Wailupe and Kuliouou Watershed Assessment and Protocol Development

Maunalua Bay, Hawaii

Final Report by

Rebecca Prescott, M.S.

Submitted to

Malama Maunalua

Table of Contents

List of Figures

Brief Summary

Wailupe and Kuliouou watersheds were assessed for potential pollution impact sites to Maunalua Bay and possible restoration sites in terms of water quality. Assessments included within channel surveys (*reach assessments*) and evaluation of subwatersheds (*neighborhood assessments*). For all reach assessments, a reach was defined as 0.25 miles of stream or channel. Neighborhoods were designated prior to neighborhood assessments, and included all residential areas within a valley that drain into each stream (the floodplain). All surveys were completed between June-September 2009.

Reach assessments along Wailupe stream determined that much of the stream bank is severely eroded. Some residents along the stream have drainage pipes leading directly from their property to the stream channel. As Wailupe is not lined with concrete, it provides a significant source of sediment to Maunalua Bay, but the natural bottom filters contaminants such as PAH's, pesticides, and heavy metals through biofilms, plants, and sediments before waters reach the Bay. Considerably more trash was observed higher up the stream channel than in the lower reaches. During all surveys of Wailupe, waters in the upper reaches were clear. Fish, birds, snails, cats, and ducks were observed using the stream, indicating that the stream provides marginal to sub-optimal habitat for organisms. In the lowest reach (closest to the ocean), water was tidally mixed and turbid. There was some evidence of trash dumping from residents along this portion of Wailupe stream, including bait traps for insects and animal carcasses.

Wailupe neighborhood assessment determined that most of the houses are single-family homes, with an average lot size of 884.9 meter-squared, roughly 54% impervious surface, and 46.2% pervious overall. Lots were larger than in Kuliouou, and therefore storage in carports was considerably lower in Wailupe. More than 60% of the neighborhood had gutters and all areas surveyed had curbs. Streets, gutters and curbs were very clean, as well as driveways. One noticeable behavior common in Wailupe was that many residents have pipes leading from their properties directly to sidewalks or gutters. Roughly 10% of the houses surveyed were completing construction, landscaping, or remodeling. In most cases, silt fencing was needed.

Noted hotspots include the Aina Haina Shopping Center, outfall at Kawaikui Beach Park in front of Hawaii Loa Ridge, Kalanianaole Highway, and one residence. One issue with all storm water outfalls at the ocean is they deposit storm water runoff at the shoreline instead of offshore in deeper waters. Hawaii Loa Ridge was not surveyed as it is a gated community and I was not allowed to enter; however I was able to gather some data from Google Earth.

Reach assessments for Kuliouou evaluated the stream channel from the coast to the catchment basin, all of which is channelized and lined with concrete. In the lowest reach, tidal mixing and even a tidal bore were observed, with turbid waters covering 100% of the stream channel. Ducks and fish were observed utilizing the area. In the upper reaches, most houses had pipes directly connected to the stream channel. Less than 10% of the residents had rooftop downspouts connected to the stream. Haleloa I and II condos and apartments were classified as a hotspot due to concrete drains connected to the stream channel directly from parking lots. Dog feces were observed in the channel adjacent to Kuliouou Neighborhood Park. It appeared that park users were throwing dog feces into the stream instead of placing it in trash bins. This is a source of bacterial and protozoa contaminants that can lead to human illness, as well as a source of nutrients. Tennis balls and cigarette butts were also recorded along the stream adjacent to Kuliouou Park. The number of pipe connections to the stream and amount of trash present increased higher up the channel.

Kuliouou neighborhood assessment concluded that on average a lot size was equal to 561.7 meters-squared, consisting of 80% single-family homes and 20% multifamily complexes, with 42.5% impervious surface overall. Due to the smaller lots, people stored more in carports and more cars were found to park along the street compared to in Wailupe. Moreover, there were fewer green spaces. Forty percent of houses surveyed had rooftop downspouts connected to an impervious surface. In the lower portion of the neighborhood, dogs were common, and dog feces in yards may be a considerable source of nutrients to streams and to Maunalua Bay. Pesticides were observed being applied by landscaping companies on church property within two blocks of the beach.

Detailed Summary of Watershed assessment, Wailupe and Kuliouou

1. Methods

Protocols for reach assessments were developed with the intent of volunteers using and completing surveys in other watersheds. A reach was defined as 0.25 miles of channel or stream (based on Unified Stream Assessment: a User's Manual version 2.0, produced by the *Center for Watershed Protection*), and worked well for dividing the stream into sections. With a minimum of two people, we walked streams from easy access points measuring **1) channel dimensions, 2) habitat quality and land use, 3) behaviors of residents along stream banks, 4) severe erosion, and 5) location and condition of storm water outfalls.** Representative pictures of behaviors, outfalls, and erosion were collected and sediments samples were gathered from several reaches along the channels for analysis of nutrients, heavy metals, and other hazardous chemicals.

Neighborhood source assessment protocols were developed as well for use with volunteers (from Unified Subwatershed and Site Reconnaissance: A user's manual by the *Center for Watershed Protection*). We determined **1) general characterization of each neighborhood**, based on the average density of houses, average lot size, estimated number of pools, and estimated percent cover of impervious and pervious surfaces. These data were collected from Google Earth images of Wailupe and Kuliouou Watersheds. From walking and driving surveys, we collected information on **2) average lot characteristics, 3) storm drain and gutter conditions, and 4) behaviors of residents and points of interest**. These data were collected by evaluating 20 randomly selected points. Random points were generated by the internet site "Random Point Generator by Geo Midpoint" (http://www.geomidpoint.com/random/) and entered into Goggle Earth. Last, information on **5) high pollution source areas** (i.e. commercial shopping centers, highways) were recorded as "Hotspots." Field data entry forms were created for both the Reach assessments and the Neighborhood assessments, data were entered into an Excel spreadsheet, and many locations were marked in a Google Earth file for presentation purposes.

A. Wailupe: Wailupe assessment went from Wiliwili Nui Ridge across to Kawaikui Beach Park, including Wailupe Beach Park, Wailupe stream, Aina Haina neighborhood, Wailupe Circle, and Hawaii Loa Ridge.

2. Reach assessments: Wailupe

2a. Channel dimensions and general characteristics

Wailupe stream is unusual for Maunalua Bay watersheds as it is not lined with concrete (Figure 1). It has been straightened and is likely a significant source of sediments to Maunalua Bay. In the lowest reach (reach #1), the channel has a rock wall with turbid flow covering 100% of the channel bottom. This is mostly seawater, as we observed a strong backwash from high surf into the channel. Above Kalanianaole highway, waters become clearer; a sandy mud bottom with large rocks was observed. During the late summer of 2009, flow decreased to 0-50% of the channel through the middle reaches, and then increased again in the last two reaches to cover 50-75% of the channel. Waters were clear throughout Wailupe stream, except for the lowest reach (reach 1) and in the second reach where the stream ran dry. The benthic substrate consisted of boulders from the second reach to the catchment basin, and the boulders got larger in size at the upper reaches.

Figure 1: Wailupe stream, one of a few natural bottom streams in the Maunalua Bay area.

The bank angle ranged from 45° to 90° in Wailupe stream resulting in considerable erosion (discussed below). The top width of Wailupe channel varied greatly due to erosion and slope failure, but on average was 10.5 m (34.4 ft). The bottom width of the channel averaged 7.85 m (25.8 ft), and the bank heights were 3.0 m (9.8 ft). In regards to bank heights, because of the instability of many sections of stream banks, we were unable to measure the height and thus had to estimate the height.

2b. **Habitat quality and land use**

Wailupe is one of the only streams draining into Maunalua Bay that is not lined with concrete; therefore, it provides a natural environment for organisms and a source of filtration of pollutants into the Bay. We found that habitat quality was sub-optimal to optimal due to straightening of the stream bed and residential land use of most land directly adjacent to the stream. A number of organisms were observed including, birds, snails, ducks, and a variety of insects, and 25% to 95% of the stream was shaded. Biodiversity appeared to be higher in Wailupe than Kuliouou, but no data were collected to determine biodiversity values. Many of the plant species along the stream are invasive species.

2c. **Behaviors of residents along stream banks**

Less than 1% of houses along Wailupe stream had rooftop downspouts connected directly to the stream and this behavior was not common. One resident expressed concern over bank erosion, and believed that by connecting his rooftop downspout to the stream bottom, he would be reducing erosion. He was unaware that this is in fact illegal. Less than 30% of the houses along the streams had PVC or corrugated pipes connected to the stream from their property (Figure 2). The number of pipes connected to the stream channel increased further back into the valley. If pipes were connected to yard runoff from highly manicured lawns or yards where pet waste is common, this would be a considerable source of nutrients and pesticides to Maunalua Bay.

Figure 2: Corragated pipe running from residence to channel along Wailupe stream and planting along bank, perhaps to prevent more erosion.

Through reaches 5, 6, 7, and 8, trash dramatically increased compared to the lower reaches of Wailupe stream. Plastic bottles, car parts, ropes, and pottery were observed. Less than 5% of the residents appeared to dump yard waste into the stream, but there

were several locations where yard waste had clearly been placed in the stream channel. In addition, one residence was using the stream channel to dump trash such as a trampoline, construction materials, pottery, and Christmas lights (Figure 3). Less than 5% of the residents were using the stream to dump construction materials. A few residents had extended their yards into the stream bank and were planting trees and other plants.

2d. Severe Erosion

Severe erosion occurred along much of the banks of Wailupe. Specific locations of severe erosion were recorded. In some cases, bank instability appeared to be a threat to property (Figure 4). Slope failure and undercutting were both common along the stream (figures 5). In some areas vegetation covered stream banks and helped stabilize sediments; however large boulders were frequently loose. Boulders and fine sediments were also observed at the mouth of Wailupe stream. Bank stabilization is highly recommended.

Figure 3: Trash dumping along Wailupe stream was common. In this location, decorative lights, pots, and a trampoline had been dumped into the stream channel.

1e. Location and condition of storm water outfalls

Storm water outfalls locations were recorded on data sheets and entered into an Excel spreadsheet. The condition of outfalls in the lowest reaches could not be determined as they were constantly underwater. In general, storm water outfalls were very clean. Many had water stains but few had any water flow or biofilms (Figure 6). None of the outfalls had odors or large amounts of trash, and there were no signs of sewage. In general, storm water outfalls were not blocked by vegetation. They were found to be consistently of similar size and shape (one meter in diameter). An important factor to note is that in the second reach, there is a road that connects

Figure 4: Severe Erosion along Wailupe Stream. erosion was a threat to property in this picture. The ban was eroded away from fencing on the property.

Figure 5: Bank undercutting along Wilupe stream, an example of severe erosion.

to the stream bottom and functions as a storm water outfall. Water stains were observed on the road. It appears that in heavy rains waters flowing down the road create counter currents (the road faces up stream), increasing the rate of erosion.

3. Neighborhood assessment: Wailupe

3a. General characterization

We estimated that 80% of Wailupe watershed consisted of single-family homes, 5% multifamily dwellings, 3% commercial, and 5% parks or open space. There were 12.8 swimming pools on average in a 0.5 square-mile area, and there was more variability in the care of homes and size of lots in the Wailupe watershed than Kuliouou. The average street width was 8.6 m (28.2 ft: Google

Figure 6: Typical storm water outfall observed along Wailupe stream, roughly 1 m in diameter. Outfalls were clean and usually few of plant debris.

Earth estimate was 8.4 m) and the average driveway width was 5.3 m (17.4 ft). Cars were commonly parked in driveways (on average two cars/driveway), and most people parked cars in carports; however, street parking was also observed (2.6 cars per 500 m). Trash or high storage in yards and carports was not common. Sidewalks were almost always clean (90%), with less than 1% of sidewalks covered in vegetation or yard waste. Roughly 90% of houses had either a carport or garage, but sheds were not as common (less than 20%). Fifty percent of the houses surveyed had manicured lawns, and most houses had some type of landscaping (Figure 7).

We estimated that at least 10% of the houses were undergoing remodeling or landscaping, none used silt fencing, and sediments were washed out into the streets. Houses throughout Wailupe watershed had pipes running directly from yards or houses to sidewalks and storm water systems, indicating a pollution source (discussed in the "behaviors" section).

Significant pollution sources include nutrients from lawn care and pet waste (that are being drained directly to storm water systems), low amounts of trash and litter, sediments from landscaping and construction, and chemicals associated with cars (such as oil, cadmium, lead, and petroleum products). We recommend discussions with residents on stenciling all storm drains, improved lawn practices to lower pesticide use and fertilizers, removing pipes running to sidewalks and gutters, and using silt fencing for landscaping and construction.

3b. Average lot characteristics

On average, lots in the neighborhoods within Wailupe drainage were 884.9 meters-squared, larger than lots in Kuliouou neighborhoods. One important consequence of this was that storage in carports and garages was low in Wailupe, decreasing the likelihood of chemical spills and trash that could be carried away by storm water runoff. Driveways were very clean, but 30% of the lots sampled had driveways that were breaking up. There were few gardens observed (25% of houses). However this may be due to the fact that some gardens are difficult to see from the road.

On a given lot, 68.5% of the lot was impervious surface, 31% pervious, 2.5% had bare soil, 20.4% was covered with grass, and 5.8% had trees. Roughly 30% of the lots assessed had small amounts of pet waste and were relatively clean of debris. Most houses did not have rooftop downspouts (or they were not visible). Of the houses that did have downspouts, 20% were connected to impervious surfaces, which would lower filtration of pollutants running from the roof. Roughly, 25% of houses had garages and 75% had carports.

Figure 7: Average home in Wailupe watershed with carport, clean driveway and sidewalks, and manicured lawn.

3c. Storm drain and gutter conditions

Curbs were always present (gutters were present at more than 80% of random points and observed throughout the neighborhoods), 65% of gutters were clean and dry, 15% had asphalt sediments, and 15% had organic matter or plant debris. Storm drains, if present within a few hundred feet of random lots selected for survey, were assessed as well. Only 25% of the storm drains were stenciled with logos to decrease residents from using storm drains as dumpsites. Stenciling all storm drains is recommended. Overall, 25% of storm drains were clean and 15% had plant debris and trash that was partially blocking the drains.

Storm water outfalls at the ocean were sometimes blocked by vegetation and trash such as styrofoam, tires, and plastics. A drainage ditch to the bay was always blocked with lots of trash (located just to the west of Kawaikui Beach Park). The outfall in the middle of Wailupe Circle (under the pier) flushes quickly as the water is deep with a considerable current; however, according to a resident, the outfall on the east side of Wailupe Circle overflows regularly

emptying into shallow water, and is blocked by an old fish pond wall and vegetation. Residents do their best to keep the outfall clear.

3d. Behaviors of residents and points of interest

More than half of the residents in Wailupe watershed have pipes (PVC or corrugated) that lead from their houses and yards directly to sidewalks (Figure 8). Sometimes these pipes are connected to gutters or storm drains. This was the most noticeable behavior of residents in Wailupe watershed regarding storm water runoff. Pipes that are not connected to pervious surfaces do not allow rainwater to percolate down through soils, naturally filtering the water and slowing the speed at which freshwater enters Maunalua Bay.

Roughly 10% of the houses in Wailupe watershed had construction, remodeling, or landscaping. None of the houses had silt fencing to prevent sediments from washing away during rains. In general, storage in carports and garages was much lower and there were slightly fewer cars parked on the street. Oil and other stains were not common on streets in the Wailupe watershed areas. Boats were somewhat common, usually parked on streets and could be a pollution source if boats are maintained at houses (paints, oil, etc.). Car washing was observed at one residence adjacent to Wailupe stream.

Figure 8: Pipe running from residence directly to sidewalk, a very common practice in Wailupe neighborhoods (Aina Haina). Pipe is connected to impervious surface and decreses filtration of runoff before entering the strean channel.

There were several open areas noted in Wailupe watershed. Pet waste was not observed at Kawaikui or Wailupe Beach Park. At the dog park adjacent to Wailupe Valley School, plastic bags were hung on the fence to encourage people to collect pet waste and rubbish bins

were readily accessible. No pet waste was observed in the park. Illegal dumping or large amounts of trash was observed at one residence (listed as a hotspot) and the catchment basin in Wiliwili Nui Ridge (Figure 9). Yard trash was always bagged.

3e. High pollution source areas (Hotspots)

One residence was listed as hotspot due to the large number of chemicals stored in the carport. Most of the containers were rusting and leaking was highly possible. There was no evidence however of chemicals in the storm drains nearby.

Kalanianaole Highway was considered a hotspot, with plastics, cigarette butts, oil, brake fluids, and cadmium from car tires causing pollution. During rush hour traffic, 125 cars/minute passed on the street.

The storm water outfall at Kawaikui Park in front of Hawaii Loa Ridge was classified as a hotspot due to the bad odor coming from the drain. There is of course no evidence of storm water treatment. Trash was observed in the drain and it was partially blocked by vegetation. There was no evidence of chemical pollution problems, but there may be a sewer leak causing the bad odor. A detailed site investigation may be required. One issue with all coastal storm water outfalls is that they deposit storm water runoff at the shoreline instead of offshore in deeper waters.

Figure 9: Illegal dumping at Catchment basin along Wiliwili Nui Ridge. Yard waste and a motercycle are easily seen in this photograph.

Aina Haina Shopping Center is a hotspot for a number of pollutants including, sediments from construction, fueling station, asphalt, highly manicured lawns and landscaping, and commercial parking lots. We estimated roughly 75 cars in the parking lot during the day, so this might be higher in evening hours. The gas station and parking lot had stains on the concrete from leaking cars. Cars are stored for short periods at the gas station and repair shop. We saw no evidence of chemical pollution from leaky waste containers at the gas station, but fueling areas are close to gutters. This shopping center is very close to the waterfront, so runoff has little chance to be filtered before reaching Maunalua Bay. Trash and littering was low except for cigarette butts. Rubbish bins were available in the parking lots.

B. Kuliouou: Assessment of Kuliouou went from Paiko Peninsula to Kuliouou Beach Park, including Kuliouou neighborhood following Kuliouou Road and Kuliouou Channel.

4. Reach assessments: Kuliouou

4a. Channel dimensions and general characteristics

Kuliouou is typical of most streams in the Maunalua area: it has been straightened and lined with concrete in its entirety (Figure 10). This increases the rate at which freshwater flows into Maunalua Bay, with the intent of decreasing flood events to residential areas. However, without a natural sediment bottom and a meandering stream, Freshwater, sediments and pollutants enter the bay at a high rate.

In the lowest reach (reach #1), from the bay up roughly 0.25 miles, Kuliouou stream has water that is considered brackish. Turbid and opaque water covered 100% of the channel in this reach. Fish, birds, and ducks utilize this roughly 1.3 m (4.5 ft) . During the summer of 2009, from the second and third reaches, flow decreased dramatically, covering only 10-25% of the channel, and roughly an inch deep. The water was clear, and biofilms were growing wherever water flow occurred. At Kuliouou Neighborhood Park, a side channel enters the stream and the banks become vertical. Flow was two inches here, with large algal mats of 3 m length (9.8 ft) downstream, suggesting that nutrient and water inputs may have increased in the area. From this point onward to the catchment basin (reaches 4 and 5), flow covered 80-100% of the channel

Figure 10: View of Kuliouou channel near Kuliouou Beach Park. Kuliouou is a typical drainage in Maunalua Bay area, as it has been striaghened and lined with concrete in its entirity.

bottom, was clear with plant material and biofilms, and was only 1-2 inches deep. Banks were vertical, and surveys of these reaches are not recommended as there is no quick exist from the channel if a flash flood occurred (Figure 11). Kuliouou channel banks are lined with concrete, and bank angles varied from 65° to 90°. The top of the channel was on average 7.2 m (23.8 ft) and the bottom of the channel was 9.3 m (30.4 ft). The banks were on average 2.5 m (8.2 ft).

4b. Habitat quality and land use

Land use along the banks of the Kuliouou channel is 80% or more suburban residential. There are two areas that are not developed (open with invasive trees and grass): one is in reach #2 just above the tidal mixing zone, and the second is at the catchment basin. Kuliouou Neighborhood Park provides some open area as well. Habitat quality along the stream banks and in the stream channel is considered poor quality, as it is lined with concrete and dominated by housing.

4c. Behaviors of residents: stream banks

Less than 1% of the houses along Kuliouou stream had downspouts directly connected from the roof to the stream channel, although this was observed (Figure 12). At one residence, a garden house was observed running from the house to the stream channel directly. Pipes (corrugated and PVC) running from houses, yards, or walls connected to Kuliouou stream was not

Figure 11: Upper reaches of Kuliouou channel, with vertical banks (no quick exist), and pipes from residence in connected to channel. Surveys of the upper reaches are not recommended.

common in the lower reaches of the stream (less than 10% of houses), but increased to close to 100% of houses in the upper channel (reaches 4 and 5; Figure 13). This may be in part due to the steepness of the land increasing as the channel progressed back into the valley, and the density of housing appeared to increase as well. Pipes running from lawns that are fertilized or have pet feces would be a high source of nutrients, pesticides, bacteria, and protozoa.

One notable behavior was that a large amount of canine feces and tennis balls found in the channel bottom adjacent to Kuliouou Neighborhood Park. It appeared as though residents were throwing pet waste into the stream channel instead of throwing it in rubbish bins that were found in the park. This may be the source of high organic nutrients and pathogens, as biofilms and algal mats were observed in the stream just below the park. Tennis balls were obviously from the tennis courts in the park.

Figure 12: Example of rooftop downspout connected to stream channel from residence along Kuliouou channel.

Figure 13: Almost all houses along Kuliouou channel in the upper reaches have pipes connected to the stream channel. Stains and biofilms are obivious along the bank walls, possibly suggesting high nutrient input or organic matter.

Two residential complexes, Haleloa I and II, had several corrugated pipes running to the stream channel. The parking lots of these complexes have concrete drainage channels connected to Kuliouou channel directly, and are a source of pollutants from cars (Figure 14). These complexes also have highly manicured lawns and would be a source of pesticides and plant material.

As along Wailupe stream, the amount of trash increased in the upper reaches of the stream channel, but not as much, likely due to the lack of access to the channel from fencing. There were no obvious dumpsites by residents in the stream, but residents frequently had trash piled at the stream bank along fences and walls (Figure 15). A few houses had wheel barrels stored next to the stream bank, and it appeared as though these residents were dumping yard trash into the channel, but this behavior was not observed.

4d. Severe Erosion

As Kuliouou is lined with concrete, severe erosion was not observed along the channel.

4e. Location and condition of storm water outfalls

The location of each storm water outfall was recorded, and is given in an Excel file. Many were marked in the Google Earth file for presentations. Storm water outfalls were in very good condition overall, with no evidence of chemical pollutants. In the second and third reaches, there were storm water gates with a diameter of 2 m (80 inches; Figure 16). These structures have metal, hinged doors and must be opened for water to enter Kuliouou channel. Many of these gates had sediments and plant material partially blocking the gateway.

Figure 14: Concrete drainage connected to Kuliouou channel from parking lot of Haleloa I, a multifamily complex. Decreases filtration of runoff before entering channel and drains a parking lot directly (hotspot).

In most cases, plant debris was the main problem in storm outfalls, but almost all outfalls were not completely blocked by plant debris. Cats and mongoose were observed using the drains as shelter, but this was rare. Biofilms were not commonly observed, suggesting that water flows infrequently through the drains. Water stains were observed on many of the storm drains. Seep pipes, which were located near the base of the stream banks through all of

Kuliouou stream, were partially blocked by cobble, in particular, pieces of asphalt. Asphalt is a source of particulates, sulphates, and petroleum products, and as streets breaks up, these small pieces of asphalt breakdown and thus are a pollutant source to Maunalua Bay.

Figure 15: Trash was commonly piled next to Kuliouou channel, but at this resident had put trash in bags (many do not have trash in bags).

5. Neighborhood assessment: Kuliouou

5a. General characterization

In Kuliouou watershed, roughly 60% of houses were single-family, 20% were multifamily dwellings, parks and open areas equaled 8%, and there were no commercial areas. Less than 5% of residents were remodeling homes. In addition, trash in the yards, carports, and streets was not common. Street width averaged 7.9 m (30 ft) in Kuliouou neighborhoods. Sidewalks were mostly clean (65%) with 10% of the area surveyed having overhanging trees and vegetation growing on sidewalks. 20% had yard waste. Yard waste was not always bagged, but was neatly placed at the curb. Using a random point survey, there were 3.6 cars per 500 meters of street.

Figure 16: Storm water gate that opens into Kuliouou channel. Many were partially blocked by sediments and plant debris.

Most houses had carports and garages (90%), and there was a larger portion of manicured lawns (70%). Towards the back of the valley, lots were steep with some eroding easily due to lack of ground cover. Lots were smaller on average and storage was medium to high in carports (Figure 17). In the Summer

street area, houses along the beach and yards were highly manicured with short distances for runoff to filter before reaching the bay. Asphalt sediments were observed in the majority of street gutters. Pet waste was observed at a number of houses in the Summer street area.

Significant sources of pollution from Kuliouou include nutrients, oil and grease, pesticides, fertilizers, pet waste, bacteria, and asphalt sediments. It is recommended that storm water retrofits to drains be considered, work with community members to decrease fertilizers, pesticides, decrease storage in carports, and increase the clean up of pet waste.

5b. Average lot characteristics

On average, lots were 561.7 meters-squared (0.15 acres). Smaller lots equaled greater storage in carports and garages, and 20% of houses surveyed had high to extremely high storage. Houses with high storage can be chemical or trash pollution sources during heavy rains. Less than 1% of the houses appeared to have gardens, but houses that had landscaping use fertilizers and pesticides.

Figure 17: Extremely high storage at a residence in Kuliouou. High storage in carports may lead to leaky chemical containers such as paint and oil, as well as trash accumulating. These can be washed into storm water systems during heavy rains.

In general, 65% of a lot was impervious and 30.3% was pervious surface. On average, lots had 8.5% bare soil, 19.9% grass cover, and 10.3% tree cover. Seventy-five percent of houses, surveyed at random points had clean driveways (15% of driveways breaking up and 10% stained or oiled). Only 15% of houses had pet waste present in the yard at the time they were surveyed, even though nearly half of the houses had one or more dogs.

5c. Storm drains and gutter conditions

None of the storm drains assessed had stenciling to help prevent residents from dumping illegally into storm drains. Storm drains were not clean overall, as 55% of storm drains survey had plant materials and trash partially blocking them. Only 10% were classified as clean.

More than 80% of the neighborhoods in Kuliouou watershed had curbs and gutters. It had recently rained when gutters where surveyed, and therefore 30% had flowing water that was clear. Seventy percent of gutters had sediments, mostly pieces of asphalt, and 30% of curbs had long-term car parking.

5d. Behaviors of residents and points of interest

Roughly 5% of the residents surveyed had some type of construction or landscaping going on, and none had silt fencing to prevent soil loss during rains. There were more cars parked on the street, and more residents used their carports for storage or other activities. Some houses had pipes running to sidewalks or to storm water systems, just as in Wailupe neighborhoods, but the number of houses with these pipes was much lower (Figure 18). There were also a couple of houses that looked abandoned with chemicals and trash in the yards and carports, but this was not common.

Figure 18: Corragated pipe running from residence to street, with a storm drain less than 20 feet away from the pipe. It wwas not clear what the resident was draining.

Of importance, there are more multifamily homes (condos, apartments) in Kuliouou than Wailupe watershed, and these housing areas have parking lots and highly manicured lawns. Drainage from these lots could be retrofitted with filters to lower pollutants entering the bay (see hotspots below).

The most notable behavior of residents was throwing pet waste into Kuliouou Channel from Kuliouou Neighborhood Park. This would be a considerable source of bacteria and protozoa to the bay, all of which are human health hazards. There were also lots of tennis balls in the channel from the park.

5e. High pollution source areas (Hotspots)

Two lots were classified as hotspots in Kuliouou watershed; One was at 360 Dalene, which had rusting vehicles, trees, plant material, roofing material, a crane, a boat, and chemical storage in the yard (Figure 19). At another residence listed as a hotspot, the roof had caved in and roof tiles were in the yard (Figure 20).

Figure 19: Resdience characterized as high pollution source with rusting vechiles, chemicals, and lots of plant debris, House appeared abandoned.

Figure 20: Abandoned home that was listed as a high pollution source due to the amount of waste and

The multifamily complexes Haleloa I and II were listed as hotspots because 1) the lawns were highly manicured and sources of pesticides (observed people applying them), and 2) the apartments and parking lots had drains connected to Kuliouou Channel. Parking lot drains are drained by concrete channels that end at the channel bank, and pipes are coming from the housing facilities to the stream as well. There is no evidence of storm water treatment, and retrofitting drainages is recommended.