South Kohala
Stream Corridor Assessment
Erosion Monitoring, and Recommendations

Final Report
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Acronyms

cu-ft	Cubic Feet
ft	Feet
HAR	Hawaiʻi Administrative Rules
IWS	Individual Waste Systems
MIT	Massachusetts Institute of Technology
msl	Mean Sea Level
OSDS	Onsite Disposal Systems
SCA	Stream Corridor Assessment
USGS	US Geological Survey

1 INTRODUCTION

South Kohala is a Hawaiʻi Coral Reef Strategy priority watershed, targeted for implementation of specific ridge-to-reef management activities. Off-shore waters (Waiʻulaʻula marine segment) are listed as impaired on the latest Hawaii State Clean Water Act 303(d) listing of impaired waters for several pollutants.[1] Sediment loads attributed to accelerated[2] rates of erosion sourced to upland areas and stream banks have been identified as a stressor to nearshore waters. Information in the *Pelekane Bay Watershed Management Plan* and the *Waiʻulaʻula Watershed Management Plan* provided a starting point for this project.

An inventory and assessment was conducted in Waiʻulaʻula Watershed to document the location, extent, and cause of relative sediment, nutrient, and toxicant-load contributions from erosion along the various channels of the stream and gulches, and to a limited extent adjacent lands. A key element of the assessment was observation of land uses and conditions, such as ground cover, which when coupled with professional judgment, was used to identify sediment sources and make inferences with respect to nutrient and toxicant sources. This Stream Corridor Assessment (SCA) provides geo-located, site-specific information on problem areas and solutions to reduce erosion rates.

Fixing sections where stream bank erosion is determined to be accelerated by anthropogenic activities will be a long-term undertaking. The first step to addressing the problem is identifying "hotspots" and areas that have the best potential to reduce sediment loads into the channels and subsequently into the near shore waters. Addressing identified stream bank erosion hotspots should be expected to reduce their contribution to the sediment loads off Waiʻulaʻula Watershed. However, it is our professional opinion that the portion of fine sediment contributed by the stream bank hotspots within the Urban and Agricultural Districts is a small percentage of the total background sediment load for both discrete storm events and on an annual basis. A SCA is a tool that can help identify stream and associated riparian areas that require restoration, and help prioritize critical areas. Establishing an erosion monitoring program that can provide trend data for select sites over the long-term will provide information on rates of erosion and can be used to help evaluate effectiveness of implemented management practices. Identifying management actions to reduce erosion will allow implementation of projects aimed at reducing delivery of sediment and associated pollutants to coral reefs.

2 STREAM CORRIDOR INVENTORY AND ASSESSMENT

2.1 Objective

The primary objective of this project was to assess the condition of stream banks within Waiʻulaʻula Watershed using a SCA approach, identify locations where channel erosion was determined to be accelerated, and make recommendations aimed at reducing erosion rates.[3] The relative loads of nutrients and toxicants entering the stream corridor associated with unstable and eroding banks was also assessed.

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[1] Impaired for Total Nitrogen, Nitrate+Nitrite Nitrogen, Total Phosphorus, Turbidity, chlorophyll a, and Ammonium Nitrogen. http://health.hawaii.gov/cwb/site-map/clean-water-branch-home-page/integrated-report-and-total-maximum-daily-loads/

[2] Accelerated is a relative term and should be referenced and compared to background rates of erosion.

[3] Approaches were influenced by similar work [e.g. http://www.dnr.state.md.us/streams/pdfs/SCAProtocols.pdf, www.cwp.org (Urban Subwatershed Restoration Manual Series)].

2.2 Project Area and Stream Hydrology

The SCA was conducted from the mouth of Waiʻulaʻula Stream at the ocean upstream to the confluence of its two primary tributary streams, Keanuʻiʻomanō and Waikoloa, located at an elevation of approximately 1,430 feet (ft) mean sea level (msl), continuing up these streams, and ending just *mauka* of Waimea town at approximately 2,700 ft msl. The headwater tributaries to Keanuʻiʻomanō and Waikoloa Streams above this elevation are primarily in the Conservation District and were not visited. Both streams are perennial (flow continuously all year) in the Conservation District, and a portion of their flow is diverted and routed to reservoirs for potable and irrigation uses within the watershed. Downstream of the Conservation District the streams become intermittent (flow seasonally) for varying distances whereupon they become ephemeral (flow during and immediately after precipitation). Flow duration and discharge in each stream is a function of rainfall. Historically Waiʻulaʻula Stream was reported as perennial along its entire run.

The headwaters of Keanuʻiʻomanō and Waikoloa Streams are located near the summit and within a caldera of the Kohala volcano in the Puʻu O ʻUmi Natural Area Reserve and Kohala Watershed Forest Reserve. Rainfall in the headwaters of the watershed is approximately 110 inches per year over an area of about 1,770 acres. Rainfall totals decrease rapidly with elevation loss, making the upper portion of the watershed the primary recharge zone for surface and ground waters. Waimea town, located at an elevation of 2,677 ft msl has an annual rainfall average of 36 inches. At the mouth of Waiʻulaʻula Stream, ten miles to the west at the coast, rainfall is a meager nine inches per year.

Both Keanuʻiʻomanō and Waikoloa Streams are steep along their reaches from the crest of their headwaters down the flank of the Kohala volcanic edifice falling in a southwest direction. At about the 2,500 and 2,700 ft msl elevations respectively they level out, and begin to flow parallel and almost due west until they merge at 1,430 ft msl forming Waiʻulaʻula Stream, which continues due west to the ocean 4.5 miles downstream. As the streams level out their lavas and soils change from Kohala to Mauna Kea volcanics. The contact zone of the two volcano lavas is roughly along Kawaihea Road. The younger Mauna Kea lavas likely flowed out and over the older Kohala deposits, and possibly buried older stream channels on the flanks and base of the Kohala edifice. The Mauna Kea lavas may be as young as 10,000 years old, making the streams that flow over them very young; one reason the stream channels are poorly developed within the watershed. The layering of the lava and ash deposits also has a significant impact on the hydrogeology under the watershed. The xeric environment of the Waiʻulaʻula Watershed west of Waimea town down to the coast limits the rate of biogeochemical weathering of the lava flows and associated development of soil. As a result of these factors, much of the landscape surface contains large tracts covered with broken rocky expanses with pockets of soil. In many sections the stream channels flow over exposed bedrock (lavas) and large boulders, which control the rate of channel development.

Keanuʻiʻomanō and Waikoloa Streams are intermittent for short distances beginning at 2,700 ft msl, whereupon they become progressively more ephemeral traveling downstream. Along Keanuʻiʻomanō, beginning at approximately 1,600 ft, and continuing downstream along the mainstream of Waiʻulaʻula Stream, there are approximately 16 perennial pools. The pools range in size from approximately 60 cubic feet (cu-ft) (450 gallons) up to 900 cu-ft (6,700 gallons). Four of these pools were able to hold water throughout the prolonged drought that affected Waiʻulaʻula Watershed from 2009 through early 2014. The source of water for these perennial pools along ephemeral reaches of the streams is most likely ground water. Given the low annual rainfall of the watershed, the high evapotranspiration losses, and the infrequent flows in the streams below 2,700 ft msl, the pools could not persist during prolonged periods without ground water inflows. The quality and quantity of the perched ground water discharging into the pools is unknown. The ground water maintaining the pools is likely relatively shallow and sourced to surface water that is lost into the bed of the upstream channels, and to a lesser degree lateral inflows sourced to rain water infiltration over the watershed. It is unknown if the ground water fluxing out the bed and banks of the pools and all sections of the various stream channels carries sewage effluent from the numerous Onsite Disposal Systems (OSDS) from Individual Waste Systems (IWS) in the watershed (Section 2.4.3.2).

2.3 Methodology

SRGII worked with the South Kohala Watershed Coordinator to gain access to the streams and gulches traversing properties within the watershed. Requests for access were made to the larger landowners. There are many small parcels that extend into the channels, making it unrealistic to secure permission to access all these properties. For some of the small properties SRGII made in-the-field-requests to landowners for permission to access the streams. At the onset of the project the Watershed Coordinator was relatively new to the position and had not yet developed a rapport or made outreach to the large land owners along the streams and gulches. As a result, SRGII allocated time to secure access permission from these land owners. Assistance in acquiring access was also provided by Carolyn Stewart, a local resident who has done a lot of watershed work in the region and the primary author of the *Waiʻulaʻula Watershed Management Plan*.

Prior to conducting field work, SRGII interviewed Ms. Stewart regarding past watershed projects, including both studies and implementation projects. Ms. Stewart provided GIS data and reports prepared by students from the Massachusetts Institute of Technology (MIT) who spent a semester in 2011 collecting physical data in the watershed. Their work included field mapping and in-situ data collection on the lower half of the watershed of: hydrographic features such as stream channels and perennial pools, soil types and soil infiltration tests, vegetation, and other physiographic variables in support of assessing erosion rates in the watershed. A key finding of their work is that surface overland flow and erosion during events is minimal between the coastline and 2,000 ft msl due to soil types, topography, and hydrology. Other data, information, and GIS maps on current and past land uses and conditions were compiled and reviewed to filter sites and prioritize areas to assess and inspect during field work.

The first round of field work was conducted in January 2014, and consisted of walking the corridors of Waikoloa, Keanuʻiʻomanō and Waiʻulaʻula Streams in the Waiʻulaʻula Watershed to assess channel stability and identify locations of sediment inputs from eroding banks, stream diversions, and other features or land uses that have an effect on channel stability and/or water quality.[4] Lands adjacent to the waterways were also assessed to locate source areas of sediments and other land based pollutants that would be delivered into the waterways under overland flow conditions. Other field work included visual assessment of bridge and ford crossings over streams and gulches; visual inspections of

[4] The use of "sediments" refers to fine particles that are transported as suspended particles in runoff. There are locations along the stream banks where particles ranging from gravel (0.35-2.5 in) and large boulders are loose and prone to failure. However, many of these larger particles are in the process of being worked by the stream as the channels form, and these larger sizes are not the sediment sizes of concern with respect to smothering and inundating corals in the nearshore waters.

agricultural parcels (e.g. range lands and crop plots); and assessment of the storm water drainage infrastructure of the built areas of the watershed (e.g. Waimea and Kamuela). Quantitative and qualitative information was collected during stream inspections via measurements and observation.

The second round of field work was conducted in August 2014, and consisted of inspecting the erosion pin sites, walking sections of stream channels not assessed during the January field work, and re-inspecting sections of stream channels and upland areas that were visited in January. Between the January and August field trips the streams and gulches carried water from their headwaters to the mouth of Waiʻulaʻula Stream. Prior to January the entire Kohala region, as well as other parts of Hawaiʻi Island were under extreme drought and stream flows were minimal and infrequent.

In January a total of 27.2 miles were walked to assess streams and gulches, 7.3 miles to assess upland areas, and 32 sites were assessed via vehicle. In August, 15 miles of streams and 4.2 miles of upland areas were walked to revisit and assess new areas, and 15 sites were visited.

2.4 Findings

2.4.1 Streams and Gulches

The reaches along the stream and gulch channels draining the Waiʻulaʻula Watershed that were inspected are geologically young. As a result, discerning between instability due to natural channel forming processes and anthropogenic impacts is challenging. The SCA focused on identifying discrete locations where sediment was, or has the probability to be, input into the streams from out-of-channel sources or from within the active stream channel (Section 2.5.2).

The streams and gulches have varying channel morphology and rates of channel adjustment/erosion. Most of the channel reaches can be classified as steep (>4% slope) and are lined with coarse bed and bank materials. Sections frequented by feral and domesticated hooved animals show signs of accelerated erosion. While not quantified, the hydrology of the streams appears to be tied to ground water. There are reaches that qualify as loosing, meaning surface water is lost along the flow path due to infiltration into the bed. Other areas contain pools that appear to be perennial or nearly so, likely due to interception of ground water. During the months of December 2013 – May 2014 several large rainfall events resulted in continuous flows in the streams from their headwaters to their outlet at Kawaihae Bay. Qualitative observations of these flow events showed the discharge volume to be relatively high and suspended sediment loads to be concentrated. No measurements of discharge or suspended sediment concentrations were taken, so computing sediment loads is not possible.

Large tracts of the land adjacent to the streams draining the watershed between Waimea Town and the coast are hydrologically disconnected, meaning that surface water runoff does not make it along flows paths to the streams. In essence, there are many small topographic sinks across the landscape where, when it does rain at rates that result in surface water, the water ponds up and does not connect to the streams. It appears that the frequency of surface water is rare, in part due to the high infiltration capacity, which in many areas was measured by the MIT students and found to be greater than the mean rainfall intensities on the watershed.

There are several permitted and unpermitted diversions in the Keanuʻiʻomanō Stream. The diversions usually consist of a rock and mortar dam built across the stream. The structures do not appear to be inducing scouring of the bed and banks. However, some may create barriers to migratory native fish when flows in the stream are low. The diversions do affect the hydrology by diverting stream water, and unpermitted diversion and pumps should be removed. During both site visits Keanuiʻiʻomanō Stream was flowing in the reach between Kohala Mountain Road and the Waiaka subdivision. In January the stream dried up just downstream of the subdivision near its confluence with Lanikepu Gulch, immediately downstream of a stretch of stream where several diversions are located. In August the stream carried water 1.2 miles further downstream to the downstream end of Anekoa subdivision where it dried up, with the exception of the perennial pools located further downstream. Maps and photographs depicting the above referenced landmarks are found in Appendix A. Diversion of water from the stream contributed to the decrease in stream flows in a downstream direction. It is unknown how much water is diverted, and how the dewatering impacts native stream fauna.

2.4.2 Landscape Condition

The watershed from Waimea town to the coast outside of the stream corridors is dominated by alien grasses, and shrubs. The low rainfall levels, high evapotranspiration rates, and geology results in a very arid environment. Ground cover is naturally sparse in sections, and in some areas, especially between Queen Kaahumanu Highway and the ocean, the surface is extremely vulnerable to erosion. Many areas within this section of the watershed are hydrologically disconnected, and it is surmised that a large amount of eroding sediments are not carried into the streams but rather, remain on the watershed. An area without sinks and that is hydrologically connected is the section of land between the coast and Queen Kaahumanu Highway. This area has been affected by wildland fires and is the lowest rainfall zone of the watershed. Ground cover in the area is less than 20 percent, and it is extremely vulnerable to erosion and direct delivery of sediment into the nearby ocean.

Wildland fires have and will likely occur again within the watershed. Areas most vulnerable are within the mid to low elevations of the project area. Besides potential for damage to buildings and infrastructure, wildfires have the potential to completely remove vegetative cover. Areas where vegetation is consumed and left barren are extremely vulnerable to erosion. Vegetation species that cover vast areas of the watershed are not drought tolerant and become desiccated during dry months, which results high fuel loads. Revegetating large tracts of land with native or non-native drought tolerant species would be a significant challenge, and is most likely not a viable option. In addition to damage from the fire directly, the strategy of creating fire lines can create swaths of land that are vulnerable to erosion. Several fire breaks were observed and did not have any measures to control runoff and erosion of their surfaces.

2.4.3 Land Uses

Two primary land uses and associated land cover types were identified as having a probable impact on the surface and ground water hydrology, including the timing and magnitude of surface runoff from storm events, its quality, and resulting land based pollutants.

- Agricultural activities: including grazing by cattle and feral ungulates, and crop fields.
- Urbanization: including housing and the built environment in the Agricultural, Rural, and Urban Districts.

The focus of the project was locating sediment sources along streams and gulches. However, during the course of field investigations, the role of ground water in transporting pollutants to the ocean was identified as an issue needing further investigation.

2.4.3.1 Agricultural Activities

Cattle

Cattle grazing and extraction of wood products began nearly 150 years ago. These activities had, and continue to have, a pronounced adverse impact on the eco-hydrology of the watershed and the leeward side of the island in general. Cattle grazing occurs on State owned parcels located between 2,150-1,194 ft msl. The corners of the grazed portion of the State parcel are as follows: Northeast: confluence of Ouli Gulch and Keanuʻiʻomanō Streams; Southeast: two miles due south at the boundary with Parker Ranch; Southwest: at the junction of the Old Rock Wall and Parker Ranch boundary; and Southeast: at Old Rock Wall on the north side of Waiʻulaʻula Stream. The northern boundary is roughly aligned along the north side of Keanuʻiʻomanō and Waiʻulaʻula Streams, the southern boundary is the fence line on the State and Parker Ranch Boundaries, and the west boundary is along the Old Rock Wall. Within this area cattle have access to the all the stream and gulch channels. The number of cattle varies and is dependent on available forage, which is a function of rainfall. During the site visit in January 2014 two cows and one bull were observed. In August 2014, eight cows and two bulls were seen.[5]

The cattle congregate in areas where shade and water are available. Although it is likely the lease holder has troughs for cattle watering, none were seen. The cattle drink directly out of the stream at several of the perennials pools and other locations where the channels are accessible. They appear to utilize and graze the upper elevations more frequently than the western lower elevation areas, likely due to better forage conditions, availability of shade along the streams, and water. At approximately 1,650 ft msl the mainstem of Waikoloa Stream branches into four stems, which then merge about 1,000 ft downstream near the confluence with Keanuʻiʻomanō Stream. The dominant tree/shrub in this area is China Berry, which creates dense thickets. The cattle utilize the area between the four stems and Keanuʻiʻomanō Stream as evidenced by areas where grazing has reduced grass cover resulting in some spots of bare ground. They rest within the channels under the thickets, and in several areas the channels were trampled and not discernible. Even though several pasture areas of various sizes were over grazed, it does not appear that sediments eroded off these areas were delivered into the streams.

The primary issue from an erosion-sediment perspective with cattle, was trampling of the streams banks and bed, where they access the channels for water or resting. Resource managers and others have discussed the benefit of cattle to control alien grasses, which when dense can create a high fuel load supply for wildland fires. In areas where the cattle are grazing there is a reduction in grass/fuel loads, and these areas would likely slow the rate of spread and burn intensity during wildland fires. However, as observed in August, much of the parcel contains a moderate to high density of alien fire prone grasses, so any benefit from cattle reducing fuel loads is not significant across the parcel. Much of the grass across the landscape has probably grown as a result of the above average rainfall that fell on the watershed since December 2013 during the winter rainy season. Prior to this year the prolonged drought conditions left much of the landscape barren, and even vegetation along the streams experienced dieback and drought stress. It is unknown, and somewhat complicated to quantify, the net benefit cattle provide as a tool to reduce fuel loads versus the resource damage they do in and along the waterways.

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[5] These counts have not been verified.

Feral Goats

Feral goats are located throughout the project area but primarily utilize lands west of the Old Rock Wall at elevations of sea level to 1,200 ft msl. Compared to adjacent watersheds, to both the north and south, the goat population is small. However, goats are voracious eaters and are known as switchers meaning they both browse and graze. By comparison, cattle are primarily grazers. Goats have impacted the stream corridor between the Old Rock Wall and Kaahumanu Highway, browsing extensively on the alien kiawe trees and other plants that dominate the stream in this reach. If left unchecked, the population of goats in this area can be expected to increase as the nearby golf course ponds provide a permanent water source, and the stream and landscaped areas around the Hapuna residential area provide forage. With increased numbers, the amount of degraded land area can be expected to increase, along with the risk of erosion.

Field Crops

Farm lots in the Lalamilo Farms area were visited, however access was limited and most observations were made from the north edge of the area along Waikoloa Stream. A variety of crops are grown and the amount of water and fertilizer used was not investigated as part of this project. Potential pollutants from the farms include: pesticides, nutrients from fertilizers, and sediments. Most of the fields are set back from Waikoloa Stream and no surface water channels were identified draining the area towards the stream. One plot of fields that does abut the stream along 1000 ft is located across from the County Recycling center. A dirt road runs parallel and between the stream and the fields and there is no vegetative buffer. The distance between the edge of the field and stream ranges from 18 to 55 ft. The ground surface is nearly level in the area and sediments did not appear to be transported off the field into the stream. However, at three locations the road surface appears to discharge storm water runoff and some sediments into the stream. It is unknown if seepage loss from irrigation water and the solutes in it are percolating into the ground water beneath the fields.

The University of Hawaiʻi Lalamilo Research Farm was inspected. The farm's facility is located on the north side of the stream at the end of Opelo Road, and the experimental fields are on the south side of Waikoloa Stream. Access from the facility to the fields is via a small bridge over Waikoloa Stream. Evidence of runoff and sediments off the fields and into the stream was observed at the bridge crossing. Field runoff into the stream was noted at two locations directly downstream from the small bridge.

2.4.3.2 Urbanization

Residential, commercial, and resort development in the watershed, both existing and new, has altered the ground cover and hydrology by increasing frequency and magnitude of runoff volumes delivered into the waterways. In some areas storm water outfalls into the streams and gulches have resulted in bed and bank scouring and accelerated erosion. Numerous existing and under construction subdivision and diffuse home lots utilize OSDS (e.g. cesspools and septic tanks), which discharge partially treated effluent into the ground adjacent to the streams and gulches. These systems are likely elevating concentrations in the receiving waters of nutrients, micro-organisms e.g. bacteria and other chemicals associated with waste water discharges.

There are several issues related to the built environment that directly or indirectly relate to the potential impacts on streams by sediment and other pollutants.

Bridges

The streams and gulches in the watershed flow under numerous bridges. Several were inspected to assess the impacts the bridge culverts have on channel morphology. In general, issues with scouring of bed and banks of streams at bridge crossings occurs when flow is constricted and velocities increase causing damage to channels as water exits the culvert. Another common issue is the outlet of culvert is often elevated above the downstream bed of the channel causing scouring. Bridges with these issues are identified in Appendix B.

Dry Wells

Storm water runoff collects and transports pollutants that accumulate on the ground surface between rainfall events to outfalls at receiving waters. Most of the newer parts of the built environment in the Waimea-Kamuela area are fitted with dry wells that collect and dispose of storm water runoff into the ground. Dry wells are vertically aligned, large diameter perforated concrete pipes placed beneath grade that are allowed to fill with storm water, which then infiltrates into ground adjacent to and beneath the well. Surface runoff from roadways, parking lots, and other impervious surfaces is directed into the dry wells. As a result of the numerous dry wells, there appear to be only a few surface storm water channels and inlets feeding subsurface storm water pipe networks and outfalls that discharge directly into the streams and gulches. During the SCA only one storm water pipe outfall was observed. There were four sections of roads with curb and gutters that route runoff directly into streams and gulches. Several bridges contain drainage scuppers that collect runoff generated on their decks and discharge into the streams below. Several surface channels were observed as well.

An ideal dry well would filter pollutants as the storm water injected into the ground flows through the well's media and subsequently through the surrounding soil and subsurface materials surrounding and underneath before reaching the water table or day lighting into surface water bodies. Studies to evaluate effectiveness of dry wells, and to determine if dry wells contribute to ground water pollution, have been conducted across the mainland. One finding was that in areas with high ground water hydraulic conductivities, the potential to transport dissolved forms of pollutants such as to ground waters is high. The US Geological Survey in Hawaiʻi conducted a study for Hawaiʻi County to assess the risk of dry wells to drinking water wells. The assessment did not include evaluating the risk of impairing water quality of surface waters. Pollutants of concern would primarily be those in dissolved form that can be transported with water, as opposed to particulate form that have high potential for being filtered in the well. A dry well design needs to consider the type of pollutants in the runoff, the hydraulic conductivity, and the estimated runoff/treatment volume of water. Installers of dry wells are primarily concerned that the wells percolation rate is high enough to prevent the well from filling up and overtopping onto the surface. It is possible that some of the dry wells in the watershed could be connected to preferential flows paths such as lava tubes, fractures, or bedding interfaces, resulting in rapid transport of the injected water and solutes it carries to ground and/or surface waters.

Infrastructure

Encroachment of infrastructure (IWS, buildings, and other features) into the stream corridors and floodways is problematic. In several areas, primarily along Keanuʻiʻomanō Stream, homeowners of lots abutting the stream have removed vegetation. This results in unstable banks, a decrease in stream cover, and potential for input of sediments and other pollutants including rubbish. Based on the best available information, all residential and commercial properties and public facilities in the watershed, with the exception of the commercial areas of Waimea Town and Resort complexes adjacent to Queen

Kaahumanu Highway and their associated private residences, use OSDS to dispose of partially treated sewage effluent from IWS or treatment works.

Along both Waikoloa and Keanuʻiʻomanō Streams weeps and seeps were oozing from the banks. At three sections along Keanuʻiʻomanō Stream seeps were observed emanating from the stream bank. The smell of the water and proximity to the backyards of the houses along the stream seem to indicate the seep waters were from OSDS. It is likely there are areas along the streams where disposed waste water effluent is discharging into the stream and/or flowing with ground water to the coast and discharging as submarine ground water.

IWS Disposal

Per Hawaiʻi Administrative Rules (HAR) Chapter 11-62, an IWS is system that can receive and dispose of no more than 1,000 gallons per day of domestic wastewater. An IWS is either a cesspool, or a septic tank or aerobic treatment tank and their associated disposal fields. A cesspool is essentially a disposal system and provides very little treatment to wastewater. Septic tank treatment effectiveness varies, and is in part a function of maintenance frequency. The quality of septic tank effluent is not significantly higher compared to cesspool effluent. Waste water effluent for a septic tank is normally further treated via percolation through a drain or leach field. A common perception is that the partially treated effluent flows down vertically through the ground. However, the variable layers and types of lava flows, and the presence of ash layers and other geologic structures (e.g. vertical dikes, cross bedding fractures, lava tubes) can all control the rate of ground water flow, and in some instance transport ground water in a lateral direction for varying distances beneath the ground surface.

Ammonium (NH_4) concentrations have been reported by DOH to exceed water quality standards in the ocean waters of Pelekane Bay, and NH_4 and Nitrate (NO_3^-) are both biologically available and can stimulate excessive algal growth in the ocean resulting in eutrophication. Pursuant to HAR Chapter 11-62, all OSDS are to be at a minimum of 50 ft from surface water bodies. On several of the house lots, primarily adjacent to Keanuʻiʻomanō Stream, leach/drain fields were observed to be very close to, and in some cases within 50 ft of, the stream. A 50 ft setback may not be adequate in all areas since there are variations in subsurface geology and hydraulic conductivity throughout any watershed. Setback distances should be conservative and based on site conditions. For example, a leach field directly over a shallow aquatard (bed of low permeability along an aquifer) could be several hundred feet from a stream, but still result in a short transport time of effluent into the stream.

2.5 Recommendations

2.5.1 General

In general, the following projects and management measures are recommended.

1. Stream corridor fencing, to exclude cattle and feral ungulates from stream channels.

2. Installation of water troughs within existing paddocks, to reduce cattle and feral ungulate concentrations in waterways.

3. Stream bank stabilization using bioengineering designs.

4. Revegetation of exposed lands that are hydrologically connected to waterways and observed to be above background sources of sediments.

5. Stream corridor setbacks, to decrease hydrologic connectivity of surface and ground water between developments and receiving waters.

6. Low impact development practices, to reduce development impacts on hydrology, including both water quantity and quality.

7. Post wildfire rehabilitation.

8. Stream crossing stabilization at stream fords and approach roads.

9. Monitoring to assess changes to the watershed's hydrology, including its quality, to assess potential impacts to stream water quality from waste water.

    a. Establishment of water quality monitoring stations at one or more perennial pools on Waiʻiʻulaʻula Stream. These pools, which are sustained via ground water, should be monitored to determine if parameters tied to waste water are present, and to monitor their trends. This type of monitoring could involve students at a nearby school.

10. Monitor developments within the watersheds and promote use of best available technologies and methods to minimize build out impacts to the watershed.

2.5.2 Proposed Remediation Sites

Several sites identified as hotspots have already been targeted for remedial actions under funding from the Clean Water Act 319 program. The watershed coordinator, with assistance from SRGII, prepared and submitted a proposal, and was awarded funds to implement projects at five sites within the watershed as described below. Additional hotspots are also identified, including prioritization for remedial and restoration actions (Appendix B).

2.5.2.1 Waimea Center Rain Garden (23PG)

A rain garden will be installed to capture nutrients and retain storm water runoff from the Waimea Center parking lot. The rain garden will collect runoff from the commercial retail center parking lot and a portion of the buildings within. Issue: delivery of polluted runoff into Waikoloa Stream. Target pollutants: Nutrients, Total Suspended Soils, Hydrocarbons, Metals and Bacteria.

2.5.2.2 Waimea Center Runoff Control (23PG)

Riparian corridor restoration is planned along 1,000 ft of Waikoloa Stream. Restoration will include stabilization of exposed and eroding stream banks, treatment of building runoff discharged into stream removal of feral cats, and installation of riparian vegetation. Issues: erosion and sediment, cat feces, pollutants discharged in Waikoloa Stream via illicit discharges. Target pollutants: Nutrients, Total Suspended Solids, Hydrocarbons, Metals and Bacteria.

2.5.2.3 Waimea Nature Park (26PT)

Waimea Nature Park is a 10-acre parcel of state land in Waimea town that is leased by the Waimea Outdoor Circle for environmental research, education, and restoration. Sections of the stream channel have and continues to erode during high flows. The Waimea Outdoor Circle holds bi-monthly community work days that are focused on removal of invasive/noxious plant species, native planting, and maintenance of the Waimea Nature Park. Riparian corridor restoration/stream bank stabilization is targeted along 2,000 ft of Waikoloa Stream where erosion is occurring. Restoration will include stabilization of exposed stream banks, removal of alien vegetation, and treatment of runoff discharged into stream. Total length of stream channel treated is approximately 3,200 ft and total runoff area is approximately 55,000 square ft. Issue: unstable and eroding stream banks. Target pollutants: Nutrients, Total Suspended Solids, Hydrocarbons, Metals, and Bacteria.

2.5.2.4 Ke Ala Kahawai O Waimea Trail

The Waimea Trails and Greenways Ke Ala Kahawai O Waimea Trail is maintained by community volunteers. The area along the trail is predominantly vegetated with non-native species such as Kikuyu grass. Riparian corridor restoration and stream bank stabilization is currently targeted for 4,000 ft of the trail along Waikoloa Stream. The trail is planned to expand down the stream, and it is recommended the area targeted for restoration be expanded an additional 4,500 ft along the length of the expansion. Restoration will include stabilization of exposed stream banks, removal of alien vegetation, and treatment of runoff discharges into stream. Total length of stream channel treated is approximately 8,000 ft and total runoff area is approximately 10 acres. Target pollutants: Nutrients, Total Suspended Soilds, Hydrocarbons, Metals and Bacteria.

2.5.2.5 Outlet of Waiʻulaʻula Stream near the Mauna Kea Resort and Mauʻu Mae Beach (2PG)

Mauʻu Mae Beach is near the mouth of the Waiʻulaʻula Stream outlet. This area had a recent fire that removed and killed much of the vegetation, which increased the threat of erosion and sedimentation due to bare ground. The National Park Service (NPS) and its partners are working with the landowner (Queen Emma) and families with ancestral ties to the area to preserve the coastal trail and to conduct restoration work in the area along the Ala Kahakai National Historical Trail. Stream corridor re-vegetation and erosion control will take place over approximately 1.5 acres. Treatments will include vegetating exposed areas, and installation of geotextile erosion mats to protect exposed and unstable surfaces. Target pollutants: Nutrients, Total Suspended Solids, Hydrocarbons, Metals and Bacteria.

3 EROSION MONITORING

3.1 Objective

Erosion monitoring provides information over time to document erosion rates of stream banks at reaches representative of elevation gradients and use conditions within the watershed. Erosion pin measurements can be used to record erosion of and deposition of the ground surface at erosion pin locations, and the information used to quantify rates of erosion and/or sedimentation.

3.2 Methodology

This project uses a low-tech, but effective method, of erosion pins. The US Geological Survey (USGS) had installed two sites in 2010.[6] This project installed an additional eight erosion monitoring points to

[6] This project was to expand on erosion pin installation sites installed by the USGS. However, maps or site coordinates were not available, nor was information on how many sites were installed. An attempt to locate one site in the field was not successful. It was eventually learned that the USGS sites were located in upland areas and not within the stream and gulch channels.

increase coverage in the Waiʻulaʻula Watershed (Appendix C). Erosion monitoring sites were selected throughout the Waiʻulaʻula Watershed based on review of aerial photos and on-the-ground conditions. Sites were located to document erosion rates of stream banks at reaches where adverse impacts were observed, and where the channel bed and banks were conducive to installation. Upland sites were selected in areas where impacts to ground cover occurred such as within areas subjected to wildland fires. Erosion pins were installed at five sites across stream channels and at three upland/out-of-channel locations. Installation sites represent general stream morphological conditions and places where stream channel erosion was evident and likely accelerated due to anthropogenic activities. Locations were recorded using DGPS and entered into a GIS file. The following information was recorded at each site: heading of the pin transect from 0.00 pin to opposite end pin (compass was set to true north), total length of the transect, and pin stations. Photographs included: 0.00 pin to opposite end pin, middle of transect to each end pin, and other photographs depicting features that could be used as reference to locate the pins in the future.

The purpose of the pins is to quantify erosion (primary) and deposition rates at sites where accelerated erosion is likely occurring, or at sites that appear vulnerable to erosion due to lack of ground cover for upland areas, and channel morphology for stream and gulch sites. Erosion pins used were 10 inch long galvanized spike nails. The pins were installed so that the nail head was flush with the ground surface. At each installation site a row of at least four pins were installed along a transect of the area of interest.

An erosion monitoring plan was developed covering both the project period and providing recommendations for continued monitoring (Appendix C). Due in part to the arid environment, the erosion monitoring plan recommends repeat monitoring every six months.

3.3 Findings

Initial measurements were taken upon installation in January 2014, and a second set of readings were taken seven months later (August 2014) (Appendix C). Any changes to ground level at the pins occurred during that time span. However, it is unknown if the changes were from one runoff event or several. Of the eight sites, changes occurred at only two locations.

At Site 7ER, located in Waimea Nature Park, two of the five pins installed were no longer present. It is possible that park visitors pulled the pins out as the site is visible and located in area where community groups routinely conduct maintenance. A comparison of photographs of the pins from January and August shows that the bank most likely did not erode ten inches (length of pin). However, the bank did erode, and this site is in need of stabilization. At Site 8ER on Waikoloa Stream downstream of 7ER, two of four pins placed across the channel were completely removed and two had no changes. The pins that were removed were just below the crest of the left and right channel banks, and it appears a high flow event induced bank retreat.

3.4 Recommendations for Continued Erosion Monitoring

Erosion pins installed were limited to sites along channels that are not covered in bedrock or large rocks. In the Waiʻulaʻula Watershed the sites with bed and banks conducive to erosion pins are located along Waikoloa Stream in the vicinity of Waimea town. In order to compute rates of erosion for discrete runoff events repeated visits to the sites immediately after events is required. This is most likely not realistic and therefore the documented rate of surface change is for each time step, or for the period that occurs between site visits. It is important to note that the data the upland erosion pins yield is not significantly representative since they are capturing changes at only very discrete locations. Monitoring of the installed erosion pins should continue, since they are installed, and effort has been expended.

Installing cross sections and conducting differential surveys at select sites within Waimea Nature Park is recommended. This method would show geometric changes over time at locations on the stream where ongoing and to be implemented projects are occurring, and can be used to quantify the effectiveness of the projects. Upon establishment of the cross sections, repeated surveys could be done by students as part of an education program.

4 RIPARIAN ZONE OVERLAYS

Improving watershed quality through zoning updates was identified as a priority by the South Kohala Conservation Action Plan. At present there are limited, general, or no setback distances for land use activities (including structures) to surface water bodies so long as they comply with codes pertaining to flooding. There is a 50 ft setback for OSDS (IWS) from surface water bodies. This distance is general and inherently assumes geologic and hydrologic conditions are the same for all OSDS sites. The 50 ft is a distance that implies it is sufficient to prevent disposed effluent from reaching a surface water body. While 50 ft may be sufficient for some sites, at other sites this distance may not be sufficient to prevent contamination of surface water. At present, design of IWS include percolation test to determine the sites ability to absorb injected effluent and distance to the water table beneath the base of the injection bed. A more conservative and costly approach would be to conduct a tracer study at proposed sites for OSDS IWS.

Two methods used to minimize the impact to streams from stream side activities are riparian and stream corridor buffers. Riparian buffers are a vegetated strip of land adjacent to streams and other water bodies used to intercept runoff and subsurface flow before they reach the water body. They are primarily used in agricultural scenarios. The width of a riparian buffer is a function of the ground slope and the area draining to the stream. Creation of riparian buffers is recommended along the Lalamilo Farm fields fronting Waikoloa Stream. Agricultural setback distances will vary; recommendations are to follow guidelines from the Natural Resources Conservation Service. While similar, a stream corridor buffer differs in that it restricts installation of infrastructure and landscape alterations to a distance back from the top of a stream bank. The objective is to prevent physical damage to the stream channel and inputs from stream side activities. In the Waiʻulaʻula Watershed stream corridor setbacks are recommended in the form of fencing streams at the outer edge of existing riparian/stream side vegetation to prevent encroachment by cattle. For IWS, the distance should be set by site conditions with a minimum of 50 ft pursuant to existing setback regulations. New developments should consider increasing the 50 ft setback. Residential and commercial setbacks should be done such that no activities, structures, or other actions destabilize stream bed or banks. In addition, steam banks where storm water discharge occurs should be fitted with protective covers to prevent scouring or destabilization of the bank or bed of the channel.

5 RECOMMENDATIONS FOR ONGOING WORK

In addition to the general and site specific recommendations targeting sediment from stream corridors, there are several recommendations regarding ongoing work in the larger South Kohala region related to watershed management.

- Conduct SCA in other watersheds of the South Kohala region to identify additional sites for remediation/restoration

- Obtain funding to implement recommendations

- Continue and expand erosion monitoring, to include correlation with coral reef health and assess effectiveness of implementation projects

- Initiate water quality monitoring (baseline and trend) to assess land use changes and potential impacts to water quality
    - Use stable isotope of Nitrogen analysis to determine source
    - Use PCR to source bacteria to host

- Work towards policy changes
    - Stream corridor setbacks for development and grazing
    - Riparian buffers for agriculture fields
    - On-site waste disposal for new developments (use of better treatment system e.g. aerobic instead of septic tanks

- Prepare and implement Burn Area Recovery Plans

- Investigate unpermitted stream diversions and restore instream flows

- Require permitted diversions to record diverted volumes, to comply with diversion allocations

- Investigate water quality impacts from dry-wells

- Compile list of small capacity cesspools

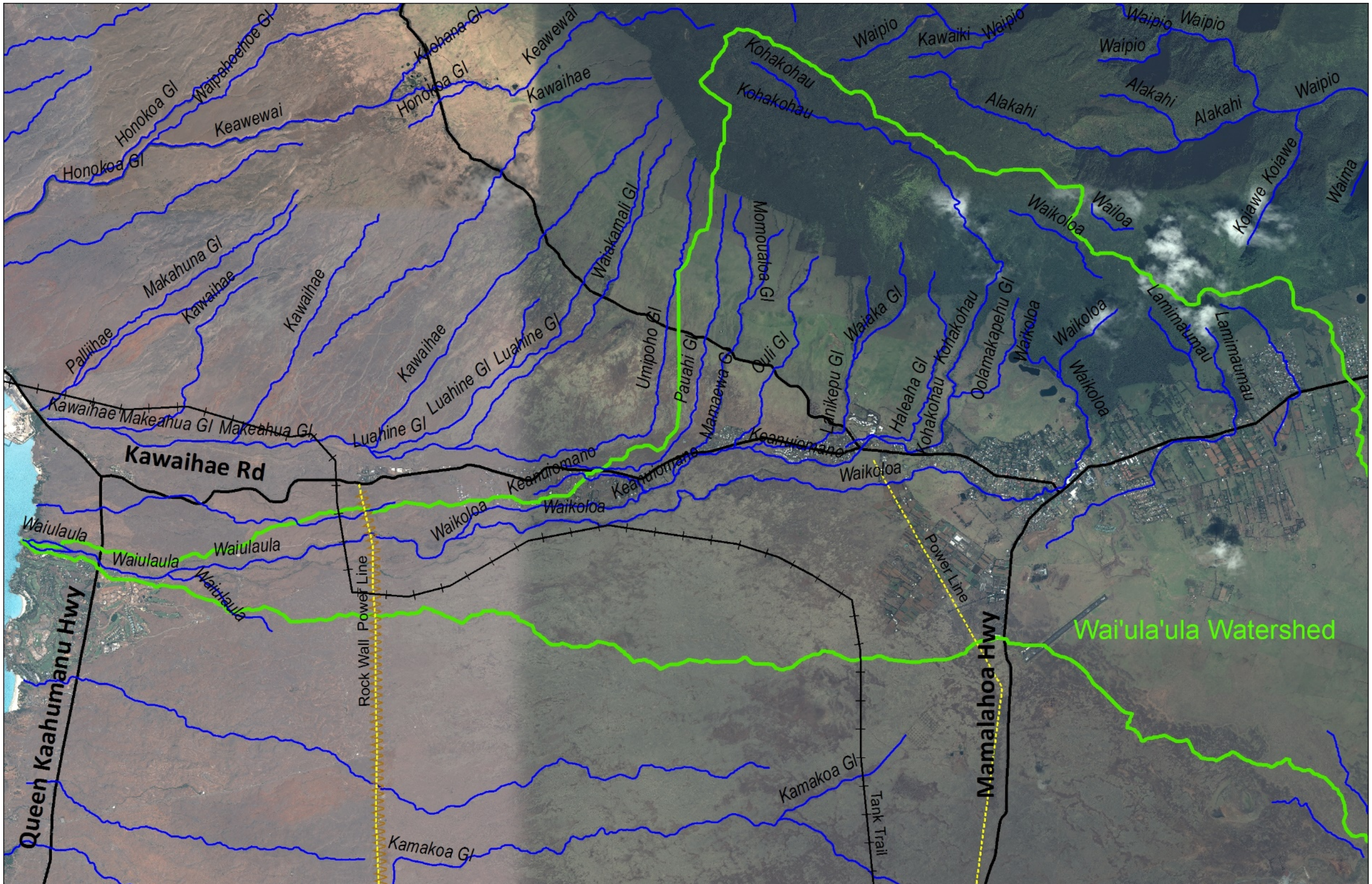
- Conduct stream biota surveys at perennial pools

- Eradicate feral goats

- Close feral cats colonies by ceasing feeding

- Improve management measures for construction sites and increase inspections to verify effectiveness

Appendix A. Project Area Photographs



Project Location: Wai'ula'ula Watershed

South Kohala SCA
September 2014

N

0 0.25 0.5 1 1.5 2 Miles

Photo 1. Wai'ula'ula Stream Mouth, outlet

Photo 2. Wai'ula'ula Stream Mouth, looking downstream

Photo 3. Wai'ula'ula Stream, steep reach

Photo 4. Wai'ula'ula Stream, steep canyon reach

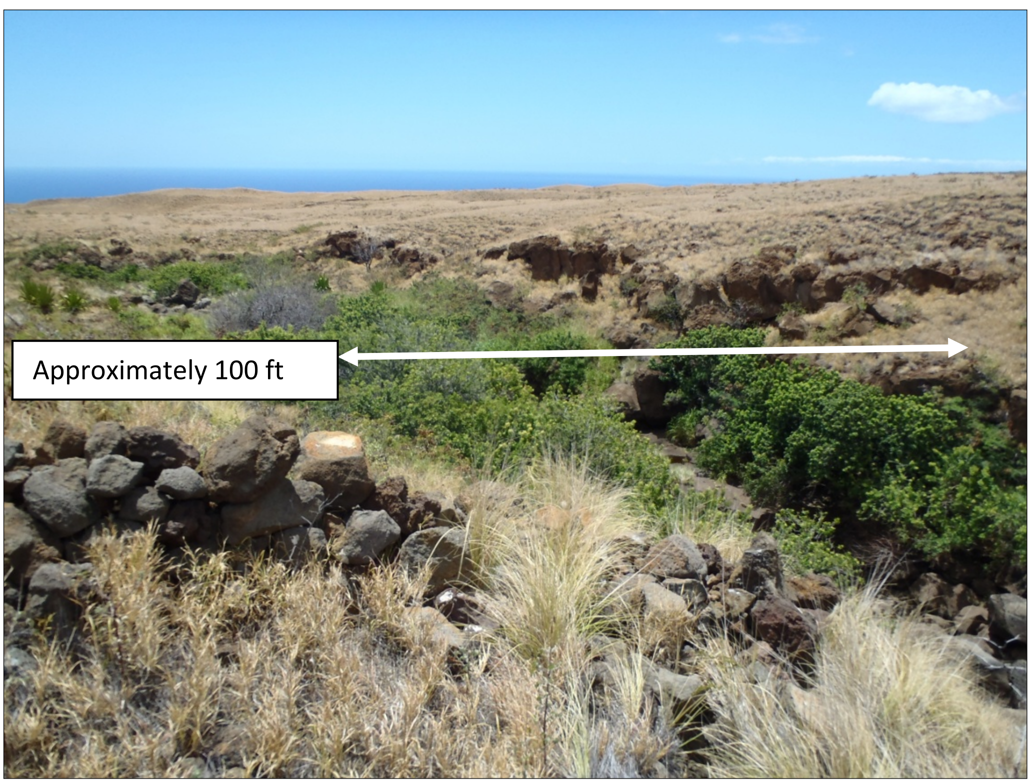


Photo 5. Wailʻulaʻula Stream, approximately 1,400 ft msl

Keanuʻiʻomanō Stream left; Waikoloa Stream (branches) right; perennial pools

Photo 6. Keanuʻiʻomanō Stream, perennial pools

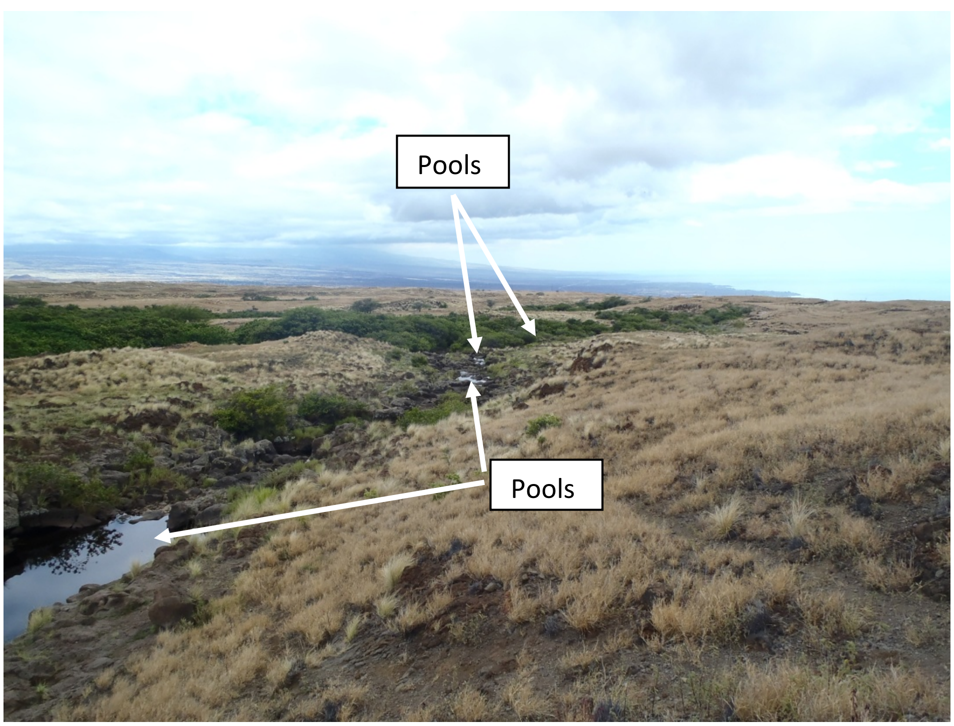


Photo 7. Keanuʻiʻomanō Stream, perennial pool

Pool supports obligate wetland plants

Photo 8. Perennial pool and typical channel

Photo 9. State Land

State land used for cattle grazing; note utilization and general cover conditions.

Photo 10. Waikoloa Stream, 1,600 ft msl

Dense stand of Christmas Berry along channel.

Photo 11. Ponds

Four ponds adjacent to Keanuʻiʻiomanō Stream. The source of water for these ponds, which are located on private parcels, is assumed to be withdrawals from the stream.

Photo 12. Keanuʻiʻomanō Stream, nearby development

Blue line depicts Keanuʻiʻomanō Stream; houses to the left and their OSDS close to stream.

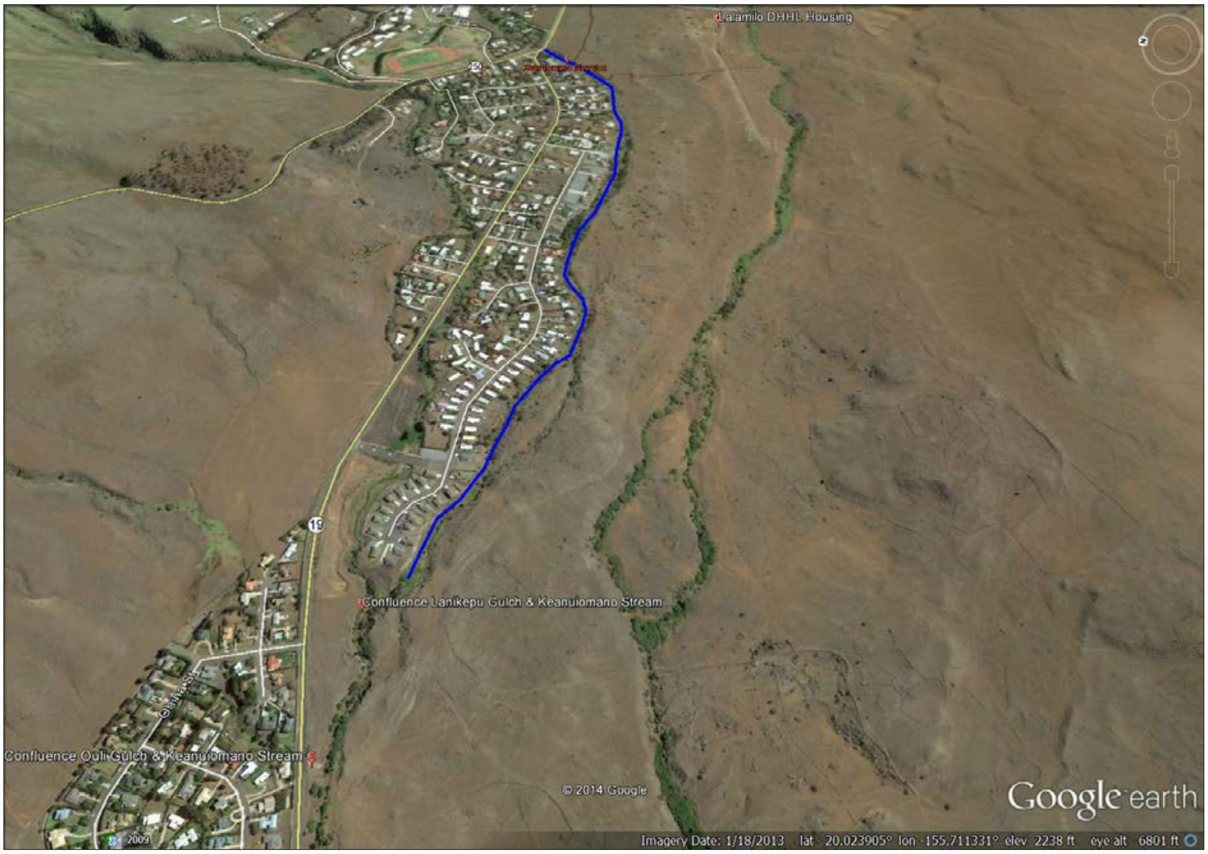


Photo 13. Rock Dam on Keanuʻiʻomanō Stream

Rock and mortar dam on stream near Waiaka Street.

Photo 14. Keanuʻiʻomanō Stream, at 1,700 ft msl

Typical channel with bedrock and boulder bed and banks.

Photo 15. Stream Encroachment

Uncontained fill above Keanuʻiʻomanō Stream.

Photo 16. Failing BMP along Stream

Silt fence failing; fill material was observed in active channel.

Photo 17. Waikoloa Stream, channel blockage

Section of Waikoloa Stream along trail below Waimea Nature Park.

Photo 18. Waikoloa Stream, failing stream bank

Section of Waikoloa Stream bank within Waimea Nature Park.

Photo 19. Waikoloa Stream at Waimea Shopping Center

Photo 20. Waikoloa Stream within Waimea Town

Stream path is under line of trees.

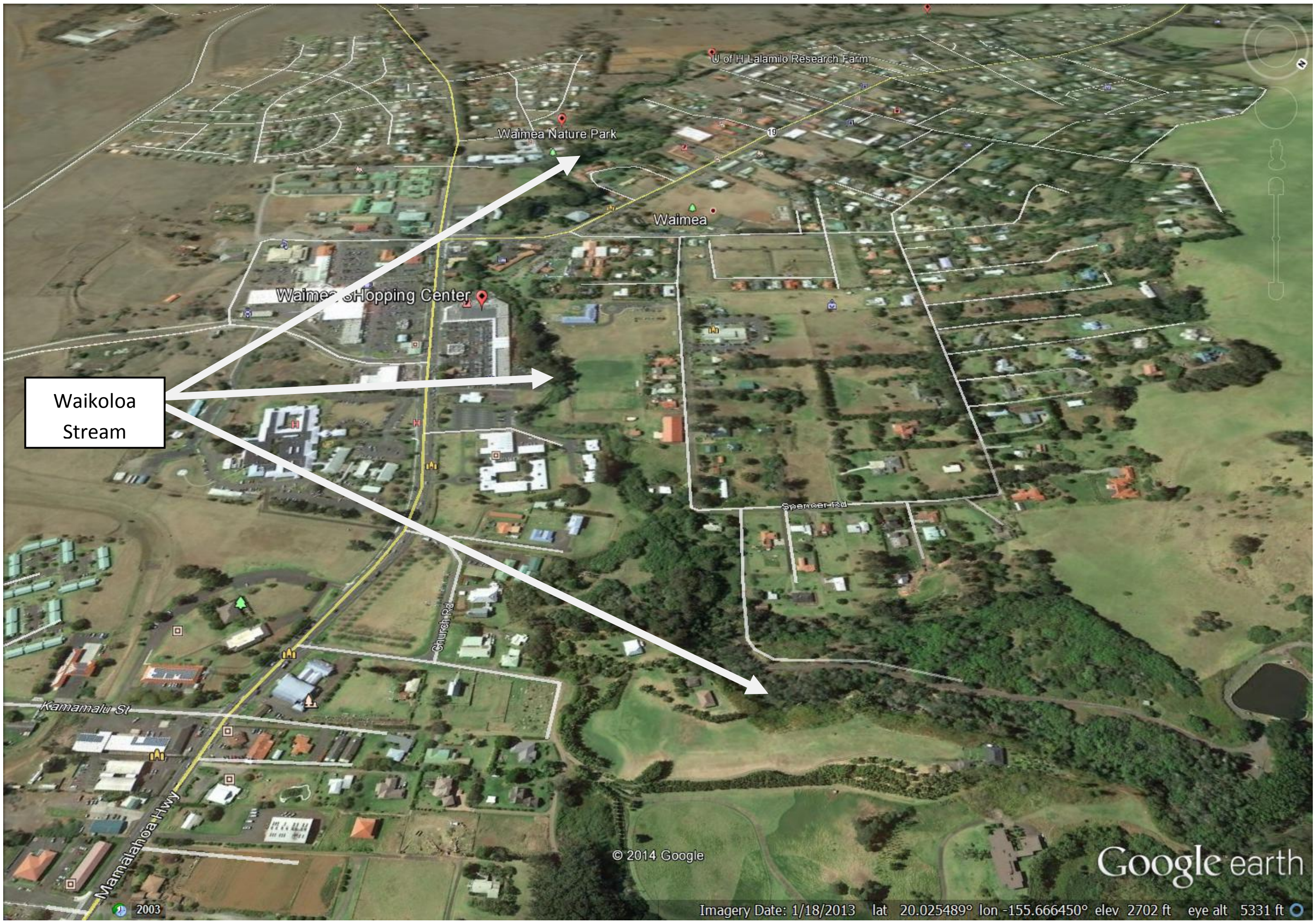
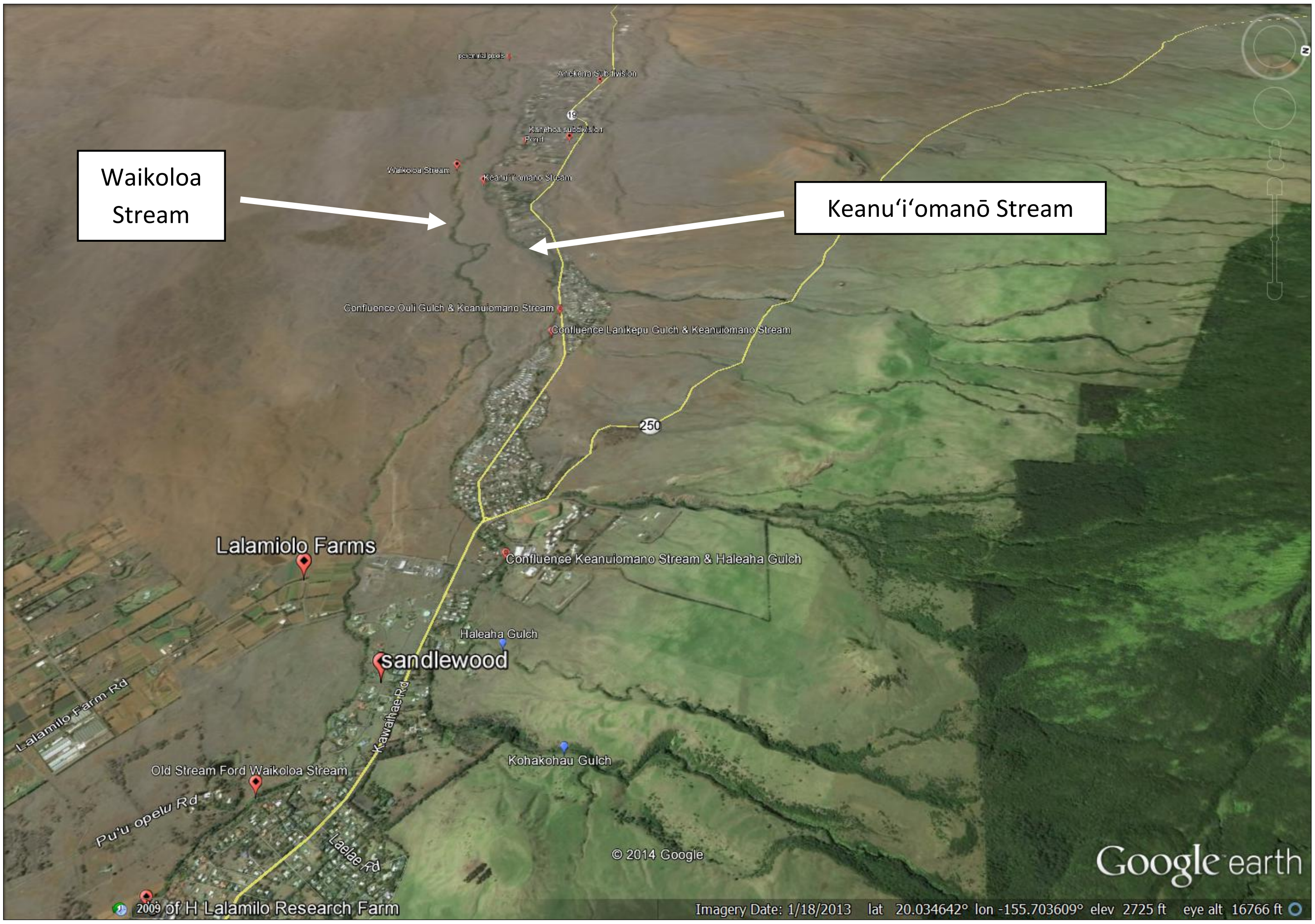


Photo 21. Waikoloa and Keanuʻiʻomano Streams, west of Waimea



Appendix B. Sites Targeted for Remediation

The following list of specific sites identified during field investigation includes: Site ID, Site Issue, Location, Land Owner, Priority for Remedial Action, and Recommended Management Measures. Each site is depicted by Site ID on a GIS derived map and in photographs. Site ID letters refer to delineation on GIS maps where: PT = Point, PL = polyline, and PG = Polygon. Under land owner, "UK" is unknown.

Site ID	Issue	Location	Land Owner	Priority	Management Measures
1PL	Road runoff / Erosion	Mau‘u Mae Beach to Kukui Point	Queen Emma Foundation	Low	Road improvement with drainage system
2PG	Burned area / Barren	Mau‘u Mae Beach	Queen Emma Foundation	Low	Install ground cover, revegetate
3PT	Runoff from maintenance yard	Mauna Kea Beach Hotel on south side of Wai‘ula‘ula Stream	UK	Low	Install dry swale
4PL	Eroding foot trail	Trail connecting Mau‘u Mae Beach to access road	UK	Low	Trail BMP, bars, kickout tread
5PT	Erosion	North side of Wai‘ula‘ula Stream crossing	Queen Emma Foundation	Low	Diversion dip
6PT	Unstable fill	Pump pad on Mauna Kea Plantation Estates, northern most pad	Mauna Kea Plantation Estates	Low	Erosion mat
7PT	Dump	1.15 miles east of shared property line of Mauna Kea Development and Mauna Kea Plantation Estates	Mauna Kea Development and Mauna Kea Plantation Estates	Low	Requires investigation to prepare recommended solution
8PT	Sediment input at dirt road crossing stream	Stream ford over southern branch Waikoloa Stream downstream of Old Rock Wall	Mauna Kea Plantation Estates	Low	Diversion swale
9PT	Sediment input at dirt road crossing stream	Stream ford over southern branch Waikoloa Stream upstream of Old Rock Wall	State of Hawaii	Low	Diversion swale and road BMPs
10PL	Degraded channel, sedimentation/erosion from cattle	Southern branch Waikoloa Stream above confluence with Keanu‘i‘omanō Stream	State of Hawaii	Low	Fencing
11PL	Degraded channel, sedimentation/erosion from cattle	Middle branch Waikoloa Stream above confluence with Keanu‘i‘omanō Stream	State of Hawaii	Low	Fencing
12PT	Sediment input at dirt road crossing stream	Confluence of Waikoloa and Keanu‘i‘omanō Streams	State of Hawaii	Low	Diversion swale and road BMPs
13PG	Cut fill pile with coarse and fine materials migrating into Waikoloa Stream	Waikoloa Stream DHHL Land Lalamilo Phase 2	State of Hawaii - DHHL	High	Stabilize pile; drainage
14PT	Ouli Gulch Outlet	Mouth of Ouli Gulch at Keanu‘i‘omanō Stream	State of Hawaii	Medium	(TBD) Possible Measure: Stabilization bank protection, bioengineering, geotechincal

Site ID	Issue	Location	Land Owner	Priority	Management Measures
15PT	Stream bank trampled by cattle	Keanuʻiʻomanō Stream at Ouli Gulch	State of Hawaii	Medium	Fencing, bioengineering, install water trough for cattle
16PG	Stream damage by cattle	Waikoloa Stream downstream of DHHL-State parcel	State of Hawaii	Low	Fencing, bioengineering
17PG	Erosion of steep exposed slope above Lanikepu Gulch	Lanikepu Gulch west of HPA	Parker Ranch	Medium	Bioengineering
18PT	Erosion of channel at culvert outfall	Lanikepu Gulch at Kohala Mountain Road	UK	Low	Outfall protection/energy dissipater
19PG	Sediment runoff into stream	Waikoloa Stream at UH Lalamilo Farm	State of Hawaii	Medium	Sediment buffer, bioengineering, grade adjustment
20PL	Sediment discharge off access road along margin of crop field	Waikoloa Stream, Lalamilo Farm Lots	UK	Low	Bioengineering, sediment buffer
21PL	Eroding and unstable stream bank in paddock	Keanuʻiʻomanō Stream at junction of Kawaihae Road and Kohala Mountain Road	UK	Medium	Fencing, revegetate exposed banks
22PL	Unstable bank on north side of Keanuʻiʻomanō Stream	DHHL Lalamilo housing along Alaneo Street	Multiple	Medium	Bioengineering, divert runoff from lots
23PG	Exposed banks, bacteria inputs from feral cat colony(s), parking lot runoff, storm water runoff from buildings, rubbish	Waikoloa Stream at Waimea Shopping Center	UK	High	Remove cats, revegetate stream banks, rain garden to intercept parking lot runoff, water harvesting of roof runoff
24PG	Unstable cut fill pile discharging sediment into Keanuʻiʻomanō Stream	DHHL Lalamilo development on south side of Keanuʻiʻomanō Stream	State of Hawaii - DHHL	Medium	Stabilization via erosion control
25PT	Storm water surface outfall into stream over unstable bank	Alaneo Street (end) and 6 other outfall locations in Waiaka Subdivision	UK	Low	Erosion control using geotextile mat
26PL	Eroding stream banks	Waimea Nature Park	Hawaii County	High	Stabilization using bioengineering practices
27PT	Stream ford Waikoloa Stream, runoff into stream, fish passage barrier	Kahawai Street (end)	UK	Low	Requires investigation to prepare recommended solution
28PL	Exposed banks, sediment input	Waiaka Subdivision	Various UK	Medium	Stabilization using bioengineering practices

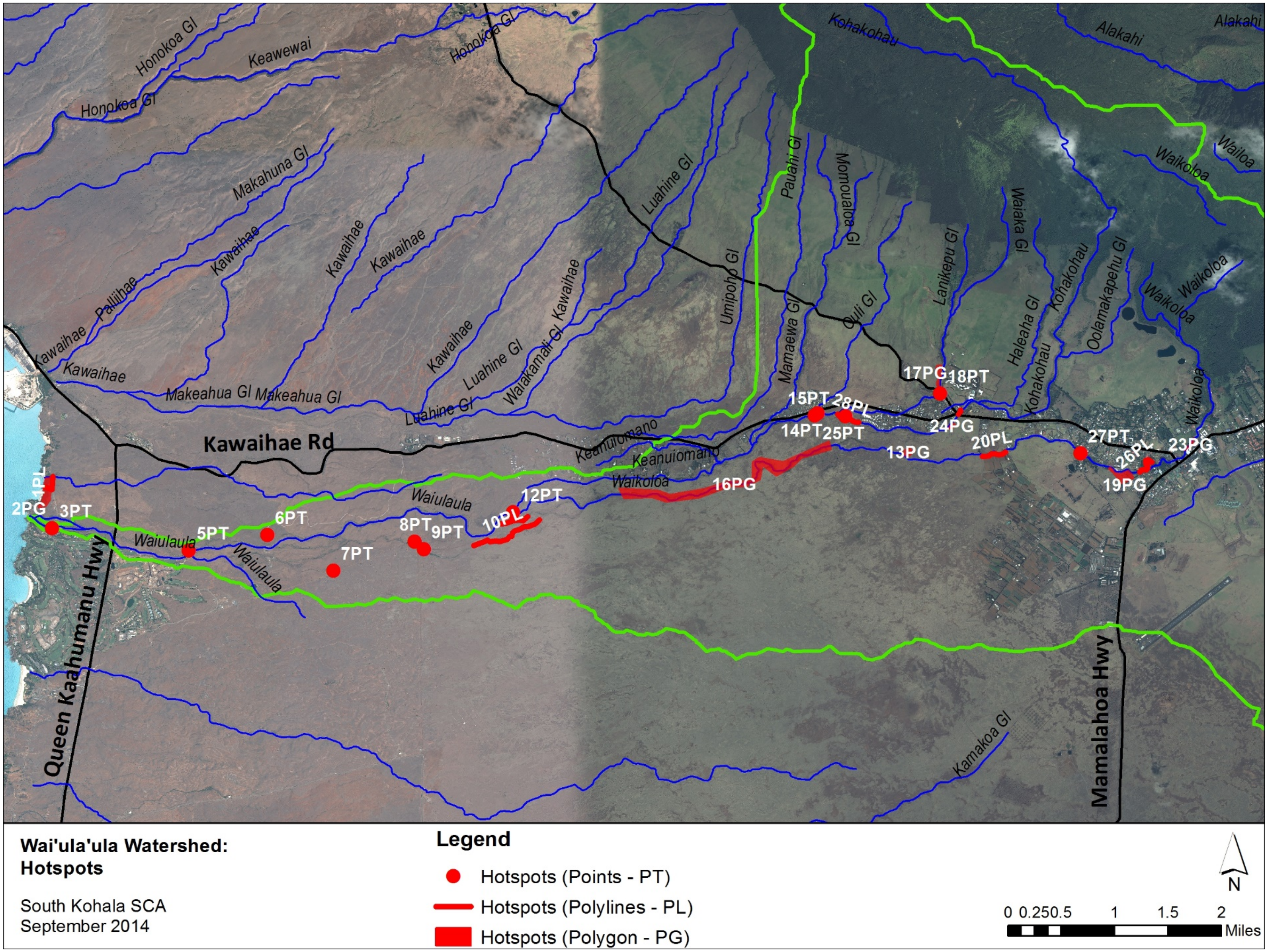

Kawaihae Rd
Queen Kaahumanu Hwy
Mamalahoa Hwy
Waiulaula
Waikoloa
Keanuiomano
Kawaihae
Makeahua Gl
Luahine Gl
Honokoa Gl
Keawewai
Makahuna Gl
Pallihae
Kohakohau
Alakahi
Wailoa
Kamakoa Gl
2PG
3PT
4PL
5PT
6PT
7PT
8PT
9PT
10PL
12PT
13PG
14PT
15PT
16PG
17PG
18PT
19PG
20PL
23PG
24PG
25PT
26PL
27PT
28PL
Wai'ula'ula Watershed: Hotspots
South Kohala SCA
September 2014
Legend
Hotspots (Points - PT)
Hotspots (Polylines - PL)
Hotspots (Polygon - PG)
N
0 0.250.5 1 1.5 2
Miles

Photo 1. 1PL, Road erosion near Mau'umae Beach

Photo 2. 2PG, Burned area at Mau'umae Beach

Photo 3. 4PL, Trail erosion on trail leading to Mauʻumae Beach

Photo 4. 4PT, Maintenance yard runoff

Edge of parking lot located on top of Waiʻulaʻula Stream south bank.

Photo 5. 6PT, Runoff/Sediment

Photo 6. 7PT, Rubbish Pile

Photo 7. 9PT, Dirt Road Crossing Channel

Dirt road approach over southern branch of Waikoloa Stream, State Land

Photo 8. 10PL & 11PL, General Landscape Image

Channel on Waikoloa Stream branch, typical of accessible steam areas where cattle bed.

Photo 9. 16PG, Typical Stream

Representative image of stream zone within trees, varying degree of stream channel damage

Photo 10. 14PT, Ouli Gulch Outfall

Photo 11. 15PT, Bank Damage

Keanuʻiʻomanō Stream access point by cattle at perennial pool

Photo 12. 28PL, Exposed Stream Banks

Photo 13. 29PT, Storm Water Outfalls

Waiaka subdivision home lots with rock mortar swales discharging onto bank of Keanuʻiʻomanō Stream

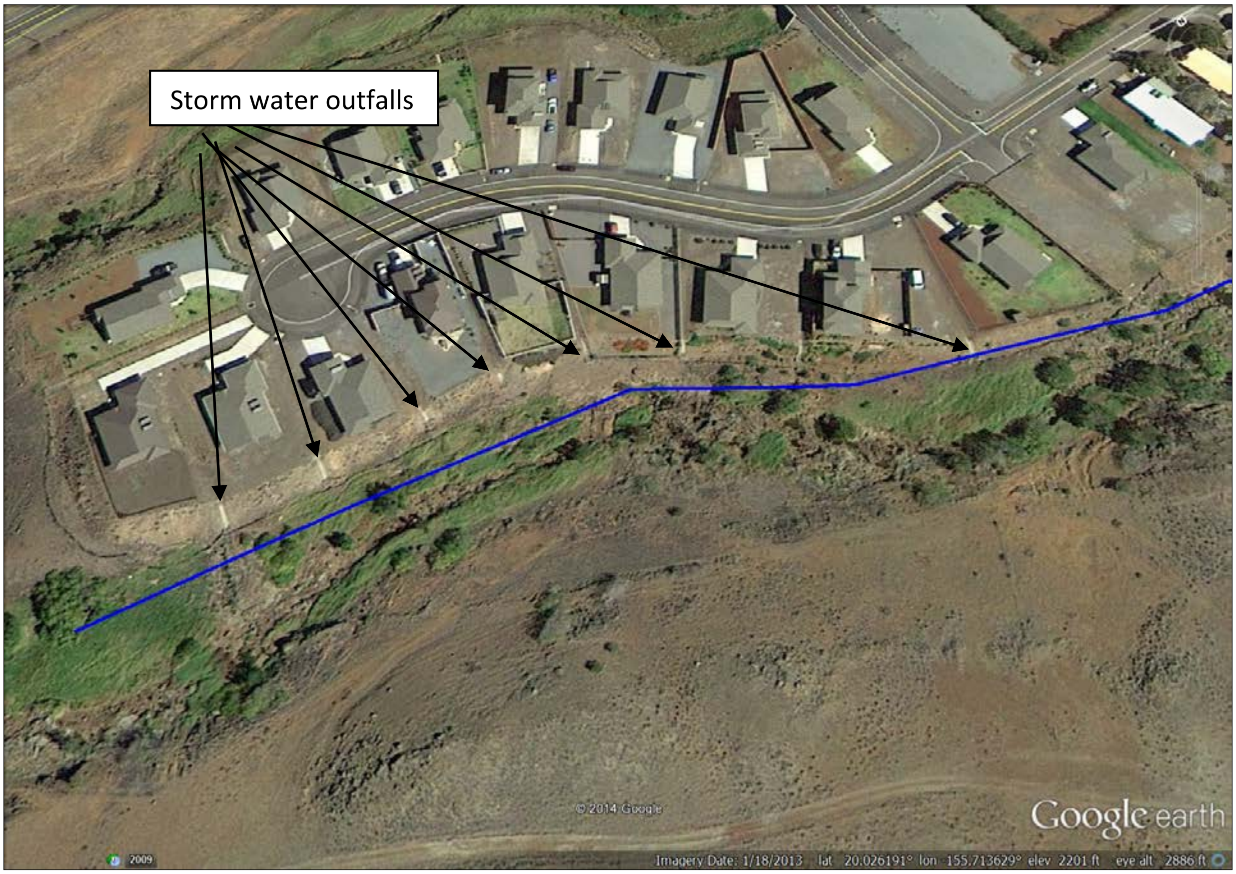


Photo 14. 13PG, Waikoloa Stream - Sediment runoff from stock pile on DHHL land

Photo 15. 24PG, Cut and Fill Piles

Cut and fill piles spilling onto floodway and stream from State DHHL Lalamilo development

Photo 16. 24PG, Aerial View of State DHHL Lalamilo Development

Build out foot print within black fence area appears to encroach onto floodway along Keanuʻiʻomanō Stream

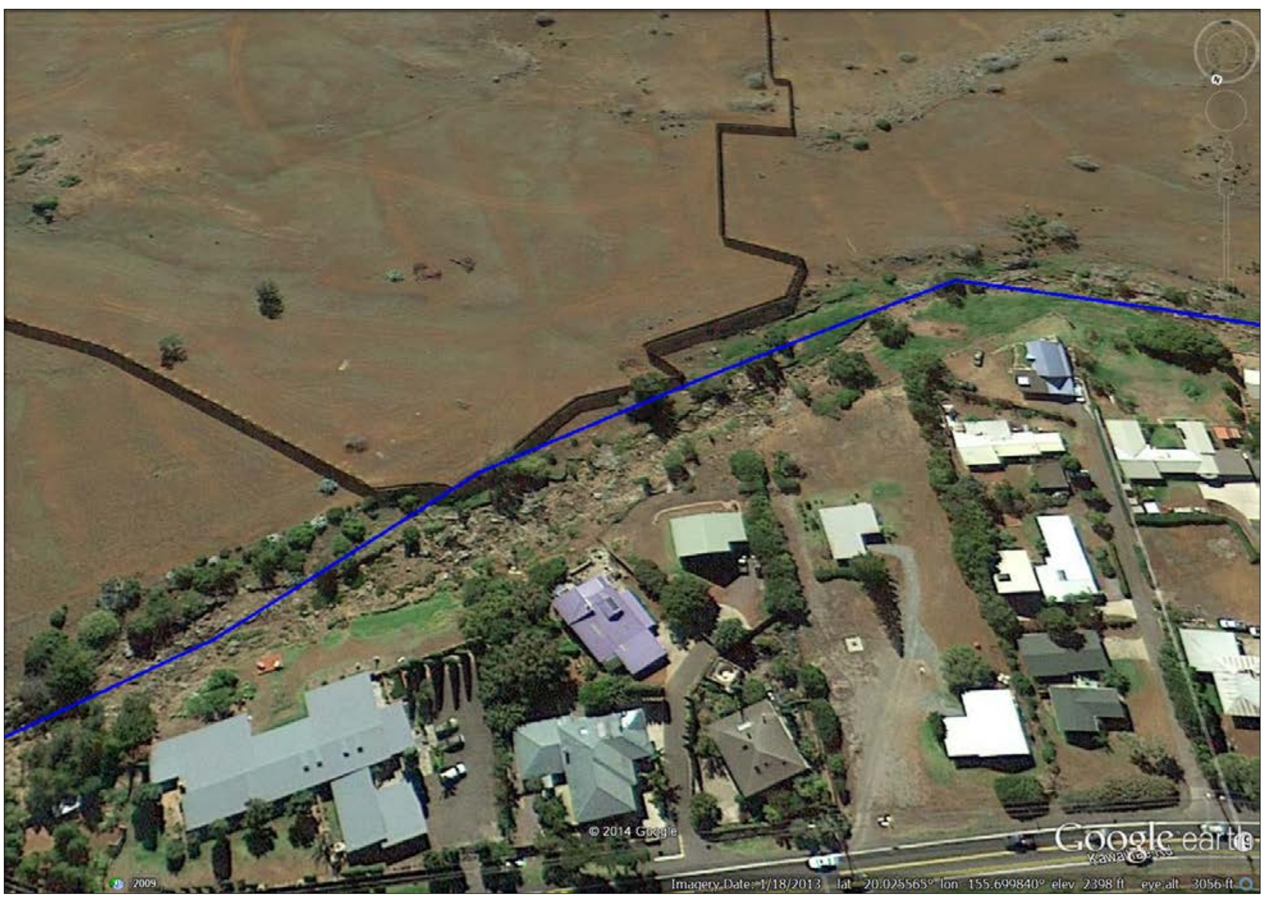


Photo 17. 17PG, Eroding slope above Lanikepu Gulch on Parker Ranch

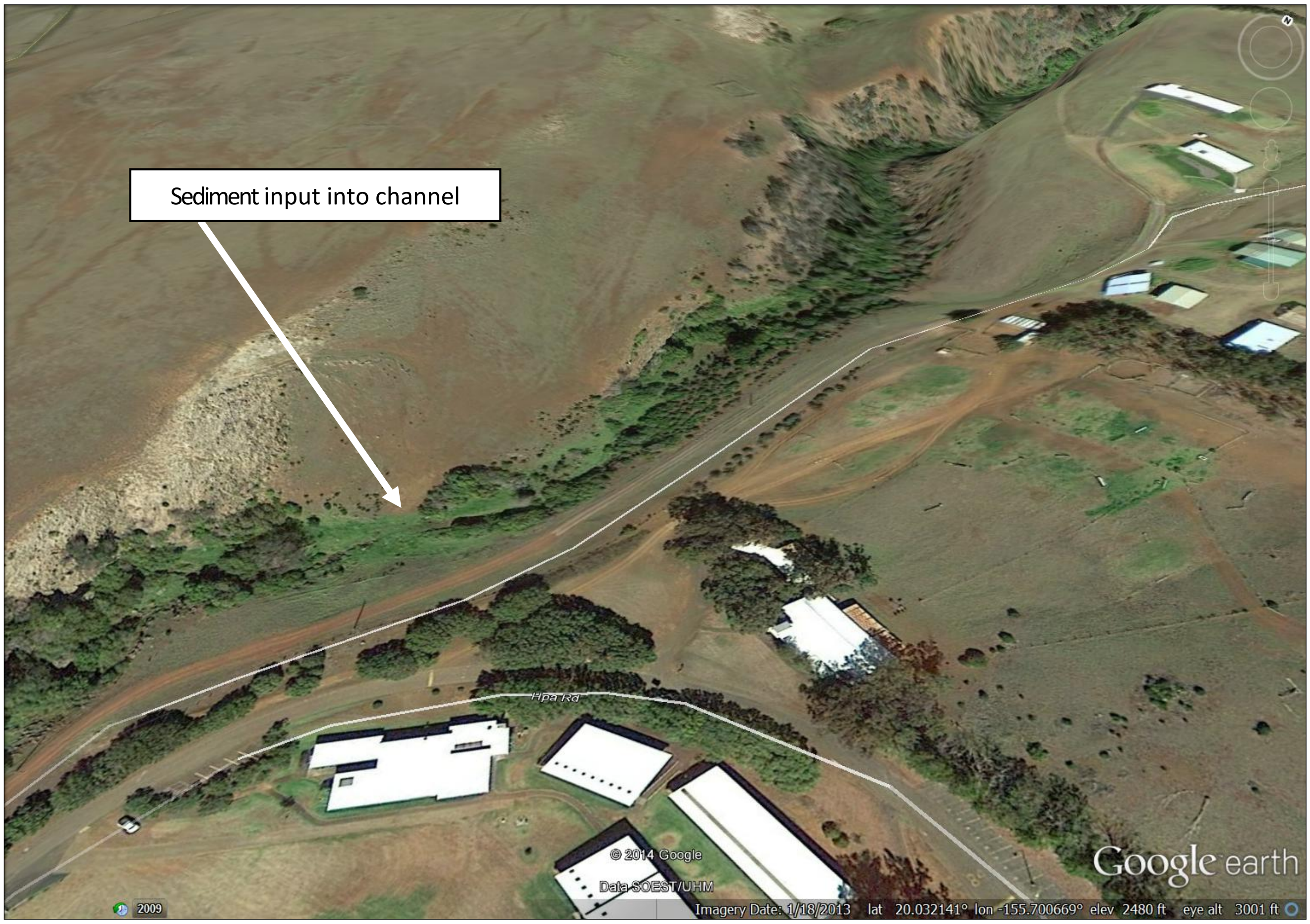


Photo 18. 21PL, Keanuʻiʻomanō Stream

Erosion and unstable bank of stream, zone used for pasture

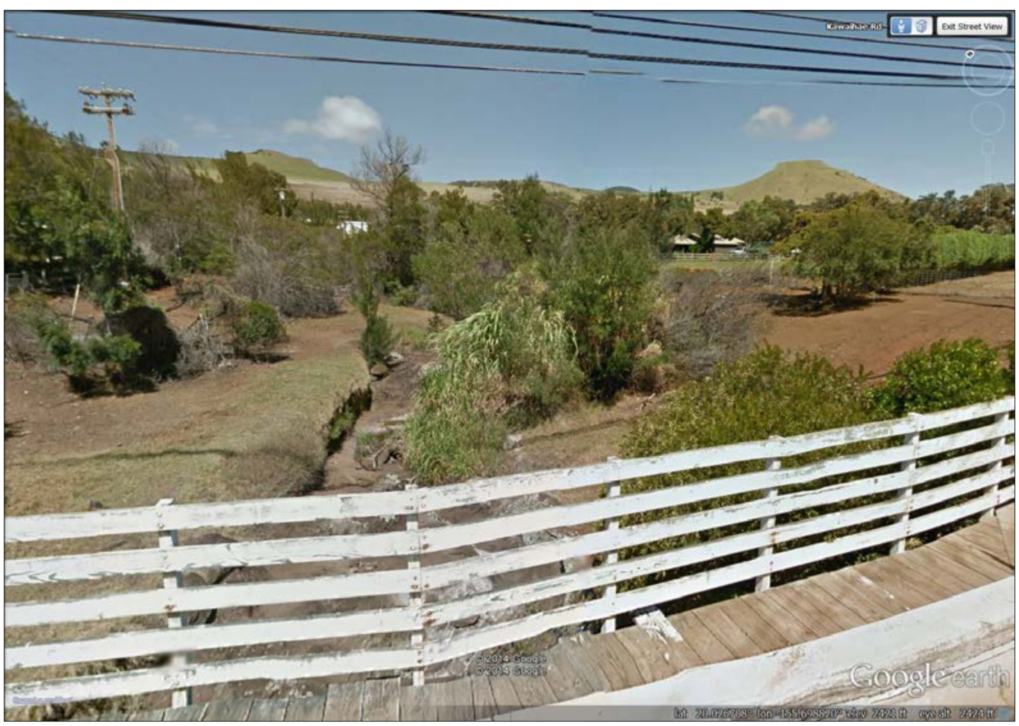


Photo 19. 20PL, Lalamilo Farm

Narrow buffer between edge of field and Waikoloa Stream

Photo 20. 30PT, Waikoloa Stream - old stream ford

Concrete ford instream creates possible fish barrier. Erosion and sediment input for approach roads into stream.

Photo 21. 19PG, University of Hawaiʻi Lalamilo Research Farm

Photo 22. 31PL, Waimea Nature Park - unstable banks

Photo 23. 23PG, Waikoloa Stream - Waimea Shopping Center

Multiple issues: degraded banks eroding, illicit discharge onto stream banks, feral cat colonies, bacteria loading into water, bare banks, parking lot runoff into stream.

Photo 24. 23PG, Waikoloa Stream - Waimea Shopping Center

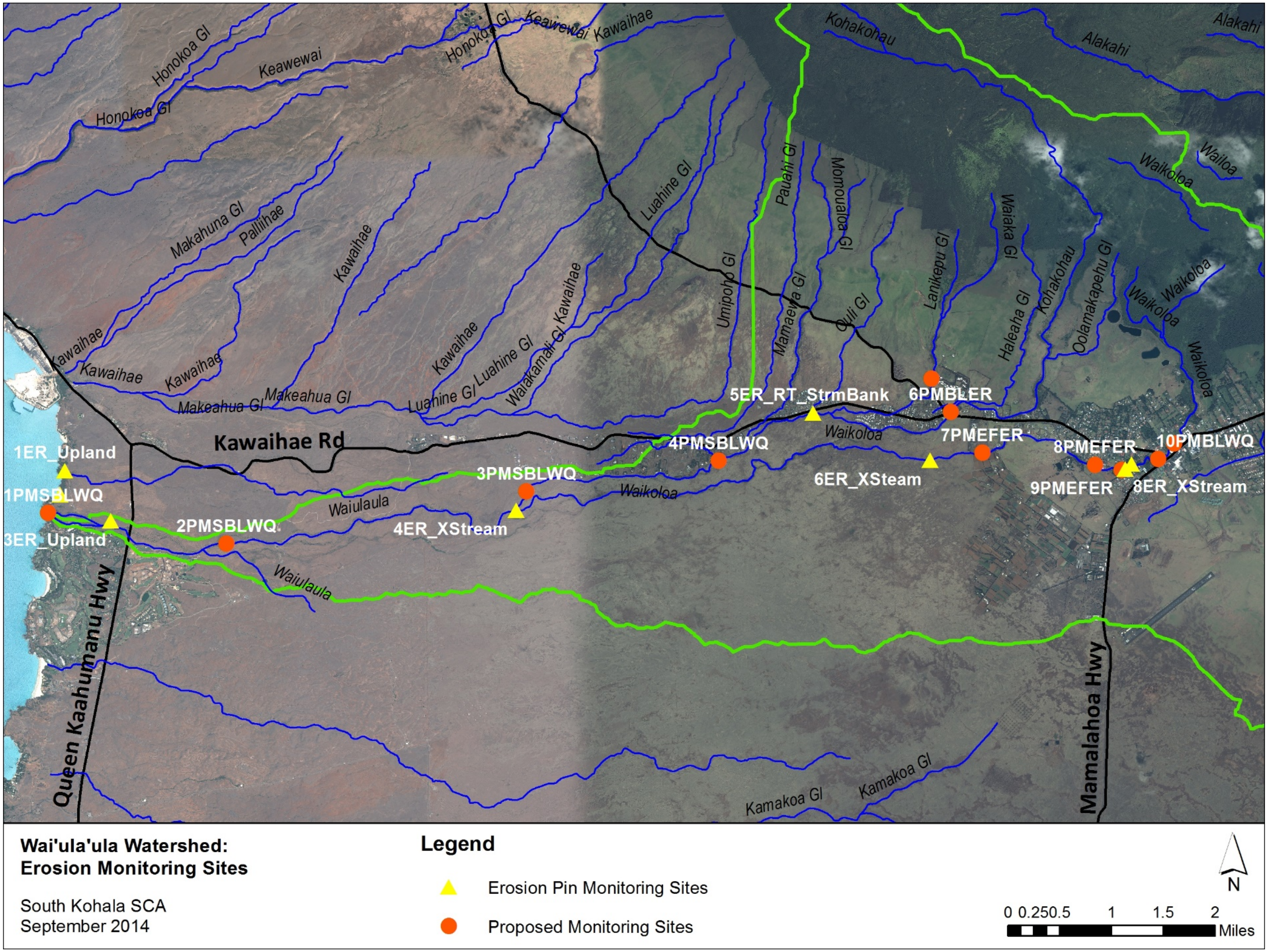
Appendix C. Erosion Monitoring

Summary of Sites, including site revisits in August 2014.

Site Code	Land Owner	Installation Location	# Pins	Delta Pin Heads
1ER_upland	Queen Emma	Flat trail area, exposed surface, near Mauʻu Mae	4	0.00
2ER_upland	State, Beach	Burn area inland from Mauʻu Mae Beach	5	0.00
3ER_upland	Queen Emma	North side Waiʻulaʻula Stream, burn area near ocean	5	0.00
4ER_XStream	State	Confluence Keanuʻiʻomanō and Waikoloa Streams	7	0.00
5ER_RT_Stream	State	Confluence Ouli Gulch & Keanuʻiʻomanō Stream	7	Station 2.0 del -0.4 ft Station 6.0 del -0.3 ft
6ER_XStream	State DHHL	Waikoloa Stream	5	0.00
7ER_RT_Stream	State	Waikoloa Stream Waimea Nature Park	5	Station 2 pin pulled Station 17 pin pulled
8ER_XStream	State	Waikoloa Stream Waimea Nature Park	5	Station 0.00 del 0.83 ft Station 17 del 0.83 ft

Codes: XStream = transect crossing stream; RT = transect along right bank of stream; upland = transect not in stream or gulch channel

Note: At 7ER site it is suspected that two pins were pulled by persons visiting the site.


Wai'ula'ula Watershed:
Erosion Monitoring Sites
South Kohala SCA
September 2014
Legend
Erosion Pin Monitoring Sites
Proposed Monitoring Sites
N
0 0.250.5 1 1.5 2
Miles
1ER_Upland
1PMSBLWQ
3ER_Upland
2PMSBLWQ
3PMSBLWQ
4ER_XStream
4PMSBLWQ
5ER_RT_StrmBank
6PMBLER
6ER_XSteam
7PMEFER
8PMEFER
9PMEFER
10PMBLWQ
8ER_XStream
Kawaihae Rd
Queen Kaahumanu Hwy
Mamalahoa Hwy
Waiulaula
Waikoloa
Kohakohau
Alakahi
Wailoa
Keawewai
Kawaihae
Honokoa Gl
Makahuna Gl
Pallihae
Makeahua Gl
Luahine Gl
Walakamali Gl
Umipoho Gl
Pauahi Gl
Momoualoa Gl
Mamaeva Gl
Ouli Gl
Lanikepu Gl
Waiaka Gl
Haleaha Gl
Oolamakapehu Gl
Kamakoa Gl

Erosion Monitoring Plan

Introduction

Streams and the channels they create are dynamic features on the landscape, changing over time due to erosion and deposition of sediments. Under undisturbed conditions rates of erosion and deposition are a function of several variables including hydrology, slope, composition of bed and bank materials, and lithology the stream is located on. Activities that alter one or more of these variables have the potential to increase rates of erosion and or deposition. Rates of erosion increase when stream bank vegetation is removed or reduced, or when activities that damage the stream channel occur. Reducing stream bank erosion where rates exceed background levels is important because sediment and associated non-point source pollutants are directly input into streams and cause adverse environmental effects on waterways, including streams and nearshore coral reef ecosystems. Upland erosion and delivery of sediments into stream systems contributes to the overall sediment load a stream transports. Similar to stream systems, alteration to ground surfaces affects rates of erosion, and in many instances rates increase as result.

Erosion pin monitoring is a simple tool that can be used to compute rates of erosion and/or deposition, and assess changes over time to surfaces of stream channels or upland areas under undisturbed and disturbed conditions. Erosion pins can be installed at locations to quantify baseline conditions and/or effects from activities such as restoration projects or land use activities. When combined with photo point monitoring, erosion pins can be used to monitor relatively small surficial changes over time at discrete locations. Documentation of adjacent land use and changes in watershed hydrologic conditions over time is important to determine how the changes impact erosion and deposition over the watershed including within and out of stream channels.

Monitoring Objectives

- Provide long-term data on stream bank stability and rates of upland erosion and deposition.
- Determine effectiveness of management practices installed to reduce stream bank erosion and rates of erosion and deposition on upland surfaces.

Sites

Select erosion monitoring sites throughout the watershed based on review of aerial photos and on-the-ground conditions. Locate sites to document erosion rates of stream banks at reaches where adverse impacts were observed, and where the channel bed and banks were conducive to installation. Select upland sites in areas where impacts to ground cover are observed (e.g. within areas subjected to wildland fires).

Methodology

Erosion Pins

The erosion pin is a 10-inch long galvanized steel spike nail with a 1/2 inch head. The number of pins installed will vary between four and eight. At a site, string a fiberglass measuring tape across the ground surface. Install an erosion pin at each end of the area to be monitored and tag with an aluminum label. Set each pin so that the bottom side of the headpin is flush with the ground surface. The top side of the pin head is 0.00 vertical reference. Assign Station 0.00 to the end pin connected to the zero point on the tape. Secure the tape to the end pin and stretch across the area to measure and install the middle pins at various distances from the end pin. Middle pin stations/distances should be referenced to the 0.00 station. Record the following information at each site: GPS coordinates, heading of the pin transect from 0.00 pin to opposite end pin (compass set to true north), total length of the transect, and pin stations.

Photo Points

Recommended photographs at each site include: 0.00 pin to opposite end pin, middle of transect to each end pin, and other photographs depicting features that could be used as reference to locate the pins in the future.

Frequency

Channel and bank monitoring should continue indefinitely. Data should be collected at each site twice a year, once in the dry season and once in the wet season (January and July).

Data Form

Date	
Site Code	
Station (ft)	
Pin to Ground	
Photo Count	