MARINE AND COASTAL SOLUTIONS INTERNATIONAL

WAIULAULA WATERSHED MANAGEMENT PLAN

Mauna Kea Soil and Water Conservation District

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Acronyms

ac.	acres
ALISH	Agricultural Lands of Importance to the State of Hawaiʻi
ASEA	Aquifer Sector Area
BMP	best management practice
CDP	community development plan
CDUA	Conservation District Use Application (DLNR)
CDUP	Conservation District Use Permit (DLNR)
CES	University of Hawaiʻi's Cooperative Extension Service
cfs	cubic feet per second
CNPCP	Hawaiʻi Coastal Nonpoint Pollution Control Program
CREP	Conservation Reserve Enhancement Program
CWDA	DOH's Critical Wastewater Disposal Areas
CWRM	Hawaiʻi Commission on Water Resource Management
CZM	coastal zone management
DAR	DLNR's Division of Aquatic Resources
DEM	digital elevation model
DHHL	Department of Hawaiian Homelands
DLNR	Hawaiʻi Department of Land and Natural Resources
DOA	Hawaiʻi Department of Agriculture
DOBOR	DLNR's Division of Boating and Ocean Recreation
DOH	Hawaiʻi Department of Health
DOT	Hawaiʻi Department of Transportation
DPW	Hawaiʻi County Department of Public Works
DWS	Hawaiʻi County Department of Water Supply
EA	environmental assessment
eFOTG	NRCS's electronic Field Office Technical Guide
EIS	environmental impact statement
EMC	event mean concentration
EPA	US Environmental Protection Agency
ER	enrichment ratios
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
ft/d	feet per day (movement of groundwater)
FUDS	Formerly Used Defense Sites
GIS	geographic information system
gpd	gallons per day
HAR	Hawaiʻi Administrative Rules
HBS	Bishop Museum's Hawaiʻi Biological Survey
HCC	Hawaiʻi County Code
HRS	Hawaiʻi Revised Statutes

HWMO	Hawaiʻi Wildfire Management Organization
LCC	large capacity cesspool
LID	Low Impact Development
LSB	University of Hawaiʻi's Land Study Bureau
LUC	Hawaiʻi Land Use Commission
LUPAG	Hawaiʻi County General Plan Land Use Pattern Allocation Guide
MG	million gallons
mgd	million gallons per day
MKSWCD	Mauna Kea Soil and Water Conservation District
MSD	marine sanitation device
MV	mass-volume (curve)
N	nitrogen
NARS	Hawaiʻi Natural Area Reserve System
NH4	ammonium
NPDES	National Pollutant Discharge Elimination System (permit)
NRCS	USDA's Natural Resources Conservation Service
N-SPECT	Nonpoint Source Pollution and Erosion Comparison Tool
OSDS	onsite disposal system
P	phosphorus
SCAP	CWRM's Stream Channel Alteration Permit
SLH	Session Laws of Hawaii
SMA	Special Management Area (permit)
TBD	to be determined
TMK	tax map key
TN	total nitrogen
TP	total phosphorus
TSS	total suspended sediment
UIC	Underground Injection Control (line or program)
USACOE	US Army Corps of Engineers
USCG	US Coast Guard
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
UST	underground storage tank
UXO	unexploded ordnance
WWMP	Wai'ula'ula Watershed Management Plan

Executive Summary

The Waiʻulaʻula Stream watershed encompasses over 18,000 acres in the South Kohala District on Hawaiʻi Island. The streams within this watershed flow more frequently than any other stream system in West Hawaiʻi, creating important habitat for the native aquatic species. The nearshore waters of Kawaihae Bay, into which Waiʻulaʻula flows, provide an important nursery ground not only for the native stream fishes but also for species important to the marine recreational, subsistence, and commercial fisheries. The upper reaches of the streams also provide water for both domestic and agricultural uses.

The watershed supports a variety of land and water uses, ranging from agriculture to urban to commercial to conservation. The South Kohala District which encompasses this watershed has experienced tremendous population and residential growth over the past 20 years. Much of this growth has occurred within the watershed. In addition, the Hawaiʻi County General Plan projects that this area will experience significant urban and suburban expansion over the next several decades. No studies have been done on the impacts of this cumulative and ongoing development on the riparian, stream, and coral reef habitats, and stream and coastal water quality. It is generally thought that the water quality within the watershed remains good. However, water quality monitoring undertaken by the Mauna Kea Soil and Water Conservation District (MKSWCD) indicates that, in some areas and for some pollutants, State water quality standards are exceeded.

Through the Waiʻulaʻula watershed management project, the MKSWCD seeks to be proactive in the management of this important watershed, focusing both on addressing existing sources of polluted runoff and threats to watershed health and preventing further degradation of the watershed resources as projected land use changes occur. The overall goal of the Waiʻulaʻula watershed management plan is to maintain healthy stream and riparian environments, both in terms of water quality and habitat integrity, that sustain a healthy *mauka-makai* connection and promote community-based environmental stewardship.

Chapter 1 provides an overview of the Waiʻulaʻula watershed management plan and its purpose, and describes the process used to develop the plan. MKSWCD took the leading role in developing the Waiʻulaʻula Watershed Management Plan (WWMP), with significant stakeholder involvement and community input. The watershed planning process was a multi-year effort to develop relationships, educate residents of the watershed on water quality issues, and seek land users and community help to identify contributing pollution sources in the watershed and recommend specific actions needed to effectively control sources of pollution. In developing the watershed management plan, the MKSWCD consulted a number of documents for assistance, including EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (EPA 2005), *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA 1993), and *Updated Management Measures for Hawaiʻi's Coastal Nonpoint Pollution Control Program* (Stewart 2009).

Chapter 2 describes the natural and socio-cultural resources of the watershed. The primary tributaries of the Wai'ula'ula watershed are Waikoloa and Keanu'i'omanō streams, both of which originate at over 4,000-ft. elevation on Kohala Mountain and flow relatively parallel to one another until they join in a series of braided channels at about the 1,440-ft. elevation to form Wai'ula'ula, which terminates in the ocean in Kawaihae Bay. These streams flow year-round in their upper reaches but are intermittent in their lower reaches because of withdrawals upstream for domestic and agricultural purposes. There are permanent stream pools in the streams below Waimea that are apparently receiving some groundwater input. During storm events, stream levels and flows can increase rapidly, demonstrating the flashiness of Hawaiian streams.

The Wai'ula'ula watershed extends from the 5,260-ft. elevation on Kohala Mountain to sea level over a distance of 8.5 miles, if measured as a straight line from headwater to estuary. Because of this steepness, climate varies considerably by elevation. The upper elevations are typically wet and cool, while the coastline is hot and arid. The watershed is typically affected by a regular pattern of orographic cloud formation and precipitation. Lower reaches of the watershed typically receive most of their moisture during Kona storms and localized convection events during the winter months. Annual rainfall in the watershed varies from about 120 inches in the upper elevations to 7 inches at the coast. Drought conditions in the watershed in recent years have exacerbated the dry conditions in the lower watershed.

The lands of the Wai'ula'ula watershed comprise the geological substrates of both Kohala Mountain and Mauna Kea. This geology has implications for both soil types and hydrology. The Wai'ula'ula watershed comprises several broad types of vegetation: forest, grassland, scrub/shrub and cultivated land. With the exception of the forested headwaters, much of the watershed's vegetation has been altered over time. For the most part, plant and animal communities reflect this change.

In the Wai'ula'ula watershed, 69.4% of the lands are designated Agriculture, 21.2% Conservation, 0.5% Rural (small farms and low-density residential lots), and 8.9% Urban. Chapter 205, HRS, delegates the responsibility for zoning within the agricultural and rural districts to the counties. The urban district is entirely under county jurisdiction, and uses are controlled only by county zoning. While there is little urban or suburban development within the watershed at present, the County's Land Use Pattern Allocation Guide shows substantial areas designated for urban and suburban expansion. Lands in the Conservation District are managed by the Department of Land and Natural Resources. A permit is required prior to any use of land in the Conservation District. Conservation lands include the Kohala Watershed Forest Reserve, Pu'u o 'Umi Natural Area Reserve, and Kohala Restricted Watershed.

Chapter 2 also describes historic and current uses and the watershed's land and water resources. It also summarizes relevant authorities at the county, state and federal levels that affect the management of natural resources and regulate potential sources of polluted runoff in the watershed.

Chapter 3 provides water quality and biological data for the watershed, as well as estimations of pollutant loads. Autosamplers were used to collect stormwater runoff in three locations that was analyzed for nutrient and suspended sediment concentrations. At the Marine Dam site (where Waikoloa stream exits the high-elevation forest), the stream has relatively low concentrations of nitrate, ammonia, and orthophosphate (PO_4). At the sampling site downstream of Waimea Town (Sandalwood site), ammonia concentrations doubled, total phosphorus concentrations (TP) more than doubled, and nitrate concentrations quadrupled. The average nitrate concentration just barely exceeded the water quality standard. The TP concentration was nearly twice the allowable amount. At the sampling site near the mouth of the watershed, total nitrogen was high, with measured concentrations nearly twice what is allowed by State water quality standards.

Nine samples of urban storm runoff were collected by taking grab samples of flowing water in parking lots, storm water running off of roads, or from pipes that collect parking lot/road runoff. All sites were located in Waimea, and samples were collected between November 2008 and April 2009. Based on this limited amount of data, it appears likely that runoff from high-use paved areas exceeds water quality criteria for sediment (by a factor of five), total phosphorus (by a factor of four), total nitrogen (by a factor of three) and nitrate (measured values are only slightly greater than the standard). These results are not surprising as urban storm runoff is usually high in sediment and nutrients.

During the period July 2006 through April 2008, the Department of Health (DOH) made frequent measurements of water quality at a number of coastal sites. Measurements in the nearshore waters of Kawaihae Bay at Waiʻulaʻula were taken on 33 separate days. Comparison of measurement against the water quality standards shows that the Bay has too much ammonia (concentrations are 2.8 more than what is allowed) and too much chlorophyll (concentrations are double what is allowed). The high chlorophyll levels indicate that there is too much algae. It is likely the high ammonia levels are contributing to high excess algae. Because ammonia is rapidly converted to nitrate in the presence of oxygen, it is likely that the source of the ammonia is nearby. The measured nitrate and total nitrogen concentrations are near the standard. Total phosphorus concentrations are slightly above the standard.

“Loads” are the total amount of a pollutant that is exported from a watershed. Loads are usually measured in pounds (of Nitrogen, Phosphorus, or Sediment) per year. Existing loads can be measured, although obtaining data is very expensive. Modeling can be used to estimate loads for locations where measurements are not available. Annual loads were, therefore, estimated for this watershed management plan using NOAA’s Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) model. One advantage of using a model is that it provides explicit estimates of the contributions of each landcover class. N-SPECT can also identify areas that are particularly susceptible to erosion or predict the change in loads resulting from land use changes.

The model's estimate of sediment concentration (TSS) was about 20% higher than the measured concentration at the Marine Dam autosampler and more than double the measured concentration at the lower edge of the town of Waimea. It is possible that NSPECT under-estimated the amount of sediment that is re-deposited a short distance from where it was eroded. Or, it is possible that some of the RUSLE/MUSLE coefficients are not appropriate to Hawaiʻi. On an average annual basis, the model predicts that the nitrogen load from the watershed is approximately 23,000 kg or 1.4 kg/acre/year, while the predicted phosphorus load is 2,176 kg or 0.129 kg/acre/year (Gaut 2009). When compared to other watersheds in Hawaiʻi, N-SPECT produced reasonable estimates of nitrogen and phosphorus loads; however, the limited water quality data collected by autosamplers within the Waiʻulaʻula watershed suggest these estimates may be high (Gaut 2009).

Assessment of ecosystem health can be based either on water quality or on biological populations. A healthy ecosystem is diverse and contains native species. Stream surveys reveal a wide array of native endemic and indigenous aquatic fish and macro-invertebrates in the watershed. According to Englund (2010), "[t]he relatively high 65% overall native aquatic insect biodiversity found within the entire Waiʻulaʻula watershed is comparable to other high quality streams" (p. 12).

Chapter 4 describes the threats to the water quality of the watershed. At this time, there are insufficient data to conclusively prioritize threats by load contribution or impacts to resources. The following threats are present in the watershed:

- Nonpoint sources of pollution in the form of agriculture, urban/suburban runoff, onsite wastewater disposal systems, streambank erosion, disturbances by feral ungulates (pigs, goats), invasive plants, and atmospheric sources of nitrogen;
- Wildfire;
- Unexploded ordnance;
- Solid and hazardous waste;
- Flooding;
- Stream diversions; and
- Climate change.

The chapter describes each of these threats in detail. Addressing the effects of some of these threats is beyond the scope of this watershed management plan.

Chapter 5 describes management measures that can be implemented to achieve watershed restoration and protection goals and address the existing impairments and threats described in Chapters 3 and 4. This plan focuses efforts primarily in the riparian corridor and on the land immediately adjacent to the riparian zone because these areas most directly impact the quality of the stream and nearshore waters and habitats. The watershed management plan describes a coordinated program of effective actions to be implemented to prevent and abate polluted runoff within the watershed, as well as address other threats that have a direct impact of overall watershed health and habitat integrity.

Chapter 5 lays out watershed restoration and protection goals and objectives, as well as recommended projects and tasks to address the goals and objectives. It identifies implementing measures that will have the greatest likelihood of achieving the stated watershed goals. Under each goal, there is a brief description of the problem to be addressed, estimated pollutant load reductions expected, and a table listing criteria by which to measure success in achieving that particular goal, followed by one or more measurable objectives. Under each objective there are one or more projects to implement the objective. Under each project there is a list of tasks, which are interim measurable milestones to gage progress toward project implementation. Worksheets for each project are provided in Appendix A, summarizing project tasks, implementation timeframe and schedule, pollutant load reduction estimates (if applicable), responsible entity and project partners, and an estimation of costs and technical assistance. Project timeframes and schedules assume a start date of 2012 for plan implementation.

Goal 1: Reduce nutrient loads in the Waiʻulaʻula watershed.		
	Objective 1a: Reduce nutrient loads in agricultural runoff from Lālāmilo Farm Lots by 20% by 2019.	
		Project NUTR-1: Assist farmers in Lālāmilo Farm Lots with the development and implementation of Conservation Plans to reduce polluted runoff. This project also addresses objectives for sediment control and stormwater management.
	Objective 1b: Fence 58,000-ft. of riparian corridors on Keanuʻiʻomanō Stream to exclude livestock from streams by 2023.	
		Project NUTR-2. Work with Parker Ranch and FR Cattle Co. to fence critical riparian areas that cattle are currently using to access water. This project will also address pathogens and sediment loads from eroding streambanks caused by cattle trampling.
	Objective 1c: Increase inspections and maintenance (pumping) of onsite wastewater disposal systems (OSDS) within the watershed by 20% by 2019.	
		Project NUTR-3. By 2016, educate home owners about proper operation and maintenance of OSDS and the effects of failing OSDS on water quality, public health, and environmental conditions.
		Project NUTR-4. Work with local realtors and lenders to establish voluntary point-of-sale inspections of OSDS in critical areas of the watershed by 2017.
Goal 2: Prevent an increase in sediment loads in the Waiʻulaʻula watershed.		
	Objective 2a: Reduce sediment loads in agricultural runoff from Lālāmilo Farm Lots by 20% by 2019.	
		Project SED-1. Assist farmers in Lālāmilo Farm Lots with the development and implementation of Conservation Plans to reduce polluted runoff. (Implement concurrently with Project NUTR-1 above.)
	Objective 2b: By 2020, improve grazing efficiency as a way to prevent overgrazing and limit wildfire size to an average of 100 acres burned per year in the fire prone area between 1,200-ft. and 2,600-ft. elevation.	

		Project SED-2. By 2013, extend the Waimea Irrigation Water System from Lālāmilo Farm Lots to the rock wall at the 1,200-ft. elevation.
		Project SED-3. Sub-divide large paddocks in the wildfire prone area between Lālāmilo and the rock wall at 1,200-ft. elevation into smaller paddocks by 2016 to improve grazing efficiency of fine fuels.
	Objective 2c: By 2016, assess 100% of the watershed's riparian corridors to identify eroding or unstable streambanks and monitor at least 10 sites over 3 years to determine annual erosion rates.	
		Project SED-4. Identify eroding and unstable streambanks and install erosion pins in representative sites to monitor annual erosion rates.
	Objective 2d: Following fencing projects (FIRE-1 and FIRE-2), remove all feral goats from the lower watershed (rock wall down to the coast) by 2020.	
		Project SED-5. Remove feral goats from the lower watershed between Queen Kaʻahumanu Highway and the rock wall at the 1,200-ft. elevation by 2014.
		Project SED-6. Remove goats from lower watershed below Queen Kaʻahumanu Highway by 2020. This project would only occur following the fencing of this area under Project FIRE-2.
	Objective 2e: By 2022, restore 25% of bare land in the watershed contributing to erosion, using techniques described in the post-fire restoration manual (Project FIRE-6).	
		Project SED-7. Identify and re-vegetate 25% of priority bare land contributing to sediment load in the watershed by 2022.
Goal 3: Reduce wildfire occurrences and associated impacts to water quality and ecosystem health.		
	Objective 3a: Reduce size of wildfires to an average of 100 acres burned per year by 2015 in the fire prone area between Queen Kaʻahumanu Highway and 1,200-ft. elevation by using grazing to manage fine fuel loads.	
		Project FIRE-1. Fence lower watershed between Queen Kaʻahumanu Highway and the rock wall at 1,200-ft. by 2013 to manage fine fuel loads with cattle grazing.
		Project FIRE-2. By 2018, develop a project to reduce the fuel load in the unfenced, ungrazed area below Queen Kaʻahumanu Highway (to sea level) in consultation with land owners, Hawaiʻi Wildfire Management Organization, NRCS, UH Cooperative Extension Service, and possible grazers.
	Objective 3b: By 2020, install measures within the watershed to facilitate rapid response by fire suppression agencies in the event of a fire start, to include reducing fuel loads in a 150-ft. to 300-ft. buffer zone around neighborhoods and along roadways by 80%.	
		Project FIRE-3. Update fire resource maps that cover the Waiʻulaʻula watershed by 2012.

		Project FIRE-4. Facilitate development and/or update of water use and access agreements between private land owners in the Waiʻulaʻula watershed and fire response agencies by 2012.
		Project FIRE-5. Construct and/or maintain at least 6 miles of fuel breaks by 2017 to protect residential communities in fire-prone areas from wildfire and to slow spread of fire starts along roadways in the watershed.
	Objective 3c: In cooperation with HWMO, develop a post-fire restoration manual of effective practices by 2015.	
		Project FIRE-6. In cooperation with HWMO, develop a post-fire restoration manual of effective practices by 2015.
Goal 4: Reduce the volume and increase the quality of stormwater runoff in the urban and suburban areas of the Waiʻulaʻula watershed.		
	Objective 4a: By 2020, treat 70% of urban stormwater runoff that is conveyed directly into streams and 30% of stormwater conveyed to dry wells in close proximity to stream channels.	
		Project STORM-1. Install storm drain and curbside catch basin filter inserts by 2016 on priority drains/ basins that discharge directly into streams.
		Project STORM-2. By 2018, install catch basin filter inserts on priority dry wells that are in close proximity to streams, where stormwater carrying pollutants may rapidly seep into stream channels.
	Objective 4b: Conduct semi-annual educational events to engage residential property owners in managing stormwater onsite for three years before 2016.	
		Project STORM-3. Develop and implement a public education and outreach program for residential stormwater management.
	Objective 4c: Decrease volumes flowing offsite and increase treatment of stormwater from existing commercial and residential developments by 15% by 2023.	
		Project STORM-4. Upgrade existing urban runoff control structures on a priority basis.
	Objective 4d: Develop written pollution prevention procedures for the operation and maintenance of existing County roads, highways, and bridges by 2019 to reduce pollutant loadings to surface waters.	
		Project STORM-5. Work with the County to formalize operations and maintenance practices for County roads, highways, and bridges by developing written guidelines.
	Objective 4e: By promoting use of Low Impact Development techniques, reduce the volume of stormwater runoff conveyed offsite from new large developments by 2025 so that total runoff volumes calculated by N-SPECT modeling of land use changes do not increase as urban and suburban expansion occurs.	
		Project STORM-6. Develop and implement a LID outreach program for large landowners, developers, State and county land managers and permitting agencies, and engineering and land use planning firms by 2015.

Goal 5: Restore and enhance riparian buffers that serve as protective filters for streams in the Waiʻulaʻula watershed.		
	Objective 5a: By 2025, restore 25,000-ft. of stream riparian corridor to provide an adequate buffer for managing stormwater, reducing pollutant loads by 10% from current levels, protecting from property loss due to flooding and erosion, and creating healthy habitat for native aquatic species.	
		Project STREAM-1. By 2017, convert marginal agricultural lands within a 15,000-ft. length of the stream corridor into native vegetation under the Hawaiʻi Conservation Resource Enhancement Program.
		Project STREAM-2. Conduct semi-annual educational events, including hands-on events and demonstration projects, for three years before 2016 to educate the public about the importance of riparian buffers.
		Project STREAM-3. Prioritize riparian buffers for restoration, and work with land owner(s) to implement restoration project(s) on at least 10,000-ft. of priority stream corridors.
	Objective 5b: By 2018, establish a county regulatory mechanism that specifically protects wetlands and riparian areas of perennial streams on Hawaiʻi Island.	
		Project STREAM-4. Help draft policy language to enact an overlay district that explicitly protects wetlands and riparian areas.
Goal 6: Protect aquatic habitat and manage instream flows.		
	Objective 6a: By 2021, ensure that instream flows for the streams within the Waiʻulaʻula watershed balance permitted sustainable water use and protection of the biological, chemical, and physical integrity of these waters, and that annual diversions do not exceed half the combined flows at the Marine Dam and Kohākōhau stream gauges.	
		Project AQU-1. Work with landowners and the Water Commission to permit or remove 100% of illegal diversions by 2018.
		Project AQU-2. Evaluate need for specific instream flow standards for streams within the Waiʻulaʻula watershed by 2019.
	Objective 6b: Maintain or improve the current native species diversity of fish and invertebrate communities in the Waiʻulaʻula watershed by 2025.	
		Project AQU-3. Consult with experts by 2016 to determine if existing dams and other instream structures are having a negative effect on ʻoʻopu instream migration.
		Project AQU-4. Prevent further introduction of invasive aquatic species into the streams and identify how to remove existing invasive species that threaten native species by 2020.
		Project AQU-5. By 2015, protect priority instream perennial pools that provide important habitat for native aquatic species.
Goal 7: Increase public education, understanding, and participation regarding watershed issues.		

	Objective 7a: Increase stakeholder awareness and involvement by 15% by implementing an integrated watershed management information and education campaign by 2016.	
		Project EDUC-1: Develop/ adapt and distribute educational materials related to watershed issues to community members. The majority of these educational materials relate to projects described above.
	Objective 7b: Recruit and engage volunteers to assist in at least two large community-based projects in the watershed every year beginning in 2013.	
		Project EDUC-2: Provide on-the-ground service learning opportunities for school children and community members.
Goal 8: Provide effective project administration and management to ensure long-term success.		
	Objective 8a: Establish appropriate administrative framework by 2012 to allow for effective and timely implementation of the Waiʻulaʻula watershed plan.	
		Project ADMIN-1: Hire Waiʻulaʻula watershed coordinator.
	Objective 8b: Implement monitoring program described in Chapter 6, following the timeframes established.	
		Project: MONIT-1: When management plan implementation begins, initiate monitoring components described in Chapter 6.

Using best professional judgment, management actions were assessed and prioritized based on a number of criterion, including load reduction potential, acreage affected, landowner buy-in, cost, ease of implementation, and community exposure (to facilitate education and outreach). This process, described in more detail in Chapter 5, resulted in projects being placed in high, medium, and low priority levels for implementation. These priority levels translated into an implementation schedule spanning 15 years.

Chapter 6 outlines the monitoring component of the Waiʻulaʻula watershed management plan. Monitoring is an essential part of watershed planning. Monitoring can identify emerging problems or document response to changes in land use or climate. Equally important, monitoring is needed to evaluate the effectiveness of implemented BMPs.

PURPOSE OF MONITORING	TYPE OF MONITORING
Implementation Monitoring	
Implementation monitoring determines whether the management strategies outlined in the work plan are being implemented as written.	
Land Use Monitoring	
Changes in land use have the potential to result in changes to water quality or integrity of riparian habitats. Such changes should be tracked and correlated with changes in baseline water quality	

Purpose of Monitoring	Type of Monitoring
Long-Term Monitoring of Water Quality	
Water quality monitoring will help identify whether new disturbances or management activities are having a negative or positive impact on water quality; measure whether there are progressive changes in water quality, either for better or for worse; evaluate, when fires occur, whether there are downstream impacts; and evaluate year-to-year variability in order to more realistically evaluate pre- and post- monitoring of BMPs.	**Long-Term Baseflow Monitoring**
	Long-Term Marine Monitoring
	Stormflow Monitoring
Monitoring of Watershed Conditions	
The purpose of the watershed condition monitoring is to assess the status and trend of watershed attributes to help determine if Waiʻulaʻula watershed management efforts are achieving goals of maintaining and restoring a healthy watershed.	**Vegetation Monitoring** ■ Stubble Height Monitoring ■ Fuel Loads ■ Vegetation Transects
	Stream Condition Assessment
	Erosion Monitoring ■ Infiltration Rates ■ Erosion Rates
	Biological Surveys of Aquatic Species

A detailed sampling and analysis plan that outlines parameters to be monitored, sampling location and frequency, roles and responsibilities, documentation and records, quality control requirements, and chain of custody will be developed prior to implementation of management projects.

Chapter 7 provides an extensive biobliography. The appendices provide additional information of interest. Appendix A provides stand-alone worksheets for each project, summarizing project tasks, implementation timeframe and schedule, responsible entity and project partners, and an estimation of costs and technical assistance. Appendix B describes the relevant Coastal Nonpoint Pollution Control Program management measures. Appendix C identifies EPA's nine key elements for developing an effective watershed management plan.

Chapter 1: Introduction

The Waiʻulaʻula Stream watershed encompasses over 18,000 acres in the South Kohala District on Hawaiʻi Island. The streams within this watershed flow more frequently than any other stream system in West Hawaiʻi, creating important habitat for the native aquatic species. The nearshore waters of Kawaihae Bay, into which Waiʻulaʻula flows, provide an important nursery ground not only for the native stream fishes but also for species important to the marine recreational, subsistence, and commercial fisheries. The upper reaches of the streams also provide water for both domestic and agricultural uses.

The watershed supports a variety of land and water uses, ranging from agriculture to urban to commercial to conservation. The South Kohala District which encompasses this watershed has experienced tremendous population and residential growth over the past 20 years. Much of this growth has occurred within the watershed. In addition, the Hawaiʻi County General Plan projects that this area will experience significant urban and suburban expansion over the next several decades. No studies have been done on the impacts of this cumulative and ongoing development on the riparian, stream, and coral reef habitats, and stream and coastal water quality. It is generally thought that the water quality within the watershed remains good. However, water quality monitoring undertaken by the Mauna Kea Soil and Water Conservation District (MKSWCD) indicates that, in some areas and for some pollutants, State water quality standards are exceeded. Through the Waiʻulaʻula watershed management project, the MKSWCD seeks to be proactive in the management of this important watershed, focusing both on addressing existing sources of polluted runoff and threats to watershed health and preventing further degradation of the watershed resources as projected land use changes occur.

The overall goal of the Waiʻulaʻula watershed management plan is to maintain healthy stream and riparian environments, both in terms of water quality and habitat integrity, that sustain a healthy *mauka-makai* connection and promote community-based environmental stewardship.

1.1 Document Overview

This watershed management plan addresses both EPA's 9 key elements for watershed-based plans and the applicable management measures for Hawaiʻi's coastal nonpoint pollution control program (CNPCP). Chapter 2 describes the natural and socio-cultural resources of the watershed. Chapter 3 provides water quality and biological data for the watershed, as well as estimations of pollutant loads. Chapter 4 describes the threats to the water quality of the watershed, and Chapter 5 describes management measures that can be implemented to achieve watershed restoration and protection goals and address the existing impairments and threats. Chapter 6 outlines the monitoring plan to measure effectiveness of implementation efforts.

1.2 Watershed Management Plan Purpose and Process Used

The Mauna Kea Soil and Water Conservation District (MKSWCD or District) took the leading role in developing the Waiʻulaʻula Watershed Management Plan (WWMP), with significant stakeholder involvement and community input. MKSWCD is a quasi-state agency established in 1955 under Chapter 180, Hawaiʻi Revised Statutes (HRS). Five volunteer directors administer the MKSWCD programs. The MKSWCD takes available technical, financial and educational resources and focuses them to meet the needs of the local land users for the conservation of soil, water and other related environmental resources. MKSWCD has a proven track record in developing and implementing watershed management plans. Prior to initiating the Waiʻulaʻula watershed planning effort, the MKSWCD was responsible for the Pelekane Bay watershed management effort. In 2005, the MKSWCD received a contract from the Hawaiʻi Department of Health (DOH) supported with Section 319(h) funding to develop the WWMP and, in 2010, received additional funding through the Hawaiʻi Department of Land and Natural Resources (DLNR) to update the plan.

The MKSWCD directors have been responsible for overseeing the project. The directors who have been involved since the beginning of this effort include: Jim Frazier; David Fuertes; Pete Hendricks; Robby Hind; Ken Kaneshiro; Brad Lau; Chris Robb; and Jim Thain. Carolyn Stewart was hired as the watershed coordinator. She has 20 years of experience in watershed planning and polluted runoff control. Consultants Mike Donoho, Jene Michaud, and Orlando Smith assisted with the development of the watershed management plan. Margaret Fowler, MKSWCD office manager, also contributed significantly to the project. Two University of Hawaiʻi graduate students – Katie Gaut and James Tait – conducted their thesis work in the Waiʻulaʻula watershed, providing information beneficial to the watershed planning effort.

This watershed planning process has been a multi-year effort to develop relationships, educate residents of the watershed on water quality issues, and seek land users and community help to identify contributing pollution sources in the watershed and recommend specific actions needed to effectively control sources of pollution. While a watershed advisory group was initially formed in December 2005 to provide input into the watershed management planning efforts, the MKSWCD found that attendance was generally low. There are many community organizations and committees already in existence, and people were not interested in attending yet another meeting. Instead, the MKSWCD decided to meet with existing organizations and committees and seek input that way.

Presentations were made at the following community meetings:

April 18, 2006	REEFTALK public presentation at Thelma Parker Library
December 20, 2006	Waimea Community Development Plan (CDP) Committee
March 1, 2007	Waimea Community Association
June 1, 2009	Watershed Public Event at Kahilu Theatre

A community stream cleanup was held on April 12, 2008, and watershed personnel helped Parker School teachers and students with several additional stream cleanups. Presentations were made at the local schools about the watershed, and the MKSWCD regularly participated in local community events, such as festivals and fairs.

In addition, there were numerous one-on-one meetings and site visits with land owners, land users, government personnel, school teachers, individuals, and other stakeholders to seek background information, to identify threats and sources of pollution, and to identify and discuss potential implementation projects. This regular dialogue with land owners, agency personnel, and other stakeholders helped shape the goals, objectives, and specific projects described in the WWMP. In particular, the District wanted to be sure there was "buy-in" from land users and responsible parties for the proposed projects.

Stakeholders – defined as people or groups who have a stake, or an interest, in the outcome of a project – that contributed to the planning process fall into several categories:

Land Owners/ Leasees:

- Department of Land and Natural Resources
- Hawaiʻi County Department of Water Supply
- Parker Ranch
- KTA Shopping Center
- Parker School
- Hawaiʻi Preparatory Academy
- FR Cattle Co.
- Queen Emma Land Co.
- Mauna Kea Properties
- County of Hawaiʻi
- State of Hawaiʻi Department of Transportation
- Various other private landowners adjacent to streams

Government Agencies:

- US Environmental Protection Agency
- National Oceanic and Atmospheric Administration
- US Geological Survey
- US Army
- Hawaiʻi Department of Health
- Hawaiʻi Department of Land and Natural Resources
- Commission on Water Resources Management
- Hawaiʻi Land Based Sources of Pollution LAS
- Hawaiʻi County Department of Public Works
- Hawaiʻi County Department of Water Supply

Community Groups, Organizations and Businesses:
- Hawaiʻi Wildfire Management Organization
- Waimea Community Association
- Waimea Outdoor Circle
- Waimea Trails and Greenways
- Starbucks

Educational Institutions:
- University of Hawaiʻi at Hilo
- Cornell University
- Massachusetts Institute of Technology

There were a number of documents that helped guide the development of this management plan. The first is EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (EPA 2005). While the document did not provide information to address specific issues that arise out of Hawaiʻi's unique environment (*e.g.*, models, load reduction estimations, absence of data), it did provide a detailed process for building partnerships, gathering data, setting goals, and identifying management strategies. Its worksheets were particularly helpful in terms of asking the right questions of stakeholders and organizing information.

The *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA 1993) and the *Updated Management Measures for Hawaiʻi's Coastal Nonpoint Pollution Control Program* (Stewart 2009) were used to provide direction on potential sources of polluted runoff in the watershed and on the range of management strategies available to addresses those sources. Throughout the watershed planning process, MKSWCD made every effort to incorporate relevant Coastal Nonpoint Pollution Control Program[1] (CNPCP) management measures into the WWMP.

In the context of the CNPCP, management measures are defined as "economically achievable measures for the control of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, and other alternatives" (EPA 1993, p. 1-5). More simply stated, each management measure can be thought of as a goal towards which the State, county, local communities, and landowners can strive in order to improve water quality.

As part of the planning process, the relevant management measures provided a starting point to help with development of goals and objectives for the Waiʻulaʻula watershed, and recommended actions ("best management practices" or BMPs) to achieve those goals and

[1] In 1990, the US Congress required coastal states to develop and implement coastal nonpoint pollution control programs (CNPCP) to be approved by the National Oceanic and Atmospheric Administration (NOAA) and the US Environmental Protection Agency (EPA). The CNPCP, jointly administered by Hawaiʻi's Coastal Zone Management (CZM) Program and the Department of Health (DOH) is designed to protect coastal waters from polluted runoff and restore impaired coastal water quality.

objectives. They were used as a checklist of sorts to ensure that all existing and potential sources of water pollution in the watershed were addressed comprehensively. Some identified threats in the watershed are not directly related to water pollution (*e.g.*, climate change, unexploded ordnance). However, they have a direct impact of overall watershed health and habitat integrity that sustains a health *mauka* to *makai* connection and ultimately contributes to nearshore water quality.

Using best professional judgment, management actions were assessed and prioritized based on a number of criterion, including load reduction potential, size of watershed effected, landowner buy-in, cost, ease of implementation, and community exposure (to facilitate education and outreach). This process, described in more detail in Chapter 5, resulted in projects being placed in high, medium, and low priority levels for implementation. These priority levels translated into an implementation schedule spanning 15 years. An adaptive management approach is recommended for plan implementation, so that as we learn from actions taken, future management strategies can be altered as necessary in response. While MKSWCD will lead the overall implementation of the management actions, a specific project lead is identified for each project described in Chapter 5 and Appendix A.

Chapter 2: Watershed Description

2.1 Physical and Natural Features

2.1.1 Watershed Boundaries

A watershed is the land area that drains water to a stream, river, lake or ocean. These drainage areas are normally confined by topographic divides, such as ridgelines. Hawaiʻi's watersheds tend to be small, in comparison to Mainland systems, short in length, and steep. On the geologically-young island of Hawaiʻi, watersheds also tend to display simple stream networks with few tributaries and have shallow, often poorly-defined channels.

The Waiʻulaʻula watershed is located in South Kohala, on the northwest coast of Hawaiʻi Island. According to the watershed layer in the Hawaiʻi State Geographic Information System (GIS), this watershed stretches from the tops of Kohala Mountain and Mauna Kea, flowing down into inner Kawaihae Bay near the Mauna Kea Beach Resort, a distance of less than 15 miles. As delineated using the island's 10-meter Digital Elevation Model (DEM), this watershed encompasses an area of about 32,000 acres or 50 square miles (Figure 1).

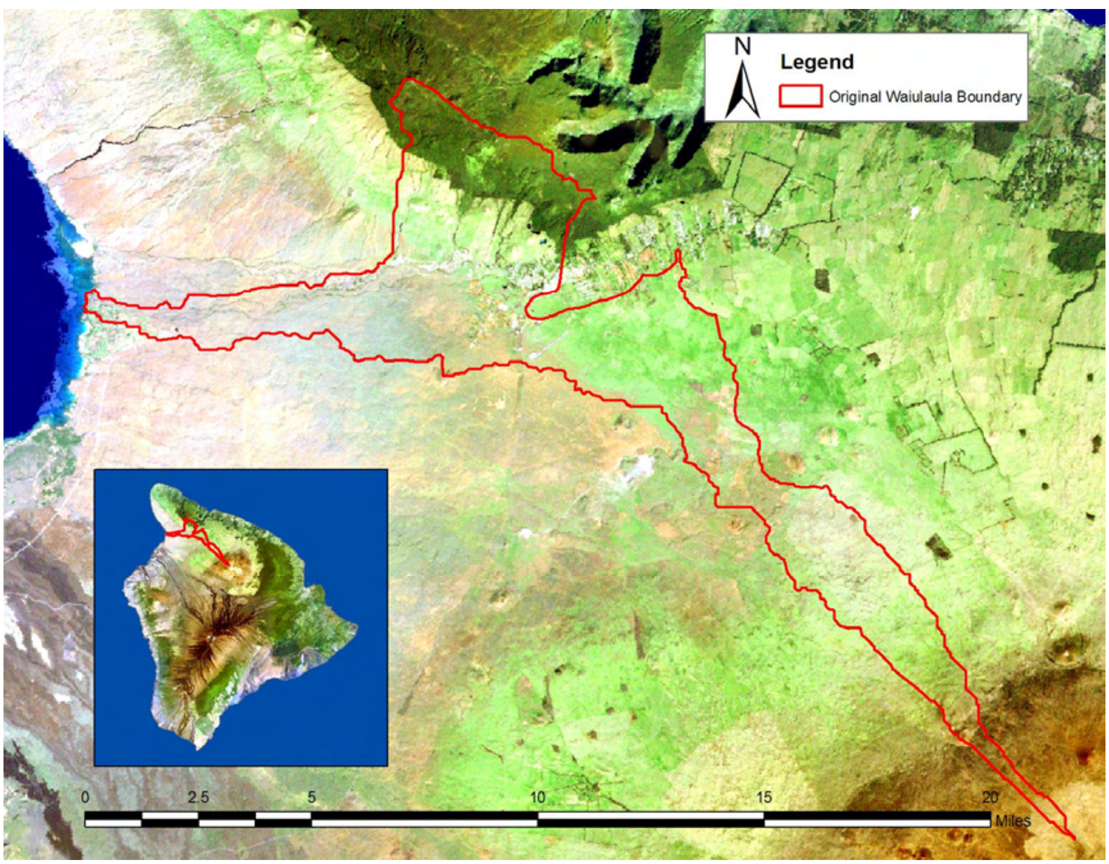

Figure 1: Original Watershed Boundary

As the Mauna Kea Soil and Water Conservation District (MKSWCD) began examining the watershed more closely, there were questions raised about the fate of runoff from the Mauna Kea "leg" of the watershed. It appears that runoff from this section of the watershed does not get into the stream systems of the watershed that outlet into Kawaihae Bay, but rather collects in the broad, flat plain of the Mauna Kea – Kohala saddle. Because the watershed boundary data would be used in the N-SPECT model to help determine pollutant loading and estimate load reductions, it was important to ensure that the MKSWCD was using appropriate watershed boundaries.

Because the MKSWCD was concerned that using the existing watershed boundary would skew modeling results, render the N-SPECT outputs meaningless, and lead the MKSWCD to focus its resources to implement management measures in an area in which it would be unable to demonstrate significant pollutant load reductions, the MKSWCD revised the watershed boundaries for the purposes of this watershed management project. For the purposes of this WWMP and project, the upper Mauna Kea boundary follows Mamalahoa Highway, thereby eliminating the Mauna Kea "leg." The revised watershed boundary encompasses an area of 18,370 acres or 28.7 square miles (Figure 2).

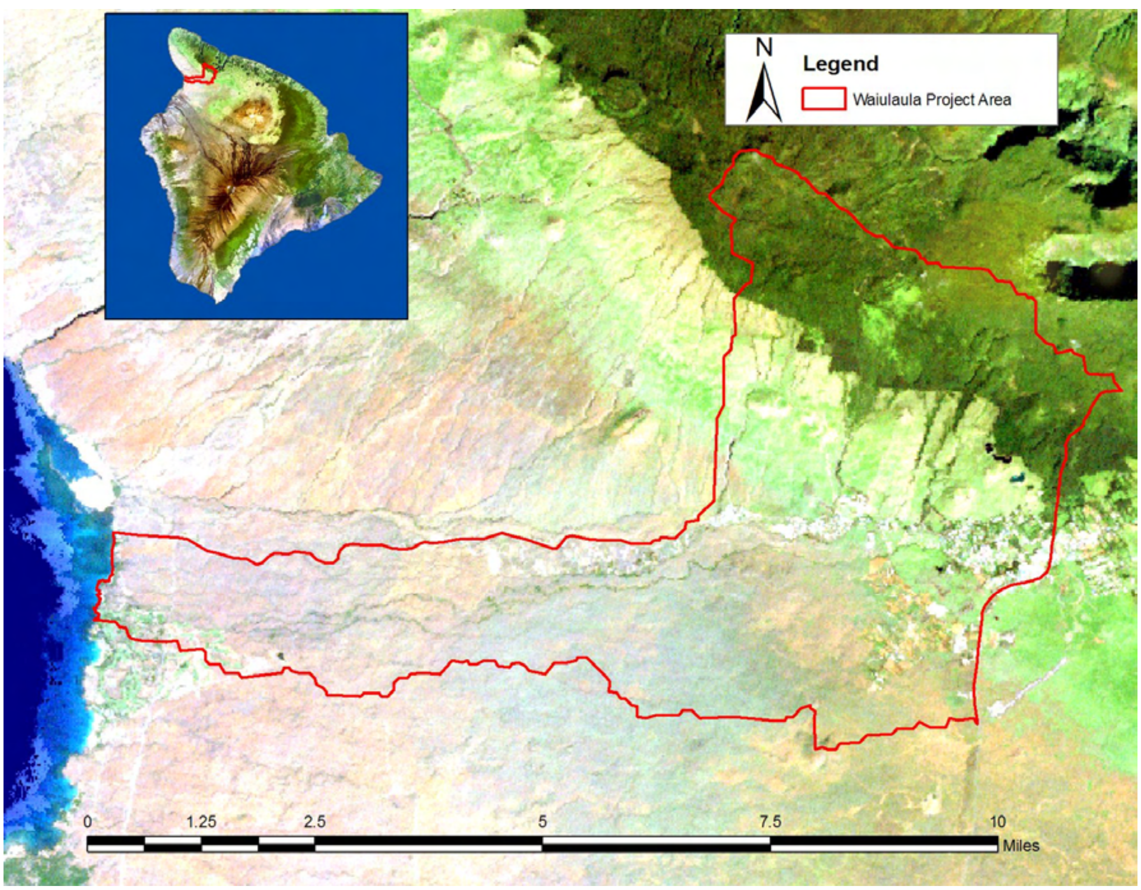

Figure 2: Revised Watershed Boundary

2.1.2 Hydrology

The hydrology of the Waiʻulaʻula watershed is very complex. "Overall, the base-flow characteristics of streams are controlled by the distribution of ground water, which, in turn, is controlled by the local geologic setting and climatic conditions. Dike-impounded and perched ground-water bodies are typical sources of perennial discharge that sustain streamflow at higher elevations" (Tribble 2008 p. 13). In the Waiʻulaʻula watershed, a low-permeability layer not far below the ground surface is likely causing a perched waterbody that forms the bog at the top of Kohala Mountain that provides the water for the streams. The watershed's hydrology is further complicated by high permeability geologic formations that cause base-flow to disappear from some places within streams, only to reappear further downstream. Withdrawals of water from the upper reaches of several primary streams for domestic and agricultural uses also reduce the natural flow of water downstream. At this time, because of the upstream withdrawals, the streams are generally perennial in their upper reaches but only flow in the lower reaches during storm events.

2.1.2.1 Surface Water Resources

The natural surface water resources in the watershed are limited to streams and the upland montane bogs that feed them. The upper elevations of the Waiʻulaʻula watershed comprise ʻohiʻa mixed shrub and ʻohiʻa/ʻōlapa montane wet forest types. These bogs form in areas where low permeability soil hinders drainage, causing standing water to accumulate. Hawaiʻi Island bogs are characterized primarily by sedges, sphagnum moss, and low-stature ʻohiʻa of varying density (Cuddihy and Stone 1990). These wet forests are unique plant communities (described under Section 2.1.9) that serve as natural sponges that store water for slow release into Kohala Mountain's various stream systems.

The primary tributaries of the Waiʻulaʻula watershed are Waikoloa and Keanu'i'omanō streams, both of which originate at over 4,000-ft. elevation on Kohala Mountain and flow relatively parallel to one another until they join in a series of braided channels at about the 1,440-ft. elevation to form Waiʻulaʻula, which terminates in the ocean in Kawaihae Bay (Figure 3). Keanu'i'omanō originates from two smaller intermittent tributaries, Waiʻaka (which becomes Lanikepu Stream) and Haleʻaha, as well as Kohākōhau Stream, which is considered perennial. It is called Keanu'i'omanō stream below the 2,200-ft. elevation. Two additional intermittent streams join Keanu'i'omanō just below this elevation -- ʻŌuli and Mamaewa (which includes Momoualoa upslope). A small intermittent tributary of Kohākōhau stream is ʻOʻolāmakapehu. (See Figure 4.)

Waikoloa Stream has no tributaries. While, historically, Waikoloa Stream has been considered perennial, "it is unclear whether [it] is now intermittent, with perhaps some occasional permanent pools downstream of Waimea, because of … numerous diversions and reservoirs" upstream (Englund *et al*. 2002). The *Hawaiʻi Stream Assessment* (CWRM 1990) classifies Waikoloa Stream as intermittent with year-round flow in the upper reaches and intermittent flow in the lower sections.

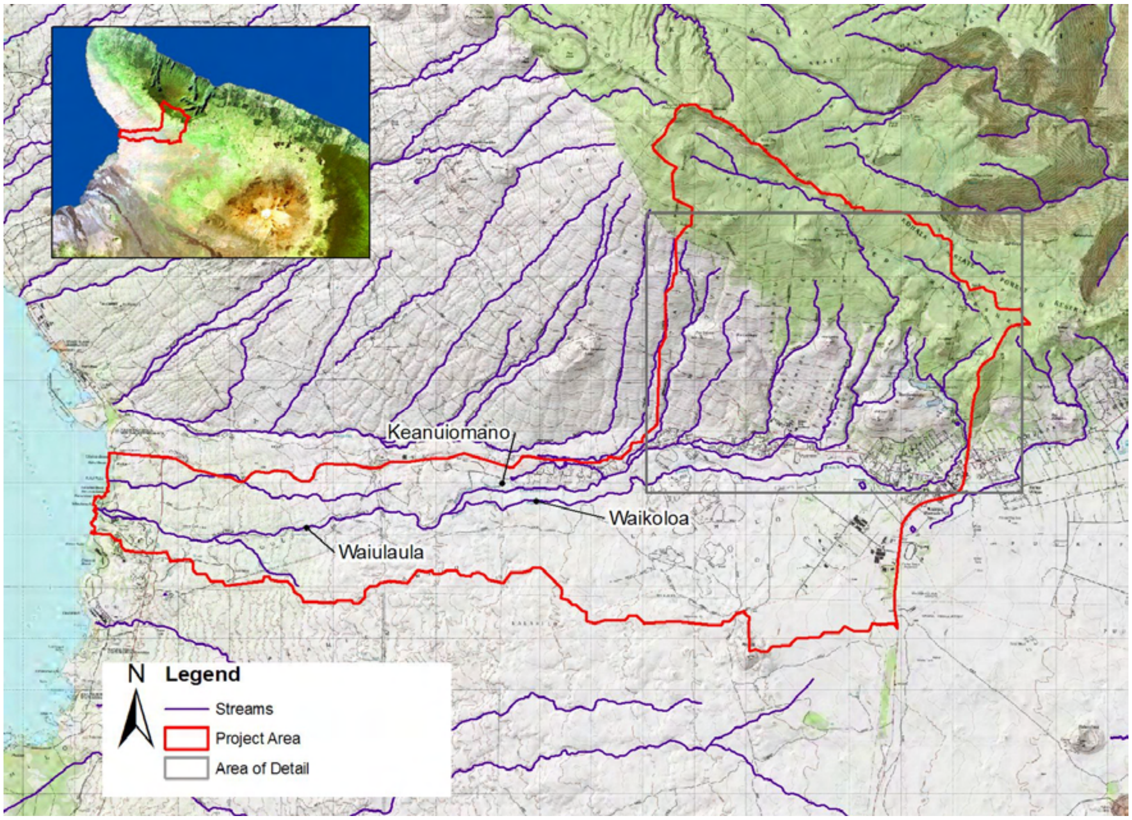

Figure 3: Overview of Streams in the Watershed

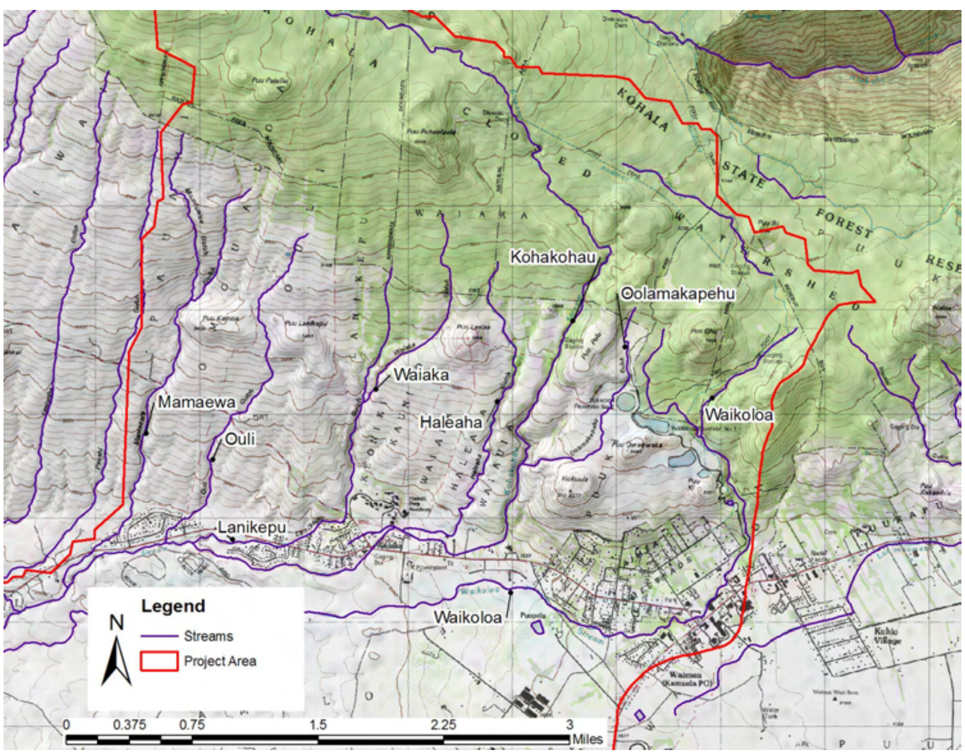

Figure 4: Upper Tributaries of Watershed

Waiʻulaʻula Stream is considered a "losing" or influent stream, because it loses water as it flows downstream. Losing streams are common in arid landscapes. Much of the loss of its flow probably occurs in the middle to lower reaches as stream flow disappears into the alluvium. This is substantiated by the small stream channel and estuary at the ocean.

The average or "mean" annual daily flow at Waikoloa and Kohākōhau, the only streams that are currently gauged, is 9.12 cubic feet per second (cfs) (5.89 million gallons per day (mgd)) and 9.82 cfs (6.35 mgd), respectively[2]. However, this mean flow likely occurs only 20-30% of the time (Rick Fontaine, pers. comm.). It is probably more revealing to look at the median flow on the flow duration curves for these streams. The median daily discharge for Waikoloa stream is 4.3 cfs (2.78 mgd) and for Kohākōhau stream 2.2 cfs (1.42 mgd) (Oki 2007). Even this level of flow requires it to have rained recently (Rick Fontaine, pers. comm.). On a more typical day, streamflow in Hawaiian streams is within the 70-75% range (meaning the percentage of time discharge equaled or exceeded this amount), or between 2.5-2.8 cfs (1.62-1.81 mgd) for Waikoloa and 0.76-0.95 cfs (0.49-0.61 mgd) for Kohākōhau. The gauges on Waikoloa Stream near the Marine Dam (USGS gauge number 16758000) and Kohākōhau Stream (USGS gauge number 16756100) provide real time data accessible via the Internet.

Waikoloa Stream near headwaters

Maximum instantaneous flow recorded at Waikoloa Stream was 3,410 cfs in November 1979. Data available for Kohākōhau Stream since 1998 indicate a maximum instantaneous flow of 1,860 cfs recorded in March 2004. During storm events, the stream level and flow can increase

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[2] Average ("mean") annual discharge for Waikoloa (data from 1948-2009) ranges from 3.87 cfs (1962) to 15.3 cfs (1998). Average annual discharge for Kohākōhau (data from 1999-2009) ranges from 4.51 cfs (2008) to 14.0 cfs (1999).

rapidly, demonstrating the flashiness of Hawaiian streams. There is a significant lag time between peak flow at the upper stream gauges (3,460-ft. and 3,470-ft. elevations) and the monitoring site at the mouth of Waiʻulaʻula, a distance, following the stream channels, of less than 12 miles. The time it takes for water to flow this distance is on the order of 1-3 hours.

There are permanent stream pools in the streams below Waimea that are apparently receiving some groundwater input. Englund (2010) noted this, as suggested by the difference between surface and sub-surface water temperatures in the pools. He noted that these permanent groundwater-fed pools are important "stepping stones" for native aquatic fish species as they travel upstream to access the upper reaches of the watershed. During recent site visits to some of these pools, it was observed that water-loving plants, such as ferns, were growing in cracks on the rocky faces surrounding the pools, despite long-term drought conditions. Englund (2010) also noted that the presence of a large, native great bulrush ʻakaʻakai (*Schoenoplectus juncoide*), the roots of which provide habitat for native dragonfly larvae such as *Anax junius* and *Pantala flavenscens*, appears to be "a good indicator of permanent spring-fed pool areas within the lower watershed area" (p. 7).

Evidence of Groundwater Seepage
Within Stream Channel

In 2005, the Hawaiʻi Commission on Water Resource Management (CWRM) adopted surface water hydrologic units and a coding system for Hawaiʻi's watersheds, after a review of the *Hawaiʻi Stream Assessment* (CWRM 1990), *State Delineation of Watersheds* (GDSI 1994), and *Refinement of Hawaiʻi Watershed Delineations* (GDSI 1999). The majority of hydrologic unit boundaries closely match drainage basin boundaries (CWRM 2005). The surface water hydrologic unit code is a unique combination of four digits (CWRM 2005). The first digit identifies the island and the following three digits the specific hydrologic unit. A Hawaiian geographic name or local geographic term is also used. The Waiʻulaʻula watershed is identified as Waikoloa 8161. According to CWRM's *Water Resource Protection Plan* (2008), the Waikoloa surface water hydrologic unit encompasses 51.96 square miles (less with our revised boundaries), 11 diversions, 4 gauges, and 2 active gauges.

The State is in the process of establishing instream flow standards for the perennial streams, in order to balance maintenance of fish and wildlife habitat, estuarine, wetland and stream ecosystems, and water quality with use of the water (CWRM 2005). Section 13-169-46 of the Hawaiʻi Administrative Rules (HAR), adopted in 1988, establishes interim instream flow standards (IFS) for Hawaiʻi. These were generally defined as the amount of water flowing in each stream on the effective date of the standard. Standards for some individual streams have subsequently been amended as a result of petitions to amend the IFS and describe the amount of water that can be withdrawn from the stream. Specific instream flow standards have not been established for any streams within the Waiʻulaʻula watershed.

2.1.2.2 Groundwater Resources

Groundwater on Hawaiʻi Island occurs as both a freshwater basal lens floating on denser underlying seawater near the coast and as high-level aquifers further inland impounded by lower permeability rocks. Generally, the source of freshwater in the higher elevations is groundwater recharge from infiltration of rainfall and fog drip, as well as irrigation water. The island's subsurface geology controls the movement and occurrence of groundwater (Bauer 2003). Unfortunately, this has not been as well studied as the superficial geology. In the Waiʻulaʻula watershed, it is likely that lava flows from Mauna Kea overlay earlier flows from Kohala Mountain, affecting the local presence and movement of groundwater. (See Section 2.1.8 "Geology.")

As a rule, groundwater normally moves from higher elevations to lower elevations and from locations of higher pressure to locations of lower pressure. The flow rate is proportional to the slope of the water table (top surface of groundwater). This slope is known as the hydraulic gradient, which is generally expressed in feet per mile. In most cases, the direction of groundwater flow is controlled by the hydraulic gradient, but is also influenced by the direction that lava layers are dipping. Bauer (2003) reports that "[n]ormal ground-water gradients range from less than one foot per mile to greater than 3 ft. per mile in South Kohala in the Lālāmilo/ʻŌuli area. Generally, steeper ground-water gradients either reflect higher rainfall and recharge or lower hydraulic conductivity" (p. 21). The hydraulic conductivity is a measure of how easily water can flow through rocks. Bauer goes on to say:

> The steep ground-water gradient between ʻŌuli 1 and 2 wells… may be attributed to the lower hydraulic conductivity associated with denser and typically thicker Hawaiite lavas (and possibly mugearite, if indeed, the bottom of these wells penetrates into Kohala lavas). Because of the arid conditions of South Kohala, the steep gradient … may be the

> result of low hydraulic conductivity of the lavas rather than from direct recharge by rainfall. However, an influx of high-level ground-water from the Waimea-Kamuela region could be enough to increase the ground-water gradient (p. 21-22).

The Kohala Aquifer Sector Area (ASEA) includes the Hawi (80101), Waimanu (80102) and Māhukona (80103) aquifer system areas (see Figure 5), with an estimated total sustainable yield of 154 million gallons per day (mgd) (DWS 2006). A portion of the Waiʻulaʻula watershed, including the headwaters of all its streams, falls within the Māhukona aquifer system area. The southern portion of the Waiʻulaʻula watershed falls within the Waimea aquifer system (80301) in the West Mauna Kea ASEA. In addition, water from the Waimanu aquifer system area is transmitted via the Upper Hāmākua Ditch and pipelines to Waimea to provide agricultural water for the Lālāmilo farmers.

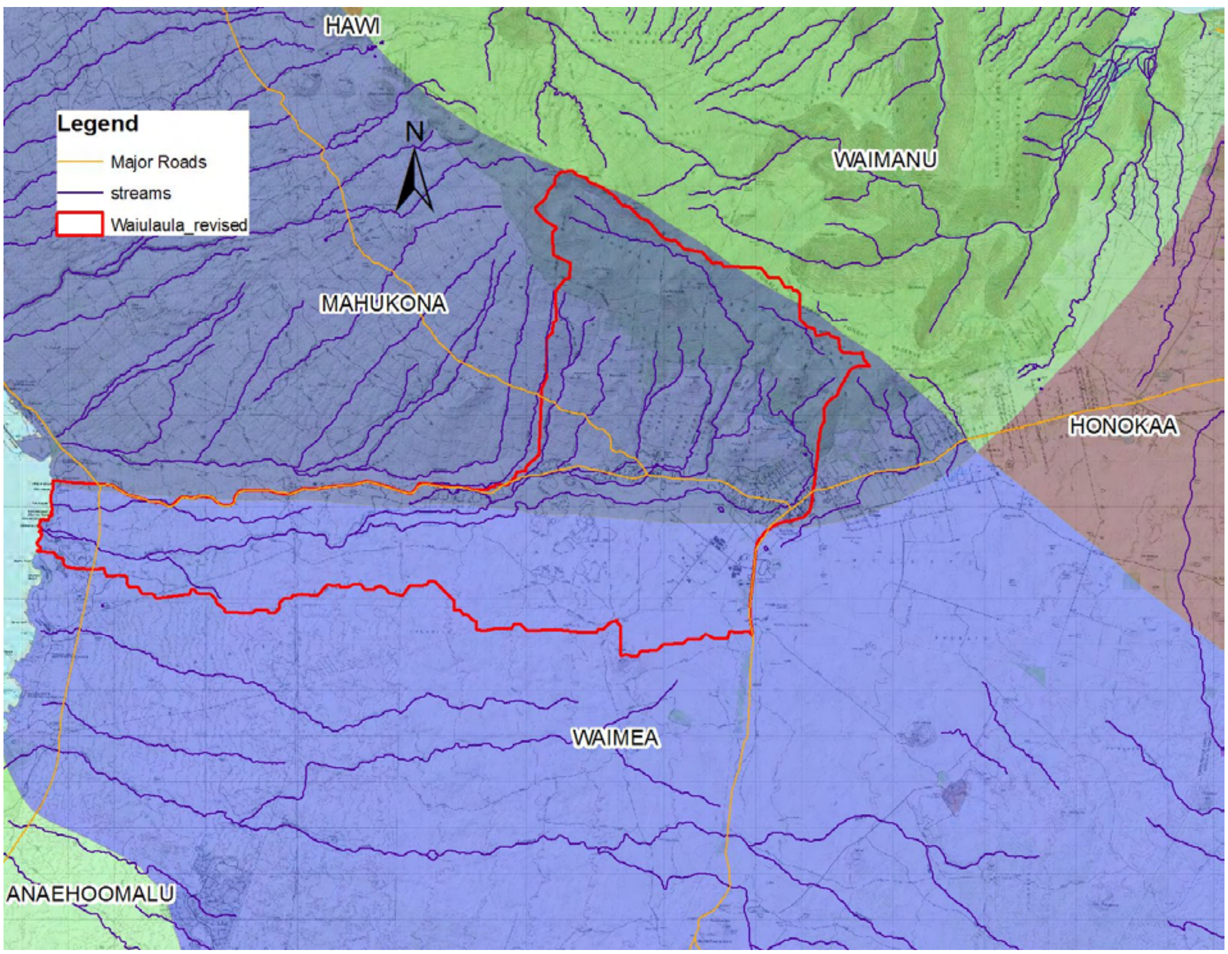

Figure 5: Groundwater Aquifers

In response to competition for water resources in the early 1990s and the lack of basic water level data, CWRM initiated a groundwater monitoring program in 1991. Since then, CWRM has taken groundwater elevation measurements from 40 public and private wells and test holes throughout the North and South Kona and South Kohala districts, including from two within the Waiʻulaʻula watershed (ʻŌuli 1 and 2). An analysis of these data found that water levels in the basal lens vary with rainfall (Bauer 2003). The direction of groundwater flow within the basal lens was also found to vary over time. This could affect the path taken by pollutants introduced into groundwater. The data also documented declining water levels in some compartments of the high-level groundwater occurring south of Hualalai's NW rift zone. The data analysis did not examine high-level groundwater occurring in or near the Wai'ula'ula watershed, however. In addition to the wells analyzed in the Bauer report, there is one additional well that has been monitored. The Kawaihae W-3 well (6147-01; USGS 200132155471101) is at the edge of the Waiʻulaʻula watershed at the 982-ft. elevation along Kawaihae Road. The USGS has measured its water levels regularly since 1975.

2.1.3 Climate and Precipitation

Because of the steepness of Hawaiʻi's watersheds, their climates vary considerably by elevation. The upper elevations of the Waiʻulaʻula watershed are typically wet and cool, while the coastline is hot and arid. The watershed is typically affected by a regular pattern of orographic cloud formation and precipitation. During typical trade wind weather, the wind blows from the northeast direction and rising moist air cools, forming clouds over the top of Kohala Mountain. The cooled clouds drop moisture in the form of rain and fog drip, keeping these upper, forested elevations wet. Fog drip is the direct interception of water from clouds or fog by vegetation. "Fog drip is likely an important contribution to the hydrologic budget in Hawaiʻi's forested areas frequently enveloped in clouds. This is especially true when there is little or no precipitation occurring" (CWRM 2008).

Bog on Kohala Mountain

The clouds formed by the typical trade wind weather rarely make it to the leeward and *makai* reaches of the watershed. These areas are typically dry and receive most of their moisture during Kona storms and localized convection events during the winter months (November to March). Drought conditions in the watershed in recent years have exacerbated the dry conditions in the lower watershed. According to DLNR's Commission on Water Resources Management, severe drought conditions affected North Hawai'i or Kohala in 1996, 1998-1999, 2002-2003, 2007-2008, and 2010. The most severe droughts of the past 15 years are associated with El Nino events.

The *Rainfall Atlas of Hawai'i* (Giambelluca *et al*. 1986) contains monthly and annual rainfall maps for each island, which generally serve as the standard isohyet maps for use in estimating precipitation across a watershed (Figure 6). Annual rainfall in the watershed varies from about 120 inches in the upper elevations to 7 inches at the coast. In Waimea, the rainfall is highly variable, ranging between 20 and 60 inches per year.

There are two rain gauges in the watershed that are part of the National Weather Service Hydronet: KUUH1 Kamuela Upper; and KMUH1 Kamuela 1. With recent technological improvements, there are more and more weather stations being established within the watershed by individuals. Many of these can be found on Weather Underground (www.wunderground.com). However, as a more recent phenomenon, these stations provide current and very recent weather data, but not historical.

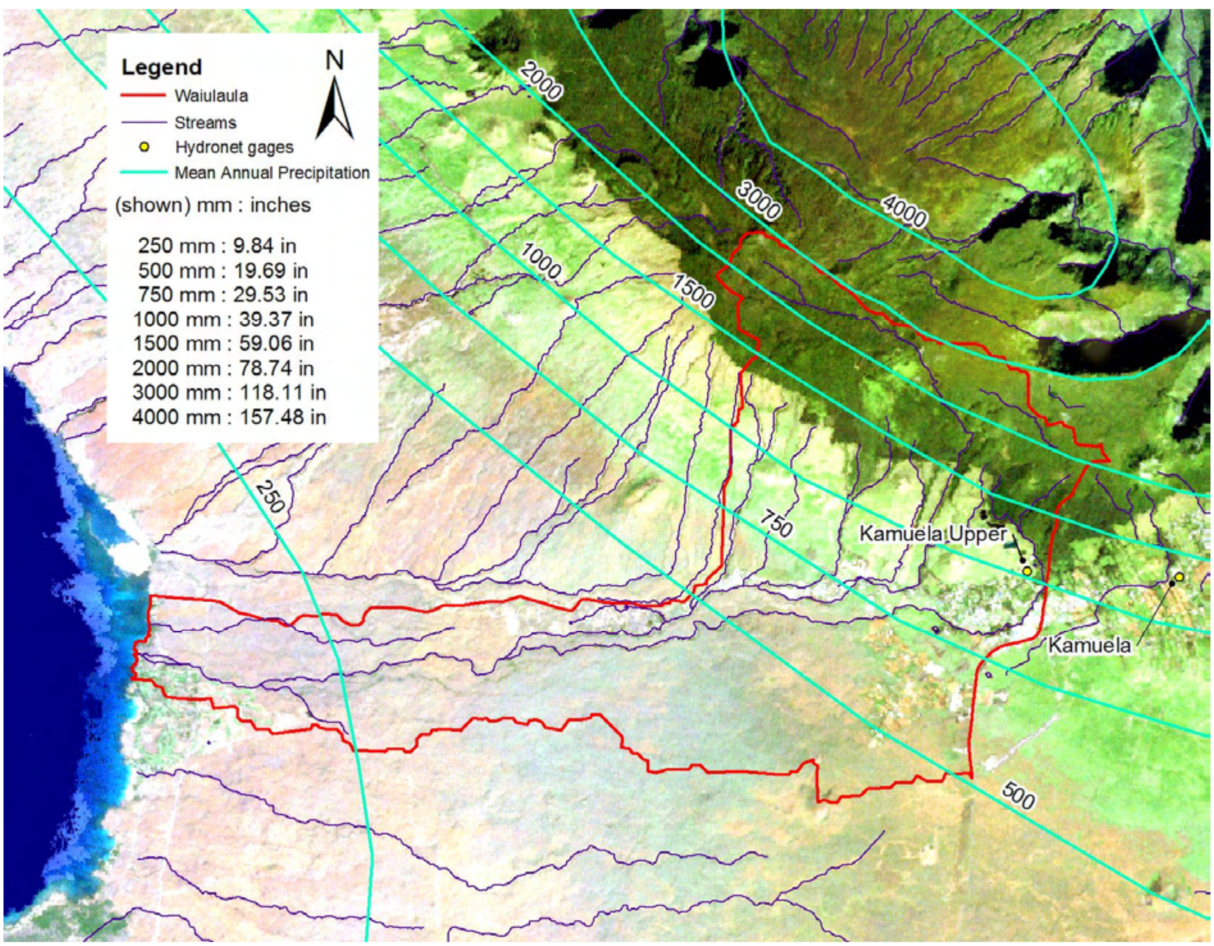

Figure 6: Annual Precipitation

As noted above, trade winds dominate the watershed area. It is during winter months that the major storms occur and the heaviest rains fall. The storms may blow in from any direction but are typically from the south, southwest, or southeast (Kona storms). *Mumuku*, fierce gusts of wind from the northeast, also blow in the watershed.

Temperatures in the watershed are also highly variable and dependent on elevation, weather and time of year. Temperatures at higher elevations are typically cooler, while the coast enjoys year-round averages of 70 to 87ºF. In the Waimea area, average temperatures range from 55ºF to 75ºF. According to DHHL (2002), "the extreme minimum temperature recorded at Waimea is 34 ºF, while the extreme maximum temperature is 90 ºF" (p. 4-1).

2.1.4 Flood Plains

FEMA has developed Flood Insurance Rate Maps or FIRMs for Hawaiʻi Island. Figure 7 shows the flood hazard rating map for the Waiʻulaʻula watershed. Zone A is the flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods of analysis. This translates into the 100-year floodplain. Zone X500 corresponds to the 500-year floodplain. There is one small area within Waimea town that falls into Zone X500.

Flooding has been identified as a problem in the Waiʻulaʻula watershed. Flooding of downtown Waimea and of roads crossing streams has been a particular concern. While flooding has been a reality for decades in Waimea, it has become an even greater problem as more and more development occurs within or adjacent to flood prone areas. As more impervious surfaces are created through increased urban and suburban development, these hardened surfaces prevent infiltration and generate greater volumes of stormwater runoff.

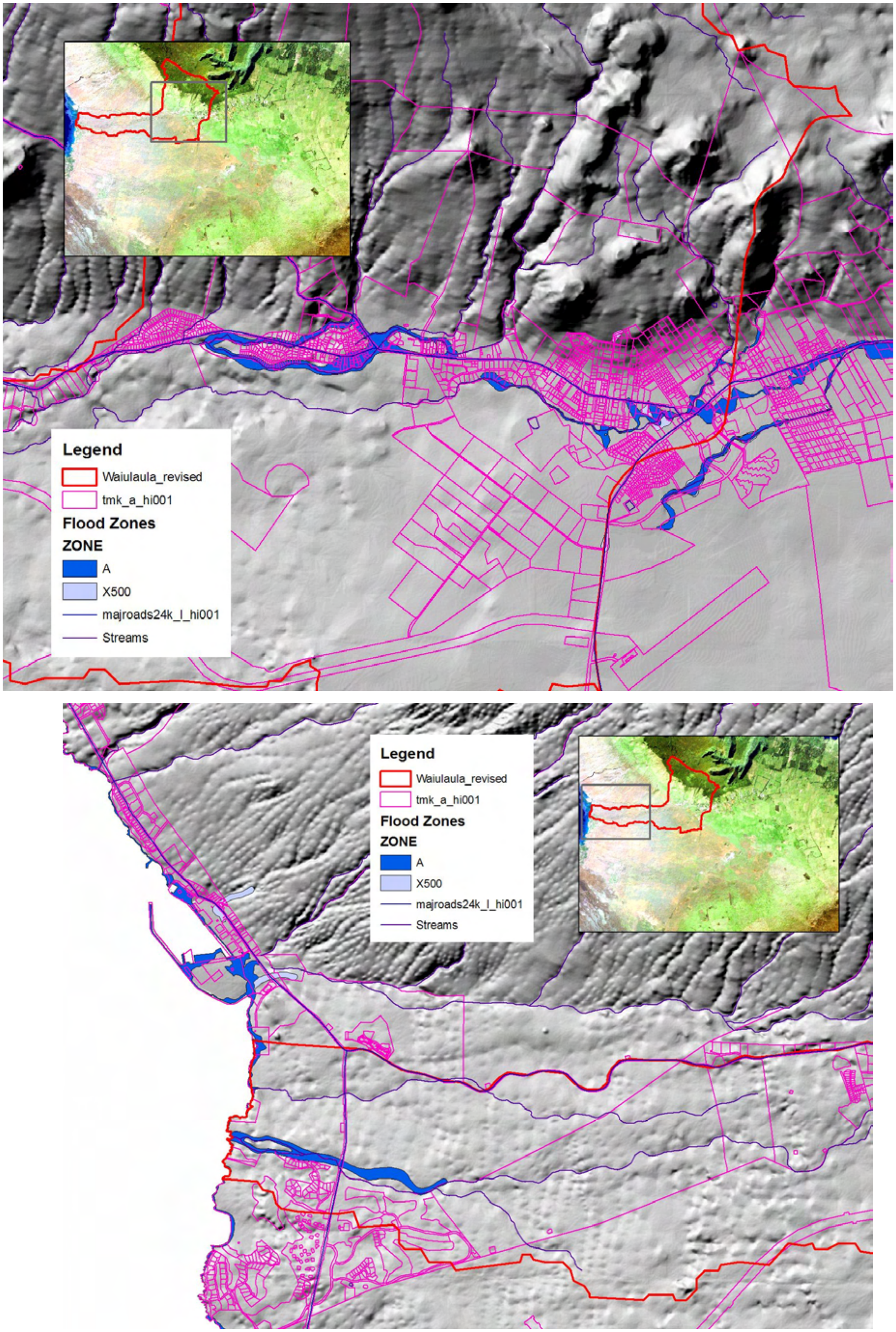

Figure 7: Flood Insurance Rate Maps for Waimea and the Coast

2.1.5 Riparian Areas

Most of the streams within the Waiʻulaʻula watershed do not have adequate vegetated buffers to intercept runoff. While fully vegetated, connected riparian corridors exist in the upper reaches of many of the streams, extensive riparian vegetation generally disappears outside of the conservation district, where land conversion to agriculture and urban/suburban development has taken place. The pockets of vegetation that exist at lower elevations often comprise invasive species, such as Christmas berry (*Schinus terebinthifolius*), that tend to grow in the stream channel itself, impeding stream flow and altering aquatic habitat.

2.1.6 Dams and Diversions

There are five structures considered dams in the Waiʻulaʻula watershed. Three of the Department of Water Supply (DWS) reservoirs above Waimea are considered dams because of the heights of the reservoir walls impounding water. There are two dams impounding water in streams, described below. Based on inventoried storage (<1000 acre-feet) and height data (<40 ft.), these dams are considered small. DWS is permitted by the State's Water Commission to take 1.427 million gallons per day (mgd) total from its diversions at the Marine Dam and Kohākōhau Dam, which is approximately 33% of the median daily discharge of Waikoloa and Kohākōhau streams combined. The specific amount of water taken from each stream varies daily and is not measured as it is withdrawn. However, the streams in the lower watershed have become intermittent because of the numerous diversions in the upper watershed (Englund 2010).

2.1.6.1 Marine Dam

The Marine Dam is a diversion dam in Waikoloa Stream at 3,460 ft. elevation, built during World War II by the United States Engineering Department to supply water for a new military encampment of several thousand Marines that was being established in Waimea. Built in 1943, the 5-ft. high Marine Dam captured stream water into a 12-inch lightweight steel clamp-on pipeline. In 1966, the steel pipeline was replaced by a more durable 18-inch ductile iron pipe. A still basin and a cleanout were also added. The Marine Dam still serves its original function today and is a major source of drinking water for the South Kohala Water System, which provides potable water to Waimea and environs.

In 1997, the Marine Dam was officially designated an "American Water Landmark" by the American Water Works Association Water Landmark Award Committee. To receive the Landmark status, the facility must be at least 50 years old and of significant value to the community. The community has always called it the "Marine Dam" in reference to those who were originally served by this facility. This is the first neighbor island facility to receive this designation.

 

Marine Dam (left) and Kohākōhau Dam (right)

2.1.6.2 Kohākōhau Dam

Planning for the development of Kohākōhau Dam started in the mid-1960s, and, by 1975, it was supplying water to Waimea and the surrounding area. This diversion dam is located on Kohākōhau Stream at the 3,470-ft. elevation. The dam is approximately 5-ft. high at the sides and 10-ft. high in the middle and about 45-ft. long. With development pressures along the Kohala and Waikoloa coasts, there was a major push to expand Kohākōhau Dam to increase its capacity. This would have required inundation of additional lands in the Kohala watershed. While strong community opposition slowed progress on the Kohākōhau Dam expansion project, the 1970s discovery and development of potable groundwater in the Lālāmilo area eased pressure to expand Kohākōhau Dam to create a larger impoundment area.

2.1.6.3 Diversions

In addition to DWS's permitted diversions, there are many other legal, as well as illegal, diversions within the Waiʻulaʻula watershed, withdrawing stream water from Waikoloa, Kohākōhau, and Keanuʻiʻomanō streams for private use. The total amount being withdrawn on an annual basis from both legal and illegal diversions is currently unknown. It is significant, however, and likely contributes to the fact that the once-perennial streams are no longer perennial in the lower reaches.

Parker Ranch is permitted by the Water Commission to withdraw 420,000 gallons per day total from three intakes on Waikoloa Stream (above the Marine Dam), Kohākōhau Stream (above Kohākōhau Stream), and Alakahi Stream (which is not in the Waiʻulaʻula watershed). Most of these intakes were developed in the early 20th century and were grandfathered in when Section 13-169-46, HAR, was adopted in 1988. The Commission on Water Resources Management has also permitted diversions on Kohākōhau Stream to Perry-Fiske (operated by the State) and the State Department of Agriculture. There are seven permitted diversions on Keanuʻiʻomanō

Stream[3], including one which diverts water from Keanuʻiʻomanō Stream via ʻŌuli ʻ*auwai* for use by members of the Kanehoa ʻAuwai Compact for irrigation of landscape and windbreak on eleven properties totaling 59.4 acres.

Regular site visits along Keanuʻiʻomanō Stream reveal numerous unpermitted withdrawals from the stream by residents of the Kanehoa and Anekona neighborhoods. These diversions normally consist of pipes or pumps inserted into the stream to withdraw water for storage in water tanks for use for landscape irrigation. There are at least a dozen unpermitted diversions within the watershed.

Diversion intake in Keanuʻiʻomanō Stream

2.1.7 Topography and Elevation

The Waiʻulaʻula watershed extends from the 5,260-ft. elevation on Kohala Mountain to sea level over a distance of 8.5 miles, if measured as a straight line from headwater to estuary. The upper elevations are generally steeply sloped and bisected by deep gulches. From about 2,500-ft. in elevation, the terrain is rugged but more gently sloped. (See Figure 8.)

[3] Baldwin, Jardine, Perry-Fiske, Schulze, Wallach, Giacometti, and Wasowski.

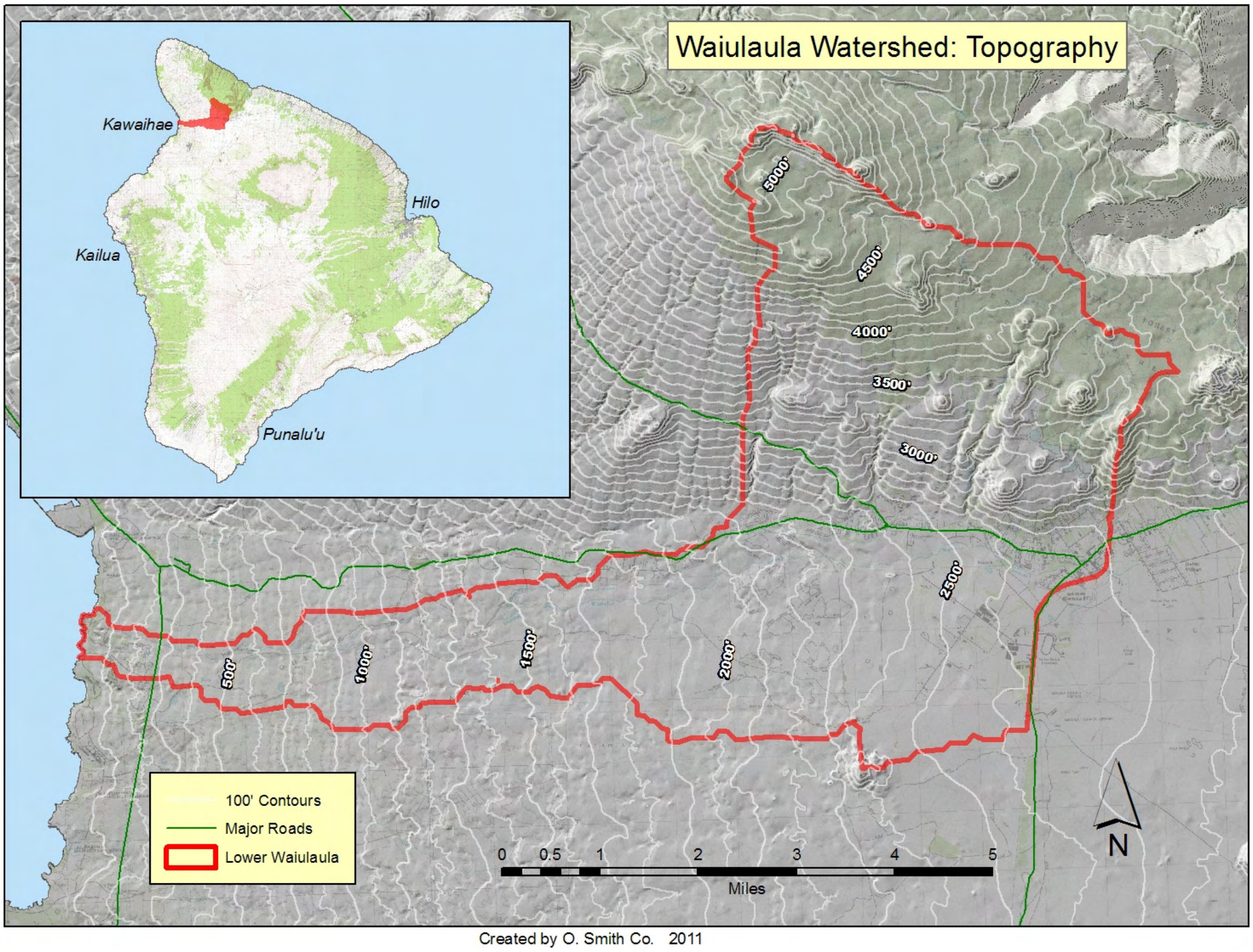

Figure 8: Topography of the Watershed

2.1.8 Geology and Soils

The Waiʻulaʻula watershed is located in the saddle between Kohala Mountain and Mauna Kea, where the Mauna Kea lavas ponded against the older Kohala dome (Clark 1986). As a result, the lands of the watershed comprise the geological substrates of both mountains.

Kohala is the oldest of the five volcanoes on Hawaiʻi Island, emerging above sea level more than 500,000 years ago. It last erupted about 120,000 years ago in the late Pleistocene era (USGS HVO website: http://hvo.wr.usgs.gov/volcanoes/kohala/). "The last eruptions were moderately explosive and formed a series of large cinder cones that stud the Kohala Mountain surface above Waimea" (Macdonald *et al.* 1983: p. 353). Kohala Mountain is now considered extinct and in a transition between post-shield and erosional stages of its life cycle. In contrast to the highly eroded valleys of the windward side of Kohala Mountain, erosion has made little headway on the leeward side (Macdonald *et al.* 1983).

Mauna Kea, the tallest mountain on Hawai'i Island, is in the post-shield phase and considered dormant. It last erupted about 4,500 years ago. The oldest exposed lava flows on the mountain are about 250,000 years old. Mauna Kea's last eruptions were more explosive than those of the shield-building phase, with viscous magma containing more gas, and produced widespread ash deposits downwind of the mountain. The fertile soils in Waimea are a result of these ash deposits.

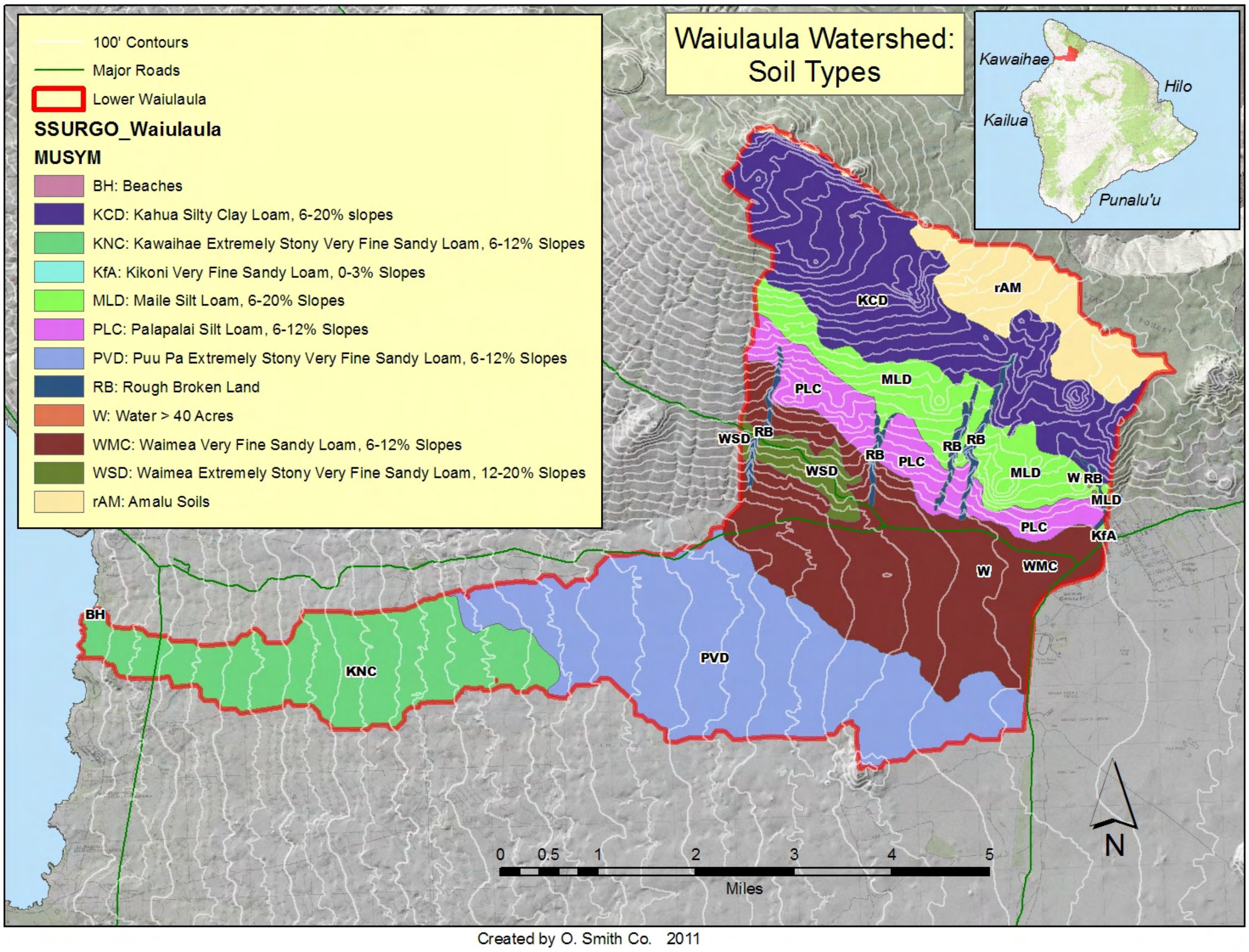

Figure 9: Soil Types in the Watershed

The watershed's geology has implications for both soil types and hydrology, as noted above. The geological substrate consists of lava flows of several volcanic series. The predominate soil types in the watershed are listed below and shown in Figure 9.

- Amalu (rAM) – poorly drained; 3-35% slopes; meets hydric criteria;
- Kahua (KCD) – silty clay loam, somewhat poorly drained; 6-20% slopes;
- Maile (MLD) – well drained silt loams that formed in volcanic ash; 6-20% slopes; moderately rapid permeability, slow runoff, slight erosion hazard;

- Palapalai (PLC) – well drained silt loams that formed in volcanic ash; 6-12% slopes; moderately rapid permeability, slow runoff, slight erosion hazard;
- Waimea (WMC) – well drained very fine sandy loam that formed in volcanic ash; 6-12% slopes; moderately rapid permeability, slow runoff, slight erosion hazard;
- Waimea (WSD) – well drained extremely stony very fine sandy loam that formed in volcanic ash; 12-20% slopes; moderately rapid permeability, medium runoff, moderate erosion hazard;
- Puu Pa (PVD) – well drained extremely stony very fine sandy loam that formed in volcanic ash; 6-20% slopes; moderately rapid permeability, medium runoff, moderate erosion hazard; and
- Kawaihae (KNC) – somewhat excessively drained extremely stony very fine sandy loam; 6-12% slopes; moderate permeability, medium runoff, moderate erosion hazard.

Figure 10 shows the soil erodibility. Soil erodibility is an estimate of the soil's ability to resist erosion, based on the physical characteristics of the soil. The watershed's soil erodibility is the highest in the dry, sparsely-vegetated and fire-prone lower watershed, greatly increasing the risk of erosion from this area.

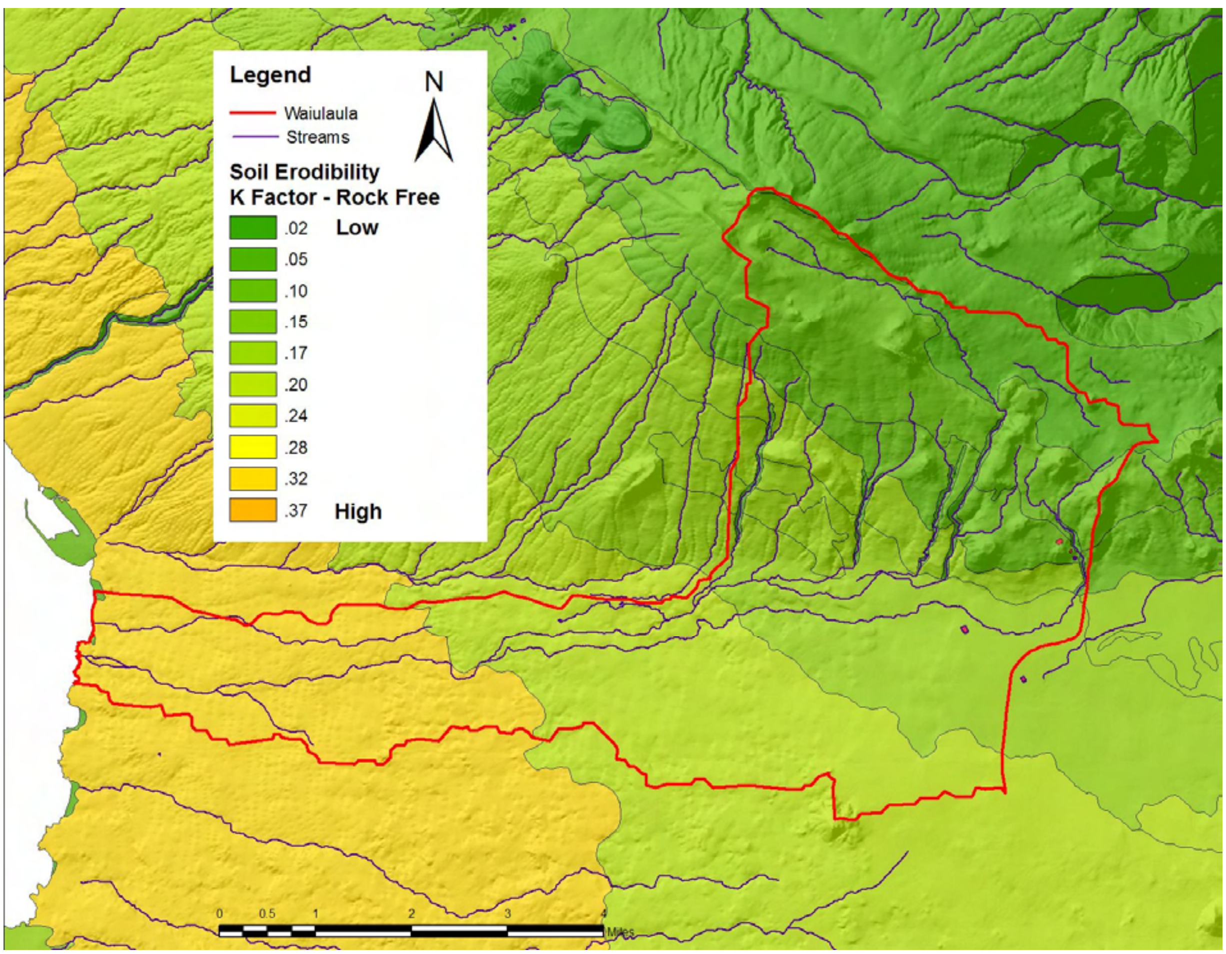

Figure 10: Soil Erodibility

2.1.9 Vegetation

The Waiʻulaʻula watershed comprises several broad types of vegetation: forest, grassland, scrub/shrub and cultivated land. With the exception of the forested headwaters, much of the watershed's vegetation has been altered over time. In fact, McEldowney (1983) found that nearly 75% of the vegetation in the area surveyed was composed of introduced grass species.

The forested section of the watershed primarily encompasses wet, predominantly-native ʻohiʻa rainforest, more specifically an ʻohiʻa/ʻōlapa Montane Wet Forest. ʻOhiʻa (*Metrosideros polymorpha*) and ʻōlapa (*Cheirodendron* spp.) comprise the upper canopy, reaching 15 to 30 ft. in height. According to McEldowney (1983), this upper canopy is usually "accompanied by native subcanopy trees (3 to 6 m tall), native shrubs (1 to 3 m tall), a herbaceous layer composed of saplings, native and introduced herbs, grasses, sedges, rushes, and ferns (<1 m tall) and numerous epiphytic ferns and bryophytes" (p. 410). Plant surveys of the Puʻu o ʻUmi Natural Area Reserve found that the

> [c]ommon associated species in the canopy of the ʻohiʻa/ʻōlapa forest included kawaʻu (*Ilex anomala*), kolea (*Myrsine sandwicensis* and *M. lessertiana*), alani (*Pelea clusiifolia* and other species) and hāpuʻu (*Cibotium glaucum* and *C. chamissoi*)…. Uluhe ferns were often codominant. Shrub species included alani, pūkiawe, pūʻahanui, naʻenaʻe, ʻōhāwai (*Clermontia* spp.), manono (*Hedyotis terminalis* and *H. hillebrandii*), and pilo (*Coprosma pubens* and *C. ochracea*). Native ferns included hōʻiʻo (*Athyrium sandwichianum*), ʻākōlea (*Athyrium microphyllum*), *Dryopteris* spp., *Asplenium* spp., ʻae (*Polypodium pellucidum*), ʻamaʻu (*Sadleria pallid* and *S. souleyetiana*), and palaʻā (*Odontosoria chinensis*). The ground cover was moss-dominated by Sphagnum sp., especially in poorly drained areas, but ground cover also included ʻalaʻalawainui, and *Cyrtandra paludosa*. Maile (*Alyxia oliviformis*) was sometimes abundant (DLNR 1989; p. 7-8).

Bog-like communities are also found in the forested watershed, primarily containing dwarfed forms of trees and shrub species found in the neighboring forests and moss hummocks mixed with grasses, sedges and rushes. According to KWP (2007), "[i]t is believed that bogs develop on poorly drained areas where clay soil formation impedes drainage, causing accumulation of perched water on top of the clay, thereby drowning out root systems of woody plants" (p. 25).

Alien plant species have also become established in the native rainforest on Kohala Mountain. Once established, these weedy plants can compete with native species for nutrients and water, and have the potential to alter the native ecosystem. Known invasive plants in the forested section of the watershed include broomsedge (*Andropogon virginicus*), kahili ginger (*Hedychium gardnerianum*), yellow ginger (*Hedychium flavescens*), *Melastoma candidum*, banana poka (*Passiflora tarminiana*), fountain grass (*Pennisetum setaceum*), blackberry (*Rubus argutus*), palm grass (*Setaria palmifolia*), fireweed (*Senecio madagascarensis*), *Tibouchina herbacea*, *Clidemia hirta*, and *T. urvelliana* (KWP 2007).

McEldowney (1983) describes the eight major plant communities that currently dominate the unforested sections of the region (Figure 11), most of them open grass or grass and shrub communities used for cattle grazing.

Zones I through III occur below the 1,500-ft. elevation. This landscape is dominated by grasses (primarily introduced buffel grass (*Cenchrus ciliaris*), fountain grass (*Pennisetum setaceum*), and native pili grass (*Heteropogon contortus*)) and thickets of kiawe trees (*Prosopis pallida*). There is also a significant proportion of bare land. This area is generally used as open range, its use dependent entirely on forage growth following seasonal or episodic rainfall. It is extremely susceptible to wildfires, which burn through this area with increasing frequency. The primary grass species are all well-adapted to fire.

The kiawe tree *(Prosopis pallida*) is an introduced species. It can desiccate an area, using all available water by tapping groundwater with its deep root system. This species is generally killed by intense fires, although a small proportion of the trees will survive if the bases are partially protected.

Zones IV through VI fall between 1,500 and 3,600-ft. in elevation. According to McEldowney (1983), these intermediate vegetation types are "basically unimproved pastures receiving little or no management" (p. 410). These zones comprise mixed grass and shrub communities containing naturalized introduced species – buffel grass (*Cenchrus ciliaris*), fountain grass (*Pennisetum setaceum*), guinea grass (*Panicum maximum*), Bermuda grass (*Cynodon dactylon*), and Natal redtop grass (*Melinis repens*) – and some scattered native shrubs (*e.g.*, ʻilima (*Sida* sp.), ʻākia (*Wikstroemia pulcherrima*)). "The higher percentage of bare ground is ephemerally covered by numerous annual herbs following both seasonal and intermittent concentrations of rainfall" (McEldowney 1983, p. 410).

Fountain grass is beginning to dominate the intermediate corridor. "Usually avoided by cattle [and even feral goats], this stiff-bladed bunch grass increases in dominance following periodic fires" (McEldowney 1983, p. 409). It has the ability to form monotypic stands which increase the fire fuel load of dry lowland regions and, when dry, are highly flammable. The plant is extremely fire-resilient, benefiting from fire at the expense of more palatable, non-fire-hardy grasses. DLNR has designated fountain grass as one of Hawaiʻi's most invasive horticultural plants, and Hawaiʻi Department of Agriculture has designated it a noxious weed.

Zones VII and VIII are wetter zones above the 3,600-ft. elevation, dominated by kikuyu grass (*Pennisetum clandestinum*). Kikuyu grows as a dense mat; therefore, it provides better protection against soil erosion. There are scattered pockets of native tree species, primarily in inaccessible gulch areas. Because this part of the watershed normally receives greater amounts of annual rainfall, it is less susceptible to fire. These zones are best suited for grazing and have been subjected to agricultural management practices.

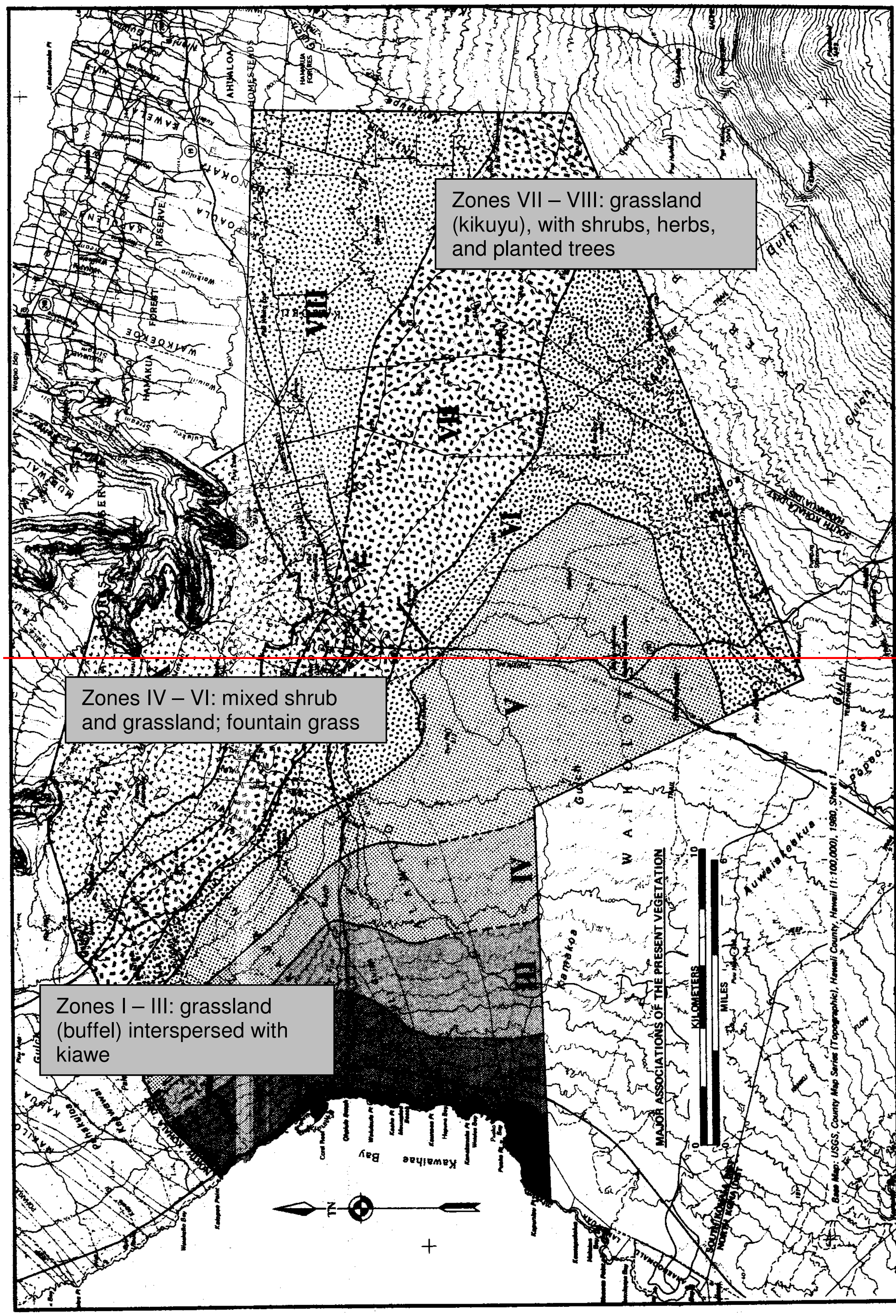

Figure 11: Zones of Major Communities of Present Vegetation (McEldowney 1983)

Fireweed (or Madagascar ragwort, *Senecio madagascariensis*) was discovered in the early 1980s in pastures on Kohala Mountain. It invades pastures, disturbed areas, and roadsides, and is toxic to livestock when eaten. It is commonly found in the pastures in the upper portion of the Waiʻulaʻula watershed. It is spread by wind, shoes, vehicles and animals. It is considered very invasive and is on the Hawaiʻi State Noxious Weed List.

Along the fringe of many of the watershed's streams, there is greater occurrence of vegetation, supported by the relatively steady source of water. In the upper elevations of pasture land (above 3,600-ft. elevation), this riparian vegetation comprises a greater proportion of native species, mostly due to its inaccessibility to grazing because of its location in gulches. In some locations in the central elevations, the vegetation often grows within the stream channel itself (comprising mostly of Christmas berry (*Schinus terebinthifolius*) and other non-natives), making access to the stream difficult and causing debris to get caught on the vegetation during storm events, increasing the potential for flooding. Kiawe trees fringe some reaches of the stream in the lower elevations.

Char (2002) noted plants that prefer a wetter habitat in shallow water and small mudflats in the riparian zone of the DHHL's proposed Lālāmilo Residential Homestead Lots (about 2,500-ft. elevation). "These include several members of the sedge family (Cyperaceae) such as ʻakaʻakai or great bulrush (*Schoenoplectus lacustris*), kyllinga (*Kyllinga brevifolia*) *Caarex longii*, *Fimbristylis dichotoma*, and *Cyperus haspan*; also found here are scattered clumps of bog rush (*Juncus ensifolius*). Other plants found along the water's edge include honohono (*Commelina diffusa*), marsh purslane (*Ludwigia palustris*), knotweed (*Persicaria glabra*), elephant grass (*Pennisetum purpureum*), and jungle rice (*Echinochloa colona*). All nine fern species found during this study are associated with moist shaded stream banks" (p. 6). Similar plants are likely found in areas of standing water and mud in other parts of the watershed, though a comprehensive assessment of riparian vegetation has not been undertaken for the watershed.

Obviously, it is difficult to know exactly how human pressures altered the distribution and composition of the native plant communities. But, generally, historical accounts document a series of human impacts on the environment of the watershed. The early Hawaiians altered the lands by developing large, irrigated agricultural systems. The sandalwood (*Santalum paniculatum* or ʻiliahi) trade of the early 19^{th} century drastically altered the landscape as the slopes were denuded of sandalwood trees. With the arrival of European settlers and whaling ships, the cattle industry was born, and cattle grazed down shrub and tree species, and the land was fenced for livestock. Trees were also harvested for firewood.

Fire has been a major threat to maintaining a healthy ecosystem in the watershed, and the changing composition of vegetation in the watershed has contributed to an increased fire hazard. Fire contributes to the erosion problem by stripping the land of vegetation. Without vegetation to hold the soil in place, it is subject to both wind and water erosion. Fire also can render to soil hydrophobic, which increases water repellency, surface runoff, and erosion.

2.1.10 Native Wildlife

The Waiʻulaʻula watershed is home to a number of native wildlife, occupying aerial, terrestrial, and aquatic environments. These species play a vital role in the ecological processes within the watershed, as well as hold cultural significance to the Hawaiian people.

Of the avian species, the watershed houses a handful of native birds. A wildlife survey done as part of the Environmental Impact Statement (EIS) for DHHL's Lālāmilo Residential Project (DHHL 2002) revealed nine species of birds. Of the nine, only one species, the Pacific Golden Plover or kōlea (*Pluvialis fulva*), was native. *P. fulva* is migratory and makes its home in Hawaiʻi during the months of August to April, where they feed on insects. Although not observed in this survey, it is expected that the native Short-Eared Owl or Pueo (*Anas wyvilliana*) resides in the region. The pueo is widespread on Hawaiʻi Island and often hunts during the day in pastures on the leeward side of the island.

Beyond the mid-regions of the watershed, which the Lālāmilo survey covered, lay the upper reaches of the watershed atop Kohala Mountain. While no formal surveys have been made specifically within the Waiʻulaʻula watershed, mountain-wide surveys have encountered many other native avian species that could potentially reside within the upper watershed. The endangered and endemic Hawaiian Goose Nēnē (*Branta sandvicensis*) has been spotted on Kohala mountain. Other native avian species that have been known to reside on Kohala Mountain are the forest birds ʻelepaio (*Chasiempis sandwichensis*), ʻamakihi (*Hemignathus virens*), ʻapapane (*Himatione sanguinea*), and ʻiʻiwi (*Vestiaria coccinea*). These birds inhabit the closed canopy ʻohiʻa and ʻōlapa forests on top of Kohala Mountain above an elevation of 4,000 feet, where they are free of diseases transmitted by mosquitoes (KWP 2007). Also established on Kohala mountain is the endangered Hawaiian duck (*Anas wyvilliana*) (USFWS 1999). The endangered Hawaiian Hawk or ʻio (*Buteo solitarious*) can also be found nesting in ʻohiʻa forests. All these birds perform a number of important roles within the ecosystem, such as seed dispersal and pollination of native plants by the nectarivorous ʻamakihi, ʻapapane, and ʻiʻiwi, pest control of insects by the insectivorous kōlea and ʻelepaio, and rodent control by the pueo and ʻio.

The Hawaiian hoary bat or *ʻō*peʻapeʻa (*Lasiurus cinereus semotus*) is the only native land mammal of the Hawaiian Islands. This endemic species is federally-protected under the endangered species list. The insectivorous bats have been spotted near Kawaihae and Honokaʻa, with some reported sightings in Waimea.

Aquatic species play extremely important ecological roles within the watershed. Their presence or absence is often used as an indicator of stream and watershed health. In the Waiʻulaʻula watershed, surveys of Waikoloa and Keanuʻiʻomanō streams conducted in 1992 by DLNR's Division of Aquatic Resources (DAR), in 2002 by Bishop Museum's Hawaiʻi Biological Survey (HBS), and in 2010 by R.A. Englund revealed a wide array of native endemic and indigenous aquatic fish and macro-invertebrates.

Englund (2010) observed 4 of the 5 native stream fish species in various locations throughout the watershed. *Lentipes concolor* (ʻoʻopu alamoʻo) was detected in Keanuʻiʻomanō Stream at the 2,700-ft. elevation. Englund notes that "[t]his indicates that native fish traverse long stretches of intermittent stream channels during periods of flowing water, using the ephemeral stream habitat as an access corridor to the headwater regions of upper Keanuʻiʻomanō Stream" (p. 11). *Awaous guamensis* (ʻoʻopu nākea) was also common in the lower Waiʻulaʻula Stream. *Eleotris sandwicensis* (ʻoʻopu ʻakupa) and *Stenogobius Hawaiiensis* (ʻoʻopu naniha) were found in the Waiʻulaʻula estuary. While *Sicyopterus stimpsoni* (ʻoʻopu nōpili) was not found during Englund's recent survey, it was observed in previous studies (1992 DAR survey). None of the native fish species have been Federally-listed, though the ʻoʻopu alamoʻo is considered a potential candidate (Loope 1998).

The ʻoʻopu have amphidromous life cycles in which adults reside in freshwater pools, migrate utilizing the intermittent stream flows, and mate in the headwaters. Eggs are deposited on rocks, hatch into larvae, and the larvae travel down the stream to the sea. Post-larval ʻoʻopu migrate back up a stream in response to freshets, restarting the lifecycle. In addition to the cultural significance of the once-plentiful ʻoʻopu as a traditional food source, the ʻoʻopu are important members of the trophic community. The indigenous ʻoʻopu nākea is omnivorous and feeds on filamentous algae as well as invertebrate species. And, the endemic ʻoʻopu alamoʻo and nōpili feed primarily on algae on the surface of rocks. These fish help control the overabundance of algae and invertebrate species.

"Englund et al. (2007) found that endemic Hawaiian aquatic insects are better bio-indicators for Hawaiian stream health as compared to the native stream macrofauna (fish, crustaceans, mollusks) because aquatic insects have more specific stream habitat requirements" (Englund 2010, p. 11). DLNR's Division of Aquatic Resources (DAR) conducts periodic surveys of the biota in Hawaiʻi's streams. Its Freshwater Database contains survey data from the State's perennial and intermittent streams, compiled from a variety of sources. The database identifies native and exotic species of fish, crustaceans, mollusks, insects, and algae, and notes the elevation at which the data were collected. The data date back to the 1960s. Data for the streams in the Waiʻulaʻula watershed were collected in 1968, 1990, 1992, 1994, 1999-2001. This database identifies 15 total aquatic insect species that have found in the Waiʻulaʻula watershed during all previous studies. Englund (2010) collected a total of 23 species of aquatic insects, of which 65% were native and 35% were introduced species. According to Englund (2010), "[t]he relatively high 65% overall native aquatic insect biodiversity found within the entire Waiʻulaʻula watershed is comparable to other high quality streams" (p. 12). In the upper reaches of Keanuʻiʻomanō, Waikoloa, and Kohākōhau streams, native species are even more dominant, maintaining an exceptionally high diversity "equaling any high quality stream found in the Hawaiian archipelago" (Englund 2010, p. 12).

The aquatic insects surveyed have important trophic roles as collectors, grazers, and predators. Collector-gatherer invertebrate species are filter feeders that consume passing particulate organic matter, effectively absorbing nutrients in the water. Native collector species found in the HBS and DAR surveys include the endemic prawn ʻōpaeʻoehaʻa (*Macrobrachium* *grandimanus*) and the endemic true flies under the order Diptera, *Forcipomyia hardyi*, *Chironomus sp,* and *Orthocladius grimshawi*. Invertebrate grazers feed on benthic algae and are responsible for maintaining healthy levels of algae. Grazers identified in this survey include the endemic true flies of the Ephydridae family, *Scatella bryani* and *Scatella clavipes*. The survey also found many native predacious invertebrates that prevent the overabundance of other invertebrates in the ecosystem. These predatory organisms were primarily the dragonflies such as the endemic *Pinao* (*Anax strenuous*) and the indigenous Common Green Darner (*Anax junius*) and Wandering Glider (*Pantala flavescens*). More information about the stream surveys is contained in Section 3.10.

2.1.11 Exotic and Invasive Species

Alien and invasive species of plants and animals are tremendous problems in Hawaiʻi, both from environmental and economic standpoints. Every year, new non-native species are introduced into the islands. The majority of the plants in the Waiʻulaʻula watershed are considered exotic and/or invasive species. These are described above in Section 2.1.9.

Much of the animal life in the watershed is also introduced. The problems caused by introduced species are well-documented: KWP (2007), SPREP (2000), Atkinson (1977), Giffen (1977), Smith (1985), DLNR (1989), Cuddihy and Stone (1990), Staples and Cowie (2001), and Stone (1985). Introduced cattle, goats, and pigs can be very destructive to their habitats. Feral pigs (*Sus scrofa*), found primarily in the upper reaches of the watershed, destroy areas of native forest, introduce weed species, and serve as vectors for disease. Feral goats (*Capra hircus*) browse on woody plants, herbs, and grasses, in both dry and wet ecosystems. They have proliferated in the lower watershed, damaging the environment through over-grazing. Improper management of domesticated cattle (*Bos taurus*) can also lead to over-grazing, while cattle accessing streams for water can have a negative effect on riparian vegetation and streambanks. Small mammals, such as rats (*Rattus rattus* and *Rattus exulans*), mice (*Mus musculus*) and mongoose (*Herpestes javanicus*), prey on native birds and feed on fruit, seeds, flowers, stems and roots of native plants. Introduced bird and insect species, of which there are many, compete with native ones for food sources and introduce new diseases.

Numerous species of alien aquatic species are established in Hawaiʻi's streams. Some were introduced intentionally as food fish, ornamentals, or for mosquito and weed control. Others were dumped into streams with no thought about the consequences. Exotic fishes, mollusks, crustaceans, invertebrates, and amphibians can compete with the native stream fauna for food and habitat, introduce parasites, and feed on native species. Invasive aquatic species can also cause economic impacts to agricultural users of water, resulting in crop damage, infrastructure damage, or contamination. While DLNR aquatic surveys of Waiʻulaʻula's streams reveal the presence of a majority of Hawaiʻi's native aquatic species, they also indicate the existence of exotic species, particularly guppies, crayfish, Tahitian prawns, green swordtails, toads and frogs, and midges.

Leptospirosis and Cryptosporidiosis are potentially fatal illnesses caused by water-borne micro-organisms spread by pigs, dogs, mongooses, rats, and even frogs. A few people become ill each year from wading in ponds or drinking water from affected springs and streams. Leptospirosis is from a bacterium, transmitted from animals to humans where people contact the bacteria through water or mud that has been contaminated by animal urine or droppings.

2.2 Socio-Cultural Resources

2.2.1 Land Use Zones (State and County)

2.2.1.1 State Land Use Districts

The Hawaiʻi Land Use Law, Chapter 205, Hawaiʻi Revised Statutes (HRS), places all lands in the State into four districts: Urban, Agricultural, Rural and Conservation. Lands in the Conservation District are managed by the State, and the jurisdiction over Rural and Agricultural Districts is shared by the State Land Use Commission (LUC) and counties. The responsibility for zoning within the Urban District is delegated to the counties. Changes to the boundaries can be made by ordinance of the County Council for areas of 15 acres or less. Otherwise, the LUC must approve changes by a 6-3 vote. Only the LUC can take land out of the Conservation District.

In the past, large-scale, urban-style developments have occurred in the Agricultural District, usually designed as a residential development and often surrounding a golf course. However, this use of agricultural lands has virtually halted as a result of the legal decision regarding the Hokulia development in South Kona.[4] As a result, landowners contemplating this type of development in the future will likely request LUC approval for a district boundary amendment to reclassify lands from Agricultural to Rural.

In the Waiʻulaʻula watershed, 69.4% of the lands are designated Agriculture, 21.2% Conservation, 0.5% Rural (small farms and low-density residential lots), and 8.9% Urban (Figure 12).

2.2.1.2 Conservation District

Lands in the Conservation District are managed by the Department of Land and Natural Resources (DLNR) pursuant to Chapter 183C, HRS, and Chapter 13-5, Hawaiʻi Administrative Rules (HAR). Generally, land use is regulated in the conservation district for the purpose of conserving, protecting, and preserving the important natural resources of the State through appropriate management and use to promote their long-term sustainability and public health, safety, and welfare. Lands within the Conservation District are further subdivided into

[4] Circuit Court Judge Ibarra ruled in 2003 that Hokulia was an urban project being built illegally on agriculturally-designated lands. He based this conclusion on his findings that the State Land Use Law (Chapter 205, HRS) requires that housing on agricultural lands be related to agricultural use and such agriculture must be economically viable.

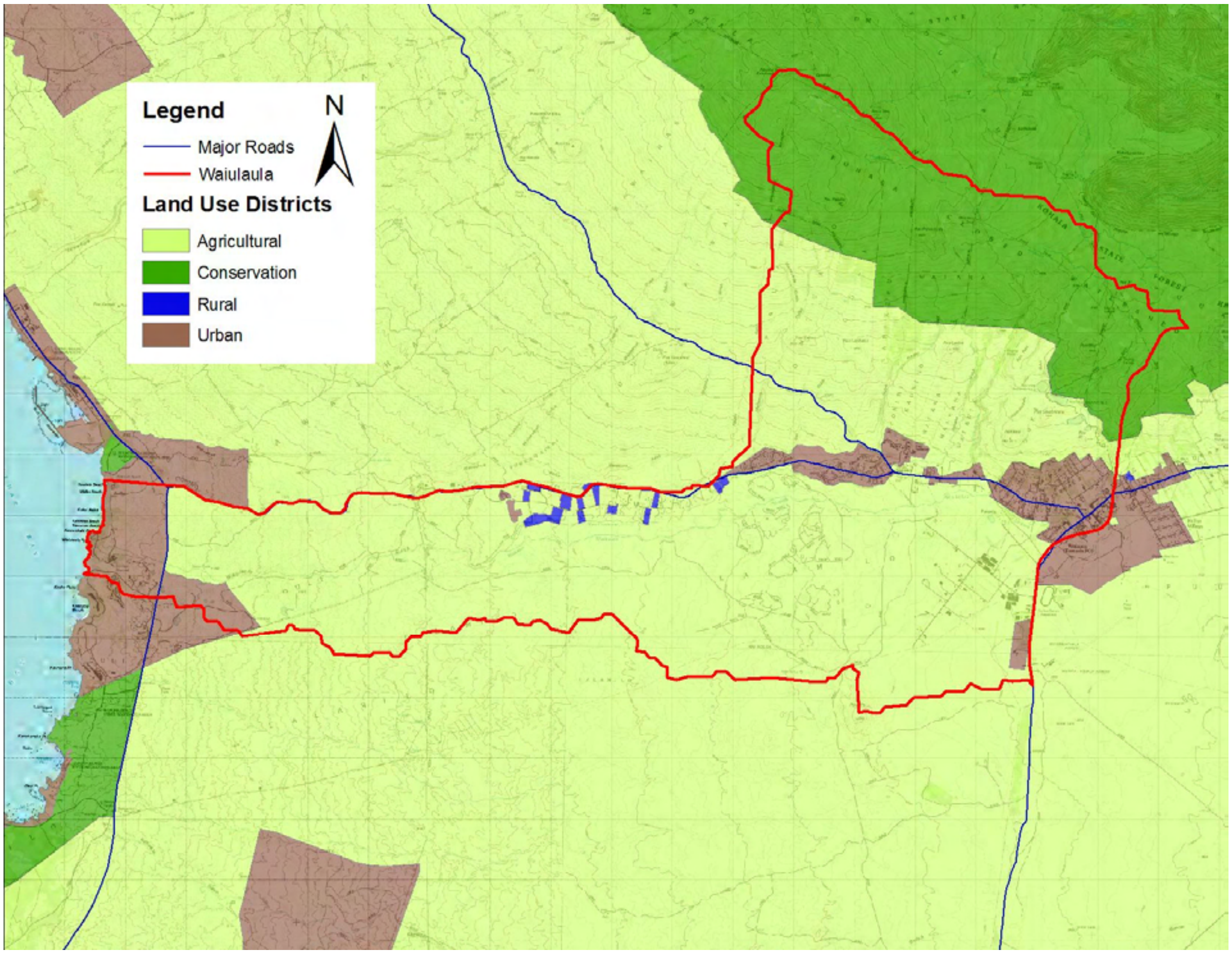

Figure 12: State Land Use Districts

subzones for which Chapter 13-5, HAR, defines specific objectives and types of activities allowed. The conservation lands within the Waiʻulaʻula watershed fall within the Protective Subzone, which has the following objective: protect valuable resources in designated areas such as restricted watersheds, marine, plant, and wildlife sanctuaries, significant historic, archaeological, geological, and volcanological features and sites, and other designated unique areas (§13-5-11). Prior to any use of land in the Conservation District, a Conservation District Use Application (CDUA) must be submitted to and approved by the Board of Land and Natural Resources.

The southeastern portion of the conservation lands within the Waiʻulaʻula watershed is designated as part of the Kohala Watershed Forest Reserve. DLNR's Division of Forestry and Wildlife (DOFAW) regulates activities in the forest reserves under Chapter 13-104, Hawaiʻi Administrative Rules (HAR). These rules prohibit taking of any plant or animal life, except by permit; disturbing of any natural or historic feature; introduction of plants and animals; dumping and littering; and fires. The rules also disallow driving motorized vehicles in any area or trail not designated for that purpose, and prohibit unlicensed vehicles. Camping is allowed in designated areas (of which there are none in the Waiʻulaʻula watershed) or sites with a permit from DLNR. Hunting is allowed only as provided for in Chapters 122 (Game bird hunting) and 123 (Game mammal hunting), HAR.

DLNR-DOFAW also regulates activities within restricted watersheds, including the Kohala Restricted Watershed, under Chapter 13-105, HAR. The rules provide for scientific research; hunting, as permitted by hunting rules; hiking and other recreational pursuits; and collecting of fruits, greenery and other plant parts for personal use with a permit for DLNR. These activities are regulated by Chapter 13-104, HAR, rules regulating activities within forest reserves.

The remaining conservation lands within the Waiʻulaʻula watershed are part of the Puʻu o ʻUmi Natural Area Reserve (NAR). Under Chapter 13-209, HAR, DLNR is responsible for the management of the State's NARs to ensure preservation of specific land and water areas which support communities of natural flora and fauna, including wetland areas. The rules and prohibitions are similar to those within forest reserves, with a few exceptions. Camping is prohibited in the NARs, and any hiking groups larger than ten individuals are required to have a special use permit from DLNR.

2.2.1.3 Agricultural and Rural Lands

Chapter 205, HRS, delegates the responsibility for zoning within the agricultural and rural districts to the counties. For agricultural lands, however, Chapter 205, HRS, outlines permitted uses of the lands classified as "A" or "B" by the Land Study Bureau's land productivity rating system.[5] In Hawaiʻi County, Chapter 25, Hawaiʻi County Code (HCC), regulates zoning and identifies permitted uses and other regulations. Under this ordinance, the State Agricultural District is further subdivided into subzones (agriculture, family agriculture, intensive agriculture, etc.), which the County also refers to as "districts."

Chapter 205, HRS, states that only the following uses shall be permitted within Rural Districts: low density residential uses (minimum lot size is one-half acre); agricultural uses; golf courses, golf driving ranges and golf-related facilities; and public, quasi-public, and public utility facilities.

Chapter 205, HRS, also requires that State and county agricultural policies, tax policies, land use plans, ordinances and rules promote the long-term viability of agricultural use of important agricultural lands. One criterion for designating land as important agricultural lands is lands identified under agricultural productivity rating systems, such as ALISH.

[5] *The University of Hawaiʻi's Land Study Bureau (LSB) prepared an inventory and evaluation of the State's land resources during the 1960s and 1970s. The LSB rated lands, except those in the urban district, in terms of agricultural productivity based on soil properties and productive capabilities (texture, structure, depth, drainage, parent material, stoniness, topography, climate, and rain). A five-class productivity rating system was developed using the letters A, B, C, D, and E, with "A" representing the class of highest productivity and "E" the lowest. There are no class A lands on the island of Hawaiʻi.*

Agricultural Lands of Importance to the State of Hawaiʻi (ALISH): As part of a national effort to inventory important farmlands, the Hawaiʻi Department of Agriculture assessed lands through a rating system for agricultural suitability to produce the Agricultural Lands of Importance to the State of Hawaiʻi (ALISH). This was adopted by the Board of Agriculture in 1977. Three classes of important agricultural lands were identified: (1) Prime – soils with best physical, chemical and climatic properties for mechanized field crops; (2) Unique – lands other than prime for unique high-value crops (coffee, taro, watercress, etc.); and (3) Other – lands needing irrigation or possessing characteristics like seasonal wetness, or erodibility that require further management for commercial production. Areas of Prime agricultural lands in the Waiʻulaʻula watershed include the Lālāmilo farm lots and a band of grazing land *mauka* of Kohala Mountain road (Figure 13).

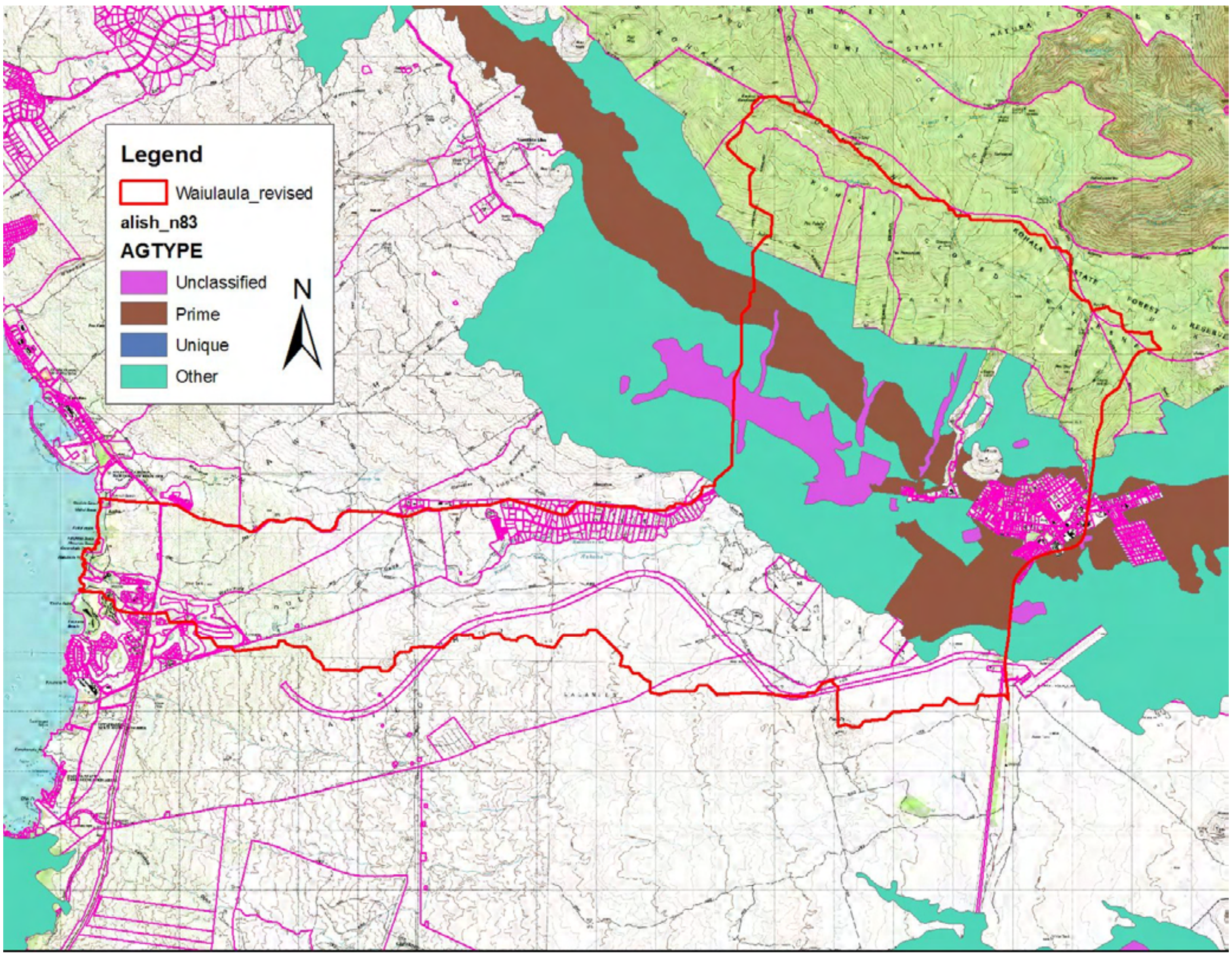

Figure 13: ALISH Agricultural Suitability

General Plan Important Agricultural Lands: Chapter 205, HRS, also mandates counties to identify and map potential important agricultural lands within their jurisdictions. One of the goals of Hawaiʻi County's *General Plan* (2005) is to identify, protect and maintain important agricultural lands on the island of Hawaiʻi. The general plan defines "important agricultural lands" as "those with better potential for sustained high agricultural yields because of soil type, climate, topography, or other factors" (Hawaiʻi County 2005; p. 14-8). In making these determinations, the county included, among other things, data from the 1989 General Plan Land Use Pattern Allocation Guide (LUPAG) maps, the ALISH classification system, and the Land Study Bureau's (LSB) Soil Survey Report. General Plan Important Agricultural Lands included in the Waiʻulaʻula watershed are the Lālāmilo farm lots and some grazing lands *mauka* and *makai* of Kohala Mountain Rd (see Figure 16).

2.2.1.4 Urban District

The urban district is entirely under county jurisdiction, and uses are controlled only by county zoning. All areas on the island, except for federal lands like the national parks and some areas in the conservation district, are zoned (Figures 14 and 15). The Zoning Code, Chapter 25, HCC, lists the permitted uses within each zone, and also the required setbacks, height limits, parking areas for commercial developments, and other controls. Within the Waiʻulaʻula watershed, 4% of the land is zoned residential, 0.7% commercial, 1.2% roads, and 1.2% open, while the remaining lands parallel State designations with 71.5% zoned agricultural and 21.2% forest reserve (conservation).

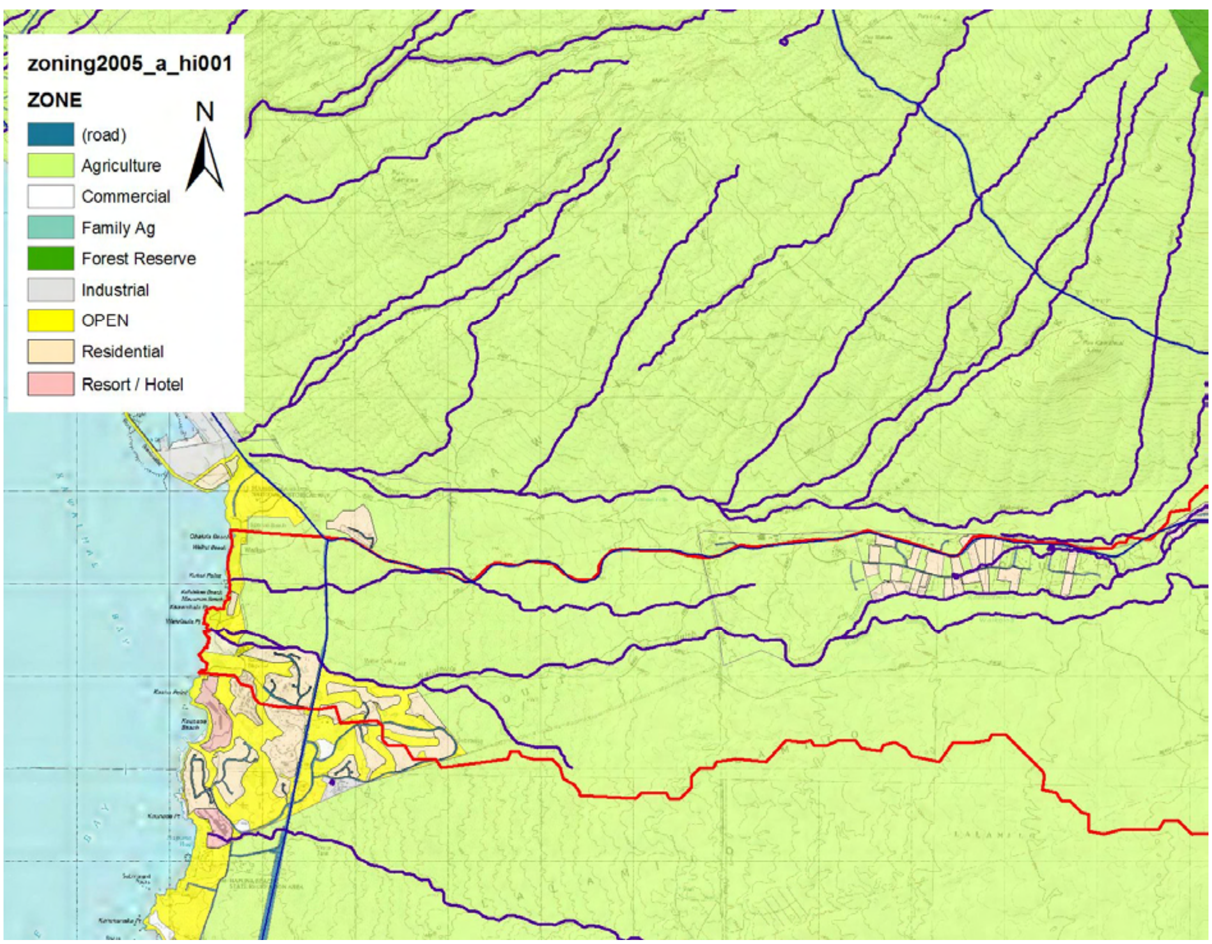

Figure 14: County Zoning - Lower Watershed

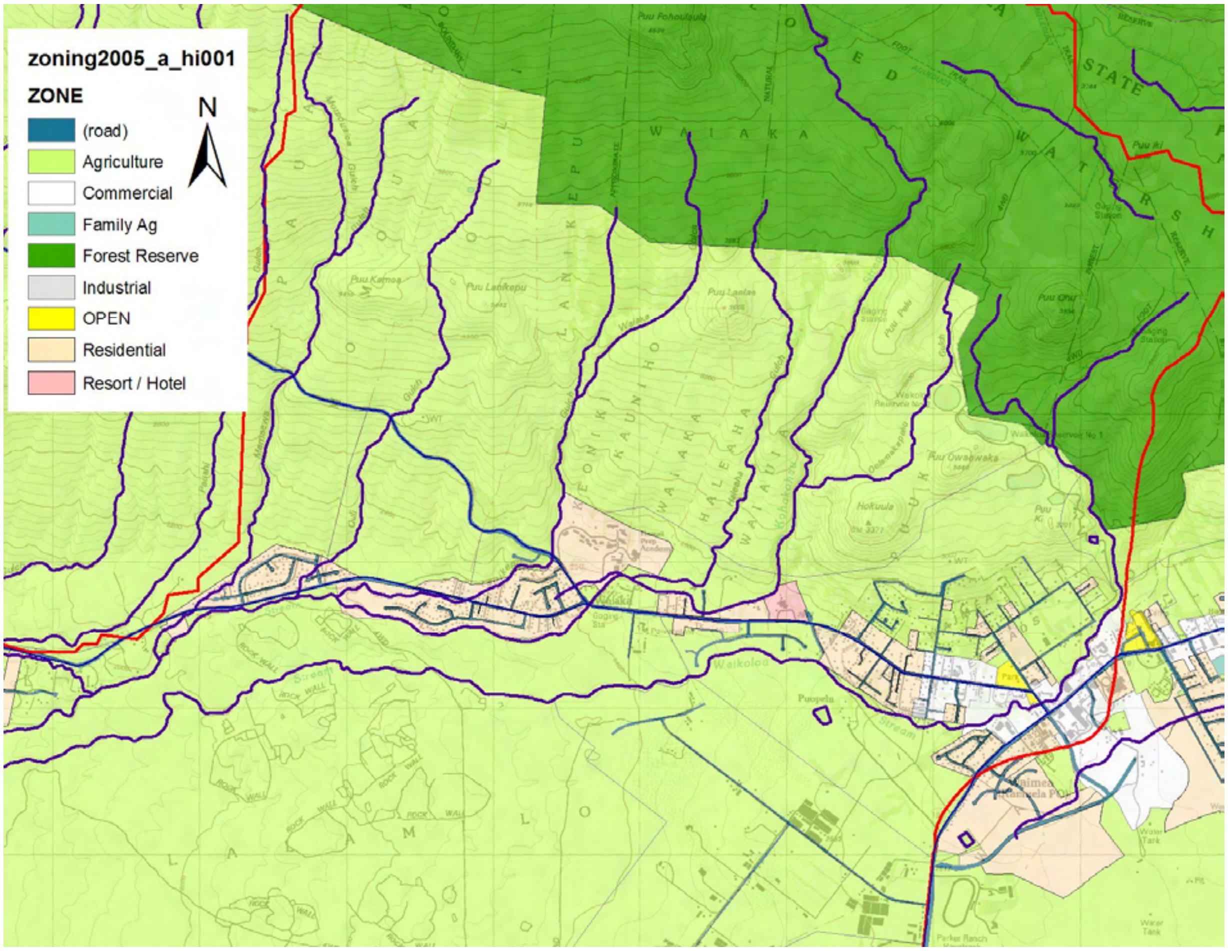

Figure 15: County Zoning - Upper Watershed

While, currently, there is little urban or suburban development within the watershed, the County's LUPAG map (see Figure 16) shows substantial areas designated for urban and suburban expansion. These areas will likely require a change in land use district classification, shifting management jurisdiction for these lands completely to the County.

2.2.1.5 Hawai'i County General Plan

Generally, all development within the County must conform to the policies outlined in its General Plan (Hawai'i County 2005) and specific community development plans. The county general plan provides a coordinated set of guidelines for decision-making regarding future growth and development and protection of natural and cultural resources. The general plan also guides revisions and updates to the county code. The plan is given the effect of law through adoption by the County Council. Generally, the general plan has policies related to protecting the county's natural resources and minimizing adverse effects resulting from the inappropriate location, use, or design of sites and structures; protecting wetlands and riparian areas; and designing drainage systems to minimize polluted runoff, retain streambank vegetation, and maintain habitat and aesthetic values.

The General Plan provides the direction for the future growth of the County. As a policy document, it provides the legal basis for all subdivision, zoning, and related ordinances and will guide revisions to the county code. The General Plan also includes Land Use Pattern Allocation Guide (LUPAG) maps by district that show conservation, agricultural, rural, resort and urban areas, urban expansion areas, and open areas (Figure 16). These serve to guide the location, type, and intensity of different land uses. The LUPAG identifies significant areas of urban expansion within the Waiʻulaʻula watershed, particularly in the lower watershed and within Waimea.

The County general plan is implemented through the specific community development plans; budgeting and capital improvement programs guided by the goals, objectives and policies of the general plan and community development plans; county laws amended to be consistent with the intent of the general plan components; and approval or disapproval of developments seeking zoning and other development approvals based on how they support the visions expressed in the general plan. The county planning department prepares an annual report to monitor progress towards achieving general plan goals, objectives and policies. The annual report is submitted to the Mayor and County Council for review. The General plan is subject to periodic review and amendment, as specified by county procedures, with significant opportunities for input by the public.

The 2005 General Plan calls for the development of community development plans, which are to be adopted by the County Council. The South Kohala Community Development Plan (CDP) was developed with significant community input and adopted by the Council on November 20, 2008. It provides a long-term plan with a planning horizon to year 2020, consistent with the General Plan. The South Kohala CDP identifies District-wide policies that address the following priority land use issues: preserve culture/sense of place; traffic and transportation; affordable housing; emergency preparedness; and environmental stewardship and sustainability. It specifically identifies a sub-policy for the District that directs the County to develop or collaborate with other agencies and organizations to develop watershed management programs for the district, as well as water quality monitoring (Hawaiʻi County 2008; p. 52).

The South Kohala CDP includes a Waimea Town Plan, providing general guidelines for the long-range future of Waimea Town. Among the recommendations that are relevant to the Waiʻulaʻula watershed management plan are the following:

- Strategy 1.1 Protect the puʻu of Waimea.
- Strategy 1.5 Expand the Lālāmilo Farm lots.
- Strategy 2.1 The County should carefully evaluate and condition, as appropriate, any rezoning that would negatively impact important agricultural lands or culturally, visually and environmentally important open space or resources in Waimea.
- Strategy 2.2 Work with Parker Ranch to phase the "Parker 2020" Development.
- Strategy 2.3 Revise the County subdivision regulations and Planning Department policies and enforcement procedures to ensure that agricultural

subdivisions are created for agricultural purposes and are not used for rural residential purposes without rezoning.

Strategy 2.4 Amend the County of Hawaiʻi's General Plan "LUPAG" map by reducing the acreage of "Low Density Urban" land in Waimea Town.

Strategy 3.1 Protect Important Agricultural Lands.

Strategy 5.7 Design and construct the Lālāmilo connector road.

Strategy 5.8 Work with the State Department of Transportation to resolve the best alignment for the proposed Waimea/Kawaihae Road bypass highway.

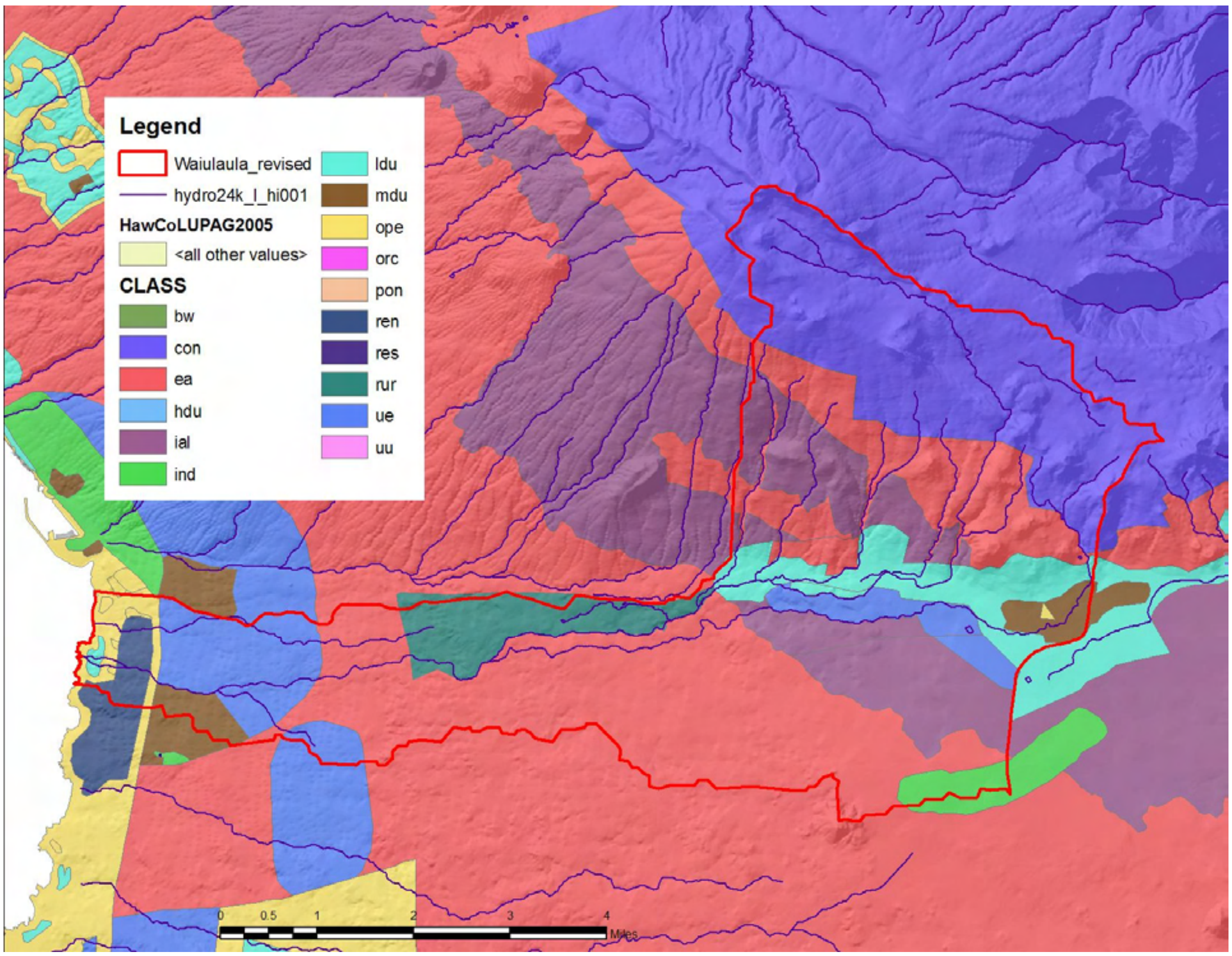

Figure 16: County LUPAG Map

bw	(breakwater)	mdu	Medium Density Urban
con	Conservation	ope	Open Area
ea	Extensive Agriculture	pon	(ponds)
hdu	High Density Urban	ren	Resort Node
ial	Important Ag. Lands	rur	Rural
ind	Industrial	ue	Urban Expansion
ldu	Low Density Urban		

2.2.2 Land Cover

Land cover is based on NOAA's Coastal Change Analysis Program (C-CAP) land cover classes (Figure 17). The majority of the watershed (58%) is in grassland, dominated by grammanoid or herbaceous vegetation and not subject to intensive management such as tilling. Evergreen forest, with trees generally greater than 5 meters tall and greater than 20% of total vegetation, accounts for 26% of the land cover. This land cover type is primarily found within the protected Conservation District. Of the remaining land cover, scrub/shrub and low-intensity developed each account for 5%, bare land 4%, and cultivated land and high intensity developed each 1%.

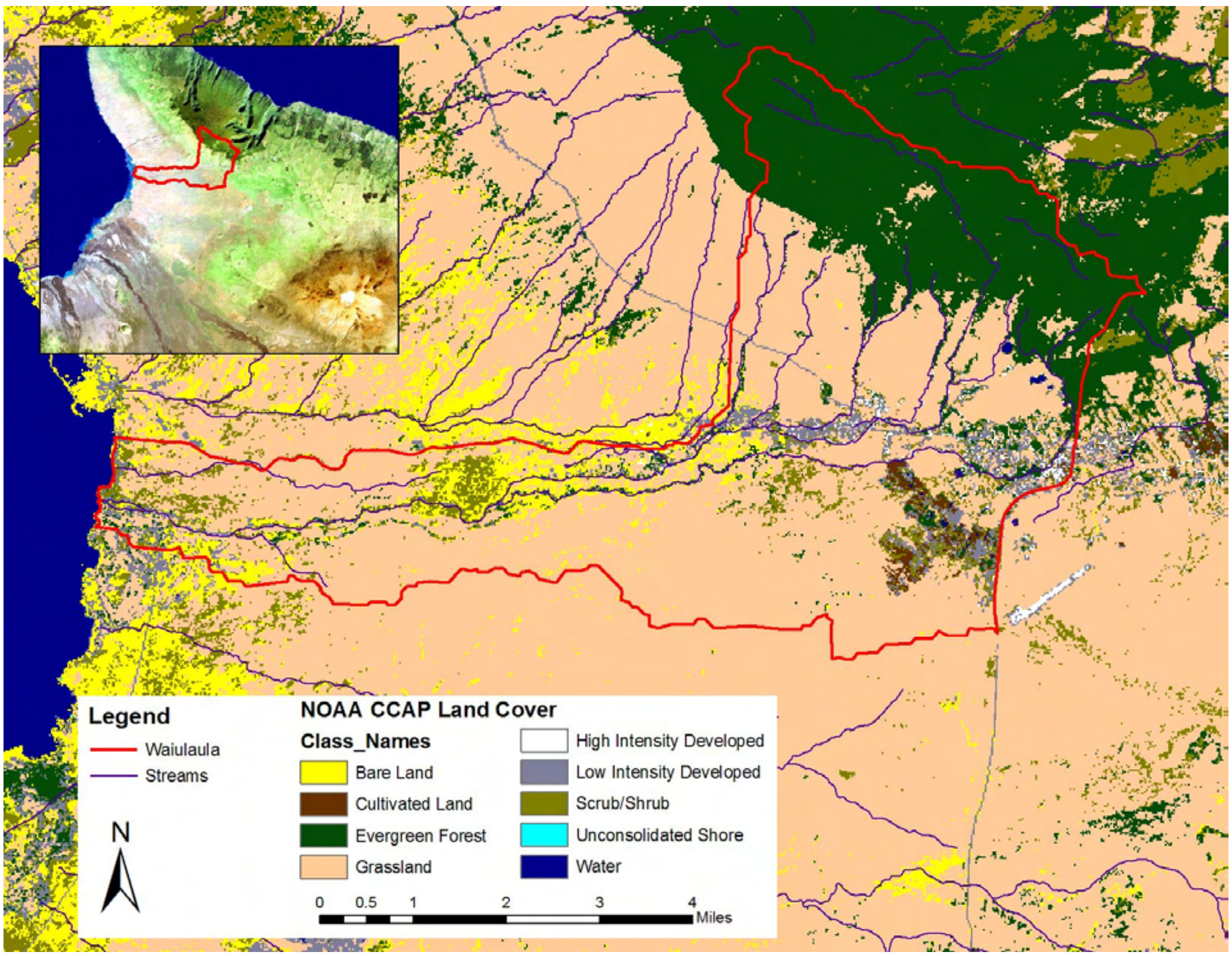

Figure 17: C-CAP Land Cover

2.2.3 Population and Local Communities (Demographics)

Waimea is the main population center within the Waiʻulaʻula watershed. Waimea is a rural community that developed around the historic Parker Ranch. Residential subdivisions extend down Kawaihae Road, located primarily between Kawaihae Road and Keanuʻiʻomanō stream to the south. Mauna Kea Beach Resort is a destination resort located near the mouth of the watershed, with a large-scale, high end hotel, restaurants, golf courses, and residential developments. Most of the commercial development in the watershed is concentrated in and around Waimea town center.

The South Kohala District, in which the Waiʻulaʻula watershed is located, was the fastest growing district on Hawaiʻi Island from 1980 to 1990 and the second fastest growing district from 1990 to 2000 (Hawaiʻi County 2008). While census data does not provide population information on a watershed basis, it is estimated that Waimea's population in 2000 was over 7,000 people. The South Kohala Community Development Plan estimates (based on building permits issued) that, since 2000, the population of Waimea alone could have increased by about 1,500 people (Hawaiʻi County 2008). There are currently around 2,900 housing units in Waimea. This does not include additional units along Kawaihae Road and at the Mauna Kea Beach Resort.

Many people are employed by the tourism sector. Agricultural operations, both truck crop farms and cattle ranching also employ people within the watershed. Waimea is the home to the headquarters of Canada-France-Hawaiʻi Telescope and W.M. Keck Observatory, numerous public and private schools (Waimea Elementary School, Waimea Middle Public Conversion Charter School, Kanu o Ka ʻĀina Public Charter School, Hawaiʻi Preparatory Academy, and Parker School), and the North Hawaiʻi Community Hospital. Waimea's per capita income is $20,773, based on 2000 census data. Median income is $51,150 for households, $55,822 for families, and $29,750 for non-family households.

2.2.4 Land Uses – Historic and Current

In the Cultural Impact Assessment for the DHHL Lālāmilo Residential Development Project, authors McGuire and Haun (2002) describe historic land uses in the area: "From ancient times, Waimea has been associated with royalty and chiefly lineages. Waimea was one of the lands which was highly valued by the *aliʻi* (chiefs) and traditional stories indicate they maintained a dominant presence there" (p. 6). Waimea was also a training ground for young chiefly warriors. McGuire and Haun (2002, p. 8) describe the story of Kekuhaopio, a trainer during the time of Kamehameha, which lists many famous battles either fought in Waimea or fought by Waimea warriors, including a battle between Kamalalawalu of Maui and Lonoikamahakihi from Hawaiʻi in the late 16th to early 17th century that took place in the Waimea area: the battle of Puʻoaʻoaka (Puʻuʻowāʻowaka Hil). McGuire and Haun also report that a battle occurred at Hōkūʻula.

With so many chiefs and warriors coming from Waimea and being trained in Waimea, an extensive agricultural field system was developed that is still evident today. Clark (1981) notes that this Waimea agricultural system can be subdivided into four field complexes, three of which are contained within the current day Waiʻulaʻula watershed:

> Field Complex 1 is located on the Kohala slopes, principally between Lanikepu and Haleʻaha Gulches on the west and east, respectively. It lies south of Puʻulaʻelaʻe, and north of Keanuʻiʻomanō and Kohākōhau Streams, once they run off the slope and turn to an east-west

> flow direction. This area is one of comparatively steep slope, and is characterized by a series of terraces and/or terraced field ridges. These features range from 0.5 to 1.5 m. in height and appear to be primarily soil with little or no stone in the retaining faces. The upper portion of the complex is dominated by mildly terraced field ridges, usually comparatively low. These seem most likely to be more of a linchet-type development than intentionally constructed ridges. The lower portion of the complex is characterized by the presence of larger terraces with broader and noticeably flatter surfaces behind the soil embankments. The method of construction of these latter features is probably cut-and-fill.
>
> In association with the agricultural fields are a series of water flow channels and at least one set of ʻ*auwai*. The water flow channels are found over the entire complex, running down the slope. With one <u>possible</u> exception, they do not appear to divert from a stream flow but, rather, simply begin as small depressions at the upper margins of the fields. The angle of slope would necessitate a very rapid flow, and some of the channels are in comparatively low-lying areas; both conditions would make diversions into fields somewhat difficult. Consequently, it seems most likely that these channels served more a drainage function, diverting water off of rather than onto the fields. Also present, however, is a clearly identifiable ʻauwai set, the main channel of which is diverted from the Kohākōhau Stream at approximately 3,000 ft elevation, that feeds a series of fields in the Waiaula land division before emptying into the Haleʻaha Gulch. A historic period irrigation ditch (with a diversion wall of concrete and boulders) is taken off of the east side of the Kohākōhau Stream, but its route was not determined.
>
> A few fields may be present immediately east of Kohākōhau Stream Gulch, but there are no signs of agricultural activity much beyond it. On the other side, an occasional low terrace, residential structure, or wall can be found beyond the first few hundred meters west of Lanikepu Gulch, but for the most part the field complex proper ends at that point….
>
> Field Complex 2 is situated between Keanuʻiʻomanō and Kohākōhau Streams on the north, and Waikoloa Stream on the south. It is characterized by a set of agricultural fields demarcated by terrace retaining faces, or low ridges of soil and/or stone. The fields average ca. 25 m in width with the long axis oriented northwest by southeast, or perpendicular to the prevailing winds. Associated with the fields is a set of ʻauwai, which diverge from the Kohākōhau Stream and angle to the southeast across the complex, draining into the Waikoloa Stream….
>
> Field Complex 3 lies south of Waikoloa Stream and north of Puʻu Pā. The existing Lālāmilo Farm Lots have destroyed much of the eastern end of this complex. The precise western extent has not yet been determined but it appears to incorporate most, if not all, of the Lālāmilo Kuleana and Ranch District…. (Clark 1981: 17-19)

The upper Lālāmilo fields of the Waimea agricultural complex differ from the Kohala field system “due to the fact that they received supplemental water by means of an extensive and complex irrigation system. Indeed, it is this difference that makes the Waimea agricultural system unique” (Clark 1981: 50).

In 1793, Captain George Vancouver brought Longhorn cattle along with some sheep, and gave them to King Kamehameha as a gift. Kamehameha put a ten-year *kapu* on the cattle, prohibiting anyone from touching or hunting them. From these cattle, large herds eventually multiplied, causing significant damage to the forest on Kohala Mountain. McGuire and Haun (2002) suggest that along with cattle, “other early western visitors introduced goats, horses, a new pig breed, and new vegetable, fruit and plant varieties. Kawaihae and its port became the impetus for the development of trade and commerce. Waimea provided much of the produce, and later on salted beef, to refurbish supplies for foreign ships” (p.18). To harvest the cattle, which all belonged to the Crown, the King hired bullock hunters, like John Palmer Parker. The meat would be salted and brought to Kawaihae. Hides were tanned and tallow was produced from the cattle. All these products were sold to the ships that resupplied in Kawaihae. In 1832, Spanish-Mexican vaquero were brought from California to teach Hawaiians how to manage the wild cattle (Bergin 2004).

Waimea had a reputation for producing fine and durable leather. However, the enterprise of tanning the hides had a noticeable effect on the forest of the area. Haun and McGuire (2002) write:

> ecologically, the tanning business had a negative impact to the landscape. The bark from native trees was used to tan hides. Lyons reports that the “Konohikis demanded high prices for bark gathering permits; and koa and ʻohiʻa were used more than scarcer trees that made handsomer leather...” Kukui was richest in tannin” (Doyle 1945: 50). Lyons’ comment implies there had already been loss of the native forest besides sandalwood. The tanneries no doubt contributed to more loss of the native forest. There were several tanneries in operation during the 1840s and 1850s. One tan works was “under the direction of Chinamen”; one owned by James Fay; and two others were at Waiemi and Pukalani, owned and run by William Burke (Olmsted 1841: 233; Barrera & Kelly 1974: 45; Native Testimony, Waimea Water Rights Case 1914 – 1915). (p. 22)

McGuire and Haun (2002) describe that the sandalwood trade started in the early 1800s. By 1811, King Kamehameha had signed an exclusive agreement with three American entrepreneurs for access to Hawaiʻi’s sandalwood resource. In return, Kamehameha received one-fourth of the net profits. As a monopoly of the aliʻi, the sandalwood trade grew unabated. Sandalwood was harvested from the slopes of Kohala Mountain and brought down to Kawaihae for shipment, until the supply of trees declined by the early 1840s. The sandalwood harvest had significant environmental impacts on the watershed resources, denuding the forest of sandalwood and causing a major change in the forest ecosystem species composition.

Other agricultural products grown in the Waimea area in the first half of the 19th century included sugar and potatoes. McGuire and Haun (2002) describe that sugar was an industry in Waimea from the mid-1830s until at least 1843. Before this time, sugar cane was grown by Hawaiians for their own consumption at locations around Waimea. The first sugar mill is described as having been established by a Chinese man named Lauki, who had come to Hawaiʻi with Captain Joseph Carter, grandfather of A.W. Carter. The mill was powered by a water wheel using water from Waikoloa Stream. Because of the demand for Irish potatoes and sweet potatoes by those in California involved with the Gold Rush, Waimea farmers began to increase their production and shipping of potatoes to California, along with other agricultural products like vegetables, sugar, molasses and coffee (Kuykendall 1965: 313-314, 321-322). Haun and

McGuire (2002) note that this export market lasted only three short years, when the Irish potato market collapsed.

By 1840, there was concern that the great herds of cattle would be diminished because of consistent hunting pressure. So, another *kapu* was placed on the cattle. In 1844, a man named William Beckley was named as konohiki of Waimea, "in addition to his role as manager of the king's and government's cattle (Lyons 1846 in McEldowney 1983: 432). Under his management, more lands were converted to pasturage and holding pens. McEldowney (1983) states that Lyons wrote that Waimea had turned into a "cattle pen." He wrote that "[b]y another unfavorable arrangement 2/3 of Waimea have been converted to a pasture for government herds of cattle, sheep, horses, etc." (Lyons 1846 in McEldowney 1983: 432).

Through the 1840s and 1850s, the government of Hawaiʻi passed new laws that initiated a process called the Mahele in which the land tenure system changed from a feudal system with all land controlled by the king and his chiefs, to a system of private land ownership. With the changes brought about by the Mahele, and in land ownership in Waimea, cattle ranching went through a major transition. Former cattlemen and others began to establish ranching operations. John Palmer Parker purchased the first acres of land that would become Parker Ranch in 1847. Bergin (2004) describes the history of Parker Ranch and its role in the development of Waimea town.

During both World War I and World War II, Parker Ranch supplied the Armed Forces in Hawaiʻi with beef. During World War II, over 20,000 men in the Army and Marines were living at a major encampment located at Puopelu in Waimea. They also used a large area of land between Waimea and Waikoloa as a firing range. Unexploded ordnance from this era remains a problem to this day.

During the war, the farmers in the Waimea area prospered, growing fresh produce for the servicemen living in Waimea. McGuire and Haun (2002) describe that,

> Each farmer leased twenty acres of lands combined between Ranch and Waimea homesteaders. The farmers learned to grow new kinds of vegetables they had never grown before – lettuce, asparagus, celery, and broccoli were especially requested by the servicemen (Nakano 1992: 101). The war helped the Waimea farmers make the shift from tenant farmers to commercial farmers. (p. 44)

Laurance S. Rockefeller constructed the Mauna Kea Beach Hotel in the early 1960s, paving the way for future resorts and hotels to be developed in the region (Hawaiʻi County 2008). In 1975, the Queen Kaʻahumanu Highway was completed, connecting the coastal towns in West Hawaiʻi and enabling further development of the coastline.

During the 1980s, Parker Ranch, under the direction of the last remaining heir, Richard Smart, developed the *Parker Ranch 2020 Plan* to guide the future development of Waimea. Smart hoped the plan would allow Waimea to expand without losing its village character. In 1992, approval of the plan was granted by the County through the adoption of Ordinance 92-65, which rezoned over 580 acres of land in the Waimea area for commercial, industrial, and residential activities, as well as for community facilities. When Richard Smart died in 1992, he left most of the Ranch assets to the Parker Ranch Trust Foundation. This foundation supports five beneficiaries: North Hawaiʻi Community Hospital, Lucy Henriques Medical Center, Parker School Trust Corporation, Hawaiʻi Preparatory Academy, and the Richard Smart Fund of the Hawaiʻi Community Foundation.

In 1994, Parker Ranch began to revise its plan in response to community concerns and in light of the fiduciary responsibilities of the Parker Ranch Foundation trustees to the beneficiaries. As the cattle industry has become less profitable, the trustees have needed to explore diversification alternatives to generate more stable income for distribution to the beneficiaries. This diversification has included selling Parker Ranch Center and Parker Square, selling land to a developer for the development of condominium homes at HoloHoloKu, and a joint venture with Schuler Homes to develop single-family homes at Lualaʻi. Figure 18 shows the Waimea Town Center Land Use Map from the *Parker Ranch 2020 Plan*.

Today, Waimea town is the commercial center of the Waiʻulaʻula watershed. There is residential development within Waimea town and along Kawaihae Road. Mauna Kea Beach Resort at the coast comprises hotel and residential developments, and golf courses. There are over 500 acres in cultivated agriculture within the Lālāmilo Farm Lots. Much of the remaining watershed is grazed or in a wildland state.

2.2.5 Water Uses – Historic and Current

For years, the presence of an extensive *ʻauwai* (irrigation channel system) has given rise to the possibility that large portions of the Waimea plains were irrigated and cultivated in ancient times. In fact, an important legal case on the water rights of Parker Ranch in the early 1900s led to the production of a detailed map of the *ʻauwai* system on the *kula lands* of Waikoloa Nui, Waikoloa Iki, Lālāmilo and Puʻukapu (Kanakanui *et al.*, 1914; Reg. Map No. 2576), which depicts flow of water to and through many of the fee simple land interests awarded to native tenants in the region (Maly and Maly 2004).

Hawaiʻi County Department of Water Supply (DWS) relies on the streams of Kohala Mountain for its primary source of water in the Waimea area. The DWS system draws its water from diversions on Waikoloa and Kohākōhau streams. According to DWS (2006), the stream diversions currently provide 1.427 mgd of water. "The *2006 DWS 20-Year Water Master Plan* indicates the estimated capacity of the surface water sources used by the water system to be 1.45 mgd" (DWS 2006, p. 801-15). The diversion on Waikoloa Stream was first developed in 1925, and the one on Kohākōhau Stream was completed in 1971. Raw water from the streams is stored in 4 reservoirs (2 of which were damaged in the 2006 earthquake and are currently undergoing repairs) with a total capacity of over 150 million gallons (MG). The water is treated in the DWS filtration plant.

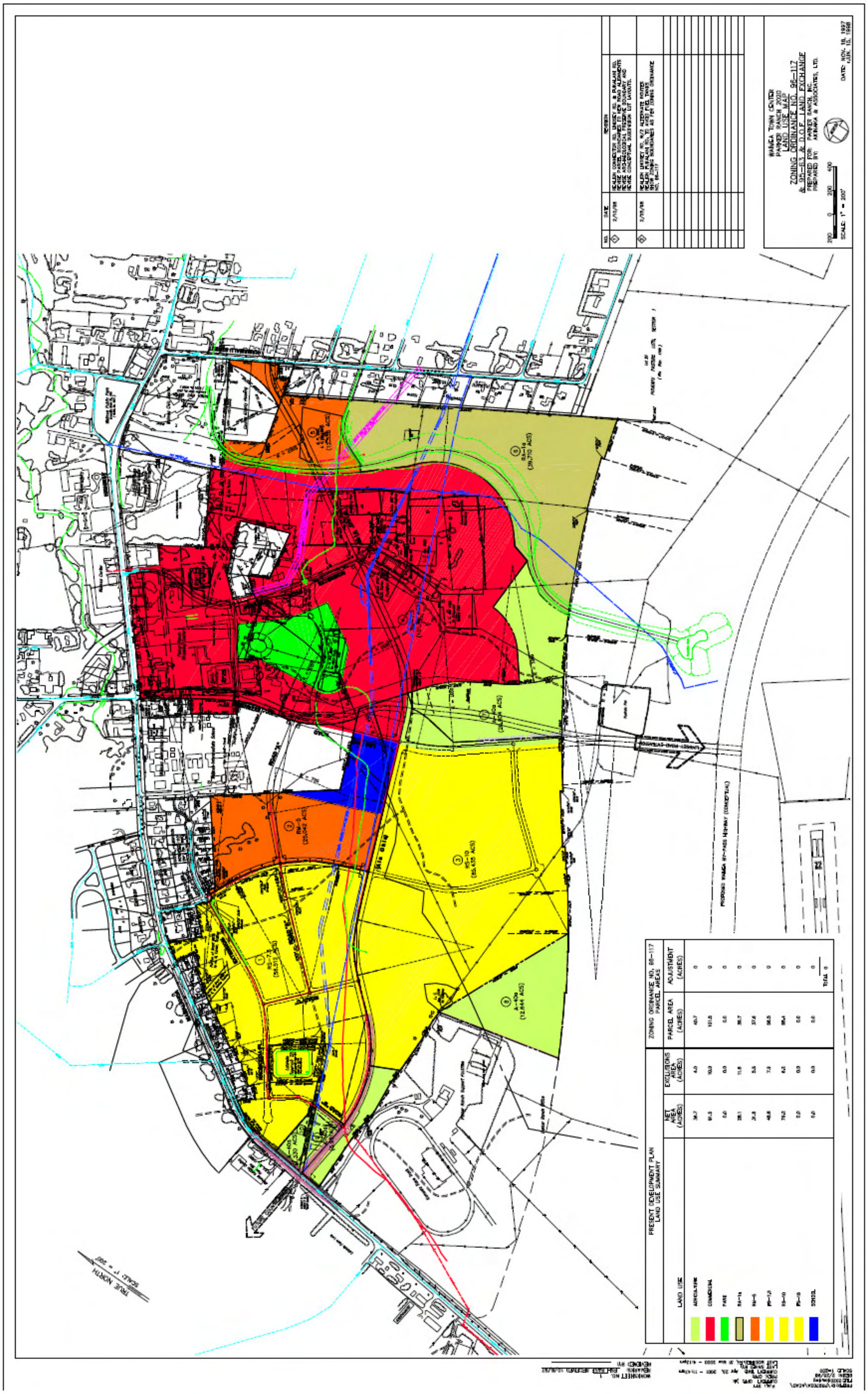

Figure 18: Waimea Town Center Land Use Map - Parker Ranch 2020 Plan

Use of surface water to supply potable water requires strict adherence to DOH regulations related to treatment and monitoring. The surface water is treated by conventional filtration for odor and color control, and for corrosion control and disinfection, and blended with groundwater before distribution (DWS 2006).

During periods of prolonged dry weather or high water usage, the treatment plant cannot process enough surface water sources to meet demand; as a result, DWS has developed a deep well in Waimea, which taps a high-level groundwater source, to supplement surface water sources. The Waimea water system provides about 2.0 mgd to users in Waimea and as far east as Paʻauilo and west to the Waiemi subdivision on Kawaihae Road.

DWS is currently updating its water use and development plan. A draft of the Hawaiʻi County Water Use and Development Plan Update was completed in December 2006. With the existing DWS filtration plant at capacity, stricter Environmental Protection Agency (EPA) standards for surface water used for domestic consumption, and rapid growth within the North and South Kohala regions taxing water supplies, the county will likely develop more groundwater resources in the very near future to meet the growing demand. Groundwater is also more reliable during periods of drought.

Surface water from outside the Waiʻulaʻula watershed is transported into the watershed for use by farmers in the Lālāmilo Farm Lots. The Hawaiʻi Department of Agriculture's (DOA) Waimea Irrigation Water System provides irrigation water to farmers in both Puʻukapu and Lālāmilo (Figure 19). Puʻukapu farm lots are located on DHHL land east of Waimea town and south of Māmalohoa Highway. The Lālāmilo farm lots are situated west of Māmalohoa Highway south of Waimea town, within the Waiʻulaʻula watershed at the terminus of the Waimea Irrigation System. Surface water from windward Kohala streams is diverted into the Upper Hāmākua Ditch to the system's 60 MG Waimea and 100 MG Puʻu Pulehu reservoirs (DOA 2004). Puʻu Pulehu Reservoir water can be transferred to the Waimea Reservoir via a booster pump and connecting pipeline (DOA 2004). The system then distributes water from the Waimea Reservoir to 566 acres of farm land in Puʻukapu and Lālāmilo. According to the DOA website (www.Hawaiʻi.gov/hdoa/arm/arm_irrigation), the system currently transports 307.2 MG per year (0.842 mgd). During the 2006 earthquake, this 15-mile long system suffered considerable damage to the water intake structures, and conveyance ditches and tunnels.

Other diversions in the watershed are described in Section 2.1.6.

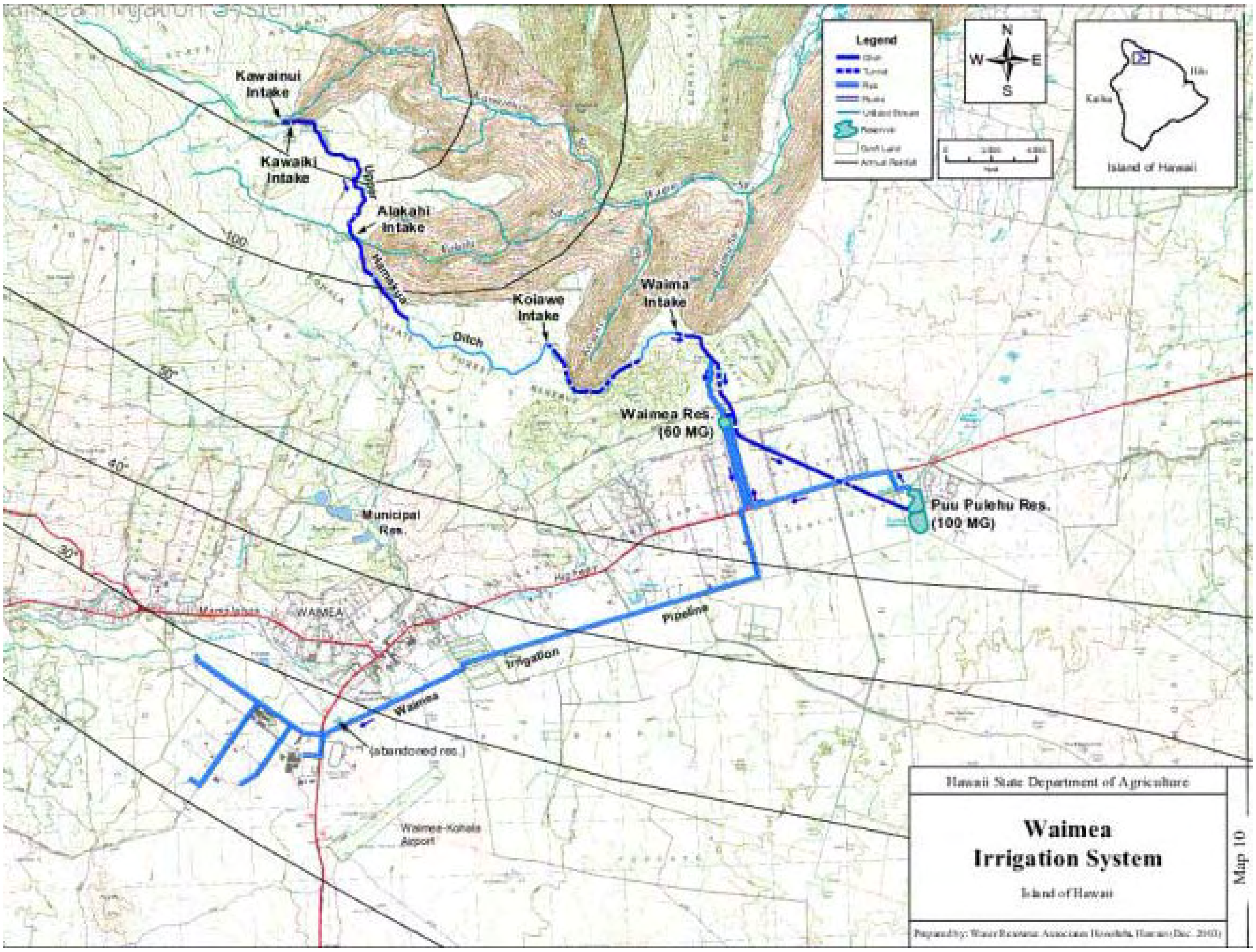

Figure 19: Waimea Irrigation System (taken from DOA 2003)

2.2.6 Flooding and Flood Control

Flooding has been a chronic problem in the Waimea area. Flooding of downtown Waimea and of roads crossing streams has been a particular concern. As Waimea has grown over the years, there are greater numbers of structures potentially in harm's way. In 2004, a 25-year storm event led to flooding of downtown Waimea when Waikoloa Stream jumped its banks, and to the closure of Waiʻaka bridge, Kawaihae Road, and Queen Kaahumanu Highway because of high water. In addition, the pipelines transmitting water from the water treatment plant to Waimea were badly damaged, leaving Waimea without potable water for several days.

While flooding has been a reality for decades in Waimea, it has become an even greater problem as more and more development occurs within or adjacent to flood prone areas. As more impervious surfaces are created through increased urban and suburban development, these hardened surfaces prevent infiltration and generate greater volumes of stormwater runoff.

2004 Waimea Flood

In 1973, the State proposed channelizing a 1,600-ft. length of Waikoloa Stream as a way to reduce the frequency of flooding in Waimea (DLNR 1973). At the time of the EIS preparation, flooding had occurred at least eight times during the previous 12 years (DLNR 1973). The EIS identified one area prone to flooding as the stream section above Lindsey Road, where flood waters flowed through Waimea Park and sections of the old Hawaiʻi Preparatory Academy (now St. James' Episcopal Church Circle). The State proposed building a concrete-lined channel beginning below the Lindsey Road bridge and ending downstream at a State of Hawaiʻi owned property (Waimea Nature Park), bypassing the meanders of the natural stream and following a straight alignment (Figure 20). The draft EIS stated that “the flood control channel will alleviate the flooding in the area for the 50 year flood event, and may be capable of a 100 year flood capacity” (DLNR 1973; p. 16). It is hoped that through the Waiʻulaʻula watershed management project and innovative stormwater management techniques, Waikoloa Stream will never have to be channelized.

In 1997, construction was completed on a grassed drainage channel on Parker Ranch land to divert Kamuela and Lanimaumau streams away from Waimea Town Center and toward open pasture land. While this flood control channel protects parts of Waimea from flooding, it falls outside the Waiʻulaʻula watershed.

Tom Nance Water Resource Engineering prepared a drainage analysis for the DHHL Lālāmilo Residential Project EIS “to establish the probable limits of flood inundation and provide greater accuracy for Keanuʻiʻomanō and Lanikepu Streams (than shown on the FEMA FIRM maps), and to provide an initial flood delineation for Waikoloa Stream” (Nance 2002). To prepare the drainage analysis, an aerial topographic survey with 2-ft. contour intervals was undertaken; the 100-year peak discharge rates for Waikoloa, Keanuʻiʻomanō, and Lanikepu streams were determined; and the areas subject to flooding by the 100-year storm peaks were computed and mapped.

The 100-year peak discharge rates used for the flood delineations on the FIRM panels for Hawaiʻi Island are based on regression equations developed in 1977. These have not been updated, despite the availability of more streamflow data. To check the validity of the

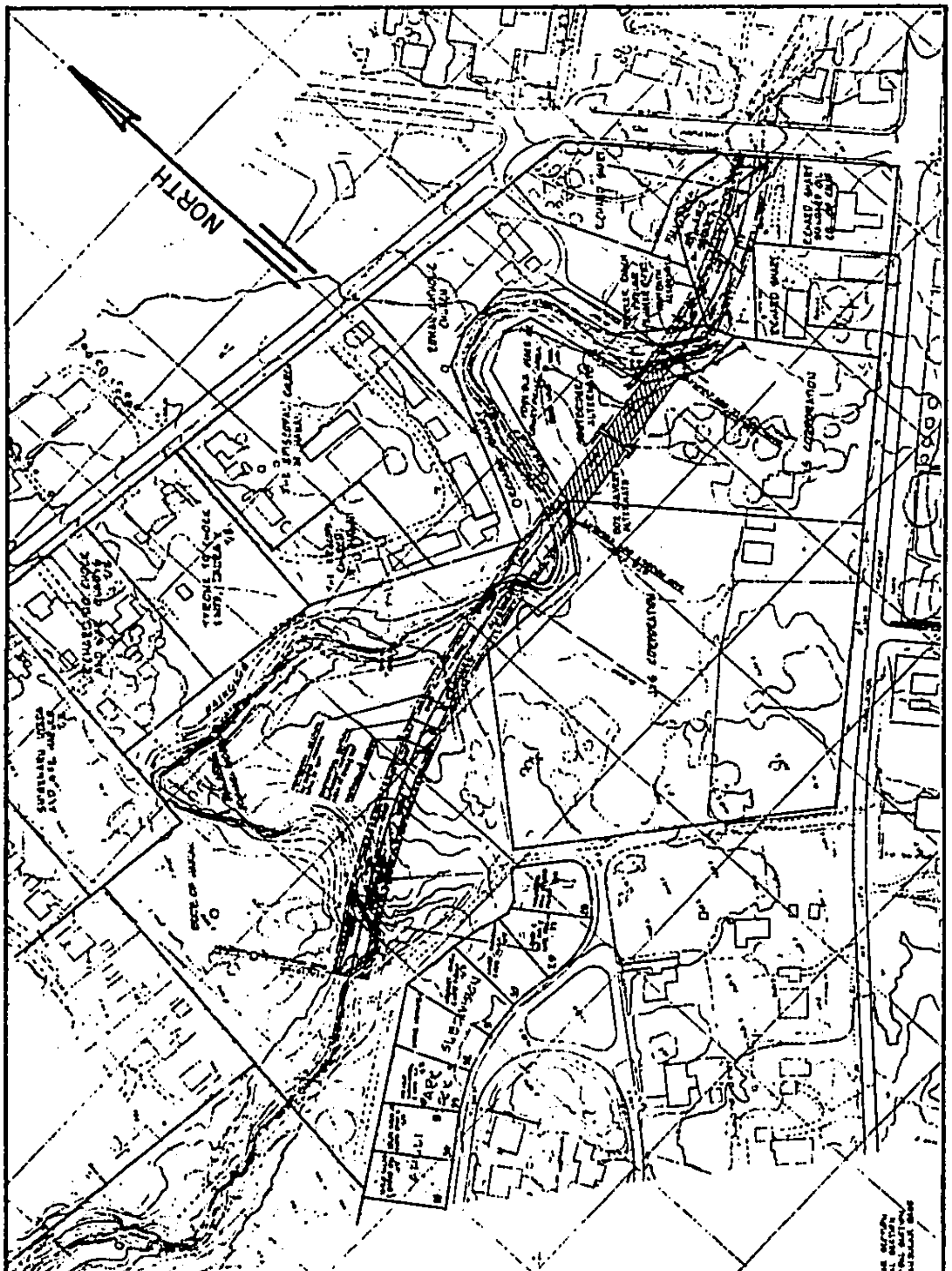

Figure 20: Proposed Pu'ukapu Flood Control Project (Figure 3 from DLNR 1973)

regression equation for leeward streams in light of the data now available, Nance (2002) compared data for four USGS gaging stations in the general vicinity of the project site. Table 1 is taken from DHHL (2002) and compares the 100-year flood peak based on a Log Pearson Type III analysis of the annual flood peaks with the 100-year flood peak computed with the 1977 regression equation.

Table 1: Comparison of Computed 100-Year Peak Discharge Rates (Table 11 in DHHL 2002)

	Keanuʻiʻomanō Stream	Luahine Gulch	Waikoloa Stream	Kohākōhau Stream
USGS Gage No.	7565	7558	7580	7560
Elevation of Gaging Station (Feet MSL)	2410	3160	3460	3273
Years of Record	31	33	53	37
Log Pearson Type III Analysis of Annual Flood Peaks:				
M (Log Units)	3.0092	1.9475	2.6779	3.0102
S (Log Units)	0.2936	0.2835	0.3457	0.3057
k_{100} (at skew = -0.05)	2.2895	2.2895	2.2895	2.2895
Q_{100} (CFS)	4801	395	2947	5130
Application of the 1977 Regression Equation:				
DA (Square Miles)	4.30	0.32	1.18	2.51
P_{24-2} (Inches)	6.00	4.40	6.20	6.20
Q_{100} (CFS)	6050	406	2407	4304

The analysis concluded the following:

> The regression equation provides a conservative (i.e., safe) estimate for the Keanuʻiʻomanō Stream gage. Since this gage is located immediately above the mauka end of DHHL's project site, the regression equation result can be used for this stream.
>
> The regression equation also provides a conservative estimate for Luahine Gulch. This gulch has the same orientation relative to rainfall patterns as Lanikepu Stream and both waterways are normally dry. For this reason, it appears reasonable to use the regression equation for Lanikepu Stream.
>
> The regression equation significantly underestimates peak runoff for the gaging station site on Waikoloa and Kohākōhau Streams. However, both these gaging stations are at high elevations in the watershed where the stream channels are relatively deeply dissected. The channel of Waikoloa Stream makai of Waimea Town has less topographic definition. This means that there would be a significant amount of overbank flow during the 100-year flood event, resulting in significant attenuation of the peak discharge rate. In other words, the regression equation is

considered to be a reasonable predictor of peak flowrates in the reach of Waikoloa Stream that passes along the south boundary of the project site.

Areas subject to inundation by a 100-year flood were determined for Waikoloa, Keanuʻiʻomanō, and Lanikepu Streams. For Lanikepu and Keanuʻiʻomanō Streams, the areas subject to inundation by the 100-year flood are considerably narrower than shown on FEMA Panel 155166 0164D. Waikoloa Stream's inundated area, with the single exception where the flow splits into two channels, is also relatively narrow. The drainage analysis determined that the capacities of the stream channels are generally sufficient to contain most of the flood waters." (DHHL 2002, pp. 4-10 to 4-13)

In 2004, NRCS developed an *Engineering Report for the Waimea Nature Park* (Ulu Laʻau) that describes alternatives for enhancing stream channel and bank stability, reducing flood-related damage to the Park and improving wildlife and aquatic habitat. It provides detailed hydrologic and hydraulic analyses of the stream reach. The hydraulic analysis determines the peak flood discharge rates at identified stream locations for various storm intensities, associated with recurrence intervals. The peak flood discharges for Waikoloa Stream through the Park were estimated using the existing FEMA analysis. Based on this information, NRCS (2004) estimated that the peak discharge for a 100-year storm at the Park would be 2,600 cfs. NRCS also conducted a hydraulic analysis to determine the characteristics of stream flow in the natural channel and with proposed modifications.

2.2.7 Stormwater Management

In Hawaiʻi County, all new urban developments (with very few exceptions) have been mandated to maintain pre-development runoff conditions (Chapter 27, HCC, "Floodplain Management"). Pre- and post- development runoffs are calculated using the County "Storm Drainage Standard." The minimum criteria used for runoff calculations are a 1-hour, 10-year storm event. This requirement inhibits conveyance of development runoff into natural drainage systems. It specifies that stormwater shall be disposed into drywells, infiltration basins or other approved infiltration methods. Chapter 23, HCC, "Subdivision" and Chapter 25, HCC, "Zoning" contain these same requirements.

Hawaiʻi County has historically relied on deep (+20 feet) 5-ft diameter drainage injection wells (or "dry wells") as the primary means of capturing and disposing of urban stormwater runoff from roads and parking lots because Hawaiʻi Island's geology allows for good lateral and downward percolation. The county allows a maximum disposal rate of 6 cfs of water per dry well (Kuba 2005). While Izuka *et al.* (2010) examined the potential effects of dry wells on county roads on the water quality of receiving waters at the coast and in drinking water wells, they did not consider effects to surface waters. Figure 21 identifies the location of many of Waimea's dry wells.

There is one large pipe discharging urban stormwater runoff directly into Waikoloa Stream. This concrete pipe is located behind the Waimea Community Education building on Māmalohoa Highway and discharges untreated runoff from storm drains along Māmalohoa Highway. PVC pipes discharge roof runoff from the KTA shopping center directly into Waikoloa stream. Within DHHL's Lālāmilo development, it appears that runoff from the subdivision's yards is being channeled down steep, rock lined slopes into Lanikepu and Keanuʻiʻomanō streams.

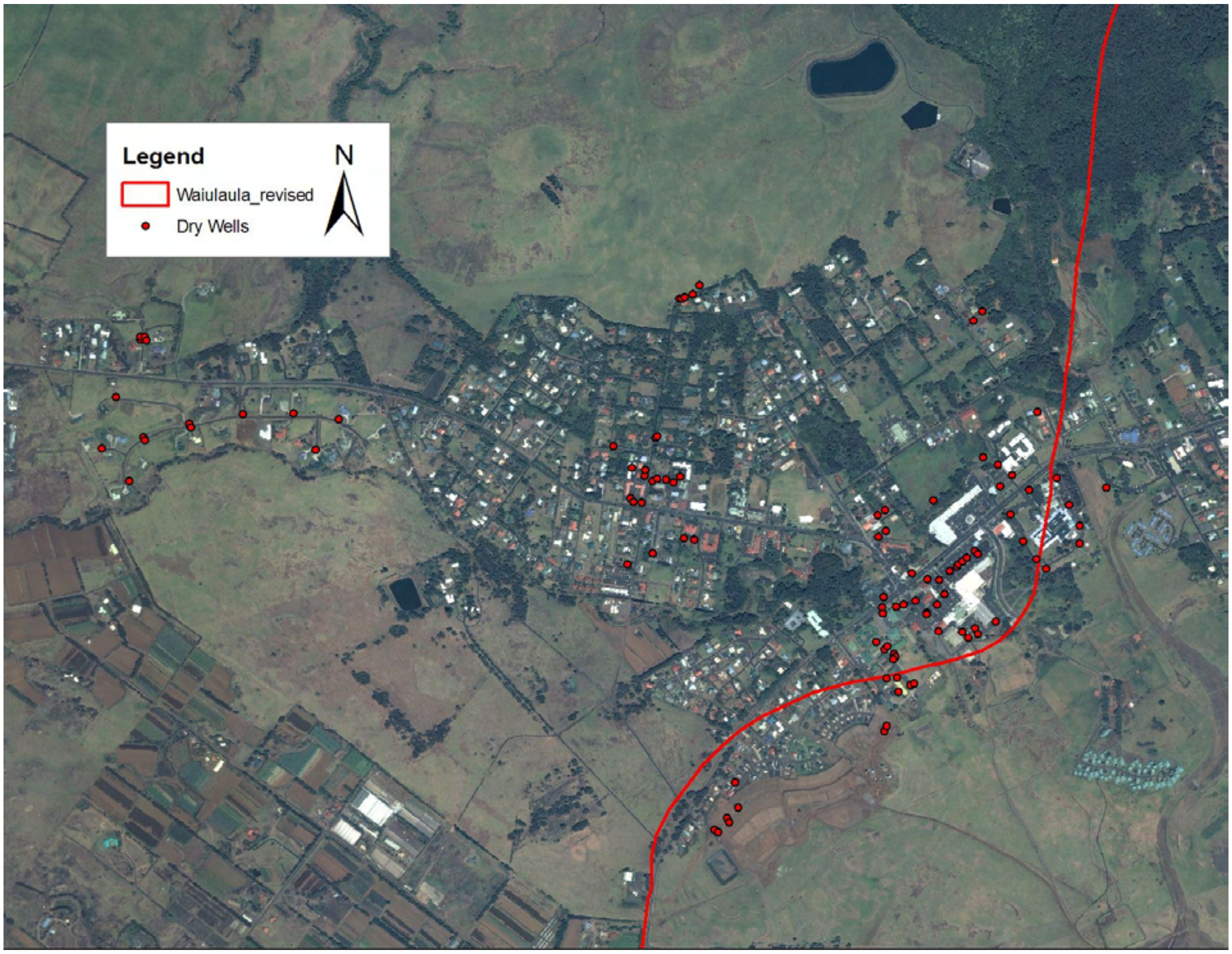

Figure 21: Dry Wells In and Around Waimea

2.2.8 Cultural Resources

The Waiʻulaʻula watershed is located in an area that has a very rich cultural history. Table 2.9 of the South Kohala Community Development Plan (Hawaiʻi County 2008) summarizes information on historical and cultural sites within the Waimea area, many of which are in the Waiʻulaʻula watershed.

Historical and Cultural Sites in Waimea: Native Hawaiian Sites (Hawai‘i County 2008)

No.	Site	Structure	Description	Wai‘ula‘ula watershed
1	Haleino "Women's Heiau"	Heiau	Historical accounts attribute the founding of the heiau to high chiefess Hoapiliahae. It is said that young virgins performed ceremonies at the heiau and learned about the science and practices of healing.	√
2	Heiau built by Makuakua	Heiau	The akua Makuakua observed a rainbow and found the goddess Wao. The two lived at Hōkū‘ula. Wao returned to the Waimea hillsides to bear children. Thus the hillsides were sacred. A kapu was proclaimed in her honor on the hillsides. The boundary of the kapu area was delineated by rolling stones down the hill. The place where the stones stopped delineated the boundary of the area.	√
3	Lālāmilo Field System		Identified in 1976 as a veritable treasure of 400+ acres of pastoral lands, house sites, hearths and stone enclosures. The field system was developed by Native Hawaiians prior to contact with western civilization.	√
4	Various agricultural, habitation, religious, and burial sites		Several of these sites are known to exist in the vicinity of various streams, pasture lands, and hillsides of Waimea. Although most have not been surveyed, they have been identified especially in areas that have not been altered by farming or urban development.	√

Historical and Cultural Sites in Waimea: Paniolo Sites (Hawai‘i County 2008)

No.	Site	Structure	Description	Wai‘ula‘ula watershed
5	Parker Ranch Race Track	Track built in 1901; Horse Barn (1915); Attendant House and Stallion Barn (1930)		
6	Additional Parker Ranch Structures	Mana Complex (1847); Spencer Home (1875); Manager's House (1885); Kahilu Hall (1918)		√
7	Parker Ranch Slaughter House		Stone wall enclosure that formed Minuke Ole pen. Built in the early 1940s.	√
8	Pukalani Complex	This complex of buildings consists of: Pu‘u Hihale Complex, Breaking Pen Stables, Carriage Barn (Surgery Barn), Black Smith Stable, Pukalani Stables	These buildings were essential to Parker Ranch's ranching operations. Possibility of incorporating this complex into a heritage community with a heritage center/museum. Built in the late 1800s.	
9	Breaking Pen		Coffee shack and stone wall enclosure. Built in 1905.	

No.	Site	Structure	Description	Wai'ula'ula watershed
10	Pu'u Hihale Complex	Viewing lanai (1900); Cowboy Gang Stables (1930, remodeled 1985); Bucking and Grooming Chute (1944)	Stone wall corral with walls 8' high by 6' wide. Cattle branding viewing lanai. Chute built for the Marine Rodeo. Referred to as the "Paniolo Heiau" and is considered the most significant Paniolo historic site in Waimea. Built in the late 1800s.	
11	Waimea Stables	Stone wall that pre-existed the stables by 50-100 years.	Converted to a working corral in 1985. Originally constructed in 1960.	
12	Kemole Corral		Rebuilt often. Originally built in 1930.	
13	Pu'u Kikoni Corral		Rebuilt often. Originally built in 1930.	
14	Pu'u Kikoni Dairy Site		Called New Dairy. Built in 1920.	
15	Anna Ranch		Anna Lindsey Perry-Fiske, the last of five generations of Lindseys to run the ranch, died at age 95 in 1995 and left the ranch as her legacy to the people of Waimea.	√
16	Pali Ho'oukapapa Dairy Site	Creamery (late 1800s); Corn Silo (1914); Corral (1920+)	Later became a working corral. Originally built in the late 1800s.	
17	Mana House Complex			
18	Makahalau Complex	Corn Crib and Silo (1914); Cowboy Camp House (1920); Makahalau Stables and Corral (1920); Purebred Bull Barns (1935)	Was once a village like Mana.	
19	Hanaipoe Line Cabin		Became the home for section chief Seichi Morifuji and was kept as a recreational cabin for ranch employees. Built in the 1930s.	
20	Waikii Complex	Corn Silos (1914); Cooking ovens (1915); Large Barn, Corn Crib and Cowboy Stable Barn (1920); Attendant Corral, Homes and Quonset Huts (various dates)	Ovens of both Russian and Portuguese origin.	

Historical and Cultural Sites in Waimea: Homes (Hawaiʻi County 2008)

No.	Site	Structure	Description	Waiʻulaʻula watershed
23	Frank Spencer House		Combined styles and the use of Koa wood. Home of Judge Bickerton and served as an early court house and hotel. Associated with several of Waimea's prominent families. Built in 1850.	√
24	Antony Smart House		Original location in Waiemi. Built during the 1830s.	√
25	Purdy House		Built by Harry W.W. Purdy who was one of Waimea's earliest foreign adventurers and a contemporary of John Palmer Parker. Built in 1840.	
26	Old Lindsey House			√
27	Hale Kea (Jacaranda Inn)		Home of A.W. Carter. The oldest part of Hale Kea was built around 1885 and was first used as an Episcopal Church.	v

Historical and Cultural Sites in Waimea: Stores (Hawaiʻi County 2008)

No.	Site	Structure	Description	Waiʻulaʻula watershed
28	Kamuela Liquor		Formerly this location was the Wakayama Theater, a gathering place for early Japanese settlers in Waimea.	
29	Chock In		One of the last surviving stores that was built near the turn of the century. Built in 1908.	√

2.2.9 Relevant Authorities/Policies

There are numerous authorities at the county, state and federal levels that affect the management of natural resources and regulate potential sources of polluted runoff (Stewart 2009). Those relevant to land and water use activities within the Waiʻulaʻula watershed are summarized below.

2.2.9.1 Agricultural Lands

The local Mauna Kea Soil and Water Conservation District (MKSWCD) is a major player in the management of agricultural lands because it develops and approves conservation plans which allow agricultural operations to receive an exemption from the county grading ordinances (Chapter 180, HRS). Without an approved conservation plan, agricultural operators are required under Chapter 10, HCC, to get a permit from the Hawaiʻi County Department of Public Works (DPW) for any earthwork.

Significant amounts of land in agriculture are State lands leased to agricultural operators. The Department of Land and Natural Resources (DLNR) Land Division is responsible for leasing these lands under Chapter 171, HRS. One of the lease conditions is that the operator works with the local soil and water conservation district to develop and implement a conservation plan. Pursuant to Act 90, SLH 2003, beginning on January 1, 2010, the authority to manage, administer, and exercise control over any public lands that are designated important agricultural lands pursuant to Section 205-44.5, HRS, will be transferred from DLNR to the State Department of Agriculture (DOA) (Section 171-3(b), HRS).

U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) usually helps in developing conservation plans to treat existing and potential resource problems and has funding available to assist with the installation of best management practices. NRCS primarily develops plans for operators seeking funding under Federal Farm Bill programs. NRCS's *Hawaiʻi Field Office Technical Guide* (eFOTG) outlines conservation practice standards and specifications.

Chapter 11-21, HAR, "Cross-Connection and Back-Flow Control," administered by DOH, requires that a reduced pressure principal back-flow preventer or air gap separation be installed as part of any piping network in which fertilizers, pesticides and other chemicals or toxic contaminants are injected or siphoned into the irrigation system (§11-21-7(a)(4), HAR).

2.2.9.2 Pesticides

Under the authority of Chapter 149A, HRS, DOA, Pesticides Branch, is the lead agency for implementing those measures that relate to regulating pesticides. Chapter 4-66, HAR, administered by DOA, relates to the registration, licensing, certification, record-keeping, usage, and other activities related to the safe and effective use of pesticides. It requires that those who apply or directly supervise others who apply restricted use pesticides be certified. Certification requires some understanding of the environmental concerns of using pesticides. This requirement is implemented under the CES/DOA Pesticide Applicator Program. Certification is not required for those using pesticides that are not classified as "restricted use."

2.2.9.3 Wastewater Disposal

Chapter 11-62, HAR, administered by DOH, outlines the requirements for locating, building and operating wastewater treatment systems and individual wastewater systems. Section 11-62-03, HAR, defines an "individual wastewater system" as "a facility which is used and designed to receive and dispose of no more than 1,000 gallons per day of domestic wastewater" and "treatment works" as "any treatment unit and its associated collection system and disposal system, excluding individual wastewater systems." The chapter provides specific requirements for both types of wastewater systems. An engineer must evaluate the site for suitability for an on-site disposal system (OSDS), including depth of permeable soil over seasonal high groundwater, bedrock, or other limiting layer, soil factors, land slope, flooding hazard, and amount of suitable area available. No OSDS can be located within 50 feet of a stream, the ocean at the vegetation line, pond, lake, or other surface water body; or within 1,000 feet of a potable water source serving public water systems. Chapter 11-62, HAR, also requires that no wastewater system (including OSDSs) be operated in such a way that it creates or contributes to: wastewater spill, overflow, or discharge onto the ground or surface waters; or contamination, pollution or endangerment of drinking water.

Chapter 11-62, HAR, also provides for the establishment of Critical Wastewater Disposal Areas (CWDAs), where the disposal of wastewater has or may cause adverse effects on human health or the environment due to existing hydrogeological conditions. CWDAs are established based on one or more of the following concerns: high water table; impermeable soil or rock formation; steep terrain; flood zone; protection of coastal waters and inland surface waters; high rate of cesspool failures; and protection of groundwater resources. CWDAs were designated for each county in 1990 and updated in 1997 (see Figure 22). Within CWDAs, DOH may impose more stringent requirements for wastewater systems, and cesspools are severely restricted or prohibited.

Chapter 11-23, HAR, also administered by DOH, establishes a state underground injection control (UIC) program in order to protect the quality of the State's underground sources of drinking water from pollution by subsurface disposal of fluids. It classifies exempted aquifers and underground sources of drinking water. Unless expressly exempted, all aquifers are considered underground sources of drinking water. UIC maps indicate the boundary line of exempted aquifers. While individual wastewater systems serving single family residential households are excluded from the chapter, no large municipal or community serving systems can use injection wells above the UIC line. Certain activities are also prohibited interior of the line.

The U.S. Environmental Protection Agency (EPA) promulgated Underground Injection Control (UIC) regulations on December 7, 1999, which prohibit the construction of new large capacity cesspools nationwide, effective April 5, 2000. A large capacity cesspool (LCC) is a cesspool serving multiple (two or more) dwellings, a community or regional development, or any non-single family residential building/business that generates sanitary wastes, containing human excreta from 20 or more persons per day. Existing LCCs were required to be replaced by an alternative wastewater system and closed by April 5, 2005.

Efforts to ban the use of new cesspools statewide have been made through revision to Chapter 11-62, HAR. The rule either bans or severely restricts the use of cesspools throughout the state. New cesspools are completely banned on the islands of Oahu and Kauai. On the islands of Maui, Molokai, and Hawaiʻi, new cesspools for individual homes only are allowed in certain areas. These areas are designated in Critical Wastewater Disposal Area (CWDA) maps. The CWDA maps also delineate areas where cesspools are completely banned. In the Waiʻulaʻula watershed, the coastal area and specific areas of Waimea are designated CWDA with no exceptions, meaning that cesspools are not allowed. While there is one small band in the lower watershed delineated as non-CWDA, the majority of the watershed is designated CWDA with 5-acre exception, in which cesspools are allowed for individual houses on parcels greater than 5 acres. The maps are based upon development density, groundwater development, potential contamination of coastal waters, and the use of OSDS.

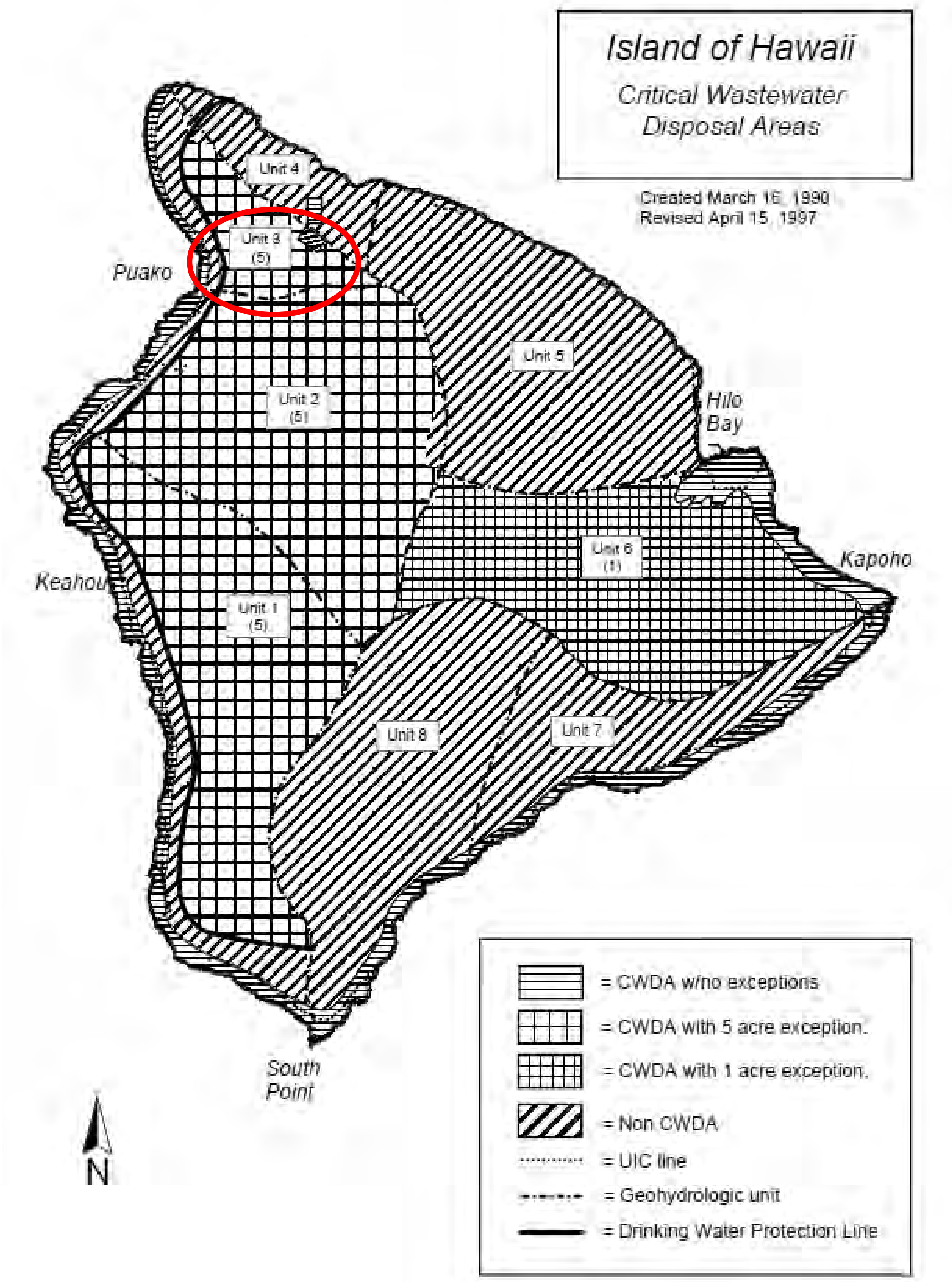

Figure 22: Critical Wastewater Disposal Areas for Hawaiʻi Island

Although the current rule still allows some new cesspools in limited areas, there are a number of items that either prohibit new cesspools or require that existing cesspools be upgraded. They include:

- Not allowing a new dwelling to be connected to an existing cesspool serving an existing dwelling;
- Requiring an existing cesspool system to meet current wastewater rules if there is a change in building usage or characteristics of the wastewater. For example, an existing cesspool must be upgraded if a non-dwelling using a cesspool is converted to a dwelling or a commercial building (*e.g.*, office space) is converted to a food establishment;
- Current rules do not allow two new dwellings (including *ʻohana* units) to be served by a cesspool; such a cesspool would be considered a large capacity cesspool (LCC), which is banned; and
- Current rules do not allow non-dwellings generating non-domestic-like wastewater to discharge wastewater into a new cesspool.

The South Kohala Community Development Plan (Hawaiʻi County 2008) includes as a District-wide sub-policy "ensure the quality of South Kohala's groundwater resources and marine resources." It goes on to recommend: "County should consider adding the following requirement to HCC 23-85(b) for residential projects: No cesspools or seepage pits shall be installed in South Kohala after the effective date of this plan. The effluent from any septic tank installed in South Kohala after the effective date of this plan shall be discharged into an absorption system that meets the design standards of the State Department of Health" (p. 51).

Chapter 17-47, HCC, administered by the County of Hawaiʻi DPW, modifies the Uniform Plumbing Code to require the use of low flow plumbing fixtures. Chapter 27, HCC, states that on-site cesspools and septic systems shall be located to avoid impairment to them or contamination from them during flooding.

2.2.9.4 Use of Recycled Wastewater

Chapter 11-62, HAR, administered by DOH, allows for the use of recycled water for irrigation with written approval by the director, provided the owner of the recycled water system submits an engineering report for approval which clearly identifies all BMPs to be implemented, an irrigation use plan, overflow control plan, management plan, public information and access plan, labeling plan, employee training plan, vector control plan, and groundwater monitoring plan. For golf courses, the director is guided by DOH's *Guidelines for the Treatment and Use of Recycled Water* (May 2002). R-2 and R-1 waters may be used for golf course irrigation.

2.2.9.5 Rubbish and Pet Waste

Chapter 342H, HRS, "Solid Waste Management," administered by DOH, prohibits disposal of solid waste anywhere other than a permitted solid waste management system. It encourages the recycling of solid wastes, including animal wastes and selected non-hazardous industrial wastes, and the composting of animal manures and by-products for agricultural and horticultural purposes. It also encourages the use of treated sludge effluent for fertilizer and other agricultural purposes.

Chapter 20, HCC, administered by the Hawaiʻi County DPW, prohibits littering on any highway, street, road, alley, sidewalk, beach, public park, or other public place in the county. Litter is broadly defined to include, among other things, dirt, paper, wrappings, cigarettes, yard clippings, leaves, wood, scrap metal, and any other waste materials.

The county also administers the ordinance addressing pet waste. Chapter 4, HCC, prohibits pet owners from allowing their pets to defecate on public streets, including sidewalks, passageways, or bypasses, or on any play areas, parks, or places where people congregate or walk, or on any public property, or on any private property without the permission of the owner of the property, unless the pet owner immediately picks up and properly disposes of the feces.

2.2.9.6 Hazardous Materials Disposal and Storage

Chapter 342I, HRS, "Special Waste Recycling," administered by DOH, prohibits disposal of used lead acid battery, except by delivery to a lead acid battery retailer or wholesaler, a collection or recycling facility, or a secondary lead smelter, and specifically prohibits disposal of electrolyte from any used lead acid battery onto the ground or into sewers, drainage systems, surface or ground waters, or ocean waters.

Chapter 342J, HRS, "Hazardous Waste," also administered by DOH, prohibits discharge of new, used or recycled oil into sewers, drainage systems, surface or ground waters, watercourse, marine waters, or onto the ground. The prohibition does not apply to inadvertent, normal discharges from vehicles and equipment, or maintenance and repair activities, provided that appropriate measures are taken to minimize releases.

Chapter 11-281, HAR, administered by DOH, regulates underground storage tanks (UST). Each UST must be properly designed, constructed, and installed, and any portion underground that routinely contains product must be protected from corrosion. UST are used to store petroleum products at gas stations in the watershed, two of which are located adjacent to Waikoloa Stream.

2.2.9.7 Urban Development

In urban areas, the county has the lead in the control of erosion during site development and ensuring proper site planning and stormwater management to protect sensitive natural features, through its ordinances and rules related to zoning, subdivisions, drainage, and erosion and sediment control.

Chapter 10, HCC, "Soil Erosion and Sediment Control," administered by the Hawaiʻi County Department of Public Works (DPW), requires a permit for grading and grubbing of land, and stockpiling of material in excess of 500 cubic yards. All grading, grubbing, and stockpiling permits and operations must conform to erosion and sedimentation control standards and guidelines. Hawaiʻi County is currently in the process of revising this ordinance.

In Hawaiʻi County, all urban developments (with very few exceptions) have been mandated to maintain pre-development runoff conditions (Chapter 27, HCC, "Floodplain Management"). Pre- and post- development runoffs are calculated using the County "Storm Drainage Standard." The minimum criteria used for runoff calculations are a 1-hour, 10-year storm event. This requirement inhibits conveyance of development runoff into natural drainage systems. It specifies that stormwater shall be disposed into drywells, infiltration basins or other approved infiltration methods. Chapter 23, HCC, "Subdivision," and Chapter 25, HCC, "Zoning," contain these same requirements.

In Hawaiʻi County, Chapter 25, HCC, "Zoning," provides for Cluster Plan Development, in which exceptions are made to the density requirements of the single-family residential (RS) district on lands greater than two acres so that permitted density of dwelling units contemplated by the minimum building site requirements is maintained on an overall basis, and desirable open space, tree cover, recreational areas, and scenic vistas are preserved. It also provides for Project Districts, which are intended to provide for a flexible and creative planning approach rather than specific land use designations for quality developments on lands greater than 50 acres, establishing a continuity in land uses and designs while providing for a comprehensive network of infrastructural facilities and systems.

If development activity will disturb one acre or more of total land area, then a National Pollutant Discharge Elimination System (NPDES) permit is required from the Hawaiʻi Department of Health (DOH). This permit process is described in Chapter 11-55, HAR, "Water Pollution Control" (http://gen.doh.Hawaiʻi.gov/sites/har/AdmRules1/11-55.pdf). A County grading permit is required for any grading and grubbing work before a NPDES permit can be issued. The grading permit allows the grading, while the NPDES permit regulates stormwater runoff from the construction site.

Typically, large development proposals must undergo numerous permit processes, with their associated environmental assessments and extensive public review. Development in the Conservation District triggers a Conservation District Use Permit (CDUP) from DLNR; development within the county's Special Management Area (SMA) requires an SMA permit from the County planning department. Chapter 343, HRS, and Chapter 11-200, HAR, both about Environmental Impact Statements, require the preparation of an environmental assessment (EA) and/or environmental impact statement (EIS) for proposed activities that trigger the environmental review process. Some of the trigger conditions include: (1) use of State or county lands or funds; (2) use within the conservation district; (3) use within a shoreline setback area; (4) use within an historic site; (5) reclassification of conservation lands; and (6) certain amendments to a county general plan.

The county administers the Special Management Area (SMA) permit process. SMAs are a subset of the State's coastal zone and include all lands and waters beginning at the shoreline and extending inland or *mauka* at least 100 yards. The SMA permit process, administered by the Hawaiʻi County Planning Department, ensures that developments in these more-sensitive coastal areas are consistent with Hawaiʻi's coastal zone management (CZM) program objectives and policies. Although each county has its own procedures for administering SMA permits, the requirements and review processes for SMA applications are based on Chapter 205A-26, HRS ("Special management area guidelines"). The county requires a permit applicant to describe the proposed development in terms of the CZM objectives and policies.

2.2.9.8 Roads, Highways and Bridges

In Hawaiʻi, roads, highways and bridges are usually developed by the State or county government, with State, county and/or Federal funds, or by private entities as part of a subdivision or other large development. Privately-constructed roads and highways usually must meet standards set by the State and/or county because they are transferred over to the State or county as public roadways upon completion of construction. Privately-constructed roads that remain private must still comply with county requirements for erosion and sediment control, stormwater management, drainage, zoning and subdivisions. A 1999 State Attorney General's opinion clarified that all public highways are County highways unless declared by Chapter 264, HRS, to be under State jurisdiction.

Construction of public roads, highways and bridges will normally trigger the Chapter 343, HRS, process because of the use of State or county funds and/or lands. In determining whether an action may have a significant effect on the environment, the approving State or county agency must consider every phase of a proposed action, the expected consequences, both primary and secondary, and the cumulative as well as the short-term and long-term effects of the action. In most instances, an action will be determined to have a significant effect on the environment if it detrimentally affects water quality or affects an environmentally sensitive area such as a flood plain, beach, erosion-prone area, estuary, fresh water, or coastal waters. Mitigation measures must be identified to address these detrimental effects.

Hawaiʻi Department of Transportation (DOT) has jurisdiction over State roadways. According to Section 264-8, HRS, specifications, standards and procedures prescribed by DOT are to be followed in the installation and construction of connections for streets, roads and driveways, concrete curbs and sidewalks, structures, drainage systems, landscaping or grading within the highway rights-of-way, excavation and backfilling of trenches or other openings in state highways, and in the restoration, replacement, or repair of the base course, pavement surfaces, highway structures, and other highway improvements.

DOT Standard Specifications are used for highway design and construction for Hawaiʻi's transportation infrastructure. The current specifications in use are dated 1994, though many sections (technical provisions) have been revised since then. The updated 2005 *Standard Specifications for Road and Bridge Construction* requires written, site-specific BMPs describing activities to minimize water pollution and soil erosion into State waters, drainage or sewer systems, and a plan indicating location of the BMPs, areas of soil disturbance, areas where vegetative practices are to be implemented, and drainage patterns. DOT's *Storm Water Permanent Best Management Practices (BMP) Manual* (February 2007) applies to projects statewide within the DOT right-of-way.

Chapter 23, HCC, provides requirements for street design in subdivisions in Hawaiʻi County. It requires the location, width, and grade of a street to conform to the County general plan and to be considered in its relation to existing and planned streets, to topographical conditions, to public convenience and safety, and to the proposed use of land to be served by the street. When an existing street adjacent to or within a tract is not of the width required by this chapter, additional rights-of-way shall be provided at the time of subdivision. Preliminary and final plats must show the location of lots, streets, water mains, and storm drainage systems, and are subject to technical review by the county director of public works, State DOH, and district engineer for DOT when the subdivision involves State highways. The ordinance also provides requirements for dedicable streets and standards for non-dedicable streets. Subdivisions, including roads, must maintain pre-development runoff conditions. Pre- and post- development runoffs are calculated using the County "Storm Drainage Standard." The minimum criteria used for runoff calculations are a 1-hour, 10-year storm event. This requirement inhibits conveyance of development runoff into natural drainage systems. Chapter 22, HCC, "County Streets," defines and regulates construction within a county street. It states that no driveway approach shall interfere with the proper runoff of waters into or passage of waters through existing drainage culverts, swales, ditches, watercourses, defiles, or depressions.

Chapter 19-127.1, HAR, administered by DOT, addresses the design, construction and maintenance of public streets and highways. It applies to all persons and agencies who design, construct, and maintain facilities which are, or are intended to become, public streets and highways in the State. The chapter establishes design, construction and maintenance guidelines that should be followed in the construction, reconstruction, and maintenance of all highways, streets, or roads undertaken either by State or county authorities or by individuals intending to dedicate the facilities to governmental authorities.

2.2.9.9 Hydromodifications

The State Water Code (Chapter 174C, HRS), adopted by the Hawaiʻi Legislature in 1987 and amended in 2004, provides the regulatory framework to protect streams, wetlands and other areas critical to water quality. The State, in its stewardship capacity, has management responsibility for all water resources of the State through the Commission on Water Resource Management (CWRM) – also known as the Water Commission. The Water Commission sets policies and approves water allocations for all water users.

CWRM issues permits to regulate the use of surface and ground water in the State. Existing uses established prior to 1987 are grandfathered in, provided the existing use is reasonable and beneficial. A stream channel alteration permit (SCAP) is required prior to undertaking a stream channel alteration in order to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses. Routine streambed and drainageway maintenance activities are exempted from obtaining a permit.

The Water Code also requires CWRM to establish and administer a statewide in-stream use protection program, including flow standards on a stream-by-stream basis whenever necessary to protect the public interest. Instream flow standards describe the flow necessary to adequately protect fishery, wildlife, aesthetic, scenic, or other beneficial instream uses. Instream uses include: maintenance of fish and wildlife habitats, outdoor recreational activities, maintenance of ecosystems such as estuaries, wetlands, and stream vegetation, aesthetic values such as waterfalls and scenic waterways, navigation, instream hydropower generation, maintenance of water quality, conveyance of irrigation and domestic water supplies to downstream points of diversion, and the protection of traditional and customary Hawaiian rights.

The State is in the process of establishing instream flow standards for perennial streams, in order to balance maintenance of fish and wildlife habitat, estuarine, wetland and stream ecosystems, and water quality with use of the water (CWRM 2005). Section 13-169-46,HAR, adopted in 1988, establishes interim instream flow standards (IFS) for Hawaiʻi. These were generally defined as the amount of water flowing in each stream on the effective date of the standard. The standards for some individual streams have subsequently been amended as a result of petitions to amend the IFS and describe the amount of water that can be withdrawn from the stream. Specific instream flow standards have not been established for any streams within the Waiʻulaʻula watershed.

Under Chapter 46-11.5, HRS, the counties are responsible for the maintenance of channels, streambeds, streambanks, and drainageways, whether natural or artificial, including their exits into the ocean, in suitable condition to carry off stormwaters. For lands comprising the channels, streams, streambanks, and drainageways that are privately owned or owned by the State, the respective owner is responsible for maintenance.

The U.S. Army Corps of Engineers (USACOE) has the authority to protect the waters of the United States, including wetlands and some streams, by regulating certain activities within those waters. Section 404 of the Clean Water Act requires that anyone interested in placing dredged or fill material into waters of the United States must first obtain a permit from the Corps. Section 10 of the Rivers and Harbors Act of 1899 requires approval prior to the accomplishment of any work in or over navigable waters of the United States, or which affects the course, location, condition, or capacity of such waters. The law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of a navigable water of the United States, and applies to all structures large or small. The initiation of a Section 404 permit process triggers a Section 401 water quality certification from DOH.

Chapter 13-190, HAR, "Dams and Reservoirs", is administered by DLNR. These rules govern the design, construction, operation, maintenance, enlargement, alteration, repair and removal of dams in the State. Written approval from DLNR of the construction plans is required for any construction, enlargement, repair or alteration project. Owners are required to provide for adequate and timely maintenance, operation, and inspection of their dams and reservoirs to insure public safety. DLNR is required to inspect all dams and reservoirs at least every five years.

2.2.9.10 Water Quality Protection

Chapter 342D, HRS, "Water Pollution," prohibits discharge of any pollutant into State waters. It allows DOH to institute a civil action for injunctive relief to prevent violation of State water quality standards. Under the statute, DOH may also request the court to order nonpoint source polluters to implement required management measures.

DOH establishes and enforces the State water quality standards contained in Chapter 11-54, HAR. All inland fresh waters are classified based on their ecological characteristics and other natural criteria as flowing waters (*e.g.*, streams), standing waters (*e.g.*, lakes and reservoirs), and wetlands. These waters are further classified for the purposes of applying water quality standards and selecting appropriate quality parameters and uses to be protected in these waters.

Three stream classifications can be found in the Waiʻulaʻula watershed. Streams within the Puʻu o ʻUmi Natural Area Reserve are Class 1(a). Streams within the Conservation District but outside of Puʻu o ʻUmi NAR are Class 1(b). All other areas of the watershed are Class 2. Note that a single stream can have different classifications in different reaches.

Class 1 inland waters are to remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. Waste discharge into these waters is prohibited. The uses to be protected in class 1(a) waters are scientific and educational purposes, protection of native breeding stock, baseline references from which human-caused changes can be measured, compatible recreation, aesthetic enjoyment, and other non-degrading uses. The additional uses to be protected in class 1(b) waters are domestic water supplies and food processing. Class 2 inland waters are to be protected for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping and navigation. Class 2 waters shall not act as receiving waters for any discharge that has not received the best degree of treatment or control.

Hawaiʻi also has water quality standards for marine waters. The receiving marine waters immediately offshore of the Waiʻulaʻula watershed are classified as AA (south of Waiʻulaʻula Point) and A (north of Waiʻulaʻula Point). The outlet of Waiʻulaʻula Stream is immediately south of Waiʻulaʻula Point, so the receiving waters at the stream outlet are classified class AA. The objective of "class AA, marine waters" is that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practical, the wilderness character of class AA waters shall be protected. The objective of "class A, marine waters" is that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters. These waters shall not act as receiving waters for any discharge which has not received the best degree of treatment or control compatible with the criteria established for this class.

2.2.9.11 Hunting in the Conservation District

Bird and mammal hunting is permitted by persons with valid Hawaiʻi hunting licenses under Chapter 183D, HRS, in designated public hunting areas following guidelines set forth in Chapter 122, HAR, Exhibits 1 and 2, and Chapter 123, HAR, Exhibits 11 and 12. Public hunting areas within the Waiʻulaʻula watershed include Units K (Puʻu o ʻUmi Natural Area Reserve) and D (Kohala Watershed Forest Reserve). Hunting for wild pigs, wild sheep and wild goats in Unit K is permitted year-round on a daily basis, while hunting in Unit D is limited to weekends and State holidays. Bird hunting is permitted on public lands during designated hunting seasons.

2.2.9.12 Conservation Lands and Nearshore Waters

DLNR manages and regulates all lands set apart as forest reserves under Chapter 13-104, HAR. Under Chapter 13-209, HAR, it is also responsible for the management of the State's Natural Area Reserve System (NARS) to ensure preservation of specific land and water areas which support communities of natural flora and fauna. Chapter 195, HRS, establishes a Natural Area Partnership program to provide state funds to help match private funds for the management of private lands that are dedicated to conservation. Chapter 173A, HRS, enables the State to acquire lands of exceptional value due to the presence of habitats for threatened or endangered species of flora, fauna, or aquatic resources. Chapter 195D, HRS, authorizes DLNR to acquire habitat for endangered species restoration. Chapter 198, HRS, authorizes DLNR to acquire conservation easements to preserve natural lands and waters.

Chapter 205A, HRS, defines the shoreline as "the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of the vegetation growth, or the upper limit of debris left by the wash of the waves." The area seaward or *makai* of the shoreline is part of the Conservation District and is under State jurisdiction. The coastal area landward or *mauka* of the shoreline is managed by the counties as part of the Shoreline Management Area (SMA) established under Chapter 205A, HRS and described above.

DLNR manages the area seaward of the shoreline. Pursuant to Chapter 183, HRS, DLNR is responsible for establishing the procedures and certifying where the shoreline is located, and for promulgating and administering the Conservation District use regulations. All activities proposed within the Conservation District, whether *mauka* or *makai*, require a CDUP, for which there is an application and review process. The Board of Land and Natural Resources can approve, deny, or approve with conditions proposed uses of the Conservation District.

2.2.9.13 Boat Operation

Rules regulating the operation of vessels in ocean waters and navigable streams, administered by DLNR's Division of Boating and Ocean Recreation (DOBOR) restrict vessel speeds in Ocean Recreation Management Areas, along shorelines, and near other vessels, docks, and swimmers/divers. Chapter 13-244, HAR, specifically states that "no person shall operate a vessel at a rate of speed greater than is reasonable having regard to conditions and circumstances."

Chapter 13-232, HAR, "Sanitation and Fire Safety," administered by DOBOR, prohibits dumping, discharging, or pumping of oil, spirits, gasoline, distillate, any petroleum product, or any other flammable material into the waters of a small boat harbor or designated offshore mooring area.

Chapter 13-235, HAR, "Offshore Mooring Rules and Areas," states that no person shall anchor, moor or stay aboard a vessel except those equipped with an approved marine sanitation device (MSD) in proper working condition, or those vessels exempt from MSD requirements in accordance with USCG regulations.

2.2.10 Future Land Use Considerations

The Hawaiʻi County's General Plan Land Use Pattern Allocation Guide (LUPAG) maps include significant urban expansion areas on both the coast and in Waimea town (see Figure 16). Proposed urban expansion areas allow for a mix of high density, medium density, low density, industrial, industrial-commercial and/or open designation in areas where new settlements may be desirable, but where the specific settlement pattern and mix of uses have not yet been determined. In the South Kohala District, this includes 12,264 acres or 42% of the designated urban expansion area for the entire island. Of this, there are several hundred acres of urban expansion land on the south side of Kawaihae Road just west of Waimea Town along Waikoloa Stream. There are also several hundred acres of rural land shown along the south side of Kawaihae Road, which would encourage low density residential development there.

Parker Ranch also has considerable development slated as part of its Parker Ranch 2020 Plan (see Figure 18). The plan calls for 750 new homes. It proposes to rezone 37.66 acres to multiple-family residential. In addition, commercial lands within Waimea Town were increased by about 104 acres in 1992 as part of the implementation of the Parker 2020 Master Plan. Lualaʻi at Parker Ranch, for which Phase 1 was completed in 2002, will eventually have 322 residential units, parks and open space on 75 acres.

DHHL's Lālāmilo Residential project proposes 442 houses on 160 acres adjacent to both Waikoloa and Keanuʻiʻomanō streams (Figure 23). The development will also include a community center, parks, general agriculture, preservation area (19.1 acres), and open space areas (44.5 acres). Phase 1, currently under development, includes 34 in-fill house lots. The remaining planned house lots will be built in subsequent phases.

Mauna Kea Resort is tentatively planning to develop a golf course and 135 large acreage residential lots with associated infrastructure and commercial use on its ʻŌuli 2 property near the bottom of the watershed. Waimea Parkside is a 40-lot subdivision on 9.18 acres in Waimea town across Lindsey Road from the park. This development is currently under construction.

Finally, the South Kohala Community Development Plan recommends expanding the Lālāmilo Farm lots by over 100 acres and constructing several connector roads around Waimea.

All these projects could have implications for polluted runoff in the watershed. The proliferation of impervious surfaces and the greater number of people living in close proximity to the watershed's streams will likely increase the generation of urban pollutants. With much of this additional growth occurring adjacent to the streams, there is a greater likelihood of the urban pollutants reaching the surface waters.

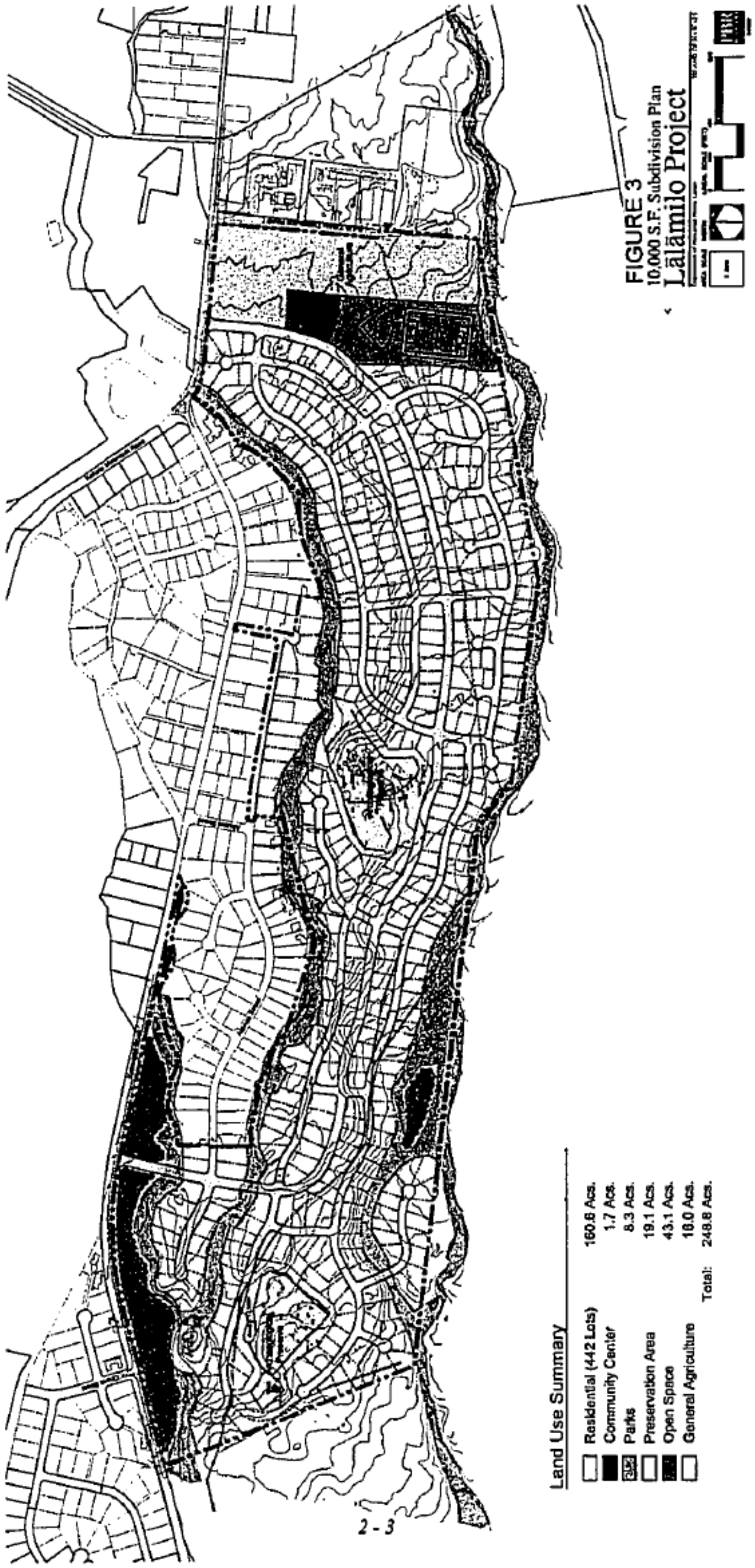

Figure 23: DHHL Lālāmilo Residential Project