University of Hawai‘i Sea Grant College Program

E Mālama I Nā ‘Āina Kumu Wai O Maunalua

A Watershed Handbook for the Residents of Maunalua

Oli aloha no Mālama Maunalua

Composed by Samuel M. ʻOhukaniʻohiʻa Gon III

Mālama Maunalua	*Maunalua is taking care*
i ka papa one mauʻu kai	*of the sandy sea grass flats*
i ke kaha kualā ʻōʻio i ka ili mālie	*fins of ʻōʻio mark the calm skin of the ocean*
Lei o lalo i ka wai māpunapuna	*Wreathed below by bubbling freshwater springs*
Lei o luna i ke kū pīnaʻi	*Wreathed above with the acclamation*
o ko lalo leo e!	*of voices echoing from below*
He leo ua lono ʻia	*A voice that is heeded*
He leo pā kāhea	*A voice carried calling*
a ke Koʻolauwahine	*by the Koʻolauwahine*
E mālama i ka ʻōlelo	*Cherish the utterance*
i kūliana e kipa mai ai	*that strives to grant welcome*
He leo e kokolo ʻana	*A voice following*
i ke ēwe o nā kūpuna	*along the ancestral birth line*
Hōʻēwe ʻia,	*Extending back generations,*
he iwi hoʻokahi nō kākou e!	*a single family indeed are we!*
ʻAuhea ʻoukou e nā hoa hānau	*Where are you then, o cousins*
o ka ʻī puka hāmama	*of the open door?*
E ʻūnonoho mai ana	*You will be sitting hither*
i ka hale lehua e hea nei, e kipa	*in the house of experts, calling us to enter*
ʻO kō mākou alo kūpuna	*Our ancestors are they*
ka i ʻoni i ka naue imua	*that marched forward*
ʻO kō mākou uhai ʻia	*On our pursuit*
i ke ala a loko o ka ōpū hālau	*along the path into a fulfilled existence*
ʻO ʻoukou, ʻo mākou	*All of you, and all of us*
i ke ēwe o ke kaula piko	*at the shared lineage of the birth cord*
Hoʻokahi kākou i ke aloha	*We are unified by aloha*
ʻO ke aloha no Maunalua wale nō e!	*It is aloha for Maunalua that does this!*

NOTES: Given in honor of Mālama Maunalua in October of 2008, it is a variant of a mele kāhea used when approaching those with shared lineage. Prefaced with imagery of Maunalua Bay, both as a call to the richness of that place, and an entreaty for restoration of its past condition. The base chant comes to us from Edith Kanakaʻole, passed to Kumu John Keola Lake, thence to this generation of chanters. Its symbolism is one of greeting, solidarity, shared effort, and the strength of aloha to realize great things. The term ōpū can translate as "existence, living" and hālau as "full, numerous."

E Mālama I Nā ʻĀina Kumu Wai O Maunalua

Caring for the Watersheds of Maunalua

A Watershed Handbook for the Residents of Maunalua

By Jolie R. Wanger

Acknowledgements

Mahalo to the following:

Harold K. L. Castle Foundation
Hawai‘i Office of Planning, Coastal Zone Management Program
Kama‘aina Kids and Hui O Ko‘olaupoko
Mālama Maunalua
National NEMO Network
Oregon State University Sea Grant
Pacific Marine Life Foundation
PBR Hawai‘i & Associates, Inc.
Sea Grant’s Sustainable Coastal Communities Network
Sustainable Resources Group International, Inc.
University of Hawai‘i College of Tropical Agriculture and Human Resources

This handbook includes content developed by Mālama Maunalua staff Andrew Laurence as part of the "Every Drop Counts" campaign.

A publication of the University of Hawai‘i Sea Grant College Program in partnership with Mālama Maunalua, supported by the Hawai‘i Office of Planning, Coastal Zone Management Program, pursuant to National Oceanic and Atmospheric Administration Award No. NA08NOS4190421, funded in part by the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, United States Department of Commerce.

This publication is also funded in part by a grant/cooperative agreement from the National Oceanic and Atmospheric Administration, Project C/CC-1, which is sponsored by the University of Hawai‘i Sea Grant College Program, SOEST, under Institutional Grant No. NA09OAR4170060 from NOAA Office of Sea Grant, Department of Commerce. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its subagencies. UNIHI-SEAGRANT-BB-11-01.

Contents

How "bay friendly" is your home?

Category	1 Score
Driveways, Walkways, and Parking Areas (Chapter 3)	All driveways and sidewalks are gravel or another porous material such as bricks. **1**
Drainage from Rooftops (Chapters 3, 4, & 5)	Downspouts are directed to lawn or vegetation. **1**
Yard (Chapter 4)	Most of the yard is planted with plants that are drought tolerant and absorb rain. **1**
Handling and Use of Outdoor Chemicals (fertilizers, pesticides, cleaners, etc.) (Chapter 6)	Spills are cleaned up, especially on paved surfaces. Minimum amounts of chemicals are applied. Application is delayed to avoid rain. **1**
Pet and Animal Waste	Pet wastes are flushed down the toilet; buried away from ditches or where children play; or wrapped and placed in the garbage for disposal. **1**
Outdoor Water Conservation (Chapter 5)	Collect water in a rain barrel or use a rain gage to tell you when you need to water the lawn (before 10 a.m. or after 4 p.m.) **1**
Score	

Total Score: _____ **Average Score:** _____

Highest Ranked Activity: _____ **Lowest Ranked Activity:** _____

This worksheet can help you evaluate your home and identify the places to focus your attention in order to maximize the contributions your home makes towards keeping Maunalua Bay clean and healthy. Refer to the action list and the handbook chapters for specific ways you can contribute.

2 Score	3 Score
Some of the driveways and/or sidewalks are gravel or another porous material. **2**	Driveways and sidewalks are asphalt, concrete or other nonporous material. **3**
Some of the downspouts are directed to lawn or vegetation and others are directed to paved surfaces. **2**	All downspouts are directed to paved surfaces, or downspouts are directly connected to storm drains. **3**
Most of the yard is in turf grass. **2**	There are areas of exposed bare soil. **3**
Applications are not delayed to avoid rain. **2**	Spills are not cleaned up. Products are used in higher amounts than recommended by the label. **3**
Wastes are left to decompose on grass or soil, and scattered over a wide area. **2**	Wastes are left on paved surfaces, concentrated in a pen or yard area, or dumped down storm drains or in ditches. **3**
Water when the lawn looks dry. **2**	Water the lawn whether it looks like it needs it or not. **3**

How'd you do? Total Score:

6-9 ***Congratulations, you are really doing your part to keep our waters clean and clear!***

10-14 ***You are moving in the right direction, a few small changes could help keep our waters clean and clear. See "Simple Actions for a Healthy Bay" on the following page for helpful tips.***

15-18 ***Consider making some simple changes around your home to make a big impact on water quality in streams and oceans. See "Simple Actions for a Healthy Bay."***

Simple Actions for a Healthy Bay

- ☐ **Water your yard efficiently. Avoid runoff.** (See Chapter 2)

- ☐ **Keep cuttings and debris out of storm drains.**

- ☐ **Use the minimum amount of fertilizers and pesticides.**
  (See Chapter 4)
  A little goes a long way!

- ☐ **Be careful with household chemicals, which can be washed into the bay.** (See Chapter 6)

- ☐ **Clean up pet waste.**
  It's best to throw it in the garbage or flush it down the toilet.
  Pet and animal waste contains bacteria, viruses, parasites, and nutrients that pollute water and are harmful to humans, aquatic life, and the ocean.

- ☐ **Prevent mud from running off your yard and report mud running off from construction sites.** (See Chapter 4)

- ☐ **Take care of your car.**
  If you see fluid under your car, see a mechanic.
  Make sure your brakes are not worn.
  Corrosion of vehicle parts is a source of heavy metals that end up on roads and get washed out to the bay.

- ☐ **Become an ambassador for the bay.**
  Keep your eyes open and report problems. (See Chapter 7)
  Talk to your neighbors.
  Organize a neighborhood project such as cleaning up drainage ditches and clearing debris from storm drains.
  Invite Mālama Maunalua to make a presentation.

Find out what more you can do at:

malamamaunalua.org
seagrant.soest.hawaii.edu

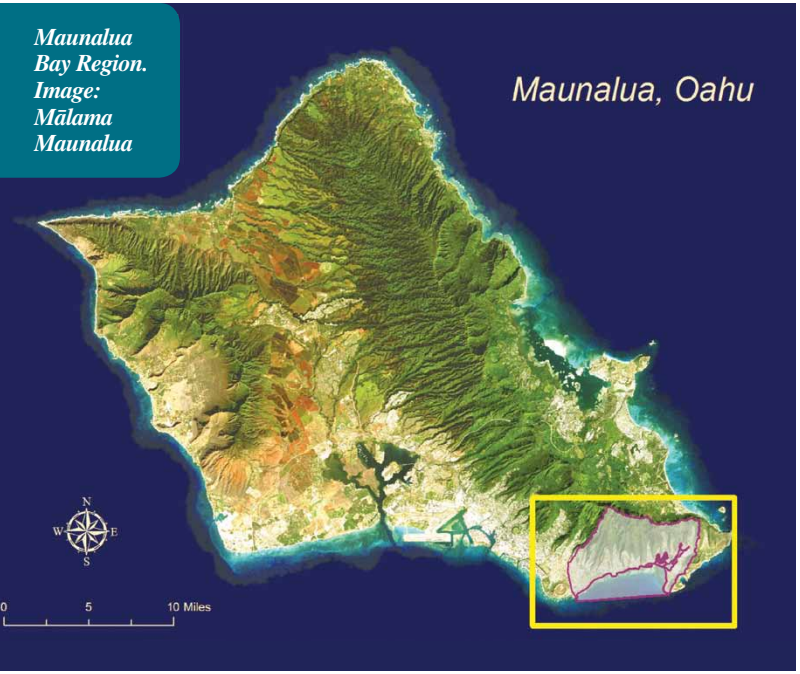
The Decline of Maunalua Bay and Strategy for Recovery

Stretching from Kūpikipikiō (Black Point) to Kawaihoa (Portlock Point), Maunalua Bay has long been treasured for its beauty, abundant resources and cultural significance. Over the past 50 years, development of the watersheds and the associated infrastructure has resulted in the efficient transport of sediment and pollutants to the nearshore coastal waters and coral reefs. As a result, the inshore of Maunalua Bay has become smothered in layers of sediment, which has contributed to a decline in the populations of fish, limu (algae), and other marine life that inhabit this once highly productive bay.

View of Kuapā pond and Kōhelepelepe (Koko Crater), 1921, U.S. Army. Photo: Bishop Museum

Prior to development, water would have been slowed, filtered and absorbed into the soil by native vegetation. Wetlands, meandering streams and fish ponds filtered water and allowed sediment to settle before water entered the sensitive nearshore reefs. One hundred years of land use changes designed to maximize the urban area included the construction of channels designed to prevent flooding. These have unintentionally created conditions detrimental to coral reefs and the nearshore marine environments of Maunalua Bay. The system funnels sediment, dirt, and pollutants directly into the bay by way of the water running off the land and into the ocean. The muddy "runoff" fills the streams and ocean waters with substances that are harmful to marine life. In some cases, the concentrations of pollutants can even be detrimental to human health.

As more roads, driveways, parking lots, buildings, and homes replace the natural vegetation of Hawai'i, the amount of runoff increases. Water cannot penetrate impervious surfaces such as concrete, asphalt, stone, metal, rooftops, and soils compacted by urban development. By paving over the land, water is forced to run



Maunalua Bay Region. Image: Mālama Maunalua

off into storm drains instead of soaking into the ground. Impervious surfaces now cover 50 - 90 percent of our urban areas. Current research indicates 10 percent impervious surfaces or less is required to protect marine life and keep coastal waters clean. Fortunately, there are many simple strategies discussed in this handbook that homeowners can implement to effectively reduce the impervious cover in our watersheds.

Unlike water that enters the sanitary sewer system (sinks, showers, toilets, etc.), the water that enters the storm drain system flows directly into Maunalua Bay, there are no treatments or filters that remove contaminants before the water enters the ocean.

Sediment covering coral. Photo: Bob Richmond

The sediments, pollutants, and trash in stormwater are detrimental to the marine life of the bay. Fine sediment settles on the ocean floor creating a layer that smothers corals and algae and precludes their spawning and recruitment. This fine sediment resuspends with wave action, causing murky water. Sediments also harbor nutrients that cause invasive algae to grow uncontrollably. Coral and native algae are easily smothered and outcompeted by the fast-growing invasive algae, which thrive under these conditions. Compounding these stresses, pollutants such as fertilizers, pesticides, and automobile fluids are absorbed by the coral which further stresses these organisms.

How Can I Help?

The most important action you can take at home is to reduce runoff from your yard into the storm drains to the greatest extent possible.

As a resident of the Maunalua Bay region your backyard, sidewalks, and streets are all directly connected to the bay, and your actions make a difference in our ocean environment!

Successful restoration of Maunalua Bay is going to take the cooperation and kokua of everyone in our community. With Maunalua's 67,000 residents working together, we can make a big difference within our own lifetime!

Every Drop Counts

This handbook will familiarize you with good practices for preventing dangerous pollutants from entering waterways, and landscape practices that enable water to more readily soak into the ground and reduce the amount of runoff. Every drop that stays on the land will work toward watering your plants, nourishing your soil, recharging the aquifers that provide drinking water, and keeping the bay pristine.

With improved ecosystem health will come safe and clean recreational areas for your ‘ohana, healthy reefs for sustainable and traditional fishing, and the restored beauty of Maunalua Bay.

Mālama Maunalua

Use Good Irrigation Practices

One of the most common ways sediment and pollutants are washed into the storm drain system is via irrigation. Fortunately, practicing efficient watering is an easy solution that will also benefit your yard and landscaping. These practices will help conserve limited freshwater resources, prevent runoff and pollutants from entering the bay and save you money on your water bill!

Efficient watering simply means:

- Watering only when your yard needs water,
- Using the minimum amount of water that your yard needs, and
- Watering at the appropriate time of day.

General Guidelines for Efficient Watering

There is no "one size fits all" formula for watering. The appropriate watering practices depend on the type of plants, the location of the landscaping, soil type, exposure to sunlight and wind, temperatures, season of the year, and other factors.

However, the following general guidelines should help you water most efficiently:

- Water your lawn and plants only when you know they need it or show signs of stress.
- Use automatic timers and rain sensors to fine tune your watering.
- In your yard, group plants with similar water needs together and water each area of your yard separately according to the needs of the plants, trees, and grass located in that area.

How Much Water?
Avoid light, shallow, daily yard waterings. This type of watering encourages plants to develop shallow root systems, which makes them more susceptible to disease, drought, and injury.

Roots develop where moisture is available. Light, surface watering encourages shallow root systems while starving the deeper roots. Plants with shallow roots are more prone to summer heat stress, drought, damage and injury.

Slow watering encourages water to percolate farther and helps plants develop deeper roots. Plants with deep roots do not need to be watered as often and are more hardy.

During hot, dry months when the top several inches of the soil are prone to drying out, plants with deep roots are better able to access moisture deep in the ground.

Signs of Insufficient Watering in Plants and Trees

- Curling leaves.
- General drooping of the plant.
- Yellowing of the leaves starting from the leaf tips and ***upper portion of the plant***, leading to the eventual browning and crinkling of leaves, and/or leaf loss.

Signs of Over-Watered Plants and Trees

Too much water can be just as bad as too little water. Plant roots need to breathe. Excess moisture pushes oxygen out of the soil depriving the roots of the air they need. Without a drying period, the plant's roots will die.

- An unexpected lightening or yellowing, or drooping of leaves, starting on the ***lower or inner part of the plant*** moving outward.
- Leaf tips or margins are brown.
- Wilting of young shoots.
- Brittle green leaves.
- Lack of new growth.
- Soil that is still damp.
- Gray or fuzzy mold growing on the soil surface. Mold grows when the soil is consistently wet.

Recommendations for Timing and Frequency

Avoid watering at midday.

In strong sunlight, drops of water on leaves can focus the light like a lens, leaving burn spots on the plant. Evaporation is also highest at midday.

Early morning is best.

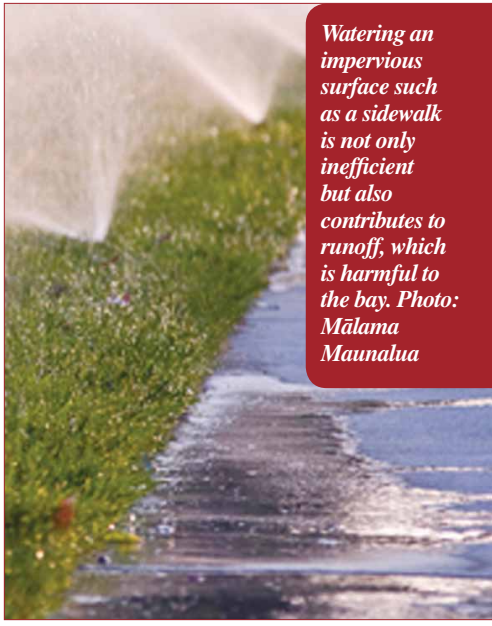
Watering in the morning enables plants, trees, and grass to dry during daylight hours, reducing the chances of disease and rot problems.

Watering at night should be avoided.

Water that remains on plants all night could encourage the spread of fungal diseases.

Evening and Night Watering Exceptions:

- *Watering late in the day, at night, or before daybreak is a strategy used in places where water conservation*



Watering an impervious surface such as a sidewalk is not only inefficient but also contributes to runoff, which is harmful to the bay. Photo: Mālama Maunalua

is critical in order to minimize evaporation and give plants the greatest opportunity to absorb the available water.

- *Automated drip irrigation can be used for night watering because the plant foliage does not get wet.*

Adjusting Sprinklers

Observe your automatic sprinkler system and manually adjust individual sprinkler heads so that the spray only waters vegetation, not pavement.

- Observe how long it takes for water to begin running off the lawn/ground and onto the pavement. This may be an indication that the ground is saturated and further watering is not necessary.
- Your soil may also drain slower than water is being delivered. Try using a slow-watering technique such as a soaker hose or drip line to allow the water to soak in (see Soil Type, page 7).

Rain Sensors

To allow for more fine-tuning of your watering practices, consider using one of these simple tools:

- Install a rain gage or moisture sensor so you will know how much rainfall has already watered your yard.
- Minimize water use, prevent overwatering, and save on water bills by installing rain sensors on sprinklers to automatically turn them off when it rains.

Because lawns usually require the greatest amount of watering, consider eliminating unnecessary grass areas to save on water.

For more detailed information on best watering practices, please refer to the additional resources listed on page 38.

Improper watering can damage your lawn and is detrimental to the landscape in general. Too much watering reduces root growth, increases disease problems, encourages weeds, and contributes to soil compaction.

Determining How Fast Water Is Absorbed By the Soil

Sprinklers often apply water faster than soils can absorb it. This leads to runoff, which carries dirt and pollution into streams and the ocean, wastes freshwater, and drives up your water bill unnecessarily.

The quality of your soil—its ability to hold and drain water—is one of the most important considerations for understanding your site and for sizing landscape features such as rain gardens (see Chapter 4, page 17). How fast your soil drains depends on its

ability to absorb water at the surface and then allow it to percolate down into the lower layers. The composition of the soil including organic matter, sand, silt, and clay all influence percolation. Testing soil helps you find out how fast water drains and if high water tables or underlying bedrock are preventing infiltration on your site.

There are two steps for assessing your soil. First, use your senses to learn about the consistency of the soil and its constituent parts. Then, dig a hole and test the soil's infiltration ability.

Soil Type
The type of soil you have is an important factor to consider in knowing how to water efficiently.

There are three main soil types:
- Sandy
- Loamy
- Clay

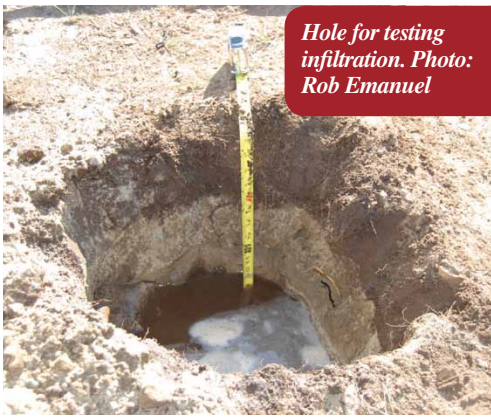
Sandy soils absorb water quickly but do not hold it well. Sandy soils allow water to drain out quickly.

Loamy soils hold water well and have a gritty texture made up of a combination of sand, silt, and clay.

Clay soils take up water very slowly and hold it well, which also means clay soils do not drain very well.

Knowing the types of soil you have in different parts of your yard will help you understand how often and how long to water, as well as how much water to apply. For example, if your soil is clayey, you may have to water for shorter periods of time but more frequently so as not to waterlog your plants or generate runoff. See page 28 for detailed steps for determining soil texture.

Infiltration
A more exact measure of how quickly your soil absorbs and drains water can be obtained with a simple "Infiltration Test." By digging a nine inch diameter hole a foot deep, saturating it by filling and draining twice and then measuring the time it takes for water to drop over a certain distance we can determine the infiltration rate. This is very useful information for assessing watering practices as well as suitability of landscape features. See page 28 for detailed steps for testing infiltration.



Hole for testing infiltration. Photo: Rob Emanuel

How Much Water Does My Irrigation System Deliver?
Once you know your soil's infiltration rate you can test how much water your current system delivers. This will help you calculate how long to water and whether you should switch to a system that delivers water more slowly.

Built-in irrigation systems are set to deliver a consistent amount of water at specific times. To ensure that the irrigation system is watering efficiently, you will need to know how much water it delivers over a period of time, and then adjust the system settings from that information.

The "Catch Can Test" is a simple way to figure out how much water your sprinkler delivers. Place cans at different distances from a sprinkler and run the sprinkler for 15 minutes. Measure and add the depth of water from all cans and divide by the number of cans. This will give you the average depth of water collected. Multiply by four to get the amount of water delivered in one hour. Most plants and lawns require only ½ inch to ¾ inch of water when plants show signs of stress. See page 29 for detailed "Catch Can Test" instructions.

Putting it All Together (What do all these tests mean?)

Example:

⇨ You learn from feeling the texture that your soil has a mixture of **sand** and **clay.**

⇨ The *infiltration* test shows your soil drains at a rate of **½ inch per hour.**

⇨ The "catch can test" shows your sprinkler system delivers **1 inch per hour.**

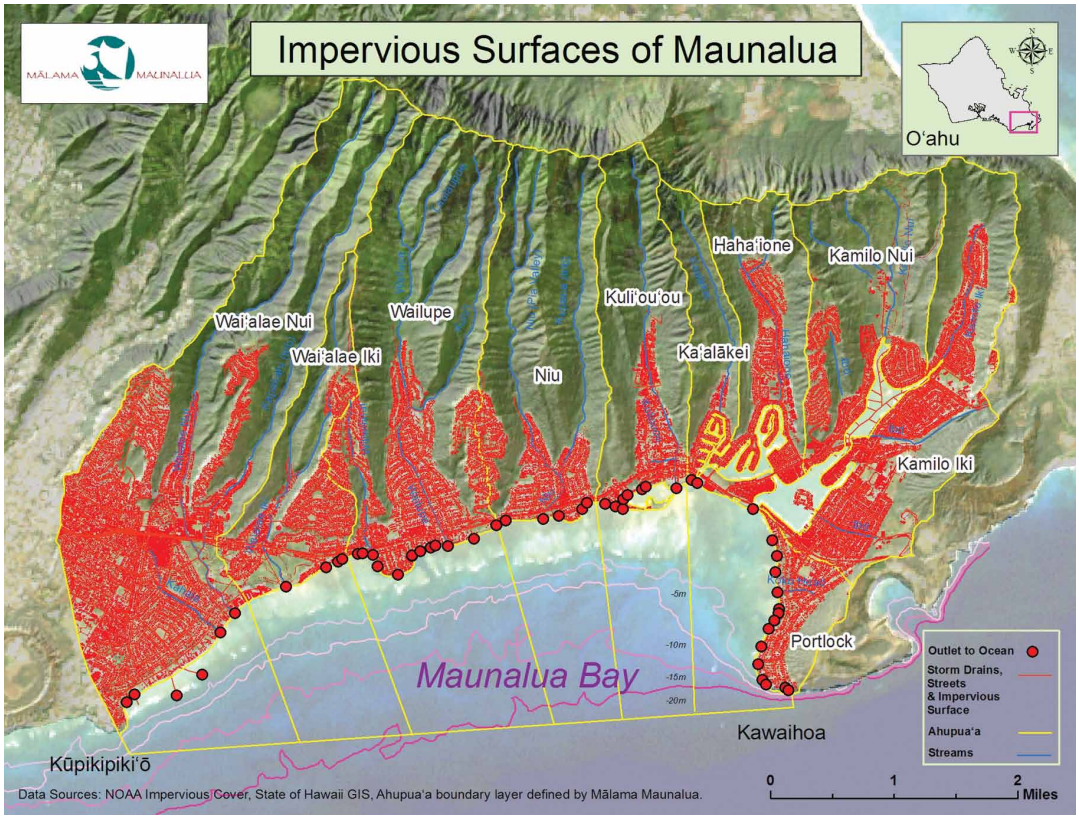
✓ Therefore, **your soil can only absorb ½ inch per hour and ½ inch will be runoff.** As a result, you should either adjust your sprinkler system to deliver no more than ½ inch per hour, or switch to a drip feed system, which delivers water at a slower rate.

Minimize Impervious Surfaces Around Your Home

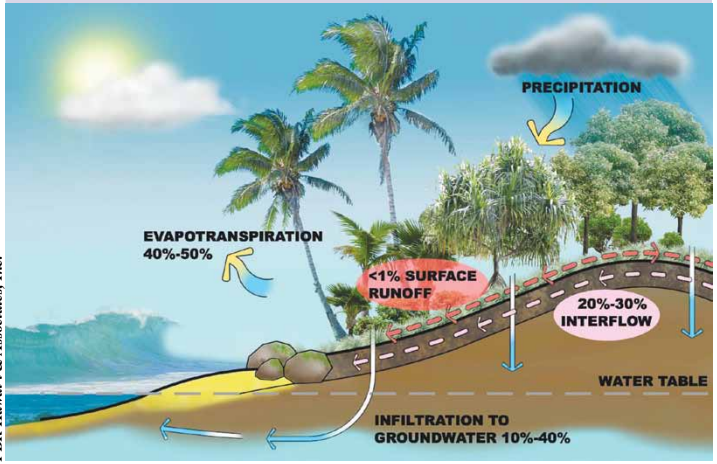
One of the main things that can be done at the residential level to help protect Maunalua Bay is to increase the amount of permeable surfaces on your property. Permeable surfaces allow water to percolate into the ground below, giving the soil a chance to absorb that water before it becomes runoff. Some permeable surfaces are also more aesthetically pleasing and can increase the value of your home.

The Impact of Impervious Surfaces on the Bay

Roads, driveways, parking areas, patios, and walkways are all commonly constructed of "impervious" materials (concrete, asphalt, stone, and compacted soils) that water cannot penetrate. The more impervious surfaces that cover a property, the greater the volume of water runoff from that property will be.



Natural Watershed Hydrology



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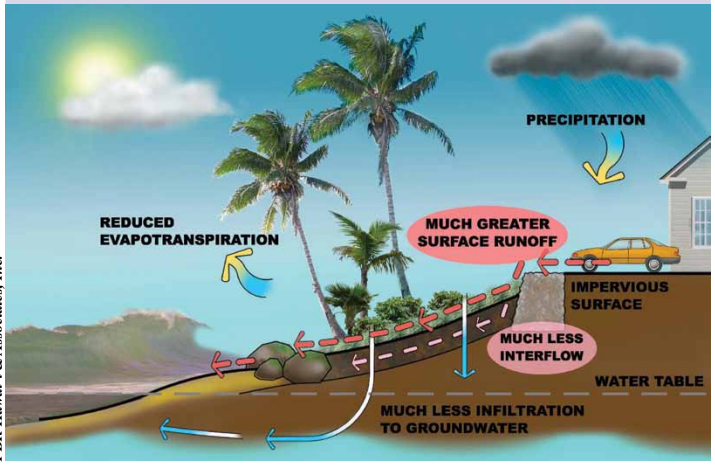
Altered Watershed Hydrology with High Impervious Cover



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The majority of impervious surfaces in our communities are found in parking lots, roadways, and buildings. These all contribute to the total imperviousness of a watershed. This total imperviousness affects the natural cycling of water (the hydrology) of our watersheds by reducing the amount of freshwater available for wetlands, streams, springs, plants, and our own uses. Instead, the water is funneled rapidly to our coastal areas with many harmful effects.

Researchers have demonstrated that watersheds with just three to four percent imperviousness can show increased flooding and impaired water quality. Recent research revealed that as imperviousness increases in beachfront communities, bacteria counts also increase significantly near urbanized stream outfalls.

Suggested Ways to Reduce Imperviousness

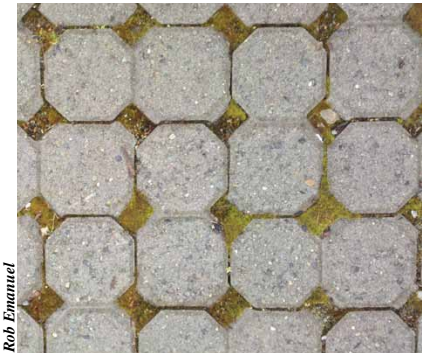
Here are some suggestions for ways to replace some of your concrete with types of permeable materials:

- For walkways, use materials such as stone or interlocking concrete pavers surrounded by grass, mulch or other permeable material.
- For driveways, use permeable pavement or break up the pavement with permeable strips that can infiltrate water or convey it to a vegetated area in the yard.
- For patios, use interlocking bricks or other materials that allow water to infiltrate into the soil.
- Reduce imperviousness of compacted soil by adding organic matter to the soil and increasing plants. Always cover bare dirt with plants or mulch.

An attractive walkway that allows water to percolate into the ground. Photo: Jolie Wanger

Pervious patio made of interlocking concrete pavers. Photo: Futura Stone of Hawai'i

Studies show pervious pavements remove 50-98 percent of suspended sediments and associated particulate metals, as well as 97-99 percent of motor oil.



Rob Emanuel

Use Good Landscaping and Yard Maintenance Practices

A key part of the strategy to care for Maunalua Bay is to:

1. Reduce the amount of pollutants carried to the bay by runoff water, and
2. Percolate water into the ground where pollutants will be filtered and our groundwater supplies will be recharged.

Residents can make a significant impact on the health of Maunalua Bay by making small improvements to the landscape at home. By mindfully selecting plants that are best suited to your site and placing them strategically to provide the best water capture and filtration benefits, you can make important contributions to the health of nearshore waters. Below are some suggestions for maximizing the benefits your landscape can provide.

Buffering Sediment and Pollution with Landscaping

Maintain Existing Vegetation

Wherever you can leave the existing vegetation such as trees, shrubs, and native plants in your yard, it makes a positive impact. Simply by not removing that vegetation you are already helping the bay.

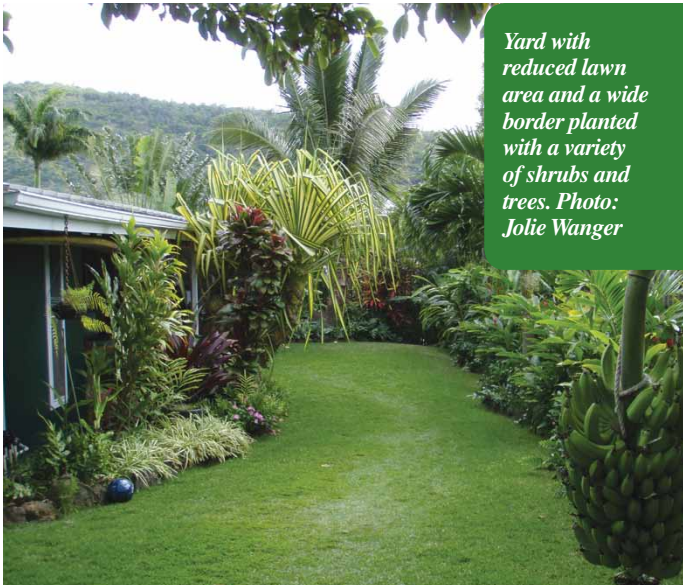
Plants offer protection for the watershed of the Maunalua Bay Region in a number of ways:

- Plants filter water and return it to the atmosphere through transpiration.
- Leaves and branches of plants, and even blades of grass, absorb the energy of falling rain by breaking the fall of raindrops, slowing them down before they hit the ground so that they are less likely to erode the soil.
- Roots of trees, shrubs, and grasses hold soil particles in place and prevent erosion.
- Vegetation helps maintain the absorptive capacity of the soil by enabling water to infiltrate deeper into the ground.
- Vegetation, such as groundcover plants, slows the velocity of runoff, and acts as a filter to catch sediment, preventing it from entering streams, storm drains, and Maunalua Bay.

Add More Plants and Trees

Planting shrubs and trees in your yard can not only enhance the aesthetics of your property, these plants act as a buffer and help to naturally filter pollutants before they can enter the waterway or the bay.

If your property is located along a stream or ditch, on the marina or on the bay, you can make substantial contributions to the protection of the bay by planting shrubs and trees between your property and the waterway. However, it is important to choose and maintain trees so that they don't drop debris into waterways and drainage canals. Trees planted along steep slopes may also inadvertently cause instability along stream banks. If you live on a steep slope, it may be best to consult with a professional.



Yard with reduced lawn area and a wide border planted with a variety of shrubs and trees. Photo: Jolie Wanger

What Plants Will Work Best for My Yard?
The environment of the Maunalua Bay Region is different than environments in other parts of the islands. It's leeward location is generally hot and dry with sandy soils along the shoreline and wetter climate in the valleys with soils that tend to be high in clay content. However, rainfall, soils, and temperatures vary. You may need to use trial and error and/or observe what is thriving around the neighborhood.

Native plants are highly recommended since they are adapted to the local climate and soils, and if chosen carefully should require less maintenance. A guide to help you select the right plants for your site is included in the Appendix (see page 34). In addition, the Honolulu Board of Water Supply (HBWS) has an excellent, comprehensive *O'ahu Planting Guide* on their website at: www.boardofwatersupply.com

Choosing the Plants Best Suited for a Site
Plants that are most appropriately suited for a particular site will need only minimal amounts of water, nourishment (fertilizers), and protection (pesticides).

To ensure that plants will thrive on your site, follow these pointers:

- Before selecting plants, study the site. Note the amount of sunlight the area receives throughout the day, and how much water the site receives. Choose plants that thrive under the conditions found there.
  - Depending on the location, the amount of sunlight an area receives may be different in the summer and winter months. Note the amount of sunlight a plant would receive at that location in the morning, during the midday hours, and in the afternoon.
  - The amount of rain the area receives may also differ considerably between the warmer and cooler months of the year. Determine whether the plants you are

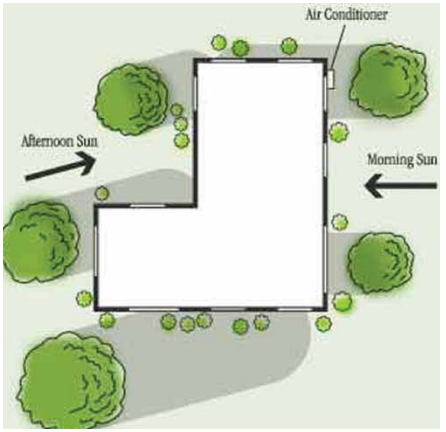


Figure Source: ArborDayHawaii.org

thinking of planting can withstand the wetter and the drier parts of the year. (Also see Native Plant list in the Appendix and the HBWS *O'ahu Planting Guide*)

- Determine the soil type at the site. Is it sandy, loamy, or clay? Does it drain well? How compacted is it? (See sections: "Testing Infiltration: the Simple Approach" and "Determining Soil Type" on page 28).
- Note any building structures or utility lines that may be impacted by plants that grow tall. Also, check with the Gas Company, the City's Department of Environmental Services, Division of Wastewater Management, and Board of Water Supply to determine whether any gas, sewer, or water lines would be damaged by a plant's root system (see Utility Notification Center information on page 18).
- Look for plants that prefer the conditions present at the site (see HBWS *O'ahu Planting Guide*).
- Limit the number of plants that need a lot of water or care.
- Replace invasive, non-native plants with native Hawaiian species, especially those that require less water, fertilizers, and pesticides. For a list of recommended native Hawaiian plants see page 34.

Planting Trees

Planting trees is a way to enhance your own property, and at the same time help take care of both the land and ocean.

- The root systems of trees hold soil in place, thereby preventing erosion of dirt and sediment into the waterways that empty into the ocean.
- The root system facilitates the infiltration of rainwater into the soil, recharging the regional water table.
- One tree can reduce stormwater runoff by 4,000 gallons a year. This reduces the amount of water that would otherwise go into the storm drains and out to the ocean.
- New tree plantings have also been known to increase the value of homes.

Some homeowners worry that newly planted trees will damage the sewer, gas, or water lines, as well as sidewalks, driveways, or even the foundation of buildings. If you choose a tree appropriately suited to the conditions of a specific location there should be no adverse impacts on any infrastructure in the area. Most tree roots grow in the top 12 inches of the soil and spread beyond the tree's canopy in order to find water and nutrients. The roots do not grow into underground pipes unless the pipes are already damaged, leaving openings for the developing roots to establish themselves. An adequately large tree pit or long, narrow continuous "tree lawn" (a strip of grass or vegetation situated between a street and sidewalk like those found in residential areas)

will provide the conditions the tree needs to survive and establish roots that do not harm infrastructure.

The Arbor Day Hawai'i checklist is a resource available to help you select the right tree: http://www.arbordayhawaii.org/trees/checklist.htm

Reduce Lawn Area
Retain only as much grass as you need for recreation and other uses on your property.

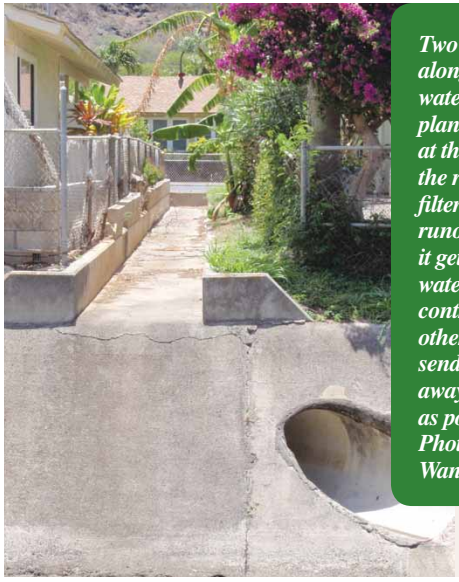
Replace the rest with plants, trees, plant beds, and mulched areas that are more absorbent and require less water, fertilizer, pesticides, and maintenance than grass. Table A-1 in the Appendix lists several native groundcovers and grasses, which can be substituted for turf grass.

While grass is important for covering areas of bare dirt and preventing erosion, certain groundcover plants, shrubs, and trees do a better job of helping percolate water into the ground and preventing erosion.

In addition, grass frequently requires more watering, fertilizers, and pesticides than other plants. Thus, replacing grass with particular groundcovers, shrubs and trees will help conserve freshwater resources, and can help reduce the amount of money you spend on watering and lawn care chemicals.

Maintain a Buffer Along Inland Waterways
Lots that are situated along inland waterways, including streams, concrete lined ditches, and marinas, play a vital role in preserving and protecting our waters.

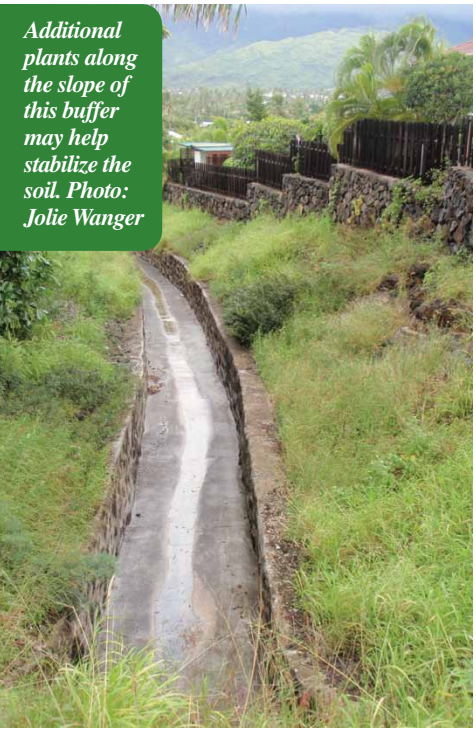
If there is a waterway that runs along your property, you can help the bay and at the same time protect your own property from erosion by leaving a strip of unmowed natural vegetation along the parts of your property that border waterways. This vegetated buffer will help filter runoff water and capture and retain soil and pollutants before they enter the water.



Two homes along a waterway. The plants and trees at the home on the right help filter and slow runoff before it gets to the waterway. In contrast, the other home sends runoff away as quickly as possible. Photo: Jolie Wanger

Here are some things to consider in establishing this protective buffer on your property:

- Make the unmowed buffer as wide as possible.
- Planting shrubs and trees in this buffer zone will provide additional protection against erosion along the water line. The root systems of these plants will help hold the



Additional plants along the slope of this buffer may help stabilize the soil. Photo: Jolie Wanger

soil in place. Consider planting native Hawaiian plants that are well suited to the local climate.

- If you must do some amount of mowing along this strip, set your mower blades at least three inches high. The taller grass will slow runoff, resist drought, and will require less fertilizer.
- Use mulched berms, compost socks, or coir logs (filled, fiber logs) to prevent soil from washing into the waterway while establishing your stream buffer.
- Cover piles of soil with tarps to protect them from rain and erosion.
- Mulch areas of bare soil to protect them from erosion.
- Limit the use of fertilizers, pesticides, and herbicides in the buffer zone to prevent nutrients and toxins from leaching into the waterway.
- If you live along the ocean or on a steep bank, it is advised to consult a professional, and it may be necessary to obtain a permit prior to undertaking a landscape project.

Always store trash and other materials well away from waterways.

The Magic of Mulch

Mulch is a very important component of good landscaping practices. When placed over bare soil, it prevents erosion during rains or soil being carried away by strong winds. Runoff can be slowed and filtered by a mulched berm when used as a buffer. It also helps retain and percolate water to roots when placed around plants. Because mulching can improve water absorption and retention in the soil, it helps reduce the need for watering. Since mulch prevents rapid evaporation of water from the soil, it is especially useful in areas prone to drought such as many areas of the Maunalua Bay region.

Use Compost Instead of Chemical Fertilizers

Chemical fertilizers are highly toxic to sensitive marine life. It is important to reduce the use of chemical fertilizers and never apply before a rain. Compost is a great alternative. Using compost to nourish your lawn and gardens can reduce the need for, and expense of, additional water, fertilizers, and pesticides.

Compost brings a host of benefits to a yard without the harmful pollutants that chemical fertilizers release into the streams, ocean, and groundwater we depend on for our survival.

According to the U.S. Environmental Protection Agency (EPA), “Compost has the ability to help regenerate poor soils. The composting process encourages the production of beneficial microorganisms (mainly bacteria and fungi), which in turn break down organic

matter to create humus. Humus—a rich nutrient-filled material—increases the nutrient content in soils and helps soils retain moisture. Compost has also been shown to suppress plant diseases and pests, reduce or eliminate the need for chemical fertilizers, and promote higher yields of agricultural crops."

Simply spread a light application of fine grade compost over your lawn. Aerating first may help the absorption of the compost. Following application, compost may be raked into the yard and watered down. It is also beneficial to leave grass clippings to allow the return of the nutrients to the soil.

Rain Gardens/Bioretention Systems

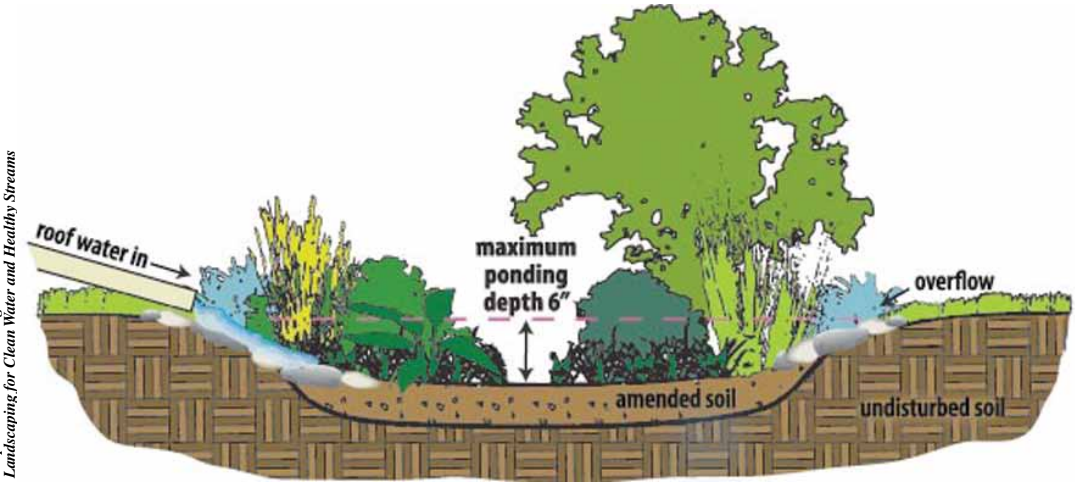
One of the most effective actions that homeowners can take is to install landscape features that compensate for imperviousness wherever possible. Creating rain gardens or other *bioretention* features in your landscape can maximize the natural benefits of the open spaces in your yard.

A rain garden is a sunken landscaped area that captures runoff from an impervious surface and allows water to soak into the ground. Soil microorganisms and plant roots break down pollutants. Overflows re-enter the stormwater conveyance system through an overflow point.

Rain Gardens Keep Our Watersheds Healthy By…

- reducing flooding by absorbing rain water from hard surfaces
- filtering oil, grease, and toxic materials before they can pollute streams, lakes, and bays
- recharging groundwater aquifers by allowing water to soak into the ground

Most rain gardens can be quite inexpensive to build (less than $1,000 or less than $500 if digging by hand). The primary costs are labor or equipment for excavation, compost, rock, plants, and mulch.



Graphic source: The Oregon Rain Garden Guide: Landscaping for Clean Water and Healthy Streams

Water flowing into a newly-planted rain garden. Photo: Jolie Wanger

The most important feature of a rain garden is a sunken ponding surface that will retain stormwater flows for a period of time sufficient to allow the water to infiltrate into the soil (not more than 24 hours). This 6-12 inch deep ponding surface is planted with a dense growth of native ornamental plants that can tolerate frequent wet and dry cycles. Utilizing native plants ensures that dry-season irrigation is not necessary once the plants are established in a year or two. A two-three inch layer of mulch is placed over all soil surfaces to keep plants moist during those times and provides additional microbiological benefits for removing waterborne pollutants. Rocks are used to arm inflow and overflow points, thereby reducing soil erosion.

Is a Rain Garden for You?

Additional, detailed information is provided on page 29 in the Appendix to help you determine if a rain garden is a good option for your site. You will learn how to calculate the area needed to treat your runoff and to properly site the garden and get water to it. If you are interested in installing a rain garden, it is probably best to work with a trained contractor. Mālama Maunalua can provide referrals to contractors that have been trained to design and install infiltration rain gardens. The UH Master Gardener program also provides assistance and advises on landscaping projects.

Before You Dig, Locate Underground Utilities

The Utility Notification Center is a "one-call agency dedicated to safeguarding citizens and construction personnel who work around utilities, as well as safeguarding the underground infrastructure of pipes, mains, and lines which bring utilities to your community."

This is a free service that you can take advantage of if you are planning any excavation. Taking this step will protect you and any underground utilities.

The Utility Notification Center is open 24 hours a day, every day, and accepts calls from contractors, homeowners, or anyone planning to dig.

Call 1-866-423-7287 before you dig!

Harvest Rain Water

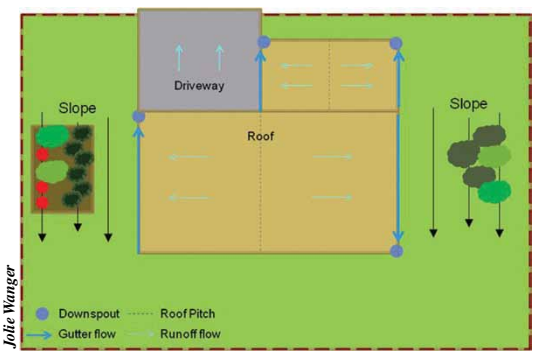
Rain barrels can be used to meet small outdoor water demands. They can be used to store water for hand-watering landscape plants or with a drip feed system. They also provide a mechanism for reducing the amount of rain water runoff during rain events by delaying the release of the water and delivering it to landscaping that can best utilize the water.

Why Rain Barrels?

- Rain barrels are a cost-effective alternative to using tap water for watering your lawn and garden.
- They can help reduce excess runoff into the storm drain system and Maunalua Bay.
- They allow us to take advantage of an existing source of freshwater that would otherwise run off the land during a storm and carry pollutants into the bay.
- They can reduce the threat of flooding to yards and homes.
- They are inexpensive to install and maintain.

Rain barrels capture water from a downspout and hold it for later use. Photo: Plow and Hearth

Steps to Get Started



Jolie Wanger

Step 1: Observe Your Site

To determine if a rain barrel is right for your property*, the first step is to identify your site's drainage conditions. Answer the questions below as you walk around your property.

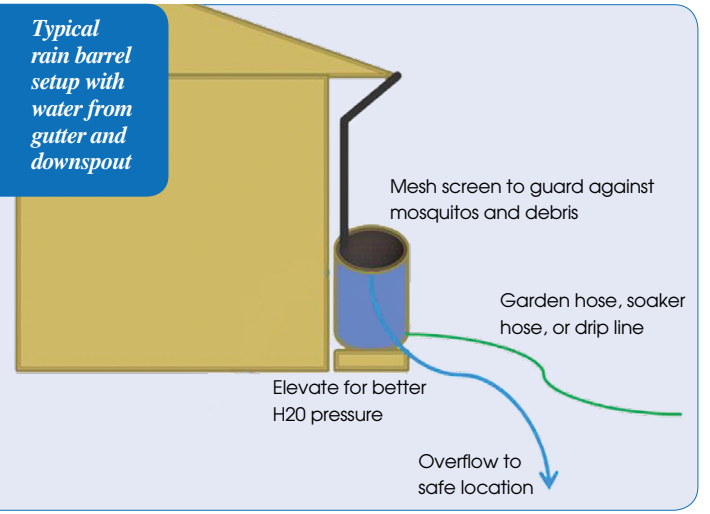
*Also refer to section on rainfall considerations below for tips on determining rain barrel size based on rainfall and roof area.

Where Does the Runoff From Your Roof Area Go Now?

Sketch a site plan. You can draw a sketch of your property or print an aerial view from the City and County of Honolulu or Google Earth as a starting point. Mark the locations of downspouts and roof lines, estimate the square footage of your roof and paved areas (Google Earth has a measurement tool that can be set to measure in feet), and map where all these areas drain.

Where Would You Like to Locate Your Rain Barrel?
Install your rain barrel based on where you will use the water in your yard. The rain barrel must be located at the base of one of the downspouts draining your roof gutter.

Where Does that Downspout Currently Drain?
The downspout you will divert to your rain barrel probably drains into a pipe or to your yard. This is the stormwater *discharge* point. See Overflow in the next section for more on managing and directing overflow water.



Typical rain barrel setup with water from gutter and downspout

Step 2: Install Your Barrel(s)

1. Before you start, make sure that your roof is clean and your gutter is clear of debris.
2. Clean the inside of new barrels with a brush and a very weak bleach solution (¾ cup Clorox per gallon of water). Rinse barrel after scrubbing and dispose of rinse water in a sink.
3. Where to place your rain barrel:
   - Select a place for your rain barrel under a downspout on level, solid ground free of any rocks, roots, or debris that can make your rain barrel rock from side to side.
4. Set up on leveled blocks for better water pressure.
   - Rain barrels should be installed on cinder blocks or bricks to provide height for gravity flow purposes. The blocks or bricks should give a minimum of 6-8 inches of height. Place bricks or cinder blocks (two of these side by side usually provide enough height and surface) where your rain barrel will sit. A full rain barrel will weigh over 300 lbs., so make sure your bricks or blocks can withstand the weight.
5. Overflow drainage.
   - Arrange your rain barrel so that the overflow valve or hose is facing away from your home's foundation. ***Always make sure to monitor your rain barrel for overflow to avoid damage to your foundation***—if you go on vacation, plan ahead!
   - Connect a 1-¼ to 1-½ inch hose to the barrel's overflow port near the top to divert overflow water. Direct the water at least six feet away from the building foundation. Note: garden hoses can be too small, causing spillage near the house foundation.

   Overflow water should flow to either:
   - an area of the yard that can absorb the runoff *(most desirable to avoid spilling onto pavement, sidewalks, and into storm drains)*; or
   - original downspout drainage location *(less desirable if this connects to storm drain but important if home structure could be impacted or there is not enough yard space to absorb the runoff).*

Note: If overflow is to the yard, monitor the overflow area and re-grade soil if necessary to make sure water drains away from structures and does not flow onto neighboring properties.

Step 3: Maintain It

General Considerations: Inspect your rain barrel monthly. Remove any debris that has accumulated on the lid that might block the screen mesh. You should also routinely clean the inside of your rain barrel. Check your overflow hose and connections often to ensure the barrel is in proper working condition.

1. Use the water in your barrel after each rain so it is empty before the next one (drain it slowly by watering your plants rather than all at once.) A full barrel is a useless barrel when it rains!
2. Clean your roof and gutters at least once a year to minimize debris in the stored rain water. Clean more often if you have large trees that drop leaves, seeds, and/or fruit on your rooftop.
3. If you treat your roof for pests or mold, unhook your rain barrel and allow several rain events to wash your roof before reconnecting. It is typically recommended to disconnect for two weeks after treatment but if you are in a dry area and receive little rain you should disconnect for longer to ensure your water remains uncontaminated.
4. Prevent leaves and other debris from clogging your barrel by placing a fine mesh over your gutter connection before connecting to your existing gutter system.
5. Mosquito Prevention
   - Drain any water that sits for long periods of time; ideally less than every 10 days, as that's how long it takes for mosquitoes to breed.
   - Keep the piece of fine mesh secured around the opening of the barrel.
   - Keep your barrel free of plant material/debris (unless you incorporate fish and/or water plants, see below).

   Other Methods You Can Try
   - Add one tablespoon of olive oil to the water each time the barrel fills to keep mosquitoes from breeding in the barrel.
   - Purchase “mosquito dunks” to control breeding. These contain a bio-control agent, not chemicals, and will not harm your pets, lawn, or garden.
   - Try using a small, solar powered fan to make small waves on the surface of the water. Mosquito larvae require still water to breathe.
   - An alternate option is to place mosquito fish in your barrel with water plants (such as water hyacinths) floating on top. With this approach, no mosquito netting is necessary as the fish will eat the mosquito larvae. The added nutrients from your fish will also be beneficial to your garden. The fish will also keep algae under control if you use a white or translucent barrel. Note: This approach is not recommended if you have small children who are at risk for climbing into the barrel. Also, screen the openings on the inside and leave enough water in your barrel between rains for the fish to survive.

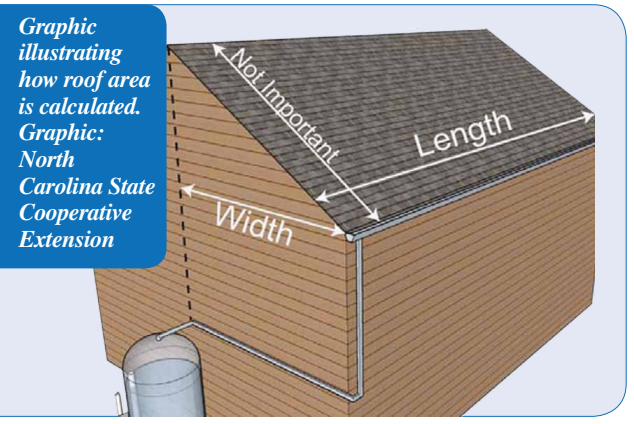
Harvested Rainwater Use and Safety Tips

1. ONLY USE RAIN BARREL WATER ON YOUR LAWN OR GARDEN! (Never for drinking!) Water collected from rain barrels is not suitable for human or pet consumption as roofs pick up contamination from leaves, bird droppings, dust, and other airborne material. Also, take care when watering green leafy vegetables due to potential bacterial contamination.
2. The water flow (and pressure) will be less than from your outdoor spigot, making sprinklers ineffective. Soaker hoses, handheld spray nozzles, and/or watering cans are all good options. Elevating your rain barrel on a sturdy platform will increase the flow. Plan to locate your barrel upslope or level with where you will use the water.
3. Some roofing materials can contaminate harvested rainwater. Also, zinc and copper coatings are toxic to plants.
4. ALWAYS SECURE YOUR RAIN BARREL COVER. Even small amounts of water can present a drowning risk to children and pets.
5. SAVE MONEY AND WATER WITH EVERY DROP!

Rainfall Considerations

Expected Rainfall for the Maunalua Region:
According to the graphs on page 23, if you live in a 2,000 sq. ft. home in the Maunalua region and have a 55 gallon rain barrel in your yard *(with a single downspout)* you can expect to collect just enough rain most days during the summer months to fill your barrel (although the rain often comes all at once rather than a little each day).

During the wetter months you might expect to collect two to three times the capacity of your barrel and will need to divert the overflow to a safe location or connect additional barrels to capture all of the rainfall. **Remember, your rain barrel capacity is based on an empty barrel. Always use your rain barrel water after a rain to empty it before the next rain event!**



Graphic illustrating how roof area is calculated. Graphic: North Carolina State Cooperative Extension

Note: The tables on page 23 provide a general indication about rainfall amounts for some areas of the Maunalua region. However, amounts vary considerably from neighborhood to neighborhood. You might consider installing a simple **rain gage** to measure the amount of rain falling at your specific location to be able to accurately design a system of water catchment to meet your needs. Once you know the amount of rain falling on your roof, you can do a simple calculation to determine how much rainwater you could collect from your roof during a given month. It might also be useful to determine how much rain falls during storm events to understand how often you will overflow your rain barrel's capacity and help you decide

if it makes sense to purchase a larger barrel or connect additional barrels together to capture more of the water.

Estimating Rainfall Volume

Example calculation for one inch rainfall event

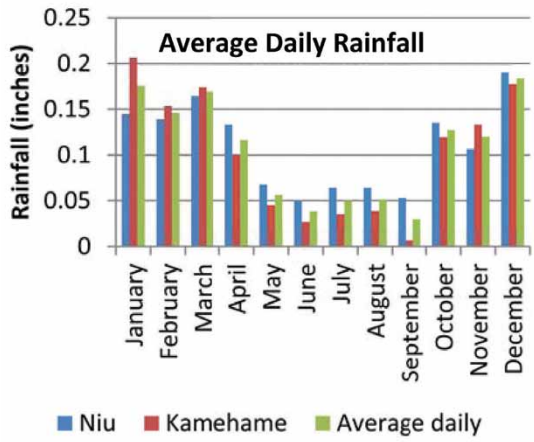
First calculate the number of gallons collected. Using the average value of one inch of rain, the number of gallons of rainwater that can be expected to be generated from a 1,000-square-foot area of roof assuming 85 percent collection efficiency is determined from the equation:

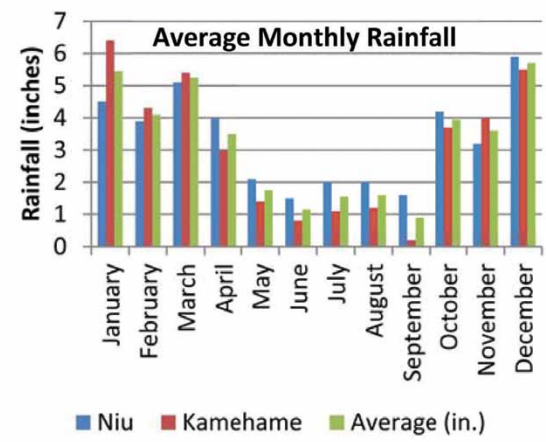
Rainfall (in) x Roof Area x 0.62 gal/sq ft/in Rain x Collection Efficiency*

In this example:

1 in x 1,000 sq ft x 0.62 gal/in rain/sq ft x 0.85 = 527 gallons!

**Reference: The Texas Manual on Rainwater Harvesting*





Rainfall data for 2010 compiled from two NOAA hydronet weather stations located in Niu Valley and Kamehame Ridge. An average of the two stations is included as the green "Average" bar. Current data can be found on the National Weather Service website: http://www.nws.noaa.gov/climate/local_data.php?wfo=hnl.

Rainfall Volume (gallons)

Roof area (square feet)	Rainfall (inches)								
	.05	.1	.15	.2	.25	.5	1	1.5	2
500	13	26	40	53	66	132	264	395	527
1,000	26	53	79	105	132	264	527	791	1054
1,500	40	79	119	158	198	395	791	1186	1581
2,000	53	105	158	211	264	527	1054	1581	2108

Blue highlighted is less than the capacity of the average rain barrel. Average daily rainfall during the summer months in the Maunalua region is around 0.5" or less (see rainfall data chart in Appendix).

Use and Storage of Household Products

Water flowing into storm drains does not pass through a wastewater treatment plant before reaching the ocean. It is, therefore, vital that we keep the water as clean as possible.

All types of household products and other pollutants such as sediment, pet waste, trash, motor oils, antifreeze, soaps, and paint should be kept out of the storm drains. Many of these are harmful to humans, animals, plants, streams, and marine life, and/or contain substances that are not easily broken down in the natural environment. **Each household plays an important role in safeguarding these products and preventing their release into the environment:**

1. Keep all household products, *including* biodegradable soaps and detergents, from entering streams or storm drains.
2. Properly dispose of oil, paint, antifreeze, and other chemicals. The City and County of Honolulu recommends the "Absorb and Trash" method for disposal of most chemicals. Some may be diluted and flushed into the sewer system. A detailed chart describing which method to use for different types of products is available at www.opala.org, or call The City and County of Honolulu's Household Hazardous Waste Information Line at (808) 768-3201 or e-mail: info@opala.org.

   Absorb and trash method:

   a) Pour the liquid into a plastic bag with absorbent material, such as shredded newspaper, old rags, or sawdust.
   b) Once the liquid is absorbed, seal the bag, then throw the bag away in trash can.
   c) An oil change box provides the same results.
3. Whenever possible, it is best to use nontoxic products.
4. When washing your car, use a commercial car wash, or wash on grass whenever possible. If you must wash in your driveway or street, use biodegradable soap.

The surfactants in soaps and detergents, even most of those labeled "biodegradable" are harmful to fish, even in small amounts.

Biodegradable Products

Important Note: While the use of biodegradable products over products that do not degrade in the natural environment is preferable, *we recommend that NO household products be allowed to enter into the storm drain system, including biodegradable soaps and detergents.*

Even biodegradable products pose certain problems for the ocean environment that surrounds Hawai‘i.

In spite of the fact that biodegradable products are widely recommended because of the ease with which they are able to be broken down into their constituent natural elements and absorbed by the environment, biodegradable products can still do harm in the environment and can still make animals sick.

The same properties that make biodegradable products effective at dissolving dirt, grease, and other substances can also be harmful to aquatic life. Simply being "biodegradable" does not provide adequate safeguards for the waters around Hawai‘i.

With this in mind, biodegradable products *are* preferred over traditional household products, however, whenever possible please ensure these products are:

1. Washed down into the sewer, or
2. Dumped into the soil where they will be filtered by plants and broken down over time by microorganisms.

A Note About Vehicle and Boat Washing

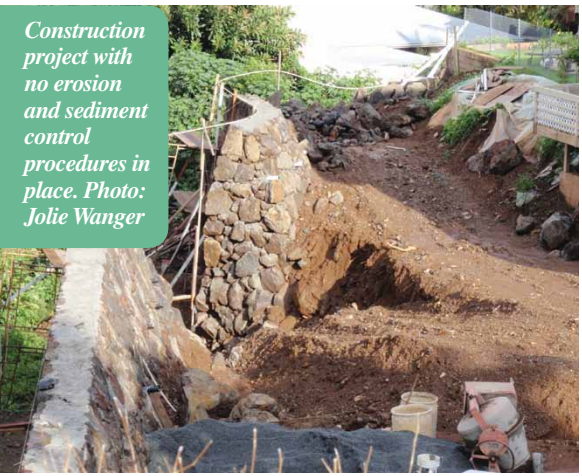
In addition to carrying detergents, vehicle and boat wash water also contains residues from exhaust fumes, gasoline, oils, and heavy metals which are toxic to sensitive marine life.

Recommended washing practices:

- ✓ Take your vehicle to a commercial car wash station that discharges used wash water into the sanitary sewer for treatment.
- ✓ If you live in an apartment or townhouse complex, wash at a designated car or boat wash stall if water drains into the sanitary sewer and not into the storm drain system.
- ✓ At home, wash over a gravel or grassy area where the water will soak into the ground and be filtered by the soil. Do not wash on paved areas.
- ✓ Wash without soap, using water, a bucket, and a sponge rather than a running hose.
- ✓ If you do use a hose, use a spray nozzle to limit the flow of water and spray only as needed. Wet down the vehicle or boat and rinse in sections at a time to use less water.
- ✓ When necessary wash with small quantities of phosphate-free, biodegradable soap.
- ✓ Dump used wash water into a sink or toilet where it will go to the sewage treatment plant.

Safeguarding Our Waters

Know the Law, Avoid Fines



Construction project with no erosion and sediment control procedures in place. Photo: Jolie Wanger

- Putting **any** pollutants into the storm drain system is against the law.
- Violations of the federal Clean Water Act can result in fines of up to $25,000 per violation, per day.

The Clean Water Act gives the EPA the authority to implement water pollution control programs.

To comply with the EPA's mandate, the **Revised Ordinances of Honolulu, Section 14-12.23(a) Environmental Quality Control - Violation** states:

> *"It shall be unlawful for any person to discharge or cause to be discharged any pollutant into any drainage facility which causes a pollution problem in state waters, or causes a violation of any provision of the city NPDES permit or the water quality standards of the State of Hawai'i."*

The City and County of Honolulu defines a **pollutant** as: "any waste, cooking or fuel oil, waste milk, waste juice, pesticide, paint, solvent, radioactive waste, hazardous substance, sewage, dredged spoils, chemical waste, rock, sand, biocide, toxic substance, construction waste and material and soil sediment. The term also includes commercial FOG waste as defined under Section 14-5A.1."
http://www.cleanwaterhonolulu.com/storm/faq/faq.html#illegal

Got Something to Report? Who to Call

As a resident, you are in the best position to monitor and safeguard our vital waterways.

By reporting any pollutant discharges **including soil runoff** from a construction site and suspicious activities when you see them occurring, you can make a big difference for your community.

To Report Spills of Hazardous Waste:

- Local: Honolulu Fire Department (HFD)
  - 911 (24 hours a day, 7 days a week)
- State: Hawai‘i State Emergency Response Commission (HSERC)
  - During business hours: (808) 586-4249
  - After business hours: (808) 247-2191

To Report Pollutant Discharge That Has Already Occurred:

- Call the City and County of Honolulu Environmental Concern Line
  - During business hours: (808) 768-3300

For National Pollutant Discharge Elimination System (NPDES) permitting questions:

- During business hours: (808) 768-3242

For More Information and/or Educational Assistance On Polluted Runoff (Public Outreach):

- Call the City and County of Honolulu, Stormwater Community Relations
  - During business hours: (808) 768-3248
- The State of Hawai‘i Department of Health, Environmental Management Division (EMD), Clean Water Branch
  - During business hours: (808) 586-4309

Share this information with your family, friends, and neighbors and encourage them to report illegal discharges and suspicious activities when they see them.

Do More

In addition to reporting problems, as a last line of defense, communities can also play an important role by organizing to clean up areas that accumulate trash, debris, and sediment before it washes into the bay. These events can be a great way to get to know your neighbors as well as give back to your community.

Trash and debris polluting Niu stream. Photo: Mālama Maunalua

Neighborhood cleanup of Niu stream to remove trash and debris. Photo: Mālama Maunalua

Do-It-Yourself Instructions

Testing Infiltration: the Simple Approach (from page 7)

Rob Emanuel

1. Dig a test hole that is 12 inches deep and about 9 inches in diameter. Set the spoils from your hole aside for a "feel" test later.
2. If you run into a hard layer that cannot be penetrated with a shovel, or you come across water in the hole, then stop and note this. This will be an important consideration for landscape features designed to infiltrate water (see page 7, chapter 2 and "Assessing Your Site for a Rain Garden" below). You can also dig another hole nearby in case you just encountered a single large rock.
3. Fill the hole with water to just below the rim. Record the exact time you stop filling the hole and the time it was completely drained.
4. Refill the hole again with water and repeat step 3 twice more. The third test will give you the best measure of how quickly your soil absorbs water when it is fully saturated as it would be during a rainy period of the year or during a series of storms that deliver a lot of rainfall in a short period of time.
5. Divide the inches the water dropped in the hole by the amount of time it took for it to drop. For example, if the water dropped four inches in two hours, then four divided by two equals two inches per hour of infiltration.

Determining Soil Type (from page 7)

1. Take a handful of the soil you have excavated from your infiltration test. Pulverize it in your hand and remove any bits of organic matter or obvious rocks.
2. Wet it with a small amount of water and rub it between your thumb and index finger. Don't saturate it until it is runny mud. You might feel stickiness, grittiness, or smoothness. The grittier the feel, the more sand is present in your soil. The slicker the soil, the more clay in it. Smooth soils are sometimes an indicator of a fine silt or loam. Discard the soil.
3. Next, take another sample in your hand. Wet it until it has the consistency of dough. You should be able to form a ball that holds together with the soil in your palm. If

you cannot get the ball to form, then your soil is very sandy. In most soils, however, you should be able to create a rough ball.

4. Knead the soil together between your thumb and fingers and attempt to form a ribbon. As you build the ribbon, it will either hold together or break off. If the soil breaks quickly in the process, then it likely has a high sand content. If the ribbon forms quickly and stays strong, it has more clay.
    - If the soil forms a ribbon less than one inch in length before it breaks, the soil is sandy or silty.
    - If the soil makes a ribbon one to two inches in length before it breaks, the soil is clayey.

Rob Emanuel

The "Catch Can Test" (from page 8)

The "Catch Can Test" is a simple way to figure out how much water your sprinkler delivers.

1. Get five to seven empty straight-edge cans. Shallow tuna cans work well.
2. Place the cans at different distances away from the sprinkler.
3. Run the sprinkler for 15 minutes.
4. Use a ruler to measure the depth of water collected in each can.
5. Add the measurements from each can.
6. Divide the total by the number of cans you used (i.e., if you used six cans, divide by six). This is the average depth of water collected in that zone.

You can calculate the amount of water the system applies in one hour by multiplying the measurement by four (15 minutes x 4 = one hour).

Assessing Your Site for a Rain Garden: (from page 18)

Step 1. Observe and map your site.

The first step is to assess how water flows across your property. We suggest you create a map of your site that includes the measurements of all structures, with arrows to indicate where the water flows after the rain lands on these surfaces.

1. Walk through your yard and note any obvious slopes or low spots.
2. Note areas where water might drain to your neighbors' or public property.
3. You will want to site your potential rain garden where water flowing into the garden will be higher than where water will naturally exit the garden.

PBR Hawai'i & Associates, Inc.

4. Look for areas nearby where overflow from a rain garden can be absorbed or safely directed into a stormwater collection point (such as a street side gutter and storm drain).
5. Determine how much area the rain garden will treat. This is done by calculating the area of the roof or other impervious surface draining into the garden.

Width of Surface Area x Length of Surface Area
= Area (square feet)

Step 2. Do you have a good location to put a rain garden?
The easiest place to build a rain garden is relatively close to a gutter downspout. It is also possible to re-hang your gutters to move the downspout to a more appropriate spot or pipe the water from the downspout to your garden if the best site is some distance away. **Note:** a rain garden **should not** be constructed in a location that stays wet throughout the rainy season, this is an indication of poorly drained soils. Also, to protect your property it is important to place a rain garden 6-10 feet away from homes and retaining walls. Finally, ensure the slope of the site is **no more** than 10 percent to prevent erosion and landslides.

Measure the slope
Tools needed:
- Two stakes
- Survey line or string
- Line level
- Measuring tape
- Calculator

Steps:

1. Place stakes in the ground at the top and bottom of the slope to be calculated.
2. Attach a survey line (or any heavy-duty string) to the two stakes. Be sure that the line touches the ground on the uphill stake. Use the level to make sure the line is level.
3. Measure the horizontal distance (along the line) between the two stakes.
4. Measure the rise (vertical distance) from the ground up to the line on the downhill stake.
5. Calculate the slope by plugging your numbers into the following formula:

$$\text{slope} = \frac{\text{RISE}}{\text{HORIZONTAL DISTANCE}} \times 100\%$$

Jolie Wanger

Note: both measurements must use the same increments (for example, inches):

Step 3. Does your soil drain well enough?

The ability of soil to drain water is one of the most important considerations for understanding the site and properly sizing a rain garden. An infiltration and texture test will help you determine the soil's capacity to absorb and percolate water down into the lower layers. See "Testing Infiltration: the Simple Approach" on page 28 for a description of a simple soil infiltration test and determining soil texture. As a general rule, a suitable infiltration rate for rain gardens is at least ½ inch per hour, however, a rate of less than one inch per hour may require a deeper or larger garden. Additionally, if the soil has a high clay content and drains slowly, consult a professional prior to installing a rain garden.

Step 4. What size will you make your rain garden?
We recommend the size of the rain garden be at least 10 percent of the impervious surface draining to the garden. Rain gardens should ideally be between 6 and 24 inches deep. Using the area of impervious surface that you calculated in step 1, multiply this by 0.10. The result will be the area of the rain garden in square feet.

(length of surface area x width of surface area) x .10
= total rain garden area

Note: Rain gardens should be a minimum of five feet wide to accommodate gentle side slopes that will host plants and minimize soil erosion.

The depth of your rain garden will also depend on your soil infiltration rate and available space for your rain garden. If you don't have the space to go wider you can go deeper.

Infiltration Rate	Depth
Between ½ and 1 inch/hour	12–24 inches
Between 1 and 2 inches/hour	6–8 inches
Faster than 2 inches/hour	6 inches

Step 5. How will you get water to the rain garden?
There are many creative and attractive options for getting the water from your downspout or other collection point to your rain garden. You can pipe it underground, run a gutter extender, or even build an artificial stream that runs only when the rain falls. Typically the outlet of the routed water and inlet of the rain garden are lined with rock (¾ inch diameter, washed drain rock or pea-sized gravel) to prevent erosion.

Attractive way to convey water from a roof downspout to a rain garden via constructed stone-line stream bed. Photo: City of Portland Bureau of Environmental Services

Designing for overflow

A properly sized rain garden should be designed to handle roughly 80–90 percent of the water that falls on a given impervious surface. Therefore, extreme events should be considered when designing your garden. For this reason, it is critical to include plans for overflow. This should be a notch or a pipe in the berm, at least two inches lower than the berm. The overflow could lead to one of several options:

- A flat area in your home landscape where water can be safely absorbed,
- Another rain garden,
- A French drain or rock-filled soakage trench,
- A swale or drainage ditch, or
- Return the water to its original destination before the rain garden was built (such as a street gutter, storm drain, or pipes and catch basin).

Rain garden overflow point lined with stone to protect against erosion. Photo: Jolie Wanger

What's Next

You have now assessed your site for suitability, have identified potential locations for a rain garden on your site, and are certain that you will be able to convey water to the rain garden and direct the overflow to a safe location. You can now feel confident in contacting a landscape professional and directing them to install a rain garden on your property. Mālama Maunalua or a Master Gardener should be able to assist you or provide referrals to landscape professionals who are familiar with rain gardens and other Low Impact Development systems.

List of Recommended Native Plants

	Name	Type *Distribution*	Landscaping Info.
	ʻĀkia, *Wikstroemia uva-ursi*	Sprawling shrub *endemic*	Once established it is very drought and wind tolerant. ʻĀkia is a good groundcover or low shrub.
	Pōhinahina, *Vitex rotundifolia*	Sprawling groundcover *indigenous*	Grows well in sandy soils. Does well over a broad range of elevations. Needs full sun and well drained soil to thrive. Once established, water only during prolonged drought periods.
	ʻIlima, *Sida fallax*	Sprawling groundcover *indigenous*	Makes a good groundcover in a hot, sunny location. Excess water can produce lush foliage, but fewer flowers. Requires well-drained soil.
	Hinahina, *Heliotropium anomalum*	Small shrub *endemic*	Watering is only necessary during prolonged drought. Allow to dry out between watering. Makes a beautiful, silvery groundcover.
	Pili grass, *Heteropogon contortus*	Grass *indigenous*	A terrific accent plant in dry sunny areas. Pili will remain greener longer and look healthier with regular watering. Water when it is dry until they are well established.

	Name	Type *Distribution*	Landscaping Info.
	ʻAkiʻaki grass, *Sporobolus virginicus*	Grass *indigenous*	Grows naturally in dry conditions but seems to prefer moist conditions until it is established. Then, watering can be cut back.
	ʻIlieʻe, *Plumbago zeylanica*	Sprawling shrub *indigenous*	Strong groundcover and is ideal for stabilizing soil erosion. Water plants when soil is dry. Looks best with regular irrigation in well drained soil.
	Kāwelu, *Eragrostis variabilis*	Grass *endemic*	Can be used with a number of native plants in full sun or open windy locations with minimal water (xeric). Water when soil is dry or nearly dry.
	ʻAʻaliʻi, *Dodonaea viscose*	Shrub *indigenous*	An excellent plant for dry, windy, full sun areas where few other plants will survive. Greatly reduce watering once plants are well established.
	Naupaka papa, *Scaevola coriacea*	Groundcover, small sprawling shrub	Dwarf naupaka. Favors xeric conditions. Heat, wind and salt tolerant. Water when dry.

List of Recommended Native Plants *(continued)*

	Name	Type *Distribution*	Landscaping Info.
	Nehe, *Melanthera integrifolia*	Groundcover *endemic*	Once established, should only water twice a week at most. When plant begins to show signs of new growth, slowly reduce the amount of watering.
	Hāpu‘u, *Cibotium menziesii*	Tree fern *endemic*	Plant in slightly acidic and well drained soil. Plants can tolerate both moist and dry conditions. Water on emerging fiddle, fronds and trunk.
	‘Ae‘ae, *Bacopa monnieri*	Grass-like *indigenous*	With good lighting ‘ae‘ae does well with light foot traffic or planted between stepping stones. Can also be grown in water.
	Akulikuli, *Sesuvium portulacastrum*	Groundcover *indigenous*	One of the most salt-tolerant coastal plants. Excellent groundcover for beach areas, saline soils, xeric landscaping, and in and around water features.
	Loulu, *Pritchardia sp.*	Tree *endemic*	Multiple endemic species. Generally favor well-draining soils and partial sun.

	Name	Type *Distribution*	Landscaping Info.
	Naio, *Myoporum sandwicense*	*indigenous*	Fast to medium growing landscape shrub or tree. Needs little care after established. Poor drainage and damp soil will eventually kill these plants.
	ʻŪlei, *Osteomeles anthyllidifolia*	Sprawling shrub *indigenous*	Requires little or no maintenance once established. If conditions are too wet, ʻūlei produces little or no flowers. Cut back on watering to initiate flowering.
	Kupukupu, *Nephrolepis exaltata ssp. Hawaiiensis*	Fern *endemic*	Moist, not soggy conditions.
	ʻUkiʻuki, *Dianella sandwicensis*	Grass-like *indigenous*	Grows in dry, moist, or wet conditions. Thoroughly water, then water weekly until established. Cut back to once or twice a week. Mulching will help retain moisture.
	Kokio keʻokeʻo *Hibiscus arnottianus*	Shrub *endemic*	Requires well-drained soil. Can be prone to root rot. Salt tolerant.

Plant list images from "Forest and Kim Starr" and Rick Barboza.

Ways to get involved in your community:

Become an **ambassador for the bay** for Mālama Maunalua (malamamaunalua.org or (808) 395-5050)

Adopt A Block/Adopt A Stream/Storm Drain Stenciling programs with the City and County of Honolulu: cleanwaterhonolulu.com/storm/hero/adopt.html

Home Garden/Landscape:

University of Hawai‘i Master Gardener Program can help answer home garden questions. Look for the “Plant Doctor” booth on Saturday’s at the Kapi‘olani Farmer’s Market and periodically at the Hawai‘i Kai Farmer’s Market.
Or call the **University of Hawai‘i Master Gardener Help Line** at:
(808) 453-6055
Monday through Friday
From 9 a.m. to 12 p.m.

Or visit the Master Gardener Program website at:
http://www.ctahr.hawaii.edu/sustainag/MG/index.html

Additional gardening services and educational programs are provided at:
The University of Hawai‘i Cooperative Extension Service Urban Garden Center
955 Kamehameha Hwy.
Pearl City, Hawai‘i 96782-2501
Phone: (808) 453-6059
Fax: (808) 453-6052

Reference Publications: HAPPI Home Series of publications available online from the University of Hawai‘i College of Tropical Agriculture and Human Resources.

Call Before You Dig!
Locate Underground Utilities: 1-866-423-7287 (Free one call 24 hr service to locate utilities before digging)

Trees: The **Arbor Day Hawai‘i** checklist is a resource available to help you select the right tree: http://www.arbordayhawaii.org/trees/checklist.htm

Mulch:

Mulching for Healthier Landscape Plants from The University of Hawai'i College of Tropical Agriculture and Human Resources.

Compost:

For more information on composting see:
http://www.epa.gov/osw/conserve/rrr/composting/benefits.htm
For detailed information on how you can do composting at home read:
Compost Hawai'i Backyard Conservation: Ideas for Every Homeowner
Yard and Garden Nutrient Management from The University of Hawai'i College of Tropical Agriculture and Human Resources.

Rain Barrels:

The Board of Water Supply offers workshops to learn how to build-your-own rain barrel at the Hālawa Xeriscape Garden:
http://www.hbws.org/cssweb/display.cfm?sid=2091

The Green House offers workshops to learn how to build-your-own rain barrel at their facility in Pauoa valley: http://thegreenhousehawaii.com/thegreenhouse.html

The Master Gardener Program will drill holes and help you install hardware if you bring a recycled barrel to the Urban Garden Center site in Pearl City. Call 453-6055 to schedule an appointment for Tuesday or Thursday between 9:00 a.m. and 10:00 a.m. or bring your barrel to their Second Saturday event. For more information, visit the Urban Garden Center's website: http://www.ctahr.hawaii.edu/ougc/index.asp

Household Chemicals/Environmental Concerns:

Report Dumping or Other Environmental Concerns:

- Call the City and County of Honolulu Environmental Concern Line during business hours: **(808) 768-3300**

Hazardous Waste Disposal: See the detailed chart: www.opala.org, or call The City and County of Honolulu's Household Hazardous Waste Information Line at **(808) 768-3201**.

For detailed information, read:

Managing Hazardous Household Products from The University of Hawai'i College of Tropical Agriculture and Human Resources.

Alternatives to Hazardous Household Products from The University of Hawai'i College of Tropical Agriculture and Human Resources.

For detailed information, read *Think Before You Dump It—Safe Disposal of Hazardous Products* from The University of Hawai'i College of Tropical Agriculture and Human Resources.

Proper Disposal

The City and County of Honolulu web page on Household Hazardous Waste has some excellent information you can use to find out what substances are toxic or hazardous and how to dispose of them properly. Visit: http://www.opala.org/solid_waste/Household_Hazardous_Waste.html#special

Note: Disposal of hazardous products is done by appointment. To make an appointment to drop off hazardous materials for proper disposal call: (808) 768-3201.

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“Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed.” Prepared for Mālama Maunalua by Sustainable Resources Group International, Inc. November, 2010.
Watershed Forestry Resource Guide: forestsforwatersheds.org

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City and County of Honolulu Department of Environmental Services: Opala.org
City & County of Honolulu Storm Water Management Program: CleanWaterHonolulu.com
City of Portland: Portlandonline.com
Hawai‘i Rainwater Catchment: http://www.hawaiirain.org/
Honolulu Board of Water Supply: boardofwatersupply.com
National Weather Service: http://www.nws.noaa.gov/climate/local_data.php?wfo=hnl
Native Plants Hawai‘i: nativeplants.hawaii.edu/index/
Northern Virginia Rain Barrel Program: arlingtonenvironment.org/barrel.htm
Portland Water District: pwd.org/news/publications.php
rainbarrelguide.com
RainBarrelSource.com
Surfrider Foundation“Ocean- Friendly Gardens”: surfrider.org/programs/entry/ocean-friendly-gardens
UH CTAHR Renewable Natural Resources Extension: Urban Forestry, Native Plants for Water Conservation: www.ctahr.hawaii.edu/rnre/Native_Plants_Water_Conservation.asp

Disclaimer

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http://seagrant.soest.hawaii.edu