Olowalu Town Stormwater Quality Enhancements

Prepared for

Olowalu Town LLC

Wailuku, HI

October 2011

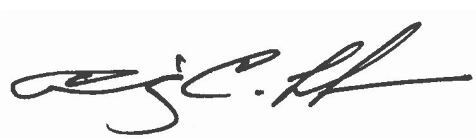
Olowalu Town
Stormwater Quality Enhancements

Prepared for

Olowalu Town LLC, Wailuku, HI

October 2011

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION



April 30, 2012

Signature — Expiration Date of License

Brown AND Caldwell

1955 Main Street, Suite 200
Wailuku, Maui, HI 96793

Table of Contents

List of Figures

List of Tables

List of Abbreviations

BMPs	Best management practices
DOH	State of Hawaii Department of Health
LEED ND	Leadership in Energy and Environmental Design for Neighborhood Development
O&M	Operation and maintenance
USBR	United States Bureau of Reclamation

Section 1

Introduction

1.1 Olowalu Town Master Plan

The Olowalu Town Master Plan is proposing to re-establish the once thriving village of Olowalu, located on the west side of the island of Maui. The subject property encompasses the lower coastal reaches of Olowalu ahupuaa; between the base of the south-west facing slopes of the West Maui Mountains and the shoreline of Olowalu. Olowalu Town will be a small-scale and mixed-use community designed to be a pedestrian-friendly community which will allow residents to live within walking distance of corner stores, schools, parks, employment opportunities, community centers, beaches, and social and civic resources, ultimately reducing reliance on automobiles. The Master Plan is guided by values and principles of sustainability by balancing the needs of Maui's growing population; yet maintaining and respecting our cultural, historical and natural resources.

At final build-out, Olowalu Town will consists of approximately 1,500 residential dwelling units to be built concurrent with appropriate infrastructure in phases spread out over a period of approximately 10 years. There will be a wide variety of single-family and multi-family dwelling types, including houses, apartments, live-work units, cottages, rural homes and farmsteads, to be offered at a wide-range of income levels, including both rental and fee-ownership. A substantial portion of the homes are planned for much-needed affordable housing and senior living.

The design of Olowalu Town incorporates smart growth and the sustainable land use principles of New Urbanism. As a result, Olowalu Town's spatial layout of land uses, varying density, connective transportation, parks/greenways, civic/social facilities, housing, employment and other land uses are balanced to create a mixed-use community. Neighborhood town centers provide economic sustainability with a range of business and employment opportunities. Olowalu Town is also designed to meet the certification requirements of *Leadership in Energy and Environmental Design for Neighborhood Development* (LEED ND). As such, the Master Plan will be built using strategies aimed at improving performance in regards to energy savings, water efficiency, reducing CO_2 emissions, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

Olowalu Town's proposed infrastructure improvements will be constructed concurrently with the project and will incorporate innovative, efficient, and sustainable technology to minimize adverse impacts upon the natural environment. Olowalu Town's Transportation system includes the relocation of the existing high speed/high volume Honoapiilani highway away from coastal resources to a new mauka alignment, which will be designed to accommodate mass transit or light rail, if needed in future. The existing highway corridor with monkey-pod trees will be preserved and converted to low speed/low volume coastal roadway. The project includes an internal roadway network, as well as an assortment of interconnected greenways and bikeways that link the community and supports overall well-being and health of residents; reducing dependency on automobiles.

Additionally, other infrastructure system improvements will require an expansion of both the existing potable and non-potable water system, the likely addition of a second ground water well to supplement the existing well; and an extensive drainage system to capture storm-water runoff.

1.2 Stormwater Quality Management

Traditional approaches to development have affected the environment of the islands. Impervious surfaces (e.g., pavement, structures) reduce rainfall infiltration and increase stormwater runoff. Stormwater runoff carries sediment and pollutants that impact the near-shore coastal waters. Olowalu Town's location adjacent to one of the most significant, accessible coral reef systems on the island of Maui dictates that stormwater quality management best management practices (BMPs) be implemented.

The United States Bureau of Reclamation (USBR) partnered with the State of Hawaii, Department of Land and Natural Resources, Commission on Water Resource Management to produce the guidance document "A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii" that describes BMPs that can be implemented to reduce the amount of stormwater runoff from a development and improve the quality of the runoff that occurs (USBR, December 2008). The publication is available online at:

http://hawaii.gov/dlnr/cwrm/planning/hsrar_handbook.pdf

The BMPs outlined in the guidance document were reviewed for applicability to Olowalu Town, and the measures considered most-suitable for the project are presented in this report.

1.3 Report Organization

Section 2 presents BMPs that are applicable to residential areas. Section 3 summarizes BMPs for commercial and public facilities. BMPs for green space and recreational sites are discussed in Section 4. Conclusions are presented in Section 5.

Section 2

Residential BMPs

The most effective stormwater management techniques are practiced at the source of runoff. Stormwater management at the individual home level offers some of the lowest cost and simplest methods to reduce stormwater runoff and improve stormwater quality. Individual homes include single family residences and multi-family residential units. These techniques have the following benefits:

- Reducing water bills.
- Reducing the size of or eliminating the need for stormwater ponds.
- Reducing stormwater infrastructure capital and operation and maintenance (O&M) costs.
- Protecting downstream areas from flooding, erosion, and sedimentation.
- Protecting downstream water quality.
- Increasing the quantity and quality of groundwater recharge.

Practices and technologies that could be implemented at single-family and multi-family residential parcels include bio-retention rain gardens, rain barrels and rain tanks, and subsurface tanks.

2.1 Bio-Retention Rain Gardens

Rain gardens consist of shallow depressions, which are typically underlain with a gravel layer, planted with native vegetation and sized to capture and treat a specified amount of runoff volume from an impervious surface. Home builders can design lawns to function as total treatment systems by providing vegetated forebays with recessed portions of the lawn acting as the rain garden. Depending on the design, the runoff can undergo sedimentation, filtration, adsorption, phytoremediation, evapotranspiration, and infiltration. They can be configured for treatment only or for both flow control and treatment. Figure 2-1 is a photograph of a typical rain garden. Figure 2-2 depicts the typical components of a rain garden. Rain gardens can also take to form of vegetated swales or grassy swales, as illustrated in Figures 2-3 and 2-4, respectively. The University of Hawaii has identified native plants that could be suitable for bio-retention rain gardens. Table 2-1 is a partial list of some candidate species.

Figure 2-1. A bio-retention rain garden

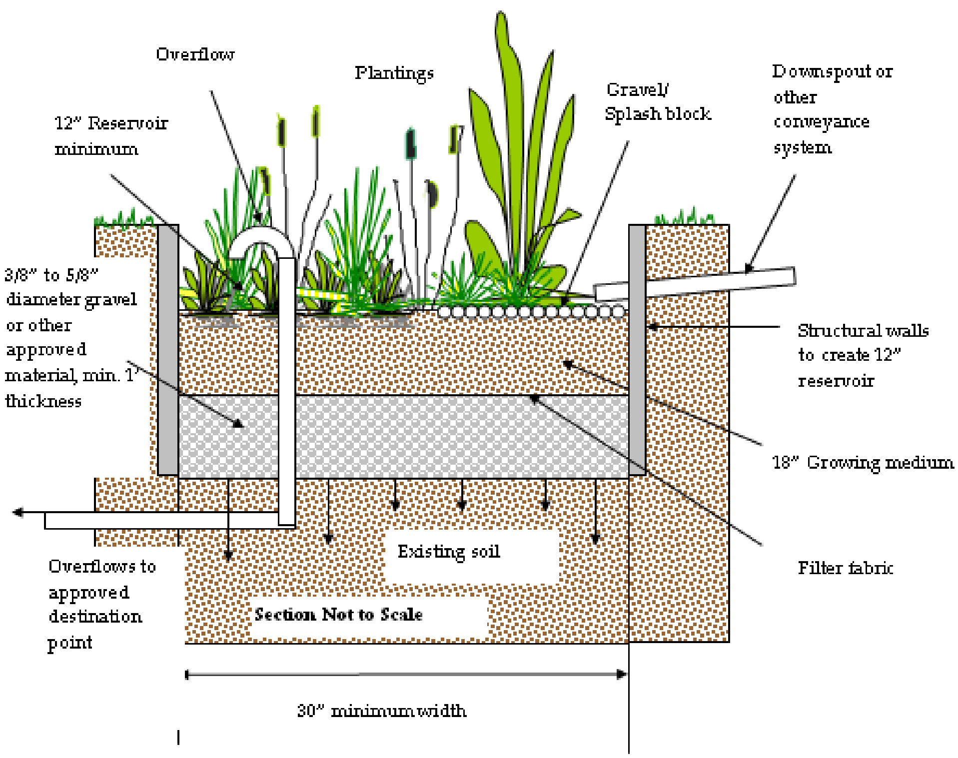


Figure 2-2. Schematic of a bio-retention rain garden

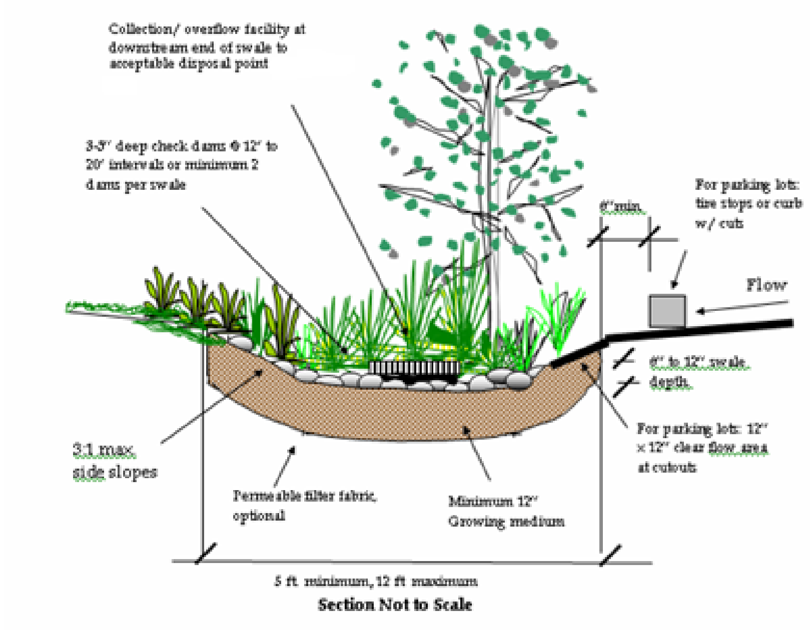


Figure 2-3. Vegetated swale

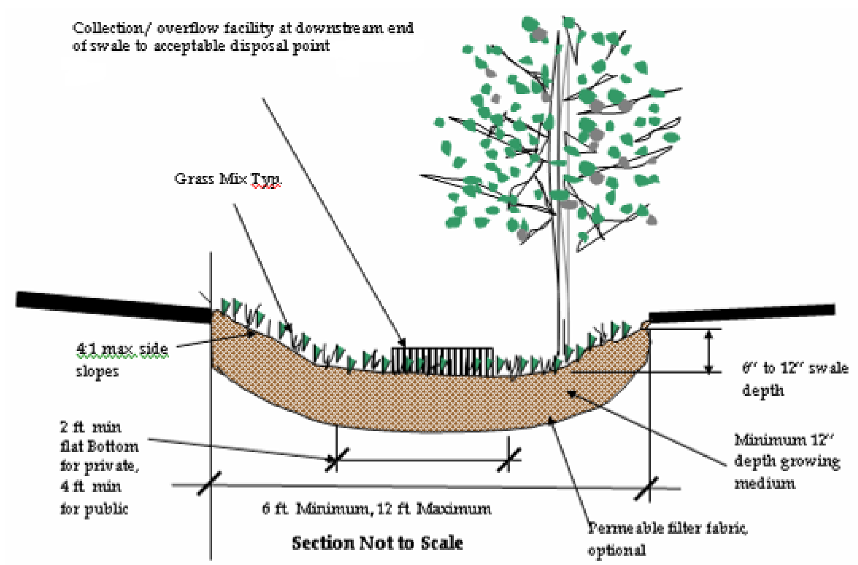


Figure 2-4. Grassy swale

Table 2-1. Potential Native Plants for Bio-Retention Rain Gardens (Partial List)	
Scientific Name	**Hawaiian Name**
Bacopa monnieri	*`ae`ae*
Carex wahuensis	*makaloa*
Dianella sandwichensis	*ukiuki*
Gossypium tomentosum	*ma`o*
Heliotropum anomalum var. argenteum	*hinahina*
Heterpogon contortus	*pili grass*
Ipomoea imperati	*hunakai*
Ipomoea pescaprae	*pohuehue*
Mariscus javanicus	*ahu awa*
Ostomeles anthyllidifolia	*ulei*
Plumbago zeylanica	*`ilie`e*
Sesbania tomentosa	*`ohai*

Source: Cabugos, et.al., 2007

Properly designed rain gardens can be highly effective at reducing runoff and removing contaminants, including metals, suspended solids, carbon, phosphorus, ammonia, and nitrogen.

2.2 Rain Barrels and Rain Tanks

A rain barrel or above-ground tank is intended to capture stormwater runoff that is generated from roofs or other elevated surfaces. They may be used individually or in tandem, and can be used for irrigation supply. Figure 2-5 is an example of a rain barrel.

Figure 2-5. Rain barrel receiving water from a roof gutter system

Typical rain barrel sizes range from 30 to 80 gallons. One inch of rain falling on 1,000 square feet of roof will produce approximately 600 gallons of runoff, therefore rain barrels are best used in conjunction with rain gardens so that rain barrel overflow does not run off the site.

2.3 Subsurface Tanks

Subsurface tanks can range from standard cylindrical tanks to component systems that can be constructed to suit site characteristics. Component tanks can be made from interlocking concrete or perforated plastic blocks of various dimensions. The assembled blocks can be wrapped in an impervious liner to harvest rain water and retain rainwater for later use. Subsurface tanks can be constructed with or without a liner, the latter allowing for infiltration. Subsurface tanks are typically connected to a pre-treatment system to prevent fouling and/or to improve the water quality for reuse or discharge. Figure 2-6 is an illustration of a subsurface tank system. Water must be pumped from the tank for irrigation reuse, making subsurface tanks more complex to operate and maintain than above-ground rain barrels. For this reason subsurface tanks are more-appropriate for implementation at multi-family housing complexes with common landscaping.

Figure 2-6. Schematic of a subsurface tank

Section 3

Commercial and Public Facility BMPs

Practices and technologies that can be applied at the commercial properties and public facilities within Olowalu Town include vegetated roofs, permeable paving, subsurface chambers, hydrodynamic devices, rain gardens, and subsurface tanks. The BMPs that were presented in the previous section can also be applied at commercial properties and public facilities.

3.1 Vegetated Roofs

Vegetated roofs consist of roofing material that includes media on which drought-tolerant native vegetation grows. The vegetation and growth media act to intercept and store rainfall. Thirty to 100 percent of the potential runoff can be stored, depending on size of the storm event. The retained stormwater percolates through the media, effectively increasing the time of concentration of the runoff. Figure 3-1 is a schematic diagram of a vegetated roof. A partial listing of some drought-tolerant native plant species that could potentially be used on a vegetated roof is provided in Table 3-1.

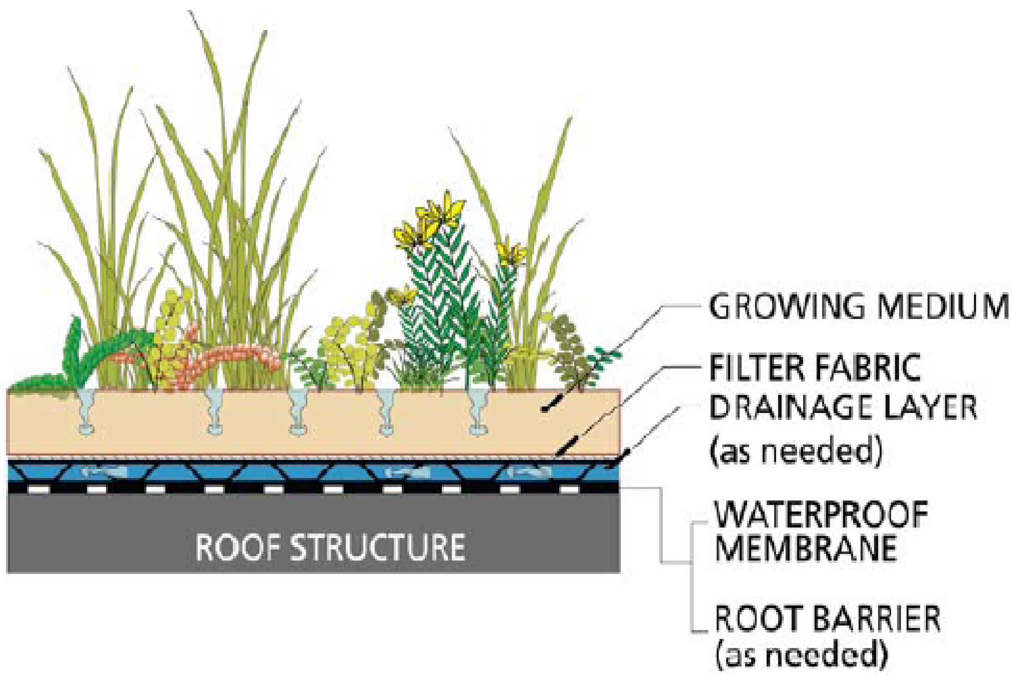


Figure 3-1. Vegetated roof schematic diagram

Table 3-1. Potential Native Plants for Vegetated Roofs (Partial List)	
Scientific Name	**Hawaiian Name**
Bacopa monnieri	*`ae`ae*
Carex wahuensis	*makaloa*
Gossypium tomentosum	*ma`o*
Heliotropum anomalum var. argenteum	*hinahina*
Heterpogon contortus	*pili grass*
Ipomoea imperati	*hunakai*
Ipomoea pescaprae	*pohuehue*
Mariscus javanicus	*ahu awa*
Ostomeles anthyllidifolia	*ulei*
Plumbago zeylanica	*`ilie`e*
Scaevola sericea	*beach naupaka*
Sesbania tomentosa	*`ohai*
Sesuvium portulacastrum	*`akulikuli*
Sida fallax	*ilima papa*
Wilkstroemia uva ursi	*akia*

Source: Cabugos, et.al., 2007

3.2 Permeable Paving

Permeable paving is designed to allow stormwater to infiltrate through the pavement structure. The pavement structure can consist of porous asphalt, porous concrete, interlocking blocks, or plastic grid systems. A uniformly-graded stone bed is laid underneath the permeable pavement. The stone bed provides temporary storage until stormwater can infiltrate into the un-compacted soil layers below. Under-drains can also be incorporated as required or desired. Figure 3-2 is an example application of permeable paving.

Figure 3-2. An application of permeable paving

3.3 Subsurface Chamber Stormwater Management Systems

Subsurface chamber systems are designed to function as stormwater detention, retention, infiltration and/or first-flush storage. These component systems come in dimensions that make them easy to configure for most sites. Their shape makes them durable and able to be placed under roads and parking lots with adequate cover. Concrete chambers are an alternative that can also be used with minimal cover requirements. Figure 3-3 is an illustration of a subsurface chamber stormwater management system installed under a parking lot.

Figure 3-3. Subsurface chambers under a parking lot

3.4 Hydrodynamic Devices

Hydrodynamic devices rely on the energy and velocity of stormwater flow to remove sediment, debris, floatables and oil. Hydrodynamic devices function to improve the quality of stormwater that flows through the stormwater system before it is discharged to the receiving waters.

One configuration utilizes baffles and chambers to rotate the flow and create a vortex, which causes the heavier elements in the flow to collect in the center of the chamber. These systems can also incorporate weirs and orifices to further reduce the velocity of the flow to allow finer sediments to settle out and trap material lighter than water (e.g. oil). Another configuration uses baffles and weirs to lengthen the flow path and reduce the velocity of the storm flow through the system. These configurations allow sediment to settle and trap material lighter than water.

Hydrodynamic devices are typically installed below grade, making them especially suited for urban area and stormwater hotspots like gas stations islands, equipment storage aprons, and vehicle maintenance areas.

3.5 Rain Gardens and Subsurface Tanks

Bio-retention rain gardens and subsurface tanks (described in the previous section) are BMPs that are also suitable for implementation at commercial properties and public facilities.

Section 4

Green Space/Recreational Area BMPs

Green space and recreational areas offer opportunities to manage stormwater by using portions of the areas as detention basins and stormwater infiltration areas. These areas offer opportunities to attenuate stormwater quality and quantity as well as provide for reclamation and reuse.

Practices and technologies discussed for green space and recreational areas are reinforced turf surfaces and infiltration trenches. The BMPs that were presented in the previous sections can also be applied to green space and recreational areas.

4.1 Reinforced Turf Surfaces

Installation of reinforced turf surfaces helps to maintain higher stormwater percolation rates, and therefore less stormwater runoff. Reinforced turf surfaces are high-density polyethylene grid structures designed to house turf grass similar to those used for permeable paving. The grass reinforcement structure distributes loads from pedestrian and vehicle traffic to the base course. The individual cells in the grass pavers minimize grass and root compaction maintaining its infiltration capability. Figure 4-1 is an illustration of a reinforced turf surface.

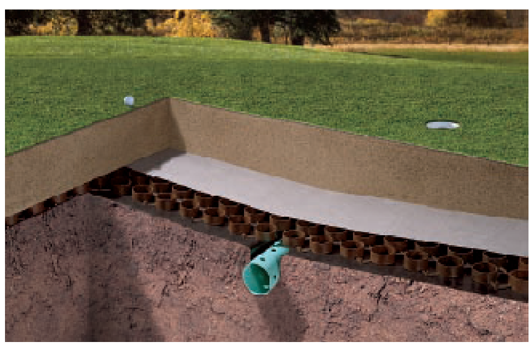


Figure 4-1. Illustration of a reinforced turf surface

4.2 Infiltration Trenches

Typical vadose zone infiltration trenches are wider than they are deep, and therefore are not considered injection wells by the Hawaii Department of Health (DOH). The trenches are backfilled with porous media. Water may enter at one end into a perforated pipe for distribution along the length of the trench or a riser pipe that allows water to enter at the bottom of the trench to prevent air entrainment. Figure 4-2 is an illustration of an infiltration trench. A disadvantage of infiltration trenches is that they cannot be backwashed and a severely clogged trench is ineffective. Therefore, reliable pretreatment is considered essential to maintaining the performance. Since vadose zone infiltration trenches allow for percolation of water through the vadose zone, water quality improvements commonly associated with soil-aquifer treatment can be expected.

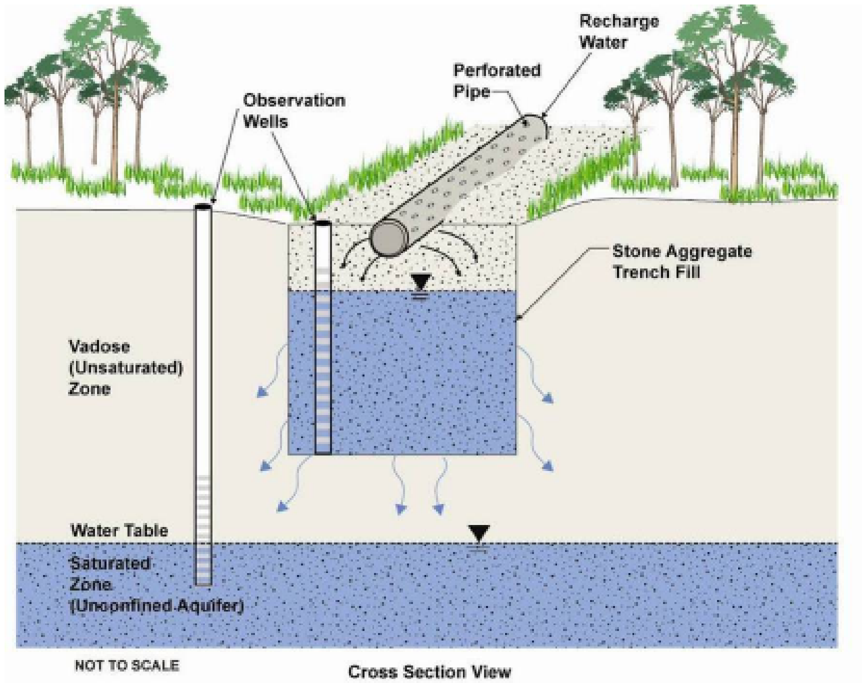


Figure 4-2. Cross section of an infiltration trench

Section 5
Conclusions

Olowalu Town's location adjacent to one of the most significant, accessible coral reef systems on the island of Maui dictates that stormwater quality BMPs be aggressively implemented to:

- Increase the volume of stormwater that infiltrates into the soil.
- Reuse stormwater where feasible.
- Improve the quality of stormwater that does run off.

The BMPs presented in this report will support these goals. Olowalu Town will develop stormwater BMP guidance documents for use by the designers of residential, commercial, public, and green space/recreational facilities within the community. Table 5-1 summarizes the stormwater quality BMPs for Olowalu Town and the areas of the community where they will be implemented.

Table 5-1. Stormwater BMPs for Olowalu Town

BMP	Applicable Olowalu Town Parcels				
	Residential		Commercial	Public Facilities	Green Space/ Recreational
	Single Family	Multi-Family			
Bio-retention rain gardens	♦	♦	♦	♦	♦
Rain barrels and rain tanks	♦				
Subsurface tanks		♦	♦	♦	♦
Vegetated roofs				♦	♦
Permeable paving			♦	♦	♦
Subsurface chamber stormwater management systems		♦	♦	♦	♦
Hydrodynamic devices			♦	♦	
Reinforced turf surfaces					♦
Infiltration trenches					♦

Section 6

Limitations

This document was prepared solely for Olowalu Town, LLC in accordance with professional standards at the time the services were performed and in accordance with the contract between Olowalu Town, LLC and Brown and Caldwell dated September 30, 2010. This document is governed by the specific scope of work authorized by Olowalu Town, LLC; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Olowalu Town, LLC and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

References

Cabugos, Leyla, Andrew J. Kaufman, Linda J. Cox, Tomoaki Miura, and Dawn Easterday. Feasibility of Rooftop Landscaping with Native Hawaiian Plants in Urban Districts of Hawaii. Proceedings or Fifth Annual Greening Rooftops for Sustainable Communities. http://www.botany.hawaii.edu/gradstudentpages/Grad_Student_Pubs/Cabugosetal2007.pdf. 2007.

United States Bureau of Reclamation (USBR). A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaii. December 2008.