders;
- Areas with a significant amount of bare/exposed soil; or
- Areas without adequate practices to control erosion and runoff from roads.

Known Opportunities for Implementation (refer to section 3.2.4.1 for more information):

- The planning team was not able to determine any specific locations for field access road management practices, although this does not indicate that none exist.

DEVELOPED AREAS MEASURE #2: NONPOINT SOURCE WASTEWATER TREATMENT

Primary Pollutants Targeted: Nutrients; bacteria/pathogens

Priority Watersheds: Kiʻikiʻi; Kaukonahua; Paukauila (*not listed in any particular order*)

Prioritization Rationale: There are over 1,000 individual OSDSs within the Kaiaka Bay Watersheds, 71% of which are cesspools (see section 7.2.9 of *Volume 1*). The 722 cesspools are estimated by the DOH to leak 298,203 gallons per day of effluent into the ground. While there is no data available that quantifies the impacts of cesspools and other OSDS on surface water quality, professional judgment deems OSDSs to be an important water quality issue.

The significance of this management measure is supported by the passing of Act 125 in July 2017, which amends HRS Chapter 342D to require that every cesspool in the state must be either upgraded to a septic or aerobic system or connected to a sewage system (with certain exemptions) by 2050.

Implementing this management measure would correspond to Strategy N, “Develop and implement a statewide effort to address cesspools,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Areas with high densities of OSDSs, especially cesspools; or
- Areas where OSDSs are located in close proximity to waterbodies.

Known Opportunities for Implementation (refer to section 3.3.4.1 for more information):

- Kiʻikiʻi, Kaukonahua, and Paukauila watersheds – There are over 500 cesspools in these watersheds.

DEVELOPED AREAS MEASURE #3: STORMWATER MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity); nutrients; chemical contaminants; trash

Priority Watersheds: Ki'iki'i; Kaukonahua; Poamoho; Paukauila (*not listed in any particular order*)

Prioritization Rationale: While the modeling only found that Developed Areas produce 1% of the total sediments, 1% of the total nitrogen, and 3% of the total phosphorus, it should be noted that the model (OpenNSPECT) only assessed rill and sheet erosion and could not account for pollutants transported and deposited by MS4s. Therefore, professional judgment was applied to conclude that stormwater management practices are important to implement in Developed Areas to reduce pollutants commonly associated with urban runoff. Additionally, some of the practices associated with this measure are relatively inexpensive and easy to implement. Practices should be implemented opportunistically.

Implementing this management measure would correspond to Strategy O, “Develop and implement a statewide effort to address urban runoff,” in the State Nonpoint Source Management Plan (Goal 4, Objective 2; DOH PRC, 2015).

Hotspots for Implementation:

- Areas with large amounts of impervious surfaces and no stormwater filtration system;
- Unstabilized landscaping projects;
- Unstabilized developed open spaces (e.g. beach park erosion);
- Unstabilized residential and commercial construction sites;
- Other areas with bare/exposed soil;
- Areas with regular application of fertilizers;
- Road crossings (i.e. bridges) over streams and waterways; or
- MS4 outfalls that empty into stream channels and have evidence of extensive erosion.

Known Opportunities for Implementation (refer to section 3.3.4.1 for more information):

- Kaukonahua Watershed – The City should implement the planned retrofits at the Wahiawā Fire Station and the Wahiawā Police Station (trench drain filters, drain inlet filters, seepage wells, replanting vegetation, and grass swales) and roadway shoulder improvement projects to control erosion at three locations in Wahiawā.
- Kaukonahua – Army DPW should implement the permanent erosion control practices outlined in their SWMP at priority areas within Schofield Barracks.
- Poamoho – The Navy should implement erosion control BMPs at the JBPHH-Wahiawā Annex to lower turbidity loads in stormwater as it flows towards the North Fork of Upper Kaukonahua Stream.
- Paukauila Watershed – The City should implement the planned retrofits at the Waialua fire station.

ARMY TRAINING AREAS MEASURE #1: FIRE PREVENTION AND MANAGEMENT

Primary Pollutants Targeted: Sediments (including turbidity)

Priority Watersheds: Kaukonahua

Prioritization Rationale: Analysis of the modeling showed that Army Training Areas are sources of 7% of the total sediments in the project area. Preventing fires on Army lands will prevent erosion and sediment-laden runoff that occurs after fires. This is especially important since approximately 20% of the land is covered in fire-prone grasses (such as guinea grass). Additionally, preventing fires in Army Training Areas will also prevent the spread of fires into Forest Lands.

Hotspots for Implementation:

- Areas that are dominated by nonnative species and are especially susceptible to wildfire (e.g. areas dominated by invasive grasses); or
- Areas where Army training activities could cause a fire.

Known Opportunities for Implementation (refer to section 3.3.4.1 for more information):

- Kaukonahua Watershed – The Army’s current fire prevention and management activities should be expanded upon.

ARMY TRAINING AREAS MEASURE #3: EROSION MANAGEMENT ALONG ROADS, TRAILS, AND FREQUENTLY USED AREAS

Primary Pollutants Targeted: Sediments (including turbidity)

Priority Watersheds: Kaukonahua

Prioritization Rationale: The modeling indicated that Army Training Areas are sources of 7% of the total sediments in the project area. A large portion of the sediments generated in Army Training Areas are likely coming from areas of exposed soil: areas classified as “bare ground” by the landcover dataset that was used in the model were found to produce 11 times more sediment than areas classified as “grasslands” and 28 times more than areas classified as “scrub/shrub.” An area of “bare ground” is located in Schofield Barracks West Range. Additionally, professional judgment was applied in prioritizing this measure since some of the practices associated with this measure are relatively inexpensive and easy to implement.

Hotspots for Implementation:

- Access roads and trails with steep topographical grades;

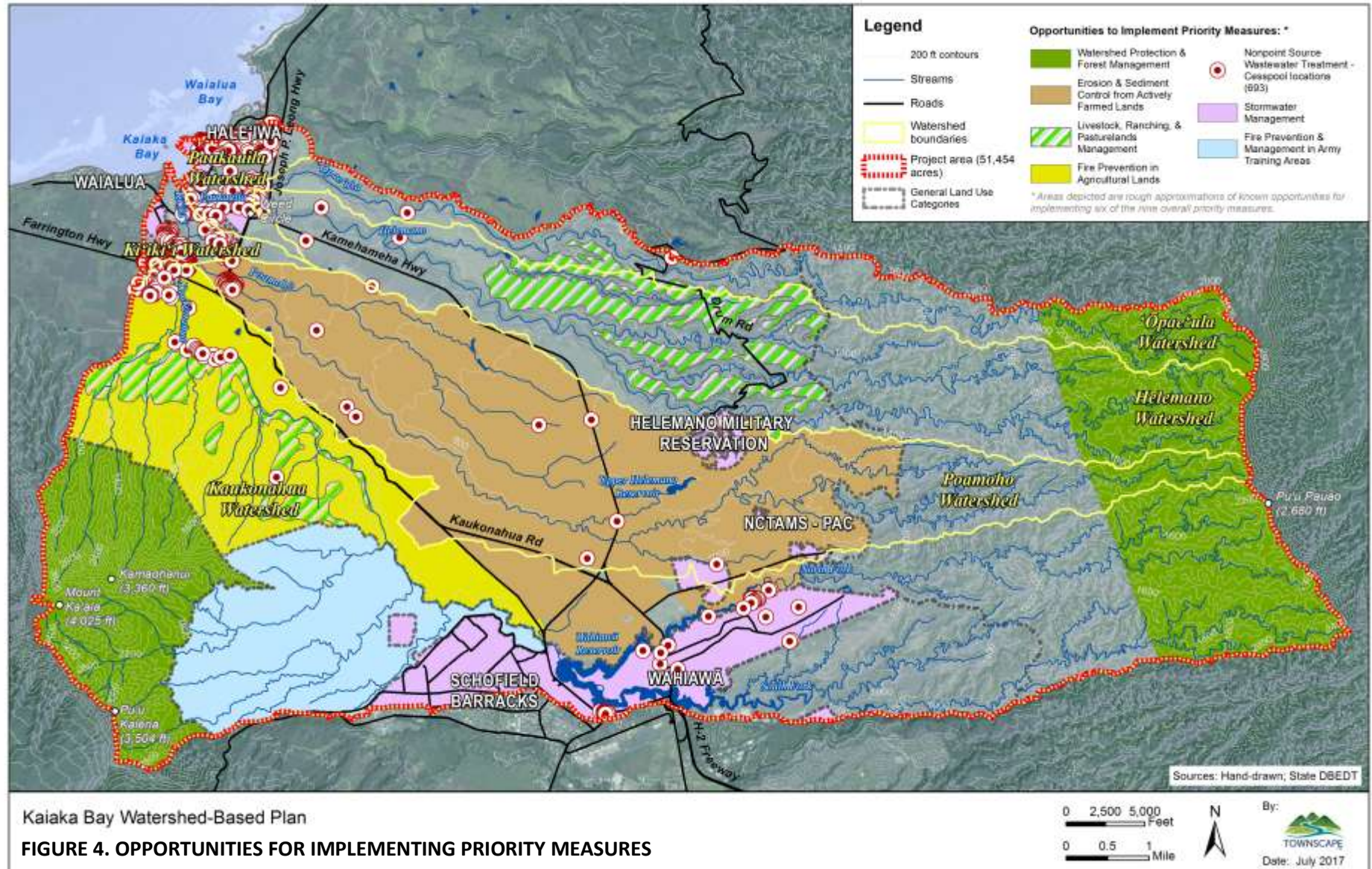
- Areas with little to no ground cover (exposed soils) as a result of prescribed burns, training activities, or construction;
- Road crossings (i.e. bridges) over streams and waterways;
- Helicopter landing zones with unstabilized soils; or
- Degraded ecosystems that are especially susceptible to erosion and/or wildfire (e.g. areas that are dominated by nonnative species and experience high rainfall, have highly erodible soils, or steep slopes).

Known Opportunities for Implementation (refer to section 3.3.4.1 for more information):

- The planning team was not able to determine any specific locations for implementing this measure, although it is visually apparent that areas of West Range have exposed soils.

3.5.2 MAP OF KNOWN OPPORTUNITIES FOR IMPLEMENTING OVERALL PRIORITY MEASURES

Figure 4 on the following page depicts the locations of known opportunities for projects related to the overall priority management measures. Note that the examples of project opportunities should not be considered the only projects that could or should be implemented in a specific watershed or for a specific management measure; they are simply opportunities that were identified in the development of this WBP. It was not possible to determine the location of every site that a practice could/should be implemented, consequently, two of the nine priority management measures do not have specific opportunities identified for implementation (Agricultural Lands Measure #8: Field Access Road Management and Army Training Areas Measure #3: Erosion Management Along Roads, Trails, and Frequently Used Areas). It should also be noted that some of the project opportunities are already being implemented but have a need for expanded effort.



3.5.3 SUMMARY OF MODELING RESULTS RELEVANT TO OVERALL PRIORITY MEASURES

While the full analysis and discussion of the modeling results are presented in *Volume 1*, section 7.3, some of the key findings that pertain to the nine overall priority management are presented in Table 41, below. The data presented should not be interpreted as expected pollutant load reductions for implementing the measure, rather, they reflect the nonpoint source pollution that is generated by the land use type in the specific watershed. Implementing an associated management measure would help to reduce the amount of NPS pollution originating in that area. Furthermore, the reader should keep in mind that the modeling results were only one of the factors used in the overall prioritization, especially given that the model, OpenNSPECT, has certain limitations that should be considered in assessing the results. Specifically, OpenNSPECT can only model rill and sheet erosion, therefore, it does account for stream channel erosion caused by instream flows, nor does it account for stormwater drainage systems, stream diversions, and other man-made hydrological alterations. The potential impacts of cesspools and other OSDS to surface water quality are not considered by the model. Additionally, the land cover classes that are a key data input in the model are not customized for Hawai'i.

TABLE 41. NINE PRIORITY MANAGEMENT MEASURES BY WATERSHED AND RELEVANT MODELING RESULTS

Stream System	Watershed	Priority Management Measure	Relevant Modeling Results*		
			Sediments	Nitrogen	Phosphorus
Kī'iki'ī	Kī'iki'ī	• Agriculture Measure #1	1% of total; 1.6 lbs/acre	0.0004% of total; 59 mg/acre	0.002% of total; 12 mg/acre
		• Developed Areas Measure #2	0% of total; 0.2 lbs/acre	0.004% of total; 854 mg/acre	0.02% of total; 180 mg/acre
		• Developed Areas Measure #3			
	Kaukonahua	• Forest Measure #1	3% of total; 0.1 lbs/acre	63.4% of total; 392,448 mg/acre	60.8 % of total; 15,706 mg/acre
		• Agriculture Measure #1			
		• Agriculture Measure #5	21% of total; 1.3 lbs/acre	0.01% of total; 95 mg/acre	0.1% of total; 20 mg/acre
		• Agriculture Measure #6			
		• Agriculture Measure #8			
		• Developed Areas Measure #2	1% of total; 0.1 lbs/acre	0.4% of total; 7,370 mg/acre	1.8% of total; 1,557 mg/acre
		• Developed Areas Measure #3			
	Poamoho	• Army Training Areas Measure #1	7% of total; 0.5 lbs/acre; "bare ground" areas generate significant sediments	0.07% of total; 624 mg/acre	0.3% of total; 113 mg/acre
		• Army Training Areas Measure #3			
		• Forest Measure #1	1% of total; 0.1 lbs/acre	5.7% of total; 160,736 mg/acre	5.5% of total; 6,440 mg/acre
		• Agriculture Measure #1			
		• Agriculture Measure #6	44% of total; 2.0 lbs/acre; "bare ground" areas generate significant sediments	0.3% of total; 1,563 mg/acre	1.3% of total; 325 mg/acre
		• Agriculture Measure #8			
Paukauila	Paukauila	• Developed Areas Measure #3	0% of total; 0.1 lbs/acre	0.3% of total; 51,915 mg/acre	1.5% of total; 10,986 mg/acre
		• Agriculture Measure #1	6% of total; 5.0 lbs/acre	0.0005% of total; 58 mg/acre	0.003% of total; 12 mg/acre
		• Developed Areas Measure #2	0% of total; 0.2 lbs/acre	0.0008% of total; 140 mg/acre	0.004% of total; 30 mg/acre
	Helemano	• Developed Areas Measure #3			
		• Forest Measure #1	2% of total; 0.2 lbs/acre	17.2% of total; 239,401 mg/acre	16.5% of total; 9,576 mg/acre
	'Ōpae'ula	• Agriculture Measure #5	10% of total; 0.8 lbs/acre	0.005% of total; 50 mg/acre	0.02% of total; 8 mg/acre
		• Forest Measure #1	1% of total; 0.3 lbs/acre	12.7% of total; 341,937 mg/acre	12.2% of total; 13,717 mg/acre

* Refer to Tables 46, 47, 50, 51, 54, and 55 in Volume 1 for complete information.

Key: Forest Measure #1 = Watershed Protection and Forest Management

Agricultural Measure #1 = Erosion and Sediment Control from Actively Farmed Lands

Agricultural Measure #5 = Livestock, Ranching, and Pasturelands Management

Agricultural Measure #6 = Fire Prevention

Agricultural Measure #8 = Field Access Road Management

Developed Areas Measure #2 = Nonpoint Source Wastewater Treatment

Developed Areas Measure #3 = Stormwater Management

Army Training Areas Measure #1 = Fire Prevention and Management

Army Training Areas Measure #3 = Erosion Management Along Roads, Trails, and Frequently Used Areas

4 PUBLIC EDUCATION & OUTREACH

A general lack of awareness of how daily activities can impact water quality is a root cause of many nonpoint source pollution issues. Successful implementation of the *Kaiaka Bay WBP* is dependent on stakeholder awareness and involvement. Landowners who are exposed to information and education campaigns may be more inclined to change their practices based on a greater awareness of water quality issues. Additionally, education and outreach are important to garner community support for management activities that are implemented by various organizations and agencies. The results of increased awareness and changed behaviors can help to improve or maintain water quality of the various water bodies in the six Kaiaka Bay Watersheds as well as the quality of Kaiaka Bay.

This chapter first describes some of the existing education and outreach efforts in the Kaiaka Bay Watersheds and then presents ways to expand on those efforts to empower, educate, and engage the public to ultimately reduce nonpoint source pollution in the Kaiaka Bay Watersheds.

4.1 EXISTING CONTEXT

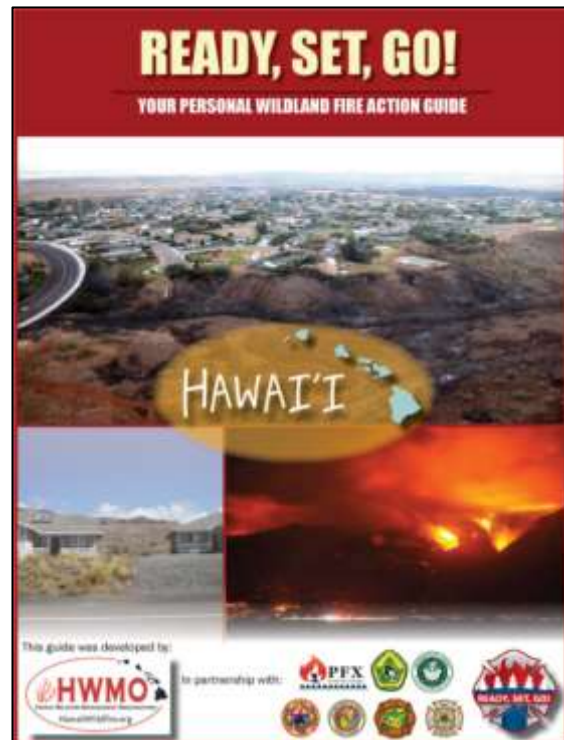
There are many on-going efforts to promote awareness of water quality issues and community involvement in activities to improve water quality. Some of the key efforts are summarized in this section.

VOLUNTEER WATERSHED MANAGEMENT ACTIVITIES

Several different organizations/agencies have ongoing volunteer programs to involve the public in natural resource management activities, such as removing invasive plants or outplanting native plants in important watershed areas. The Waiʻanae Mountains Watershed Partnership and the Koʻolau Mountains Watershed Partnership have active projects to engage and educate community members about natural resource management issues and regularly organize volunteer work days. DOFAW has a volunteer program that organizes trips to control weeds in certain areas, including in Kaʻala NAR (within the Kaiaka Bay Watersheds). The Oʻahu Army Natural Resources Program also has regularly planned volunteer work days in important watershed areas, including Kaʻala NAR.

WILDFIRE PREVENTION & AWARENESS

The Hawaiʻi Wildfire Management Organization (HWMO) is a nonprofit organization that is dedicated to education, outreach and technical assistance, project implementation, and research focused on wildfire prevention, mitigation and post-fire recovery in Hawaiʻi. HWMO produces educational materials and coordinates many outreach activities throughout the



The HWMO produces outreach materials to educate the public on how to prevent fires.

year. More information about HWMO can be found at <https://www.hawaiiwildfire.org>.

DOFAW is involved with and committed to several community risk reduction initiatives, including participating in local efforts to spread awareness about fire prevention, funding fire-related organizations (including the HWMO), and developing fire protection plans for interested communities. DOFAW also has several brochures aimed at helping the public be fire-safe around their homes and property. For more information, see

<http://dlnr.hawaii.gov/forestry/fire/community-risk-reduction/>.

The O'ahu Army Natural Resources Program works to educate military personnel on the risks of wildfire and how to prevent fires in Army training areas. OANRP conducts outreach to soldiers and prepares educational materials.

AGRICULTURAL EDUCATION & OUTREACH

Organizations such as the West O'ahu SWCD and ORC&D work directly with farmers and are valuable sources of information regarding agricultural conservation practices and relevant rules/regulations/permits that pertain to agriculture. They organize various meetings, workshops, and events throughout the year to help share important agricultural information. For example, the West O'ahu SWCD, in coordination with UH CTAHR, launched a new program in December of 2016, called "Together We Farm," to support immigrant and new farmers with the development, implementation, and monitoring of conservation plans. The program will involve hosting farmer-to-farmer meetings that cover a specific topic (e.g. integrated pest management), have a guest speaker, and an include an open forum for farmers to ask questions and share ideas. Language translation services are also part of the program. Fund development for this program is still in process. The also ORC&D hosts a variety of workshops throughout the year as well as an annual "Parade of Farms" to showcase local farms and agribusinesses.



Outreach material used to inform soldiers about the risks of fire; Image courtesy of OANRP, Army Environmental Division.



"Together We Farm" is a program run by the West O'ahu SWCD that provides services to new and immigrant farmers

ACTIVITIES RELATED TO NPDES PERMITS FOR STORMWATER SYSTEMS

Public outreach and education activities include those conducted by the City, the State DOT-HWYS, the Army, and the Navy as part of their municipal separate storm sewer system permits. The activities conducted by each of these agencies have a lot of overlap, although each agency conducts a few activities that are unique. Some of the key activities conducted by these agencies as reported in their respective Storm Water Management Plans are presented in Table 42 below.

Note that these activities are conducted in multiple locations on O'ahu; not all take place in the Kaiaka Bay Watersheds.



The State DOT-HWYS has a program called "Hawai'i Storm Patrol" designed to engage and educate youths on stormwater-related issues.

TABLE 42. PUBLIC EDUCATION AND OUTREACH ACTIVITIES CONDUCTED BY PERMITTED MS4 OPERATORS

	CITY	STATE DOT-HWYS	ARMY	NAVY
Storm Drain Placards/Stenciling	x	x	x	x
Participation in Special Events	x	x	x	x
School Education	x	x	x	x
Surveys	x	x	x	x
Website and/or Other Public Communications	x	x	x	x
Adopt-A-Stream and/or Stream Cleanup Event	x		x	
Adopt-A-Block	x			
Adopt-A-Highway		x		
Community Cleanup Events				x
Forming Key Partnerships		x		x
Storm Water Logo Contest			x	
Quarterly Division Meetings			x	
Environmental Compliance Officer Training			x	

EDUCATION & OUTREACH TO MILITARY PERSONNEL

OANRP works with Army personnel to give presentations and briefings to soldiers and other key players within the Army about the risks posed by invasive species and how to prevent spreading them. They also brief landscape maintenance staff on invasive plants and how to conduct maintenance in infested areas. OANRP also places informative signs to delineate endangered species habitat, to warn about the fire policy, or to indicate the presence of a noxious weed.

BEACH CLEANUPS

Organizations such as Surfrider Foundation do periodic beach cleanups at various locations on O‘ahu every year. While Kaiaka Bay has not been a focus of past efforts, community and nonprofit organizations such as Surfrider could do a project there in the future.

OTHER PUBLIC EDUCATION INITIATIVES

The City DFM and the Honolulu Board of Water Supply are currently collaborating on an outreach program to encourage property owners to install rain barrels to catch runoff from their roofs. By reducing the amount of water that enters storm drains, rain barrel catchment systems can reduce the negative effects on streams and beaches when rain water picks up debris and pollutants from the ground. Stormwater captured in a rain barrel can be used for outdoor, non-drinking water activities, such as landscape irrigation. The Honolulu Board of Water Supply (BWS) encourages use of rain barrels to reduce the amount of drinking water used for non-drinking purposes.

4.2 POTENTIAL STRATEGIES & PROGRAMS

This section presents some potential education and outreach strategies and programs that could be implemented to improve public awareness of local water quality issues, encourage positive changes in behavior, provide information about funding and other resources available, and promote compliance with important regulations. The strategies are presented in no particular order.

Strategy: Multilingual Agricultural Outreach & Education Programs for Farmers

Description: Develop a program and/or expand existing programs to organize and hold educational workshops for farmers in multiple languages to educate farmers on agricultural conservation practices, the purpose of conservation plans, relevant rules/regulations/permits (e.g. the City grading/grubbing permit or City/State stormwater regulations), and where they can go for additional information and resources. It would be valuable for key government officials to attend workshops that pertain to rules/regulations/permits that pertain to their respective department. The program can also provide training in multiple languages for certain certifications, such as the State of Hawai‘i Restricted Use Pesticide Applicator license. The State Department of Agriculture currently hosts workshops on pesticide application so farmers can learn about applicable regulations and how to comply (“education before regulation”); this method can be emulated but be in multiple languages and be on a variety of topics and regulations. Additionally, the program can provide translators to assist conservation planners when they are working directly with farmers who are not English first-language. Outreach materials, such as brochures and pamphlets, can also be created in different languages to portray key information and direct farmers to important resources.

The West O‘ahu SWCD program, “Together We Farm,” is a great example of a program designed to support immigrant and new farmers, especially since language translation services are part of the program. Programs such as “Together We Farm” should receive adequate funding to continue and expand their efforts.

Implications for Water Quality: Education and training about conservation practices, conservation plans, and important rules/regulations/permits for farmers in multiple languages can help spread awareness about the importance of conservation practices and increase compliance with local regulations. These results would protect or improve water quality in the Kaiaka Bay Watersheds.

Potential Participants/Champions: West O‘ahu SWCD; ORC&D; City (related to Grading/Grubbing permit, stormwater regulations, and other local regulations); Pacific Gateway Center (for translation services)

Strategy: “Hike Pono” Program

Description: Develop strategies to inform visitors as well as residents on how to recreate in O‘ahu’s forests in a manner that minimizes impact to resources. This includes staying on known trails, preventing littering, and preventing the spread of invasive species by properly cleaning gear and dogs. Recreation includes hiking, hunting, use of motorized vehicles, and other activities that are conducted in O‘ahu’s forests. The program can include hosting workshops, creating an informative video to show on arriving airplanes, airing television/radio commercials, sharing information on social media, announcements at public meetings, creating signage near popular hiking areas, and posting community outreach flyers. Outreach materials, such as brochures and pamphlets, can also be created to share important information.

Implications for Water Quality: Erosion, damage to vegetation, and trash can be reduced in frequently accessed areas.

Potential Participants/Champions: DOFAW; Hawai‘i Tourism Authority

Strategy: Public Education on Invasive Species

Description: Develop strategies and expand existing programs that inform the public on the impacts of invasive species, such as plants and feral pigs, on Hawaiian watersheds. One component of the program could be a “Weed Watch” public information initiative that informs the public of target weeds, identification methods, reporting protocol for new infestations, and contingency plans for quick removal of reported infestations. The education and outreach efforts should also include information on what is being done to control invasive species and how the public can help. One resource for learning about invasive plants is the OISC website*. The program could also encourage using native plants for landscaping (see the “Plant Pono” website or the BWS “O‘ahu Planting Guide” website for information**). A variety of outreach methods could be used, including hosting workshops, airing television/radio commercials, sharing information on social media, and posting community outreach flyers. Outreach materials, such as brochures and pamphlets, can also be created to share important

information.

Implications for Water Quality: Preventing the spread of invasive species can help maintain or improve water quality by preventing erosion, preserving natural hydrological cycles, and maintaining native ecosystems.

Potential Participants/Champions: OISC; KMWP; WMWP; DOFAW

* OISC "Target Pests" website: <http://www.oahuisc.org/target-pests/>.

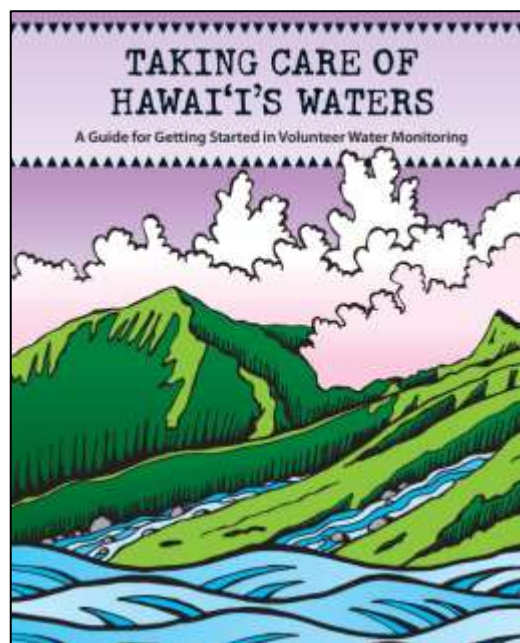
** "Plant Pono" website: <http://www.plantpono.org/>; BWS "O'ahu Planting Guide" website: <http://www.boardofwatersupply.com/conservation/xeriscape/oahu-planting-guide>.

Strategy: Community-Based Water Quality Monitoring Programs

Description: Develop a community-based water quality monitoring program for the Kaiaka Bay Watersheds. The program should conduct regular monitoring of water quality in various water bodies, including streams, the Wahiawā Reservoir, and Kaiaka Bay. Participants in the program should be trained in proper water quality sampling methods in order to ensure that the data can be used for official purposes by the State DOH CWB.

Implications for Water Quality: A community-based water quality program will accomplish two things: 1) It will educate and engage the public in water quality issues; and 2) It will generate additional and on-going water quality data that the City and State can use to assess the quality of the water bodies to guide management and funding priorities.

Potential Participants/Champions: DOH CWB; DLNR Division of Aquatic Resources (DAR); Surfrider Foundation; other community organizations



The Hawai'i Tourism Authority sponsored a manual for developing community-based water quality monitoring programs. This manual can be used as a guide for creating a program in the Kaiaka Bay Watersheds.

Strategy: Integrate Lessons or Projects Related to Water Quality & Watershed Management into School Curriculum & Programs

Description: Coordinate and collaborate with the State Department of Education (DOE) to incorporate lessons about water quality, sources of pollution, and watershed management into classrooms or other

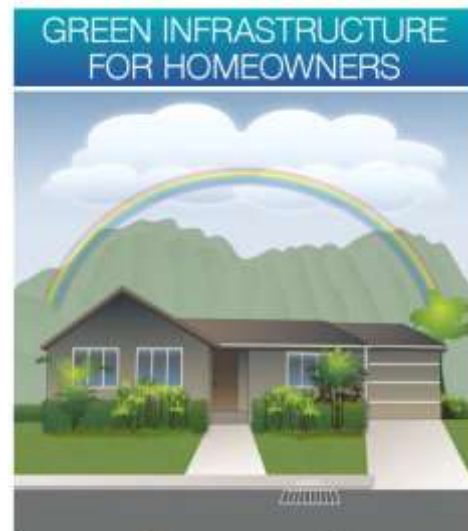
school programs. The lessons should be integrated into a larger science or social studies curriculum. Explore opportunities to implement hands-on learning projects, such as water quality monitoring, native tree planting, or creating rain gardens on school grounds. The BWS sponsored a program to teach school children in Mānoa Valley (outside the Kaiaka Bay Watersheds) about water conservation; this program could be used as an example of how an agency such as DOH or DFM could sponsor a school program about water quality and watershed management.

Implications for Water Quality: Education programs in schools can help promote awareness about water quality issues and encourage positive changes in behavior to reduce sources of pollution. Educating children is a priority not only because they are the future, but they also are open to new information and can go home to their families with the information.

Potential Participants/Champions: DOE; DOH; City DFM

Strategy: Expansion of Public Education Related to Stormwater

Description: Develop and/or expand a public education and outreach program to inform local communities about nonpoint source pollution and what they can do to improve/protect water quality. The program should inform the public on how everyday actions such as littering, car washing, using herbicides, disposing pet waste, and disposing of household or automotive chemicals can affect the quality of their environment. Information on how homeowners and residents can modify their activities at their residence to reduce sources of pollutants should be provided. The stormwater education and outreach program can include hosting workshops, airing television/radio commercials, announcements at public meetings, sharing information on social media, posting community outreach flyers, distributing surveys, and other means of including the public in providing input into and commenting on stormwater management efforts. Outreach materials, such as brochures and pamphlets, can also be created to share important information about stormwater management and steps residents can take to prevent pollution.



The City's manual on green infrastructure is an example of one type of outreach material that can be used to educate the public on stormwater management and preventing NPS pollution.

Implications for Water Quality: Convincing others to change their behaviors and properly dispose of materials can reduce nonpoint source pollution. It is important that the public be aware of the significance of their behavior and that their actions can either pollute or protect our waterways.

Potential Participants/Champions: City DFM; DOH CWB

Strategy: Public Education for Replacement of Cesspools

Description: Develop a public education and outreach program to inform local communities about the impact of cesspools on water quality. The program should promote the proper maintenance of cesspools to reduce impacts to water quality as well as providing information about the conversion of cesspools to other types of OSDs or connecting to a sewer system. Information should be provided to direct the public to resources to aid in the upgrade, including the \$10,000 tax credit for qualified property owners. The education and outreach program can include hosting workshops, airing television/radio commercials, announcements at public meetings, sharing information on social media, and posting community outreach flyers. Outreach materials, such as brochures and pamphlets, can also be created to share important information.

Implications for Water Quality: Proper maintenance and/or replacement of cesspools will reduce sources of nutrients, bacteria, and other pathogens that can flow into waterbodies in the Kaiaka Bay Watersheds.

Potential Participants/Champions: City Department of Environmental Services (ENV); DOH

Strategy: Stream/Beach Clean-Ups & Restoration

Description: Develop a program to coordinate community-based stream/beach clean-ups and riparian/coastal area restoration. Stream and beach clean-ups remove trash and other debris from the area. Restoration of the riparian area around streams or the coastal habitat around Kaiaka Bay can include removing invasive plants, planting native plants, and working to stabilize the streambank using a variety of methods (see “Developed Areas Measure #4: Stream, Riparian, and Wetland Management” in section 3.3.2 for information about specific types of practices that can be conducted to improve streams).

Implications for Water Quality: Stream clean-ups not only improve the quality of the stream, but also prevent the transport of trash and debris to Kaiaka Bay and improve the flow of water, thereby reducing flood hazard. Restoration/stabilization of riparian areas/streambanks would prevent erosion (reducing sources of sediments, turbidity and nutrients). Community stream clean-ups and restoration efforts would also engage the public in helping to restore water quality and teach them about the harms of illegal dumping.

Potential Participants/Champions: DOH CWB; DLNR DAR; City DFM (Adopt-A-Stream program); Surfrider Foundation; other community organizations

4.3 SUMMARY OF STRATEGIES & IMPLEMENTATION CONSIDERATIONS

Education is one of the most powerful tools to enhance environmental conditions and reduce pollutant loads by increasing awareness of watershed conditions and providing opportunities that allow community members to participate in the solution. Perhaps the most effective education strategies are those that provide hands-on activities that lead to tangible outcomes, turning education into action. Involving individuals in the solution returns ownership of (and responsibility for) the resources to the community.

The strategies for education and outreach strategies and programs related to improving water quality in the Kaiaka Bay Watersheds that were described in the previous section are summarized in Table 43. For each recommendation, the following information is provided:

- **Relative Impact on Pollutant Loads:** This is a rough order of magnitude estimate based on what pollutant sources the strategy might impact and its degree of impact. Values are presented in terms of “Low,” “Med,” or “High.”
- **Potential Participants/Champions:** This listing should not be construed as agreement to implement or fund the project/program, but rather a list of entities that might be able to implement or participate in the suggested strategy.
- **Potential Support/Funding:** Most of the strategies require some level of support such as funding or technical support. Possible supporting entities are listed not as commitments, but rather as possibilities. In some cases, the sources of support/funding are the exact same as the potential participants/champions. Support could also come from competitive grants.

Note that all of the strategies could be implemented in the near future (within the next one to four years) if adequate funding were procured. All recommendations should be considered on-going, long-term projects.

TABLE 43. SUMMARY OF STRATEGIES RELATED TO EDUCATION AND OUTREACH

STRATEGY	RELATIVE IMPACT ON POLLUTANT LOADS	POTENTIAL PARTICIPANTS/CHAMPIONS	POTENTIAL SUPPORT/FUNDING
Multilingual agricultural outreach & education programs for farmers	Med	West O‘ahu SWCD; ORC&D; City (related to Grading/Grubbing permit, stormwater regulations, and other local regulations); Pacific Gateway Center (for translation services)	City
“Hike Pono” program	Low	DOFAW; Hawai‘i Tourism Authority	DOFAW; Hawai‘i Tourism Authority
Public education on invasive species	Low	OISC; KMWP; WMWP; DOFAW	DOFAW; DOH
Community-based water quality monitoring programs	Low	DOH CWB; DLNR DAR; Surfrider Foundation; other community organizations	DOH CWB; DLNR DAR
Integrate lessons or projects related to water quality & watershed management into school curriculum & programs	Low	DOE; DOH; City DFM	DOE; DOH; City DFM
Expansion of public education related to stormwater	Med	City DFM; DOH	City DFM; DOH
Public education for replacement of cesspools	Med/High	City ENV; DOH	City ENV; DOH
Stream/beach clean-ups & restoration	Low/Med	DOH CWB; DLNR DAR; City DFM; Surfrider Foundation; other community organizations	DOH CWB; DLNR DAR

5 IMPLEMENTING THE KAIKA BAY WATERSHED-BASED PLAN

Identifying key implementation strategies will help to ensure that the management measures and other strategies identified in the *Kaiaka Bay Watersheds Implementation Plan* are developed and implemented with a solid foundation and necessary oversight to accomplish measurable pollutant load reductions. This chapter describes several key strategies and considerations for implementing a WBP, including identifying potential funding sources and implementation costs.

5.1 IMPLEMENTING ENTITIES

An important component of an implementation strategy for a WBP is the identification of the entities who may be involved in implementation. In the Kaiaka Bay Watersheds, there are several point sources of pollution that are regulated by permits and other types of regulations, including the Wahiawā WWTP and the various stormwater systems (operated by the City, State DOT-HWYS, Army, and Navy). These point sources are already required to comply with specifics for pollutant loads and remediation strategies under various permits (e.g. NPDES permit). Some of the recommended management practices and strategies are already being implemented by the permit-holders of the point sources while others represent opportunities for expanding on existing efforts.

Perhaps even more important for implementation than coordinating with permit-holders is obtaining the cooperation of private parties, community organizations, local and state government, and other landowners to implement measures and strategies to reduce nonpoint sources of pollution, since NPS pollution is the greatest remaining water quality issue in the nation and is the reason that many of Hawai'i's waterbodies remain impaired. Some of the public education and outreach strategies outlined in Chapter 4 can help to garner awareness and interest among the public for implementing certain practices. The ultimate success of the WBP is dependent on stakeholder awareness and involvement, as well as on available funding (see section 5.4).

According to the *State Nonpoint Source Management Plan*, one of the major goals of the DOH CWB is to “Implement NPS management strategies to restore impaired waters and protect high quality waters from NPS pollution” (Goal 3; DOH PRC, 2015). The first objective of the goal is to “Invest in projects to achieve and demonstrate water quality improvements through implementation of watershed-based plans...” These statements reflect the State of Hawai'i's commitment to reducing NPS pollution by implementing and providing funding for priority management measures and strategies outlined in WBPs.

An additional strategy for expanding the potential for different entities to implement projects and practices that reduce NPS source pollution is discussed in relation to Key Issue #13 in Chapter 2: Policies, Programs, and Regulations. The strategy describes how regulations should be more flexible to allow entities with NPDES permits and other types of permits to implement projects/practices that address NPS pollution within the same watershed to be credited toward the permit holder's requirements or allow the permit-holder more flexibility in implementation deadlines for other projects. This strategy would allow funds to be spent on projects to control NPS pollution that perhaps have a more significant effect on water quality than some of the projects required under the permit. Essentially, more regulatory emphasis on controlling NPS pollution would significantly improve water quality in the Kaiaka Bay Watersheds and in Kaiaka Bay.

Since it is not known which management measures or practices will receive funding or who will apply for funding, the individuals, organizations, businesses, and agencies that may be involved in implementation are not determined. Some potential implementing entities for each of the four general land use types are presented below, however, the lists are not meant to be inclusive of all potential implementing entities.

Potential Implementing Entities			
<u>Forest Lands</u>	<u>Agricultural Lands</u>	<u>Developed Areas</u>	<u>Army Training Areas</u>
<ul style="list-style-type: none"> • DLNR DOFAW • KMWP • WMWP • OISC • OANRP • Kamehameha Schools 	<ul style="list-style-type: none"> • NRCS • West O‘ahu SWCD • ORC&D • City DPP • DOA • ADC • Other land owners • Farmers 	<ul style="list-style-type: none"> • U.S. Army (DPW) • City DFM • City ENV • Other landowners • Residents 	<ul style="list-style-type: none"> • U.S. Army <ul style="list-style-type: none"> – ITAM – DPW – OANRP

In summary, collaboration among government agencies, landowners, nonprofits, community members, and visitors is essential to successfully implement the WBP.

5.2 IMPLEMENTATION STRATEGIES & CHALLENGES

Chapters 2 and 4 identified key strategies to address policies/programs and education/outreach, respectively. Chapter 3 described priority management measures to implement in each watershed for the four general land use types. The last section of Chapter 3, section 3.5, presented the overall priority management measures for the entire project area. It is important to note that the priority management measures in specific watersheds should not be considered rigid; if an interested party has the necessary resources to implement a practice that is deemed a lower priority, the opportunity should be taken. Any installation of a management practice is a positive gain towards reducing NPS pollution. However, with so many recommended strategies and measures, it can be difficult for funding entities to determine the most efficient manner to select projects for funding.

There is no single, ideal management practice system for controlling a particular pollutant in all situations. Rather, the system should be designed based on the type of pollutant, the source of the pollutant, the local environmental conditions, the pollution reduction goals, the economic situation of the landowner/implementer, the experience of the system designers, and the willingness and ability of the landowner/implementer to maintain the practices. The relative importance of these and other factors will vary depending upon other considerations such as whether the implementation is voluntary or mandatory (e.g., discharge permits).

A strategy for implementing management practices is to focus on priority pollutants within the same area or drainage system so that the practices function together to achieve the most significant reductions in pollutant loads. For example, if projects were funded that especially targeted sediments coming from agricultural areas within in the Poamoho Watershed, the effects of the implemented practices would be synergistic and result in a more significant local effect than if a variety of types of

practices were implemented far and wide across all six watersheds (which span over 50,000 acres). Indeed, the EPA's "National Management Measures to Control Nonpoint Pollution from Agriculture" recommends that "practices must fit together to perform effectively," meaning that management practices should be strategically selected for implementation in coordination with applicable landowners to function together to effectively target pollutants and achieve the most significant reductions in pollutant loads (EPA, 2003). The EPA guidelines also caution that not all practices are suitable for every location and that practices should be tailored to be site-specific according to various land uses, land management approaches, topography, soils, and water quality issues.

While the *Kaiaka Bay WBP* itself is not subject to evaluation under many state and federal laws that apply to other types of documents, including the National Environmental Policy Act, HRS Chapter 343 (Environmental Impact Statements), the National Historic Preservation Act, or HRS Chapter 6E (Historic Preservation), the implementation of some types of management practices may require certain permits and/or compliance with federal, state, and county laws designed to protect natural and cultural resources. Such legal requirements should be considered before the implementation of specific practices at individual locations. Most legal obligations typically fall onto the landowner.

Some additional challenges to implementation include procuring the necessary funding, data gaps regarding the effectiveness of certain practices at reducing pollutant loads, generating public interest, and ensuring that implemented practices will be maintained.

5.3 FINANCING IMPLEMENTATION

Implementing a WBP requires funding for programmatic elements, installation of management practices, monitoring, and education and outreach. This section presents some potential financial resources as well as important considerations for the cost of implementation.

5.3.1 FINANCIAL RESOURCES

Funding can come from a range of sources including federal, state, local, and private entities. Funding mechanisms can include contracts, private funds, local grants, cost-share agreements, and volunteer efforts. The State DOH is an important financial resource for funding the implementation of projects/strategies outlined in this WBP; in fact, one of the objectives outlined in the State Nonpoint Source Management Plan is to "Invest in projects to achieve and demonstrate water quality improvements through implementation of watershed-based plans..." (DOH PRC, 2015). The DOH can award grants (sourced from Clean Water Act Section 319 funding; see below) for projects that can reduce NPS pollution.

Some of the potential funding resources to support the implementation of the *Kaiaka Bay WBP* include:

- **EPA:** The EPA has several different programs that provide funding for watershed-related projects. Some of the key programs are described below.
 - **Clean Water Act Section 319 Funding:** The DOH CWB can award grants sourced from 319 funding administered by the EPA to go toward implementing projects that address NPS pollution. Since this plan follows EPA guidelines for a WBP (i.e. it includes the nine key elements) and nearly all waterbodies within the Kaiaka Bay Watersheds are listed on the

State's 303(d) list of impaired waterbodies, projects/practices proposed in this plan may be eligible for this federal funding. Grant cycles are generally yearly.

- **Clean Water State Revolving Fund:** As the EPA's largest source of infrastructure financing, the fund provides low interest loans to county and state agencies for a variety of projects in the form of a revenue bond. While the fund has traditionally been used for financing publicly owned wastewater and stormwater infrastructure projects, it can also fund a wide variety of other projects, including green infrastructure, tree planting, and land acquisition for water quality improvement and protection. However, these types of projects are often difficult to finance because they lack a dedicated source of revenue to repay loans. A strategy for funding these projects known as a "sponsorship" has been implemented in five states (Ohio, Iowa, Idaho, Oregon, and Delaware); a sponsorship could be explored for the state of Hawai'i. The DOH administers these funds and local (county) governments are eligible to apply to fund various point and nonpoint source projects.
- **USDA/NRCS:** The NRCS works with land owners and land managers to fund implementation of practices that conform to practice standards. A farmer who is interesting in NRCS funding opportunities must become an NRCS cooperator and have a conservation plan developed for their property. The NRCS prioritizes farmers who are working on actively farmed/utilized land and not fallow or natural land. Funding is administered through cost-sharing and may cover up to 90% of the cost. The NRCS has many different programs that can provide funding; two key programs are described below.
 - **Environmental Quality Incentive Program:** Provides up to 90% cost-share funding for implementing conservation practices that address natural resource concerns and to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. The minimum commitment is one year after completion of conservation practice; the maximum term is 10-years.
 - **Conservation Stewardship Program:** Provides an annual payment to landowners of private agricultural lands and non-industrial private forest land for implementing, improving, maintaining, and/or managing conservation activities. The amount of the annual payment is dependent on the operational performance of the implemented practices. A supplemental payment is available to participants who also adopt a resource-conserving crop rotation. Requires a five-year contract.
 - **Agricultural Conservation Easement Program:** Provides technical and financial assistance to help conserve agricultural lands and wetlands and their related benefits. By enrolling land in an agricultural easement, the land is prevented from conversion to non-agricultural uses, protecting long-term viability of agricultural and conservation values.
 - **Agricultural Management Assistance Program:** Producers receive conservation technical and financial assistance to construct or improve water management or irrigation structures, use conservation practices and diversify their operations, including transition to organic farming methods. Eligible recipients can receive up to \$50,000/fiscal year in payments.
 - **Farm Service Agency Loan Programs:** The Farm Service Agency gives a variety of farm loans, including farm ownership loans (up to \$800,000), farm operating loans (up to \$800,000), and micro-loans (up to \$35,000). These loans can be used for many activities and farm-related purchases, including equipment, labor and materials, as well as for installing conservation practices.

- **Regional Conservation Partnership Program:** RCCP is a new partnership program that combines the authorities of four former programs as enacted by the new Farm Bill of February 2014. NRCS would issue an RFP for partnership proposals and eligible organizations (such as agricultural producer associations, farmer cooperatives etc.) can apply for funding that is then used for eligible participants, i.e. farmers. For areas designated by NRCS as “partner project areas” or “critical conservation areas”, assistance can be obtained independent of a partner organization.
- **U.S. Fish and Wildlife Service:** Funding may be available through the USFWS. The Service has a variety of different programs that provide funding for certain types of projects; one project that may be applicable to the Kaiaka Bay Watersheds is described below.
 - **Partners for Fish and Wildlife Program:** Provides up to \$25,000 (with an equal amount match from the landowner) for habitat restoration of private and county-owned lands. Projects that need more than \$25,000 (or a greater match from the government) are allowed on a case-by-case basis. Requires a 10-year landowner commitment.
- **U.S. Department of Defense (DOD):** There are several funding opportunities available from the DOD. The U.S. Army Garrison Hawai‘i has several existing programs that implement projects that protect watersheds and reduce pollutant loads being discharged (e.g. OANRP, ITAM, and the DPW Environmental Stormwater Program). They also provide funding for a number of different organizations, including the Watershed Partnerships. Additionally, funding for additional projects may occasionally be available if the project is in line with Army objectives. For example, the Natural Resources Division (i.e. OANRP) sometimes provides funding for the construction of fences outside of Army lands to protect specific endangered species that the Army is charged with managing. The Navy is a source of funding for projects on Navy lands. For example, the Navy could implement stormwater management practices at the JBPHH-Wahiawā Annex to comply with the WLAs set in place by the TMDL for Upper Kaukonahua Stream. At a national level, the DOD has funding programs that can provide financial assistance for specific types of projects, such as:
 - **Legacy Resource Management Program:** Provides financial assistance to DOD to help preserve natural and cultural resources. Projects can include habitat preservation, archaeological studies, invasive species control and similar initiatives.
 - **Brownfields – Urban Waters Program:** This program is administered by the U.S. Army Corps of Engineers to help communities prevent, assess and safely clean up contaminated lands (i.e. “Brownfields”) that can be safely re-used after remediation of the contamination.
- **Hawai‘i Department of Land and Natural Resources:** The DLNR is a source of funding for projects in State-owned conservation lands and other State-owned lands. They also provide funding for a number of different organizations, including the Watershed Partnerships. In addition, the DLNR has several different programs that administer grants to private parties. Some of these programs are described below.
 - **Hawai‘i Conservation Reserve Enhancement Program:** The program provides incentives to encourage farmers and ranchers to voluntarily remove environmentally sensitive lands from agricultural production. Once enrolled, landowners are asked to commit to a 15-year contract where they will enact conservation practices to best manage their natural resources on- and off-site. Cost-sharing and other financial incentives are provided. The program is funded under a partnership between the DOA, NRCS, and DOFAW.

- **Forest Stewardship Program:** Provides technical and financial assistance for private landowners of forested or previously forested land to promote land stewardship, enhancement, conservation, restoration, and forest production and products. The program offers 50% reimbursement of allowed practices as approved in a management plan. The program may also be able to fund the development of the management plan (up to 75%). Requires a ten-year contract.
- **Wildland Urban Interface Grants:** Funds are awarded annually to communities, organizations, and agencies to implement projects to reduce the risk of wildland fire within the “Wildland Urban Interface.” The grants are awarded through a competitive process administered by DOFAW.
- **City & County of Honolulu:** The City is a source of funding for some of the practices that are currently on-going and/or are required by various regulations/permits. The City could generate revenue for implementing additional projects by increasing or establishing new fees. For example, the idea of creating a new stormwater fee and/or a water quality fee were discussed in Chapter 2. The funds generated by these new fees would be specially designated for specific types of projects geared towards reducing NPS pollution and improving water quality.
- **Honolulu Board of Water Supply:** Although the BWS is part of the City and County of Honolulu, it is listed separately in this list since it is considered a semi-autonomous agency and is funded entirely by the sale of water to its customers. The BWS has funding available for projects and programs that protect priority watershed areas that are important for groundwater recharge. The BWS currently designates \$3.3 million a year for funding watershed management projects; they currently fund many different agencies/organizations/projects.
- **Private Funding:** Private landowners could fund management practices on their lands (e.g. agricultural entities, homeowners, businesses). In most cases, the implementation of management practices will benefit the private landowner as well as contribute to the management of the overall watershed.
- **Local Grants:** Grants from various foundations and other private organizations may be available on an annual basis or intermittently. For example, during FY17, ORC&D received a grant from the City that will allow them to provide cost-sharing services to a limited number of farms for the development of conservation plans. Opportunities for different grants will vary from year-to-year.

For additional information about potential funding sources, see the EPA’s “Guidebook of Financial Tools: Paying for Sustainable Systems,” which describes financial resources for watershed planners in both the public and private sectors. The UH CTAHR also compiled a comprehensive list of financial incentive programs for forest landowners in Hawai’i compiled by; the information is available at <http://www.ctahr.hawaii.edu/forestry/incentive.html>.

5.3.2 IMPLEMENTATION COSTS

The financial resources required to implement the strategies and practices outlined in this WBP vary considerably depending on the specific project, scale/size of the project, and location. For example, the potential cost of implementing the practices that are included under “Permanent/Structural BMPs” for

the “Stormwater Management Measure” (Developed Areas Measure #3) vary considerably – installing a hydrodynamic separator in a storm drain would cost several thousand dollars while installing a vegetative BMP, such as a vegetative swale, would only be a fraction of the cost. Both practices reduce pollutant loads in stormwater, yet the cost of implementation varies significantly. Therefore, it is very difficult to estimate costs for implementing the various management measures.

Factors such as the cost of necessary equipment, operations and maintenance requirements, and the training required for implementation, will influence selection of specific management practices. Comparison of cost to the pollutant reduction potential will also affect the selection of practices for implementation. Another consideration is initial cost versus long-term maintenance cost. It is important to note that the cost for implementing a project can sometimes appear to be relatively high compared with the potential pollutant load reduction, however, the cost to implement an individual project often decreases as the number of units installed increases, making the cost-benefit ratio more favorable.

Costs to implement structural management practices can sometimes include the following:

- Engineering requirements
- Permitting requirements
- Purchasing of materials, including shipping
- Construction/installation
- Construction management
- Operations and maintenance

For non-structural practices, implementation costs may include the following:

- Planning/consulting fees
- Site-specific testing
- Cost of materials
- Maintenance

5.4 IMPLEMENTATION TIMELINE

The implementation timeline for the management measures and other strategies described in this WBP is contingent upon a number of factors, including the availability of funding, the extent of outreach to landowners and other stakeholders, the willingness of landowners/stakeholders to implement practices on their land, and the effectiveness of pollutant load reduction. The ability of landowners, farmers, and other entities to maintain the practice is also a critical factor for considering implementation; a project/practice should not be implemented unless there is a reasonable assurance that it will be maintained. Otherwise, funds should be delegated to a different project or location where maintenance is assured.

While there are many unknown variables that will affect the overall implementation schedule, it is reasonable to state that each of the nine overall priority measures should be funded and implemented in some locations within the next five years. The nine overall priority measures, presented in section 3.5, are as follows:

- Forest Lands Measure #1: Watershed Protection and Forest Management;

- Agricultural Lands Measure #1: Erosion and Sediment Control from Actively Farmed Lands;
- Agricultural Lands Measure #5: Livestock, Ranching, and Pasturelands Management;
- Agricultural Lands Measure #6: Fire Prevention;
- Agricultural Lands Measure #8: Field Access Road Management;
- Developed Areas Measure #2: Nonpoint Source Wastewater Treatment;
- Developed Areas Measure #3: Stormwater Management;
- Army Training Areas Measure #1: Fire Prevention and Management; and
- Army Training Areas Measure #3: Erosion Management Along Roads, Trails, and Frequently Used Areas.

Refer to Figure 4 in section 3.5.2 for a map depicting known locations of known opportunities for projects related to the overall priority measures.

The State DOH CWB Polluted Runoff Control Program expects to be able to issue a Request for Proposal (RFP) in 2018 to implement projects in the Kaiaka Bay Watersheds using CWA Section 319 funding. The first project(s) would then be funded and implemented in 2019. It would be reasonable to expect that for every subsequent year another project will be funded. It should be noted that applicants for 319 grants may submit proposals for watersheds that are not deemed “priority” by the State for that year, however, those that are priorities will get additional points when scored.

Many measures described in this WBP will need to be implemented continually over the long-term. For example, the Forest Lands Measure #1, “Watershed Protection and Forest Management,” describes a number of different practices that are aimed at restoring and protecting the forested ecosystems in the Kaiaka Bay Watersheds. This management measure includes practices that cannot simply be implemented and considered complete or achieved; rather, they are on-going efforts that require continuous maintenance and can continually be expanded upon. Instead of trying to develop a schedule for implementing specific measures or practices, it is perhaps more useful to develop a timeline for implementing priority measures/practices in priority areas. Future efforts can expand on those efforts to include secondary priority areas and/or secondary priority management measures/practices.

Given that it is a goal of the State DOH CWB to implement practices to reduce NPS pollution, the priority measures should be considered by the DOH for funding in the near future. Additionally, there are many other potential funding sources that should be pursued to implement the priority measures (see section 5.4.1 for more information about funding).

A more specific implementation timeline can be developed by funding entities on an annual basis, such as the DOH CWB, since implementation is contingent upon funding. Target timeframes for implementation can be assigned to specific management practices or to overall management measures on a yearly basis. The EPA suggests that when developing an implementation timeline, it is helpful to consult with those who have had previous experience in applying the recommended actions to identify the key steps. It is also necessary to collectively discuss tasks to identify those that are feasible as well as the responsible parties (EPA, 2008).

6 EVALUATION & MONITORING

A well-designed and comprehensive monitoring program is essential to evaluate how the Kaiaka Bay WBP is being implemented and to determine the level of progress achieved towards reducing pollutant loads. This is critical to determining the progress towards improved water quality over time and to securing additional funding. Without current information on water quality conditions and pollutant sources, effects of land-based activities on water quality cannot be assessed, effective management and remediation programs cannot be implemented, and program success cannot be evaluated.

This chapter outlines strategies for evaluating implementation progress and monitoring for improvements in water quality. The chapter is written with the working assumption that there will be a designated entity that will be responsible for conducting the monitoring. It also assumes there will be adequate funding for the monitoring program. These assumptions allow for the best planning of an effective monitoring program for this WBP.

6.1 MONITORING GOALS & OBJECTIVES

The first step in developing a monitoring plan is to define the goals and objectives of the monitoring program (EPA, 2003). Once the goals and objectives are identified, the monitoring approach can be designed.

The monitoring goals should correspond to the overall goals of the WBP, which are to:

- Measurably reduce erosion and sediment loads from all land use types;
- Measurably reduce nutrient loads from all land use types;
- Address other types of pollutants (e.g. pesticides, hydrocarbons, pathogens, metals, etc.) as opportunities arise or as future needs indicate necessary;
- Improve existing regulations and programs related to watershed management and identify opportunities for new programs; and
- Increase the education, understanding, and participation of major landowners and the local community regarding watershed stewardship and water quality monitoring activities.

Monitoring goals are typically broad statements. The monitoring goals of the Kaiaka Bay WBP are as follows:

- Measure progress in implementing management practices and BMPs; and
- Detect any changes or improvements in water quality in impaired water bodies over the long-term.

Monitoring objectives are more specific than goals and can be used to provide information about the ideal monitoring design, including what data should be collected and what geographic and temporal scales are necessary for the monitoring. All of the possible monitoring objectives for the Kaiaka Bay WBP are not specified in this plan since it is not yet determined which projects will be implemented in which locations or watersheds, however, the objectives should correspond to the monitoring goals. Some examples of monitoring objectives are as follows:

- Detect a significant decrease in total nitrogen loading in the Wahiawā Reservoir within the next ten years;
- Detect a significant decrease in turbidity in Kaiaka Bay within the next ten years; or
- Detect a significant reduction in sediment loads coming out of the Forest Lands of the Poamoho Watershed within the next ten years.

Ideally, the monitoring objectives should identify specific pollutant load reduction targets for each water body and each type of pollutant. However, the practical reality of the Kaiaka Bay WBP is that there is limited baseline water quality data available from project area sources over a consistent historical basis for use in establishing specific reduction targets (see “Baseline Monitoring,” section 6.1). Moreover, much of the data that are available (e.g. USGS water quality gauges) are not in the same units of measurement as the State Water Quality Standards and are therefore not comparable. Consequently, specific pollution reduction targets for the Kaiaka Bay Watersheds cannot be accurately quantified. However, monitoring conducted from this point forward can identify implementation progress, water quality trends, and ultimately determine whether or not State Water Quality Standards are achieved. There is clearly a need to address both the current lack of available information and ongoing monitoring to set targets and measure progress towards reducing pollutant loads. The DOH CWB recognizes this issue and is striving towards developing a water quality monitoring program that will monitor pollutants of concern and determine their sources (“Strategy T” in the “State Nonpoint Source Management Plan, 2015 – 2020” [DOH PRC, 2015]).

6.2 TYPES OF MONITORING

The EPA recognizes seven general types of monitoring used in watershed management (Table 44). Each type of monitoring is used for a specific purpose to address a certain type of goal. There are five types that are most applicable to the goals of the of the Kaiaka Bay WBP (indicated in **bold** text in Table 44). Two of these types, implementation and trend monitoring, are the priority types of monitoring recommended in this plan for the Kaiaka Watersheds and are the focus of this chapter. These monitoring design types are considered by the EPA to be two of the most important types of monitoring for assessing progress in reducing NPS pollution (EPA, 2001; EPA, 1997; EPA, 1997a). Other types of monitoring could be implemented on a project-by-project basis as need arises or funding allows.

TABLE 44. GENERAL CHARACTERISTICS OF MONITORING TYPES

Type of Monitoring	Purpose	Number/Type of Water Quality Parameters	Location of Monitoring	Frequency of Measurements	Duration of Monitoring	Intensity of Data Analysis
Baseline	Collect data prior to implementation of practices for comparison	Variable	Installation & reference site(s)	Low	Short to medium	Low to moderate
<u>Implementation*</u>	Determine the extent to which practices are implemented	None	Installation site(s)	Variable	Duration of project	Low
<u>Trend*</u>	Detect long-term changes in one or more parameters	Usually water column	Reference site(s)	Low	Long	Low to moderate
Project	Determine whole system effectiveness	Variable	Variable	Medium to high	Long	Medium
Effectiveness	Evaluate the performance of individual practices	Near activity	Installation & reference site(s)	Medium to high	Short to medium	Medium
Validation	Evaluate a model to validate estimated pollutant load reductions	Few	Installation & reference site(s)	High	Medium to long	High
Compliance	Determine whether water-quality criteria are met	Few	Installation & reference site(s)	Variable	Variable	Moderate to high

Sources: EPA (2003); MacDonald et al. (1991).

Note: Text in **bold** indicates monitoring types most applicable to the goals of the of the Kaiaka Bay WBP.

* Implementation and trend monitoring are the priority types of monitoring recommended for the Kaiaka Watersheds.

6.2.1 IMPLEMENTATION MONITORING

Implementation monitoring is used to determine whether management measures and other strategies are being implemented as specified in a WBP. This type of monitoring can help to address the following goals:

- Determine the extent to which management practices are implemented (including voluntary implementation efforts);
- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation of management measures;
- Support work-load and costing analyses for assistance or regulatory programs;
- Compare adoption rates of management practices across geographic areas; and
- Determine the extent to which management practices are properly maintained and operated.

Implementation monitoring is the most feasible type of monitoring that can be performed because it requires a minimum level of effort and does not require water quality sampling or statistical analysis. It can be used as a surrogate in place of more intensive monitoring (e.g. project monitoring) to ensure that some level of pollutant reduction is occurring by simply documenting the pollution control practices are installed.

Additionally, implementation monitoring is considered essential for evaluating the effectiveness of a management practice or watershed management program, since effectiveness cannot be determined without a thorough documentation of which practices have been implemented (EPA, 1993). By tracking management measures and water quality simultaneously, managers will be able to evaluate the performance of the management measures implemented.

As part of the implementation monitoring process, various types of information should be documented and maintained in a GIS database or other type of database, including:

- Which management practices are being implemented;
- Where and when they were installed;
- The size/scale of the practice(s) implemented at each site;
- Who installed them; and
- What pollutants they are targeting.

The status of implementing the Kaiaka Bay WBP should be evaluated at least on an annual basis to document accomplishments and prioritize upcoming actions based on current knowledge.

For more information about techniques for conducting implementation monitoring, refer to EPA's series of reports for urban, agricultural, and forested areas called "Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures" (EPA, 2001; EPA, 1997; EPA, 1997a). Additionally, EPA's "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" contains a detailed discussion of techniques and procedures to assess implementation, operation, and maintenance of management measures in Chapter 8 (EPA, 1993).

6.2.2 TREND MONITORING

Trend monitoring refers to the long-term monitoring of changes in one or more parameters on a watershed scale to determine overall trends. These parameters could include water quality data as well as public attitudes, land uses, and the use of management practices, however, this WBP focuses on water quality parameters for trend monitoring. Trend monitoring is particularly helpful for monitoring the cumulative, long-term effects of nonstructural practices and is a powerful indicator of how successful the watershed management program has been at improving water quality. It should be noted that a key limitation inherent to trend monitoring is that it does not provide an indication of the effectiveness of specific BMPs (the EPA calls that type of monitoring “effectiveness monitoring”).

Long-term trend monitoring is necessary given that there can be long and uncertain lag times between the implementation of management measures and the response at the watershed level. For example, the results of implemented erosion control measures might take years to become evident since sediments that are already in the drainage network still need to move through the system.

The EPA’s “Monitoring and Evaluating Nonpoint Source Watershed Projects” (2016) presents information on nine different trend monitoring design options. Of the nine, two design types are most suitable for trend monitoring in the Kaiaka Bay Watersheds: “single watershed before/after” and “single-station long-term trend.” These two approaches are very similar; both involve long-term sampling at strategic locations to collect water quality data that reflects all land uses and activities that occur upstream. It is recommended to conduct trend monitoring at multiple locations throughout the Kaiaka Watersheds to collect information about what is happening within each of the four general land use types. This approach, when conducted over many years, will help to uncover the overall impacts of all implemented measures within the watersheds.

Figure 5 on the following page depicts suggested locations for trend monitoring locations in the Kaiaka Watersheds. There are 15 monitoring locations suggested on the map: three are existing USGS gages, one is an existing DLNR gage that is currently not in service, and the remaining 11 are new suggestions for water quality monitoring based on the overall priority management measures in this plan. The Army previously conducted water quality sampling in East Range (Kaukonahua Watershed). It is not known whether the Army gage is still in place, but the approximate location of the gage is indicated on the map. The placement of the suggested new gages should not be considered final, rather, they are placed to represent the land use type and management measures that occur mauka in that watershed and could be adjusted depending on the actual implementation of measures. Additionally, it is expected that not every suggested new gage will be installed at once; rather, gages should be installed downstream of measures as they are implemented in each watershed. Note that gages 14 and 15 are noted to be priority monitoring locations with respect to the other new suggested gages since they are located near Kaiaka Bay in and would reflect all measures implemented mauka in both the Ki’iki’i and Paukauila stream systems. Refer to the accompanying table (Table 45) for information about each of the 15 suggested monitoring locations, including which watershed the gage is located in, which priority management measures are most applicable, and what water quality parameters should be monitored. The suggested water quality parameters to be monitored at each location are based on the primary pollutants of concern in that watershed, identified in *Volume 1* of this WBP, and reflect the goals of the WBP which state that pollutants other than sediments and nutrients should be addressed opportunistically or as deemed necessary.

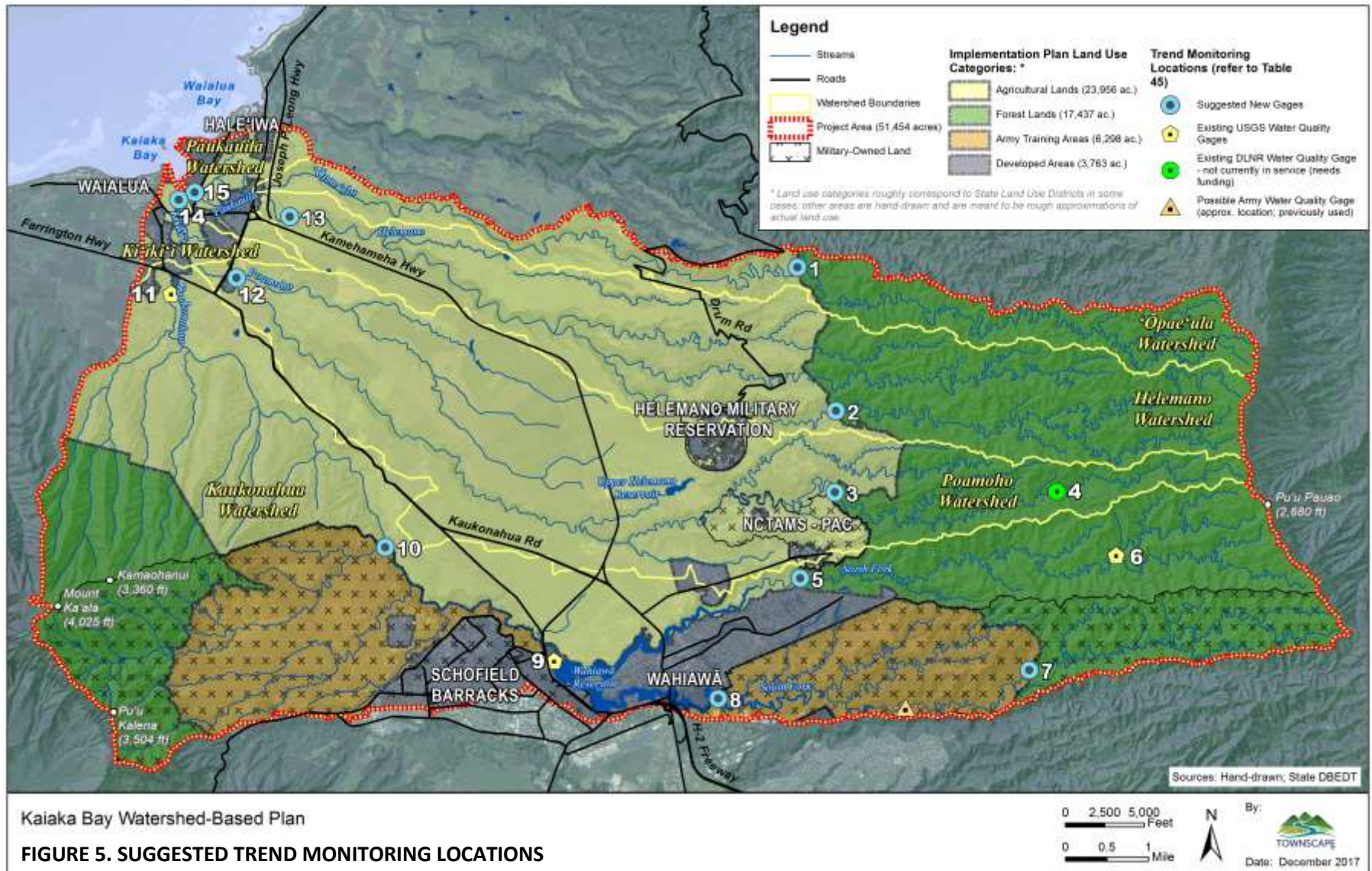


TABLE 45. SUGGESTED TREND MONITORING GAGES FROM FIGURE 5

Gage # (from Figure 5)	New or Existing?	Watershed	Management Measure	WQ Parameter	Other Notes
1	New	‘Ōpae‘ula	• Forest #1	• Turbidity • Total suspended solids (TSS) • Nutrients*	
2	New	Helemano	• Forest #1	• Turbidity • TSS • Nutrients*	Gage could alternatively be located on one of the northern tributaries
3	New	Poamoho	• Forest #1	• Turbidity • TSS • Nutrients*	Not necessary if DLNR gage is in service; gage could alternatively be located on one of the northern tributaries
4	Existing – DLNR Gage	Poamoho	• Forest #1	• Turbidity • TSS • Nutrients*	Currently not in service
5	New	Upper Kaukonahua – North Fork	• Forest #1 • Developed Areas #3 (runoff from the Navy JBPHH-Wahiawā Annex [NCTAMS-PAC])	• Turbidity • TSS • Nutrients*	Would help monitor TMDL requirements; however, somewhat redundant for Forest Measure 1 because of mauka USGS Gage
6	Existing – USGS #16200000	Upper Kaukonahua – North Fork	• Forest Measure #1	• Turbidity • Suspended sediments ** • Nutrients*	
7	New	Upper Kaukonahua – South Fork	• Forest Measure #1	• Turbidity • TSS • Nutrients*	
8	New	Upper Kaukonahua – South Fork	• Army Area #3	• Turbidity • TSS	
9	Existing – USGS #16210200	Lower Kaukonahua	• Developed Areas #2 • Developed Areas #3	• Turbidity • Suspended sediments ** • Nutrients*	
10	New	Lower Kaukonahua	• Army Area #1 • Army Area #3	• Turbidity • TSS	
11	Existing – USGS #16210500	Lower Kaukonahua	• Agriculture #1 • Agriculture #5 • Agriculture #6 • Agriculture #8	• Turbidity • Suspended sediments ** • Nutrients*	
12	New	Poamoho	• Agriculture #1 • Agriculture #6 • Agriculture #8	• Turbidity • TSS • Nutrients*	

- Table continued on next page -

TABLE 45. SUGGESTED TREND MONITORING GAGES FROM FIGURE 5 (CONTINUED)

Gage # (from Figure 5)	New or Existing?	Watershed	Management Measure	WQ Parameter	Other Notes
13	New	Helemano	• Agriculture #5	• Turbidity • TSS • Nutrients*	
14 [†]	New	Ki'iki'i	• Agriculture #1 • Developed Areas #2 • Developed Areas #3	• Turbidity • TSS • Nutrients*	Priority [†]
15 [†]	New	Paukauila	• Agriculture #1 • Developed Areas #2 • Developed Areas #3	• Turbidity • TSS • Nutrients*	Priority [†]

* Nutrients includes total nitrogen, nitrate + nitrite, and total phosphorus.

** The USGS gages measure suspended sediments, not TSS. Note that the State WQS are in terms of TSS.

[†] These sampling locations are priorities since they are the most downstream points in both stream systems – water quality monitoring would reflect all measures implemented upstream.

Key: Forest #1 = Watershed Protection and Forest Management; Agriculture #1 = Erosion and Sediment Control from Actively Farmed Lands; Agriculture #5 = Livestock, Ranching, and Pasturelands Management; Agriculture #6 = Fire Prevention; Agriculture #8 = Field Access Road Management; Developed #2 = Nonpoint Source Wastewater Treatment; Developed #3 = Stormwater Management; Army Area #1 = Fire Prevention and Management; Army Area #3 = Erosion Management Along Roads, Trails, and Frequently Used Areas

Appropriately collected water quality data can be evaluated with simple statistical analyses to determine whether pollutant loads have been significantly reduced. Statistical associations drawn between implementation and water quality data can be used to infer whether management measures have been successful in improving water quality in a watershed (EPA, 2003). While quantitative data is the most useful for determining clear trends over time, qualitative information is also valuable. Methods for collecting qualitative data could include using sediment pins to track erosion rates over time or using photo points to visually document erosion, vegetative cover, or water conditions over time. Note that it is important to assess the seasonal or annual variability of the data as well as analyze how and major land use changes may have affected the criteria being assessed. Moreover, there are often long and certain lag times that can occur between implementation and response at the watershed level.

Refer to Table 46 on the following page for a list of progress indicators that could also be monitored in the Kaiaka Watersheds (in addition to the water quality parameters listed in Table 45). Following the goals of this WBP, pollutants other than sediments and nutrients should be monitored opportunistically or as deemed necessary.

TABLE 46. OTHER TYPES OF PROGRESS INDICATORS

Issue	Indicator	Unit of Measure	Current/Baseline Data Available*
Pathogens	<i>Escherichia coli</i>	MPN/100 ml	Yes
	<i>Clostridium perfringens</i>	MPN/100 ml	Yes
	Enterococci bacteria	MPN/100 ml	Yes
Other Pollutants	Oil and grease (hydrocarbons)	Varies	No
	Heavy metals	Varies	No
	Chemicals	Varies	Very little
	Ammonia	Mg/L	Yes
	Chlorophyll <i>a</i>	Mg/L	Yes†
General Habitat	Trash	Qualitative or pounds	Yes†
	Low biodiversity (aquatic and/or marine species)	Qualitative or varies	Yes
	Invasive species (plants/ungulates)	Qualitative or percent cover	Varies
	Stream flow	Cubic feet per second	Yes
	Stream channel stability	Qualitative or feet eroded	No
Other Environmental	Temperature	Degrees	No
	Dissolved oxygen	Mg/L or percent saturation	No
	pH	pH scale	No
	Salinity	Grams per liter or parts per thousand	Yes (Yost et al. 2009)
Programmatic/General	Funding awarded for implementing practices/programs	\$ or no. of projects	Yes
	Reduction in total impervious surfaces	Acres	Yes
	LID features	Number	Yes
	Conservation plans	Number created or renewed	No
	Stream or beach clean-ups	Number per year	Yes
	LID features	Number	Yes

Trend monitoring in the Kaiaka Bay Watersheds could possibly be conducted by a volunteer community-based organization. Participants should be trained in proper water quality sampling methods to ensure that the data is collected in a consistent and methodical manner. General guidance on water monitoring to be conducted by volunteers is available in a publication entitled “Taking Care of Hawai‘i’s Waters: A Guidebook for Getting Started in Volunteer Water Quality Monitoring.”

For more information about techniques for conducting trend monitoring, refer to the EPA’s “Monitoring and Evaluating Nonpoint Source Watershed Projects (EPA, 2016).

6.2.3 MEASURABLE MILESTONES

The EPA (2008) suggests defining interim, measurable milestones to help determine the success of implementing a WBP in terms of relevant time scales, such as short-term (one to two years), mid-term (two to five years), and long-term (five to ten years or longer). These milestones can help to track implementation on a programmatic level as well as the pollutant reductions being achieved and the affected change in the health of the watersheds. Evaluation of the milestones should be incorporated into the monitoring design(s) selected, especially implementation monitoring and trend monitoring. Some suggested milestones for the Kaiaka Bay WBP are presented below.

Suggested Short-Term Milestones (≤ 2 years)

- Entities for monitoring program are identified
- Data management system developed for collecting monitoring data
- Water sampling gages installed
- DOH CWB issues requests for proposals for project to implement any or all of the priority management measures listed in this WBP to receive funding (i.e. 319 funding)
- KMWP procures funding to complete the Southern Helemano fence
- The effluent from the Wahiawā WWTP is classified as R-1 by DOH; plans to use the R-1 water for irrigation expand
- Explore implementing strategies related to policies, programs, and regulations listed with a short time-frame to implement (Ch. 2; Table 2)
- Develop or pursue funding for programs/projects related to education and outreach (Ch. 4; Table 43), especially related to education on replacing cesspools

Suggested Mid-Term Milestones (≤ 5 years)

- All nine priority management measures in this WBP have been implemented within the Kaiaka Bay Watersheds (or are planned for implementation)
- The Southern Helemano fence is completed
- Pipelines from the Wahiawā WWTP to ADC agricultural lands are constructed to transport the R-1 effluent to be used for irrigation purposes (construction begins by 2020)
- Formally define roles & responsibilities for SWCDs and DPP in the City's grading/grubbing permit exclusion process (e.g. an MOU)
- Explore implementing other strategies related to policies, programs, and regulations listed with a medium time-frame to implement (Ch. 2; Table 2)
- A public education program to encourage the replacement of cesspools has been implemented by DOH
- Significant increase in the number of applicants to receive the \$10,000 tax credit for replacing cesspools
- Trend monitoring indicates improvements in water quality (see "Progress Indicators" in previous section)

Suggested Long-Term Milestones (> 5 years)

- All planned/priority fences in Forest Lands are constructed and are ungulate-free
- All 79 cesspools that qualify for the tax credit for upgrading their system (and the additional 33 that potentially qualify) have upgraded and received the tax credit
- Explore implementing strategies related to policies, programs, and regulations listed with a long time-frame to implement (Ch. 2; Table 2)
- The Wahiawā WWTP ceases to discharge into the Wahiawā Reservoir; all effluent is used for irrigation
- State Water Quality Standards are achieved for all currently impaired water bodies in the Kaiaka Bay Watersheds; water bodies are removed from the State 303(d) list
- Trend monitoring indicates significant improvements in water quality

6.3 DATA COLLECTION & DATA MANAGEMENT

The data collection and management aspects of a monitoring program are key components to its success. The systems used – including sampling methods, the quality assurance and quality control (QA/QC) aspects of data handling, how and where data are stored, and who manages the stored data – determine the reliability, longevity, and accessibility of the data. Successful monitoring programs typically resemble research, complete with focused objectives, methodical sampling methods, statistical analyses, thorough data interpretation, and clear reporting. A qualified statistician should be consulted to review the plans for these aspects of the selected monitoring design(s).

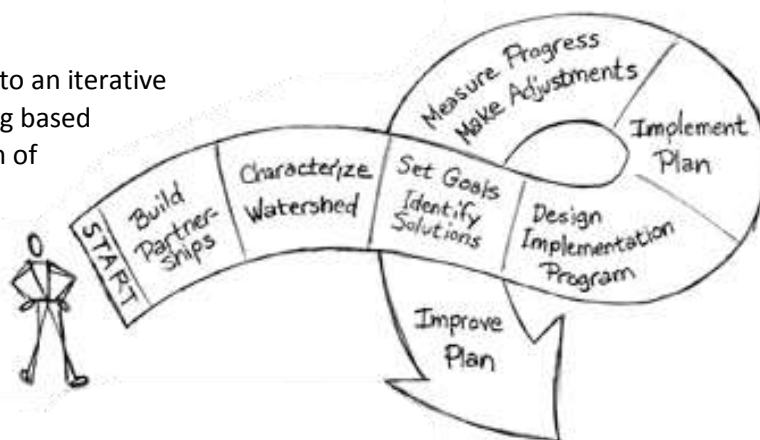
The frequency, location, and type of sampling should be consistent over the years and at different sites being monitored to allow for statistically valid comparisons and analysis. There are many different types of water quality sampling methods that can be done, including grab, composite, integrated, and continuous sampling. Refer to the EPA's "Monitoring and Evaluating Nonpoint Source Watershed Projects" (2016) for a detailed discussion of the utility of the different sampling methods (see also EPA, 2008; EPA, 2004; EPA, 2001; EPA, 1997; EPA, 1997a; EPA, 1993).

Another important aspect of data collection and management for a monitoring program is developing a QA/QC system. Effective QA/QC procedures and a clear delineation of QA/QC responsibilities are essential to ensure the utility of the monitoring data. Quality control refers to the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process. Quality assurance includes the quality control functions and involves a totally integrated program for ensuring the reliability of monitoring and measurement data. Projects that receive EPA funding are required to have a QA/QC component in their monitoring plan ensures that the precision, accuracy, completeness, comparability, and representativeness of data are known and documented. A QA/QC system is documented in writing and provides the policies, objectives, responsibilities, and procedures to be followed throughout the study design, sample collection, sample custody, laboratory analysis, data review, and data analysis and reporting phases (EPA, 2003; EPA, 1993). Additional information on the EPA requirements for developing a QA/QC system for monitoring data can be found in EPA publications (e.g., EPA, 2016; EPA, 2004; EPA, 2003; EPA, 1993). Additionally, the publication titled "Taking Care of Hawai'i's Waters: A Guidebook for Getting Started in Volunteer Water Quality Monitoring" provides information on water sampling, data collection methods, and QA/QC planning.

While this plan was written with the assumption that there will be a designated entity responsible for collecting and maintaining data and information on water quality and/or watershed conditions in the Kaiaka Bay Watersheds, there is no such entity at the time of writing. Consequently, it is important that the parties responsible for ensuring successful implementation of the Kaiaka Bay WBP determine who should take the lead on collecting, managing, and analyzing the monitoring data for the Kaiaka Bay Watersheds. Depending on the type and scale of monitoring to be conducted, monitoring may be conducted by a variety of entities, including community-based volunteer groups, a nonprofit organization, the State DOH CWB, or a combination of various efforts. Several of the monitoring approaches could be conducted by a community organization; for a discussion on this subject, refer to section 4.2 as well as the publication titled "Taking Care of Hawai'i's Waters: A Guidebook for Getting Started in Volunteer Water Quality Monitoring."

6.4 ADAPTIVE MANAGEMENT

The term “adaptive management” refers to an iterative process of evaluation and decision-making based on available monitoring data with the aim of improving the management approach to continually become more efficient and effective. Due to the lack of complete information regarding the appropriate type, extent, and location of management measures and practices, it is highly likely that changes will be needed once aspects of the WBP are implemented. If progress is monitored adequately, managers and



Watershed planning is an inherently adaptive process; monitoring is essential to improve the plan and continually make progress

landowners will be able to adjust implementation plans, schedules, and models as needed to ensure more cost-efficient achievement of water quality objectives (EPA, 2003). Essentially, adaptive management is the overall goal of a monitoring program, since the collected information does no good if it is not used to improve the management approach. The ability to adapt future decisions to new information is the hallmark of adaptive management (Runge, 2011).

According to the Adaptive Management Working Group (U.S. Department of the Interior), there are five conditions that make adaptive management the most useful, all of which are relevant to the Kaiaka Bay Watershed-Based Plan. The conditions are as follows:

1. Management is required in spite of uncertainty;
2. Clear and measurable objectives guide decision-making;
3. There is an opportunity to apply learning to management;
4. Monitoring can reduce uncertainty; and
5. There is sustained commitment by stakeholders including decision-makers.

Another reason why an adaptive management approach should be a cornerstone in the implementation of the Kaiaka Bay WBP is because it is a clearly stated objective in the “State Nonpoint Source Management Plan, 2015 – 2020” (DOH PRC, 2015). Goal 4, Objective 4 states that the DOH CWB should “apply adaptive management to improve the State NPS Program and investigate innovative approaches to address NPS pollution in Hawai‘i.”

The measurable milestones and selected progress indicators described in this chapter can serve as triggers to indicate whether progress is being made in implementing the WBP and improving water quality. They can also indicate whether the implementation approach needs to be reevaluated if there is not adequate progress. While quantitative data is preferred for adaptive management, qualitative data can also be valuable in documenting change over time and can be used in the decision-making process. The Kaiaka Bay WBP should be evaluated annually to determine progress and adapt implementation strategies and priority projects based on current knowledge.

6.5 SUMMARY

The Kaiaka Bay WBP characterizes the watershed conditions (*Volume 1*) and makes recommendations on how to reduce point source and nonpoint source pollutants (*Volume 2*). While this is an essential first step towards improving the health of the watersheds and the marine environment of Kaiaka Bay, a well-designed monitoring program is essential for an adaptive management approach to continually improve the WBP. Two types of monitoring are recommended: implementation monitoring and trend monitoring. Together, these monitoring approaches will provide adequate information to infer whether the implementation of the Kaiaka Bay WBP is resulting in improved water quality over time. Note that it is a top priority to identify the entities responsible for monitoring, whether they be community-based volunteer groups, a nonprofit organization, the State DOH CWB, or a combination of various efforts. The monitoring approaches presented in this chapter should serve as guidelines for implementing a useful monitoring program that can help make implementation of the WBP the most effective and efficient possible.

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