# 4 Recommended Actions

The following actions are recommended to improve the overall health of the Ala Wai watershed. Ideas were generated primarily from recommendations made in the literature. Additional concepts were added by agencies, organizations, and the study team based on their expertise and observations made during the course of the analysis. These recommendations were developed into project descriptions while taking into account the primary study objectives, guiding principles, and issues and concerns that were raised through consultations.

The Ala Wai Watershed Analysis recommends five types of actions: projects, plans, studies, programs, and partnerships. ***Projects*** involve some type of construction or physical action. For instance, a stream channel improvement project may require the installation of interlocking revetment blocks to stabilize stream banks. ***Plans*** establish objectives, study existing conditions, analyze strategies for improving conditions, identify stakeholders, and schedule the actions necessary to achieve the plan objectives. ***Studies*** seek a greater understanding of a specific question, such as how to improve flood control or increase sustainable groundwater yield. ***Programs*** provide an ongoing service or investigation with no foreseeable conclusion, such as a long-term water quality monitoring program. ***Partnerships*** are an effort to pool resources of entities with similar or overlapping goals in order to increase efficiency and productivity.

## 4.1 Project List

On the following page is a list of 28 actions recommended by this Ala Wai Watershed Analysis. Actions are grouped into six categories to provide some reference to the issue they address.

## 4.2 Project Sheets

Each recommended action is described in a two-page "project sheet." The write-ups include the project number, action title, purpose, background and objectives, preliminary scope, participating agencies, estimated cost, and references.

The *purpose* is a one sentence statement of the intent of the action. The *background and objectives* provide a brief description of the problem or issue being addressed, and describe how the proposed action was developed. The *preliminary scope* outlines the elements of the recommended action. The *participating agencies* suggest those agencies that might have an interest in participating in the action being proposed. The identifications of possible lead and other involved agencies for each project are recommendations and do not obligate a particular organization to conduct the study or project. The *estimated cost* is a general approximation of what funds might be necessary given the preliminary scope described. The *references* are a list of

documents that might be useful when further developing each action for implementation.

The problem definitions and project scopes were generated from interviews, maps, and reference documents reviewed during the data collection phase. A detailed analysis of the data, including specific reference citations, may be found in Appendix C.

These descriptions are offered as preliminary information and are subject to change by the organization(s) involved in the execution of each proposed action. Actual project initiations will depend greatly upon funding, staffing availability, and legislative and government support. Information and recommendations in the project sheets are from the literature unless otherwise noted.

## ALA WAI WATERSHED ANALYSIS RECOMMENDED ACTIONS

**WATER QUALITY**

01 Ala Wai Watershed Monitoring Program
02 Ala Wai Watershed Nutrient Reduction Program
03 Ala Wai Watershed Bacteria Reduction Program
04 Ala Wai Watershed Household Hazardous Waste Reduction Program
05 Ala Wai Canal Water Circulation Project
06 Ala Wai Harbor Waste Reduction Program
07 Conservation District Public Access Plan
08 Urban District Public Access Plan

**EROSION AND SEDIMENT CONTROL**

09 Ala Wai Watershed Erosion and Sedimentation Reduction Project
10 Ala Wai Watershed Contaminated Sediment Reduction Program
11 Sediment Disposal Study

**FLOOD CONTROL**

12 Urban District Storm Water Runoff Master Plan
13 Ala Wai Canal Flood Control Project
14 Makiki Flood Control Project
15 Mānoa Flood Control Project
16 Pālolo Flood Control Project

**PUBLIC HEALTH AND SAFETY**

17 Streamside Dumping Prevention and Cleanup Program
18 Litter Reduction Program
19 Ala Wai Canal Health Awareness Program
20 Ala Wai Canal Maintenance Program

**BIOTIC ENVIRONMENT**

21 Ala Wai Watershed Aquatic Habitat Project
22 Ala Wai Watershed Bioassessment Study
23 Forest Ecosystem Restoration Master Plan

**OVERALL WATERSHED**

24 Urban Stream Corridor Preservation Project
25 Ala Wai Research Watershed Partnership
26 Ala Wai Watershed Public Education Program
27 Ala Wai Wetland Restoration Project
28 Ala Wai Watershed Partnership

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# Ala Wai Watershed Monitoring Program



## Purpose

To provide background data on which to base management decisions and evaluate projects, programs, and other actions in the watershed.

## Project Background and Objectives

Most watershed research occurs on the U.S. mainland where land features are very different from those in Hawai‘i. Hawaiian watersheds are generally shorter, steeper, and have smaller drainage areas than their mainland counterparts; therefore, conclusions drawn from national studies are often inapplicable to Hawai‘i. Locally, there is also a lack of background data specific to the Ala Wai watershed from which to draw meaningful conclusions that would help to develop solutions to problems. For many waterways, there are no data or the existing data are too old to be of use. Additionally, existing data may not be comparable due to differences in collection time or methods and inconsistencies in reporting.

For the Ala Wai watershed, water quality monitoring is limited to a handful of gauging stations, most of which are along Mānoa Stream and the Ala Wai Canal. Funding constraints have eliminated stations in other parts of the watershed. The Ala Wai Watershed Association has begun “visual assessments” at 22 stations along Makiki, Mānoa, and Pālolo Streams, as well as at the Mānoa-Pālolo and Ala Wai Canals. These visual assessments are conducted by trained volunteers and include turbidity, plant growth, channel flow alteration, channel condition, habitat available for native species, percent embeddedness, bank stability, canopy cover, riparian condition, and trash and litter.

Regular monitoring data are necessary for determining ambient conditions, which are used in setting water quality standards. Some typical water quality monitoring parameters include rainfall, stream flow, temperature, turbidity, dissolved oxygen content, salinity, and pH. These measures should be taken at strategic locations to minimize the number of monitoring locations, maintenance, and other costs.

Monitoring could also provide data for determining the effects of land use on the environment, which could then be used to determine the effectiveness of different programs and projects on the watershed. However, monitoring is costly, therefore making it infeasible to collect large amounts of data that may not be helpful in evaluating pertinent issues. Therefore, monitoring should be restricted to data that are necessary for evaluating all or most watershed questions. The monitoring of other specific parameters should be included in the design of individual projects to determine the specific effects of that action.

Because monitoring data are so costly to obtain, what little data are collected should be readily available to eliminate repetition. Currently, different agencies, groups, and individuals collect various types of data, often making it difficult to determine if desired information is available and if so, who is conducting the research. Historical information may also be difficult to access because it is stored at various locations. A centralized database would make research more accessible to decision-makers and others who wish to execute projects.

*Regular water quality monitoring allows for the determination of ambient conditions and changes due to human influences.*

## Preliminary Scope

This program will (1) provide general background data that will be useful in maintaining public safety and restoring and maintaining watershed health and (2) make this data readily accessible for use by agencies, academicians, and others who are conducting research and programs in the watershed. The data collected through monitoring will provide baseline information from which to observe trends in water quality, as well as to better understand known water quality problems. This program may include, but not be restricted to, the following components:

- Determine what data would be useful to decision-makers in shaping water quality policies; examine the need to measure contaminant concentrations and TMDL and NPDES-specific parameter sampling.
- Determine sources of various contaminant loadings. This may be incorporated into projects that focus on specific problems, such as nutrients or sediments.
- Determine appropriate locations for monitoring to occur, including storm drains.
- Develop a monitoring plan that inventories the activities being conducted in the watershed and identifies responsible parties.
- Delegate monitoring activities amongst agencies, the academic community, and school and/or community groups.
- Monitor background data such as daily rainfall, runoff, sediment load, stream flow, and other data identified as being important.

## Participating Agencies

DLNR may participate based on their jurisdiction over the upper watershed areas, as well as their interest in ensuring water quality and the prevention of rapid runoff and soil erosion. USGS is potentially a principal partner in monitoring due to its current monitoring activities and its mission to "provide reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life."

Additional participants may include the NRCS and UH-WRRC due to their research objectives in biological, earth, and water resources. DOH could be an agency responsible for monitoring environmental health parameters, such as bacteria and other pollutant levels. (ENV) could also be a valuable partner because of their sampling and pollutant monitoring activities. Land developers and contractors may also be involved based on their interest in construction site management. Community organizations may participate in less technical monitoring activities. USGS, DLNR, or DOH could potentially house the "data bank" for both historical and current research material.

## Estimated Cost

Costs could range between $50,000-$100,000 per new station per year for five years. The number of stations may range from three to nine.

## References

C&C DTS. (1998). *Ala Wai Canal Dredging Conceptual Design and Environmental assessment-Sources of Contamination/ Potential Pollutants*.

C&C DTS & Department of Design and Construction, (1998).*Ala Wai Canal Dredging Final Environmental Assessment.*

Laws, E. A., et. al. (1993). *Hypereutrophication of the Ala Wai Canal: Prospects for Cleanup*.

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State of Hawaii OEQC. (1976). *Improvement of the Ala Wai Canal Final Report*.

State of Hawai'i DOH Clean Water Branch. (1997). *Water Quality Monitoring Report-May 1996-97 Ala Wai Canal Watershed Project*.

State of Hawaii DOH Environmental Planning Office, (1993). *Revised Total Maximum Daily Load Estimates for Six Water Quality Limited Segments, Island of O'ahu, Hawaii*.

## Purpose

To identify the sources of nutrients in the Ala Wai system so that practicable BMPs for nutrient reduction can be chosen and applied.

## Project Background and Objectives

Studies conducted between the 1970's and 1990's found that the Ala Wai Canal system frequently does not meet State water quality standards for nitrogen or phosphorous. Excessive nutrient concentrations can exacerbate algal or phytoplankton blooms; however, the extent to which nutrients cause the problems in the Canal versus other factors, such as poor circulation, is not known.

Freeman modeled the average annual nutrient loads for the Ala Wai watershed in his 1993 report. He expresses caution at their use because historical data were not complete. Freeman's model estimates are as follows:

| Nutrients | | |
|---|---|---|
| | Pounds per day | |
| Source | P | N |
| Groundwater | 3.3 (8%) | 9.4 (10%) |
| Urban Storm Drains | 22.4 (52%) | 13.7 (15%) |
| Other Non-Point Sources | 17.3 (40%) | 67.3 (75%) |
| Total Non-Point | 43.0 | 90.2 |
| *Cesspools* | *11.0* | *42.0* |

The actual number of cesspools in the watershed is not known, but ENV identified many of them in mountainous areas, where infiltration to groundwater is unlikely due to a thick layer of geological material. Application of BMPs to cesspools is a continuing effort of the City and State. Building permits for dwellings with cesspools on O'ahu now generally require upgrade to a septic system with a leaching field.

Freeman's model concludes that significant shares of the total nutrient load originate in the Conservation District. However, application of BMPs to Conservation lands may be difficult, given their rough terrain, high rainfall, and geographic extent (45%) of the watershed. Some erosion control BMPs might be practicable because reduced soil erosion could be correlated with reduced nutrient levels.

Freeman's model estimates that urban storm drains contribute over half of the total phosphorous but only 15% of the total nitrogen in the watershed. BMPs may be practical if specific sources or land uses can be identified. For example, DOH has stated that high densities of domestic animals and birds in urban areas may contribute significant levels of nutrients. If so, BMPs that would address the ubiquitous nature of this source could be developed.

The over-application of fertilizers is also cited as a nutrient source. Reports have speculated that the Ala Wai Golf Course and agricultural activity in Pālolo Valley have contributed nutrients via infiltration to the groundwater. There are no data to substantiate these theories but the contribution of nutrients by these sources could be estimated through fertilizer application data or monitoring wells. Additionally, accurate estimates of household fertilizer application rates would aid in BMP selection.

In the 1998 Ala Wai Consent Decree Report, DOH reported very high total nitrogen coming from the H-1 Freeway. Therefore, it may be worthwhile to monitor freeway storm water runoff for nutrients. The State currently holds a Municipal Separate Storm Sewer System permit under the NPDES program. Limited monitoring of some of their highways already exists, although none occurs within this watershed.

In general, the extent of nutrient related water quality problems is not well documented. Efforts to obtain additional data should be carefully defined to optimize funding due to the expense of using automated sampling devices linked to simultaneous stream-flow and rainfall recorders at the same location. The City has certain monitoring requirements associated with their NPDES permit; it may be possible to supplement the City's program to better identify sources and contaminant levels.

## Preliminary Scope

This program will determine the degree of impact that nutrients have on the Ala Wai system and identify nutrient sources. The program may include, but not be limited to:

- Conduct a cesspool inventory to determine the extent of this problem, if any.
- Apply erosion control BMPs to the Conservation District, perhaps including stream bank stabilization or long-term efforts to restore the native plant ecosystem.
- Identify specific land-based nutrient sources that contribute to urban storm drains. Develop BMPs that would target specific sources such as domestic animals and birds.
- Obtain fertilizer application rate data at the Ala Wai Golf Course and at the agricultural farms in Pālolo Valley and estimate the potential for over-application and leaching into groundwater. Monitoring wells could also be installed on the golf course.
- Estimate the potential quantities of nutrients contributed by urban activities, such as fertilizer (over) application and nutrient loading from domestic animals and wild birds. Previous difficulties in obtaining records of fertilizer sales could be overcome by protecting the data providers and aggregating data so that individual vendors and products could not be identified. This data could be verified with field surveys of homeowners and landscapers on their purchasing habits and application rates.
- Monitor freeway storm water runoff for nutrients to determine the true extent of nitrogen contributions from the H-1.
- Tailor the City's current NPDES monitoring program to assist in identifying sources and levels of contaminants.
    - Identify appropriate locations for monitors, such as at the foot of the Conservation District and at downstream locations, to distinguish land uses from one another, or at high-density areas vs. low-density areas.
    - Monitoring should continue for a statistically valid period of time, likely at least five years.

## Participating Agencies

DLNR may participate based on its jurisdiction over the upper watershed areas, as well as its interest in ensuring water quality. USGS is potentially a principal partner in monitoring due to its current monitoring activities and its mission to "provide reliable scientific information." Other participants may include DOH due to its jurisdiction over the TMDL program. ENV could also be a partner because of its sampling and pollutant monitoring activities. Additionally, ENV and DOT both carry NPDES permits. The C&C Department of Design and Construction (DDC) may be involved in the construction of structural BMPs, and the Department of Parks and Recreation (DPR) may be consulted in improving fertilizer techniques. The Department of Planning and Permitting (DPP) would be involved in requiring and enforcing the use of BMPs.

## Estimated Cost

Costs could be in the range of $50,000-$100,000 per year for five years for two new sampling stations. The number of stations may range between three and nine.

## References

C&C DTS. (1998). *Ala Wai Canal Dredging Conceptual Design and Environmental assessment-Sources of Contamination/ Potential Pollutants*

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

Ikeno, D. E. (1996). *Urban Runoff in Manoa and Palolo Streams*.

Laws, E. A., et. al. (1993). *Hypereutrophication of the Ala Wai Canal: Prospects for Cleanup*.

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State of Hawaii DOH Clean Water Branch. (1997). *Water Quality Monitoring Report – May 1996-97 Ala Wai Canal Watershed Project*.

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State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed*.

State of Hawaii DLNR DOWALD. (1993). *Environmental Assessment and Negative Declaration for the Ala Wai Canal Improvement*.

State of Hawaii OEQC. (1976). *Improvement of the Ala Wai Canal Final Report*.

# Ala Wai Watershed Bacteria Reduction Program



## Purpose

To determine the source of bacteria in the Ala Wai system, their impacts on human health, and ways to reduce levels to within state standards.

## Project Background and Objectives

Bacteria are found naturally in terrestrial and aquatic environments. While some bacteria are benign, or even beneficial, certain biological contaminants can negatively affect water quality. *Escherichia coli* is a human pathogen that may cause such symptoms as diarrhea and abdominal cramps. High coliform counts were detected in Ala Wai waterways as early as 1969 and have since been found to exceed State standards "virtually 100% of the time." Several Ala Wai water bodies were identified as "impaired" from high bacteria counts, including the Ala Wai Canal and Harbor, Kahanamoku Lagoon, Kūhiō Beach, and Māmala Bay.

Studies have shown that bacteria counts in the Ala Wai Canal decline with depth, likely because the source is at the surface and the salinity of the water increases with depth. One bacteria source could be the Mānoa-Pālolo Drainage Canal, which collects water from streams in the upper watershed where high levels of *E. coli* and *Clostridium perfringens*, fecal waste indicator bacteria, have been found. In particular, one study found that levels of *C. perfringens* in the lower portions of the Pūkele and Waiʻōmaʻo Streams and downstream of the Pālolo Housing area in Pālolo Valley exceeded background levels. Additionally, bacteria counts have been high at the Kapahulu end of the Ala Wai Canal. The source of bacteria in Pālolo streams is suspected to be sewer line leaks and cesspools in the residential areas of Pālolo Valley, although this has not been confirmed. Also, the high counts of *C. perfringens* were only from one report and may not be a true representation of normal stream conditions.

Other suspected sources of bacteria may be improper disposal of domestic pet wastes, as well as from pigeons and other animals in the watershed. Bacteria at the Kapahulu end of the Ala Wai Canal is thought to come from storm drains, although this has not been proven. While there are several suspected bacteria sources to Ala Wai waterways, none have been confirmed.

Fecal coliform counts have been used to indicate human waste contamination in streams and potential health risk to individuals who are exposed to the water. Water-borne pathogenic conditions may include hepatitis A and viral and bacterial gastroenteritis.

Leptospirosis is a bacterial disease whose symptoms may include fever, headache, chills, muscle aches, vomiting, diarrhea, and others. Severe cases may even result in death. While recent "hot spots" have included Maunawili, Kapena Falls, and Nuʻuanu Stream, leptospirosis may be found in waters throughout the state.

It is unknown if the bacteria present in Ala Wai waterways threaten human health or aquatic life. Paddlers who train and race in the Canal have reported skin infections, purportedly from contact with the water. A survey conducted for the "Ala Wai Canal Watershed Water Quality Improvement Project" found that skin rashes were much more prevalent in canoe clubs that practiced in the Ala Wai Canal as opposed to a canoe club that practiced in Kailua Bay. Laboratory tests to identify the cause of the rashes were not done. Additional confirmation of the previous observations should be made in order to properly assess the risk.

*Paddlers on the Ala Wai Canal may be exposed to a higher health risk due to bacterial infection.*

## Preliminary Scope

This study will identify the various human-induced and natural sources of bacteria to the Ala Wai water system. Studies will also identify the health impacts associated with elevated levels of bacteria and test the hypothesis that high bacterial counts in the Ala Wai Canal are responsible for skin infections. The reduction program will then utilize the data derived from the studies to develop ways to reduce the bacteria loads in the Ala Wai Canal and develop ways to lower the risk of detrimental health impacts to humans. The following actions may be included in this program:

- Determine the contribution of various suspected sources of bacteria, including pet wastes, feral animal sources, pigeons, etc.
- Identify health impacts from bacteria in the waterways, such as staphylococcus and other skin infections reported by paddlers in the Ala Wai Canal. This study should include laboratory tests to identify the cause of the reported skin infections.
- Monitor the storm drains at the Kapahulu end of the Ala Wai Canal for pollutants to determine if they are the source of fecal coliform.
- Eradicate feral animals in the upper watershed to reduce their contribution to bacteria levels.
- Eradicate rats to reduce the spread and persistence of leptospirosis.
- Educate the public on proper pet waste disposal, including information on pet wastes as a source of bacteria, and responsibilities on private and public properties.
- Increase enforcement of Litter Control Ordinances for Solid Waste Disposal, ROH Section 29-4.4(a)(9), that prohibits the disposal of pet waste on public or private property.
- Convert existing cesspools to sewer systems and repair leaking sewer lines.
- Install waste collection facilities at public access areas.

## Participating Agencies

DLNR may participate based on its jurisdiction over the upper watershed areas, as well as its interest in ensuring water quality. DOH may be involved due to this program's direct impact on public health and its oversight of wastewater systems.

Additional participants may include ENV because of its sampling and pollutant monitoring activities and its management and treatment of municipal wastewater. WRRC may also participate due to its research objectives in biological, earth, and water resources.

## Estimated Cost

$250,000-$500,000

## References

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

Gonzales, F. I. (1971). *Descriptive Study of the Physical Oceanography of the Ala Wai Canal*.

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I*.

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State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed*.


*Impaired water bodies affected by high bacteria counts.*

# Ala Wai Watershed Household Hazardous Waste Reduction Program



## Purpose

Identify, monitor and reduce household hazardous wastes of concern.

## Project Background and Objectives

Pesticides are a major contributor to water pollution. Dieldrin and chlordane are termiticides that have been found in Ala Wai Canal fish and sediments, as well as in groundwater. Chlordane was banned by the EPA in 1988 and Dieldrin was banned from agricultural use in 1974, although existing stocks of dieldrin could be used through 1987.

Dieldrin has been detected in the BWS's Kaimukī Station, a battery of wells serving BWS's high and low service systems. concentrations have not exceeded EPA's "actionable levels" of 0.050 parts per billion. The actual rate of infiltration or leaching of the pesticides from application sites through the soil layers and into the aquifers has not been estimated because only a few years of monitoring data are available.

Additionally, these termiticides have been found in Ala Wai watershed streams and canals. A 1990 USFWS study found that Mānoa Stream had the highest concentrations of dieldrin, chlordane, and heptachlor among several streams sampled nationwide. A 1992 study found that concentrations posed significant health risks if fish from Mānoa Stream or the Ala Wai Canal were consumed for any length of time. Chlordane and heptachlor cancer risks were found to exceed EPA action levels. The DOH recommended periodic testing of fish for the termiticide presence and levels. However, routine monitoring of aquatic organisms is not normally carried out due to the costs involved.

Termiticides were also detected in sediments in the Ala Wai Canal, which has prevented ocean disposal of some dredge sediment. This is worth noting because the Canal has not been dredged since 1978-79, before dieldrin and chlordane were banned. Therefore, future accumulations of sediment may not contain similar levels of termiticides, though this is speculative.

In Hawai'i, termiticides were injected into the ground around the perimeter foundations of buildings. This application was usually at or near the "drip line" (the location on the ground where rain dripping from the roof would fall), facilitating their movement into groundwater. Dr. Stephen Lau, former director of WRRC proposed a BMP to install rain gutters on all buildings where rainfall might be sufficient to cause downward movement of termiticide treatments into groundwater. Gutters would catch and divert rainfall away from the "drip line" and thereby reduce infiltration rates. Building owners would also benefit from termiticides remaining in place for a longer period of time therefore becoming more cost-effective. BWS explored the concept of a tax-benefit for building owners who installed or maintained gutters but was uncertain of the actual quantifiable benefits of such a program so nothing further was accomplished.

Concentrations of dieldrin and chlordane are thought to be declining since their use has been discontinued. However, there are no adequate time-series data that would show trends in concentrations. Prudence would suggest a need for continued monitoring in order to identify trends in concentrations. Other data gaps include the lack of information on water quality and specific contaminants. There are no recent sediment and water quality analyses for previously reported pollutants such as dieldrin, and no studies have been conducted to confirm suspected contamination sources.

Other household hazardous wastes such as oils, paints, and cleansers are also of concern. Improper disposal of wastes is suspected of causing several fish kills over the years and is also thought to contribute unmonitored toxins in our water systems. The C&C Department of Environmental Services provides information on recommended disposal options for different types of household wastes and has a disposal hotline where citizens may call for information.

## Preliminary Scope

This program will reduce household hazardous waste contamination of water resources in the Ala Wai watershed by identifying the extent of the problem, confirming sources, and implementing BMPs to reduce hazardous waste entry into the environment. This program may include these and other actions:

- Research to determine the current extent of household hazardous waste contamination and to confirm the major sources of this type of pollution within the watershed.
- Ban or restrict mobile or persistent pesticides while identifying, developing, and adopting non-pesticide alternatives. This should include pesticide alternatives, such as manual clearing along streams or in areas with direct runoff to streams.
- Require Best Management Practices (BMPs) for pesticide use and educate the public on BMPs.
- Increase public education on hazardous wastes and their environmental effects, laws concerning their use and disposal, penalties for misuse and disposal, and how to access disposal /collection programs. Enhance "Amnesty Day" programs and other hazardous waste collection programs; investigate periodic curbside pickups. Require retailers of toxic materials to serve as drop-off/recycle centers for wastes.
- Conduct a pilot program to test areas where termiticide ground treatment has occurred in order to identify or determine the levels of contaminants that may currently be present at building sites. This program could include a comparison of building sites with and without rain gutters to identify their effectiveness in retaining the contaminants on-site and in reducing leaching downward through the soil into the groundwater.
- Develop a termiticides analysis kit and develop a model of termiticides transport into groundwater.
- Systematic monitoring of known pollutants in streams and storm drains to determine the impacts of hazardous material and to determine trends in concentrations. Routine groundwater monitoring by BWS should be archived and accessible for reference on contaminant levels in wells. BWS and the DOH will be the action-agencies should pesticide levels become actionable.
- Monitor contaminant levels in aquatic organisms. This type of monitoring could potentially be carried out in coordination with DOH.

## Participating Agencies

A key participant may be ENV because of its sampling and pollutant monitoring activities, its mission to protect public health and the environment, and its clean water and waste disposal programs. DLNR may also participate based on its jurisdiction over the Ala Wai Canal, as well as its interest in ensuring water quality. DOH and EPA may be involved due to this program's direct impact on clean water and public health. Additional participants may include the WRRC due to its research objectives in biological, earth, and water resources.

## Estimated Cost

$100,000-$250,000

## References

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

C&C DTS. (1998). Ala Wai Canal Dredging Conceptual Design and Environmental assessment-Sources of Contamination/ Potential Pollutants.

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State of Hawaii OEQC. (1976). *Improvement of the Ala Wai Canal Final Report*.

# Ala Wai Canal Water Circulation Project



## Purpose

To improve water quality in the Ala Wai Canal by increasing water circulation and flow.

## Project Background and Objectives

Water quality in the Ala Wai Canal generally does not meet State standards because of poor circulation and flow. Heavy silting occurs at its confluence with the MPDC due to a drastic decrease in water velocity that allows sediments to settle out of the water column. The sill that forms inhibits water circulation on the Kapahulu end of the Canal. Low oxygen conditions result from the poor circulation and entrapment of denser saline water in the upstream basin. This results in poor habitat for many species of zooplankton, fish, and other organisms that require higher oxygen content in the water. Therefore, ecosystem diversity has been reduced to those organisms such as tilapia and other alien species that can survive in low-oxygen conditions. A 1999 report concluded that "muddy and contaminated substrate, coupled with the nutrient-rich and poorly circulated waters of the Canal, has created a less diverse ecosystem significantly different from that which was established prior to the 1960's."

Salinity generally increases in depth due to freshwater runoff from streams at the surface. Bacteria in the Ala Wai Canal have been found to be concentrated in the upper portions of the water column, in part because bacteria die off as salinity increases.

Several individuals and organizations have proposed a seawater flushing system of 20-30 cfs to increase water circulation and flow in the Canal to address these water quality problems. Seawater pumping was selected over other water sources due to the costs involved. Potential well locations were investigated at the Ala Wai Golf Course, Honolulu Zoo, and Ala Wai Golf Course Base Yard. The base yard location was favored for development of salt water wells due to its suitable geology and proximity to the Canal. A prototype test well will be drilled in the first half of 2003 to determine the yield and the effects continuous pumping will have on the surrounding area.

The Ala Wai Canal accepts high levels of nitrogen and phosphorous from its tributaries and through regeneration from bacterial action on dead phytoplankton that sinks to the Canal bottom. Poor circulation allows these nutrients to persist and feed phytoplankton and algae, which increase turbidity. Phytoplankton production is suspected of generating much of the Canal sediment. Phytoplankton growth is currently limited by light intensity and not nutrient availability. A seawater flushing project is expected to reduce nutrient levels and increase the velocity of water in the Canal, therefore decreasing phytoplankton productivity. This should help to improve the estuarine habitat in the Canal by decreasing turbidity and sedimentation caused by biological activity.

Additionally, the seawater used in the flushing system would mix with surface waters and potentially decrease the presence of fecal coliform colonies that die off when exposed to salt water. The proposed velocity of the system would not be strong enough to flush sediments from the Canal. Therefore, periodic dredging would still be necessary.

Another, more recent alternative to improve water quality is an aeration system that would increase the levels of dissolved oxygen (DO) in Canal waters. Higher DO could support a greater variety of organisms, including "beneficial" bacteria. This bacteria removes nitrogen from the water and out-competes phytoplankton and algae, thus improving water clarity. The aeration system also creates vertical movement of water and facilitates mixing. Similar benefits would result between the flushing and aeration systems; however, the seawater flushing system would not oxygenate the water and the aeration system would not provide the benefits of increasing the Canal's salinity. A combination of the two technologies could also be investigated.

## Preliminary Scope

This project will improve water quality in the Ala Wai Canal through increased circulation and water movement. Two methods for accomplishing this are proposed; however, other technologies that meet the needs of the Canal, including a combination of techniques, should also be investigated. The following are potential methods for improving water circulation:

- Ala Wai Canal Seawater Flushing System.
  - Includes five deep water wells that produce approximately 13 – 17 million gallons per day flow.
  - Flushing system will produce 20-30 cfs of velocity at the Kapahulu end of the Canal.
- Ala Wai Canal Aeration System.
  - Includes a pump house, air manifolds and tubing.
  - Addition of "beneficial" bacteria to facilitate nitrogen removal from Canal waters, thus making it less available for phytoplankton and algae.
  - Creation of habitat for the bacteria through the installation of special mats on the Canal bottom.
- Ala Wai Canal Flushing and Aeration System – consider a combination of seawater flushing and aeration.

## Participating Agencies

A key participant may be DLNR based on its jurisdiction over the Ala Wai Canal, as well as its interest in ensuring water quality. DOH may also be involved due to this program's direct impact on water quality. ENV could participate based on their sampling and pollutant monitoring activities, their mission to protect public health and the environment, and their clean water program.

## Estimated Cost

Seawater flushing project: $5.5 million capital cost + $200,000 per year for operation and maintenance

Aeration project: $450,000 capital cost + less than $200,000 per year for operation and maintenance + cost for beneficial bacteria.

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*The Ala Wai Canal currently experiences poor circulation.*

# Ala Wai Harbor Waste Reduction Program



## Purpose

To reduce the impact of marine vehicles on the water and sediment quality of the Ala Wai watershed.

## Project Background and Objectives

The Federal Clean Water Act Section 303(d) mandates that each state submit to the EPA a list of water bodies that are not expected to meet State water quality standards, even after action is taken to control nonpoint source pollution. The "Draft 2002 List of Impaired Water Bodies" includes the Ala Wai Canal and Harbor for nutrients, pathogens, metals, turbidity, suspended solids, enterococci, chlorophyll-a, and fecal coliform. The priority for dealing with the pollutants, other than nutrients, is "medium."

Various metals such as lead and copper have been found in the biota and water of the Ala Wai system. Sources of lead include gasoline and motor vehicle parts. Copper sources also include vehicle parts and gasoline, as well as copper-based marine anti-fouling agents that are carried into the Ala Wai Canal via tidal flux. The relative concentrations of various sources of copper have not been determined and contamination trends are inconclusive.

A 1976 report found that zinc and copper concentrations were higher in the Harbor than in the Canal itself, suggesting that they may have originated in the Harbor area. Mercury was also suspected of being a Harbor contaminant because values tended to increase with proximity to the Harbor. The suspected source of these contaminants was marine anti-fouling paints, via leaching and peeling of marine anti-fouling and anti-rust boat paints.

The 1998 environmental assessment (EA) for the Canal dredging confirmed the 1976 report. The EA found that marine anti-fouling agent residuals associated with vessel repair facilities, such as mercury and organotins, were transported into the Ala Wai Canal from the Boat Harbor via tidal exchange.

*The Ala Wai Boat Harbor has 699 berths.*

## Preliminary Scope

This project will reduce the contribution of marine vessels to metal contamination in the Ala Wai Boat Harbor. The program could include, but is not limited to the following:

- Ensure boat wastes are disposed of properly, instead of dumped overboard.
- Discourage and/or ban the use of anti-fouling and anti-rust paints that contain heavy metals.
- Require boat paints to be scraped in dry dock and wastes be disposed of properly to reduce metal contamination.
- Require proper maintenance of boats to reduce the likelihood of leaching.
- Perform light bottom dredging of Harbor areas to collect paint peelings and other marine-vehicle-related wastes.

## Participating Agencies

DLNR may be a key participant based on DOBOR's dual mission to provide facilities for recreational boating and support opportunities for ocean activities and "to preserve Hawaii's natural and cultural resources." Additionally, DOBOR's responsibilities include facility development, management, operation, and repair, as well as regulating boating facilities and the recreational use of State waters. DOH may also participate because of the Clean Water Branch's mission to protect and restore inland and coastal waters for marine life and wildlife.

## Estimated Cost

$250,000-$500,000

## References

C&C DTS. (1998). Ala Wai Canal Dredging Conceptual Design and Environmental assessment-Sources of Contamination/ Potential Pollutants.

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*The Ala Wai Boat Harbor includes 22 dry storage spaces, a vessel wash down area, a fuel dock, and a pump out station.*

# Conservation District Public Access Plan



## Purpose

To enhance appreciation and stewardship of the watershed and to facilitate management and maintenance by providing access to areas in the Conservation District.

## Project Background and Objectives

The Conservation District holds many opportunities for recreation, research, and education. However, many people do not venture outside of the Urban District and, therefore, have little connection with the natural environment. Access could enhance appreciation for the watershed by providing avenues for awareness. It would also allow for maintenance personnel or volunteers to manage debris and vegetation along waterways and stream banks. Managed access also provides for recreational opportunities, fire fighting, search and rescue procedures, support of cultural practices, tourism, hunting, invasive species control, research, and other management actions.

Despite the benefits of public access, there are also many issues to consider. Threats to health and safety are foremost among these concerns. The 1999 Sacred Falls and 2002 Mānoa Falls rock slides are a reminder of the severity of events that could occur on unimproved lands, as well as the liability issues that are associated with access. Other hazards may include flash flooding, disorientation, an inadequate level of preparedness, unstable footing or tree branches, and other incidents that might occur from a misstep or accident. Leptospirosis and other water-borne pathogens are other hazards that should be taken into account.

Humans may also impact the natural environment. The Ala Wai watershed has 18 trails that collectively run 30.18 miles. This is the greatest density of publicly accessible trails on O'ahu, although there are no trails in Pālolo Valley. The Makiki and Mānoa trails are very heavily used, but the human impact on trails and the surrounding environment has not been quantified. Access could provide opportunities for dumping, erosion, and the introduction of noxious weeds.

Conflicting uses within the watershed are also a contentious issue. Dirt biking trails have been known to cause erosion and may prove dangerous when paired with other more passive recreational activities. Similarly, pig hunting is usually not compatible with activities such as hiking. However, a recent pilot study in Makiki has shown that given the proper precautions, hunting can co-exist with hiking trails.

One concern for public access is how to improve safety and well-being. Additionally, the impact that humans have on trails is not understood well, therefore making it difficult to develop ways to mitigate human-induced erosion and alien species introduction. Another question is the social carrying capacity of these areas. If one goal of access is to provide appreciation for the watershed, at what point is the experience diminished by the number of users?

DLNR-DOFAW is currently conducting an environmental risk assessment for public access on state lands. The purpose of this assessment is to determine the potential impact of the environment on user groups, as well as their impact on the environment. A preliminary trails analysis completed in 2001 on a select number of trails and parks found that Mānoa Falls Trail was highly traveled by both local and tourist users. The report identified hazards such as wet weather conditions, slippery trails, protruding roots and rocks, leptospirosis, falling rocks and branches, and human error.


*Mānoa Falls Trail sign warning of the danger from falling rocks.*

## Preliminary Scope

Prepare a plan for improved access in the conservation areas. Especially important in following *ahupua'a* concepts is mauka-makai access. The Urban District public access project may include but not be restricted to the following:

- Minimize hazards on trails.
  - Identify hazards for each trail.
  - Maintain trails regularly.
  - Conduct regular inspections and reassess risks on a regular basis.
- Minimize risk to users.
  - Identify the gap between user preparedness and actual trail conditions for each trail.
  - Develop ways to bridge the gap, including adequate signage, training, maintenance, and education.
- Minimize human impact on the environment.
  - Identify human impacts on trails and the ecosystem.
  - Monitor human impacts to determine the intensity of any problems.
  - Research optimal trail materials and technologies to minimize human impacts and to increase safety and enjoyment of the resource.
  - Install boot brushes and signs to educate the public.
- Maintain the positive experience of the Conservation District through research that identifies the social carrying capacity of trails and publicly accessible areas.
- Optimize the watershed experience for all user groups.
  - Identify the needs of each user group.
  - Determine which groups are compatible and under what conditions.
  - Design special programs for those groups that require special areas, precautions, or are not otherwise compatible with other groups.
- Gain a public access right of way for Pālolo Valley.

## Participating Agencies

DLNR may be a key participant based on its jurisdiction over the upper watershed areas, as well as its interest in ensuring water quality. Additionally, the DOFAW administers the Na Ala Hele Program that regulates and maintains public trails.

USFWS may also participate because it is the principal federal agency responsible for conserving, protecting and enhancing fish, wildlife, plants, and their habitats. Similarly, it is the mission of the US Forest Service to sustain the health, diversity, and productivity of the Nation's forests and grasslands. Additional support may come from civic organizations such as the Hawaiian Trail and Mountain Club and the O'ahu Pig Hunters Association.

## Estimated Cost

Plan: $100,000-$250,000
Implementation: $500,000-$1 million

## References

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*Sign restricting mountain bike use of a trail.*

# Urban District Public Access Plan



## Purpose

To provide access to waterways in the Urban District to facilitate maintenance and to enhance appreciation of the aquatic environment.

## Project Background and Objectives

The objective of providing access is to allow for recreational opportunities and for maintenance personnel or volunteers from the public to maintain waterways and stream banks by removing debris, managing plantings. In many cases, streams reflect the evolution of the urban landscape that now dominates 55% of the Ala Wai Canal watershed. Streams have been channelized to provide efficient storm drainage at the expense of the natural environment both within the stream itself and along stream banks where vegetation normally flourishes. Additionally, structural modifications have not always been conducive to maintenance procedures, and sometimes even make maintenance difficult by restricting access to personnel and equipment.

The second objective is to enhance the visual and natural environment within the urban areas. This will increase public awareness and appreciation of the waterways and foster stewardship of the watershed. As waterways have evolved from natural flowing streams to confined, urban drainage ways, cultural perceptions have changed from one that values free-flowing water as a resource to one that confines and shields streams from view as storm waters are conveyed as rapidly as possible to the sea. This cultural shift has resulted in public acceptance of the "chain-link fence mentality," which discourages people from entering the waterways and effectively distances them to the point where streams and canals become dumping grounds for litter, rather than natural features to be enjoyed, valued, and protected.

Access to the Ala Wai Canal itself is excellent with the exception of those banks that are directly adjacent to the Ala Wai Golf Course. Parts of the Canal wall are also deteriorating and may pose some hazard to users. Access to stream banks throughout the rest of the watershed is poor and spotty because of private ownership of streambeds and adjacent banks. Access to public lands may also be restricted by chain-link fences.

Several issues arise when trying to provide public access throughout the urban watershed. Of particular concern are the objections of home owners to the location of public access trails between private property and streams. Property owners are often concerned with the safety and security of their homes and families, as well as nuisances such as littering and noise that may accompany increased accessibility to their properties. However, there are many public land opportunities for access without directly confronting issues of private ownership and private property. Therefore, initial efforts to increase access should focus on public lands.

A second issue is that many stream segments are in the hands of private owners, which may make it more difficult to provide for access. Additionally, private ownership of streams and stream banks puts the burden of stream maintenance on the owner who may also be liable for water quality maintenance issues.

In the 1970's, the University of Hawai'i proposed improved access along Mānoa Stream through the Mānoa Stream Park, a streamside linear park. Recently, the 1998 Ala Wai Canal Watershed Water Quality Improvement Project also proposed improved access. Much of the route could potentially be constructed on public property, on stream banks, or on roadways. The development of streamside access ways could also include stream bank stabilization and habitat restoration as park features.

The State Legislature has authorized funds (approximately $500,000) to the Department of Land and Natural Resources for an initial "design-and-build" project contract but the funds have not been expended. The purpose of this funding was to implement stream bank restoration coupled with improved access as an initial set of pilot projects.

## Preliminary Scope

Prepare a plan for improved access in the urban areas. Especially important is mauka-makai access, in following *ahupua'a* concepts. The Urban District public access project may include but not be restricted to the following:

- Identify public lands, easements, and rights-of-way adjacent and near waterways (Makiki, Mānoa, Pālolo, Mānoa-Pālolo Drainage Canal) and their tributaries.
- Assess the feasibility of use of these public lands (or portions of them) for access to and along waterways.
- Identify opportunities for use of private land through the acquisition of that land or through easements.
- In conjunction with watershed and stream restoration projects, recommend a phased program of improved access.
- Determine the types of activities appropriate in streamside access areas and design for those activities (ex: jogging paths, bicycle routes, passive recreational areas, maintenance access, etc.).
- Provide for stream repair and habitat development, where applicable.
- Stabilize and repair Ala Wai Canal walls.
- Develop public access along the banks of the municipal golf course. Note that the golf course is actually State-owned land under Executive Order 3885 to the City for "golf course" and "park purposes" and that other watershed planning projects may consider use of the golf course for sediment capture and storage needs.
- Develop the Mānoa Stream Park from the Ala Wai Canal up the Mānoa-Pālolo Channel and Mānoa Stream through the University of Hawai'i to Mānoa Falls.

## Participating Agencies

A participating agency could include DLNR-DOFAW due to its jurisdiction over the upper watershed areas, as well as its interest in ensuring water quality and the prevention of rapid runoff and soil erosion. Additional participants may include the C&C DDC, which is responsible for planning, designing, and managing construction of the City's Capitol Improvement Program.

Additionally, the C&C Department of Facility Maintenance (DFM), which administers the City's repair and maintenance programs for roads, bridges, streams, flood control systems, traffic signs and markings, city buildings and office facilities, may be involved. Private land owners should also be involved if their properties will be affected by this action.

## Estimated Cost

Plan: 100,000-$250,000
Implementation: $500,000-$1 million

## References

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

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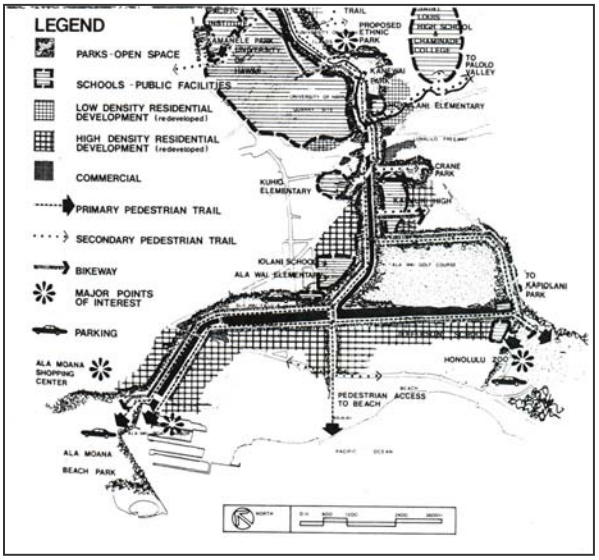


*This portion of Mānoa Stream Park was designed in 1978.*

# Ala Wai Watershed Erosion and Sediment Reduction Project



## Purpose

To reduce the amount of sediment that reaches the Ala Wai Canal.

## Project Background and Objectives

The Ala Wai Canal accepts heavy sediment loads that reduce its flood capacity and recreational, aesthetic, and habitat value. Additionally, dredging of the Canal is costly due to the lengthy permitting process and multiple concerns that must be addressed regarding the thousands of residents and tourists that live along and use the Ala Wai Canal. Therefore, it is ideal to reduce the required dredging frequency for the Canal.

Some sediment originates from exposed soils at construction sites and from road runoff via storm drains. However, most of the sediments are likely produced through natural processes enhanced by steep slopes, thin soil cover, and high rainfall typical of Hawaiian watersheds. In addition to this, human influences, such as the introduction of feral ungulates and invasive plants, are suspected of indirectly increasing erosion rates. Alien vegetation tends to out-compete native flora, thereby creating a single-story monoculture suspected of being inferior to multi-storied native forests in breaking the erosive force of rainwater. To compound this, feral ungulates destroy the forest understory and the ability of the canopy to dissipate the force of the rains that fall. Pigs also uproot trees, exposing soil and leaving it prone to erosion.

If most of the Ala Wai sediments are in fact from the upper watershed, control actions should focus on minimizing human and alien species impacts that exacerbate erosion. However, current erosion and sediment data are lacking, therefore limiting the degree to which this problem can be addressed. For example, the total amount of sediment from this area is unknown, as well as the amount of sediment that comes from each sub-watershed. Other processes, such as the effect of alien species on erosion, are not fully understood.

While more research is needed to determine the optimal actions to reduce erosion and sedimentation, it would take many years to complete these types of studies; some effort should be made to immediately address the problem. Actions could include either on-site measures to reduce erosion and runoff, or off-site measures to collect sediments before they reach the Canal area. On-site measures may include feral ungulate and alien vegetation control, restoring ground cover to denuded areas, and stream bank stabilization.

Off-site measures could include sediment basins or traps that are regularly dredged. For example, it has been recommended that a sediment basin be constructed in the MPDC, where it could be routinely dredged at a lower cost than if the sediments accumulate in the Ala Wai Canal. A series of sediment basins in the Ala Wai Golf Course should also be investigated. This could be incorporated as a part of the golf course water hazards to maintain this recreational asset for the community. Additionally, sedimentation basins could be designed to serve multiple purposes, such as providing a source of non-potable irrigation water for the Golf Course.

Sediment basins should also be considered near the foot of the Conservation District. Not only will it be located where most of the sediment is suspected of originating, it would trap sediments before they travel downstream and may potentially be contaminated by urban runoff and/or seawater.

***Sediment accumulation in the Ala Wai Canal.***

## Preliminary Scope

This project will reduce the quantity of sediment that reaches the Ala Wai Canal by implementing on-site and off-site actions and by gathering data that will be used to develop strategies to moderate man's impact on erosion. This study/project will include, but is not limited to:

- Conduct research to support the design of actions that would reduce erosion and sediment. These studies may be components of the proposed Research Watershed Partnership, or conducted separately.
  - Determine suspended sediment loads, the amount of sediment that originates in the Conservation District, its proportion of the overall sediment load, and the effects of land use on sediment loads and types.
  - Determine the effectiveness of native vs. alien forest in reducing soil erosion.
  - Determine the effect of shallow-rooted plant species on soil creep and slope stability.
  - Determine the magnitude of the effect of feral ungulates on erosion.
  - Develop a model to evaluate the effectiveness of BMPs and controls.
- While this research is taking place, some on-site actions should be taken, either as a part of the proposed Forest Ecosystem Restoration, or as erosion BMPs.
  - Identify and stabilize exposed soil and unstable stream banks.
  - Identify and apply BMPs for the Conservation District.
  - Control feral ungulates.
  - Re-vegetate denuded and riparian areas with native forest cover.
- Additionally, these off-site, sediment-control measures could be taken:
  - Identify appropriate locations and designs for sediment collection measures, such as traps or basins.
  - Investigate multi-purpose sediment collection structures that may provide non-potable irrigation water to large consumers, perhaps through the proposed Wetland Restoration Project.

## Participating Agencies

A participating agency could include DLNR due to its jurisdiction over the upper watershed, its dredging operations in the Ala Wai Canal, and its interest in ensuring water quality and the prevention of rapid runoff and soil erosion. Other participants may include NRCS, USGS, and UH-WRRC due to their research objectives in biological, earth, and water resources. The City DPP, land developers, and contractors may become involved through their interest in construction site management. Other agencies may include EPA and DOH, due to their regulation of sediment disposal, and COE through its ecosystem restoration mission. DDC could also become involved in the construction of erosion control BMPs. BWS may become involved if an irrigation water source can be incorporated into sediment detention structures.

## Estimated Cost

$500,000 - $1 million

## References

C&C DDC. (2000). *Draft Environmental Assessment: Ala Wai Canal Watershed Project, Manoa Valley District Park Streambank Improvements, Honolulu, Oahu, Hawaii.*

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# Ala Wai Watershed Contaminated Sediment Reduction Program



## Purpose

To reduce the amount of contaminated sediment in the Ala Wai Canal.

## Project Background and Objectives

The Ala Wai Canal accepts heavy sediment loads that must be periodically dredged to maintain flood capacity and recreational attractiveness. While most of the sediment is suspected to originate in the Conservation District, contaminants are associated with human activities in the Urban District.

Contaminated sediments pose health risks by exposing recreational users of our waterways to heavy metals, pesticides, and other chemicals. Additional health risks occur as animals are exposed to the contaminants and potentially absorb them into their tissue. Many people fish and crab in the Ala Wai Canal for subsistence and may ingest the contaminants from their catch. A Fish Consumption Risk Assessment done for the Ala Wai Canal Watershed Water Quality Improvement Project (1998) concluded that the health risk due to lead was considerable for children who consumed one whole fish from the Ala Wai Canal.

Contaminated sediments also degrade the estuarine habitat of the Ala Wai Canal by exposing organisms to heavy metals, pesticides, and other chemicals that accumulate in tissue and build up throughout the food chain. They create difficulties during dredging operations by requiring additional testing and special disposal methods. Clean sediments determined by testing to be suitable for ocean disposal may be transferred to the EPA-approved South O'ahu Ocean Dredge Material Disposal Site (SOODMDS) approximately 3.8 miles seaward of the Airport Reed Runway. Sediments found to be unsuitable for ocean disposal in part of the Canal require a special disposal alternative through treatment and placement at the Honolulu Airport Reef Runway.

Urban sediments are sometimes contaminated with herbicides from residential and institutional spraying, termiticides from previous ground treatment, and heavy metals and other automobile-generated substances from the estimated 1.6 million miles per day driven by vehicles through the watershed. Vehicle-related pollution is often in the form of fine particles that accumulate on roadways and are eventually swept into surface waters via storm drains. The City and County of Honolulu Department of Environmental Services (ENV) has conducted a study that determined that street sweeping is an effective method for removing roadway pollutants. ENV is currently studying the effectiveness of storm drain filters in removing contaminants such as copper and lead from street runoff.

Other suspected sources of contaminated sediment include construction sites and storm drains. However, there is little data on the effect of land use on sediment levels of contamination, making it difficult to develop strategies to reduce sediment contamination.

*Urban sediments running down a street.*

*Urban runoff accumulating at a drain.*

## Preliminary Scope

The primary objective of this program is to develop and implement strategies that moderate human-induced sediment contamination. This will result in a reduction in dredge disposal costs by reducing or eliminating contaminated sediment in the Ala Wai Canal. The program will include, but not be restricted to, the following actions:

- Develop recommendations for the reduction and/or removal of contamination or contaminated sediment.
- Quantify the contribution of vehicles to contaminated sediment. Move to reduce vehicle-related pollution.
- Implement and enforce various on-site construction regulations.
  - Grading and permit regulations.
  - Required use of BMPs by contractors.
  - Soil testing at construction sites with existing or previous structures that may have had pesticide application.
  - Treatment of contaminated soils, possibly through bioremediation.
  - Recommendation and implementation of other appropriate on-site measures.
- Install storm drain filters at key locations. This could include laboratory analysis of the residues to determine the types of pollutants present in runoff, as well as the levels of pollution from different areas. This feature could be considered as its own project or as a complement to street sweeping.
- Continue regular street sweeping, especially in areas of high vehicle density. Laboratory analysis of collected particles could determine the types and amounts of pollutants that end up in the streets. Street sweeping could be conducted as a separate project or as a complement to the above-mentioned storm drain filter project.
- Identify appropriate locations and designs for off-site sediment control measures such as sediment traps and basins. Implement these measures to reduce the amount of contaminated sediment that reaches the MPDC and the Ala Wai Canal. The proposed Wetland Restoration Project could serve this purpose and use wetland plants to bio-remediate contaminated sediments.

## Participating Agencies

DLNR could participate based on its jurisdiction over Ala Wai Canal dredging operations and its interest in ensuring water quality. Other participants may include NRCS, USGS, and UH-WRRC due to their research objectives in biological, earth, and water resources. DPP, land developers, and contractors may become involved due to their interest in construction site management. Other agencies that may participate include EPA and DOH, because they regulate sediment disposal. DDC may participate in the construction of contaminated sediment BMPs. DOT, DFM, and ENV may also participate in the control of motor-vehicle-related contaminants. COE may participate through its ecosystem restoration mission.

## Estimated Cost

$250,000-$500,000 annually

## References

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# Sediment Disposal Study



## Purpose

To investigate alternatives for the disposal of sediment dredged from the Ala Wai Canal and feeder tributaries.

## Project Background and Objectives

There are many locations on O‘ahu that must periodically be dredged. These include storm drains, stream mouths, flood control projects, and harbors. At present, the most feasible alternative for the disposal of Ala Wai sediment is at the EPA-approved SOODMDS at Māmala Bay, about 3.8 miles offshore of the Airport Reef Runway in about 1,400 feet of ocean water. Disposal at this site is subject to EPA and U.S. Army Corps of Engineers (COE) authority via an environmental review and permit process that incorporates the opportunity for public comment.

Sediment dredging and disposal have become a difficult and costly public problem for two reasons. The intense urbanization of O‘ahu has created high land values and a situation where vacant lands are not available to de-water dredge spoils adjacent to dredging locations. Dredged sediment must therefore be transported to a disposal location as a liquid material over land, which is prohibitively costly. If there is nowhere to de-water the sediment adjacent to the dredging area, current practice is to haul the sediment via ocean-going barge to the SOODMDS.

Ocean disposal of sediment has been questioned because of public concerns related to environmental quality. Although EPA and COE have found over 95% of recent Ala Wai dredge sediment to be acceptable for ocean disposal, there is concern that the pollutant problem could worsen. Communities have already raised concern over the transport of sediment through their neighborhoods, especially when those sediments have been found to be too contaminated for ocean disposal.

Sediment contamination is associated with urbanization and the intense use of roadways with accompanying vehicle contaminants (including lead, copper, cadmium, oils and grease). Lead was the contaminant of greatest concern in the current Ala Wai Canal dredging project. Additionally, high densities of urban activities have included historic use of pesticides, such as dieldrin and chlordane, to control termites that have leached through the soil into groundwater supplies. These chemicals have been found in Ala Wai Canal sediments and detected in some BWS wells, although not at levels high enough to warrant well closure.

A rational is needed to investigate maintenance dredging and alternatives for dredged sediment disposal. Some disposal alternatives include bioremediation; reuse as structural fill, soil amendments, or topsoil; ocean disposal; upland disposal; or encasement. Such an investigation should also consider the dredging needs of areas other than the Ala Wai Canal.

Dredging is costly due to the lengthy permitting process and multiple concerns that must be addressed regarding the thousands of tourists and residents that use and live along the Ala Wai Canal. Therefore, it is ideal to reduce the frequency of dredging required for the Canal.

Dredge disposal options increase for cleaner sediments. This would support collecting sediments at the foot of the Conservation District where most of the sediment is suspected of originating, before it travels downstream where it may potentially be contaminated by urban runoff and/or seawater.

*Ala Wai Canal dredging, 2002*

## Preliminary Scope

This study will provide environmentally and socially acceptable recommendations for the disposal of dredge materials from the Ala Wai Canal and other sites. This project should include but not be limited to the following:

- A 2002 study conducted for the COE included the following tasks that could provide preliminary data for this study.
  - Inventory all O'ahu locations that require periodic maintenance dredging; assemble existing information about each, including the volume of sediment to be dredged, recommended dredging interval, composition of the materials to be dredged, and potential contaminants; and present method of dredging and disposal.
  - Identify and evaluate alternatives for dredge material disposal, including land-based treatment, re-cycling, de-watering, transporting, and ocean disposal.
- Consider environmental, social, cultural, and economic factors in the evaluation process.
- Evaluate disposal alternatives, perhaps by EPA and COE.
- Make recommendations for various dredging situations. It may be that for some dredge sites, disposal options are different than for other dredge sites. For example, dredged material from harbors and the Ala Wai Canal, with their large volumes of sediment and where contaminant levels are not an issue, may most feasibly be disposed at the ocean disposal site. However, with gradually tightening environmental regulations, it is prudent to start a process to identify disposal alternatives.

## Participating Agencies

A participating agency could include DLNR due to its jurisdiction over dredging operations in the Ala Wai Canal. Other participants may include NRCS, USGS, and UH-WRRC due to their research objectives in biological, earth, and water resources. DPP may also be involved due to its interest in permitting dredging operations. Other agencies that may participate include EPA and DOH, due to their regulation of sediment disposal. DDC may also become involved in the construction of contaminated sediment BMPs. COE may be able to provide some support through its Planning Assistance to States program. Additionally, as the agencies that regulate dredging activities, the EPA and COE may conduct a joint study of alternatives.

## Estimated Cost

$250,000-$500,000

## References

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# Urban District Storm Water Runoff Master Plan



## Purpose

To reduce the potential for flooding by coordinating compatible flood control projects in an appropriate sequence.

## Project Background and Objectives

Urban development in lowlands, stream valleys, and coastal areas has encroached into flood plains. Because of this, lives and structures are sometimes threatened by flash floods caused by heavy rainfall and storm events. Structural and non-structural measures have been employed to reduce the resulting threat of damages. Oceanic floods, including tsunamis and high sea and surf conditions also threaten the coastal areas.

Measures that may be considered for flood control include runoff and sedimentation management, retention of parts or all flood runoff, diversion of runoff into floodways, and the confinement of flood waters by levees or other structures. Very little literature is available on oceanic flooding and possible flood abatement measures for that particular scenario.

Many flood control projects have been planned and built to reduce the threat of floods to life and property. While some projects are adequate in conveying storm water, others are not capable of handling 100-year design flows. There are also some locations that are outside of the 100-year flood area that have reported periodic flooding.

Flooding in this watershed is typically caused by inadequate capacity of natural streambeds to accommodate flood flows, restrictive bridge openings, and previously constructed channels that were not designed to accommodate current standards. Therefore, the capacity of the streams and existing improvements should be evaluated to determine if they are adequate.

In the past, previous flood control projects allowed for development within the 100-year flood zone. However, while these properties may be protected from lesser floods, they are still at risk from larger storm events. Because there are so many areas that may be affected by floods, projects must be prioritized to identify those areas with the most immediate threats and potential for damage.

Several agencies at all levels of government are involved in flood control projects. This raises the potential for piece-meal projects to overlap, therefore creating redundancy, or for a particular agency to not fully address a complete flooding problem should the area in question cross jurisdictional boundaries. A holistic approach to flood control should be taken in order to ensure minimal overlap and conflict between projects and to maximize effectiveness and efficiency. A master plan will identify all of the flood control issues and needs for the watershed, assess the adequacy of existing structures, identify proposed improvements and locations, and recommend a plan of action.

A flood control master plan should also take into account purposes other than flood control. For example, storm water modifications should be designed to accommodate aquatic and riparian habitat, maintenance issues, and recreational use where appropriate. Additionally, storm water storage facilities could potentially provide non-potable water for use as irrigation to large institutions such as the Ala Wai Golf Course, the Honolulu Zoo, and Kapi‘olani Park.

*The densely populated urban district of the Ala Wai Watershed.*

## Preliminary Scope

This project will reduce the flood potential in the Ala Wai watershed urban district. An overall plan will ensure problems are addressed in a holistic manner, prioritize projects, and minimize conflict. The plan may include the following components:

- Identify previous flood control projects and assess their ability to meet current flood control standards.
- Identify and describe on-going and planned projects for problem areas.
- Identify areas requiring further study.
- Identify the risk associated with particular flood-prone areas and prioritize projects. Recommend a logical sequence to implement projects, taking into account risk and how each project will affect those downstream.
- Identify the agencies that have jurisdiction over any particular project, agencies that may share jurisdiction.
- Monitor parameters that are required for storm flow modeling, such as canal high water marks and crest stage gauge readings.
- Flood plain zoning: establish encroachment zones in the potential tsunami inundation areas and regulate use of the undeveloped flood plain.
- Flood fighting units: organize flood fighting sub-units to stress the techniques of proper preparation and clean-up procedures.
- Develop methods and identify products that perform flood abatement, while reducing or minimizing impervious cover.
- Develop incentives for on-site water storage on private lots.
- Recommend multiple-use projects that can serve purposes in addition to storm water control, such as maintenance or habitat provision.
- Investigate the feasibility of using storm water as a source of non-potable water.
  - Determine need and potential supply.
  - Identify potential users.
  - Determine feasibility.
  - Identify possible locations for collection.

## Participating Agencies

DLNR may be a primary participant due to its role as the State's primary agency responsible for flood control. CWRM may be specifically involved if stream diversions are proposed as a method of flood control. Agencies that may offer support include COE through its water resources development authorities and NRCS through its Watershed Protection and Flood Prevention Program. DDC may be involved as the City's agency responsible for capital improvement projects, as well as DFM, due to its responsibility of maintaining the streams. Adjacent private property owners also may share in the planning and implementation of this plan.

## Estimated Cost

$500,000-$1 million

## References

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# Ala Wai Canal Flood Control Project



## Purpose

To reduce the flood potential of the Ala Wai Canal and its effect on surrounding areas.

## Project Background and Objectives

Watersheds in Hawaii tend to be short and steep, therefore leading to flash flood conditions during storm events. The Ala Wai Canal collects drainage from the Makiki Stream, Mānoa Stream, and Pālolo Stream drainage basins. The peak discharge rate for the 10-year flood flow event was estimated to be 12,300 cfs, and 22,900 cfs for the 100-year event. The Canal was originally constructed in the 1920s to accommodate floodwaters from all three drainage basins. However, due to sedimentation from the upper watershed and restrictive bridge openings, the capacity of the Canal has been reduced to an estimated 6,500 cfs at a location 2,000 feet upstream of the confluence with the Mānoa-Pālolo Drainage Canal. As a result, the 10-year flood outline around the Ala Wai Canal covers most of the area makai of Date Street as well as most of Waikīkī.

A 1994 report concluded that the Canal has only marginal capacity to handle the 10-year or more frequent flood event and definitely can not handle the 100-year event flood flow due to inadequate capacity. Additionally, the Canal section between the Kalākaua and Ala Moana Boulevard bridges is approximately 100 feet narrower than upstream sections, restricting flow. Further impeding flow are the Ala Moana, Kalākaua, and McCully Street bridges, with their large pilings and restrictive openings. This poses a high risk to the densely populated areas surrounding the Canal and to the economically critical tourist destination of Waikīkī.

A storm in 1967 caused the Ala Wai Canal to overflow its banks and poured 2 feet of water onto Ala Wai Boulevard near its confluence with the Mānoa-Pālolo Drainage Canal. Ala Wai Elementary School was flooded with 6-12 inches of water that created damage estimated at $10,000. Moderate rainfall has also caused flooding in the Ala Wai Golf Course when the Canal capacity was lowered by sedimentation.

While earlier reports determined that dredging would be required to accommodate even the 50-year flood, it was found that maintenance dredging would not significantly improve the Canal's flood carrying capacity. An increase in the Canal depth was modeled and the associated report concluded that uniform deepening of the Canal was not cost effective in that it would only reduce water levels approximately 1-foot in a 100-year flood event.

City drainage standards recommend capacity for a 100-year storm event. Previous studies on flood control alternatives have resulted in options that would meet this requirement, but would produce unpopular aesthetic effects, while the option that yielded the highest benefit to cost ratio did not provide for the 100-year level of protection.

A 1994 report by DLNR determined that while there is an extensive 100-year flood zone surrounding the Canal, flooding was infrequent and damages have been minor. Periodic dredging is done to maintain capacity. The land adjacent to the Canal has various owners and the environmental and social concerns are high. COE is currently conducting a Feasibility Study that is investigating and evaluating solutions to flood control problems related to the Ala Wai Canal.

*November 1965 - flood waters overtop the Ala Wai Canal and flow onto Ala Wai Boulevard.*

## Preliminary Scope

This project will be compatible with the Storm Water Master Plan proposed in Project No. 12 and will reduce the flood potential to Waikīkī and other areas surrounding the Ala Wai Canal. Actions that may be included as a part of this project are as follows:

- Evaluate the extent of the flood problem and the associated potential damages.
- Survey the Canal wall bank elevations to determine accurate flood capacity for analysis.
- Identify existing storm sewers and verify that they are all functioning properly.
- Investigate the feasibility of increasing the flood-carrying capacity of the Canal's mauka areas and tributary streams through storm water retention basins, detention basins, or other methods. As a part of this, the feasibility of diverting flood flows over a portion or all of the Ala Wai Golf Course should be examined. The Golf Course may require reconfiguration to serve as a temporary storm water retention basin. This concept could be developed separately as its own project.
- Conduct a more refined analysis of flood control alternatives within the Canal itself.
  - Investigate the feasibility of new floodwalls and combination of dredging, new floodwalls, and levees.
  - Analyze bridge openings along the Canal and their ability to convey storm water to the ocean. Investigate the reconfiguration of the existing bridges to allow for unimpeded movement of floodwater to the ocean.
  - Investigate the feasibility of widening the Ala Wai Canal from the McCully Street bridge to its mouth to allow for unrestricted flow.
- Accommodate multiple purposes in flood control features, where feasible.
  - Include ecosystem improvement features, such as native species habitat improvement, where feasible. Shelter for juvenile organisms should also be considered.
  - Accommodate recreational activities.
  - Accommodate maintenance activities.

## Participating Agencies

DLNR may be a primary participant due to its role as the State's primary agency responsible for flood control. CWRM may be specifically involved if stream diversions are proposed as a method of flood control. Flood control can be implemented through its Section 209 authority and the current Ala Wai Feasibility Study. NRCS may also offer support through its Watershed Protection and Flood Prevention Program. Property owners along the Canal such as the HI Department of Education and the C&C DPR may also participate in this project.

City agencies such as the DDC and DFM may be involved as the City's agencies responsible for capital improvement projects and stream maintenance if flood control problems at the Canal are found to be related to situations upstream where the City has jurisdiction.

## Estimated Cost

More than $3 million

## References

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# Makiki Flood Control Project



## Purpose

To reduce the flood potential for areas around Makiki Stream.

## Project Background and Objectives

Hawai‘i experiences high amounts of rainfall, but due to the high permeability of the soils and rocks, most streams do not flow continuously year-round. Watersheds here tend to be short and steep, therefore leading to flash flood conditions during storm events

The Makiki Stream drainage basin covers 2.7 square miles. The 100-year flood outline for Makiki Stream extends over the Ala Moana area makai of Makaloa Street and most of the McCully residential area downstream of South King Street, including Lunalilo Elementary School and Washington Intermediate School.

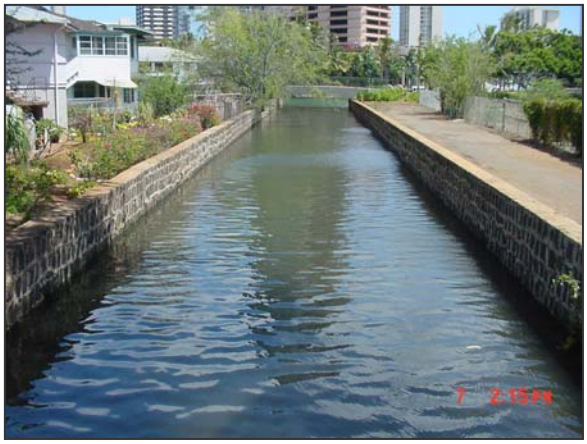
Previous flood drainage improvements to the stream include Makiki Ditch, a 6,400-foot-long improved lateral channel that connects Kanahā Stream to Makiki Stream and 16,000 feet of CRM-wall open channel and underground piping improvements in the lower reaches constructed in 1930. Channel improvements for Makiki Ditch above Wilder Avenue were constructed in 1982-83.

Low-lying areas around Roosevelt High School have also been affected by the overflow of Kanahā Stream and while outside of the 100-year flood plain, the area between Ke‘eaumoku Street and Kalākaua Avenue has reportedly been flooded repeatedly. Channel improvements have been recommended for Kanahā Stream makai of Roosevelt High School.

Frequent overflow of the existing drainage channel has occurred in the areas downstream of King Street and is thought to be due to the channel’s inadequate capacity (500-1,500 cfs) to accommodate flows from the entire drainage area (5,600 cfs). This has resulted in over 100 properties being regularly affected by flooding, including Lunalilo Elementary School. A 1975 study projected that damages to these areas over the course of 50 years would total $10.5 million.

The Fern Street area of McCully was estimated to be subject to a flood recurrence interval of only 1.1 years. Flood plain zoning and relocation of properties within the flood plain are impractical due to the level of development that already exists adjacent to Makiki Stream. Therefore, improvements to increase the capacity of the existing channel appear to be the most cost-effective means of reducing the threat of flooding.

A 1994 DLNR Report found that flooding in the lower reaches of Makiki Stream was “isolated but fairly frequent,” with “hot spots between Kalākaua [Avenue] and Ke‘eaumoku [Street].” Historical damages have been classified as “median,” and existing control measures include an existing ditch, channel, and periodic cleaning. Land ownership along the stream was varied and the environmental and social concerns were unknown. This project was categorized as a “median” priority.



*Makiki Stream along residential properties in the McCully area.*

## Preliminary Scope

This project will alleviate the potential for flood damages in Makiki Valley. Components of the project may include the following:

- Channel improvements from Ala Wai Canal to King Street to handle a design flow of 5,600 cfs could include the following recommendations from a 1975 report and environmental impact statement. These actions would need to be re-evaluated to ensure they meet current needs.
  - Channel and box culvert improvements from Ala Wai Canal to Philip Street.
  - Reconstruction of the Kapi'olani Boulevard Bridge.
  - Adjustment of existing storm drain, sewer and water lines affected by the project.
  - Adjustment to private utility lines not compatible with the projects.
  - Adjustment and restoration of existing street and property improvements.
  - Maintenance road alongside the open channel to permit maintenance access.
  - Alignment studies for the section between Philip Street and South King Street to allow for suitable tie-in to upstream improvements.
- Channel improvements for Kanahā Stream makai of Roosevelt High School.
  - Construction of a box culvert from King Street to existing box culvert at Wilder Avenue.
  - Construction of concrete channel for Makiki Ditch from Wilder Avenue to Pensacola Street.
  - Construction of channel improvements for Makiki Ditch above Wilder Avenue.
- Study the possible solutions to the flooding problem that would be compatible with the highly developed urban areas along Makiki and Kanahā Stream.
- Accommodate multiple purposes in flood control features, where feasible.
  - Include ecosystem improvement features, such as bank stabilization or native species habitat improvement, where feasible. This may be accommodated through natural stream bottoms or low flow channels, stream feature (pools, runs, riffles, etc.) maintenance, riparian vegetation preservation, impervious cover reduction, etc.
  - Accommodate recreational activities.
  - Accommodate maintenance activities.

## Participating Agencies

DDC may be the primary participant due to its role as the City's primary agency responsible for capital improvement projects. DFM may also be involved as it is tasked with repair and maintenance of City facilities, as well as stream maintenance.

DLNR may be also somehow be involved as the State's primary agency responsible for flood control. CWRM may be specifically involved if stream diversions are proposed as a method of flood control. Other agencies that may offer support include COE through its flood control authorities and NRCS through its Watershed Protection and Flood Prevention Program. Private property owners along the Canal may also participate in this project.

## Estimated Cost

More than $3 million

## References

City and County of Honolulu. (1975). *Engineering Report of Alternative Structural Schemes for Makiki Stream Flood Control Unit I at Honolulu, Oahu, Hawaii.*

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# Mānoa Flood Control Project



## Purpose

To reduce the flood potential for areas around Mānoa Stream.

### Project Background and Objectives

Mānoa Stream experiences flooding due to the inadequate capacity of the natural stream channel to accommodate flood flows. Additionally, more level terrain in the Woodlawn area slows down the flow of water. These characteristics, coupled with several restrictive bridge crossings, have led to the stream overtopping its banks during storm conditions. Several actions along this section of stream could provide protection from flood conditions. The Woodlawn Bridge could be reconfigured to allow for unimpeded flow and the capacity of the Stream could be increased above and below the bridge to accommodate current storm water drainage standards.

Development along the stream has also altered the natural drainage way and may also contribute to flood-prone conditions by increasing stream flow and bank erosion. The 100-year flood outline for Mānoa Stream extends into developed areas, especially in the areas between Kahaloa Drive and Woodlawn Drive and below Dole Street. Embankment protection and maintenance along Mānoa Stream will help to minimize erosion and control vegetative growth that may otherwise impede water movement. Streamside development, however, may still be at risk of flooding. A long-term solution such as a streamside park could act as a buffer between private property and potential flooding and also allow for stream bank maintenance. However, private ownership of stream banks, which sometimes extends to the center of the stream itself, may prove difficult.

During the last Century, more than 12 major floods have occurred and claimed two lives during two different storms in 1918 and 1950. Other flood conditions include May of 1927 when 50 farmers suffered $23,000 worth of damage from heavy rains, November of 1965 when residential homes were flooded from bank-overtopping in the Kānewai-Koali Road area and part of the stream bank collapsed due to undercutting, and in December of 1992 when Mānoa Stream overtopped its banks and flooded Woodlawn Drive. More recently, Mānoa Stream flooded mauka of Mānoa Marketplace in January of 2002 after 2.5 inches of rain was recorded at Lyon Arboretum in three hours.

Mānoa Stream has only an 860-foot-long section of "improvements." This concrete-lined section was constructed in 1952 and runs from upstream of Lowrey Avenue to downstream of East Mānoa Road. Improvements for the sections upstream and downstream of the 1952 improvements were designed in the 1970's but were never constructed. Several small improvements have been made to the stream since the 1988 New Year's Eve Flood, but these improvements were designed based on flood flows of less than 100-year frequency storms. A 1995 DLNR report concluded that in order for Mānoa Stream to accommodate the 100-year storm, its capacity would need to be increased to 10,700 – 11,400 cfs.

The Mānoa-Pālolo Drainage Canal was constructed in 1935 to provide a direct outlet to the Ala Wai Canal for combined flows from the Mānoa and Pālolo Streams. Present capacity of the Drainage Canal just upstream of the Date Street Bridge is 5,000 cfs, which is less than the projected 10-year frequency flood.

*Mānoa Stream above Woodlawn Drive.*

## Preliminary Scope

This project will be compatible with the Storm Water Master Plan proposed in Project No. 12. The following actions will help to reduce the flood potential of Mānoa Stream, as well as to direct development out of the flood plain, therefore reducing the likelihood of damage due to flood conditions.

- Yearly stream maintenance program to maintain embankment areas free of vegetative overgrowth and to allow the free movement of water, especially at bridge openings.
- Assess the adequacy of the existing channel capacity and increase the stream capacity to accommodate the 100-year storm, where necessary.
- Ensure flood improvements allow for native species habitat considerations.
- Stream bank maintenance that may include:
  - Embankment protection, including CRM walls.
  - Stream bank stabilization to re-grade the bank to a gentler slope to reduce erosion.
- Flood control in the Woodlawn area:
  - Widen and deepen the upstream and downstream approaches to the Woodlawn Bridge to increase the capacity of the flow under the bridge.
  - Linear park between East Mānoa Road bridge and Woodlawn Drive bridge to provide for flood plain management.
- Accommodate multiple purposes in flood control features, where feasible.
  - Include ecosystem improvement features, such as bank stabilization or native species habitat improvement, where feasible. This may be accommodated through natural stream bottoms or low flow channels, stream feature (pools, runs, riffles, etc.) maintenance, riparian vegetation preservation, impervious cover reduction, etc.
  - Accommodate recreational activities.
  - Accommodate maintenance activities.

## Participating Agencies

DDC may be the primary participant due to its role as the City's primary agency responsible for capital improvement projects. DFM may also be involved as it is tasked with repair and maintenance of City facilities, as well as stream maintenance.

DLNR may also somehow be involved as the State's primary agency responsible for flood control. CWRM may be specifically involved if stream diversions are proposed as a method of flood control. Other agencies that may offer support include COE through its flood control authorities and NRCS through its Watershed Protection and Flood Prevention Program. Private property owners along the Canal may also participate in this project.

## Estimated Cost

More than $3 million

## References

C&C DDC. (2000). *Draft Environmental Assessment: Ala Wai Canal Watershed Project, Manoa Valley District Park Streambank Improvements, Honolulu, Oahu, Hawaii.*

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# Pālolo Flood Control Project



## Purpose

To reduce the flood potential for areas around Pālolo Stream.

## Project Background and Objectives

Hawai‘i experiences high amounts of rainfall, but due to the high permeability of the soils and rocks, most streams do not flow continuously year-round. Watersheds here tend to be short and steep, therefore leading to flash flood conditions during storm events

The Pālolo Stream drainage basin covers 3.8 square miles. Pālolo Stream joins Mānoa Stream makai of Wai‘alae Avenue to form the Mānoa-Pālolo Drainage Canal, which conveys the waters of the two valleys into the Ala Wai Canal.

Improvements to Pālolo Stream include the enlargement of certain sections, the lining of three sections totaling roughly 3,400 feet, and the construction and/or improvement of walls and embankments. These improvements have generally been found to protect the surrounding land. However, Pālolo Stream has had eight major floods in the past century that have claimed 6 lives, and floodwater has destroyed and swept away bridges, homes, and other installations.

Specifically, mudslides caused by a flood in November of 1965, covered part of Myrtle Street and damaged three homes. Additionally, a 1967 flood caused landslides, debris, road damages, and erosion. Asphalt pavement on Lai Road was washed out by hillside runoff. A landslide covered a roadway and deposited large trees into the stream, isolating several families at the uppermost portion of the Valley. In the lower reaches of Pālolo, erosion toppled retaining walls and moved several homes from their foundations.

A 1983 report by the City and County of Honolulu Department of Public Works concluded that a flood improvement project in the St. Louis Drive to Keanu Street area was not justifiable. Some property owners have independently protected their properties from erosion with rock and/or masonry walls, and while some properties immediately downstream of the Pālolo Stream Flood Control Unit II improvements have had some damages, most properties show no indications of flood damages. No damages were attributed to flood waters in this area, therefore failing to justify a City project. However, it was recommended that property owners be encouraged to protect their properties at their own expense.

Since then, a 1994 report by DLNR found that the area near the confluence of the Mānoa and Pālolo Streams experiences isolated and infrequent flooding, which has historically produced minor damages. The area lies within the Urban District and there is an existing channel improvement. At the time of the report, there was no commitment by any level of government to construct any control measures. Land ownership along the stream was varied, but the environmental and social concerns were favorable. This project was considered a low priority. The need for flood improvements to the St. Louis High School area, and other portions of the stream, should be re-evaluated to resolve the contradictory reports.

*Pālolo Stream near St. Louis School is overgrown with grass and other vegetation.*

## Preliminary Scope

This project will alleviate flooding and erosion hazards for Pālolo Valley. Components of this project may include the following tasks:

- Re-evaluate the need for flood improvements in Pālolo Valley.
- The channel transitions at the end of the Pālolo Stream Flood Control Unit II improvements have been eroded and washed away. This should be reconstructed.
- Periodic clearing of large debris, boulders, and trash from the stream bottom.
- Evaluate the need for flood and erosion control measures in the St. Louis High School area.
  - Reinforced concrete channel on Pālolo Stream from St. Louis Dr. to Keanu St., will also alleviate erosion along Pālolo Stream.
  - Install energy dissipators to reduce the erosive force of water on the downstream bank of the stream curve.
- Accommodate multiple purposes in flood control features, where feasible.
  - Include ecosystem improvement features, such as bank stabilization or native species habitat improvement, where feasible. This may be accommodated through natural stream bottoms or low flow channels, stream feature (pools, runs, riffles, etc.) maintenance, riparian vegetation preservation, impervious cover reduction, etc.
  - Accommodate recreational activities.
  - Accommodate maintenance activities.

## Participating Agencies

DDC may be the primary participant due to its role as the City's primary agency responsible for capital improvement projects. DFM may also be involved as it is tasked with repair and maintenance of City facilities, as well as stream maintenance.

DLNR may be also somehow be involved as the State's primary agency responsible for flood control. CWRM may be specifically involved if stream diversions are proposed as a method of flood control. Other agencies that may offer support include COE through its flood control authorities and NRCS through its Watershed Protection and Flood Prevention Program. Private property owners along the Canal may also participate in this project

## Estimated Cost

More than $3 million.

## References

C&C Department of Public Works. (1983). *Preliminary Report Palolo Stream Flood Control, Honolulu, Oahu, Hawaii*.

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U.S. Army Corps of Engineers Honolulu District. (1992). *Urban Flood Control Study Honolulu, Hawaii Final Reconnaissance Report Main Report*.

*Lower reaches of Pālolo Stream.*

# Streamside Dumping Prevention and Cleanup Program



## Purpose

To reduce the amount of large-item dumping in streams and canals that impede the flow of water and may contribute to water contamination as these items break down.

## Project Background and Objectives

In its 1992 reports, Edward K. Noda and Associates found that the most obvious items found in the Mānoa-Pālolo Drainage Canal were "construction-related debris, such as scraps of wood and metal." Other common dumping sites are those areas behind some institutional sites. Large amounts of fluorescent light bulbs were found discarded behind St. Francis High School. Large items such as "bed frames, metal racks, and several deteriorated automobile bodies, plant wastes, and scrap materials" have been found behind the University of Hawai'i at Mānoa (UHM) campus.

Other large items found in other parts of the watershed include car engines, shopping carts, furniture, appliances, plywood, pipes, fixtures, and tires. In general, items have been found near bridges or in remote sites.

Bulky items not only create eyesores, they can also obstruct bridge openings and waterways in general, therefore fostering conditions that could cause flooding. Additionally, different types of garbage could potentially contribute to water quality degradation. Fluorescent light bulbs contain a phosphorous mixture and mercury vapor, which could contaminate stream water. The metal items found in the streams "were often so completely corroded that they were unrecognizable," therefore potentially contributing to heavy metal concentrations in the waters of the Ala Wai system.

The City and County of Honolulu is responsible for stream and channel maintenance, unless the streambed, channel, or stream bank is owned by the State or a private entity, in which case it is to be maintained by the respective owner. The State owns the Ala Wai Canal proper and is therefore responsible for maintaining it. The State DLNR DOBOR operates a debris trap in the Ala Wai Canal, but this is only effective in capturing small floating debris. Large items such as appliances are not collected by these devices.

Discussions with AWWA identified that dumping occurs throughout the watershed, but particularly in the Tantalus-Roundtop area. Due to its isolation and several vehicle pull-outs, this area has been used as a dumping ground for abandoned vehicles and large appliances. Steep topography makes it difficult for volunteers or government crews to remove the items. Community volunteers have implemented some measures to reduce the dumping problem, including a neighborhood watch type system where residents report dumping activities, the installation of mile markers so police can find illegal dumpers more easily, and the installation of bollards in pull-outs to prevent vehicles from backing up to the edge of the ravine.

The City provides free collection services for bulky items such as furniture, appliances, and mattresses. Most appliances are recycled, but the City recommends that items be donated if they are still in usable condition.

*Wooden bollards were installed in Tantalus to reduce illegal dumping. The remains of a charred vehicle may be seen in the foreground.*

## Preliminary Scope

This program will reduce the amount of large-debris items in the streams and waterways of the Ala Wai watershed. Both preventive and clean-up measures should be investigated. This program may include, but not be limited to the following actions:

- Enforce existing legislation that requires stream owners to maintain streams and waterways.
  - City litter control ordinance (Article 4, Chapter 29, ROH)
  - Stream Maintenance Ordinance (Article 26, Chapter 41, ROH)
- Coordinate between government entities and volunteer groups to ensure proper training, equipment, safeguards, supervision, and support for clean-up efforts.
  - Clean-up of stream and canal beds and banks before the wet season to reduce the amount of debris before heavy runoff conditions can contribute new material and carry the existing debris downstream and out to sea.
  - "Spring cleaning" after the rainy season to remove debris that was transported into waterways and downstream during winter storms.
- Install landmarks or markers to direct police to locations where illegal dumping is observed.
- Install preventive measures such as bollards to reduce the potential for dumping to occur.
- Enhance the City's bulky item pick-up program.
  - Improve awareness.
  - Include automobiles for a nominal fee.
- Reduce the number of abandoned vehicles in the waterways.
  - Identify the last registered owner of an abandoned vehicle via the automobile's vehicle identification number and prosecute the owner for abandoning the vehicle. Recover the cost of removing the vehicle from the owner.
  - Improve the City's abandoned vehicle removal program.
- Develop and program to educate the public on the effects and penalties of stream dumping and various cleanup efforts.

## Participating Agencies

DLNR may be a key participant based on its jurisdiction over the upper watershed areas, as well as their interest in ensuring water quality. Other key players include DDC, which may be involved in the construction of structural BMPs and DFM, which in addition to maintaining City facilities, is responsible for stream maintenance under City jurisdiction.

Private property owners may be included due to their responsibility to maintain the length of the stream channel that falls within their property. Additional support for clean-ups may come from civic organizations such as the Ala Wai Watershed Association, Mālama Mānoa, and other volunteer groups.

## Estimated Cost

$100,000-$250,000 per year.

## References

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan – Volume II Technical Appendices.*

State of Hawaii DLNR DOWALD. (1992). *A Maintenance Plan for the Ala Wai Canal, Honolulu, Oahu, Hawaii.*

State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii.*

# Litter Reduction Program



## Purpose

Reduce the litter and debris that reach the Ala Wai Canal, Māmala Bay, and the Pacific Ocean.

## Project Background and Objectives

Traditional litter control efforts based on public education and advertising have had beneficial effects over the years and Honolulu's litter problem may not be as pronounced as that in many other large cities. However, litter and debris remain a severe and significant issue for the Ala Wai Canal. It degrades the visual environment and could be damaging to the economically important tourism industry in adjacent Waikīkī. Litter also damages small craft in the Ala Wai marinas and drifts to Māmala Bay, adjacent beaches, and to the Pacific Ocean where it can affect marine life and birds.

There are two main sources of litter and debris. Debris consists primarily of organic material such as leaves, branches, and sometimes whole tree trunks. Organic debris likely originates in the Conservation District and its presence is generally attributable to natural processes. Organic debris that originates in the Urban District can be controlled via maintenance, though some such material may find its way into waterways via illegal disposal practices.

Litter consists of manufactured material such as plastic bottles, cups, bags, plates, and many other types of materials associated with typical urban rubbish disposal. Litter in the Ala Wai watershed appears to originate as "fugitive rubbish," rubbish that escapes proper disposal through wind or other modes of dispersal, rather than as a result of intentional discarding practices. Much of the lower elevations of the Ala Wai watershed consist of high-density, low-rise residential units where household rubbish disposal is via the typical garbage can, plastic bag, or box. This method of rubbish disposal, twice weekly, results in some rubbish being placed curbside the evening before the morning pick-up. During the night, the rubbish is exposed to gusty trade-winds, domesticated animals, and other activities that may release poorly packaged rubbish, which then is transported by winds into street gutters, catch-basins, and the City's storm drain system and into the waterways, streams, and the Canal itself.

In other areas of Honolulu, the City has implemented the automated trash pick-up system that requires each household to use a large, city-provided rubbish container with lid. But in the high-density neighborhoods of the Ala Wai Canal, the City has not been able to install the automated pick-up system because there is not enough curbside area for all of the special rubbish containers. As a result, piles of loosely bound rubbish can be observed on collection days, and is blown down streets and waterways on windy days. One potential resolution may be to establish no parking ordinances on rubbish pick-up days that may be expanded to facilitate curbside street sweeping. However, such solutions are unlikely given the traffic and parking difficulties in these high-density residential areas.

Another potential solution may be to require residents to better package their rubbish, or require landlords to supply suitable rubbish containers with lids. Rules and regulations are currently in place to require suitable rubbish containers, but enforcement by the City is not occurring.

High-rise residential and business units must use private rubbish haulers and place rubbish in large bins with lids that are picked up on site. If smaller unit properties applied this method, the problem of fugitive rubbish would be solved. But such a solution is slow in being implemented and enforced in Honolulu due to its expense. Solutions to this issue do not seem to be in the immediate future, making the following task even more critical to be implemented.

## Preliminary Scope

This program will reduce the amount of litter that enters the Canals and waterways in the Ala Wai watershed.

- Improve stream maintenance and debris reduction along and within waterways.
  - Initiate periodic inspections by government officials or volunteers, if an adequate reporting system can be developed.
  - Improve maintenance of publicly owned parcels.
  - Enforce maintenance requirements by private owners.
  - Stabilize and restore riparian vegetation and stream banks in the Conservation District.
  - Stream maintenance improvement is also a function of other watershed tasks, and may be best accomplished under another project.
- Improve the rubbish disposal practices in problem-areas of the Ala Wai Canal watershed. Potential improvements may include:
  - Use of large, lidded bins to replace the current on-site method of rubbish disposal.
  - Implement the automated pick-up method.
  - Strictly enforce existing rules that require tightly lidded containers.
- Resolve issues of rubbish pickup cost and operation including:
  - Union issues if the automated pick-up method is implemented.
  - Insufficient curbside area for curbside bins to be placed for pick-up.
  - Provision of additional/modified bins and equipment for high-density rubbish pickup.
- Install and maintain structural catches for vegetative debris throughout the watershed.
- Install and maintain all the debris and litter-catching booms that were originally proposed in the Ala Wai Canal Water Quality Improvement Project (1998).
  - At present, only one such boom has been installed at the Kapahulu Storm Drain outlet into the Ala Wai Canal and this installation needs some minor modifications to be effective in trapping litter.
  - Additional locations for debris and litter-catching booms are near the mouth of the Manoa-Palolo Drainage Canal below the Date Street Bridge, near the mouth of Hausten Ditch, and near the mouth of Makiki Stream.
  - The actual cost of litter/debris-catching booms is low, and maintenance (removal of the accumulated rubbish) would require a small recurring cost.
- Enact a program to educate the public on the penalties and impacts of littering on the environment.

## Participating Agencies

The ENV may be a key participant based on their responsibility for environmental management, including waste disposal. Other key players include the DFM, which has the responsibility of stream maintenance, the DPP, which could be involved in litter control-related permitting, and DLNR, which has an interest in ensuring water quality. Private property owners may be included to develop and implement solutions on their properties.

## Estimated Cost

$50,000-$100,000 per year

## References

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii.*

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# Ala Wai Canal Health Awareness Program



## Purpose

To protect the health of paddlers and others using the Ala Wai Canal and tributary streams.

## Project Background and Objectives

The Ala Wai Canal and its tributaries are home to many activities such as canoe paddling, fishing, kayaking, and other water sports. However, poor water quality and bank conditions have reportedly increased health risks for users. The following have been identified as potential health issues for "users" of the Ala Wai:

Fishers – At present the State Department of Health (DOH) has posted signs at the Ala Wai Canal (and all urban streams on O'ahu) to notify fishers that no aquatic organism taken from the Canal should be consumed. The posting was done because a 1998 DOH risk assessment found elevated levels of lead in a sampling of tilapia, which could adversely impact children and adults who consumed the fish.

Monitoring of the levels of lead (and other contaminants) in fish and other aquatic organisms is the responsibility of DOH. DLNR, as the agency responsible for maintenance of the Ala Wai Canal, should assure that such monitoring takes place because not only can the data be used to assess the risk to human health, the data can also be used as part of the periodic evaluation and permit application process to dredge and dispose of Ala Wai Canal sediment. It should also be noted that State and Federal water quality objectives are to maintain waters that are "fishable and swimmable." Continued monitoring is one element of the overall effort to achieve these objectives. Until elevated levels of lead or other contaminants are no longer present in aquatic organisms that are likely to be consumed, postings against consumption should remain in place.

Paddlers and swimmers – For years paddlers have complained about itchiness and skin infections or "staph" attributed to exposure to Ala Wai Canal waters. A survey conducted for the 1998 Ala Wai Canal Watershed Water Quality Improvement Project found some anecdotal evidence for this allegation. Though the long-term goal is for Ala Wai Canal waters to be "swimmable," rapid achievement of this goal is not likely given the mass loadings of polluted runoff that contribute to elevated levels of bacteria and other organisms such as phytoplankton.

In the short term, users should shower both before and after exposure to Ala Wai Canal waters to prevent "self-infection." Self-infection occurs when bacteria on the skin gets into abrasions that are often caused by sun and salt water exposure and the activity of canoe handling. Canoes may also be a bacterial vector because they are stored in the open and become sites for puddled water, gecko and rat droppings, and insects or insect wastes. Paddlers' water bottles, skin, and gear are exposed to these bacteria making showering necessary. However, there are no shower facilities and changing rooms at many canoe club launching sites. Existing showers are inadequate and do not provide adequate drainage. Adequate showers and change rooms would encourage showering after water activities and it is recommended that such facilities be constructed along the Ala Wai Canal to serve the paddling community.

Users of the Canal (paddlers and fishers especially) are at risk from "spills" of contaminants from outfalls. Typically, spills are noted and advisory warnings broadcast or posted by agencies responsible. For example DOH will issue advisories for spills of hazardous and toxic materials including petroleum products and the Department of Environmental Services will issue advisories if there are sewage spills. However, there may be no immediate warnings to paddlers and fishers who are actually on site and engaged in activities on or in the Canal waters. Installation of an immediate warning system seems appropriate.

## Preliminary Scope

This project will lower the risk to health conditions for users of the Ala Wai watershed, and specifically, the Ala Wai Canal. Three actions are recommended:

- Reduce the long-term health risks associated with consumption of fish and other organisms from the Ala Wai Canal and its tributary streams.
  - Monitor the levels of lead and other contaminants in fish and other aquatic organisms to assess the current risk to human health, as well as to determine any trends or anomalies in contaminant levels.
  - Maintain signs and other methods of warning the public about the risks associated with consuming organisms from the Ala Wai Canal and other waterways.
- Reduce the risk of skin infection to those with direct contact with Ala Wai Canal waters.
  - Construct shower and changing facilities at several locations along the Ala Wai Canal. The locations should be determined in discussions with canoe clubs. Such facilities have basic standard designs already approved by the City, though some architectural treatment may be desired given the nature of the Waikiki area in general. The cost of each facility is estimated to be $250,000.
- Evaluate alternatives and select an immediate warning system for paddlers and fishers along the Ala Wai Canal of possible spills. Conduct this activity in conjunction with meetings of paddlers and fishers. It is not clear if the need for this warning system is significant enough to justify its installation and the meetings could help determine this. One idea for a warning system might be a series of blinking lights along the Canal banks. Lights would be quickly noticeable and would not entail the addition of noise to the already noisy Waikiki environment.

## Participating Agencies

DOH may participate based on its mission "to monitor, protect, and enhance the health and environmental well-being of Hawaii's people." DLNR may also be involved due to its jurisdiction over the Ala Wai Canal, as well as its interest in ensuring water quality

DDC may participate as the City agency that implements capital improvement projects. ENV may also be involved due to its sampling and pollutant monitoring activities

## Estimated Cost

$1 million-$3 million

## References

C&C DTS. (1998). Ala Wai Canal Dredging Conceptual Design and Environmental assessment-Sources of Contamination/ Potential Pollutants.

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State of Hawaii DOH Clean Water Branch. (1997). *Water Quality Monitoring Report – May 1996-97 Ala Wai Canal Watershed Project*.

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State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii*.


*Department of Health fish consumption warning.*

# Ala Wai Canal Maintenance Program



## Purpose

To establish an efficient and cost-effective program to maintain the Ala Wai Canal.

## Project Background and Objectives

The primary objective of maintenance is to provide for adequate channel capacity of the Canal so that it can serve its main function as a drainage-way for storm water runoff from the Ala Wai Canal watershed. Maintenance requires periodic dredging of the Canal.

The major need of maintenance of the Canal is to provide for adequate funding and a scheduled process to perform the actual dredging and disposal of accumulated sediment in the bottom of the Canal and the mouths of its feeder streams - Makiki, Hausten Ditch, the Kapahulu Storm Drain, and the Mānoa-Pālolo Drainage Canal.

The recommended maintenance dredging interval is every 10 years. To achieve this, a maintenance fund and program is required to ensure that adequate funding and the appropriate permits and environmental documents and approvals are ready when the time comes to dredge. The actual dredging project is then a relatively simple bidding process to obtain the least cost vendor. At present, there is no maintenance fund, and environmental permits and approvals are obtained on an *ad hoc* basis which is time-consuming and excessively costly.

The Canal has been dredged twice in its 74-year history - once in 1966 and again in 1978-79. Dredging is currently taking place but it has been 23 years since the last action. Deferred maintenance has deleterious effects on storm-water channel capacity. The tourism industry is hard-hit by the ugliness of a sediment-filled water body which has objectionable odors from accumulated anaerobic sediments. Additionally, tourists and residents alike are denied recreational opportunities due to the accumulation of sediment. The lack of frequent and efficient maintenance results from poorly available set-aside funding and the lack of a suitable maintenance program that incorporates environmental and permit processes.

The major cost of maintenance will always be borne by the State because the vast majority of material to be dredged is under State jurisdiction. At present, the funding for maintenance is by special appropriation by the legislature. Unfortunately, the current method of funding does not permit a scheduled and timely maintenance program. The legislature should establish a program in the Department of Land and Natural Resources to accomplish the maintenance dredging of the Canal. Alternatively, such a program might practically be better suited in the Department of Transportation's Harbors Division, which undertakes similar ocean-based dredging of harbors across the state on a periodic basis and which is an agency very familiar with dredging and disposal requirements and practices whereas the Department of Land and Natural Resources has less need for, and therefore less expertise to conduct, such maintenance dredging work.

There are other actions that would contribute toward providing a cleaner, more attractive body of water. Such projects as litter reduction, improved circulation, wetland restoration, public access, and the reduction of contaminants are discussed as separate projects in this current report.

*Current Ala Wai Canal dredging.*

## Preliminary Scope

This program will streamline the permitting and environmental documentation process required for regular maintenance of the Ala Wai Canal, with special emphasis on dredging activities. Additionally, it will ensure that all maintenance requirements, including funding, are accounted for so they are accessible at regular intervals, as opposed to the current system where funding and permits are only obtained when they are critically necessary.

- Develop a maintenance fund to provide needed services such as regular dredging.
  - Determine the agency best suited to coordinate Canal maintenance, including regular dredging operations. Jurisdiction currently falls under DLNR, but DOT Harbors Division, already has similar responsibilities in other areas.
  - DLNR (or DOT Harbors Division) should establish a maintenance fund reserve so that dredging can be performed every 10 years.
  - The maintenance fund should be incorporated into the maintenance program.
- Develop a maintenance program which would ensure that the appropriate permits and environmental approvals are in place at the needed times, and that the project design and specifications for contract bids will be on schedule. The existing set of documents (environmental, permits, design and bid specifications) should serve as an excellent basis to initiate the proposed program.
  - This may include the development of a programmatic Environmental Impact Statement for maintenance dredging to eliminate the need for an EIS every 10 years. However, EAs may still be necessary.
  - Similarly, permits for regular maintenance activities should be sought to reduce the need for new permits for every action.
- Establish periodic sampling and monitoring of sediment quality as part of the overall maintenance program and in preparation for the next dredging event.
- Other proposed projects in this current report are intended to reduce dredging requirements in terms of the total volume of sediment, or the frequency of dredging. For example, reducing the rate of soil erosion in the watershed or capturing eroded soil prior to discharge to the Canal by constructing sediment catchments could reduce dredging requirements.

## Participating Agencies

DLNR may be involved due to its jurisdiction over the Ala Wai Canal. DOH may also participate based on its mission "to monitor, protect, and enhance the health and environmental well-being of Hawaii's people," and its jurisdiction over sediment disposal.

Additional participants may include DOT Harbors Division because of the possibility of collaborating with DLNR on dredging activities, ENV due to its sampling and pollutant monitoring activities, DPR due to its maintenance activities at the parks adjacent to the Canal, and DPP to coordinate permitting on maintenance issues.

## Estimated Cost

$1 million-$3 million

## References

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii*.

State of Hawaii DLNR DOWALD. (1992). *Ala Wai Canal Improvement, Honolulu, Oahu, Hawaii, Feasibility Report*.

# Ala Wai Watershed Aquatic Habitat Project



## Purpose

To preserve, restore, and/or enhance native aquatic species habitat.

## Project Background and Objectives

In the "Hawai'i Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources" developed by the National Park Service for DLNR, the Ala Wai System was ranked "moderate" for aquatic resources. The ranking system included possible ratings of "outstanding," "substantial," "moderate," "limited," "without data," and "unknown." A total of nine native species and thirteen introduced species were recorded. This ranking was made based on only six surveys, the last of which was conducted in 1989. Only 44% of the 376 perennial streams surveyed in the assessment had biological data on which to base ratings.

There is very little information on Hawaiian stream fauna and their habitat in general, including information on the significance of estuaries and embayments to their life cycles. However, "Hawaii's Native and Exotic Freshwater Animals," written by DLNR DAR biologists, has found that most native stream species such as *o'opu* favor clear, well-oxygenated water and stream beds with boulders, cobbles, and gravel bottoms.

However, stream habitat has been altered over the years by human activities such as channelization, which has been installed to protect lives and property that have been developed too close to streams. While channelization conveys flood waters to the ocean very efficiently, it also eliminates habitat for native species by removing runs, riffles, and pools from the streambed, and eliminating trees and other riparian vegetation that shade the stream and provide food. Additionally, because the base flow of the stream is spread out over a wider channel, flows are shallower, slower, and warmer than conditions that favor native species.

The streams in the Ala Wai watershed exhibit varying degrees of stream channel modification. Makiki Stream has a 6,400-foot, lining-improved, lateral channel and 16,000 feet of CRM-wall open channel and underground piping improvements in the lower reaches. Mānoa Stream only has an 860-foot-long, concrete-lined section of improvements, but there are also several bridge crossings. Pālolo Stream has three lined sections of walls, embankments, and enlargements that total approximately 3,400 feet.

These channel improvements were constructed without consideration for habitat requirements and have allowed alien species to establish themselves. Anecdotal evidence suggests that alien species are not only established in the lower reaches of Ala Wai streams, but that they have also been steadily progressing mauka into the upper reaches as well.

In addition to the existing modifications, additional improvements have been recommended as flood control measures on all three stream systems. Guidelines should be developed to advise engineers on materials and methods that are aquatic habitat-friendly, but still perform the intended task.

To develop these guidelines, more data is needed on the habitat requirements of native species. For example, the optimal stream flow required for a healthy habitat is unknown. There is also little evaluation of historic and current stream flows, and the impacts of human development on flow volumes. Groundwater pumping and stream diversions are typical causes of reduced flows, although the impact of these actions in the Ala Wai watershed is unknown. Channel hardening may also restrict groundwater from seeping into streams, thereby supplementing their flow. Reduced stream flows may result in habitat loss, warmer water temperatures, and lower dissolved oxygen levels.

## Preliminary Scope

This project will determine habitat requirements for native aquatic species and recommend improvement alternatives, including guidelines for future stream channel alterations and proposals for modifying existing improvements.

- Study native species to better understand their habitat needs. An important component of this may be to determine the minimum stream flow requirements for specific aquatic species.
- Develop stream modification guidelines that take into account aquatic species habitat.
  - Recommend meanders, riffles, and other features to maintain or mimic natural habitat conditions.
  - Identify materials that mimic natural boulders and stream bottoms and banks or their functions.
  - Keep stream bottoms unlined and natural where possible.
  - Where stream bottoms must be lined, design low-flow channels to maintain faster flows and lower temperatures.
  - Implement stream bank improvements to minimize erosion.
  - Recommend appropriate riparian improvements, including vegetation.
  - Incorporate maintenance considerations, such as crew and equipment access.
- Identify existing channel modifications that may be altered to improve native aquatic species habitat.
  - Identify improvements that require upgrading or repair and incorporate stream modification guidelines into the design of such modifications.
  - Recommend specific improvements that would modify existing urbanized channels and restore ecosystem functions to native species habitats.
  - Develop a method of prioritizing the upgrade of existing modifications, based on monetary cost and benefit to native aquatic species.
- Develop stream maintenance BMPs that minimize impacts to aquatic and riparian habitat.

## Participating Agencies

DLNR may be a key participant, based on DAR's mission to "manage, conserve and restore the state's unique aquatic resources and ecosystems." CWRM also administers the State Water Code and has the mission of protecting and enhancing the waters of the State. The USFWS may also participate because it is the principal federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats. Other participants may include UH due to its research expertise, and DOH Clean Water Branch, with its mission to protect and restore inland and coastal waters for marine life and wildlife.

## Estimated Cost

$250,000-$500,000

## References

Miller, Jacquelin N. (1975). *Ecological Studies of the Biota of the Ala Wai Canal*.

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State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

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State of Hawaii OEQC. (1976). *Improvement of the Ala Wai Canal Final Report.*

U.S. Army Corps of Engineers, Honolulu Engineer District. (1999). *Ecosystem Restoration Ala Wai Canal Watershed Honolulu, Hawai'i*.

USFWS. (1978). *Stream Channel Modification in Hawaii*.

Yamamoto, M. N. & Tagawa, A. W. (2000). *Hawai'i's Native and Freshwater Stream Animals.*

*Pālolo Stream makai of the Kiwila Street Bridge. It is channelized, with a wide bottom that results in slow-moving water and no shade.*

## Purpose

To understand the biology of aquatic and riparian species and monitor their populations and presence in order to set restoration goals.

## Project Background and Objectives

In 1990, the Hawai‘i Stream Assessment rated the Ala Wai System as “moderate” in terms of aquatic resources, but this was based on only 6 surveys, the last of which was completed in 1989. Of the 376 perennial streams identified in the State, only 164 (44%) had some biological information from which the stream’s aquatic resources could be assessed.

According to EPA, bioindicators may be used for “setting protection or restoration goals, for determining what to monitor and how to interpret what is found, for prioritizing stressors and choosing control measures, and for assessing and reporting the effectiveness of management actions.” EPA supports the use of biological indicators (bioindicators) in assessing watershed health. In order for bioassessments to be able to indicate the conditions of a stream, biological criteria must be referenced against an ideal or pristine condition. Since it is generally agreed that there are no pristine streams left in Hawai‘i, minimally impacted streams are used to provide these reference conditions.

Certain native species could serve as bioindicators because they tend to be sensitive to environmental degradation. *O‘opu* have been suggested as bioindicators because they are easily identifiable, are specifically adapted to Hawaiian streams, and are found on all of the major islands. However, because *o‘opu* are amphidromous species, it should be noted that their populations may not necessarily reflect the conditions of the streams they are found in. A small recruitment class may indicate some sub-optimal condition within the watershed, but it may be difficult to identify what that condition is, and whether it is located in the streams themselves, or in the near-shore waters. Other species should be considered as potential bioindicators a well, including some alien fish species, insect taxa, algae, riparian biota, and āholehole, ‘ama‘ama, or other estuarine species.

Additional research is still needed to better assess the true value of using a particular species as a bioindicator. Research into the population dynamics of particular species, especially those used as bioindicators, would help in refining the metrics used in the bioassessments. Other data that would be helpful in drawing conclusions from bioassessments are information on the “biology, larval life history, and genetic structure” of native amphidromous species and the effects of pollution on aquatic and marine biota, especially the long-term effects of continual exposure to particular contaminants.

The UH Stream Research Center, has developed “The Hawai‘i Stream Bioassessment Protocol, Version 3.01.” This protocol uses a multi-metric approach to assess stream habitat and biological integrity that together are used to indicate stream degradation. This and other methodologies should be evaluated for their applicability to the purposes of this study.

The Federal Clean Water Act Section 303(d) mandates that each state submit to EPA a list of water bodies that are not expected to meet State water quality standards, even after action is taken to control nonpoint source pollution. The 2002 List of Impaired Waters includes several Ala Wai System water bodies: Makiki Stream, Mānoa Stream, Pālolo Stream, the Ala Wai Canal and Harbor, Gray’s Beach, Kahanamoku Lagoon, Kūhiō Beach, and Māmala Bay. A Total Maximum Daily Load (TMDL) is the maximum amount of pollution that a water body can assimilate without exceeding State water quality standards. TMDLs are established for each WQLS to bring it into compliance. Bioassessments can be used to help develop TMDLs for a particular stream. An additional benefit of this study is that it could monitor native species and provide data tat may be useful in evaluating habitat restoration efforts, such as those that would be generated by the Aquatic Habitat Study.

## Preliminary Scope

This study will help to assess the condition of stream biological resources in the Ala Wai watershed through the use of bioassessment protocols.

- Design the sampling methodology.
- Survey the streams, estuaries, and near-shore waters.
  - Collect the organisms.
  - Survey the habitat.
- Identify appropriate indicator species.
- Prepare and analyze data.
- Obtain water quality score result.
- Present the results for management.
  - Draw conclusions from the results of the assessment and translate them into management decisions.
  - Make recommendations.
- Research the population biology and life history of aquatic species to help refine sampling methodologies and the interpretation of metrics used in the bioassessment.
- Maintain regular follow-ups to the original bioassessment. Volunteer organizations such as AWWA may be able to perform regular visual surveys.

## Participating Agencies

DLNR may be a key participant, based on the Division of Aquatic Resources' mission to "manage, conserve and restore the state's unique aquatic resources and ecosystems." CWRM also administers the State Water Code and has the mission of protecting and enhancing the waters of the State.

The US Fish and Wildlife Service may also participate because it is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife, plants, and their habitats. Other participants may include UH due to its research expertise, and DOH Clean Water Branch, with its mission to protect and restore inland and coastal waters for marine life and wildlife. Civic groups such as AWWA could also provide additional data collection resources.

## Estimated Cost

$25,000 per stream

## References

Miller, Jacquelin N. (1975). *Ecological Studies of the Biota of the Ala Wai Canal*.

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

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UH, Center for Conservation Research and Training, The Hawaii Stream Research Center. (1997) *Biocriteria for Assessing the Biological Integrity of Hawaii's Streams*.

UH Center for Conservation Research and Training, The Hawaii Stream Research Center. (2002). *The Hawaii Stream Bioassessment Protocol, Version 3.01*

Yamamoto, M. N. & Tagawa, A. W. (2000). *Hawai'i's Native and Freshwater Stream Animals.*

# Forest Ecosystem Restoration Master Plan



## Purpose

To restore the native forest ecosystem.

## Background and Objectives

Much of the native ecosystem that once existed in the Koʻolau Mountains have been disturbed, modified, or destroyed to varying degrees. As a result, native plant and bird populations are in decline. Additionally, there is much in terms of data collection that needs to be done in order to understand not only baseline conditions, but also the processes that are currently occurring.

Native forests have been impacted by the arrival of man, both directly and indirectly. Feral pigs have inhabited the Koʻolau Mountains for 150 years and destroy the native forest by feeding on tree ferns and other plants, rooting, and trampling the forest floor. Goats and cattle no longer maintain significant populations on Oʻahu, but their previously unrestricted access caused long-lasting effects. Damage was caused by their feeding on native vegetation, trampling roots and seedlings, and indirectly causing erosion and alien species dispersal.

Alien plants account for much of the present forest ecosystem. In addition to feral ungulate impacts, man destroyed much of the forest while seeking such commodities as sandalwood. Conservation workers attempted to reforest the mountains with such alien species as eucalyptus, ironwood, and Norfolk pine due to their rapid growth rate in comparison to native species such as ʻōhiʻa and koa. Alien plants such as Christmas Berry, *Schinus terebinthifolius,* and Juniper Berry, *Citharexylum caudatum,* out-compete native species for nutrients, light, space, and water in disturbed areas. Non-native plants reduce the native multi-storied canopy to a single story that is thought to be inferior in breaking the erosive force of rain on the soil, thereby enhancing erosion. Some alien plants also have shallow root systems that do not hold soil in place as well as natives do.

In 1994, USFWS listed 11 plant species in the Koʻolau Mountains Plant Cluster as endangered. Major threats to their survival included habitat or range destruction, modification, or curtailment; fire threat; disease; predation; competition with alien plants; and over utilization for commercial, recreational, scientific, or educational purposes.

Partially as a result of the decline in habitat, native forest bird species are also in decline. Additional threats to bird species include diseases such as avian malaria and pox, and predators, such as mongooses, rats, and feral cats. The Oʻahu ʻelepaio, *Chasiempis sandwichensis*, was placed on the USFWS list of threatened and endangered species in 2000, with much of the Ala Wai watershed Conservation District designated as critical habitat. Studies have found that predator control, primarily for rodents, effectively increases reproduction and survival of females, although results are short term and only persist for the duration of the control method.

One aspect that hinders restoration efforts is the lack of data on biotic ecosystems in Hawaiʻi. Not only is there little data on baseline conditions such as vegetative cover and hydrology, but there is little understanding of interactions between species and the interconnectedness of functions.

A comprehensive master plan of the Ala Wai watershed forest areas should be developed to manage biological, physical, and human resources. Actions that should be considered by the plan may include additional research, feral animal eradication or control, alien predator control, alien plant eradication, native plant restoration, soil stabilization, stream bank stabilization, and riparian ecosystem restoration. The Koʻolau Mountains Watershed Partnership is already investigating the idea of developing a comprehensive plan for feral ungulate management in the natural areas and has received funding for their Mauka Restoration Project that will couple pig hunting with native species out-planting.

## Preliminary Scope

Actions undertaken through the master plan are expected to restore natural functions of the native forest that have been damaged or diminished over time. Such functions include native plant and animal habitat provision, soil loss minimization, and groundwater replenishment. Potential actions addressed by the master plan to accomplish these objectives include:

- Assessment of baseline conditions including vegetative cover mapping, hydrology, etc.
- Assessment and prioritization of critical issues.
- Identification and development of restoration strategies.
- Selection of preferred alternatives.
- Identification of responsible entities.
- Establishment of a timeline to implement priority actions and programs.
- Identification of funding sources and sustainable practices.
- Definition of metrics to assess and evaluate the effectiveness of actions.
- Potential actions to be investigated during the development of the Master Plan may include:
  - Feral pig control/eradication through measures such as fencing and hunting.
  - Noxious weed eradication.
  - Native plant propagation and planting.
  - Native forest bird predator control program.
  - Public education regarding human induced threats such as weed introduction and other alien species releases.
  - Soil stabilization.
  - Stream bank stabilization.

## Participating Agencies

DLNR DOFAW would be a key agency involved in forest ecosystem restoration as the primary landowner in the area and due to their jurisdiction over the Honolulu Watershed Forest Reserve. USFWS would also be a key agency based on its involvement with endangered species programs.

BWS and U.S. Forest Service may be supporting agencies based on their interests in forest health and sustainability. Additionally, non-government organizations such as AWWA, KMWP, and the South O'ahu Soil and Water Conservation District may offer additional support through volunteer services.

## Estimated Cost

$250,000-$500,000

## References

Hawaii Tropical Forest Recovery Task Force. (2001). *Hawaii Tropical Forest Recovery Action Plan.*

Ko'olau Mountains Watershed Partnership. (2002). *Ko'olau Mountains Watershed Partnership Management Plan.*

Vanderwerf, E. A. & Smith, D. G. (2002). Effects of alien rodent control on demography of the O'ahu 'Elepaio, and endangered Hawaiian forest bird.


*Entrance to the Makiki Forest Recreation Area.*

# Urban Stream Corridor Preservation Project



## Purpose

To provide for proper maintenance and actions that promote public health and safety in and around the waterways of the Ala Wai watershed.

## Project Background and Objectives

Adequate stream management and maintenance ensures water quality, protects aquatic species habitat, minimizes erosion, preserves flood capacities, and enhances aesthetics. However, management and maintenance of the streams and waterways in the Ala Wai watershed, and urban watersheds in general, is difficult due to the numerous public and private entities that have jurisdiction over different stream segments. Public maintenance jurisdiction of the Canals and streams lie with the State Department of Land and Natural Resources and the City and County of Honolulu Department of Facility Maintenance. These multi-jurisdictional issues do not allow for the holistic planning of stream bank maintenance, debris removal, and erosion and flood control.

Many streamside properties also include stream banks and in some cases, extend to the middle of the stream itself. Section 41-26.3 of the Revised Ordinances of Honolulu (ROH) mandates that "The owner of any stream has the duty to maintain, dredge and clear such stream so that the natural flow of water runs unimpaired. The owner shall also be responsible for the removal of any debris, vegetation, silt or other items or material of any kind that may interfere with the natural flow of water." This adds to the number of parties responsible for stream maintenance and although Section 41-26 ROH allows for enforcement actions, private stream owners are rarely issued a violation for failing to maintain their section of a stream.

Private ownership of stream banks and streams has also led to development right up to the stream edge. Oftentimes, flood control measures even promote this type of development because they give a false sense of security. However, previously constructed flood control measures may not have been designed to meet current standards and even if they were, they do not guarantee against flood damage. Stream corridor preservation could protect against flooding by prohibiting future encroachment into the flood plain.

Additionally, development close to streams may lead to erosion like at Mānoa Stream. Urban development adjacent to the stream in the lower Woodlawn area is suspected of accelerating erosion. Steep slopes at Mānoa Valley District Park have also created unstable banks.

In order to plan holistically for the maintenance of urban streams, agency jurisdiction must either be consolidated, or be clearly defined and duties delegated for seamless action to take place. This promotes accountability of action. Stream corridor preservation consolidates jurisdiction and improves management of the corridor by restricting or removing development that is too close to the banks. This effort to acquire jurisdiction over privately owned lands should occur over the long-term.

Stream corridor preservation could also provide for public access to streams in the Urban District, which is often hampered by private ownership. Public access to waterways promotes stewardship and maintenance of the resource, as well as provides for recreational and educational opportunities.

## Preliminary Scope

This project will identify stream corridors and recommend methods for their preservation to remove/restrict development from flood zones, to reduce the impact on erosion, and to facilitate the holistic maintenance and management planning of urban waterways. This project may include, but not be limited to:

- Identify the width of an appropriate stream corridor that would protect both human development and the stream from flooding, erosion, and maintenance issues.
- Identify various landownership within the stream corridor.
- Develop alternatives for preservation including short, medium, and long-term options. Acquisition/agreement techniques and tools to investigate may include:
  - Annexation – unilaterally annex land according to set conditions.
  - Development agreements – developers donate portions of streamside parcels in exchange for other incentives.
  - Interagency cooperation – agencies approving permits work together to preserve corridors.
  - Land acquisition – includes full title purchase, easements, eminent domain.
  - Land use regulations – setback ordinances.
  - Landowner agreements – transferable development rights.
  - Official corridor map – reserves land, is consistent with comprehensive plans, and forbids the construction or expansion of permanent structures into the stream corridor.
  - Incentives – reduction in real property tax, density transfers, variances.
  - Partnerships – with diverse public and private agencies/organizations.
  - Public involvement in planning – process is used as a tool to obtain buy-in, public agreement, and compliance.
- Recommend the appropriate options to pursue for stream corridor preservation and prioritize actions.
- Consolidate agency jurisdiction over private streams.
- Develop corridor preservation alternatives for developing and urbanized watersheds to use as a template for other watersheds.

## Participating Agencies

DFM may participate based on its responsibility to maintain urban streams that are owned by the City. DLNR may also be involved because of its jurisdiction over the Ala Wai and Mānoa-Pālolo Drainage Canals. Private land owners will need to be included to determine the best course of action for their properties.

## Estimated Cost

More than $3 million

## References

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan-Volume I.*

State of Hawaii DOH. (1998). *Ala Wai Canal Watershed Water Quality Improvement Project Management and Implementation Plan – Volume II Technical Appendices.*

State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii.*

*Urban stream corridors should be protected to allow for maintenance, flood damage and erosion reduction, habitat, and where appropriate, public access.*

# Ala Wai Research Watershed Partnership



## Purpose

To establish a research watershed partnership within the Ala Wai Canal watershed to study watershed properties and processes in Hawai‘i.

## Project Background and Objectives

Polluted runoff, non-point source pollution, is a major environmental problem, not only in the Ala Wai Canal watershed, but also in the Hawaiian Islands in general, and in many other Pacific Islands as well. Polluted runoff includes eroded soil as well as a broad range of contaminants. Streams, estuaries, bays, near-shore waters, and coral reefs are all adversely affected by polluted runoff.

Much research and monitoring have been carried out over the years in many diverse geographic areas. However, still lacking is a unified approach to training, modeling, research, and the development and application of best management practices (BMPs) to enable improved water quality in Pacific Island environments to meet the national goals of “fishable and swimmable” waters.

The Ala Wai watershed is a logical focal point to consider consolidation and investment to foster the development of improved research, training, and management. The presence of a major set of tributary streams and the Ala Wai Canal itself provide the natural geographic variations necessary for such studies and pilot project evaluation.

The University of Hawai‘i at Mānoa (UHM) is an educational leader in the Pacific region and has diverse capabilities including engineering, geography, culture, environmental studies, and planning. Mānoa Stream, Mānoa Valley, and the Ala Wai Canal have been objects of investigation and planning by the University for many years. With the inclusion of Lyon Arboretum, the Waikīkī Aquarium, the Hawai‘i Nature Center, and the newly acquired “Paradise Park,” there are abundant educational resources to contribute to large-scale watershed studies. Additionally, UHM owns a portion of Mānoa Stream.

The City could be a major partner in this proposed endeavor because it must maintain its waterways and monitor water quality as a requirement of its NPDES permit. Similarly, the State could also be a major partner because of its ownership and management of extensive land areas in the Conservation District and responsibility for the Ala Wai Canal itself.

Federal agencies have expressed an interest in establishing “research watersheds” in which investment can be made by multiple parties to support long-term gauging and research programs. The community has also expressed an interest in this watershed in particular and is active in its management through projects such as the lo‘i restoration in Pālolo Valley behind ‘Ānuenue School.

The partnership could guide and maintain long-term research infrastructure and investigations that may extend for years, including stream and rainfall gauging and water quality and environmental monitoring. Multi-jurisdictional studies could also be achieved as the partnership provides a medium in which to pool resources. The partnership would build on institutions, facilities and planning opportunities within the Ala Wai watershed, including the Hawai‘i Nature Center, Waikiki Aquarium, Lyon Arboretum, UHM, the former Paradise Park that has been newly acquired by UHM, and other projects and institutions in this most vital of Honolulu’s watersheds.

## Preliminary Scope

This partnership will provide a venue for different agencies and organizations to come together to undertake large-scale watershed research projects. This will lead to a better understanding of watershed properties and processes in Hawai'i, therefore leading to better management decisions.

- A consortium committee would be convened to organize participants, decide on management procedures, and determine funding sources and amounts. A work plan would be developed and commitments obtained.
- Initiate research projects.
  - Applications would be made to the consortium for approval and possibly assistance in funding.
  - The watershed could be used as a venue for testing and evaluating BMPs, such as stream bank erosion control measures or erosion reduction actions.
  - Vegetation re-plantings could be conducted to test the thesis that certain communities of native species may provide greater resistance to erosion than do alien species plant complexes.
  - Conduct multi-disciplinary analyses of metals, organic chemicals, physical conditions, and other parameters on the same samples to provide a more complete understanding of watershed processes and current impacts.
- Develop and maintain computer models of the watershed based on data that result from the research.
  - Transport model for termiticides and other pesticides into groundwater.
  - Transport model for household hazardous wastes.
  - Model of watershed processes such as erosion, water infiltration and transport, and ecosystem dynamics.
- Create a "data bank" within an agency or organization to be periodically updated by each responsible entity so current and historical information can be easily found.

## Participating Agencies

USGS is potentially a principal partner due to its mission to "provide reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life." EPA may also be involved due to its mission to safeguard the environment and its programs that generate environmental data and develop them towards management.

Additional participants may include NRCS-SCS and UH-WRRC due to their research objectives in biological, earth, and water resources. DOH could be an agency responsible for monitoring environmental health parameters, while ENV could also be a valuable partner because of its sampling and pollutant monitoring activities. DLNR may participate based on its jurisdiction over the upper watershed areas, as well as its interest in ensuring water quality and the prevention of rapid runoff and soil erosion.

## Estimated Cost

Initiation: $50,000-$100,000

## References

C&C DTS & DDC. (1998).*Ala Wai Canal Dredging Final Environmental Assessment*.

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State of Hawaii DOH. (2001). *Total Maximum Daily Loads for Ala Wai Canal, Island of Oahu, Hawaii*.

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State of Hawaii DOH Environmental Planning Office. (1993). *Revised Total Maximum Daily Load Estimates for Six Water Quality Limited Segments, Island of O'ahu, Hawaii.*

State of Hawaii DLNR DOWALD. (1992). *A Management Plan for the Ala Wai Canal Watershed, Honolulu, Oahu, Hawaii*.

State of Hawaii DLNR DOWALD. (1992). *Ala Wai Canal Improvement, Honolulu, Oahu, Hawaii, Feasibility Report*.

State of Hawaii DLNR DOWALD. (1993). *Environmental Assessment and Negative Declaration for the Ala Wai Canal Improvement, Honolulu, Oahu, Hawaii*.

State of Hawaii OEQC. (1976). *Improvement of the Ala Wai Canal Final Report.*

## Purpose

To encourage an appreciation of watersheds and educate residents and visitors on their role in protecting and managing natural resources.

## Background and Objectives

People have lost their awareness and appreciation of watersheds, as well as their functions and relevance. Additionally, many people do not understand the relationship between their individual actions and the health of the environment they live, work, and play in. This ignorance of the natural world has led to a neglect, and sometimes even a purposeful degradation, of streams and forests.

Streams have been channelized to alleviate flooding, therefore allowing development within flood plains. These concrete-linings were designed to efficiently move storm water downstream as quickly as possible, and often did not incorporate natural features or aesthetic qualities. The general population therefore tends to neglect urban waterways, and is often unaware of even the presence of some urban streams. This has led to poor maintenance and a degradation of streams from littering and the dumping of wastes.

Another problem that arises from a lack of understanding of the watershed includes the contamination of surface water quality by day to day activities such as vehicle, home, and lawn and garden maintenance. Fuel and other vehicle residues are deposited on the roadways and washed into streams via storm drains, and are considered the major source of metals in surface waters. Additionally, runoff from private car washes runs into storm drains, carrying residues and soaps into streams. Storm drains also are used as a disposal for wastes such as oils and grease for those who do not consider the ramifications of their actions.

Excessive herbicide use may contaminate surface water through runoff. Excessive fertilizer use has been suspected of increasing surface water nutrient levels and while there has been no research data to confirm this in the Ala Wai watershed, BMPs have been recommended to minimize impacts of pesticide and fertilizer use.

Detrimental human impacts can occur even in the undeveloped areas of the watershed. Some activities such as dirt-biking may cause erosion and should therefore be restricted to designated areas that are properly maintained. Additionally, seemingly benign activities such as hiking may also create impact problems when the number of hikers exceeds the ecosystem's natural ability to repair damage that is caused. Hikers may also inadvertently introduce alien weeds by carrying seeds from another area on their shoes.

Some invasive plant species such as *Miconia* were brought into Hawai‘i as ornamental plants and have quickly spread throughout the state. Potentially threatening animals are also both legally and illegally brought into Hawai‘i as exotic pets. Aquarium fish have been dumped into local streams after their owners are no longer able to care for them, and sometimes out-compete native aquatic species for resources, and prey upon them well.

Education on watersheds could help to promote an appreciation of the natural environment and hopefully cause residents and visitors to be more aware of their actions. Additionally, education programs could also include suggested BMPs and ways to volunteer and learn more. Because watershed issues are so complex, it may be helpful to utilize the resources of several existing educational facilities to be able to cover the many aspects of watershed education. Potential participating facilities include the Hawai‘i Nature Center, Lyon Arboretum, University of Hawai‘i at Mānoa, Waikīkī Aquarium, and ‘Ānuenue Elementary School.

## Preliminary Scope

Watershed education will promote an appreciation for the environment and foster stewardship of natural recourses. Additionally, education on the impacts of human activities will change behavior in such a way that environmentally sound practices will be incorporated into every day activities. A potential program could include:

- Coordinated programs between education entities that specialize in different aspects of the watershed. Potential participants and areas of expertise may include:
  - The Hawai‘i Nature Center – Forest functions and restoration; trails and human impacts.
  - Lyon Arboretum – Botany; horticulture; native plant restoration; ethnobotany.
  - University of Hawai‘i at Mānoa – scientific research on conservation-related issues in botany, biology, zoology, oceanography, soil science, etc.; impacts of urban activities on the watershed; BMPs.
  - Waikīkī Aquarium – near-shore resources and human impacts.
  - ‘Ānuenue Elementary School – cultural aspect of watersheds and uses.
- Cooperation with the State Department of Education to utilize watershed resource centers and coordinate programs for school children.
- Education campaigns.

## Participating Agencies

UH is a key player in this program in that many of the potential facilities are affiliated with the University, including Lyon Arboretum and Waikīkī Aquarium. The University also has a wealth of knowledge and expertise in the many scientific and social aspects that affect watersheds today. Additionally, UH and the State Department of Education have education missions that coincide with this program.

EPA, DLNR, DOH, and ENV may be involved as support agencies based on their expertise, management, and oversight of watershed-related programs. They also have an interest in public education in that it may affect behavior and the improvement of watershed health.

Non-government organizations such as the Nature Conservancy and the Sierra Club may offer additional support in the form of volunteer labor or educational materials.

## Estimated Cost

$50,000-$100,000

## References

Adopt-A-Watershed Organization website
http://www.adopt-a-watershed.org/aawlinks.htm
Harold L. Lyon Arboretum website
http://www.hawaii.edu/lyonarboretum/
Hawaii Nature Center website
http://www.hawaiinaturecenter.org/
State of Hawaii Department of Education website.
http://doe.k12.hi.us/
University of Hawaii at Mānoa website
http://www.uhm.hawaii.edu
Waikiki Aquarium website
http://waquarium.otted.hawaii.edu/

*Lo‘i kalo at ‘Ānuenue School in Pālolo Valley.*

## Purpose

To restore the wetland functions previously present in the lower portions of the watershed.

## Project Background and Objectives

The Makiki, Mānoa, and Pālolo Streams transport pollution generated from upstream land uses to the Ala Wai Canal. Pollutants include sediments, nutrients, pesticides, and metals. Other challenges for the Ala Wai Canal watershed include erosion, flooding, and native species habitat degradation and loss.

Historic accounts suggest that hundreds of fish ponds and lo‘i terraces once covered Waikīkī and the surrounding lowlands. Although not the typical wetland identified by mainland standards, these features likely performed functions similar to conventional wetlands. For example, the presence of a coral reef suggests that the near-shore waters were clean and perhaps filtered of sediment. However, most of the wetlands that were present during early human habitation of the area were filled in to accommodate residential, resort, and other developments.

Typical wetlands slow the speed of flood waters and serve flood and erosion control functions by acting as natural sponges that trap and slowly release surface, ground, and flood waters. This is especially beneficial in countering the increased volume and flow of surface runoff from impermeable surfaces in the urban area. EPA estimates that those states that have lost 80% or more of their wetlands have also recently experienced the most severe flooding, while the Sierra Club determined that a typical 1 acre wetland can store about three-acre feet of water, or approximately one million gallons of floodwater.

Additionally, wetland plants hold soil in place with their roots and buffer coastlines and stream banks from storm surges, waves, and stream currents, therefore reducing erosion. Other wetland functions include a filtering or bioremediation action that retains some excess nutrients, pollutants, and sediments that would otherwise create water quality problems in downstream areas. The Sierra Club estimated that wetlands can reduce street runoff related pollutants by as much as 90%. Wetlands are also thought to maintain stream flow during dry periods and replenish groundwater.

Another important function of wetlands is that they serve as biologically productive areas. Wetlands are some of the most productive ecosystems in the world and USFWS estimates that 43% of the nation’s threatened and endangered species require wetlands for their survival. In Hawai‘i, not only do water birds use wetlands as habitat, many fish and insect species use them in their juvenile stages as food sources and shelter from predators. Water birds that may still be found on O‘ahu include the Hawaiian duck, *koloa maoli*; the Hawaiian common moorhen, *‘alae ‘ula*; the Hawaiian coot, *‘alae ke‘oke‘o*; and the Hawaiian stilt, *ae‘o*. All of these birds are endemic and listed on the Federal List of Endangered and Threatened Wildlife and Plants, and have wetland habitat loss as their major threat. DLNR DOFAW believes that if available, reconstructed wetlands or multipurpose flood control or sediment detention basins would be used by water birds as supplemental habitat.

Constructed wetlands are typically engineered to mimic the processes and functions of natural wetlands, and are often used in treating wastewater. These wetlands are constructed in basins or channels with a natural or constructed subsurface barrier to minimize seepage.

*Waikīkī duck pond c.1915.*

## Preliminary Scope

The restoration of wetlands in the Ala Wai watershed will reestablish previously eliminated ecosystem functions. Such functions may include sediment and storm water retention, bioremediation of pollutants, erosion mitigation, and habitat provision. Potential actions involved in wetland restoration may include:

- Collect past and present information on the watershed.
- Site selection taking into account hydrology, topography, geology, soils, biota, land ownership, socio-economic characteristics, and agency requirements.
  - A possible site is the Ala Wai Golf Course, a 145-acre site that sits adjacent to the Mānoa-Pālolo Drainage Canal and the Ala Wai Canal. The Golf Course is listed as a Brownfield site by the State Department of Business, Economic Development and Tourism. Wetland restoration may not require the entire golf course, therefore allowing for continuation of its current use.
  - Additional sites may include the area surrounding the confluence of the Mānoa and Pālolo Streams and various state and county parks such as Mānoa Valley field or Kānewai field.
- Site assessment including former conditions, previous presence of wetland, knowledge of factors that resulted in wetland degradation or loss, and current conditions.
- Set goals, objectives, and target criteria to provide clear motivations for the project, an overall framework for action, and a standard for evaluation of outcomes.
- Coordination of agencies, landowners, other stakeholders, and public involvement.
- Conduct alternatives analysis and design wetland features.
- Implement wetlands through site preparation, plant preparation, installation/ construction, and as-built documentation.
- Site maintenance including volunteer and agency coordination.
- Monitoring including parameter selection, methodology identification, data collection, analysis, and recommendations for improvement.
- Adaptive management.
- Restore cultural activities such as lo‘i or fish pond functions where feasible.

## Participating Agencies

Many federal agencies are involved in wetland management and restoration activities. Some federal agencies with active programs, support, and funding opportunities include EPA, USFWS, NRCS, COE, and NOAA. State and City agencies that may also partner in a wetland restoration effort include DOH, DLNR, UH, and ENV. Additionally, several non-government organizations participate in wetland projects, including Ducks Unlimited, the Nature Conservancy, and the Sierra Club.

## Estimated Cost

USFWS estimated that it costs $500 - $1500 per acre to restore wetlands. Wetland creation or enhancement projects may vary in cost, depending on features.

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# Ala Wai Watershed Partnership



## Purpose

To create an overall cooperative body that can manage the watershed in a holistic manner.

## Project Background and Objectives

Management and maintenance of the Ala Wai watershed is fragmented amongst various government agencies and private landowners. This makes stewardship activities difficult as jurisdictional responsibilities are blurred and do not allow for holistic planning.

EPA suggests that the watershed approach for water resource management relies on three components: a geographic focus, continuous improvement based on sound science, and partnership/stakeholder involvement. It is recognized that watersheds transcend political and other socially constructed boundaries, therefore making it necessary to involve all those with an interest in the watershed. This may include "all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens and others." Sound science is also a necessary component of watershed management in that it allows for the identification of problems and solutions, the development of plans, and the evaluation of actions.

Partnerships are recommended in implementing a watershed approach because they involve the people that are the most affected by management decisions, ensure "that environmental objectives are well integrated with those for economic stability and other social and cultural goals," and provide that "the people who depend upon the natural resources within the watersheds are well informed of and participate in planning and implementation activities." Several organizations and partnerships already exist, including the Ala Wai Watershed Association, the Koʻolau Mountains Watershed Partnership, the South Oʻahu Soil and Water Conservation District, and potentially the Research Watershed Partnership described as project number 24.

AWWA is a community-based organization that serves as a conduit for information sharing and volunteer opportunities within the community. The Koʻolau Mountains Watershed Partnership focuses on protecting the forested areas of the Koʻolau Mountains, and includes land owners and associate members with an interest in watershed protection. The mission of the South Oʻahu Soil and Water Conservation District is "to provide education regarding conservation in an urban setting, serve as an information clearing house regarding community concerns in conservation, be an advocate for conservation when ever appropriate, while serving the needs of the agricultural community of South Oʻahu." While these organizations may already exist and provide valuable services, they represent parts of what is needed for holistic and effective watershed planning.

## Preliminary Scope

The Ala Wai Watershed Partnership will allow for the holistic planning and implementation of watershed management and maintenance activities. Significant efficiencies will be realized in terms of information gathering and sharing, and coordination between entities, as the partnership will be used as a "one-stop-shop" for data, activities, policies, and interests in the Ala Wai watershed. The partnership may undertake these actions:

- Solicitation of potential participants and other interest groups.
- Establish goals and objectives.
- Compose vision and mission statements.
- Develop policies and procedures for deliberations and coordinated action.
- Develop a management or action plan for implementing policy goals.
- Create a public awareness/involvement program.
- Implement management/action plan and public awareness/involvement plan.
- Develop and maintain a "data bank" that includes historical and current information to provide a complete and efficient method of locating and retrieving data on the watershed. This may also include a listing of existing watershed-related agencies, programs, research, funding sources and contact information.

## Participating Agencies

DLNR currently participates in a Watershed Partnership Program and provides support services to the seven watershed partnerships currently in existence in the state. Additional support is provided by EPA.

Active participation is necessary from all levels of government and the community. The following are lists of potential cohorts in the partnership. Community involvement and landowners: Ala Wai Watershed Association, Neighborhood Boards, Vision Teams, Resident's Associations, KMWP. Government agencies: City - BWS, ENV, DPR, DFM; State - DLNR, DOH, DBEDT OSP; Federal - EPA, USFWS, USDA NRCS, USGS. Scientific/technical community: UH, South O'ahu Soil and Water Conservation District, Research Watershed Partnership. Public education/Non-Government Organizations: The Nature Conservancy, The Hawai'i Nature Center, The Waikiki Aquarium, the Lyon Arboretum, The Sierra Club.

## Estimated Cost

Establishment: $20,000-$40,000
Coordination: $50,000-$70,000 annually (DLNR DOFAW website)

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