

West Maui Recycled Water Verification Study



Prepared for:
County of Maui, County Council

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**West Maui Recycled Water Verification Study
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CHAPTER 1 INTRODUCTION

The West Maui Recycled Water Verification Study, is the third and final in a series of verification studies that identify options for increasing the use of recycled water from the County of Maui's Wastewater Reclamation Facilities (WWRFs) on the island of Maui. The South Maui R-1 Recycled Water Verification Study identified expansion opportunities with estimated costs and prospective recycled water customers in the South Maui area. That study was completed and transmitted to the County Council in December, 2009. The Central Maui Recycled Water Verification Study identified the components and estimated costs required for both an R-1 upgrade to the Kahului WWRF as well as options for developing a recycled water distribution system in Central Maui and the prospective customers that could be served. That study was completed and transmitted to the County Council in December, 2010. Both of the previous studies were required by budget provisions as required by the County Council. This study was prepared as plans are underway to expand R-1 water production at the Lahaina WWRF.

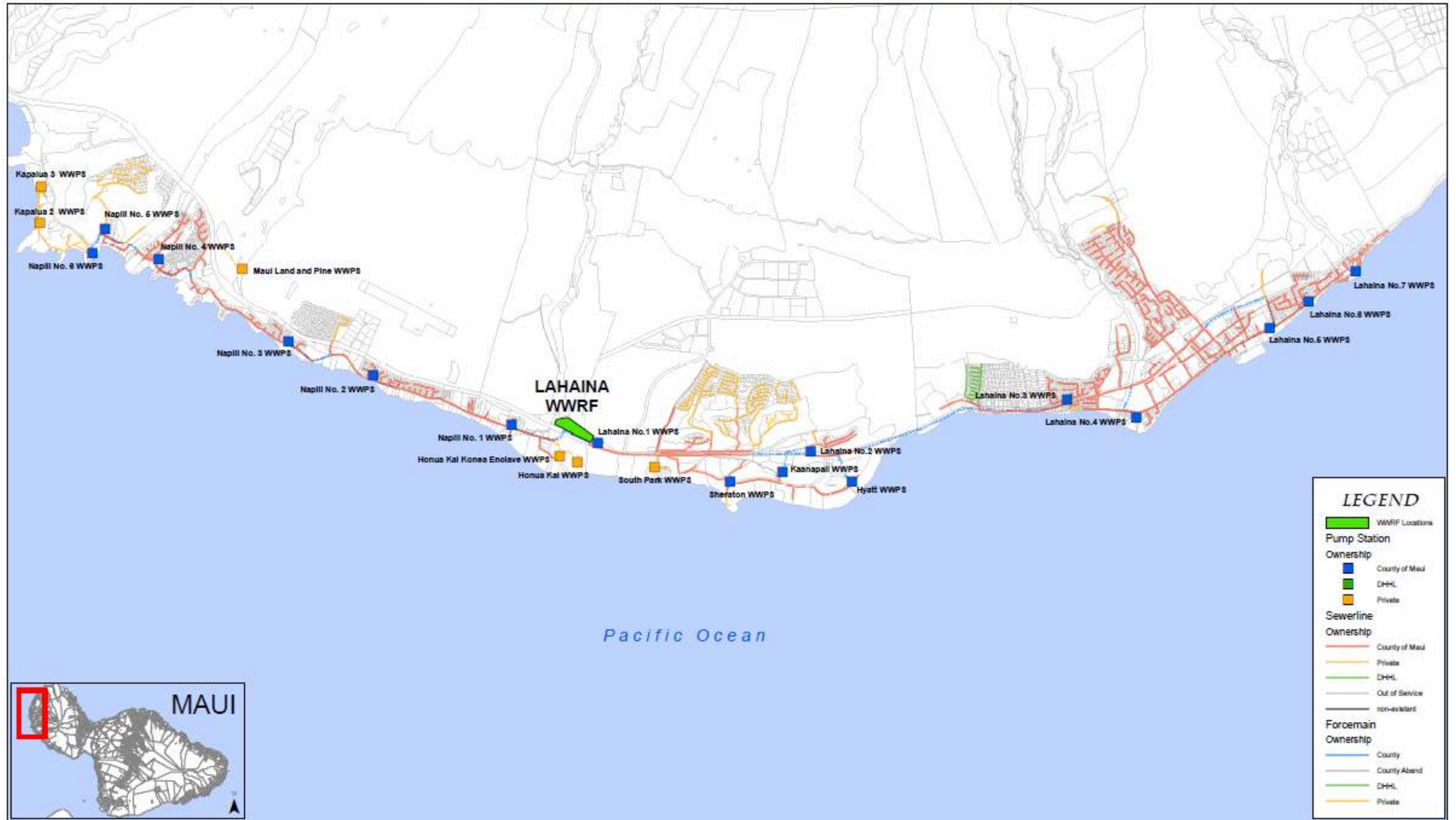
Background

The Lahaina WWRF serves the West Maui area from Kapalua to Puamana (**Figure 1-1**). The current dry weather treatment capacity is 9.0 million gallons per day (mgd). The current average dry weather flow is 4.2 mgd however only a portion of the facility's effluent is treated to R-1 water quality. R-1 water is the highest quality of recycled water identified by the State of Hawaii's Department of Health. It can be used for a multitude of purposes with very few restrictions. During the peak summer demand period, up to 40% of the current wastewater flow or 1.7 mgd of R-1 water, is reused from the Lahaina WWRF. The two reasons preventing more R-1 water from being produced and reused from the facility are 1) not enough R-1 disinfection capacity and 2) the lack of a fully pressurized distribution system.

The production of R-1 water is currently limited to 2.0 mgd because there is only a single ultra violet (UV) disinfection channel at the Lahaina WWRF. At present, however, design and construction projects are underway to upgrade the existing UV channel to be more efficient and to add additional channel(s) so the facility's R-1 capacity will be increased to 7.5 mgd.

Ultraviolet (UV) system improvements are currently in the design phase with construction scheduled in FY 2013. Funding for the design and construction of 2.5 mgd of UV capacity will be provided by the Wastewater Reclamation Division (WWRD). Funding for the design and construction of 5.0 mgd of UV capacity, as well as, the design of an elevated 1.0 million gallon (MG) R-1 water storage tank and related components, is being contributed by Intrawest, the developer of the Honua Kai Resort. In exchange for this contribution, the County of Maui has agreed to make 185,000 gallons per day of R-1 water available for use by the Honua Kai Resort for irrigation of the resort's landscaping. The Honua Kai Resort has tapped into the 16" R-1 water line that is in place along Honoapiilani Highway and has been utilizing the R-1 water since June, 2009. Due to the current absence of a fully pressurized R-1 water distribution system, R-1 water can only be provided to the Honua Kai Resort when the Lahaina WWRF is pumping R-1 water to the Kaanapali Resort's golf course R-1 water reservoir.

FIGURE 1-1: LAHAINA WWRF LOCATION AND SERVICE AREA
LAHAINA WASTEWATER RECLAMATION FACILITY



Facility Location and Service Area

1 Inch = 0.65 miles
 1 Inch = 3,439 feet

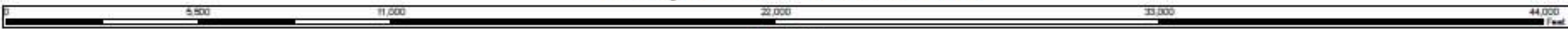


Figure 1-1
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Two separate R-1 water distribution systems are served by the Lahaina WWRF. The original system was built in the 1970's and was used to deliver recycled water to an open reservoir at the 700 foot elevation for Pioneer Mill's sugar cane fields. In 2002 this system was modified to deliver water to an open reservoir at the 300 foot elevation for Maui Land and Pineapple Company's pineapple fields. The existing 20 inch R-1 water force main that fills these two reservoirs is still available and in good condition but is not being used at this time since both Pioneer Mill and Maui Pineapple Company no longer farm in the area. The other R-1 water distribution system delivers up to 1.3 mgd of R-1 water through a 16 inch pipeline that is in place along Honoapiilani Highway to the Kaanapali Resort golf course reservoir. This pipe line is only pressurized when R-1 water pumps at the Lahaina WWRF are operating to fill the reservoir. The 20 inch line and the 16 inch lines are adjacent to each other at the Lahaina WWRF. The County WWRD is currently developing a plan to connect these two pipe lines to create one fully pressurized distribution system.

The County of Maui's WWRD developed its water reuse program to proactively supplement Maui's limited water supplies and to reduce the use of injection wells for effluent disposal. To support this program, the County established an ordinance (Chapter 20.30 of the Maui County Code) that requires commercial properties to utilize recycled water for irrigation purposes if it is available.

The water reuse program is currently funded through a combination of recycled water fees and sewer user fees. To make the R-1 water competitive with other conventional water sources, sewer user fees pay for approximately 75% of program costs while recycled water user fees account for the remaining 25%. These costs include debt service and operation/maintenance expenses. Any new infrastructure is paid for by increases in sewer user fees,

Fees for recycled water service are set in the County's annual budget. The recycled water consumer classes with respective rates for fiscal year 2012 are shown in **Table 1-1**.

**Table 1-1
Recycled Water Consumer Classes and Rates**

Consumer Class	Rate (\$ per 1,000 gallons)
Major Agriculture	\$ 0.15
Agriculture	\$ 0.33
All Others	\$ 1.28

Chapter 20.30 also has included an "Avoided Cost" clause that allows the consumers to pay the same rate that they pay for their respective non-potable water sources if that rate is less than the County's current consumer class recycled water rate.

Objectives

The main purpose of this report is to identify and evaluate options for expanding the County of Maui's R-1 water distribution system in the West Maui area. Such action would replace current or projected future potable water use at commercial properties and reduce the use of injection wells for effluent disposal.

Report Outline

The remainder of this report includes the following chapters:

- Chapter 2 addresses the issue of recycled water quality with regard to the ongoing challenge of excessive salinity in the recycled water originating from the Lahaina WWRF.
- Chapter 3 identifies options for expanding the Lahaina WWRF's R-1 water distribution system. Each option that is identified lists commercial properties that could be served, the peak volume of R-1 water that each property requires and the estimated cost for developing the required infrastructure to deliver the R-1 water to these properties.
- Chapter 4 provides a summary of the expansion opportunities.

CHAPTER 2 RECYCLED WATER QUALITY

An ongoing challenge with regards to utilizing R-1 water from the Lahaina WWRF for landscape and agricultural irrigation is excessive salinity. Excessive salinity in irrigation water will result in sodium accumulating in soils. This condition will restrict osmotic uptake of water to the irrigated plants and could cause burning, yellowing or wilting of plant leaves and vegetation. Salinity begins with the source water for the West Maui area, as the water has a higher salinity than other island sources. This base value is then increased by ground water intrusion into the County's wastewater collection system. Ground water near the coast is heavily impacted by sea water. The Front Street area in particular has been identified as the main location of ground water intrusion. This sewer line was installed in the 1940's. Since the sewer line is generally below sea level, salt water leaks into failed pipe joints and cracks in the pipe that have developed over the years. Beyond the County sewer system, private sewer laterals are also contributing salty ground water to the collection system.

The County's Wastewater Reclamation Division (WWRD) has made efforts to reduce ground water intrusion into the Front Street Collection system. Intrusion points have been identified by conducting sampling and performing total chloride tests as well as by performing closed circuit television inspections of the sewer line. In the 1990's, defective pipe joints were grouted to reduce the salt water leaking into the collection system. This effort resulted in a reduction in chloride levels in the Lahaina WWRF's R-1 water from approximately 800 mg/L to 600 mg/L. Another project completed in 2009 involved the relining of select portions of the Front Street sewer line with cured in place pipe (CIPP). This project resulted in a chloride reduction from approximately 600 mg/L to 550 mg/L. Additional areas of the collection system along Front Street are scheduled to be repaired or replaced in the near future.

As a comparison, chloride levels in the recycled water from the Kihei WWRF are typically in the 190-200 mg/L range. Monsanto utilizes R-1 water from the Kihei WWRF for seed corn irrigation but is unable to utilize R-1 water from the Lahaina WWRF due to its excessive salinity.

Once the Lahaina WWRF's R-1 water distribution system is fully pressurized, commercial properties within 100 feet of the system must connect and utilize R-1 water for landscape irrigation as required by Chapter 20.30 of the Maui County Code. A concern is that landscapes at these properties, which have been irrigated for years with low saline potable water, may suffer when irrigation commences with much higher saline R-1 water. The best approach to reduce salinity levels is to locate areas of salt water intrusion into the wastewater collection system and repair them. This approach however, will take time and financial resources and still does not address the issue of private sewer laterals that are defective and allowing salt water to enter the County's wastewater collection system. A method that is being successfully employed by the Honua Kai Resort is to install a "fertigation" system. Such a system injects gypsum into the R-1 water before it enters the resort's irrigation system. Gypsum contains calcium which improves soil percolation rates. Improved percolation rates allow sodium to more readily drain from the root zone areas of the landscape plants. This added step for users will require investment by the property owners. Commercial properties that are required to use the R-1 water from the Lahaina WWRF per MCC 20.30 may elect to exercise

Section 20.30.080C that allows recycled water customers to recover their cost to retrofit their irrigation systems to accommodate recycled water. This section reduces the recycled water rate by one-half until all retrofit costs have been recovered by the consumer. This places the more of the cost to produce and distribute R-1 water back on to the general sewer users. Other methods utilized to flush sodium from the root zones include excessive irrigation rates, occasional use of potable water for irrigation and blending potable or stream water with the R-1 water. Seasonal heavy rain fall events also are helpful in flushing accumulated sodium from soils.

CHAPTER 3 R-1 WATER DISTRIBUTION SYSTEM OPTIONS

The WWRD has explored several options for expanding the Lahaina WWRF's existing R-1 water distribution system. Each option identifies the commercial properties that could be served, the estimated peak volume of R-1 water that each property requires and the estimated cost for developing the required infrastructure to deliver the R-1 water to these properties. The estimated peak R-1 water demands were obtained either from each project's landscape architect, from previous reports prepared by consultants or by using the standard irrigation requirement of 6,315 gallons per acre per day. Cost estimates were based on previous engineering cost estimates from planning studies that were conducted by consultant engineering firms. Components of the cost estimates included linear feet of pipe, service laterals, R-1 storage tanks, ultra-violet disinfection system upgrades, and R-1 water pumping station installations or upgrades. **Appendix "A"** provides a detailed explanation on how the cost estimates for each option were determined. **Figure 3-1** shows the locations for the potential R-1 distribution system expansions and the projects that they would serve.

Option 1 – Construct R-1 Water Storage and Additional Ultra Violet Disinfection Capacity

Storage is a critical component of water distribution systems. The Lahaina WWRF currently has very little storage capacity at the facility and no County-owned offsite elevated storage. The expansion of recycled water use will require several components to be constructed. These facilities include: (1) An elevated 1.0 MG reservoir at approximately the 200 foot elevation . (2) a tie into the existing 20 inch R-1 water line that previously served the two higher elevation reservoirs. (3) an interconnection of the existing two R-1 water force mains at the Lahaina WWRF, (4) a 2.0 MG R-1 storage reservoir at the Lahaina WWRF, (5) new pumps to deliver R-1 water to the storage tank, and (6) the installation of a pressure sustaining valve at the Kaanapali Golf Course reservoir. These components along with expanded UV disinfection will result in a fully pressurized R-1 water distribution system.

The 1.0 MG R-1 storage tank will be located on land owned by the Department of Hawaiian Home Lands (DHHL). A tentative agreement has been drafted between the County and DHHL that will allow the County to utilize two acres of land for the location of the storage tank. Enough land area is available for an additional 1.0 million gallon tank if future R-1 water demand increases. In exchange for use of the 2 acre parcel of land, DHHL will require that the County reserve R-1 water capacity for their planned future commercial and industrial developments (see Option 5).

A pressurized distribution system will allow commercial properties that are in the vicinity of the existing 16" R-1 water pipe line along Honoapiilani Highway to connect to the system and have access to the water. Currently this pipe is only pressurized when water is being pumped to the Kaanapali golf course R-1 water reservoir. This severely limits the availability of R-1 water to commercial properties that are adjacent to the R-1 water pipe line. Thus, the construction of the improvements listed above must be

completed in order to increase the volume of recycled water produced and distribute it to prospective customers.

All or partial funding for the construction of the elevated 1.0 MG reservoir and its related components or the storage reservoir at the Lahaina WWRF could possibly come from Starwood, the developer of North Beach Lot #3 (as well as lots 1 & 2) and to a lesser extent, the Hyatt Regency Resort. Both developments were required as a condition of development to contribute their “fair share” to recycled water system improvements. A concern is that the development of Starwood’s North Beach Lot #3 may take longer than the WWRD’s timetable for creating its elevated R-1 water storage reservoir. The County may have to utilize its own funding mechanisms such as an SRF loan or a government bond to pay for the construction of R-1 water storage. Another possible source of funds is a federal grant from the Bureau of Reclamation (BOR). The grant was offered to the County in 2009 but had to be declined because projects were not designed and the County was not prepared to come up with the required 75% matching funds. Since that time, the BOR had decided that it will allow contributions from developers to be counted as part of the County’s required matching funds. The storage reservoir at the Lahaina WWRF is important from an operational cost perspective as it would allow the facility to store recycled water during the day when most of the wastewater is processed and then pump the R-1 water to the higher elevation reservoir during the later evening and early morning hours when electricity rates are lower. An existing unused 1.35 MG filter backwash basin at the Lahaina WWRF could be potentially converted to R-1 water storage. The basin needs to be evaluated by a qualified engineering firm to determine if it would be suitable for R-1 water storage. If suitable, it represents a potential cost effective option to increase R-1 water storage capacity at the facility.

The addition of more UV disinfection capacity and the development of a fully pressurized distribution system must be completed before any of the other options discussed in this study can be implemented. Projects that could be provided with R-1 water once the UV production capability is increased and additional storage capacity and its related components are constructed are listed in **Table 3-1**. Peak R-1 water demands for each property and a cost estimate for the required improvements are also included.

**Table 3-1
Option 1 – Properties Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Maui Kaanapali Villas	2,000	--
Royal Lahaina Resort	56,000	--
International Colony Club	5,200	--
Outrigger Maui Eldorado	16,100	--
Kaanapali Ocean Resort (N. Beach Lot #1)	45,000	--
Kaanapali Ocean Resort (N. Beach Lot #2)	35,000	--
Starwood (N. Beach Lot #3)	43,000	--
Honua Kai (N. Beach Lot #4)	185,000	--
County of Maui, Parks. Dept. Shoreline Access	1,300	--
Total Option 1	388,600	14,100,000

Option 2 – Extend System from Honoapiilani Highway to Kaanapali Resort

The R-1 water line along the Honoapiilani Highway could be extended to the Kaanapali Resort where the R-1 water would be used to irrigate the landscaping at the various resorts, hotels and other commercial properties. Potable water is used for virtually all of the landscaped areas at these properties thus approximately 340,000 gallons per day could be displaced by implementation of this option.

Required improvements for this option include approximately 10,500 linear feet of transmission line and eight service laterals. **Table 3-2** provides estimated R-1 water usage and cost information for this option.

**Table 3-2
Option 2 - Properties Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Hyatt Regency	93,000	
Kaanapali Ali'i	60,000	
Kaanapali Beach Hotel	36,000	
Maui Marriott	36,000	
Westin Maui	60,000	
Whaler's Village	5,000	
Whaler	20,000	
Kaanapali Royale	19,200	
Sheraton	30,000	
Total Option 2	359,200	6,020,000

Option 3 – Extend System from Honoapiilani Highway to Honokowai

Option 3 involves extending the R-1 water line along Honoapiilani Highway to Honokowai where R-1 water could be used to irrigate landscapes at condominiums and a shopping center. Required improvements include approximately 3,600 linear feet of transmission line and six service laterals. **Table 3-3** provides estimated R-1 water usage and cost information.

**Table 3-3
Option 3 – Properties Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Papakea Resort	30,000	
Resort Quest Kaanapali Shores	20,000	
Kaanapali Beach Vacation Resort	25,000	
Maui Kai	5,000	
Mahana	10,000	
Honokowai Shopping Center	4,000	
Total Option 3	94,000	2,180,000

Option 4 – Extend System from Honoapiilani Highway to Upper Kaanapali Condominiums

An extension of the existing R-1 water distribution system to upper Kaanapali area along Kaka`alaneo Road would allow existing and planned future condominium complexes as well as a tentatively planned hospital to utilize R-1 water for landscape irrigation. Required infrastructure includes approximately 3,000 linear feet of additional transmission line and five service laterals. Due to the fact that these projects are at a higher elevation, each property will need to install a booster pumping system to increase the R-1 water pressure so that their respective irrigation systems would function properly. This system, if extended further mauka, could ultimately provide R-1 water service to projects planned by Kaanapali Land Development Company as part of the Kaanapali 2020 plan although it is uncertain at this time when the various phases of the plan will be implemented. The cost of this mauka extension is not included in this study due to the uncertainty associated with the Kaanapali 2020 development. The extended system could also potentially provide R-1 water to the Kaanapali Coffee plantation. Coffee however, is very susceptible to salinity thus it is unlikely that the R-1 water from the Lahaina WWRF would be suitable for this type of agricultural crop unless it is significantly diluted with low saline ditch water. The plantation also is situated between the 200 and 500 foot elevation thus much of it is higher than this proposed option is capable of delivering R-1 water to without additional pumping and storage. **Table 3-4** provides estimated R-1 water use and cost information.

**Table 3-4
Option 4 – Properties Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Kaanapali Plantation	63,000	
Kaanapali Hillside	16,000	
The Vintage at Kaanapali*	50,000	
The Summit at Kaanapali*	15,000	
West Maui Hospital*	40,000	
Total Option 4	184,000	3,100,000

*Future developments

Option 5 – Extend System from Lahaina WWRF to Department of Hawaiian Home Lands Commercial/Industrial Developments

As explained in the Option 1 discussion, the County of Maui is planning to utilize two acres of land owned by DHHL that is adjacent to the existing 20 inch R-1 water line for the location of an R-1 recycled water storage tank. This tank would be located at approximately the 200 foot elevation and provide water pressure for recycled water projects at lower elevations. A tentative agreement has been reached between the County and DHHL for the use of this land. As part of this agreement, the County is obligated to reserve future R-1 water capacity for DHHL’s planned commercial/industrial

developments that will be in close proximity to the Lahaina WWRF. This agreement will be finalized once the actual location of the storage tank(s) are determined by a geotechnical analysis that is currently being performed by the consultant firm that is also designing the UV disinfection system improvements and the R-1 water storage and delivery system. **Table 3-5** provides estimated R-1 water use and cost information for this option.

**Table 3-5
Option 5 - Properties Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
DHHL Commercial	110,000	
DHHL Industrial	25,000	
Total Option 5	135,000	510,000

Option 6 – Use Existing System to Deliver R-1 Water to Private Reservoir for Agricultural Irrigation

The existing R-1 water pipe line that was previously used to deliver R-1 water to Maui Pineapple Company’s 300 foot elevation reservoir could be used again to provide irrigation water to an agricultural operation. A company by the name of UTS Bioenergy has met with County officials in April, 2011 and expressed an interest in using R-1 water for the growth of a biofuel crop such as corn for the production of alternative energy. Due to the salinity of the R-1 water, it will need to be blended with stream water from the Honolua Ditch to a 25% R-1 content to lower the salinity to a level that will not damage the crop. UTS Bioenergy will need to gain DHHL’s permission to use the land around the reservoir as well as land owned by Maui Land & Pineapple Company above the West Maui Airport. Approximately 800 acres of land is required by UTS Bioenergy for their operation. The peak daily irrigation demand for 800 acres is approximately 3.43 mgd but since the R-1 water would need to be diluted by 75% with ditch water, the peak R-1 water demand would be reduced to approximately 0.86 mgd.

This option could be exercised independently of the previous five options discussed in this report and existing pumps at the Lahaina WWRF could be used to deliver water to the existing 300 foot reservoir. However, once the 1.0 MG reservoir at the 200 foot elevation is constructed and placed into service, it will be relied upon to provide pressure to projects at lower elevations. This will require that another pumping system be in place to pump R-1 water from the proposed 200 foot storage tank to the existing 300 foot reservoir. The installation of the auxiliary pumping system as well as the costs to operate and maintain it would be the responsibility of UTS Bioenergy. **Table 3-6** provides the estimated R-1 water use for this proposed project.

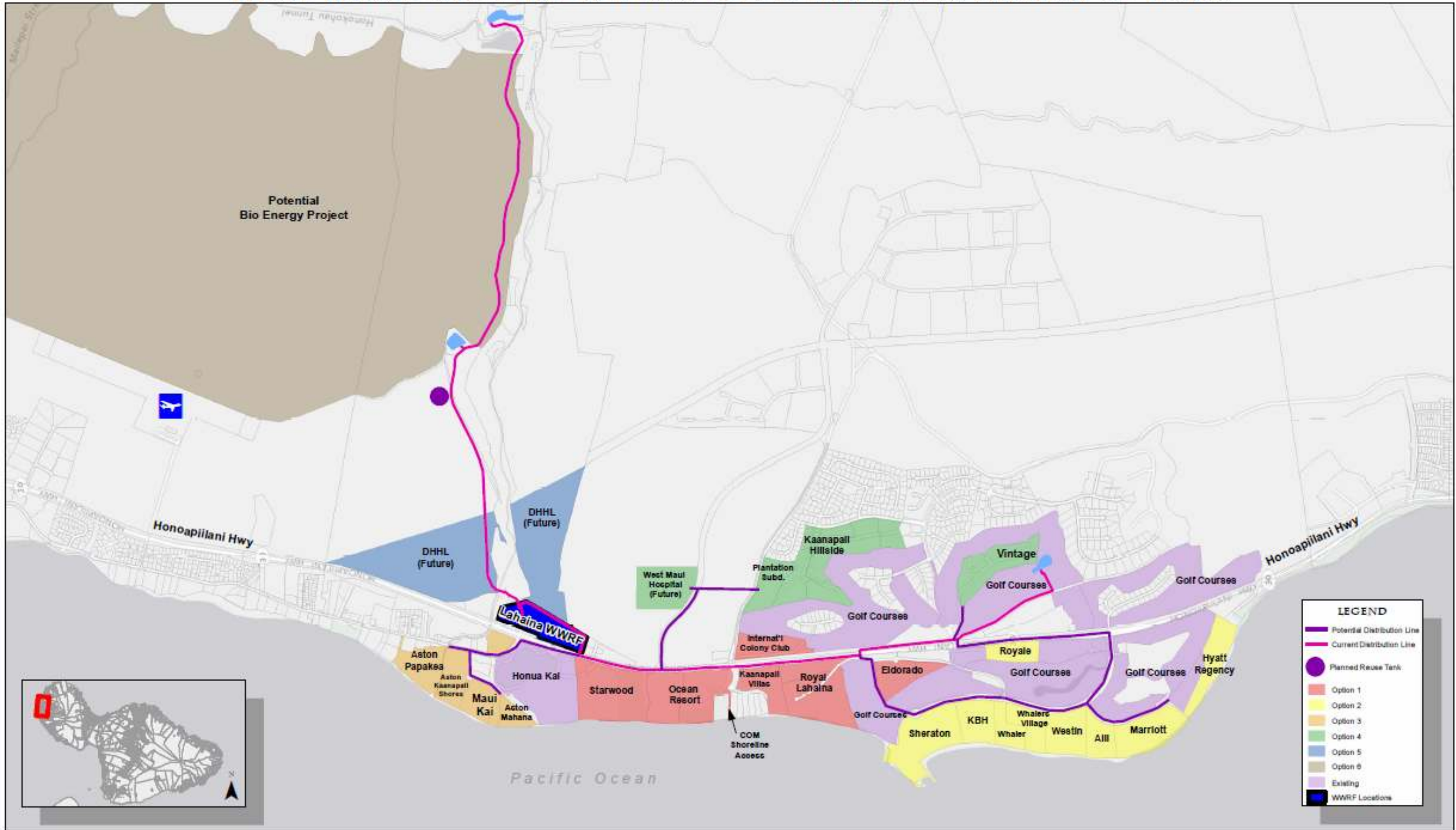
**Table 3-6
Property Served**

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
UTS Bioenergy (Proposed)	860,000	
Total Option 6	860,000	0

Potential Project

The Hawaii Housing Finance and Development Corporation's Villages of Leialii Affordable Housing project is in the process of evaluating whether it will develop its own wastewater reclamation facility and recycled water system or install a sewer system to the County's Lahaina WWRF as well as a recycled water line back to the project. The Villages of Leialii would generate 1.02 to 1.25 mgd of wastewater and would be required to accept the same volumes of recycled water from the Lahaina WWRF. The cost, which is the responsibility of the developer, of constructing the recycled water distribution system would cost \$51 to \$60 million depending on the concept selected. Improvements to the Lahaina WWRF would also be required since the facility would need to add wastewater treatment capacity to accommodate the wastewater from this project. The WWRD has recommended that it would be more cost effective for the Villages of Leialii to build its own wastewater facility and reuse the recycled water from the facility within its boundaries for landscape irrigation. Thus, this potential project is not included in this report as an option to be considered for recycled water system expansion.

WEST MAUI POTENTIAL R-1 RECYCLED WATER EXPANSION OPTIONS



LEGEND

- Potential Distribution Line
- Current Distribution Line
- Planned Reuse Tank
- Option 1
- Option 2
- Option 3
- Option 4
- Option 5
- Option 6
- Existing
- WWRF Locations



1 inch = 1,580 feet / 1 inch = 0.25 miles



Created By: Maui County Waterworks, LLC

Figure 3-1
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CHAPTER 4 SUMMARY OF R-1 WATER DISTRIBUTION SYSTEM DEVELOPMENT OPPORTUNITIES

The objectives of the County of Maui's water reuse program are to displace current or projected future potable water that is used for irrigation at commercial properties and reduce the use of injection wells for effluent disposal. The increase in peak volume of R-1 water that could be used from the Lahaina WWRF if the first five options discussed in this report were implemented would be approximately 1.2 mgd. Adding this volume to the existing 1.7 mgd peak demand of R-1 water currently being used would mean the total peak R-1 water demand could be 2.9 mgd. Adding the additional volume of 0.86 mgd of the proposed biofuel project would increase the total peak R-1 water demand to approximately 3.8 mgd.

The lack of large water users (agriculture, golf course etc.) nearby the Lahaina WWRF limits the volume of R-1 water that can be reused from the facility. Pumping R-1 water to the 300 foot elevation reservoir where the water could be used for some type of agricultural operation is possible but does not seem likely at this point in time. The land is owned by DHHL and any agricultural endeavor will need to obtain an agreement to use the land in the area. Additionally, due to the salinity of the R-1 water, it would most likely need to be blended with stream water from the Honolulu Ditch as a means to lower the salinity so make it usable. Blending water sources would reduce the volume of R-1 water that could be used by any agricultural operation.

Elevated storage as discussed in the Option 1 segment of this report is necessary to create the appropriate pressure that will allow even distribution of recycled water throughout the nearby community. In-plant storage also must be increased to allow the Lahaina WWRF to store R-1 water during the day and economically pump it during the evening hours when electrical power costs are less. Thus, Option 1 must be constructed and in operation before Options 2, 3, 4 and 5 can be considered for implementation.

As pointed out in the South and Central Maui Recycled Water Verification Studies, irrigation demands decrease significantly during the cooler, winter months. This fact will result in excess recycled water being available during these cooler, wetter periods. This means that while the use of injection wells at the Lahaina WWRF will be reduced during the peak R-1 water use summer and fall seasons, there will always be more recycled water that will need to be disposed of to the injection wells during the cooler, wetter winter season. It is not uncommon for R-1 usage to be cut in half during the winter and spring season.

Table 4-1 summarizes the options discussed in this report. Included is the cost, gallons of potable water displaced, cost per gallon displaced and general comments about each option.

**Table 4-1
Option Summary of R-1 Water Use and Potable Water Displacement**

Option	Description	Estimated Cost	Gallons of Potable Water Displaced/Day	Cost/Gallon Potable Water Displaced/Day	Comments
			Total R-1 Gallons/Day	Cost/Total R-1 Gallons/Day	
1	Construct R-1 Water Storage & Additional UV Disinfection Capacity	\$14,100,000	407,800	\$34.58	<ul style="list-style-type: none"> Impacts nine (9) projects (5 laterals installed). Includes core production & distribution system components that must be constructed before Options 2, 3, 4 & 5 are feasible.
			407,800	\$34.58	
2	Extend System to Kaanapali Resort	\$6,020,000	340,000	\$17.71	<ul style="list-style-type: none"> Impacts nine (9) projects. Option 1 must be constructed before this option is feasible.
			340,000	\$17.71	
3	Extend System to Honokowai	\$2,180,000	94,000	\$23.19	<ul style="list-style-type: none"> Impacts six (6) projects. Option 1 must be constructed before this option is feasible.
			94,000	\$23.19	
4	Extend System to Upper Kaanapali Condominiums	\$3,100,000	184,000	\$16.85	<ul style="list-style-type: none"> Impacts five (5) projects. Requires booster pumping by projects Option 1 must be constructed before this option is feasible.
			184,000	\$16.85	
5	Extend System to DHHL Developments	\$510,000	135,000	\$3.78	<ul style="list-style-type: none"> Impacts two (2) projects. Option 1 must be constructed before this option is feasible.
			135,000	\$3.78	
6	Deliver R-1 Water to Proposed Biofuel Agriculture	\$0	0	n/a	<ul style="list-style-type: none"> Impacts one (1) project. Requires additional pumping of R-1 water
			860,000	\$0.00	

Notes:
a. Costs are for CIP construction only. No operational/maintenance/finance costs are included.
b. Detailed estimates can be found in Appendix "A".

Appendix A – Cost Estimates

Option 1 Cost Estimate

Construct R-1 Water Storage and Additional Ultra Violet Disinfection Capacity

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	UV 2.5 mgd Additions	3	ea.	\$1,400,000	\$4,200,000
2	1 MG Storage	3	ea.	\$2,650,000	\$7,950,000
3	R-1 lateral/meter	6	ea.	\$30,000	\$180,000
4	Force Mains Connection	1	ea.	\$150,000	\$150,000
5	Pressure Sustain Valve	1	ea.	\$50,000	\$50,000
6	Pump Station Upgrade	1	ea.	\$300,000	\$300,000
7	Design	1	ea.	\$1,300,000	\$1,300,000
TOTAL OPTION 1 COST					\$14,130,000

Option 2 Cost Estimate

Extend System from Honoapiilani Highway to Kaanapali Resort

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	10,500	LF	\$500	\$5,250,000
2	R-1 lateral/meter	8	ea.	\$30,000	\$240,000
3	Design	1	ea.	\$500,000	\$500,000
TOTAL OPTION 2 COST					\$5,990,000

Option 3 Cost Estimate

Extend System from Honoapiilani Highway to Honokowai

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	3,600	LF	\$500	\$1,800,000
2	R-1 lateral/meter	6	ea.	\$30,000	\$180,000
3	Design	1	ea.	\$200,000	\$200,000
TOTAL OPTION 3 COST					\$2,180,000

Option 4 Cost Estimate

Extend System from Honoapiilani Highway to Upper Kaanapali Condominiums

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	5,500	LF	\$500	\$2,750,000
2	R-1 lateral/meter	5	ea.	\$30,000	\$150,000
3	Design	1	ea.	\$200,000	\$200,000
TOTAL OPTION 4 COST					\$3,100,000

Option 5 Cost Estimate

Extend System from Lahaina WWRF to Department of Hawaiian Home Lands
Commercial/Industrial Developments

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	500	LF	\$500	\$250,000
2	R-1 lateral/meter	2	ea.	\$30,000	\$60,000
3	Design	1	ea.	\$200,000	\$200,000
TOTAL OPTION 5 COST					\$510,000