

Central Maui Recycled Water Verification Study



Prepared for:
County of Maui, County Council

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CHAPTER 1 – INTRODUCTION

This study was prepared as required by a fiscal year 2011 budget provision that stated:

“Provided, that prior to expending funds the Department of Environmental Management shall work with the Department of Water Supply and private entities on a new verification study that provides the Council with future alternatives for the transmission and optimization of R-1 recycled water from the Kahului Wastewater Reclamation Facility (WWRF) in order to provide a source of irrigation water for existing and planned future projects, and to provide alternatives to the use of injection wells. The Department of Environmental Management shall transmit a status report regarding this matter to the Council by January 1, 2011.”

This study includes data on the current status of R-2 recycled water usage in the Central Maui area, as well as, information regarding developing planned and future projects.

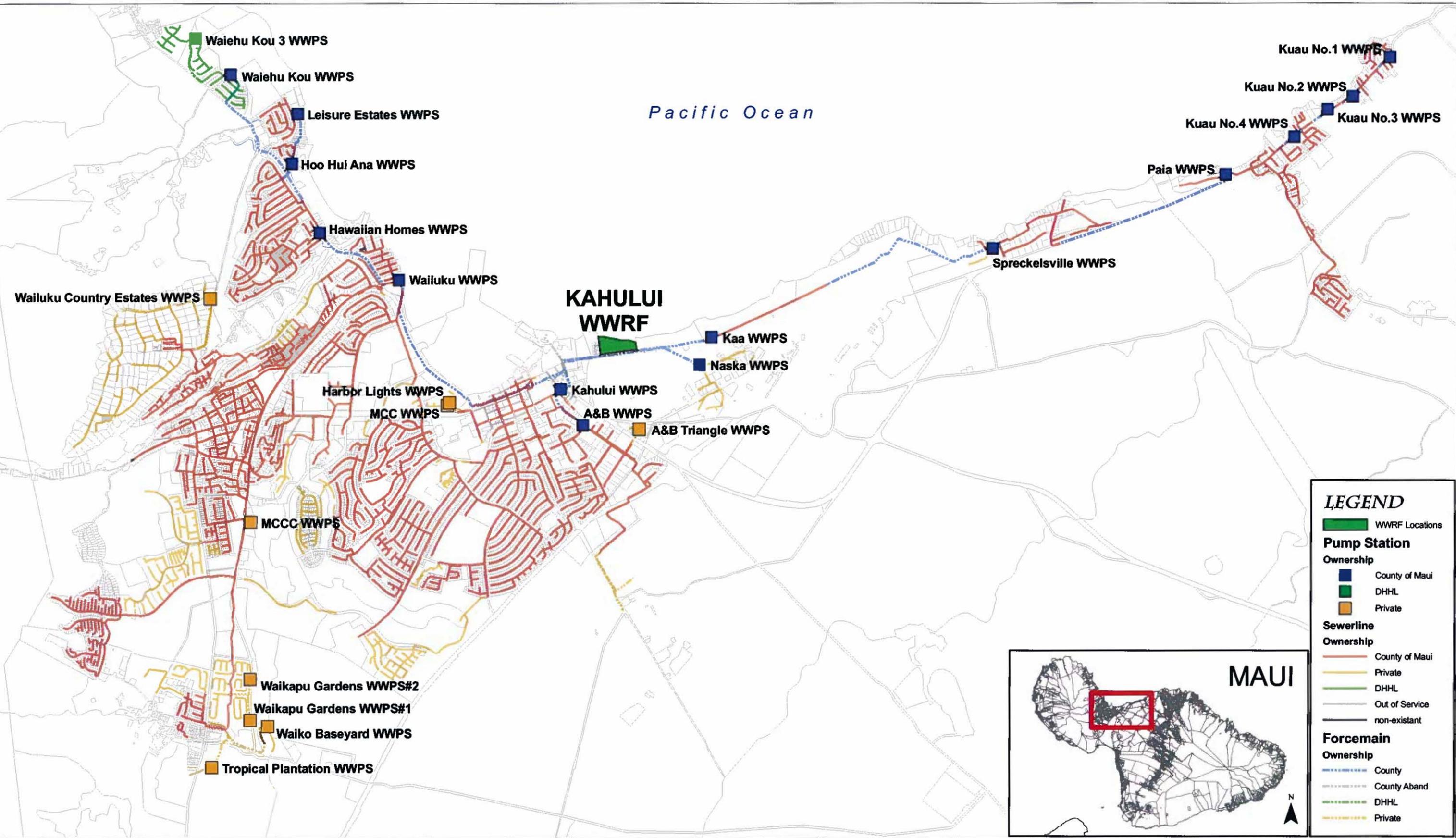
Background

The Kahului WWRF serves the Central Maui area from Waiehu to Kuau (**Figure 1-1**). The current dry weather flow capacity is 7.9 million gallons per day (mgd). Currently, all of the wastewater processed by the facility is treated to R-2 recycled water standards meaning that there are restrictions on its uses and applications. Key restrictions on the use of R-2 water via spray irrigation are that R-2 water can only be used at night and there must be 500 foot buffer zones between the area being spray irrigated and adjacent properties or roadways. In order for the recycled water from the Kahului WWRF to be utilized in the urban environment such as for spray irrigation at commercial properties, the facility would need to undergo an upgrade to enable it to produce R-1 water. An R-1 upgrade at Kahului WWRF would improve the facility's capability of consistently producing recycled water that meets or exceeds regulatory standards. It also allows greater flexibility of use for R-1 water customers.

While the Hawaii Department of Health (DOH) has approved the use of R-2 water for sugar cane irrigation, HC&S has indicated their preference for R-1 water due to its user flexibility and concerns about workers coming in direct contact with the recycled water.

The current average dry weather wastewater flow to the Kahului WWRF is 4.40 mgd. The volume of R-2 water reused from the facility ranges from 3 to 7% of the incoming wastewater flow. The daily average of R-2 water used is 0.2 mgd with most of the recycled water utilized within the Kahului WWRF for landscape irrigation and industrial uses. Some of the R-2 water is sold to construction companies that use it for dust control.

KAHULUI WASTEWATER RECLAMATION FACILITY



LEGEND

WWRF Locations

- Green square: WWRF Locations

Pump Station Ownership

- Blue square: County of Maui
- Green square: DHHL
- Orange square: Private

Sewerline Ownership

- Red line: County of Maui
- Yellow line: Private
- Green line: DHHL
- Grey line: Out of Service
- Black line: non-existent

Forcemain Ownership

- Blue dashed line: County
- Grey dashed line: County Aband
- Green dashed line: DHHL
- Yellow dashed line: Private

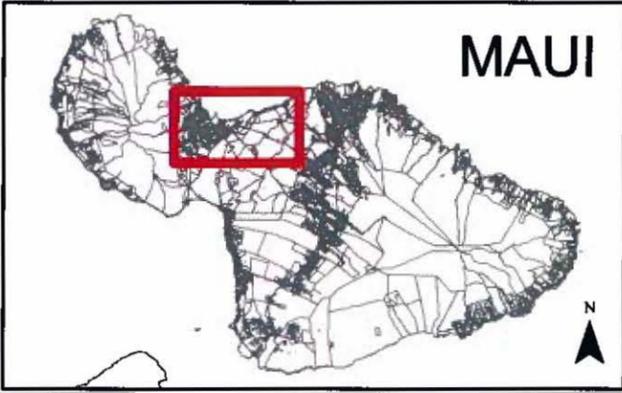


Figure 1-1
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The County of Maui's Wastewater Reclamation Division (WWRD) developed its water reuse program to proactively supplement Maui's limited water supplies and to reduce the use of injection wells for effluent disposal. To support this program, 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.

Currently, the water reuse program saves over 400 million gallons of potable water each year. The WWRD has developed R-1 water distribution systems in South and West Maui. In Central Maui however, a recycled water distribution system has not been developed. This is because the majority of commercial properties that could potentially be provided with recycled water currently utilize inexpensive non-potable water for their irrigation needs. Non-potable water sources used at these properties are brackish water wells or ditch water.

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 fees account for the remaining 25%. These costs include debt service and operation/maintenance expenses. Fees for recycled water service are set in the County's annual budget. The recycled water consumer classes with respective rates for fiscal year 2011 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 purpose of this report is to identify and evaluate options for (1) upgrading the Kahului WWRF to R-1 water capability and (2) identify the location of a recycled water distribution system in the Central Maui area. These actions would allow R-1 recycled water to replace current or projected future potable and/or non-potable waters used 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 provides a discussion on the required infrastructure and an estimated cost to upgrade the Kahului WWRF to R-1 water capability.
- Chapter 3 identifies options for developing a recycled water distribution system from the Kahului WWRF to various areas in the Central Maui region. Each option

that is identified lists commercial properties that could be served, the peak volume of recycled water that each property requires and the estimated cost for developing the required infrastructure to deliver the recycled water to these properties.

- Chapter 4 provides a summary of these opportunities.

CHAPTER 2 – KAHULUI WWRF R-1 WATER UPGRADE

The purpose of this chapter is to provide a cost estimate to upgrade the Kahului WWRF to R-1 water capability. As explained in Chapter 1 of this report, the Kahului WWRF currently produces R-2 recycled water. While R-2 water may be used for spray or drip irrigation of some agricultural crops, it has limited potential for landscape irrigation at commercial properties as most properties utilize spray irrigation and the Hawaii DOH requires 500 foot buffer zones for R-2 water applied via spray irrigation. Thus, an R-1 upgrade would be required at the Kahului WWRF if the recycled water from the facility was to be distributed to Central Maui commercial properties for landscape irrigation. While an R-1 upgrade would not be required if the recycled water was distributed to HC&S for irrigation of sugar cane or other crops, it would still be desirable since it would significantly increase the reliability of recycled water service as well as provide HC&S with more flexibility when utilizing the recycled water. With R-1 water, no buffer zones would be required and workers would be more at ease when coming in direct contact with this highly treated recycled water. In addition, HC&S has stated that the most desirable location to use the recycled water would be in the vicinity of Maui Lani towards Maalaea where seed cane is cultivated. The recycled water distribution system could be designed and constructed so that it provides R-1 water to commercial properties for landscape irrigation and then provides whatever excess R-1 water is left over to HC&S where it could be used for seed cane irrigation.

R-1 water is recycled water that is at all times oxidized, filtered, and then exposed to a high level of disinfection. Coagulation capability is required to remove excess solids, if present, from the recycled water prior to filtration and continuous turbidity monitoring is also required to insure that the turbidity of the recycled water is low enough to insure satisfactory disinfection. The Kahului WWRF utilizes activated sludge to achieve oxidation and the facility has existing traveling bridge sand filters that while approved for the production of R-1 water, are limited because the loading rate to these filters can not exceed 2 gallons per minute per square foot. The existing filter basins could be retrofitted with a coagulation system and another type of filter with a higher loading rate. Therefore, the equipment that would need to be installed to upgrade the Kahului WWRF to R-1 water capability includes a coagulation system, a filtration system, a turbidity monitoring system, an automatic diversion system for use when R-1 turbidity standards are not met and an ultra violet disinfection system.

Based on the above R-1 water equipment requirements, the budgetary construction cost estimates to upgrade the Kahului WWRF to R-1 water capability are shown below in Table 4-1. The R-1 water capacity after the upgrade would be 6.0 mgd. The addition of a third UV channel could increase the R-1 capacity to the facility's hydraulic and treatment capacity of 7.9 mgd.

Table 2-1: Budgetary Cost Estimate – Kahului WWRF R-1 Water Upgrade

Equipment	Number of Required Units	Cost Estimate
Coagulation System	1	\$300,000
Filtration System	1	\$1,600,000
Turbidity Monitoring System	2	\$25,000
Diversion System	1	\$240,000
UV Disinfection System	2	\$2,800,000
Budget Construction Cost Estimate		\$4,965,000

CHAPTER 3 – RECYCLED WATER DISTRIBUTION SYSTEM OPTIONS

There are essentially three options for developing a recycled water distribution system in the Central Maui area. **Figure 3-1** shows the locations for the potential R-1 water distribution systems and the properties that they would serve. All options include constructing R-1 storage and pumping at the Kahului WWRF as well as offsite elevated storage to create the required pressure for adequate R-1 water delivery. Appendix "A" provides a detailed explanation on how the cost estimates for each option were determined. The options are:

- Option 1: Develop a distribution system from the Kahului WWRF to Maui Lani where R-1 water could be used for landscape irrigation at commercial properties in the Kaahumanu Avenue vicinity. This option will create pressure through elevated storage and must be constructed before Options 2 and 3 are considered.
- Option 2: Develop a distribution system from the Kahului WWRF to Kanaha Beach Park and the Kahului Airport where R-1 water could be used for landscape irrigation.
- Option 3: Develop a distribution system from the Kahului WWRF to HC&S where R-1 water could be used for agricultural irrigation. This option could connect to an existing non-potable water distribution system previously constructed and utilized by Maui Land & Pineapple Company to deliver cannery wastewater to HC&S where it was used for seed cane irrigation.

Discussion of Options

Option 1: Develop Distribution System from Kahului WWRF to Maui Lani.

The distribution system would include a 1 MG storage tank and pumping station at the Kahului WWRF and have approximately 18,500 linear feet (3.5 miles) of R-1 water transmission pipe line. This line would extend from the Kahului WWRF up Kaahumanu Avenue to the Maui Lani development where an additional 1 MG storage tank and booster pump station would be located. Construction cost for installing the R-1 water pipe line will be high due to existing utilities, traffic and groundwater mitigation. Hotels, County parks and Maui UH College are just some of the commercial properties that could be provided with R-1 water with this alternative. Many of these properties utilize good quality brackish ground water for landscape irrigation thus potable water displacement will not be significant with this option. **Table 3-1** lists the projects that could be provided with R-1 water and the estimated construction cost associated with this option.

Table 3-1: Option 1 – Properties Served

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Ho`Aloha Park	12,630	--
First Hawaiian Bank	4,000	
Maui Seaside Hotel	15,800	--
Maui Beach Hotel*	19,850	--
Boys & Girls Club of Maui	32,500	--
Maui UH College*	94,730	--
Maui Botanical Gardens	18,950	--
War Memorial Complex*	63,150	--
Ke`Opulani Park*	360,000	--
Ka`ahumanu Avenue Median	25,260	--
Ka`ahumanu Center	44,200	--
Kaiser Permanente Wailuku	6,000	--
Maui Police Department	6,000	--
Kaiser Permanente Maui Lani	6,000	--
Baldwin High School	20,000	--
Dunes at Maui Lani Golf Course*	1,100,000	--
Maui Lani Park & Common Areas**	170,500	--
Total Option 1	1,999,570	\$24,022,000

*Currently utilizes brackish water.

** Future project with planned use of brackish water

Option 2: Develop Distribution System from Kahului WWRF to Kanaha Beach Park and Kahului Airport.

This option should be developed only after the core distribution components identified in Option 1 are completed. R-1 water storage both at the Kahului WWRF and at the elevated location in the vicinity of the Maui Lani Development is required before Option 2 is feasible. This option consisting of approximately 7,800 linear feet of pipe line would extend from the Kahului WWRF to the Kanaha Beach Park and Kahului Airport entrance road area. **Table 3-2** lists the projects that could be provided with R-1 water and the estimated construction cost with Option 2.

Table 3-2: Option 2 – Properties Served

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
Kanaha Beach Park	157,900	--
Kahului Airport & Access Road	67,000	--
Total Option 2	224,900	\$3,972,000

Option 3: Connect to Existing Non-Potable Water Distribution System to Provide R-1 Water to HC&S and Other Commercial Properties

An advantage of this option is that two parallel existing non-potable water transmission lines approximately 20,000 feet long that were previously constructed and utilized by Maui Land & Pineapple Company (ML&P) to deliver an average flow of 1 MGD and a peak flow of 1.8 MGD of cannery wastewater to Hawaiian Commercial & Sugar Company (HC&S) are available for use. HC&S has stated that recycled water would be best utilized for seed cane irrigation. Seed cane is grown in the area between Maui Lani and Maalaea and the existing ML&P pipe lines discharge to a lined 0.5 MG reservoir owned by HC&S in the vicinity where seed cane is grown. HC&S representatives have stated that while this reservoir is usable, it is not in the best location for distribution of water to all of their seed cane designated growing areas. Further evaluation would need to be conducted to determine which other reservoirs and ditch systems would be suitable to distribute recycled water particularly if more than 1.8 MGD of R-1 water was required by HC&S. Nevertheless, this system is in place and offers an opportunity for the County of Maui to add an important segment of a recycled water distribution system. It also allows HC&S to use an alternative source of water that will at least partially help offset the water shortages associated with recent surface water reductions mandated by the Hawaii Department of Land and Natural Resources Commission on Water Resources Management.

The ML&P pipe lines will have adequate capacity to deliver R-1 water to HC&S as well as other commercial properties along the distribution system alignment where the R-1 water could be used for landscape irrigation. The existing MLP pipe lines would need to be connected to the R-1 transmission line constructed along Kaahumanu Avenue in Option 1 by installing approximately 1,300 feet of transmission line along South Kane Street. A pressure sustaining control valve and level monitoring system would need to be installed at the HC&S receiving reservoir. Negotiations would need to take place at the appropriate time to finalize the purchase price of this system. The projects that could be provided with R-1 water in Option 3 are listed in **Table 3-3**. All the projects listed with the exception of HC&S utilize potable water for irrigation.

Table 3-3: Option 3 – Properties Served

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
HC&S Seed Cane*	1,800,000	--
Kahului Elementary School	25,000	--
Maui High School	100,000	--
Kahului CC & Park	50,000	--
Hale Mahaolu	10,000	--
Total Option 3	1,985,000	\$1,850,000

*Currently uses non potable ditch water.

Option 3A: Develop a Dedicated Distribution System to HC&S

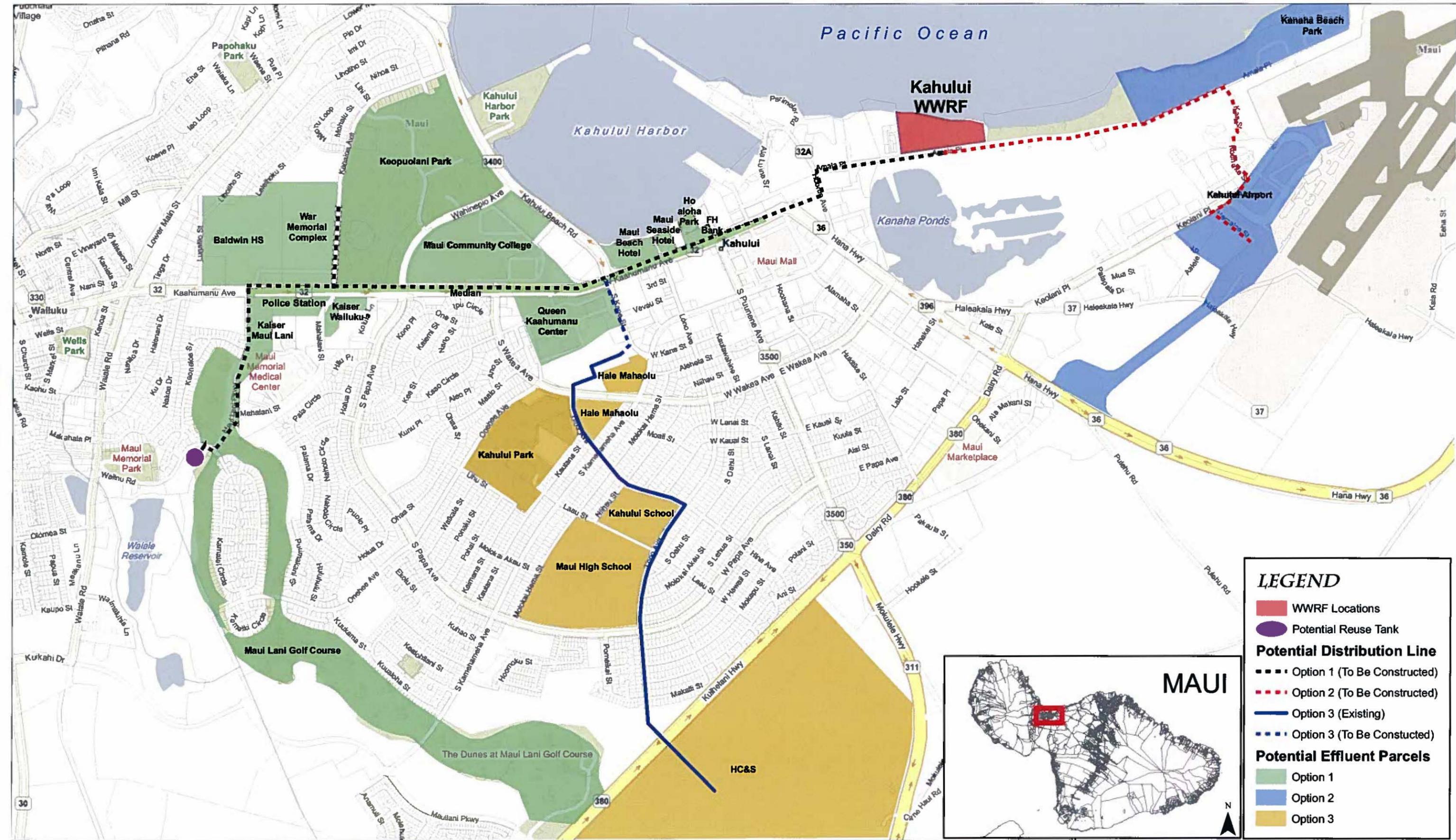
An abbreviated version of Option 3 would be to create a dedicated system that would only serve HC&S by constructing only enough R-1 pipe line along Kaahumanu Avenue to reach the existing ML&P pipe lines. While this option would eliminate the high cost of extending a pipe line up Kaahumanu Avenue to Maui Lani as well as the elevated 1.0 MG R-1 storage tank and booster station, it takes away critical core distribution capability from the distribution system. R-1 water would be pumped from the Kahului WWRF directly to the HC&S reservoir and once the reservoir was full, the pumps would shut down. The main disadvantage to this approach is that the distribution system would only be pressurized while R-1 water is being pumped to the HC&S reservoir. This scenario would not allow the distribution system to effectively serve any other commercial properties due to a lack of consistent service pressure within the distribution system.

Table 3-4: Option 3A – Property Served

Property	Estimated Peak R-1 Demand (GPD)	Estimated Cost (\$)
HC&S Seed Cane*	1,800,000	--
Total Option 3A	1,800,000	\$11,380,000

* Currently uses non-potable ditch water.

CENTRAL MAUI POTENTIAL R-1 RECYCLED WATER EXPANSION OPTIONS



LEGEND

- WRF Locations
- Potential Reuse Tank
- Potential Distribution Line**
- Option 1 (To Be Constructed)
- Option 2 (To Be Constructed)
- Option 3 (Existing)
- Option 3 (To Be Constructed)
- Potential Effluent Parcels**
- Option 1
- Option 2
- Option 3



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. As stated earlier in this report, many of the properties that could potentially utilize recycled water for irrigation in the Central Maui area are already utilizing non-potable water sources. These sources are typically brackish ground water and in the case of HC&S, ditch water from Maui's streams. With full construction of the three options described in Chapter 3, an approximate total of 4.2 MGD of R-1 recycled water could be used during peak irrigation periods at the various properties served by the R-1 distribution system. Of this volume, approximately 0.6 MGD of potable water could be displaced by R-1 water. The use of injection wells could be reduced by up to 95% of the current wastewater influent flow rate to the Kahului WWRF during peak irrigation periods.

Implementation of water reuse from the Kahului WWRF will be costly. The facility must first be upgraded to R-1 water capability at a cost of approximately \$5 million. R-1 quality recycled water will provide users with greater flexibility in its use and applications due to its higher quality and improved reliability than R-2 quality recycled water. The most expensive cost will be constructing the core components of a functional water distribution system. Recycled water storage, pumping and pipe lines all must be developed as the Kahului WWRF has none of these critical distribution system components in place at this time. Elevated storage as discussed in the Option 1 segment of this report is necessary to create the pressure that will allow even distribution of recycled water throughout the distribution system. Thus, Option 1 must be constructed and in operation before Options 2 and 3 can be considered for implementation.

Other points to consider are:

- 1) Wastewater flows to the Kahului WWRF will gradually increase over time as more development takes place. This will result in more recycled water being available for reuse as well as more effluent that will need to be disposed of. Expansions to the Kahului WWRF's R-1 capacity and distribution systems discussed in this report would be required so that the recycled water could be provided to additional commercial properties in the Central Maui area.
- 2) Irrigation demands decrease significantly during the cooler, winter months. This fact will result in excess recycled water being available during the winter season. This means that while the use of injection wells for effluent disposal may be reduced through water reuse, there may always be some excess recycled water; especially during the winter season; that may need to be disposed of into the injection wells.
- 3) HC&S may have the ability to use more than the 1.8 mgd of recycled water from the Kahului WWRF stated in Chapter 3. The two 14 inch lines mentioned in Chapter 3 have the ability to transport several million gallons of recycled water per day. However, HC&S use of recycled water is dependent on several issues including:
 - a. Seed cane is the best use of recycled water because nitrogen present in the recycled water can reduce sugar yields in mature cane if the recycled

water is used at 100% concentration. While blending recycled water with ditch water can reduce nitrogen levels, blending may not be an easy task for HC&S due to constraints of its existing distribution system.

- b. Some of the distribution systems owned by HC&S are considered Hawaii State waterways. The Department of Health does not permit recycled water of any quality to enter State waterways. This fact limits the use of recycled water by HC&S to areas where it has distribution systems that would be dedicated only to recycled water.
- c. HC&S qualifies for the "Avoided Cost" clause in the County of Maui's mandatory recycled water use ordinance (Chapter 20.30 of the Maui County Code). The County of Maui is required to match the cost of the ditch water that is used to irrigate sugar cane. This fact means that revenue from the sale of recycled water to HC&S will be minimal.
- d. Many companies and businesses are facing economic stress. The County of Maui should carefully evaluate business viability before committing large capital expenditures for recycled water distribution.

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 Potable Water Displacement

Option	Description	Distribution System and R-1 Upgrade Improvements	Distribution System Improvements Only	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	Kahului WWRF to Maui Lani	\$28,987,000	\$24,022,000	191,340	\$151.49 (\$125.55)*	<ul style="list-style-type: none"> • Impacts seventeen (17) projects. • Includes core distribution system components that must be constructed before Options 2 & 3 are feasible. • Most of the projects have existing non-potable water irrigation sources.
				1,999,570	\$14.50 (\$120.37)*	
2	Kahului WWRF to Kahului Airport	\$8,937,000	\$3,972,000	224,900	\$39.74 (\$17.66)*	<ul style="list-style-type: none"> • Impacts two (2) projects. • Option 1 must be constructed before this option is feasible.
				224,900	\$39.74 (\$17.66)*	
3	Kahului WWRF to ML&P System to HC&S	\$6,815,000	\$1,850,000	185,000	\$36.84 (\$10.00)*	<ul style="list-style-type: none"> • Impacts five (5) projects. • Option 1 must be constructed before this option is feasible. • Cost is dependent upon negotiated price for ML&P non-potable pipe lines.
				1,985,000	\$3.43 (\$0.93)*	
3A	Dedicated System to HC&S	\$16,365,000	\$11,380,000	0	n/a n/a	<ul style="list-style-type: none"> • Impacts one (1) project. • Core distribution system not constructed.
				1,800,000	\$9.09 (\$6.32)*	

*(cost/gallon for distribution system improvements only)

Notes

- a. Costs are for CIP construction only. No operational/maintenance/finance costs are included.
- b. Plant upgrade to R-1 capability required prior to development of options. (Approximate cost is \$5 million).
- c. Detailed estimates can be found in Appendix "A".
- d. R-1 upgrade improvements only need to be competed once.

APPENDIX "A" – COST ESTIMATES

Kahului WWRF R-1 Water Upgrade Cost Estimate

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Coagulation System	1	ea.	\$300,000	\$300,000
2	Filtration System	1	ea.	\$1,600,000	\$1,600,000
3	Turbidity Monitoring System	2	ea.	\$12,500	\$25,000
4	Diversion System	1	ea.	\$240,000	\$240,000
5	UV Disinfection System	2	ea.	\$1,400,000	\$2,800,000
TOTAL R-1 UPGRADE COST					\$4,965,000

Option 1 Cost Estimate

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	12,800	LF	\$1,000	\$12,800,000
2	Pipe	5,625	LF	\$500	\$2,812,500
3	R-1 lateral/meter	17	ea.	\$30,000	\$510,000
4	1 MG Storage Tanks	2	ea.	\$2,650,000	\$5,300,000
5	Land Purchase	1	acre	\$1,000,000	\$1,000,000
6	Pump Station	2	ea.	\$800,000	\$1,600,000
TOTAL OPTION 1 COST					\$24,022,500

Option 2 Cost Estimate

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	7,825	LF	\$500,000	\$3,912,500
2	R-1 lateral/meter	2	ea.	\$30,000	\$60,000
TOTAL OPTION 2 COST					\$3,972,500

Option 3 Cost Estimate

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	1,300	LF	\$500,000	\$650,000
2	Pipe (ML&P)	20,000	LF	\$50*	\$1,000,000
3	R-1 lateral/meter	5	ea.	\$30,000	\$150,000
4	Pressure Sustaining Valve	1	ea.	\$50,000	\$50,000
TOTAL OPTION 3 COST					\$1,850,000

*Cost information obtained through preliminary verbal discussion with ML&P.

Option 3a Cost Estimate

Item No.	Description	Quantity	Unit	Cost/Unit	Cost
1	Pipe	6,250	LF	\$1,000	\$6,250,000
2	Pipe	1,300	LF	\$500	\$650,000
3	Pipe (ML&P)	20,000	LF	\$50*	\$1,000,000
4	R-1 lateral/meter	1	ea.	\$30,000	\$30,000
5	1 MG Storage Tank	1	ea.	\$2,650,000	\$2,650,000
6	Pump Station	1	ea.	\$800,000	\$800,000
TOTAL OPTION 3a COST					\$11,380,000

*Cost information obtained through preliminary verbal discussion with ML&P.