# APPENDIX J

## Resource Conservation and Augmentation

Water Resource Protection Plan 2019 Update

# J Resource Conservation and Augmentation

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# J Resource Conservation and Augmentation

Through its review of existing demands, authorized planned uses, and hydrologic data, the Commission on Water Resource Management (CWRM) has found that some areas of the State of Hawaiʻi are approaching the limits of ground water resource development. Nearly all of Oʻahu, Molokaʻi, and part of Maui have been designated as Ground Water Management Areas, where ground water use and development is regulated by CWRM. North Central Maui (Nā Wai ʻEhā) has been designated as a surface water management area, having similar regulations. The current municipal water use in the state of Hawaiʻi is approximately 223 million gallons per day (MGD) and current estimates are that this total use will increase to almost 270 MGD by the year 2035. Rising development pressure and population growth, combined with the uncertainty of climate change will create more competition for water in the future. A possible future scenario with dwindling natural water supply forces our society to explore and plan for water conservation and the use of more expensive alternatives like reusing treated wastewater and stormwater, treating surface water, and desalinating brackish or ocean water.

Estimates of ground water availability throughout the State are based on the best available, albeit limited, data. There are emerging indications of threat to our ground water sources that cannot be ignored. Recent climate change research suggests that rainfall patterns in Hawaiʻi are changing, both spatially and temporally. Some research suggests that dry areas will become drier and wet areas wetter. Droughts may become more prolonged, while large rainfall events may be less frequent but have increased intensity. While not a certainty, changing rainfall patterns will have an impact on water availability across the State of Hawaiʻi. Increased demand for water and competition for water in some areas of the State force stakeholders to rethink traditional supply and demand regimes.

There are several State and county agencies that currently implement various water conservation measures. Private businesses and organizations have also incorporated varying degrees of water conservation within their operations. The State of Hawaiʻi recently developed a water conservation plan to begin a water conservation program which will coordinate the various ongoing conservation efforts and implement programs designed to improve water conservation and use efficiency across the State.

Resource augmentation should also be embraced as an important component of sustainable water resource management. Water augmentation sources include: water that is imported from neighboring regions, rainwater/storm water, gray water, and wastewater reclamation and reuse, and desalination of brackish water and seawater. Several of the county water and wastewater agencies employ reclamation techniques to process surface water and wastewater. Many privately-owned wastewater treatment facilities also recycle and reuse wastewater. However, there is no statewide water resource augmentation program.

This section reviews existing conservation and augmentation activities in Hawaiʻi and establishes goals and priorities for statewide planning programs. The State Water Code states that CWRM shall plan and coordinate conservation and augmentation programs in cooperation with other federal, State, and county agencies, and private and public entities created for the utilization and conservation of water.[1] The State should provide leadership and guidance for the establishment, development, and implementation of statewide water conservation and augmentation programs.

## J.1 Goals & Objectives

CWRM, on behalf of the State of Hawaiʻi, establishes the following goals and objectives for water conservation and resource augmentation programs and projects statewide[2]:

- Foster the collaborative development, implementation, and update of short- and long-range plans for conserving and augmenting water supplies.
- Promote coordination and cooperation among agencies and private entities.
- Provide guidance, assistance, and oversight in the establishment, development, and implementation of statewide water conservation and augmentation programs.
- Encourage coordination between conservation activities and augmentation planning.
- Promote the utilization of the best available information and technology in planning and implementing conservation and augmentation projects.
- Provide the regulatory and planning framework for integrating resource conservation and augmentation into a comprehensive water management program.
- Support county and community-based conservation efforts by providing information resources and advisory assistance.
- Encourage water conservation and use of alternative water sources, whenever possible, through comments provided during land use planning and permitting review.

[1] HRS §174C-5(12) and §174C-31(d)(4).

[2] HRS §174C-5(12) and §174C-31(c)(1).

## J.2 Statewide Water Conservation Program[3]

Water supply planning and water conservation programs are closely related. Conservation programs directly affect short- and long-term water requirements and help reduce the risk of water supply deficiencies. Water conservation measures are implemented to achieve the following objectives:

- Reduce the demand for water;
- Reduce energy costs and the carbon footprint associated with increased water production;
- Improve efficiency in use and reduce losses and waste of water; and
- Ensure the long-term viability of the resource.

Although government has taken the initiative in pursuing water conservation policies, the success of any water conservation program ultimately depends on public participation and cooperation. It is essential to the development and implementation of a good water conservation program that the community embraces and adopts a conservation ethic. Community leaders, elected officials, government agencies, private water companies, and environmental groups must be involved in the planning process. The following text describes the Hawaiʻi Water Conservation Plan, which was developed by CWRM 2013. Further Hawaiʻi Water Conservation Plan details can be found online (http://state.hi.us/dlnr/cwrm/planning/hwcp2013.pdf).

**Need for a Water Conservation Plan**

As an island state, Hawaiʻi has limited access to natural fresh water supplies. Competition for fresh water, increasing population and development pressures, the rising awareness of environmental and cultural water needs, and the impacts of global climate change require that Hawaiʻi become as efficient as possible in its uses of limited fresh water supplies. In some areas of the state, demand for water is approaching the sustainable limits of supply, and these demands are expected to increase in the future. In order to sustain and protect our water for future generations, we must strive to be as efficient as possible in all of our water uses.

CWRM is the primary steward of the water resources public trust and has broad powers and responsibilities to protect and manage Hawaiʻi's water resources. This includes the authority and duty to develop plans and programs to conserve water across the State of Hawaiʻi. While various state agencies and municipalities have developed and implemented individual programs to conserve water, there has been a lack of coordination and communication to collaborate those efforts toward a common goal.

[3] CH2MHILL. 2013. *Hawaiʻi Water Conservation Plan Final Report*. Prepared for Commission on Water Resource Management. February 2013

**Hawaiʻi Water Conservation Plan Purpose**

The purpose of the Hawaiʻi Water Conservation Plan is to identify and implement water use and delivery efficiency measures to conserve the fresh water resources of the state. The plan is intended to be a guiding document for CWRM as they develop and implement water efficiency measures that can be implemented across the state by various water user groups. In "owning" the Hawaiʻi Water Conservation Plan, CWRM serves as a coordinator, funding source, and clearing house and offers technical assistance. Because CWRM is not a water purveyor, it can lead by example, but otherwise cannot directly implement water efficiency programs. CWRM depends on water purveyors and users in Hawaiʻi to participate and implement the measures outlined in this plan.

It is important to note that this Hawaiʻi Water Conservation Plan focuses mainly on "demand side" measures of water use and delivery efficiency measures and programs to implement them. Although other types of "supply side" measures are commonly mentioned when discussing water conservation, such as reuse of recycled water or stormwater capture for ground water recharge, these practices are not the emphasis of this plan. For the purposes of the Hawaiʻi Water Conservation Plan, water conservation is defined as the reduction in fresh water use by improving the efficiency of water delivery and end water uses. However, CWRM views all water sources, including alternative sources, as valuable resources to be used wisely. Many of the recommended best management practices can be applied regardless of the nature of the water source.

**Principles and Planning Process**

CWRM began this process to develop a water conservation program with three overarching objectives:

1. Develop a coordinated statewide water conservation planning strategy and policy framework.
2. Develop a statewide water conservation program to implement the planning and policy framework.
3. Work collaboratively with water conservation stakeholders to achieve CWRM objectives.

The planning process for developing this water conservation plan involved forming an advisory group, defining a water use baseline, setting water conservation goals and strategies, developing recommended best management practices (BMP), defining and evaluating implementation approaches, and establishing an implementation and funding plan.

**Water Conservation Advisory Group**

There are numerous categories or sectors of water uses across the State of Hawai‘i. The uses range from municipal water supply to military to golf course and agriculture. Within the municipal and military sectors, there are also commercial, industrial, institutional, and other uses that are served. Realizing the need for collaboration and cooperation to succeed in a water conservation program, CWRM sought to establish an advisory group of stakeholders that would represent such a diverse water use spectrum. The Water Conservation Advisory Group (WCAG) is composed of water industry professionals and experts from across the state with knowledge or interest in water efficiency and conservation. Members represent all major water use sectors in the private industry as well as all levels of government.

During the development of this water conservation plan, the volunteer WCAG met six times over a period of 18 months to help create the statewide water conservation plan and program. During the six facilitated meetings, the WCAG contributed water use data, water conservation program information, participated in the development of sector-based BMPs, and established an initial prioritization of water conservation program elements. CWRM believes that there should be a continuation of the WCAG or some derivative group of core members to support the implementation of water conservation programs in the state and to provide expert advice during the evolution of the State Water Conservation Program.

**Water Use Characterization**[4]

The largest water use sectors by volume in Hawai‘i are the municipal and the agricultural sectors. The municipal (including military) water demand is approximately 223 million gallons per day. Water use data show that the residential sector is the largest municipal water use category, accounting for nearly two-thirds of all municipal water use. After that, the largest municipal water use categories are commercial, institutional, and hotel. Therefore, the categories in which municipal water conservation BMPs should be targeted include residential, commercial, institutional, and hotel use. The data also illustrate that there is a strong seasonal outdoor water use, and that outdoor water conservation BMPs should be considered.

When the plan was developed, agricultural use was estimated at well over 350 MGD (which represents both the reported and estimated unreported uses), irrigating approximately 50,700 acres statewide. However, water use data are measured at different points within each irrigation system. Most data sets represented metered deliveries from main ditches and pipelines to water use at farm/field level diversion points, so do not represent total water diversions. Almost all of Hawai‘i’s remaining large agricultural irrigation systems are legacy sugar plantation delivery systems. Many of these systems have fallen into disrepair, but some are undergoing rehabilitation through State-funded efforts. Rehabilitation, modernization, and improved maintenance of these systems have the potential to improve water delivery efficiency while also

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[4] CH2MHILL. 2013. *Hawai‘i Water Conservation Plan Final Report*. Prepared for Commission on Water Resource Management. February 2013. Note that water demand/uses were estimated based on best available data at the time of this report.

improving the reliability of agricultural water supplies. It is important to note that some agricultural operations also have non-irrigation water uses for pest control and to meet regulatory requirements.

There are 104 golf courses in Hawai‘i with an estimated average water use of 53 MGD in total across the golf course sector. The data indicate that the average 18-hole golf course in Hawai‘i covers 124 irrigated acres, has a peak month water use of 0.65 million gallons per day, and an average annual water use rate of 0.37 million gallons per day. Based on the data provided by water users and purveyors and on a per unit area basis, the average golf course irrigation water use was about half the average agricultural irrigation water use. However, the range in reported water use for individual agricultural and golf course sector sites was wide enough that a general comparison of water use across these two sectors is not possible.

**Water Conservation Measures and Prioritization**

During the plan development process, the WCAG formulated a list of BMPs for the municipal, military, agricultural, and golf course sectors. The idea of establishing a landscape water use sector was considered, but since landscape use is common in all these sectors, the WCAG acknowledged the Landscape Industry Council of Hawai‘i (LICH), Landscape Irrigation Conservation Best Management Practices manual. Practices in the LICH manual can be applied within appropriate sector program elements.

A comprehensive list of sector-based BMPs was developed and the WCAG was led through a prioritization exercise to initially rank the BMPs based on specific criteria. CWRM and the project team devised implementation approaches for each of the BMPs. These implementation approaches were then prioritized based on the following factors consistent with CWRM’s internal strengths and weaknesses as well as external threats and opportunities: ease of implementation, cost to CWRM, cost to “implementer,” and whether the proposed BMP builds upon existing programs. The BMPs/implementation approaches were grouped into sector-based water conservation programs, and recommendations were made for program implementation and scheduling.

**Implementation Plan**

The Hawai‘i Water Conservation Plan implementation section describes prioritization, scheduling, and resources needed to implement recommended water conservation programs. There must be a balance of incentives and policy to elicit changes across the water use spectrum. The cost of implementation (both staffing and financial) is a major factor on whether a program can be implemented or not. Benefit-cost analysis is one factor to consider when choosing a project for implementation. Because staff and funding are both limited, implementation of the plan will occur over time and can be advanced as more staff and funding are available. This phased approach to implementation will require wise use of State funds and may necessitate new approaches to working together to implement the BMPs.

CWRM’s approach is to initially provide technical assistance and incentives where possible and to later establish or implement regulations and policies aimed at conserving and protecting our water resources. In this plan, there are a limited number of measures that are policy and/or regulation oriented and require certain actions by permitted water users over time. In most cases, however, CWRM intends to establish a conservation framework and invite voluntary participation by different user groups for purposes of awareness, demonstration, documentation, or to receive dedicated funding for water conservation. The underlying premise of the plan is to build upon existing water conservation efforts where they exist and ones that have high stakeholder interests and opportunities for cost-sharing, establish partnerships to encourage voluntary participation in CWRM-sponsored water conservation programs, and to foster understanding and support for water efficiency. Any regulatory enforcement should give the affected parties reasonable time to comply without severe economic hardship. Over time, as data collection on water use and water savings evolves, additional programs may become viable and funding may be dedicated to support additional water conservation programs.

The implementation plan describes a 10-year planning horizon. Two key implementation programs recommended for the first 2 years are: (1) procedure for conducting and requiring annual standardized water loss audit for municipal, military, and other public water systems, and (2) irrigation metering demonstration projects for agriculture irrigation systems. Providing technical assistance and guidance will help affected stakeholders prepare for and begin to comply with policy and regulatory measures over some reasonable period of time. If funding is available, CWRM will consider incentives to encourage the use of Water Sense/high efficiency plumbing fixtures and equipment as well as water efficient commercial equipment.

In addition to the recommended water conservation programs, CWRM will continue to expand its role in coordinating new and existing water conservation programs, improving our water use data collection capacity, exploring policy actions, and pursuing funding opportunities to increase program effectiveness.

Recognizing that some water users and sector groups are ahead of others in the implementation of water conservation measures, and in view of the current staffing and funding limitations of CWRM, this plan may also serve as a technical resource for water users to independently implement the prioritized BMPs identified in this plan. The recommended BMPs for each sector, along with a brief description, qualitative estimates of water savings and costs, and possible implementation mechanisms are provided in Section 7.1.2 of the Hawai’i Water Conservation Plan.

BMPs may also be considered and incorporated into long-range water use and development plans as a strategy for meeting future demands and promote sustainable water management. The various other State and County agencies responsible for developing and updating other water use and development components of the Hawai‘i Water Plan are encouraged to incorporate appropriate water conservation BMPs as part of their long-range plans.

**CWRM Role and Vision**

This Hawai‘i Water Conservation Plan establishes the Water Conservation Program in CWRM. CWRM anticipates taking a lead coordination role for water conservation across the State while partnering and collaborating with the WCAG and interested stakeholders. Water conservation programs should complement existing water conservation programs or measures within stakeholder agencies and organizations. Water conservation policies should be developed and enforced giving affected parties reasonable time to comply with rules and regulations. Program success will depend on coordinating water conservation program implementation, sharing resources, and building upon small achievements. CWRM will pursue a sustainable funding strategy to implement the Hawai‘i Water Conservation Plan.

Regular water conservation plan updates and section revisions evaluate program effectiveness, reflect changes happening in the community or in governmental regulations, and other factors such as new technologies. A five-year update or revision to this plan is recommended.

**Implementation**

Commission staff completed the priority implementation action: irrigation metering demonstration projects for agriculture irrigation systems in 2014. This project was done in cooperation with the U.S. Geological Survey. Workshops were held on Kaua‘i, O‘ahu, Maui and the Big Island. These full-day workshops were comprised of a classroom session covering the theory of open-channel flow measurement. This was followed by a hands-on flow measurement exercise where participants learned to make velocity measurements and convert this to flow rates. Participants were invited from government and private sector.

This training effort has helped stream diverters to begin measurement of the amount of water they divert and report these measurements to CWRM on a monthly basis.

Commission staff also completed a pilot water audit training program in 2016, partially fulfilling the priority implementation action: procedure for conducting and requiring annual standardized water loss audit for municipal, military, and other public water systems. This program focused on Hawai‘i Public Utilities Commission (PUC) – Regulated drinking water utilities and reached 10 public water systems. The objective of this program was to train utility owners/operators to conduct water audits using the standardized American Water Works Association method of water audits.

CWRM’s water audit program was formally established by law when Hawai‘i Governor David Ige signed Act 169, SLH 2016, into law. Act 169 requires all county-owned public water systems, public water systems serving a population of 1000 or more, and public water systems in water management areas to submit annual water audits to CWRM. These audits are to be completed using the American Water Works Association’s free water audit software and Level 1 validated by a third-party. The Act requires CWRM to establish a water audit program and to provide technical assistance to affected utilities. The Act also authorizes federal and private funding to complete the purposes of the Act.

In 2017, CWRM began the Hawaiʻi Water Audit Validation Effort (WAVE) technical assistance and training program to help the approximately 100 affected public water systems meet the requirements of Act 169. The program includes workshops and follow-up technical sessions with the utilities culminating in completed audits for submission to CWRM. Level 1 validated audits from County-owned public water systems are due to CWRM on July 1, 2018 and Level 1 validated audits from the large capacity systems and those in water management areas are due to CWRM on July 1, 2020. The overall goal of the training is to help utilities build internal capacity to complete annual water audits and to utilize the results of the audits to address any issues discovered within their respective water systems. More information on this program is available online at www.Hawaiiwaterloss.org.

## J.3 Other Water Conservation Plans and Programs

**Fresh Water Initiative**

Facing climate change and uncertainties in future fresh water availability, the Hawaii Community Foundation began its Fresh Water Initiative in 2013 to collaborate with multiple public and private parties to develop a water security strategy. A blue-ribbon panel of stakeholders was assembled to form the Fresh Water Council for the purpose of mapping out a secure water future for the State of Hawaii. The Council incudes representation from agriculture, government, private landowners and the scientific community. This collaboration resulted in the report: *A Blueprint for Action, Water Security for an Uncertain Future*. The report outlines three main goals statewide by year 2030: (1) 40 million gallons of water conservation; (2) 30 million gallons of water reused; and (3) 30 million gallons of increased ground water recharge. The Council has been successful working with Hawaii's legislature to pass bills supporting these three goals.

Bills passed by the 2016 Hawaii Legislature related to the Fresh Water Initiative include the following: Act 169, Relating to Water Audits; Act 170, Relating to Water Management; Act 171, Relating to Water Infrastructure Loans; Act 172, Relating to Water Security; Act 173 Relating to Hydroelectric Power; Act 174, Relating to Agriculture.

**Act 172**

Act 172, Session Laws of Hawaii 2016, requires the Department of Land and Natural Resources (DLNR) to establish a two-year pilot program for a Water Security Advisory Group (WSAG) to enable public-private partnerships that increase water security by providing matching state funds for projects and programs that:

1. Increase the recharge of ground water resources;
2. Encourage the reuse of water and reduce the use of potable water for landscaping irrigation; and
3. Improve the efficiency of potable and agricultural water use.

Act 172 also states that the WSAG shall advise DLNR on the priority of proposals for qualified projects or programs and recommend high-priority programs for the award of matching funds through this pilot program. The Legislature appropriated $750,000 of funding toward the implementation of Act 172.

To evaluate a proposal for a project or program that increases water security, Act 172 required the creation of a WSAG made up of:

1. The manager and chief engineer of the board of water supply for each county (or their designee);
2. The deputy director of the Commission on Water Resource Management;
3. A member with knowledge of agricultural water storage and delivery systems;
4. A member from a private landowning entity that actively partners with a watershed partnership;
5. A member with knowledge, experience, and expertise in the area of Hawaiian cultural practices; and
6. A member representing a conservation organization.

To solicit qualified individuals for the non-government seats, the Chairperson of DLNR issued a call for applicants via press a release on November 17, 2016 (http://dlnr.hawaii.gov/blog/2016/11/23/nr16-223/).

CWRM issued a request for proposals for projects under Act 172. Sixteen proposals were submitted and 11 selected for funding. These 11 proposals were approved by the Board of Land and Natural Resources at its June 9, 2017 meeting. More information is available on CWRM's website at: http://dlnr.hawaii.gov/cwrm/planning/watersecurity/ .

Under the State Water Code, CWRM is responsible for planning and coordinating a water conservation program. Outside designated Water Management Areas, the CWRM does not have clear authority to require the counties and other jurisdictions and interests to develop and implement water conservation programs and measures. County governments have the authority to institute mandatory conservation measures within their water systems, as necessary, by enacting the appropriate ordinances, rules, and regulations.

It is important for a statewide conservation program to be coordinated with the four counties, the Federal Government, and private interests. Coordinating different conservation programs requires planning and consultation, and successful program implementation requires widespread public participation and cooperation among government agencies, water users, water purveyors, and various community and special interest groups.

The basic goal of a water conservation program is to enhance the welfare of the people of the State through proper development, protection, control, and regulation of the water resources of the State for all beneficial uses. To this end, all water utilities and water agencies are encouraged to adopt policies, principles, and practices for efficient water use through a balanced approach, combining demand management with judicious source development.

To encourage water conservation programs, CWRM developed a prototype water conservation plan for five of the DLNR's facilities. The long-term intent of the *Prototype Water Conservation Plan for the Department of Land and Natural Resources* (February 2005) is to provide a framework for the development of water conservation plans for all State agencies, and to provide conservation program options and strategies for water purveyors throughout Hawai‘i. To facilitate State agency implementation of water conservation programs, CWRM developed the *Conservation Manual for State of Hawai‘i Facilities* (May 2007), which contains information on designing a program and water conservation guidelines for indoor domestic uses, landscaping uses, cooling and heating applications, and medical facility uses. The *Prototype Water Conservation Plan for the Department of Land and Natural Resources* and the *Water Conservation Manual for State of Hawai‘i Facilities* are available on CWRM's website at http://www.hawaii.gov/dlnr/cwrm/planning/conserve.htm.

## J.3.1 DLNR Prototype Water Conservation Plan

The *Prototype Water Conservation Plan for the Department of Land and Natural Resources* was completed in February 2005. The plan was designed to serve as a pilot project, with potential application for the development of water conservation plans for typical government institutional facilities.

The DLNR Water Conservation Plan examines five selected facilities as models for other planning efforts. DLNR is an appropriate agency for piloting water conservation planning because the agency has multiple types of facilities and water usage characteristics (e.g., office buildings, baseyards, harbors, municipal/irrigation demands, potable/non-potable water systems). The plan addresses both potable and non-potable water demands, identifies appropriate water conservation measures, provides implementation schedules and budgets for the installation of water conservation measures, and recommends post-installation monitoring of water use.

The plan development was partially funded through the Water Conservation Field Services Program (WCFSP) administered by the U.S. Department of the Interior, Bureau of Reclamation. The WCFSP is designed to: encourage water conservation; assist water agencies to develop and implement effective water management and conservation plans, coordinate with state and other local conservation program efforts, and generally foster improved water management on a regional, statewide and watershed basis. The program emphasizes: water management planning, conservation education, demonstration of innovative technologies, and implementation of conservation measures. The Bureau of Reclamation's *Municipal and*

*Irrigation (M&I) Conservation Plan Guidebook*, which provides methods and measures aimed at improving overall water management, assisted CWRM in the scoping of the DLNR Water Conservation Plan.

The goals of the DLNR Water Conservation Plan are summarized for each facility as follows:

- **Kalanimoku Building:** Achieve a 15% water use reduction, estimate cost savings over the long term, and free up water supplies for additional uses.

- **Kaka‘ako Waterfront Park:** Achieve a 15% water use reduction, estimate cost savings over the long term, and free up water supplies for additional uses.

- **Ala Wai Harbor:** Account for all water usage at the facility, achieve a 15% water use reduction, estimate cost savings over the long term, and free up water supplies for additional uses.

- **Honokōhau Harbor:** Account for all water usage at the facility, achieve a 15% water use reduction, estimate cost savings over the long-term, and free up water supplies for additional uses.

- **Hilo Baseyard:** Achieve a 15% water use reduction, estimate cost savings over the long term, free up water supplies for additional uses.

The plan recommends monitoring all conservation measures installed pursuant to the plan through metered water use (water billings).

As stated earlier, one of the key objectives of the project was to serve as a model for developing a statewide water conservation plan. Another goal was to develop an assessment approach and planning methodology that could be used in the formulation of facility water conservation plans. The development of facility-specific water conservation plans begins with understanding each facility's water usage. Creating and adopting a consistent assessment methodology to evaluate water usage and identify possible water conservation measures is the first step in developing a facility-specific water conservation plan. The water conservation assessment methodology could be used as a template by State agencies to conduct internal evaluations of their facilities (either by their in-house staff or by consultants).

The water conservation assessment methodology consists of the following basic steps:

1. Identify current water use at the facility:
    a. Complete a water system inventory to understand the facility's current water system layout.
    b. Gather past water consumption data (e.g., water billings, and water metering records).
    c. List all water uses including domestic, irrigation, maintenance, etc.
    d. Measure water quantities used on average in each water use category. This may require the installation of sub-metering systems to determine specific water usage throughout the facility.
    e. Identify significant water uses.

2. Identify existing conservation measures:
    a. List all existing water conservation measures.
    b. Assess existing water conservation measures and any previous attempts to implement conservation measures to understand relative success or failure.
    c. Identify areas without water conservation measures.

3. Identify applicable/practical water conservation measures:
    a. List potential water conservation measures to be considered.
    b. Discuss potential water conservation measures with facility staff.

4. Complete cost-benefit analysis and environmental assessment of potential water conservation measures:
    a. Develop projected water conservation plan implementation costs.
    b. Develop estimated water savings based on water conservation measures selected.
    c. Evaluate water conservation plan feasibility through cost /benefit analysis.
    d. Complete environmental assessment identifying resources and any possible negative impacts.
    e. final recommended water conservation plan based on cost/benefit and environmental analysis.

5. Create a conservation plan implementation schedule:
    a. Develop a timetable of interim and long-term conservation measures for agency implementation.

6. Develop initial steps to be taken by facility:
    a. Consider installing sub-metering systems to monitor water usage.
    b. Identify implementation costs, including labor.
    c. Identify activities for monitoring performance and results.
    d. Educate facility staff on water conservation measures.
    e. Post signs to educate water users on water conservation.
    f. Post signs identifying contacts if facility is in need of repair.

The State should lead by example through the development of facility-specific water conservation plans for State agencies. Cooperative efforts between the State and counties can enhance program development and expand its application. General recommendations of the DLNR Water Conservation Plan include:

- Government agencies should pursue public/private partnerships to increase public awareness and to implement and promote water conservation efforts.

- Each State facility/site should designate a project manager to develop and implement a site-specific water conservation plan.

## J.3.2 Water Conservation Manual for State of Hawai‘i Facilities

On January 20, 2006, Governor Linda issued Administrative Directive No. 06-01 requiring all State agencies and programs to increase their commitment towards implementing innovative and resource efficient operations and management. Examples of better management practices cited in this directive include:

- Reduced energy and water use;

- Reuse and recycle options;

- Improved construction and demolition waste management;

- Environmentally preferable purchasing;

- Efficient use of transportation fuels, especially greater use of alternative fuels; and

- Increased incorporation of sustainable building practices.

New State facilities and augmentations to existing facilities are to be designed and constructed to meet and achieve certification requirements of the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) standards. State agencies are specifically directed to implement water and energy efficient operational practices to reduce waste and increase conservation.

The *Water Conservation Manual for State of Hawai‘i Facilities*, developed by CWRM in 2007, contains information and guidelines to help State agencies comply with Administrative Directive No. 06-01. The manual provides detailed information on how to implement water efficient practices at State buildings and facilities. The conversion of State buildings and facilities to water-efficient status will assist State agencies in their efforts to obtain LEED certification, as required by the Governor's directive.

### J.3.3 State Department of Accounting and General Services

- The Hawai‘i Department of Accounting and General Services (DAGS) issued an Energy Savings Performance Contract for 10 State office buildings in the Capitol District. This contract (Capitol District - Energy Savings Performance Contracting (ESPC), Phase 1 Buildings - DAGS Job No. 52-10-0599) included energy and water benchmarking, retrofit of electrical and water fixtures and devices with more efficient ones, estimation of energy and water savings. These are some project highlights: State Capitol District including 10 buildings covering approximately 1.3 million square feet.

- Buildings include: Kalanimoku, Ke‘elikolani, Kekaulu‘ohi, Kekuanaoa, Ke‘oni ‘Ana, Kinau Hale, Lili‘uokalani, No. 1 Capitol District (Hemmeter), State Capitol, Leiopapa-A-Kamehameha.

- Project size: $33.9 million constructed in FY2010 and FY2011.

- Creates an estimated $1.5 million in State Tax Revenue in FY2010 and FY2011 with an additional $1.7 million over the next 20 years.

In 2013, DAGS issued another ESPC to retrofit 33 State-owned buildings across all major Hawaiian islands with energy and water savings equipment and fixtures. This project is expected to save DAGS $28 million in operational costs over the 20-year contract period.

### J.3.4 County Conservation Programs

In general, the counties practice conservation by protecting watershed areas in order to realize dependable yields. Counties also practice conservation by reducing system leaks and losses, adopting universal metering, encouraging or requiring the installation of devices to reduce water use, implementing public education programs, adjusting water rates to influence demand, and as a last resort, rationing water use during severe shortages.

Water conservation can be beneficial to a water utility and its customers by reducing demand in dry years and prolonging short supplies during other emergency conditions. Efficient water use can also result in energy savings, particularly on hot-water use. It has been estimated that hot-water use can be reduced by almost one-third through effective water conservation measures.

Reduced water use also results in energy savings, as less water must be treated and distributed throughout the system. Moreover, water conservation within the home and in industry decreases the volume of wastewater flow. This, in turn, reduces treatment and collection system costs. In Hawaiʻi, reductions in pumping costs could be significant, and deferred development of new water sources will postpone capital improvement costs.

In planning a water conservation program, a water utility should consider some of the potential disadvantages involved. One of these considerations is the reduction of revenues, the effect of which is felt almost immediately. Less revenue may postpone needed capital improvements, which means the utility could later face higher construction costs.

However, water conservation can also make water available to service undeveloped areas. Water conservation and land-use planning efforts should be coordinated so as to avoid inadequate water availability for future use.

Water conservation cannot be regarded as a substitute for a utility's obligation to maintain an adequate reserve capacity. Without adequate reserves, water shortages may become more frequent, and drought impacts may threaten public health.

Many states and municipalities throughout the continental United States have developed water conservation programs with varying degrees of success. Noteworthy programs have been implemented in cities such as Denver, Oakland, Los Angeles, and Washington, D.C.

The counties of Maui, Kauaʻi, Hawaiʻi, and the City and County of Honolulu have independently undertaken water conservation programs and strategies. Their conservation efforts are summarized below.

#### J.3.4.1 Maui Department of Water Supply Conservation Program

The Maui County Department of Water Supply (DWS) maintains 750 miles of water lines, 145 storage tanks with 295 million gallons of water storage capacity, six water treatment facilities, and 35 ground water sources for 35,753 customers. DWS employees maintain the water system 24/7. The DWS also works hard to sustain its water resources for the long term. We work closely with the State to ensure that our sources are protected for the public trust, that our customers will have continuous and reliable water supply.

The DWS is developing and expanding its water conservation program, which includes both supply side and demand side measures.

<u>Supply Side Water Conservation Measures</u>
Supply-side measures to date include leak detection, preventive and predictive maintenance, use of reclaimed water and alternate system backups and resource protective measures.

**(1) Leak Detection**
An effective leak detection program is critical to identify unaccounted for water in order to proactively prevent as much water loss as feasible. There are major benefits to having a leak detection program that include the ability to: respond more quickly to identified leaks; find "hidden" leaks creating ongoing water loss; reduce pressure, especially during low demand; and replace aging and weakened pipe. A total of 361 miles of transmission lines were surveyed from FY 2008 - 2013; 88 leaks were found and repaired (mostly in the Central Maui area).

**(2) Preventive & Predictive Maintenance**
This is two pronged. Facilities are regularly maintained and pumps are periodically calibrated. In the course of such maintenance, facilities are regularly checked for signs of wear. DWS also has a system inventory with age, diameter and material of lines and other facilities. Based upon the status and performance of system facilities, upon known inventory status and demand trends, DWS maintains a 30-year project list. This can help to reduce unaccounted-for water in the system by targeting old and substandard lines for replacement.

**(3) Reclaimed Water Use**
About 3.905 MGD is in use countywide with 1.8 MGD utilized in South Maui. As part of its Water Use & Development Plan process, DWS is currently investigating the costs and benefits of large scale capital investment to further expand reclaimed water use to offset potable use.

**(4) Back-up Sources**
In the event of a major leak, most areas of the Central system can be served by other sources so that any key portion of system could be valved off at need.

**(5) Watershed & Resource Protection**
DWS has provided financial support to seven Watershed Partnerships on Maui and Molokaʻi to ensure upland watersheds are fully functioning so fresh water resources can be utilized and enjoyed by the people of Hawaiʻi in perpetuity. Since 1995, we have provided $8.12 million dollars of funding to seven Watershed Partnerships comprise a total number of 54 of partners. All of these partners, including the County and State entities, are working in partnership to protect over 150,000 acres located within a key watershed area critical to future DWS water source protection, development and recharge.

The Watershed Partnerships collectively address a variety of threats to the watershed including activities such as ungulate control through fencing and targeted hunting practices; eradication of invasive weeds and plants; reforestation and vegetation of upland areas and other habitats critical to the recharge and protection of water supply; and suppression and management of wildland fires resulting in the loss of forests.

These efforts have successfully resulted in essential tangible outcomes and deliverables and include: fence installation, maintenance and monitoring resulting in a reduction in feral animal populations; eradication if invasive weeds and plants (nearly 35,000 acres); hunting programs with native species of plants and trees; documentation, protection, and research of rare species; establishment of volunteer programs in all watersheds; interpretive hikes and field studies; resource monitoring and mapping; installations of trails, camps, and helicopter landing zones; educational presentations and displays at public events and schools; and landscape level watershed protection through the protection and out-planting of native plant species and County-wide community garden projects.

Demand Side Water Conservation Measures

Demand-side measures to date include low flow fixture distribution, a tiered rate structure, public education and outreach programs, and regulations as well as resource protection. Ongoing planning efforts are evaluating the benefits and costs of increased aggressiveness in these efforts.

**(1) Low Flow Fixture Distribution**

To date DWS has given out 38,207 low flow showerheads, 40,686 bathroom aerators, 25,747 kitchen aerators, 24,016 self-closing hose nozzles, 3,957 toilet tank bags (displaces .8 gallon per flush) and many more leak detection dye tablets, vs. a customer base of about 35,000 meters.

**(2) Water Audits/Retrofits**

The Department co-funded its first direct install retrofits in the late 1990s with low flow toilets. However, no large scale programs were funded. More recently, smaller retrofit projects of high efficiency toilets have been installed in various County properties.

With the encouraging results of the Department of Water Supply's various retrofit projects, DWS decided to retrofit the entire Kalana O Maui (Maui County) building. DWS constantly asks the community to conserve water. Implementation of this project would show the public that the county is doing its part in conserving its finite water resources.

The Maui County Building is a nine-story structure built in 1971. Typical of most office buildings, the majority of water use within the Maui County building comes from domestic uses (e.g toilets, urinals, sinks, drinking fountains, etc.) and the surrounding landscapes which are irrigated by an existing irrigation system with 6 sprinkler heads with timer and most of the time being watered manually.

There were 45 3.5-GPF toilets, 18 - 3.0-GPF urinals, and 56 3.5-GPM bathroom faucets in the Maui County Building. These fixtures were replaced with 1.28-GPF toilets, 0.5-GPFurinals and faucets were installed with 1.5-GPM aerators. Overall savings was estimated at 63%.

The Water Use & Development Plan, currently in development, is evaluating the costs and benefits of high efficiency fixture rebates and direct installation programs as part of the Water Conservation Program. Ongoing trials will help to provide some preliminary data on the effectiveness of some of these options. Longer term options for the future may also include review of various means of sub-metering multi-family units and multi-purpose buildings. Studies indicate that metering un-metered units is among the most effective conservation measures, by billing explicitly for water use rather than hiding this cost in the rent.

**(3) Water Conservation Pricing**

DWS currently has a tiered rate structure to encourage conservation (Maui County Code Chapter 14.10). Data improvements under way could enable the Department to move toward a more aggressive tier structure.

**(4) Regulations Related to Water Conservation**

Maui County has the following existing regulation and rules that support water conservation:
1) Prohibition of discharging cooling system water into the public wastewater system (Maui County Code Title 14, Chapter 14.21A.015);
2) Plumbing code regulations that require low flow fixtures in new development (Maui County Code Title 16.20B);

3) Requirements that all commercial properties within 100' of a reclaimed water line utilize reclaimed water for irrigation and other non-potable uses (Maui County Code Title 20, Chapter 20.30.020A);
4) A water waste prohibition with provision for discontinuation of service where negligent or wasteful use of water exists (Maui County Code Title 14, Chapter 14.03.050);
5) A provision enabling the Water Director to enact special conservation measures in order to forestall water shortages (Maui County Code Title 14, Chapter 14.06.020).

In addition, a comprehensive conservation ordinance has been drafted, is planned to be included as part of the Maui Island Water Use and Development Plan and may be implemented in stages (Maui County Code Title 14, Chapters 14.02 and 14.03)

**(5) Public Education & Outreach Activities**

- Public Advertising - Conservation marketing efforts include public ads that run on local radio stations and newspapers to encourage water conservation. In FY 13 DWS entered into a Memorandum of Agreement (MOA) with the Honolulu BWS to implement a Summer Water Conservation Program. This program is a multi-agency partnership to conserve water in Maui County and the City and County of Honolulu. A total of 1,278 conservation ads were aired on local and cable TV stations. Similar MOA was executed for FY 14.

- Annual Water Conservation Poster Contest – This project is on its 5th year. A total of 1,713 public, private and home-schooled students participated in the last four years. Winning and honorable mention entries are featured in the DWS Water Conservation Calendar.

- Native Plant Giveaway – DWS provides native, drought tolerant plants to the public. This is to encourage the use of less thirsty and appropriate plant in their area. Plants are given away at the annual Maui County Fair, Maui Contractors Association's Home Expo, Arbor Day and other community events. Maui Nui Botanical Gardens is the source of native plants for Department outreach projects and give-aways as part of its grant agreement.

- Community Gardens – DWS supported the following community garden projects by providing native plants, irrigation materials, installation and staff hours:

- Ka Hale O Keola Homeless Resource Center; UH-Maui College –Sustainable Living in Maui Community Garden; Lahainaluna High School Garden Project; Greenhouse; Pomaikai Elementary School Garden Project; and Wahikuli Rain Garden.
- Permit Review - The permit review process is also utilized as an educational tool, with use-specific conservation and site specific recommendations included in each review.

- Community Events - The DWS participates in various public events every year, such as the Maui County Fair, Earth Day, Arbor Day, Maui Contractors Association's Home Expo, and East Maui Taro Festival.

- Expanded education and marketing efforts under consideration include targeted marketing survey and campaign development, a hotel awards program, a building manager users group, and an agricultural users group.

**(6) Water Conservation and Landscaping**

Located in Wailuku, Maui DWS co-funds operations of the Maui Nui Botanical Gardens, and funded construction of its nursery and portions of other facilities and displays. This provides a resource for promoting expertise in propagating and maintaining native plant materials, helps to increase the potential marketability of appropriate native plants, promotes a water conservation ethic, provides training on appropriate propagation, planting, irrigation and maintenance techniques, and generally helps to increase the likelihood of successful appropriate landscapes with a "Hawaiian Sense of Place". It also helps to protect watersheds by promoting native and non-invasive plants over potentially invasive species, providing for educational opportunities on the importance of the watershed and how to protect it, and serving as a major demonstration and educational facility.

DWS developed (with help from the County arborist committee) and disseminated a brochure entitled “Saving Water in your Yard, What and How to Plant in your Area”, which is distributed by the Maui Nui Botanical Garden as well as by the Department at events and with permit reviews. Future plans for landscape conservation include a conservation ordinance, landscape audit and retrofit program and smaller satellite demonstration projects. DWS is also investigating the costs and benefits of major capital expenditure in reclaimed water transmission to offset use of potable water in South Maui landscapes. The pending conservation ordinance includes mandatory watering schedules and irrigation efficiency measures among other requirements.

**(7) The Pre-rinse Spray Valve Trade-Out Program**

This program is designed to replace 200 high water use spray valves with high efficiency, low water use spray valves. Older, less efficient spray nozzles typically use about 4 to 6 gallons per minute. This program can reduce the volume of rinse water to 1.6 gallons per minute and result in substantial savings per nozzle replaced. Water use for rinsing is reduced by up to 60 percent and energy use for hot water reduced by up to 60 percent. This program will be available until there is 100% market penetration. Nozzles will be available for trade-out similar to our other fixture programs.

**Ongoing Water Conservation Planning Efforts**

Source options considered as part of the Water Use and Development Plan process will include consideration of extensive conservation measures as a source supply. In order to displace or delay source development an aggressive program is required. Preliminary design of such a program is ongoing as part of the Water Use & Development Plan process. Anticipated program elements include targeted audit and direct install programs, rebates and incentives, expanded conservation requirements for landscaping, and other uses, expanded marketing efforts including user groups, such as a hotel awards program, a building manager information program, agricultural user working groups/services, as well as energy production and efficiency measures, continued watershed protection and restoration and possible major capital expenditure to support reclaimed water use.

### J.3.4.2 Honolulu Board of Water Supply Conservation Program

The Honolulu BWS manages an integrated island-wide water system that serves all parts of O‘ahu. The system pumps an average of 150 million gallons of ground water per day from wells, shafts, and water tunnels. To protect the long-term viability of ground water resources on O‘ahu, the Honolulu BWS has adopted an integrated approach to ensure a sustainable water supply, by balancing the needs of the community, the economy, and the environment.

Pursuant to the goal of sustainability, the Honolulu BWS’s water conservation program seeks to foster effective water management policies and practices that reduce per capita use of potable water through resource management, supply system optimization, and consumer education. The program applies the following strategies:

- Public education and outreach;
- Leak detection, repair and maintenance;
- Large water user programs;
- Regulation; and
- Alternative source development, recycling, and conservation alternatives.

The Honolulu BWS conducts extensive outreach and educational programs and participates in community events to promote resource protection and increase collective awareness of the importance of water. The Honolulu BWS strives to assist in the development of water awareness and implementation of conservation efforts through educational programs that can be described under four program headings:

- **Public Education Program:** This program targets both adults and children through printed materials, the Water Conservation Week Contest for elementary school children, public service announcements and television/radio/print interviews, public speaking engagements, and participation in a number of community events and activities. Group tours of watershed areas, the Hālawa Xeriscape Garden, and the Honouliuli Water Recycling Facility are also offered.

- **School Education Program:** Teachers and students from preschool through high school are provided with publications, brochures, and other media explaining O‘ahu's water resources. Water conservation information, statistical reports, and summaries are also provided. Other publications provide students with a comprehensive understanding of water and water systems nationwide. The Honolulu BWS sponsors a Water Conservation Week Poster Contest for public and private elementary schools on O‘ahu, and participates in the Hawai‘i State Science and Engineering Fair by sponsoring water quality and water conservation awards. Classroom visits and speaking engagements are also done by BWS staff.

- **Watershed Education Program:** This program is designed to teach people in the community about the importance of healthy watersheds to replenish ground water resources. Watershed and forest protection, active stewardship of the land, and public and private partnerships are emphasized. Participants include State, City and County of Honolulu agencies, community groups, and school and environmental organizations.

- **Community Education Program:** Community education efforts include the Honolulu BWS Neighborhood Board Liaison Program, which encourages grass roots involvement and relationships between the Honolulu BWS and O‘ahu communities. Volunteer neighborhood representatives have a personal Honolulu BWS contact for information, concerns, and inquiries. The Honolulu BWS participates in community events such as the Aloha Fun Run/Health and Fitness Fair, Building Industry Association Show, Food and New Products Show, Farm Fair, and City-sponsored "Sunset" events (e.g., Sunset on the Beach, Sunset on the Plain, Sunset in the Park).

The Honolulu BWS provides assistance to watershed partnerships, agencies, and organizations through the Watershed Management Partnership Program. Project proposals for grant awards are submitted to the Honolulu BWS for consideration. To be eligible for the program, projects must be located on Oʻahu and should be relevant to watershed studies, watershed resource protection, educational outreach for watershed management and protection, invasive species control, forest protection, or water conservation activities.

The Honolulu BWS also utilizes the agency's website for conservation education and outreach. The "Kid's Corner" page includes interactive, educational activities designed for children. The website's conservation page includes information and links for consumer conservation measures inside and around the home, information on the Ultra-Low Flush Toilet Rebate Program, xeriscaping resources and planting guide, and a registry of nurseries that grow "less thirsty" plants.

The agency also provides a Water Waste Hotline (808-748-5041) for the public to report broken water pipes, a malfunctioning irrigation sprinkler, faucets left running, or other water waste.

#### J.3.4.3 Kauaʻi Department of Water Conservation Program

The Kauaʻi Department of Water (DOW) operates 11 separate, unconnected water systems from Kekaha to Haʻena. Kauaʻi DOW monitors, operates and maintains 50 deep well pumping stations, 19 booster pumping stations, 4 tunnel sources, 58 storage tanks, and 75 control valve stations. Approximately 21,500 accounts are served through 400 miles of pipeline.

In 2001, the Kauaʻi DOW implemented its Water Plan 2020 project – a comprehensive long-range plan to replace or repair aging infrastructure throughout the island. The plan guides the Kauaʻi DOW for future operations and identifies the needed improvements required to continue in providing safe, affordable and reliable water service to the community in a sustainable and financially secure manner. Water conservation plays an important role in this plan and in the Kauaʻi DOW's overall mission.

Current Supply-Side Conservation Programs:

- **100% Customer Reading:** Currently all customer accounts are metered, including temporary fire hydrant meter and temporary construction meter accounts. Separate landscape meter services are available from the Kauaʻi DOW depending on the availability of adequate water supply.

- **Meter Replacement, Repair, and Defective Meter Programs:** All water supplied by the Kaua'i DOW is measured by suitable water metering devices. The Kaua'i DOW maintains a water-meter-shop test and repair program. According to standard operating procedures, testing of all 5/8 inch displacement water meters that were not tested within 10 years is required. Removed meters should be replaced with new or re-built meters. Large meters (compound, propeller, torrent, turbine and crest meters) should be tested every two years. Potential defective meters are reported by the Billing Section of the Fiscal Division for replacement or repaired by the Operations Division.

- **Non-metered Water Analysis Report:** The non-metered water estimates are valuable in deciding whether a leak detection program is justified. The report is designed to monitor source/supply production and customer consumption on a bi-monthly basis. The difference between metered source production and metered sales to consumers is the non-metered water that is pumped into the system but not sold. Non-metered water includes line flushing, reservoir cleaning, firefighting, sewer flushing and street cleaning, and it's also a result of leaks, unauthorized water use, and inaccurate metering. The Fiscal Division monitors the report and informs the Operations Division if non-metered water is excessive.

- **Leak Detection Program:** The Kaua'i DOW conducts case-by-case leak detection investigations and repair for suspected section of leaking pipeline. The Kaua'i DOW is evaluating the purchase of leak detection equipment and/or use of contracted leak detection services to expand its program.

- **Storage Tank Reservoir Overflow Alarm and Automatic Level Controls:** The Department maintains and operates tank overflow alarms and automatic valves to prevent system losses to unnecessary overflows.

Current Demand-Side Conservation Programs include:

- **Plumbing Code Regulation:** In July 1993, the County of Kaua'i amended the County Plumbing Code to require the installation of water saving fixtures for new construction. The plumbing code also requires installation of pressure reduction valves in order to maintain a maximum 80-pound per square inch building service pressure.

- **Voluntary Emergency Water Shortage Notice:** The Kaua'i DOW requests voluntary water conservation during dry periods and emergency water outages. High consumption during dry summers has resulted in distribution of water shortage notices for affected areas. Water customers are asked to voluntarily reduce consumption by 10-25% in systems that are unable to meet higher peak demands. During emergencies (i.e. pump failure, pipeline breaks, storm damage, etc.) water conservation notices are issued to customers.

- **Public Outreach/Education Program:** Kaua'i DOW's existing and future water conservation programs involves targeting both adults and children through printed brochures, advertisements, public service announcements, presentations, workshops and other media. Every year, the Kaua'i DOW coordinates an island-wide water education festival for fifth grade students called, Make a Splash with Project WET (Water Education for Teachers). Project WET is an international-interdisciplinary-environmental education program. This festival brings together parents, students, teachers, government resource agencies and enthusiasts of all kinds for a common goal: to educate and promote awareness of water resources in a fun and interactive environment. Learning stations and exhibits are set up and led entirely by volunteer Kaua'i DOW employees, educators and community members.

The Kaua'i DOW's current conservation promotions include:

- Low Flow Shower Head Distribution
- Low Flow Kitchen Aerator Distribution
- Shower Timer Distribution
- Leak Detection Tablet Distribution
- Public Education – Presentations; Community Events; Publications and Brochures; School Programs

Information on conservation measures and other public outreach materials listed below are accessible through the Kaua'i DOW's website, www.Kauaiwater.org.

- Water conservation brochure "35 Tips to Save Water"
- Table tents for restaurants, "Water served on request only"
- Free low-flow water fixture forms
- Tips for conserving water around the house and outdoors
- Leak detection and instructions on fixing a leaky faucet
- Xeriscape resources and information on DOW's demonstration project at the agency's Lihue office
- Kids page with educational activities

- Public education programs for schools, clubs, and organizations

### J.3.4.4 Hawai‘i County Department of Water Supply Conservation Program

The County of Hawai‘i’s Department of Water Supply provides domestic water service via 24 water systems and 67 sources located throughout the island. The individual water systems are not interconnected, except in the more densely populated districts of South Hilo and Kona. The Department of Water Supply services approximately 35,000 customers with about 8.5 billion gallons of water annually.

The Hawai‘i County water rates are designed to encourage conservation through an inverted-block rate structure, which charges higher unit costs for heavy water users. The Department of Water Supply has also published educational brochures and handouts that are available to the public. During periods of drought or low rainfall, the department may publish water conservation notices in local newspapers and include notice inserts in customer’s water bills. These notices typically call for a voluntary reduction of domestic use by 10% and restrict agricultural irrigation to the hours between 8 p.m. and 6 a.m. Water conservation notices also includes tips on how to reduce water to meet the 10% voluntary reduction. If subsequent use reductions are insufficient, the department may issue notices for mandatory use reductions until the water supply situation has stabilized.

### J.3.4.5 Military Water Conservation Programs[5]

The U.S. Department of Defense does not have a department-wide water conservation program, but each division follows the respective governmental requirements. Military installations throughout Hawai‘i have been required to conserve water through various mandates including recent Executive Orders. Some examples are the installation of electric water meters and reductions of water usage by a specific amount each year. There currently is not a document adopted by all military branches that describes a water conservation plan.

Federal agencies must also improve their water efficiency and management by the following:

- Reducing potable water consumption intensity 2 percent annually through fiscal year 2020, or 26 percent by the end of fiscal year 2020, relative to a fiscal year 2007 baseline.

- Reducing agency industrial, landscaping, and agricultural water consumption 2 percent annually, or 20 percent by the end of fiscal year 2020, relative to a fiscal year 2010 baseline.

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[5] CH2MHILL. 2013. *Hawai‘i Water Conservation Plan Final Report*. Prepared for Commission on Water Resource Management. February 2013

- Identifying, promoting, and implementing water reuse strategies consistent with state law that reduce potable water consumption.

There may be opportunities to partner with military housing contractors to implement water conservation programs and practices within the housing communities.

### J.3.5 Recommendations for Water Conservation Programs

As described above, several State and county agencies currently implement various water conservation programs and measures. Private businesses and organizations (e.g., Hawai‘i Green Business Program, Landscape Industry Council of Hawai‘i, Hawai‘i Lodging and Tourism Association) have also incorporated water conservation in their daily operations and program activities. The State recently developed the Hawai‘i Water Conservation Plan, which covers all sectors of water use for government agencies and private entities. The following are recommended:

- The Commission on Water Resource Management should continue to implement recommendations in its Hawai‘i Water Conservation Plan (http://state.hi.us/dlnr/cwrm/planning/hwcp2013.pdf)

- The Commission on Water Resource Management should convene the Water Conservation Advisory Group at least once a year to develop and implement water conservation initiatives and programs in all water use sectors.

- The Commission on Water Resource Management should continue to work with the State Building Code Council as well as individual County building departments to adopt higher water efficiency standards in the building and plumbing codes.

- The Commission on Water Resource Management should pursue water conservation program funding through the state budgeting process, exploring sustainable funding mechanisms, grants, and cost-sharing with other government agencies.

- The Commission on Water Resource Management should support and assist the development and implementation of individual water conservation plans for government and the private sector.

- The Commission on Water Resource Management should explore ways to incorporate water conservation planning into its regulation and permitting processes.

- Existing and developing State agency conservation efforts should be identified in the next update of the SWPP. The SWPP should also suggest specific agency conservation goals and actions.

- Water users and water system operators should consider recommended BMPs for independent implementation as water conservation has been shown to be a cost-effective strategy for stretching limited water supplies.
- The agencies responsible for preparing other Hawai‘i Water Plan components should incorporate appropriate water conservation measures as part of their resource strategies to meet existing and future demands.
- State agencies should conduct facility water audits and implement appropriate water conservation measures to reduce water demands and achieve cost savings.
- Promote Administrative Directive No. 06-01 requiring all State agencies and programs to increase their commitment towards implementing innovative and resource efficient operations and management.
- Because water in Hawai‘i is relatively inexpensive compared to energy costs, the water-energy nexus in Hawai‘i should be further studied to incentivize water conservation through the reduction of energy usage. This is elaborated further in the following section.
- Water and land use planning efforts should be coordinated to avoid inadequate water availability for future land use.
- Support the Fresh Water Initiative and goals identified in the report: A Blueprint for Action, Water Security for an Uncertain Future.

## J.4 Water-Energy Nexus

Water and energy systems are inextricably linked in modern society. This is true for both drinking water and wastewater systems. For the majority of drinking water systems in Hawai‘i, energy is used to pump ground water from wells and to lift this water to elevated reservoirs in order to provide water service to customers. In the case of wastewater, energy is used to pump wastewater to treatment plants where more energy is used for the treatment and disposal and/or reuse of recycled water. Water is also used in energy production in Hawai‘i where electricity power plants use water for steam generation and cooling. This water-energy connection is referred to as the water-energy nexus.

The water needed for energy production is referred to as water “embedded” in energy and the energy needed for water supply and wastewater treatment is referred to as energy “embedded” in water. It is not precisely known how much energy is embedded in water and how much water is imbedded in energy in Hawai‘i. We do know that conserving water conserves energy both from the water supply and wastewater disposal ends of the use cycle.

Hawaiʻi Energy estimated that in 2013 the state's public water and wastewater utilities consumed an estimated 290.3 million kilowatt-hours (kWh) per year amounting to around 3.2 percent of total electrical utilities' sales.[6] The U.S. Geological Survey estimated that in 2005 statewide withdrawal of fresh ground water for thermoelectric power was 37.8 million gallons per day.[7]

The substantial amount of energy used by water and wastewater utilities and the volume of water used for energy production presents opportunities for utilities to find ways for conserving both water and energy by improving efficiencies in their production processes. Water and wastewater utilities should conduct energy and water audits to inform their decision making.

### J.4.1 Programs

There are very few programs targeting combined water-energy conservation in Hawaiʻi. Some county water utilities have low-flow showerhead and/or low-flow pre-rinse spray head giveaways. This will help to save both hot and cold water and would also help to reduce energy demands to heat the water.

State and County government allows agencies to enter into energy (and water) savings performance contracts (ESPC). An ESPC is a contractual arrangement where the contractor finances a facility's capital energy and water efficiency improvements and is paid on a schedule for achieving energy and water saving performance goals in the facility. Hawaiʻi Department of Business, Economic Development and Tourism found that there were eight state and county ESPC projects initiated since 1996 including 242 buildings. These projects realized an annual cost savings of $44.0 million for all projects combined (an average of 39% savings).[8]

Hawaiʻi Energy is a ratepayer-funded energy conservation and efficiency program under contract with the Hawaiʻi PUC serving the islands of Oʻahu, Maui, Molokaʻi, Lānaʻi, and Hawaiʻi. Hawaiʻi Energy is exploring ways to partner with water and wastewater utilities to improve energy efficiency and developed the *Water & Wastewater Energy Management Best Practices Handbook, Hawaiʻi Edition, April 2014*.[9] This handbook outlines steps to be taken to develop a utility energy management program.

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[6] 2014, July 28, Hawaiʻi Energy, DLNR Release Two New Handbooks to Encourage Water Conservation and Greater Energy Efficiency [News Release], Retrieved July 29, 2014, from http://dlnr.Hawaiʻi.gov/cwrm/

[7] Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., 2009, Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344, 52 p.

[8] Hawaiʻi Energy Facts & Figures May 2014 [slide presentation], Retrieved July 29, 2014, from http://energy.Hawaiʻi.gov/resources/Hawaiʻi-state-energy-office-publications

[9] April 2014. Hawaiʻi Energy. Water & Wastewater Energy Management Best Practices Handbook, Hawaiʻi Edition. Retrieved July 30, 2014 from http://www.Hawaiʻienergy.com/water-and-wastewater.

CWRM developed the *Hawai'i Water System Audits and Water Loss Control Manual, February 2014*.[10] This manual is a how-to guide for drinking water utilities to conduct a comprehensive water audit and to determine intervention strategies to reduce system water losses within its system (from the water sources up to the customers' meter). Controlling system water losses and efficiencies is referred to as internal water conservation. Water system loss control can lead to decreased pumping of water thereby reducing the amount of energy consumed by the utility.

### J.4.2 Gaps

There is a limited data compiled on the actual amount of water embedded in energy and energy embedded in water. This is true for Hawai'i as well as across the United States. There needs to be better understanding of the energy consumption of a unit measure of water for the development, delivery, treatment and disposal of water in Hawai'i. This is also referred to as the energy intensity and can be expressed in terms of kilowatt-hour per million gallons (kWh/mg).

Another challenge is coordinating energy efficiency programs and water efficiency programs, which are typically run by the energy or water utilities independent of the other. There could be improved program delivery and return on investment if the energy and water programs are integrated or offered collaboratively.

### J.4.3 Recommendations

While Hawai'i is an island state, it shares many of the challenges that the continental U.S. faces when it comes to improving collaboration between the water and energy industries and organizations. It is helpful to look for examples of work addressing these concerns. The Alliance for Water Efficiency collaborated with the American Council for an Energy-Efficient Economy to prepare the report *Addressing the Energy-Water Nexus: A Blueprint for Action and Policy Agenda*.[11] This report was a result of a series of workshops attended by a diverse group of individuals form water and energy organizations and outlines a blueprint for advancing water and energy efficiency programs and policies. The following thematic elements are from the *Blueprint for Action*:

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[10] February 2014. Commission on Water Resource Management. Hawai'i Water System Audits and Water Loss Control Manual. Retrieved July 30, 2014 from http://files.Hawai'i.gov/dlnr/cwrm/planning/hwam2014.pdf

[11] Alliance for Water Efficiency and American Council for an Energy-Efficient Economy. (2014 May). Addressing the Energy-Water Nexus: A Blueprint for Action and Policy Agenda. Retrieved July 29, 2014 from http://www.allianceforwaterefficiency.org/water-energy-intro.aspx

1. Increase the level of collaboration between the water and energy communities in planning and implementing programs.
2. Achieve a deeper understanding of the energy embedded in water and the water embedded in energy.
3. Learn from and replicate best practice integrated energy-water efficiency programs.
4. Integrate water into energy research efforts and vice versa.
5. Separate water utility revenues from unit sales, and consider regulatory structures that provide an incentive for investing in end-use water and energy efficiency.
6. Leverage existing and upcoming voluntary standards that address the energy-water nexus.
7. Implement codes and mandatory standards that address the energy-water nexus.
8. Pursue education and awareness opportunities for various audiences and stakeholders.

The elements above were developed for the continental U.S. where the energy and water infrastructure is interconnected across state lines and where western water laws apply. However, all of these thematic elements are relevant in the state of Hawaiʻi and could be adopted wholesale as recommendations for Hawaiʻi.

In addition to the general recommendations above, CWRM should gain a better understanding of Hawaiʻi's water-energy nexus by conducting detailed audits to determine water demands for the generation of electricity (embedded water) and energy demands for providing drinking water and for treating wastewater (embedded energy).

**Hawaii Water Energy Nexus Report**

In an effort to understand the true cost of water and energy production to utilities, the State of Hawaiʻi DLNR CWRM surveyed water, wastewater, electrical and renewable energy purveyors throughout the State. The intent of the survey was to characterize, compare and provide a baseline for water and energy use for the operation of the various utilities over the 2014 and 2015 calendar years. A total of 137 utility companies were identified and contacted for participation in the study. Entities were identified based on registration with the PUC, DOH, and/or CWRM. Systems requiring little to no energy use, such as individual wastewater systems, wind farms and solar fields, were exempt from the study. Participation in the study was voluntary.

Water and energy consumption data was obtained from 39 public and private utilities throughout the State. To quantify the water energy relationship, energy intensity, or the amount of energy required to collect, treat and distribute 1,000 gallons of water, was calculated for each individual system or facility. Likewise, for electrical systems which consume water for energy production, water intensity, or the amount of water needed to produce a unit of energy, was calculated for each facility. Marginal cost, or the cost to produce a unit of water, was used to visually represent the cost of water use to the utility. **Table J-1** summarizes the energy intensities and marginal costs for water, wastewater and recycled water industries in 2014 and 2015. **Table J-2** summarizes the water use by electrical utilities in 2014 and 2015. Cost information for electrical utilities was not available. The findings presented herein are based on the data collected from the 39 participating utilities and may not accurately represent the industry as a whole.

### Table J-1 2014 and 2015 Water and Energy Use

| Year[1] | Industry | Energy Intensity (kWh/kgal) | | Marginal Cost ($/kgal) | |
|---|---|---|---|---|---|
| | | Range | Average | Range | Average |
| **2014** | Water | 0.0 – 24.6 | 4.4 | $0.06 - $9.22 | $1.66 |
| **2015** | Water | 0.0 – 23.9 | 5.1 | $0.03 - $7.50 | $1.70 |
| **2014** | Wastewater | 2.1 – 23.5 | 7.2 | $0.49 - $8.66 | $2.54 |
| **2015** | Wastewater | 3.1 – 24.2 | 12.1 | $0.91 – 6.98 | $3.87 |
| **2015** | Recycled Water | 0.1 – 6.3 | 3.5 | - | - |

[1] The number of participating utilities varied for each year; therefore, data for 2014 and 2015 cannot be compared against each other as the number of utilities or participating utilities may not be the same.

### Table J-2 2014 and 2015 Electrical Water Use

| Year[1] | Water Intensity (kgal/kWh) | |
|---|---|---|
| | Range | Average |
| **2014** | 0.00 – 1.09 | 0.15 |
| **2015** | 0.00 – 1.45 | 0.35 |

The energy intensities for each industry varied from system to system, depending on system characteristics. **Table J-3** summarizes some of the primary drivers of energy and water use for each industry. Understanding the primary drivers of energy use can help utilities develop and implement energy management strategies to decrease energy use and minimize operating costs. Opportunities for energy management include optimizing the operations of the system, using renewable energy sources, mitigating energy use during peak energy demand periods and monitoring energy consumption. These strategies target energy reduction and water use by association.

## Table J-3 Primary Drivers of Energy and Water Use

| | |
|---|---|
| Water | • Pumping: elevation, distance, volume, pressure<br>• Volume treated<br>• Source: surface water, brackish, ocean, groundwater<br>• Treatment technology |
| Wastewater | • Pumping<br>• Volume collected and treated<br>• Level of treatment: primary, secondary, tertiary<br>• Treatment technology: activated sludge, UV disinfection |
| Recycled Water | • Pumping - distribution<br>• Volume collected and treated<br>• Level of treatment: R-1, R-2, R-3, R-O<br>• Treatment technology: trickling sand filter, UV disinfection<br>• Effluent distribution |
| Electrical | • Volume of electricity generated<br>• Type of electricity production: fossil fuels, renewable energy |

In addition to energy management programs, water conservation programs targeting both utilities and end users should be initiated to protect Hawaii's fresh water resources. Utilities and agencies often pursue water conservation programs independently with dispersed results. Greater collaboration between utilities and government agencies is necessary to develop effective and mutually beneficial conservation initiatives and programs, including partnerships and collaboration between energy and water utilities. Water conservation benefits everyone and as such, should be perceived as a partnership effort by all users. Strategies requiring collaboration between multiple stakeholders include promoting the use of recycled water, joint infrastructure improvements and development of appropriate water use polices. Working together in unison will yield greater net benefits and long term results for both users and the environment.

## J.5 Developing a Resource Augmentation Program

To meet future water demands throughout the State, alternative water sources should be developed to augment naturally occurring water supplies. The order in which to pursue development of alternative sources is influenced by local and county-level needs and constraints. In some areas of the state, water availability is limited by the extent and capacity of the pump and distribution system, rather than a scarcity of surface and ground water resources. In other areas, increasing water demands may only be met by augmentation, alternative water sources, or water transfers. Further, scientists are observing that climate change is affecting the expected timing and intensity of rainfall patterns in Hawaiʻi. It is uncertain how this will affect water supplies and the future availability of water, but some models predict that the dry areas of the state may become drier and the wet areas wetter. Given this uncertainty, it is important to look for alternatives to augment natural ground and surface water supplies, especially if there is a chance that future water availability will be decreased due to climate change.

Judicious management of water resources is the primary tool for sustaining Hawaiʻi's people, environment, culture, economy, and lifestyle. Water can be a factor limiting growth and development and in turn, growth and development can limit and decrease the viability of the resource. Land use planning and water resource planning are thus closely linked.

Resource augmentation must be recognized as an important component in water resource management. Alternative water supplies are renewable, drought resistant, environmentally sound, and socially responsible. Goals and priorities must be established to integrate the use of alternative water resources into daily life, and to encourage the development of these supplies in an efficient and safe manner.

The State is not a water purveyor, with the exception of a few small public water systems and agricultural water systems. The county water agencies currently operate all municipal water systems and are responsible for developing municipal water sources. The DLNR Engineering Division is the agency that conducts source development for State facilities that are not able to be served by existing public water systems.

It is the State's responsibility to encourage the development and maximum beneficial use of alternative water resources to augment the water development programs of each county. The State should also provide leadership and guidance to the counties and private water purveyors in the form of goals and priorities established through an integrated resource augmentation program. Such a program would ensure that the pursuit and development of alternative-water sources is executed in an efficient and sensible manner, and would also encourage cooperation, development of implementation incentives, and innovative thinking among State, county, and private entities.

Current CWRM programs that promote the use of alternative sources include water use regulation, instream flow standard assessment, and long-range planning. In designated water management areas, applicants for water use permits must show that no alternative water sources are available to meet their needs. If an alternative source is available, CWRM will deny requests for use of public trust resources in favor of the available alternative. In setting instream flow standards, in order to minimize impacts of streamflow restoration on existing uses, the Water Code directs CWRM to consider the availability of alternative water sources, among other physical solutions.[12] Finally, CWRM's *Statewide Framework for Updating the Hawai'i Water Plan*[13] advocates the use of an integrated resource management (IRP) approach for updating the County Water Use and Development Plan components of the Hawai'i Water Plan. IRP is a comprehensive form of planning that encompasses least-cost analysis of resource management options, participatory decision-making process, and the development of water resource alternatives. IRP attempts to consider all direct and indirect costs and benefits of demand-side and supply-side management, in addition to augmentation of supply.

The State Water Code states that CWRM shall plan and coordinate conservation and augmentation programs in cooperation with other agencies and entities.[14] Planning for resource augmentation requires considerable lead-time for research and technical-resource acquisition, pilot programs and testing, and funding attainment. Resource augmentation program goals and priorities should be developed in consideration of a realistic time frame for implementation. The following section reviews various resource augmentation methods and resources and describes CWRM's role as an advisory agency for expansion and further development of augmentation programs statewide.

## J.6 Water Supply Augmentation Resources

Most of Hawai'i's freshwater supplies have been developed through traditional means, including ground water wells, stream diversion systems, and surface water reservoirs. However, current and anticipated demands for water will require new source development and may surpass the volumes of naturally occurring ground and surface water in some areas of the State. In order to sustain Hawai'i's growing population and to meet the needs of industry, the State and county governments must actively pursue alternative water supplies. Alternative water sources should be developed not only to meet certain water demands, but also to help ensure the long-term viability of our ground water aquifers and watershed areas.

[12] HRS §174C-71(1)(E)

[13] Commission on Water Resource Management. (2000). *Statewide Framework for Updating the Hawai'i Water Plan*

[14] HRS §174C-5(12) and §174C-31(d)(4).

There are several issues to consider in exploring resource augmentation; they are:

- **Reliability considerations:** The source is vulnerable to drought conditions or seasonal variations in precipitation; there is a dependence on fuel types that are susceptible to shortages or cost inflation; the economical development of the source must have sufficient capacity to meet demand.

- **Quality considerations:** The treatment process must be capable of producing water that can meet increasingly stringent water quality standards; the source should be suitable for the production of drinking water, irrigation water, or industrial water.

- **Efficiency & economic considerations:** The cost of developing alternative water sources in comparison to that of traditional source development must be considered; cost implications of alternative source development in planned stages to meet demand is also important; long-term operation and maintenance costs must be compared.

- **Technology:** An understanding of the history and dependability of related technologies must be gained; it is beneficial to investigate foreseeable advances in technology; including specialized technology and equipment requirements; public opinions/concerns regarding the technology should be solicited.

- **Environmental Impacts:** Environmental impacts of alternative water source development should be compared to that of traditional source development; utilities need the ability to mitigate negative impacts; it would also be appropriate to compare benefits of traditional source development with alternative source development.

Several alternatives could increase or extend freshwater supplies. Reclaimed wastewater can provide for non-potable demands, including irrigation and industrial applications. Reclaimed stormwater could be used for artificial ground water recharge, environmental restoration, fish and wildlife habitat support, recreation, municipal uses, irrigation, and industrial uses. Desalinated water is well-established as a source of drinking water in other parts of the U.S. and in the Middle East, Japan, and the Caribbean. Other alternatives on the household-level, including the use of grey-water systems and rain barrels for landscape watering, can also help extend freshwater supplies.

The following sections discuss the alternatives of stormwater and wastewater reclamation and desalination methods to augment ground and surface water supplies. Each method is also briefly evaluated with regard to the issues listed above. For clarification purposes, the following definitions are offered:

| | |
|---|---|
| Wastewater reclamation: | *The treatment of wastewater such that it may be used for beneficial purposes.* |
| Recycled water: | *The useable end product of the wastewater reclamation process.* |
| Water reuse: | *The beneficial use of recycled water.* |

## J.6.1 Gray Water Reuse

The Hawaiʻi State DOH defines gray water as wastewater discharged from:

- Showers and bathtubs;
- Hand-washing lavatories;
- Wastewater that has not contacted toilet waste;
- Sinks (not used for disposal of hazardous, toxic materials, food preparation, or food disposal); and
- Clothes-washing machines (excluding wash water with human excreta e.g., diapers).[15]

With the increased acceptance of water reuse in Hawaiʻi, guidelines were needed to advise homeowners, land users, contractors, and engineers on the safe use of gray water. Gray water is an attractive option to supplement the water needed for residential landscape irrigation. Gray water from sinks, tub/shower drains, and washing machines are estimated to be 50 to 80 percent of the total residential wastewater generated. By reusing this wastewater stream to meet irrigation needs, not only is household freshwater use reduced, but also the amount of wastewater entering individual wastewater systems. Some of the nutrients found in gray water from cleaners and detergents could be considered fertilizers for plants.

In 2009 the Hawaiʻi DOH published guidelines that are intended to advise users on the proper application of gray water to protect both human health and the environment. As many of the health and safety concerns from gray water reuse are associated with the bacteria that can accumulate in gray water holding systems, the guidelines recommend subsurface application and monitoring of irrigated areas to ensure ponding does not occur.

[15] Hawaiʻi DOH, Guidelines for the Reuse of Gray Water, June 22, 2009

The 2009 guidelines recommend the following for the reuse of gray water for irrigation:

- Never use spray irrigation to apply gray water. Application of gray water must be done by utilizing a subsurface system.
- Gray water should never be used to irrigate root crops, vegetables that will be eaten raw, or other crops where the consumed portion of the plant rests on the ground.
- Gray water should be used to irrigate established lawns and plants.
- Seedlings and barren areas where a potential for runoff and/or ponding exists should not be irrigated with gray water.

## J.6.2 Wastewater Reclamation

Wastewater reclamation has been practiced for decades in the continental United States and other parts of the world, especially in areas where freshwater sources are limited. Water reuse should be viewed as a key component of sustainable water resource management. Recycled water can be a drought-proof and reliable supply of water. It can replace potable water currently being used for non-potable purposes. In some instances, the availability of recycled water has stimulated Hawaiʻi's economic development by attracting business activity. Water reuse also provides a mechanism for nutrients in wastewater to be utilized by vegetation, thereby reducing the need for fertilization. Finally, when compared to the traditional disposal methods through outfalls and injection wells, wastewater reclamation and reuse is recognized as an environmentally preferred method of effluent disposal. While water-reuse applications have grown significantly in Hawaiʻi in recent years, recycled water is still an underutilized resource. In 2013 CWRM updated its *Hawaiʻi Resource Survey and Report* to provide current information on water reuse programs across the state. The information presented in this section of the WRPP has been adapted from the 2004 and 2013 reports.

In 1999, approximately 13% of the volume of municipal consumption in Hawaiʻi was attributed to recycled water sources, and this figure continues to increase with the eventual implementation of planned and proposed reclamation and reuse projects. As Hawaiʻi's population increases, wastewater volumes will increase proportionally, creating more recycled water and reuse opportunities. Integration of water reuse into the statewide water use policy will be critical as water demands increase.

Recycled water must meet strict water quality standards set by the Environmental Protection Agency (EPA) and the Department of Health (DOH). These water quality standards ensure proper treatment and disinfection, although treatment levels differ depending on the end use. The EPA and DOH regulations require wastewater treatment and encourage the availability and reuse of its by-product, recycled water. In 2016 the DOH updated its reuse guidelines to streamline the approval process of reuse projects and to also provide clarity on the appropriate use of recycled water. In some cases, it may be less expensive to develop recycled water distribution systems than to develop new sources of water and continually pay effluent-disposal costs, particularly with the implementation of Total Maximum Daily Loads through the National Pollutant Discharge Elimination System permitting system. While there are significant initial capital costs for communities to develop recycled water distribution systems, the addition of recycled water to municipal water budgets will secure long-term sustainability of communities and economic growth.

The typical Wastewater Treatment Plant (WWTP) is a large facility that requires significant amounts of land and operational resources, but smaller scale applications of reclamation technology are becoming more common in subdivisions, and even serve single-family homes. Small and decentralized wastewater management systems provide local solutions for wastewater collection, treatment, and reuse. The Hawaii Legislature passed Act 229 in 2015 to encourage the State to explore the feasibility of scalping wastewater from the sewage system to reuse at airport facilities. Such studies will not only encourage innovation in the reclamation and reuse of wastewater, but could also demonstrate the avoided costs associated with the transmission of wastewater to large, regional facilities.

### J.6.2.1 Recycled Water Applications

There are numerous uses for recycled water. Some of the reuse applications listed below are already taking place in Hawaiʻi on a small scale:

- Constructed Wetlands
- Ground Water Recharge
- Irrigation
- Recreational Uses
- Construction-Related Uses
- Recharge of Natural Wetlands
- In-Stream Flow Restoration
- Composting
- Toilet and Urinal Flushing
- Industrial Uses

Wastewater reuse in Hawai‘i is being aggressively implemented in some parts of the state, such as Maui County and the ‘Ewa Plain on O‘ahu. However, wastewater recycling is not a priority in other areas. As stated earlier, the integration of water reuse into the statewide water use policy will become more critical as our potable water demands increase.

In 2013, CWRM updated the *Hawai‘i Water Reuse Survey and Report* to monitor the utilization of recycled water in Hawai‘i. The report inventories and describes existing reuse projects in the state, and more importantly, identifies opportunities for future reuse projects in Hawai‘i. The results of the *2013 Hawai‘i Water Reuse Survey and Report* and the updated DOH reuse guidelines should be incorporated into a guidance document to assist county reuse initiatives. Recycled water remains an underutilized resource with many opportunities for expansion. *Volume II: Recycled Water Projects* of the 2016 *Reuse Guidelines* (http://health.hawaii.gov/wastewater/home/reuse/) identify areas where recycled water can be utilized on each island.

Recycled water at different levels of treatment is widely used for agricultural and landscape irrigation on the U.S. mainland. There are also direct and indirect potable reuses of recycled water, where recycled wastewater is “purified” through advanced treatment and introduced into the potable, drinking water system. In direct potable reuse, the purified recycled water is added to a drinking water system as an additional source water input to the potable treatment phase or at some point in the distribution system. The State of Texas is studying direct potable reuse to meet its water supply needs.[16] Indirect potable reuse involves an intermediate storage phase prior to the purified recycled water being added to the drinking water system. Unplanned indirect potable reuse is very common in the U.S. Communities that are situated along major waterways, such as the Mississippi River, have historically produced potable water from river sources that have circulated through multiple cycles of withdrawal, treatment, and discharge.[17] U.S. EPA’s 2012 Reuse Guidelines provides examples of planned indirect and direct potable reuse in the U.S. and elsewhere.[18]

### J.6.2.2 Guidelines for Treatment and Use of Reclaimed Water

The DOH issued the *Guidelines for the Treatment and Use of Reclaimed Water* (Guidelines) in November 1993 and most recently updated the Guidelines in January 2016. They are now referred to as the *Reuse Guidelines*. The document is divided into two volumes and identifies requirements for both purveyors and the users of recycled water. Volume I: Recycled Water Facilities identifies the technical requirements that must be met for the distribution of recycled water. Volume II: Recycled Water Projects outlines the application process required to utilize

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[16] Texas Water Development Board. *Evaluating the Potential for Direct Potable Reuse in Texas.* Retrieved from http://www.twdb.state.tx.us/innovativewater/reuse/projects/directpotable/index.asp

[17] Asano, T. (1998). *Wastewater Reclamation and Reuse: Water Quality Management Library, Vol. 10,* Boca Raton, Florida: CRC Press LLC.

[18] U.S. Environmental Protection Agency, Office of Wastewater Management. (2012, September). *Guidelines for Water Reuse*. (EPA/600/R-12/618).

recycled water and identifies areas that are approved for its application. The Guidelines are referenced in Chapter 11-62 of the Hawaiʻi Administrative Rules (HAR).

To guide the safe application of recycled water, DOH has defined three categories for areas of its application: Restricted areas, Conditional areas, and Unrestricted areas. Restricted areas are defined in the 2016 *Reuse Guidelines* as:

1. Areas within the Zone B capture zone delineation (CZD) for public drinking water sources that draw water from a shaft excavated along the surface of the water table where ground water travel to the shaft is two years or less;

2. Areas within a 1,000 foot radius of zones designated as Ground Water under the Direct Influence (GWDUI) of surface water (also a Zone B CZD); and

Areas within 1,000 feet of wetlands, ponds or enclosed bays that fall within a designated reserve or protected conservation district.

If recycled water is to be used in Restricted areas, it is subject to the following requirements:

1. Notification of agencies or entities, such as drinking water purveyors or protected conservation district or reserve managers, involved with or connected to the potentially impacted area.

2. Chemical analysis of designated constituents in the effluent recycled water for treatment plants supplying more 10,000 gallons per day.

3. Hydro-geologic study to predict the impact of recycled water.

4. Possible soil or ground water monitoring based on the results of the items 2 and 3 above.

Conditional areas are defined as:

1. All public drinking water CZDs;

2. Designated reserves; and

3. Protected conservation districts, excluding those specifically designated under Restricted Areas.

If recycled water is to be used in Conditional areas, it is subject to the following requirements:

1. Notification of agencies or entities, such as drinking water purveyors or protected conservation district or reserve managers, involved with or connected to the potentially impacted area.

2. Chemical analysis of designated constituents in the effluent recycled water for treatment plants supplying more 10,000 gallons per day.

Recycled water use in unrestricted areas is not subject to the requirements of Restricted and Conditional areas.

All Waste Water Recycling Facilities (WWRF) that purvey recycled water must meet the recycled water quality standards established by the DOH Guidelines. However, WWRFs constructed prior to the passage of the original 1993 Guidelines may have certain components of their treatment system "grandfathered," making them exempt from the Guidelines. For example, the County of Maui's Lahaina WWRF's UV disinfection system was designed and constructed prior to the 1993 Guidelines. The UV system does not have the backup capacity required by the Guidelines so it was "grandfathered" by DOH since it was approved prior to 1993.[19]

All projects that use recycled water must first receive DOH approval. The DOH approval process has certain design and site inspection requirements. Purveyors of recycled water are required to keep operational records of the daily volumes and water quality produced by their water reclamation facilities. These records are subject to review by DOH during annual operation and maintenance inspections of each facility.

Maui County was the first county in Hawaiʻi to establish rules for recycled water use in 1997. In 2002, the Honolulu BWS adopted rules governing the use of recycled water in the City and County of Honolulu. Both sets of rules incorporate the DOH Guidelines. The Maui County rules include sections on establishing recycled water service, design standards for on-site and off-site recycled water facilities, operational guidelines, monitoring and enforcement provisions, and fees and charges. Honolulu BWS rules establish requirements to ensure protection of water sources and public health.

Further information on the current DOH Reuse Guidelines can be found at:
http://health.hawaii.gov/wastewater/home/reuse/

[19] CWRM. 2013 Update of the Hawaiʻi Water Reuse Survey and Report. 2013

### J.6.2.3 Recycled Water Classifications, Definitions, and Allowable Uses

Recycled water is classified as either R-1, R-2, or R-3 based on the level of treatment it has received. The first step in wastewater reclamation is primary treatment, which removes settled or floating solids. In secondary treatment, organic matter is removed, usually through “biological cleansing” using bacteria. Tertiary-treated recycled water is filtered and disinfected to remove up to 99% of impurities and suspended solids. Purveyors of recycled water must meet the treatment and water quality standards summarized below for R-1, R-2, and R-3 waters.

R-1 water is tertiary-treated recycled water that has undergone a significant reduction in viral and bacterial pathogens and meets the highest recycled water standards. R-1 water is oxidized, filtered, and exposed to disinfection processes to remove bacteria and viruses. It is of non-potable quality, but it is deemed safe for human contact. R-1 water is now approved for a number of applications including spray irrigation of golf courses, parks, athletic fields, school yards, residential properties that are managed by an irrigation supervisor, road sides and medians, and for vegetables and fruits that are eaten raw. The number of projects in Hawaiʻi utilizing R-1 water has increased significantly in recent years.

R-2 water is disinfected, secondary-treated recycled water. R-2 water has been oxidized and disinfected; however, the disinfection criteria are not as stringent as that of R-1 water. Therefore, the reuse applications of R-2 water are limited. Spray irrigation using R-2 water is limited to evening hours, and a 500-foot buffer zone between the approved-use area and adjacent properties is required. Several golf courses in Hawaiʻi are irrigated with R-2 water, although some are exempt from the 500-foot buffer zone requirement because they existed before the DOH established the Guidelines. Food crops that are irrigated with R-2 water must be either irrigated via a sub-surface irrigation system or, if irrigated with spray irrigation, must undergo extensive commercial, physical or chemical processing determined by the DOH to be sufficient to render it free of viable pathogenic agents, before it is suitable for human consumption.

R-3 water is undisinfected secondary-treated recycled water, and there are severe limitations on its use. Currently, the Parker Ranch pasture-irrigation project on the Big Island and the Puʻu O Hoku Ranch constructed-wetlands project on Molokaʻi are the only projects in Hawaiʻi that utilize R-3 water.

Reverse osmosis (R-O) is a method of treatment that is used in wastewater reclamation and in seawater or brackish water desalination. R-O water is wastewater that has undergone secondary treatment, followed by purification through an ultra-fine membrane that allows only water to pass. R-O water is then disinfected prior to use.

A complete list of the allowable uses of recycled water is summarized in the DOH Guidelines under Chapter III – Uses and Specific Requirements for Recycled Water.

### J.6.2.4 Wastewater Reclamation Issues and Constraints

In the development of water reuse programs and projects, there are several issues that can delay progress. Certain planning and preparatory efforts must be carried out to address economic issues, legislative constraints, and public acceptance. Jurisdictional and regulatory obstacles, however, cannot be surmounted without first addressing the issue of public perception of water reuse.

To realize success, a water reuse program or project should incorporate the following elements:

1. Gain public acceptance.

2. Encourage cooperative planning among agencies.

3. Overcome regulatory hurdles.

4. Strategize on funding sources.

5. Grow a customer base and encourage demand.

The following sections provide information and strategies for achieving these program elements and for facilitating water reuse projects.

1. **Gain public acceptance**

   Sound and proactive communication and education programs are essential for water reuse projects and programs to succeed. Failure to educate the public early on may delay or even stop the implementation of water reuse projects or programs.

   Two key concepts must be emphasized in public outreach programs:

   - *Recycled water can be an important component of the community's overall water supply.* The main reason for implementing water recycling programs is to supplement limited freshwater supplies.

   - *Recycled water is safe for approved uses.* The community must gain a basic understanding of how wastewater is treated and made safe through the recycling process. The community may have concerns regarding the safety of using recycled water for landscape irrigation, especially in locations such as parks, school yards, shopping centers, hotels, and condominiums. Agricultural producers may also share similar concerns. Proactive public education programs, with emphasis on disinfection, monitoring, and quality assurance, will help the community feel more comfortable with the idea of using recycled water.

Target audiences for education and outreach programs include politicians, schools, the general public, community organizations, and new and potential recycled water users. The educational outreach program described below is based on the County of Maui Department of Public Works and Environmental Management, Wastewater Reclamation Division program, and may be used as a template for other outreach programs throughout the state. The following are examples of outreach methods that are appropriate for each target audience:

**Government Officials:** A significant amount of time should be expended educating local government officials on the benefits and applications of recycled water through presentations at council meetings and other public meetings. Literature and testimony from local and national water reuse experts are also effective, and personal meetings allow elected officials to ask questions and broaden their knowledge of reuse.

**Schools:** Educating young people is the best way to establish long-term support for the concept of recycling water, and to develop behavior that will enhance sustainability within the community. Outreach programs should first notify school administration and teachers of the availability of an environmental-education program on water conservation and wastewater reclamation and reuse. Components of the program could include classroom presentations, water quality lab activities, wastewater reclamation facility tours, career-day speaker appearances, and assistance with school science projects. Desktop demonstrations, slide shows, videos, poster boards, and information booklets can be incorporated into the program, along with the distribution of promotional items such as rulers, stickers, magnets, and water conservation kits.

**General Public:** In addition to printed informational materials and promotional items, the general public can benefit from tours of wastewater reclamation facilities, where information can be shared on-site and face-to-face. Educational videos can be broadcast on community-cable access television, and copies of the video can be made available for loaning upon request. Additionally, press releases announcing improvements and expansions to recycled water programs and facilities and media coverage can help spotlight and reinforce the importance of recycled water.

**Community Organizations:** Presentations can be developed and shared with community groups such as the Rotary Club and other community associations, the local Chamber of Commerce, hotel and other business associations, and engineering, architecture, and contractor associations, which often have regular meetings and welcome guest speakers. These speaking engagements can be utilized to provide the most current information on recycled water programs, and can encourage public involvement by raising interest and identifying groups who will champion the program.

**New and Potential Recycled Water Users:** Educational presentations that focus on the production, safety, and proper management of recycled water can be made to the owners, managers, and employees of new and potential water reuse projects. Such presentations should emphasize water quality monitoring of the recycled product, including turbidity monitoring, automatic diversion of substandard recycled water, and fecal coliform monitoring. The presentations should also discuss best management practices and examples of successful local and national water reuse projects. Facility tours should be offered as a follow-up to these presentations, along with educational pamphlets and promotional items.

**2. Encourage cooperative planning among agencies.**

Water reuse provides benefits in both water supply and wastewater disposal. A common issue encountered by municipalities in the early stages of a water reuse program is the determination of which agency, the water supplier or the wastewater-services provider, will champion and administer the program. Recycled water is the link between water and wastewater. Therefore, no matter which agency takes the lead in the development and operation of a reuse program, the other agency should support the program in some capacity.

To implement recycled water use, county agencies must also coordinate permitting and management actions. For example, designing office and commercial buildings with dual water supplies for the purpose of flushing toilets and urinals with R-1 recycled water represents an excellent opportunity to displace the use of large amounts of potable water. The DOH Guidelines allow R-1 water to be used for toilet and urinal flushing, if the county plumbing code incorporates language pertaining to dual water supplies within buildings. Therefore, all counties in Hawai‘i should incorporate Appendix J of the 1997 version or later of the Uniform Plumbing Code into their respective county plumbing codes. Appendix J includes the provisions required to meet DOH Guidelines. Failure to update county plumbing codes for dual water supplies within buildings could result in the DOH denying projects that want to utilize recycled water for toilet and urinal flushing.

The Central Oahu Non-Potable Water Master Plan Study was completed in 2013 and was intended as a blueprint for cooperative planning amongst non-potable water stakeholders in Central Oahu. The primary focus of the study was planning for the distribution of non-potable water supplies to augment the needs of agriculture operation in one of the main growing regions of the State. The study is described in further detail below.

**3. Overcome regulatory hurdles.**

There are at least two state regulatory issues in Hawai‘i that restrict recycled water from use in potentially high-volume applications. Both of the issues are related to the DOH regulations and are summarized as follows:

1. The DOH Wastewater Branch does not permit the use of R-1 water for single-family lot irrigation; and

2. The DOH Clean Water Branch does not permit the discharge of recycled water into State waters.

In examining the first issue, it should be emphasized that yard and landscape irrigation consumes significant amounts of potable water, and such use can comprise up to 65% of a home's consumption on the leeward sides of the islands. The DOH Guidelines state that R-1 water may be used for "any form of irrigation served by fixed irrigation system supplied by buried piping for turf and landscape irrigation of a residential property where managed by an irrigation supervisor." In the past, the DOH has approved the use of R-1 water for multi-family residential developments.

However, the DOH has not approved projects proposing the use of R-1 water for irrigation in single-family residential developments. The Guidelines do not allow the use of recycled water on privately owned single-family residential lots and do not address specific requirements for dual-plumbed, recycled water facilities.

The DOH also is concerned that, even if the irrigation system for an entire single family development is managed by an irrigation supervisor, the agency cannot ensure adequate protection of public health due to insufficient staff. The agency feels that they lack personnel to properly monitor for conditions such as cross connections to the potable water system and overspray of R-1 irrigation water.

Concerns regarding monitoring and R-1 overspray can be addressed through reporting requirements and design requirements for irrigation systems. Future planned communities wishing to utilize R-1 water for irrigation could be required to provide the DOH with periodic cross connection inspection reports by a licensed plumber. Further, the development's single-family lots should be designed and built with subsurface drip irrigation systems. Maintenance of the common-area irrigation components should be performed by one contractor, and homeowners in the development would be required to use the same contractor for any necessary irrigation system repairs within their property.

As for the second issue regarding the discharge of R-1 water to State waters, it should be noted that recycled water is commonly used on the continental U.S. and in foreign countries for recharging natural wetlands and for instream flow restoration. The U.S. Bureau of Reclamation encourages the use of recycled water for these purposes. In Hawai‘i, this type of application of recycled water is not permitted as it is considered an unauthorized discharge to State waters.

Chapter 11-54-04 of the HAR, which lists the basic water quality criteria, also states that all waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including substances, or conditions or combinations thereof, in concentrations which produce undesirable aquatic life. The DOH Clean Water Branch's primary concern with the use of recycled water for recharging natural wetlands or restoring stream flows is that nutrients in the recycled water could result in excessive algal growth in the receiving waters.

The nutrient levels in recycled water can be reduced through a process called anoxic zone biological nutrient removal. Wastewater recycling facilities can be designed or retrofitted with anoxic zones that significantly reduce nitrogen and phosphorus concentrations in wastewater. Maui County has added this nutrient-removal process to the treatment at all three of the County's wastewater reclamation facilities.

To encourage the safe application of recycled water, the 2016 *Reuse Guidelines* identified areas where recycled water application is either restricted, conditional or unrestricted.

**4. Strategize on funding sources.**

To find effective funding sources, an understanding of the economics of recycled water must be attained. An important component of implementation of water reuse programs is to determine how to pay for recycled water reuse projects. Water reuse projects in general, with the development of recycled water distribution systems in particular, are expensive to construct and operate. The revenues earned from selling recycled water are often insufficient to pay for the full capital and operating costs associated with the production and delivery of the recycled water. This is especially true if the recycled water purveyor sets the recycled water rate comparable to the user's existing water rate. Setting recycled water rates at levels that will allow the purveyor to recover the full capital and operating costs of the recycled water system will most likely result in rates that are significantly higher than the rates paid for traditional water sources. Thus, there would be no economic incentive for a user to convert to recycled water.

Rather than laying the entire financial burden on the recycled water user, it is preferable to spread the cost of financing water reuse projects. There are four main potential sources of funds for water reuse projects:

- Recycled water users
- Potable water users
- Sewer users
- Government grants

Fees from recycled water users can be charged through recycled water rates (dollars per thousand gallons of recycled water used) or through direct, up-front payment of a portion of the project costs. These up-front payments are called assessment fees, capacity fees, connection fees, impact fees, or system-development fees, but they all basically represent a “joint venture” between the recycled water purveyor and the user to pay for all or a portion of the capital costs of the project.

Potable water users may be charged an appropriate portion of recycled water project costs, if they benefit from the implementation of the recycled water program (e.g., if water reuse results in reduced chances of potable water rationing). Similarly, sewer users may be charged a fee for water reuse projects if they receive benefits from reuse. Because future injection wells or outfall discharges of effluent in Hawaiʻi may be limited in the future by regulatory agencies, water reuse becomes an acceptable alternate disposal method, and it is appropriate for sewer users to pay for a portion of water reuse projects.

Government grants currently represent an unlikely source of funds, due to limited state and federal budgets, but recycled water purveyors in Hawaiʻi should be vigilant in the search for potential sources of government grants from various state and federal agencies. (Government loans are not considered sources of funds because they must be repaid. They do, however, represent a low-cost method of obtaining construction funding and are desirable for that reason.)

A good way to encourage reuse and public support of any fees associated with a reuse project is to develop the rate structure and fees with significant community input. A successful example is the County of Maui’s recycled water rate structure. The community-based committee formed to help develop the rate structure consisted of representatives from large landowners, the Maui Chamber of Commerce, the Maui Hotel Association, the Maui Realtor Association, members from the County of Maui’s Wastewater Reclamation Division and Department of Finance, and the County’s consultant. The committee decided upon a “composite” rate structure for its water reuse program that identified three main user classes: Major Agriculture ($0.10 per thousand gallons), Agriculture, including golf courses ($0.20 per thousand gallons) and All Other ($0.55 per thousand gallons). The recycled water rates were set to levels that were somewhat less expensive than the conventional alternative water sources used by the three user classes. Connection fees and meter fees were also developed. Because effluent disposal was an important factor driving Maui’s water reuse program, sewer user rates were also slightly increased.

Maui’s approach has allowed recycled water to become an attractive non-potable water source because it is less expensive than conventional alternative water sources. At the same time, sewer users help pay for the water reuse program because it is believed that they must be held responsible for not only the collection and treatment of wastewater they produce but for its ultimate disposal, whether it be through injection wells or though water reuse. It is recommended that recycled water purveyors in Hawai‘i attempt to recover the capital and operations cost of their respective water reuse programs by having recycled water users, sewer users and potable water users all contribute through their bimonthly user fees.

5. **Grow a customer base and encourage demand.**

Ordinances that require commercial properties to utilize recycled water for irrigation or other purposes have been used in several states to establish a strong customer base and maximize recycled water usage. Mandatory use ordinances are established because of a shortage of potable water resources or due to environmental problems associated with effluent disposal. Several cities in the continental U.S. have passed ordinances as part of their water reuse programs. Thus far, Maui County is the only county in Hawai‘i to have a mandatory use ordinance in place. The DOH Wastewater Branch attempted to establish such an ordinance in 2001, but it was not approved by the Legislature.

Maui County’s mandatory use ordinance was passed in 1996, primarily as a means to reduce the use of injection wells for effluent disposal, and secondarily to proactively supplement the limited potable water supplies within the County. Although the bill was eventually passed, it faced substantial opposition from some landowners, and an extensive public education and outreach effort was required. The ordinance required commercial properties within one hundred feet of the County’s recycled water distribution system to connect to the system within one year of the system’s availability, and to use the recycled water for irrigation. Thus, the ordinance was successful in reducing effluent, supplementing the water supply, and building a broad customer base for recycled water.

The passage of mandatory use ordinances in the other three counties could accelerate the development of water reuse programs. The DOH could also propose a statewide, mandatory reuse ordinance to support the agency’s goal of increasing Hawai‘i’s recycled water use. For an ordinance to be passed at the State or county level, a comprehensive, educational effort should be undertaken as early as possible to convince lawmakers and the general public of the many benefits such an ordinance can provide. At a minimum, any proposed mandatory use ordinance should contain sections on connection requirements, cross-connection control measures, an inspection policy and penalties for violation, system-reliability requirements, water quality requirements, and fees and rates for recycled water service.

### J.6.2.5 Pharmaceuticals and Personal Care Products as Pollutants

Pharmaceuticals and Personal Care Products (PPCPs) are “any product used by individuals for personal health or cosmetic reasons or used by agribusiness to enhance growth or health of livestock. PPCPs comprise a diverse collection of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, and cosmetics.”[20] The PPCPs that are not entirely absorbed by the body are excreted and end up in the wastewater stream or stormwater runoff. Research has shown that PPCPs are present in waterbodies in the U.S. mainland and that PPCPs may cause ecological harm; however there have been no studies linking PPCPs in the environment to adverse human health effects.[21]

Since PPCPs can be found in our wastewater, there are potential ways for these PPCPs to enter our aquifers. Septic tanks, cesspools, and leaky municipal sewer pipes can leach PPCPs directly into the ground. Conventional wastewater treatment is not designed to remove PPCPs. There is also a risk that wastewater reuse can introduce PPCPs into our aquifers. It is important to ensure that we minimize the chance that wastewater reuse (e.g., through irrigation, ground water recharge) contaminates our precious drinking water aquifers.

PPCPs are currently unregulated by the U.S. Environmental Protection Agency, however the EPA is working with drinking water systems to determine the level of PPCPs in drinking water systems. The EPA may in the future decide to include PPCPs as regulated contaminants in the future.[22]

CWRM supports research into characterizing treated wastewater to identify any PPCPs present, and to assess whether the reuse of the treated wastewater can introduce PPCPs into our drinking water aquifers. The Honolulu BWS and the U.S. Geological Survey are beginning to investigate the presence of PPCPs in Hawaiʻi’s wastewater and if wastewater reuse is transmitting PPCPs into our aquifers.

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[20] Environmental Protection Agency, Pharmaceuticals and Personal Care Products (PPCPs) accessed on February 27, 2014, http://www.epa.gov/ppcp/

[21] Environmental Protection Agency, Pharmaceuticals and Personal Care Products (PPCPs) accessed on February 27, 2014, http://www.epa.gov/ppcp/

[22] American Water Works Association, Pharmaceuticals and Personal Care Products in Drinking Water, accessed on February 27, 2014, http://www.drinktap.org/home/water-information/water-quality/pharmaceuticals-ppcps.aspx

### J.6.2.6 Act 229 Requiring the State Department of Transportation to Conduct a Feasibility Study on the use of Water Scalping Technology at State Airport Facilities

In 2015, Governor Ige signed into law Act 229, SLH 2015 which requires the State Department of Transportation (DOT) to conduct a feasibility study to determine if water scalping technologies can be implemented at State airport facilities. The purpose of this Act is to explore the sustainability and conservation potential of extracting and treating wastewater from the sewer network and putting towards supplementing non-potable demands. This Act also promotes a decentralized wastewater treatment system, thereby relieving the demand on a centralized treatment and disposal facility. Wastewater scaping has been successfully implemented in Australia and is currently being explored in several cities across the U.S.

### J.6.2.7 Act 170 Requiring the Hawaii Water Plan to Utilize Recycled Water in State and County Facilities

In 2016, Governor Ige signed into law Act 170, SLH 2016. This Act amends the Hawaiʻi Water Plan section of the State Water Code to add an additional objective of utilizing reclaimed water for non-potable uses in 100% of all State and County facilities by December 31, 2045. This provision is problematic since it would be prohibitively expensive to retrofit all State and County facilities to utilize on-site reclaimed water and even more so to connect to any available wastewater recycling facilities (due to mostly remote proximity). A more reasonable requirement would be to require new State and County facilities or renovated State and County facilities to utilize reclaimed water.

### J.6.2.8 Act 248 Prohibiting the Discharge of Treated or Raw Sewage into State Waters

In 2016, Governor Ige signed into law Act 248, SLH 2016. This Act amends Chapter 342D, Hawaii Revised Statutes, prohibiting any discharge of treated or raw sewage into State waters after December 31, 2026 with the exception of sewage treatment plants that utilizes sewage to produce clean energy or those receiving a variance from the Director of Health.

### J.6.2.9 CWRM Programs to Encourage Wastewater Reuse and Resource Augmentation

The State has completed two efforts since the last update of the WRPP toward the planning and development of recycled water sources: The *2013 Update of the Hawaiʻi Water Reuse Survey and Report* was prepared to assist in planning efforts for wastewater reuse; and the 2013 *Central Oʻahu Non-Potable Water Master Plan – Appraisal of Opportunities Report* examined the potential for non-potable supplies to support agricultural demands in Central Oʻahu. These projects and subsequent findings are described below.

<u>The Central Oʻahu Non-Potable Water Study</u>

There has been a significant shift in land use in Central Oʻahu over the past 20 years. Monocrop plantation agriculture has declined significantly, leaving vast tracts of agricultural lands lying fallow. Projected future uses of these lands include diversified agriculture, biofuel production, military base expansion, and new urban developments. There is a significant non-potable water demand associated with each of these activities. Use of non-potable water sources to meet the non-potable needs of these planned activities will protect and preserve potable ground water for higher uses.

About 25 MGD of ground water from the Central and Pearl Harbor Aquifer Sector Areas are currently permitted for non-potable water use. Twelve MGD are from the Wahiawā Aquifer System and 13 MGD are from the Waipahu-Waiawa Aquifer System. If alternative water sources could serve these non-potable water uses, over 25 MGD of ground water could be preserved for future potable use.

There are numerous sources of non-potable water in the Central Oʻahu region, including surface water, agricultural irrigation ditches, recycled wastewater, and stormwater. Infrastructure for the production, conveyance, and distribution of non-potable water is increasing, yet in most cases development of this infrastructure is being done by separate entities and without consideration of integration. The benefits of coordinated planning and integration include optimization of water use, pollution reduction, increased environmental compliance, energy savings, shared costs, and preservation of high quality ground water.

Recognizing the potential for a regional solution that leverages partnerships among area stakeholders, results in economies in savings and avoided costs, and provides a myriad of environmental benefits, CWRM undertook efforts to explore and identify available options and opportunities for development and integration of alternative non-potable sources.

The key objectives of the study included:

1. Consult with key stakeholders and water experts to help guide this study.

2. Inventory current and potential sources of non-potable water in the Central Oahu area, including, but not limited to Wahiawā Reservoir (i.e., Lake Wilson), City and County of Honolulu Wahiawā Wastewater Treatment Plant (WWTP), Schofield Barracks WWTP, stormwater capture and reuse, Waiāhole Ditch water, and existing (and future) urban wastewater systems. The inventory should assess current and potential water quantities, current and potential service areas, water quality characteristics, water service constraints, system storage and conveyance appurtenances, and any other source characteristics important to regional non-potable water master planning.

3. Identify current and future demand for non-potable water in three general areas in Central Oahu, including but not limited to agricultural demands in the Kunia Road

Corridor, the former Galbraith Estate property, and landscape, park, and golf course irrigation demands along the Kamehameha Highway Corridor, and other non-potable uses in the residential, military, and commercial sectors.

4. Explore options for matching the sources of non-potable water identified in Objective 2 with the water demands identified in Objective 3.

5. Identify selected scenarios for integration of available and potential non-potable water supplies.

Additional sub-objectives of the plan included:

- Maximize the use of available non-potable water supply options.

- Identify options which facilitate improvement of water quality in Wahiawā Reservoir, whereby future irrigation water supply from the reservoir is not regulated as reclaimed water.

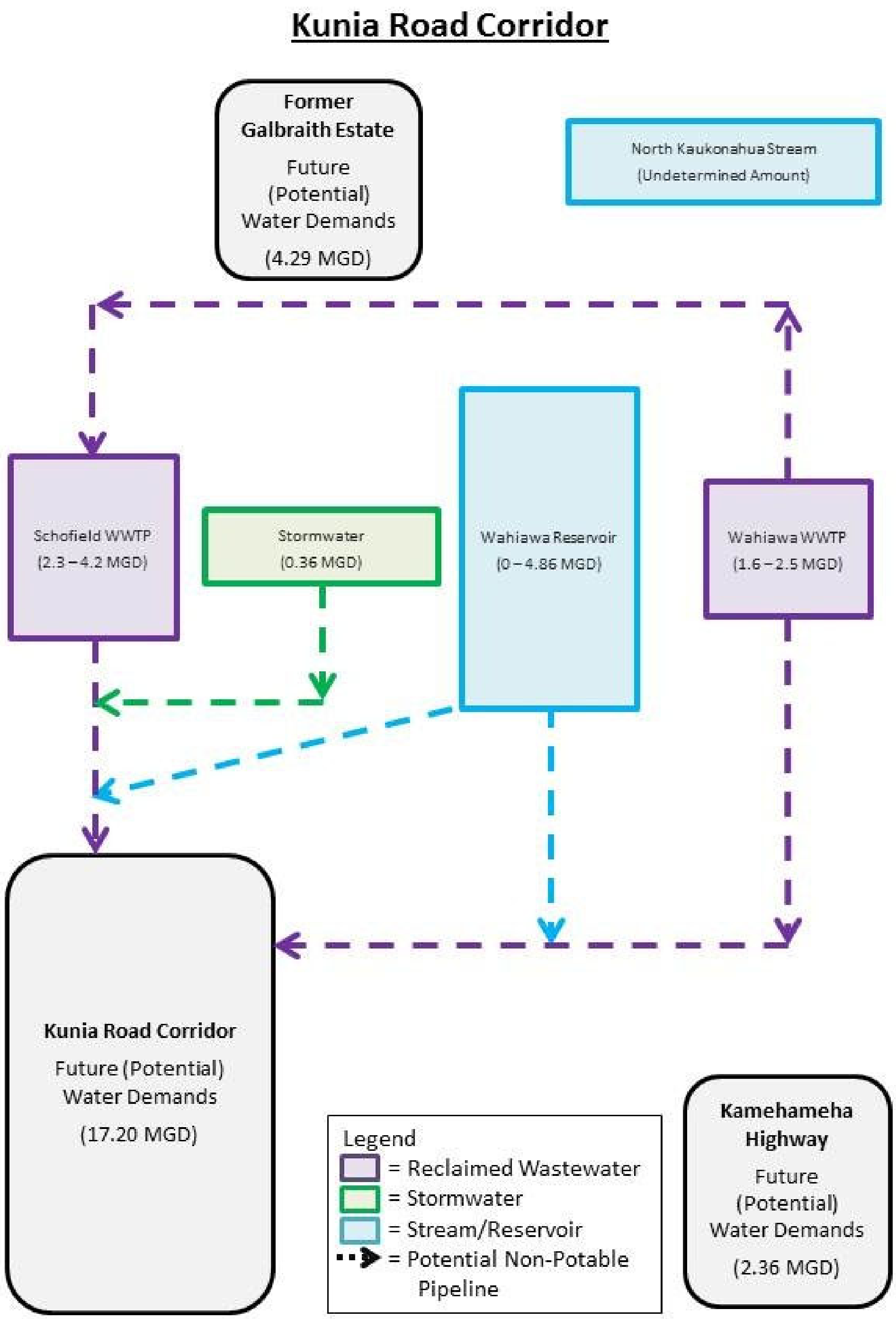
- Assess current non-potable water supply constraints relative to service area location, available storage and conveyance infrastructure, and rough estimates of required infrastructure capital costs based on best available information.

The Study found that future non-potable water demands are projected to increase based on agricultural parcels being put into cultivation on the former Galbraith Estate lands. Additional non-potable water demand may also come from expanded agricultural irrigation within the Kunia Road Corridor on lands not currently served by Waiāhole Ditch or ground water sources.

A single preferred water supply option was not identified for any of the selected study areas. Instead, a more holistic approach was taken to arrive at a grouping of technically feasible alternatives, many of which can be more fully integrated with each other to develop a long-term and adaptive water supply system (**Figure J-1**).

The Study also found that greater coordination and integration of water supply planning and project implementation should be established. The HBWS is currently undertaking such efforts as part of its development of the North Shore Watershed Management Plan (WMP) and the Central Oahu Watershed Management Plan as it relates to both potable and non-potable water supply and demand. The Central Oahu Non-Potable Study should help to inform the WMPs with regard to non-potable water use and development. The WMPs will also provide a mechanism for integration of regional planning between agencies such as Hawaiʻi Department of Agriculture (DOA) and Agribusiness Development Corporation (ADC), as well as private entities.

## Figure J-1 Schematic of Potential Kunia Corridor Non-Potable Sources and Demands



Leadership is needed to sustain the momentum achieved by this plan and to motivate stakeholders toward implementation of one or more of the integrated opportunities. DOH, DOA, and CWRM are all suited to facilitate this process.

2013 Update of the Hawai‘i Water Reuse Survey and Report

The objective of the *2013 Update of the Hawai‘i Water Reuse Survey and Report* is to update the status of recycled water projects and assess any future recycled water projects in the state. It is the policy of CWRM to promote the viable and appropriate use of recycled water in so far as it does not compromise beneficial uses of existing water resources or contaminate potable water aquifers. The updated report provides CWRM with a current picture of recycled water use in the State to better coordinate resource augmentation planning.

The report contains an overview of the current status of water reuse in Hawai‘i and descriptions of the existing water reuse projects within each respective county. Opportunities for future water reuse projects and ideas for future recycled water applications are also examined. New reuse opportunities, created through expansion of existing recycled water distribution systems, will significantly increase the volume of recycled water that is utilized, thereby improving the economies of scale for reuse program costs. The procurement of funding will determine if, and when, the existing systems will be expanded.

In addition to identifying reuse opportunities, the report discusses obstacles that restrict the growth and implementation of reuse projects, and their possible solutions. Finally, the report provides an overview of federal funding sources that may be applied to the development of reuse projects, and a directory of the existing projects in Hawai‘i. The report recommends regular updates every five years to inform and assist CWRM in the reuse-planning component of sustainable resource management.

## J.6.3 Stormwater Reclamation

Stormwater flows are part of the urban water cycle. Stormwater consists of the runoff water from the impervious surfaces in cities and developed areas, such as streets, sidewalks, roofs, parking lots, and other areas where water cannot percolate into the subsoil.

Stormwater reclamation, sometimes referred to as rainwater harvesting, can potentially provide water for numerous uses. Non-potable water demand for uses such as irrigation and toilet flushing can be supplied by reclaimed stormwater. Many communities in the southwestern region of the U.S. already incorporate stormwater reclamation and reuse into green buildings and developments. The lack of water sources in these areas has made stormwater reclamation an important component of water resource planning and management. It is important to note that there are no guidelines for the treatment and use of reclaimed stormwater in Hawai‘i.

In addition to the various use benefits, stormwater reclamation reduces the amount of pollutants that are deposited into waterways and nearshore waters, and also provides for flood control and containment. Since most urban areas are already applying programs for flood control and the reduction of non-point source pollution, stormwater reclamation and reuse can be viewed as a sensible extension of the urban water cycle. These flood and pollution controls could help provide an alternative water source for non-potable demands.

Stormwater quality can vary dramatically depending on the rainfall amount, frequency, and collection location. Contaminants such as petroleum products, fertilizers, and animal feces are picked up by stormwater runoff. Therefore, stormwater reuse applications require different treatment levels, depending on the risk of public exposure to the recycled water. Secondary treatment with disinfection removes solids and organics, and produces recycled water of adequate quality to meet many non-potable water demands. Tertiary treatment (which removes nutrients) may be required for applications where people are more likely to come in contact with the recycled water. The risk of exposure to pathogens and contaminants is further reduced through measures such as regular pipe and system maintenance, reliable disinfection, application controls, and crop-irrigation restrictions. County and public health agencies ensure the protection of public health through management programs that delineate risk-reducing management and monitoring actions. In addition to treatment and disinfection requirements, stormwater reuse programs provide rules and recommendations for application methods. For example, stormwater reused in irrigation may need to be applied through sub-surface drippers, rather than surface sprinkler systems. Furthermore, irrigation may be restricted to non-food crops.

Another risk-reducing management action is to provide guidelines and rules for stormwater reuse in various soil types. Soil influences the effect that nutrients, salts, heavy metals, and organic hydrocarbons may have on the environment and nearby surface water bodies. It may be necessary to implement controls to prevent excess irrigation runoff from entering nearby streams or the ocean.

#### J.6.3.1 Methods for Stormwater Reclamation

On the household scale, rain barrels can be used to collect, store, and distribute stormwater in landscaping. Rain gardens, or vegetated infiltration basins, constructed in the vicinity of the home to take advantage of natural site drainage patterns are another means of containing stormwater runoff that facilitates infiltration. These methods of stormwater reclamation can be classified as “source reuse” and “small lot reuse” technologies. There are five categories used by the U.S. Bureau of Reclamation (Reclamation) to classify stormwater runoff reclamation technologies. **Table J-4** lists and describes each of these technologies.

Water-impounding reservoirs, which are regulated by DLNR’s Dam Safety Program, have been used for irrigation and flood control purposes in a few areas across the state. These include Hawai‘i Island’s Pu’ukapu Reservoir, Kaua‘i’s Wailua and Kapahi Reservoirs, the Waikamoi and Olinda reservoirs on Maui, and the Wahiawā reservoir on O‘ahu.

In the past, a number of projects were envisioned to impound surface water for treatment and domestic use. Although these projects were not completed, the Kohakohau River Dam project on Hawaiʻi and the Kōkeʻe Water Project on Kauaʻi were two outstanding project ideas. Proposed surface water impoundment projects, however, can significantly impact the environment and ecosystem. For example, the diversion of water from its natural course or the construction of a dam would have direct and cumulative impacts on stream flows, aquatic habitats, riparian habitats, land use patterns, public health, farming operations, and other downstream and stream-related uses. However, proper planning, site selection, design, construction, and operation of an impoundment facility could be appropriate for certain areas, allowing the capture, containment, and treatment of stormwater to provide for non-potable demand. With this benefit in mind, programs for dam safety, flood control, and stormwater capture should be designed to be mutually complementary.

## Table J-4 Stormwater Reclamation Technologies

| Technology | Description |
|---|---|
| **Source Reuse** | Use rain barrels or cisterns to collect precipitation or stormwater runoff at the source to provide water for a variety of non-potable purposes or, with treatment, potable water. |
| **Small Lot Reuse** | Manage precipitation or runoff as close to source as feasible. Examples: infiltration planter boxes, vegetated infiltration basins, eco roofs (vegetated roofs), porous pavements, depressed parking lot planter strips for biofiltration, narrowed street sections with parallel or pocket bioswales. |
| **Stormwater Capture** | Employ ditches, storm drainage system interception, dry wells, infiltration galleries, and injection wells to capture stormwater. |
| **Stormwater Storage** | Use aquifer storage and recovery, stream-bank storage, detention basins, and surface reservoirs to store stormwater. |
| **Stormwater Distribution** | Distribute stormwater via gravity ditch or pipe networks, operated/regulated ditch systems, pressure pipe networks, onsite wells. |
| Source: CH2MHill. *Hawaiʻi Stormwater Reclamation Appraisal Report*. Prepared for the U.S. Bureau of Reclamation and the State of Hawaiʻi Commission on Water Resource Management. July 2005 | |

Related to stormwater impoundment are other types of structures used to facilitate stormwater infiltration into the subsurface. These structures are sometimes built primarily for the purpose of artificially recharging ground water aquifers. Artificial recharge is the process by which the natural infiltration of surface water or precipitation into a ground water body is supplemented by infiltration induced by man. It is typically accomplished via three methods:

- Water spreading
- Infiltration pits, shafts, or tunnels
- Injection or disposal wells (sometimes called recharge wells)

Water spreading promotes the recharge of ground water aquifers by encouraging infiltration. Water is spread over a large surface area and allowed to percolate into the ground. This can be accomplished by diverting runoff into shallow basins or depressions, ditches, or open irrigation systems. Another method of water spreading is to build dams across stream channels, in order to increase the wetted perimeter and spread the stream over a larger cross section of the stream channel and banks.

Where space is limited or in areas where impervious layers near the surface tend to restrict the infiltration of water, artificial recharge is achieved by diverting water into infiltration pits, shafts, or tunnels. These excavations are used to either penetrate the impervious layer or to provide direct access to the ground water body.

In the 1990s, numerous injection (disposal) wells were constructed throughout the state. The primary purpose of these wells is to dispose of stormwater runoff, and the amount of recharge that results from these disposal wells is uncertain.

Throughout the era of sugar and pineapple plantations, artificial recharge was incidental to irrigation practices, but in some areas contributed largely to ground water recharge. Leakage from reservoirs and ditches, together with percolation from irrigated fields, constituted a considerable amount of recharge. Some agricultural users returned excess irrigation water to the ground water sources. For example, the 75-mile long East Maui Irrigation Co. ditch system collects and transports 160 MGD on average of surface waters originating in East Maui watersheds to the 27,000 acres of Hawaiian Commercial and Sugar (HC&S) former sugarcane fields in central Maui. Pumpage from the Kahului Aquifer System Area in central Maui is far in excess of the aquifer's established sustainable yield based on natural recharge estimates. The twelve-month moving average withdrawals from the Kahului Aquifer System Area in December 2012 was 37.56 MGD, 3,756% of its estimated sustainable yield of 1 MGD. The current contribution of return irrigation recharge from leakage from reservoir's and ditches is estimated to contribute an additional 10 MGD to the Kahului Aquifer System Area.[23] The disposal of stormwater in wells, pits, and tunnels currently contributes very little recharge to our ground water supply. Regulations restrict the construction and use of injection wells for storm water disposal to coastal areas to avoid potential contamination of drinking water aquifers.

Several reservoirs, such as the Waiawa reservoir, probably lose some seepage to the ground water body, but supporting hydrologic data is not available. The Honolulu BWS operates four open reservoirs in Nuʻuanu Valley, but it is doubtful that seepage from these reservoirs reaches the basal water body. In 2015 they initiated a partnership with the University of Hawaiʻi at Manoa to evaluate the potential and risks of utilizing the reservoirs for aquifer recharge through the construction of injection wells.

[23] May 25, 2010 CWRM Staff Submittal

### J.6.3.2 Rainwater Catchment

Rainwater catchment through rain barrels or larger residential cisterns allow homeowners to implement stormwater reclamation and reuse. For some, the lack of access to a public water system necessitates the need for a rainwater catchment system. It is estimated that 30,000 to 60,000 people in the state are dependent on these systems for their water needs[24]. However, current State plumbing codes do not acknowledge rainwater catchment systems unless they are part of a public water system. To address this shortfall the State Building Code Council is working to adopt an updated plumbing code that may include provisions for rainwater catchment systems. Encouraging rainwater catchment helps to offset a household's water demands, thereby creating a more sustainable residence.

### J.6.3.3 Urban Runoff Recycling: A Model Facility

The first full-scale, dry-weather, stormwater runoff recycling facility began operating in Santa Monica, California in December 2000. This project is truly innovative, because it contributes to the Santa Monica's Sustainable City Program goal of reducing urban runoff into the Santa Monica Bay. It also provides a significant public education opportunity that takes advantage of the plant's location in the tourist area near the Santa Monica Pier.

The Santa Monica Urban Runoff Recycling Facility (SMURRF) is an outstanding example of how a public facility can be constructed to integrate educational and art components that are responsive to the immediate neighborhood, and serve to enhance community pride. The facility is open to the public and is designed to move visitors through the plant via an elevated walkway, descending from one end of the site to the other, also providing an alternate access to the beach. Each piece of equipment is emphasized with a prominent base, dramatic lighting, and colorful tile work, and the visitor is directed past the plant components in a logical manner. Visitors are able to observe the results of the treatment process at five locations throughout the plant, and information plazas teach visitors about the workings of the facility, the local urban watershed, and the public's role in preventing stormwater pollution. By investing in architecture, landscaping, and art, the project was successfully integrated into the lively atmosphere of the Santa Monica Pier, while showing a sense of respect for the local community and achieving a positive effect on public perception in the community and among the governing bureaucracy.

SMURRF uses conventional and advanced treatment components to remove debris, sediment, oil, grease, and pathogens from stormwater collected by the city's storm drain system. The plant can treat a maximum of 500,000 gallons per day (gpd) of runoff from a 5,100-acre drainage area that produces stormwater flows averaging 265,000 gpd. The treatment processes include: coarse and fine screening to remove trash, plant material, and debris; degritting systems to remove sand and grit; dissolved-air floatation to remove oil and grease; microfiltration to remove turbidity; and ultraviolet radiation to kill pathogens. The treated product water meets the

[24] Macomber P. S. H. *Guidelines on Rainwater Catchment Systems for Hawai'i*. 2004. College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa

standards of the California Department of Health Services and California's Title 22 requirements. The treatment train was recommended because it was able to meet current reclaimed water requirements, while allowing for future expansion with reverse osmosis, to meet ground water recharge requirements.

The product water is distributed for landscape irrigation and toilet flushing. Landscape-irrigation water is provided to street-median landscaping, city parks, and a cemetery. Dual-plumbed customers using the product water for indoor use (flush toilets) include the City of Santa Monica Public Safety Facility and the City's Water Garden.

The project was funded by the City of Santa Monica, the City of Los Angeles, the State of California Water Resources Control Board, the Metropolitan Water District, Federal Intermodal Surface Transportation Efficiency Act grant funds, and Los Angeles County Proposition "A" grant funds. Capital costs totaled $9 million: plant costs totaled $6.3 million, and distribution system costs were $2.7 million. Approximately $2 million of the plant costs are attributed to the 500,000-gallon concrete storage tank, which had to be designed and constructed for tight site considerations (with one side of the tank serving as a retaining wall for a freeway onramp). Approximately $750,000 of the plant cost can be attributed to architectural components designed to incorporate public art and education. The actual cost of the stormwater treatment system is estimated at $2.9 million ($5.80 per gallon).

### J.6.3.4 Act 42 Stormwater Utilities

In 2015 Governor Ige signed into law Act 42, SLH, which authorizes the counties to charge user fees to create and maintain stormwater management systems or infrastructure. This Act therefore gives the counties the means to establish stormwater utilities to reclaim and reuse stormwater generated from urban areas. There are currently no known efforts under way at any of the counties to establish a stormwater utility.

### J.6.3.5 Hawai‘i Stormwater Reclamation Appraisal Report

The *Hawai‘i Stormwater Reclamation Appraisal Report* was completed in June 2005 by The U.S. Bureau of Reclamation in consultation with CWRM. The report documents Reclamation's appraisal-level (planning-level) investigation of potential stormwater reclamation and reuse opportunities under Title XVI Program of Public Law 102-575, as expanded by Section 104(b) of the Hawai‘i Water Resources Act of 2000 (Public Law 106-566). Title XVI projects include reclamation water reuse and recycling, and Reclamation policy identifies the following uses as appropriate for funding under Title XVI: environmental restoration, fish and wildlife, ground water recharge, municipal, domestic, industrial, agricultural, power generation, and recreation. Within those broad categories, more specific uses, particular to stormwater capture and local needs, are identified.

In preparing the report, agency consultation meetings were conducted to collect stormwater reuse opportunity ideas, and this resulted in the identification of 31 opportunities for consideration. In this study, opportunities are specific locations where significant benefits may be gained from pairing supply and demand for reclaimed stormwater. Such opportunities must also be consistent with the goals of Title XVI and the desires of participating stakeholders.

The initial set of 31 opportunities was reduced to nine using a two-step screening process (preliminary and detailed). Preliminary screening criteria included factors such as implementability (institutional, regulatory, and land use), demand constraints, and generalized stakeholder acceptance. Detailed criteria such as operational flexibility, long-term permit compliance, flow augmentation, ground water recharge opportunities, and reuse potential were also considered.

The nine projects that came out of the screening process were evaluated and ranked on the basis of: ease of delivery and operation, dependability of water supply, simplicity of storage and water treatment, institutional considerations, the degree to which prior investment has been maximized, and cost. Specific areas of investigation included: basin land use, vegetation, soil, and slope characteristics; existing irrigation conveyance and natural stream networks; precipitation; expected demand area and size; and hydrology. Institutional factors were also assessed to identify potential direct and indirect effects on the institutional environment closest to the opportunity area. Existing knowledge and threshold-level information obtained informally during the study were used to establish the social and cultural context of the projects. Finally, preliminary cost estimates generated from rough general designs were examined and compared.

The nine candidate opportunities included locations on Moloka‘i, Kaua‘i, O‘ahu, Hawai‘i, and Maui. However, feasibility has not been established for all the opportunities described in the study. To move the opportunities toward funding for construction under Reclamation’s Title XVI program, several key elements must be addressed:

- Congressional authorization needs to be obtained for Reclamation involvement in conducting feasibility studies.

- A project sponsor must be identified. In some cases, there is already an organization or entity that has taken responsibility for success of the project. In others, discussion with local stakeholders to date has focused on whether the project represents a “good idea” and is valuable and viable. It is vital to this process to investigate interest in ownership and market the opportunities to local groups capable of completing the funding and construction process.

- Owing to the significant nonfederal funding contribution required, additional education and outreach to local stakeholders is needed. In many cases, matching contributions for a project will be allocated by nonfederal, elected representatives. To maximize the chances of success, key constituent groups would have to be identified and approached regarding the potential benefits of the project. Such groups must be given ample opportunity to explain concerns and needs for making the project successful for all involved.

### J.6.3.6 2008 Appraisal of Hawai‘i Stormwater Reclamation and Reuse

In 2008 Reclamation, in partnership with CWRM, completed a refinement of the 2005 Hawai‘i Stormwater Reclamation Appraisal Report. This study produced three study element reports under the broad title of *2008 Appraisal of Hawai‘i Stormwater Reclamation and Reuse*. Much of this appraisal explores opportunities to capture and reuse stormwater to augment potable supplies with a secondary benefit of improving water quality discharged to our streams and near-shore coastal waters during storms. In refining the 2005 report, the 2008 delved into further details of the regulatory framework, stormwater treatment methods, prioritization of opportunities, and evaluation criteria for overall ranking of opportunities. Newly identified opportunities were analyzed considering factors such as proximity to existing infrastructure, needed infrastructure, benefits and stakeholders. The opportunities were further evaluated for potential reuse demand, potential stormwater volume, partnerships, likelihood of implementation, institutional constraints, and coarse cost estimates.

The 2008 *Appraisal of Hawai‘i Stormwater Reclamation and Reuse* consists of three study elements:

Study Element 1 has two components: (1) Develop a statewide framework for identifying and resolving institutional barriers to stormwater reclamation and reuse, and (2) develop a handbook for reclamation and reuse technologies and best management practices for existing and new developments.

Study Element 2 consists of an appraisal of opportunities for ground water recharge of stormwater over a brackish water (caprock) aquifer in a dry, but rapidly developing area on O‘ahu called the ‘Ewa Plain.

Study Element 3 consists of an appraisal of statewide opportunities for augmenting ground water supplies with stormwater, including ground water recharge.

This report addresses the statewide framework and identifies issues that are potential barriers to stormwater reclamation and reuse, and opportunities for overcoming these barriers. Study Elements 2 and 3 are discussed in *An Appraisal of Stormwater Reclamation and Reuse in the ‘Ewa Plain of Hawai‘i* and *An Appraisal of Stormwater Reclamation and Reuse in Hawai‘i*, respectively.

The three report elements combined identified 21 potential opportunities for stormwater reclamation and reuse:

E-1 – Makakilo Ridge
E-2 – Kapolei Flood Control Channel
E-3 – Fort Barrette Road Swale
E-4 – Honouliuli Recharge Trench
E-5 – Fort Weaver Road Swale
E-7 – Waiāhole Ditch Conveyance to ʻEwa Recharge Trench
O-1 - Wheeler Army Air Base and Schofield Barracks
O-2 – Mililani North Stormwater Channel
O-3 – Mililani South Stormwater Channel
O-4 – Waipahu Stormwater Channel
O-5 – Waikele Stormwater Channel
O-6 – Nuʻuanu Valley Surface Water
O-7 – Pālolo Stream Stormwater Channel
E-7 – Waiāhole Ditch Conveyance to ʻEwa Recharge Trench
M-1 – Waiale Road Stormwater Drainage
M-2 – Kahului Flood Control Channels
M-3 – Kahoma Stream Flood Control
M-4 – Lahaina Flood Control Channel
K-1 – Nwilwili Diversion
K-2 – Lihue Airport
H-1 – Lower Hāmākua Ditch

In order for any of these opportunities to be implemented, there needs to be a project champion(s), stakeholder collaboration, and funding sources. There would likely be an intermediate step of a feasibility study and environmental review prior to the engineering, design, and construction phases. Significant challenges to stormwater reuse, which can be overcome, include uncertainty of stormwater treatment and water quality requirements for reuse, infrastructure needs, and the unreliability of storm events. Climate change impacts to rainfall patterns in Hawaiʻi make stormwater reclamation and reuse an attractive option as an alternative water supply source. A successful stormwater reuse project would take advantage of the surfeit of water runoff during large rainfall events by capturing, treating, storing and distributing the water for some beneficial reuse.

In addition to producing the three-part report, a handbook of best management practices (BMP) for stormwater reclamation and reuse in Hawaiʻi was produced.[25] The handbook is intended to be a guide to homeowners, developers, and planners for managing stormwater as a resource rather than as a nuisance to be disposed of. Alternative stormwater BMPs and technologies for

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[25] Commission on Water Resource Management. (2008). *A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawaiʻi.*

new developments, retrofits of existing developments, open space, rural, and agricultural areas are presented. The handbook focuses on five different land uses – individual homes, neighborhoods, commercial & institutional, green space/recreational, and rural/agricultural - and identifies BMPs for each. Some of the BMPs and technologies apply to more than one type of land use. Applying these technologies and practices will support ground water sustainability, improve surface water and near-shore water quality, reduce erosion, and mitigate flooding. In addition, The Office of Planning's CZM Program developed a low impact design guide that can be found on their website at: http://planning.hawaii.gov/czm/initiatives/low-impact-development/. Further study of the obstacles, constraints, and opportunities to increase stormwater recharge statewide from mauka to makai should be undertaken.

### J.6.3.7 Stormwater Reclamation Issues and Constraints

Stormwater reclamation is not commonly practiced in Hawai'i. This section provides an overview of the broader issues related to establishing the economic, social, and technical climate to expand water reuse and develop reclaimed stormwater as an alternative water supply. The discussion below is adapted from the June 2005 *Hawai'i Stormwater Reclamation Appraisal Report,* prepared by the U.S. Bureau of Reclamation in cooperation with CWRM, to investigate opportunities for stormwater reclamation in Hawai'i (**Section J.6.3.6** provides a summary of the project).

**Demand and Pricing:** Reclamation and reuse of stormwater often provides opportunities for multipurpose benefits, for example, flood control and ground water recharge. In many ways, these activities have potential to mitigate impacts of development or provide water supply to maintain or increase traditional land uses such as agriculture. With the exception of some types of urban or industrial runoff, quality of reclaimed stormwater is often good and does not share the same stigmas associated with reclaimed wastewater.

For these reasons, there have not been significant obstacles identified in establishing a market for reclaimed stormwater. With a few exceptions, demand for reclaimed stormwater is primarily a function of scarcity of the resource in general, rather than any particular association with the supply. One significant exception to this finding is use of urban or industrial runoff for drinking water.

At the same time, this appearance of a commodity status for reclaimed stormwater places it more firmly in competition with more traditional methods of supply based on price alone. This must be evaluated case-by-case, but emphasis must be placed on long-term economic benefits associated with reducing the need to establish new sources of supply. In urban areas, increased development may actually increase the potential yield of reclaimed stormwater, without the need to develop new sources, based on changing land use conditions. The passing of Act 42, which allows the counties to collect fees to establish stormwater utilities may provide a favorable cost-benefit to reclaiming and reusing stormwater.

**Needed Research and Demonstration Studies:** It is necessary to establish that public health and safety are maintained with the use of reclaimed stormwater. It is also necessary to proceed in an environmentally sound manner. The areas of greatest concern regarding reuse of stormwater are: potential contamination of aquifers and other potable water supplies by poor-quality runoff, and environmental or habitat degradation resulting from diversion of surface flows from the natural hydrologic regime. From a water quality perspective, urban runoff, particularly associated with industrial processes or transportation corridors, contains the highest concentration of contaminants, often hydrocarbons or heavy metals. In more rural areas, agricultural runoff can carry high concentrations of nutrients, pesticides, and in some areas, salts. Additional research and pilot studies are needed to demonstrate economical methods of adequately treating stormwater prior to injection into aquifers or introduction in potable water systems.

**Seasonality:** The fundamental challenge of most methods of stormwater reuse is that stormwater is primarily available in excess during the rainy season and most needed in the dry season. Therefore, it must be stored for at least a season, in sufficient quantity to justify the cost of construction of the impoundment. This relationship informs expectations regarding the size of storage needed. The closer beneficial reuse mimics the pattern in which stormwater is available, the less storage is needed. In such a case, the opportunity is primarily one of diversion to an alternate flow path, rather than storage.

**Volume:** For a reuse opportunity to be successful, the runoff volume that can be consistently collected for beneficial use must be in concert with the demand for water use. In some cases, such as aquifer recharge, it has been assumed that whatever stormwater is available can be absorbed into the aquifer, given an adequately designed infiltration or injection system. In other cases, such as storage for reuse as fire suppression, the amount of collected water is likely to be very small, compared to the expected stormwater runoff. This poses no problem, unless the intent of the opportunity is, for example, to provide flood control, which is not likely to be adequately addressed by such a limited reuse demand.

On the other hand, if the purpose of the opportunity is to provide irrigation to certain crops, a cost-benefit relationship exists between the expected crop yield increase due to irrigation and the cost of opportunity construction. It is important to understand how much stormwater may be available and the related storage requirements to evaluate the efficiency of the reuse alternative.

**Timing:** A distinction has been made among long-term seasonality, year-to-year hydrologic variability, and large-event conditions. The latter is termed “Timing”, as flood events are, virtually by definition, difficult to adequately capture. Large volumes of excess runoff are available during these infrequent events, but often it is not cost effective to construct storage to capture all that is available. Similarly, to have a positive impact on flooding, capture of a large volume of water is often required; however, it may be difficult to revise such volumes in an efficient way.

**Spatial Separation:** Hawai‘i has a complex infrastructure of under-used old drainage and irrigation-conveyance elements that may alleviate the challenge of water transfer from capture point to use. Nevertheless, it may be a significant challenge to improve and maintain such infrastructure to provide reliable transfer water across basin boundaries. Aquifer recharge can also alleviate this challenge by using subsurface connectivity to transmit water to the point of use.

**Changing Conditions:** Rapid development of urban areas (or, to a lesser extent, changes in agricultural land uses) has the potential to change the stormwater runoff hydrology of a basin, as well as the expected demand for a beneficial reuse. Estimates of the potential impact are only as accurate as estimates of the expected changes.

**Sediment:** For ambient water quality, habitat development, or potable water use, source water quality and sediment load can be a significant issue. In addition to soil particulates, urban runoff can contain a wide variety of contaminants associated with sediments, including heavy metals and hydrocarbons.

**Temperature:** Ambient water quality and habitat development often have associated temperature criteria. Releases from reservoirs, which may have stratified conditions, can lead to release temperatures that do not match ambient and seasonal conditions. Alternatively, increasing base flow by infiltration and percolation through stream beds and stream banks can restore more natural temperature management to stream systems.

**Capture Location and Mechanism:** Stormwater must be captured before it enters a natural stream system. In rural areas, this can present a significant challenge. In most cases, existing irrigation systems may be used to intercept surface runoff along hill slopes. In urban areas, storm drainage systems can be intercepted before the outfalls, but cost and space constraints can make it prohibitive to retrofit facilities.

**Area of Application:** Some types of uses may require small volumes of water distributed over wide areas. Others may have more localized demands.

**Delivery Location and Mechanism:** Some uses require subsurface delivery; others may require surface systems. The contents of the report and assessment methods are discussed in more detail in **Section J.6.3.6**.

## J.6.4 Desalination

Desalination can remove dissolved minerals, including but not limited to salt, from the source water. Seawater, brackish water, or treated wastewater can be processed through several desalination methods: distillation, vacuum freezing, reverse osmosis, and electrodialysis. Distillation and reverse osmosis are the more popular methods, and significant advancements in these technologies have been made since the 1980s.

Desalination plants can process a variety of input water, or feedwater types. Seawater can be taken up through offshore intakes or wells drilled into the beach or seafloor. Brackish ground water, which is generally less costly to process, and reclaimed water are other sources of feedwater. Pretreatment and post-treatment processes are also used for disinfection and elimination of other types of pollutants, including microbes and pathogens.

A variety of pretreatment processes are used to remove materials that interfere with desalination. Biocides, usually chlorine solutions, are used to remove algae and bacteria. Ozone or ultraviolet light treatments can be used to remove marine organisms. Some distillation plants must remove metals from the feedwater to prevent system corrosion. Reverse osmosis membranes can be impaired by chlorine, suspended solids, and particles. Thus the feed water must be further pretreated with dechlorination techniques, coagulation, and filtration.

Desalination plants that produce water for domestic use have post-treatment processes to ensure that the product water meets health standards and recommended aesthetic and anti-corrosive standards. The purity of desalinated product water is usually higher than drinking water standards, and the lack of dissolved solids and minerals creates acidic pH levels that are corrosive to pipes. Therefore, desalinated water for municipal use is mixed with water that contains minerals or is otherwise adjusted for hardness, alkalinity, and pH prior to distribution.

### J.6.4.1 Methods for Desalination

Common desalination methods can be described in two categories: phase change (distillation) methods, and membrane separation methods. These methods are generally described below.

**Thermal Separation Methods**

**Distillation (Evaporation):** Distillation involves heating saline or brackish water until it forms water vapor. This vapor, which is largely salt-free, is condensed to liquid form for storage and distribution. Common methods of distillation are multistage flash, multiple effect distillation, and vapor condensation. Some distillation plants produce freshwater, using a hybrid production process that employs two or more of these technologies. The waste product of distillation methods is a highly concentrated brine solution.

**Freezing:** This phase-change method is characterized by the formation of ice crystals with the dissolved salts remaining in the solution. Fresh water is produced by separating the ice crystals from the solution and melting the crystals. This process uses much less heat than the distillation method, but it has substantially higher operating and maintenance costs.

**Membrane Separation Methods**

**Reverse Osmosis:** Osmosis occurs when water passes through a semi-permeable membrane, separating two solutions of different salt concentrations. In natural osmosis, water moves out of the diluted solution until the concentrations of the two solutions become equal, or when the pressure on the concentrated-solution side of the membrane rises to the same osmotic pressure. The osmotic pressure may be referred to as the osmotic head, or the difference of the depths of the liquid surfaces of the two solutions. When a pressure greater than the osmotic pressure is exerted on the more concentrated solution, reverse osmosis occurs. The result is the movement of water from the more concentrated side of the membrane into the more dilute solution. In the reverse osmosis process, the concentrated solution can be either seawater or brackish water. The osmotic-pressure gradient is induced to move more water into the diluted solution. This water is then collected, stored, and distributed to various users.

**Electrodialysis:** Salts in solution disassociate into positively and negatively charged ions called cations and anions. Electrodialysis depends on the action of semi-permeable membranes than can selectively pass either cations or anions. When stacks of alternating cation- and anion-permeable membranes are placed in a direct current electric field and feed water is passed between the membranes, the cations migrate to the negative electrode (cathode) and the anions move to the positive electrode (anode). The membranes trap the ions in cells between the membranes, and the resulting solution is removed as waste brine. Water passing through the membranes is collected and removed for use as desalted water.

### J.6.4.2 Desalination Issues and Constraints

The issues and constraints associated with different desalination methods are summarized then evaluated in the following paragraphs. A general discussion of environmental issues and challenges related to desalination follows. Other issues and considerations may also be relevant depending on the particular site or application.

**Thermal Separation Methods**

**Distillation (Evaporation):** Although distillation methods are capable of handling large quantities of saline water, there are disadvantages including, high thermal-energy requirements, high capital costs, high operating and maintenance costs, and severe scaling and corrosion problems. Scaling is a condition that results from the buildup of salt deposits on plant and pipe surfaces, and is caused by the high-salt concentration of seawater. Scaling increases in high-temperature environments, and in distillation plants it results in reduced plant efficiency and greater pipe corrosion. Scales can be removed by chemical or mechanical means and can be reduced by introducing additives to inhibit crystal growth, reducing temperatures or salt concentrations, removing scale-forming constituents, or seeding to form particles. In addition to problems with plant scaling, the intake and outfall structures and pipes can become corroded or fouled with marine organisms, and must be mechanically or chemically cleaned.

Distillation, in some cases, may not be competitive with other desalination methods. In Hawaiʻi, the feasibility of using waste heat from a nuclear-power plant was considered by the Honolulu BWS and Hawaiian Electric Company (HECO) in the 1960s, but it was concluded at that time that the proposal was premature.

**Freezing:** The freezing method has limited applications, is relatively new, and is capable of producing only up to 100,000 gpd on a practical basis. Although it requires only about 15% of the energy used by the distillation process and results in minimal scaling and corrosion problems, its operating and maintenance costs are high. These costs are incurred in separating the ice from the brine, washing the ice crystals, and melting the crystals to form fresh water. As technology improves, the freezing method may have a future, especially in areas where only poor-quality water sources are available and where large quantities of product water are not required.

**Membrane Separation Methods**

**Reverse Osmosis:** Because reverse osmosis requires the use of permeable membranes, the feedwater must be pretreated to remove particles that can build up and clog the membranes. The quality of the product water depends on the pressure, the salt concentration of the feedwater, and the membrane's salt- permeation constant. Water quality can be improved by sending the product water on a second pass through the membranes.

The filters used for pretreatment of feedwater must be cleaned via backwashing, to clear accumulated particles and solids. The reverse osmosis membranes must also be cleaned several times a year with alkaline cleaners to remove organic fouling, and with acid cleaners to remove scale and inorganic precipitates. Membranes must be replaced every three to five years, and replacement procedures require partial or complete plant shut down.

Because reverse osmosis plants operate with lower temperatures, plant scaling is not as serious a problem as in distillation plants. However, reverse osmosis plant intakes and outfalls can also become corroded or fouled with marine organisms, and must be mechanically or chemically cleaned.

**Electrodialysis:** An electrodialysis reversal (EDR) system has been developed, which reverses the polarity of the electrodes several times an hour. This reversal process minimizes scaling and other adverse effects on the membranes. It should be noted that electrodialysis does not remove bacteria and other uncharged particles. Accordingly, it is necessary to stabilize and disinfect the product water before use.

### J.6.4.3 Evaluation of Desalting Methods

Desalting methods must be compared with considerations to economics, location of area of need, availability and quality of feedwater, operational problems, energy demand, quantity and quality of product water needed, and environmental impacts. The most practical approaches for desalination in Hawai‘i would be electrodialysis and reverse osmosis. For the foreseeable future, we may conclude that Hawai‘i's municipal needs cannot be met through distillation, freezing, and ion exchange methods, although improving technology may make these methods more attractive in the future.

**Environmental Issues**
While Hawai‘i is surrounded by a virtually unlimited supply of salt water, desalination is the option of last resort because of its high economic and environmental costs relative to other alternatives. Open water intakes can harm fish and other marine organisms as they are trapped in the screen or killed during the processing of the salt water. While subsurface intakes can minimize impacts, the disposal of highly-concentrated brine byproduct, which may contain other chemicals and pollutants used in the processing, are another environmental challenge.

In Hawai‘i, brine is disposed via injection wells. Because it is denser than seawater, hypersaline brine will tend to sink and spread out slowly along the ocean floor. However, injection well regulations in Hawai‘i are focused on ensuring the protection of inland drinking water sources, not the marine environment. Monitoring of daily flows, injectate quality, and annual/periodic tests of well performance are conditions of injection well permits. If the monitoring data show that corrosivity standards for salt have been exceeded, then it is deemed a hazardous waste, and the DOH's Hazardous Waste Branch will become involved. Neither of these two programs address the issue of marine environmental impacts associated with brine disposal. There is a gap between the science of generalized flows to the ocean and the mixing of ocean discharges in receiving waters. While the water quality standards for marine waters require (all estuaries except Pearl Harbor) that salinity not vary more than ten percent from natural or seasonal changes considering hydrologic input and oceanographic factors,[26] injection wells are not addressed under current water pollution control permits.[27]

# J.7 State and County Resource Augmentation Programs

## J.7.1 The Importance of Dams and Reservoirs for Resource Augmentation

Historically, dams and reservoirs in Hawai‘i were predominantly developed by the agricultural industry in the early 1900s as part of their large irrigation systems. Today, dams and reservoirs continue to be used by the agriculture industry, in addition to providing storage for drinking water, flood control, hydro-electric, recreation, and other purposes.

Reservoirs are a vital component of any resource augmentation program. Their ability to store large capacities of water can buffer the effects of the variability in the supply and demand of an alternative water source. For example, non-potable water for irrigation may not always be needed due to changes in the climate or growing cycle, but it is always being produced. Without reservoir storage this would not be a viable resource to meet agricultural water demands.

[26] HAR 11-54.

[27] HAR 11-55 Appendices B through L.

Reservoirs also provide a means to mitigate the effects of climate change. Climate change research suggests that extreme precipitation events will become more prevalent in the near future. Reservoirs enable the capture of rainfall and surface flows during storm events, and can supplement natural water sources during drought conditions.

**Table J-5 Reservoir Storage Capacity Ranked by Storage Per Unit Area** lists the number of reservoirs by island and their normal storage capacity as reported to the DLNR Dam and Reservoir Safety Program. However, to properly assess the storage potential that exists to compliment any resource augmentation program or to mitigate the effects of climate change, the rate of sedimentation for these reservoirs must be known.

### Table J-5 Reservoir Storage Capacity Ranked by Storage Per Unit Area

| Island | Normal Storage Capacity (acre-feet) | % of State Total | Number of Reservoirs | % of State Total | acre-feet per acre |
|---|---|---|---|---|---|
| **TOTAL*** **(5 main islands)** | **36,210** | <100 | **133** | 95 | 0.009 |
| Kauai | 15,553 | 43 | 52 | 37 | 0.044 |
| Oahu | 10,803 | 30 | 16 | 11 | 0.028 |
| Molokai | 4,365 | 12 | 1 | 1 | 0.026 |
| Maui | 4,347 | 12 | 54 | 39 | 0.009 |
| Hawaii | 1,242 | 3 | 10 | 7 | <0.001 |

Note: Data from State inventory lacks normal storage capacity for seven reservoirs out of 140 statewide.
Source: Penn, D., 2013, NWRI Progress Report: Acquire Sedimentation Data to Promote Reservoir Sustainability and Advance Watershed Science. University of Hawai‘i Water Resource Research Center.
http://www.wrrc.hawaii.edu/research/project_penn/sedimentation.pdf

Sedimentation of Hawai‘is reservoirs is a constantly occurring process that can reduce the functionality of a reservoir if not regularly addressed. Officially recorded storage volumes are based on design specifications for the initial installation of the reservoir. Regular bathymetric surveys are required to determine the rise in reservoir bed elevations that occur over time to therefore determine the normal operating capacity of a reservoir.[28]

[28] Penn, D., 2013, NWRI Progress Report: Acquire Sedimentation Data to Promote Reservoir Sustainability and Advance Watershed Science. University of Hawai‘i Water Resource Research Center. http://www.wrrc.hawaii.edu/research/project_penn/sedimentation.pdf

The most recent effort to determine reservoirs sedimentation rates was undertaken by the University of Hawaiʻi's Water Resource Research Center (WRRC). Their initial investigation found that data on actual sediment delivery, trapping efficiency, accumulated volume and release is limited.[27] Therefore, further research is needed before an assessment of reservoir capacities can be made to compliment any resource augmentation program(s).

The primary means of collecting any information on reservoirs in Hawaiʻi is through the DLNR Dam and Reservoir Safety Program. Dams and reservoirs must be properly maintained and managed to mitigate any potential threat they may pose to those who live in their vicinity.

### J.7.1.1 DLNR Dam and Reservoir Safety Program

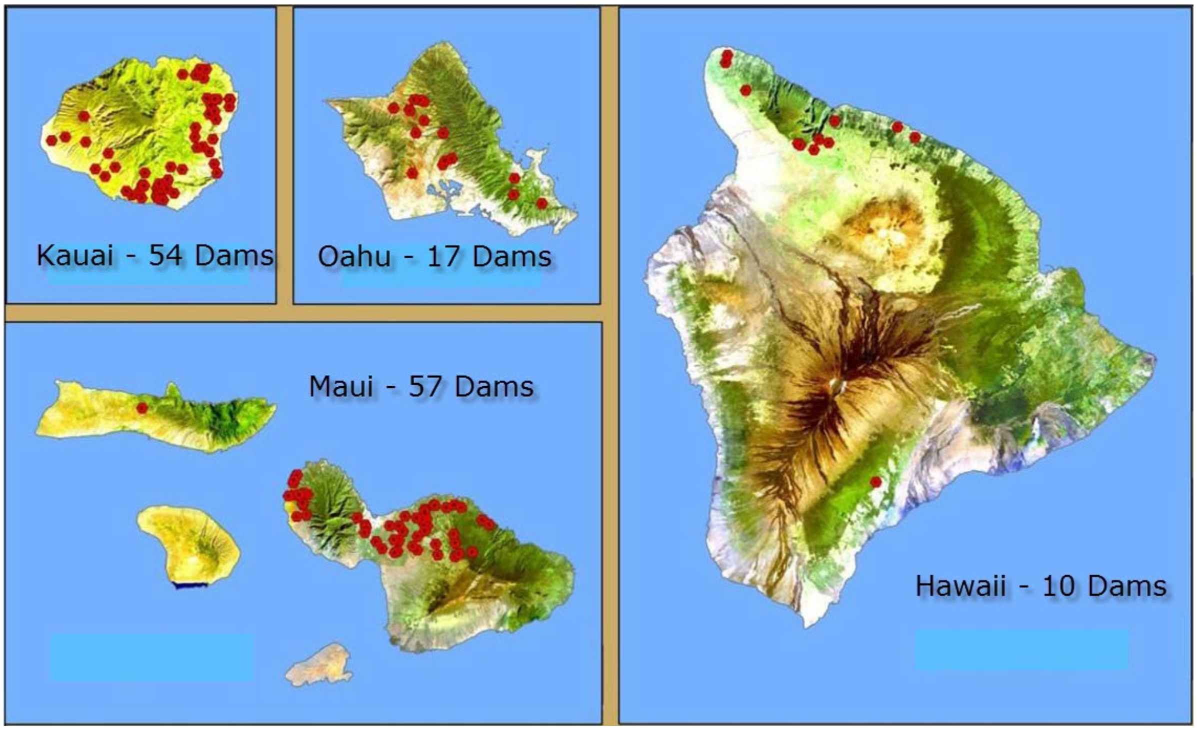
The DLNR Engineering Division administers the Hawaiʻi Dam and Reservoir Safety Act of 2007 (Chapter 179D HRS), which along with HAR Chapter 13-190.1 governs the design, construction, operation, maintenance, enlargement, alteration, repair, and removal or dams, reservoirs, and appurtenant works in the Hawaiʻi.

Only dams that meet a certain size criteria of height and volume are regulated by the DLNR. Regulated dams are identified as having artificial barriers which are 25-feet or more in height or have an impounding capacity of 50-acre-feet (approximately 17 million gallons) or more. Dams less than 6-feet in height, regardless of storage capacity, or that have a storage capacity not in excess of 15-acre-feet (5 million gallons) regardless of height do not fall under the jurisdiction of DLNR, unless otherwise specified. A permit from the Board of Land and Natural resources is required for all dam construction, alteration, enlargement, modifications or removal work. To assist dam owners and designers DLNR has developed guidance documents and a standard set of general permit requirements. These can be found online at: http://dlnreng.hawaii.gov/dam/.

DLNR maintains a database of regulated structures, which includes classifications regarding size, hazard potential, and overall condition. DLNR staff routinely inspects these structures to keep the database current. The Hawaiʻi Dam and Reservoir Safety Act of 2007 authorizes the DLNR implement enforcement actions for failure of owners to comply with the requirements of Act, non-compliance with dam safety permit terms and conditions, and non-compliance with certificate to impound terms and conditions.

As of 2013 there are 138 regulated dams and reservoirs throughout Hawaiʻi. **Figure J-2** breaks this figure out by island. The majority of the regulated dams and reservoirs in the state are privately owned (69%), with the state and county governments owning only 31%.

### Figure J-2 Locations of Regulated Dams and Reservoirs (2013)




### J.7.1.2 DLNR General Flood Control Plan Program

DLNR developed the State General Flood Control Plan in September 1983 in order to coordinate floodplain management initiatives. The goal of the State General Flood Control Plan (SGFCP) is to assist the State in decision-making regarding flood hazards and prioritize areas to best focus limited resources. The last Statewide inventory of flood history and flood studies was performed in 1994. Therefore, an update of the SGFCP is necessary, and is authorized by Hawai‘i Revised Statutes Chapter 179.

The SGFCP is currently being updated and will utilize digital database and website technologies to provide educational information and public awareness tools on flood risks, flood histories, hydrologic data, mitigation initiatives, a library for flood studies and post-flood reports, and other related information. The SGFCP update will also implement geospatial and internet technologies that will allow partner agencies to share, communicate, and utilize collected information[29].

[29] https://dlnreng.Hawai‘i.gov/fcds/gfcp/

## J.7.2 County Resource Augmentation Programs

The following sections describe resource augmentation programs currently administered by the counties, as well as other private projects. The County of Maui has a well-developed and successful wastewater reclamation program. In the City and County of Honolulu, wastewater reclamation and desalination are being championed by the BWS. Wastewater reclamation is also being practiced at a smaller scale in the counties of Kauaʻi and Hawaiʻi.

### J.7.2.1 County of Maui

**Wastewater Reclamation**

The County of Maui's Wastewater Reclamation Division is considered to be a water reuse leader in Hawaiʻi. In 1990, Maui County developed a plan and embarked on a long-range program to reuse millions of gallons of a valuable resource, high-quality recycled water, which previously had been disposed into injection wells. To lay the foundation for the county's program, several key components were initiated including: water reuse feasibility studies; a community-based rate study; the creation of a Water Recycling Program Coordinator position; upgrades to the Kihei (South Maui) and Lahaina (West Maui) wastewater reclamation facilities to R-1, tertiary-treatment capability; passage of an ordinance mandating the use of recycled water at commercial properties; adoption of rules for recycled water service; and the creation of a recycled water rate structure, which recovers monies spent on distribution-system development from both recycled water and sewer users.

**Program Development:** The impetus behind the development of Maui County's water reuse program was a regulatory-agency belief that Maui's effluent-disposal practices were causing environmental problems. The United States Environmental Protection Agency and local environmental groups expressed a concern that injection wells may contribute nutrients that cause alga blooms in coastal waters. In 1995, the EPA placed a limitation on the amount of effluent that could be disposed into the injection wells at the county's Lahaina Wastewater Reclamation Facility (WWRF). This factor played a major role in the passage of the bill, which led to the mandatory recycled water use ordinance on Maui. Increased recycled water use on the island and the results from scientific studies, which indicated that other non-point nutrient sources might be the cause of the periodic alga blooms, have eased this concern somewhat. Nevertheless, effluent disposal will continue to be a factor driving the County of Maui's water reuse program, since most of its wastewater reclamation facilities rely on injection wells. As performance of these injection wells eventually decline, increasing the use of recycled water from the respective facilities, rather than drilling additional wells, may be required by regulatory agencies.

**Potable Water Supply:** Water supply is now a factor driving the County of Maui's water reuse program. The island of Maui has limited supplies of available fresh water. The island's main water source, the ʻĪao Aquifer System Area, supplies most of Central and South Maui with potable water. Much of this water is used for landscape irrigation at parks, schools, condominiums, hotels and single-family residences. Due to increasing development in these areas, the ʻĪao Aquifer System Area is showing signs of overpumping. Over the past several years, monitoring of the aquifer's wells has indicated that chloride levels are increasing and freshwater levels are decreasing. As a result, CWRM designated the ʻĪao Aquifer System Area as a Ground Water Management Area. The nearby Waiheʻe Aquifer System Area has also been the subject of designation concerns. CWRM designates water management areas to ensure the long-term sustainability of the resource by establishing administrative control over the withdrawal of ground water in the area.

**Recycled Water Infrastructure:** Wastewater Reclamation Division uses recycled water from all five of its facilities. Distribution systems have been developed in South Maui and West Maui. South Maui has the most complete distribution system at this time and as a result, the most water reuse projects. The South Maui system now provides recycled water to eighteen separate projects, with more scheduled to connect to the distribution system in the near future. Uses include landscape irrigation, agricultural irrigation, fire control, industrial cooling, composting, construction activities, and toilet and urinal flushing.

West Maui distribution is limited, due to insufficient recycled water storage, but it does service Maui County's largest water reuse project, the Kaanapali Resort. Up to 1.2 MGD is utilized by the resort for golf course and landscape irrigation. Plans are now being developed to expand this system to provide R-1 water to condominiums and hotels in the Kaanapali area. R-1 water is also pumped to Maui Pineapple Company, but use has been limited due to above-average rainfall since the distribution system was built. Maui Pineapple Company will also phase out pineapple production in west Maui in the year 2006.

In addition to the major distribution systems described above, recycled water is utilized from Maui County's facilities on Lanai, Molokaʻi, and in central Maui. On Lanai, wastewater is processed to R-3 quality utilizing stabilization ponds, and then the entire plant flow of approximately 0.25 MGD is sent to an auxiliary WWRF owned and operated by the Lanai Company where it is upgraded to R-1 quality and used for golf course irrigation. On Molokaʻi, the State Department of Transportation utilizes R-2 water for landscape irrigation along the Maunaloa Highway. Finally, in central Maui, R-2 water is used to irrigate coconut trees and native Hawaiian plants at the Kanaha Cultural Park, which is adjacent to the Kahului WWRF.

**Economics:** Since water supply and wastewater disposal were both important factors driving Maui County's water reuse program, both recycled water users and sewer users share the costs associated with recycled water production and delivery. A portion of the sewer fees collected from all commercial and residential users of Maui County's sewer system is used to pay for the recycled water program's operation, maintenance, and infrastructure costs. Maui County officials believed that sewer users must not only pay the costs associated with wastewater collection and treatment, but must also help bear the costs of effluent disposal, whether it is through the use of injection wells or through water reuse. This approach allowed Maui County officials to set the price of recycled water at rates that encourage users to connect to the distribution system. The following user classes, with corresponding costs of recycled water, were created:

- Major Agriculture (> 3.0 MGD): $0.10/1000 gallons;
- Agriculture (including golf courses): $0.20/1000 gallons; and
- All Others: $0.55/1000 gallons.

The rates were set at levels slightly below the costs of the water sources typically used by the three recognized user classes. An “avoided cost” category was also created which allows recycled water consumers to pay the same rate for recycled water as they were paying for other non-potable water sources. Connection fees for the south and west Maui areas, where major R-1 distribution systems were developed, were also established to help pay for the recycled water program.

**Public Education and Outreach:** Proactive public education has played an important role in the success of Maui County’s water reuse program. The Wastewater Reclamation Division’s (WWRD) Water Recycling Program Coordinator conducts up to 100 presentations per year on water conservation, wastewater treatment, and water reuse to schools, community groups, and the general public. Tours of the County’s wastewater reclamation facilities are also provided. In addition, the coordinator issues press releases announcing new projects that use recycled water and expansions to County recycled water distribution systems. Promotional items such as bumper stickers, magnets, rulers and pamphlets are also utilized. Generally, the public has supported the concept of reusing wastewater within the community. As a result of its proactive approach to public education, the County has encountered little opposition to its water reuse program.

Most of the water reuse projects in Maui County are provided recycled water by the County of Maui’s WWRD. There are also private systems, including resorts and housing developments that treat their own wastewater and utilize the recycled water for golf course irrigation. The Pukalani and Makena Golf Clubs on Maui, the Challenge at Mānele on Lanai and the Kaluakoʻi Golf Club on Molokaʻi blend recycled water with other non-potable sources to satisfy their respective irrigation demands.

Lanai has changed its economic base from pineapple cultivation to tourism in recent years. Two resorts, the Lodge at Koele and the Mānele Bay Hotel, are located on the island and both recycle their wastewater at their respective golf courses. Water reuse is important on Lanai, because the island typically receives below-average rainfall and Maui County prohibits the use of potable water for golf-course irrigation.

Molokaʻi is lightly populated and one of the least-visited islands in the Hawaiian chain. The bulk of the wastewater produced is treated at the County of Maui's Kaunakakai WWRF and disposed of via injection wells. A small volume is used for landscape irrigation along the Mauna Loa Highway. The Kaluakoi Resort on the west end of the island also recycles its wastewater for use on its golf course.

Puʻu O Hoku Ranch is located in south-east Molokaʻi in Kaunakakai and recently commenced operation of a constructed wetlands system in the year 2004. The system is relatively small and is designed for only 3,700 gpd. Wastewater is collected from the ranch and treated to R-3 quality using septic tanks, effluent screening, and a constructed wetland. The R-3 water is used to irrigate trees and shrubs via a sub-surface drip irrigation system. The ranch benefits from the improved wastewater treatment capability and the creation of a drought-proof supply of water that satisfies much of its irrigation requirements.

**Program Expansion:** The County of Maui has two existing R-1 recycled water distribution systems, both of which have the potential to be expanded. The South Maui system is the most complete, as it has recycled water storage both at the Kihei WWRF and offsite at an elevated, covered storage tank. The West Maui system does not have adequate storage, and is thus limited in the number of projects that it can serve.

### J.7.2.2 City and County of Honolulu

**Wastewater Reclamation**

In contrast to the County of Maui, where water reuse has been championed by the municipal-wastewater agency, Honolulu BWS has emerged as the lead agency for water reuse in the City and County of Honolulu. The use of recycled water has increased significantly on Oʻahu since the Honolulu BWS developed a comprehensive water reuse program in the late 1990s. The Honolulu BWS recognized that recycled water is a resource valuable to extending Oʻahu's potable water supplies.

**Program Development:** Most water reuse growth on the island has occurred in the arid ʻEwa district of southwest Oʻahu, where significant development has occurred in recent years. Sugar cane cultivation has given way to numerous residential, commercial, and industrial developments. The change in land use has adversely affected the region's water resources. The recharge of the region's caprock aquifer has been significantly reduced by the elimination of sugar-cane irrigation, and the construction of impermeable surfaces. Also, the amount of potable water used in the region has dramatically increased, placing a strain on Oʻahu's aquifers.

Development in the ʻEwa area includes: a number of golf courses that use brackish water from the caprock aquifer for irrigation; residential subdivisions, which use potable water for irrigation of yards, parks and median strips; and the Campbell Industrial Park that uses potable water for industrial processes.

**Recycled Water Infrastructure:** The City and County of Honolulu was required to build the secondary treatment facilities at the Honouliuli Wastewater Treatment Plant (WWTP) to comply with a 1993 consent order by the DOH. The main objective of the consent order was to establish secondary treatment at the plant, and to reuse portions of the treated effluent. Improvements to the facility were completed in 1996, with approximately 2.0 MGD of recycled water being used for in-plant demands. In 1995, EPA, the DOH, and the City entered into a consent decree that required the City to develop a water reuse system that would allow the City to recycle 10 MGD of water by July 2001. The Honouliuli WWTP was selected for implementation of the water reuse requirements, because of the increasing demands on the ‘Ewa aquifer, the reduction of recharge due to the cessation of sugar cane cultivation, and the close proximity of the facility to potential users of recycled water.

The City and County of Honolulu selected Veolia Water North America (formerly U.S. Filter Corporation) to oversee construction, own, and operate the Honouliuli Water Recycling Facility (WRF). Recycled water distribution systems were built to deliver R-1 and R-O water to the potential users. CWRM adopted a policy to champion direct and indirect water reuse in the ‘Ewa plain. Recognizing that recycled water is a valuable resource in the ‘Ewa plain, and knowing that R-1 water would ultimately be available in the area, CWRM issued interim water use permits to the planned golf courses and other non-potable users in the area, and conditioned these water use permits on conversion to R-1 water once it became available and acceptable for use.

The Honolulu BWS purchased the Honouliuli WRF in 2000 from Veolia Water North America, with the intent of integrating water reuse into a plan to conserve water resources through conservation and the development of new water supplies. The Honouliuli WRF receives secondary effluent from the Honouliuli WWTP and produces both R-1 and R-O grades of recycled water. R-1 water is now delivered to eight golf courses, three parks, and a median strip, where it is used for landscape irrigation. R-O water is delivered to refineries and power generation facilities in Campbell Industrial Park. Hawaiian Electric Company’s Kahe power plant and the proposed Campbell peaking power plant are scheduled for connection to the RO water system within the next two years. Veolia Water North America operates and maintains the Honouliuli WRF on a contractual basis, while the Honolulu BWS operates and maintains the distribution system.

**Program Economics:** The Honolulu BWS has individual agreements in place with its recycled water customers. In general, golf courses and other landscape irrigation customers pay less than industrial customers. The initial rates for R-1 water were set significantly lower than what it costs the Honolulu BWS to produce and deliver the recycled water to the golf courses. Once the agreements expire, the Honolulu BWS may need to increase its recycled water rates, to recover the costs associated with production and delivery. The rate increase may place an economic hardship on the golf courses, and they may decide to revert back to less-expensive caprock wells for irrigation. Irrigation use is allowed, as long as well pumpage remains within permitted allocations and chloride levels in well water do not exceed 1,000 milligrams per liter. If the golf courses do revert back to ground water sources for irrigation, the Honolulu BWS recycled water program could be affected.

**Public Education and Outreach:** The Honolulu BWS's water reuse program is staffed by a recycled water program manager and three recycled water program coordinators. As in the case with the County of Maui, proactive public education has been an important component of the Honolulu BWS's water reuse program. The Honolulu BWS hired a public relations firm to develop a strategy and promotional/educational items to gain public acceptance of its program. The program's recycled water coordinators play a key role in outreach efforts. The coordinators participate in outreach efforts, conduct numerous tours of the Honouliuli WRF, and provide presentations to the community on a regular basis.

**Program Expansion:** Water reuse has been successfully practiced on O‘ahu for decades. The oldest Hawaiian reuse project is at Waialua Diversified Agriculture, where recycled water has been blended with stream water and used for irrigation of sugar cane and diversified agriculture since 1928. Other projects with successful track records include the Marine Corps Base Hawai‘i Kaneohe Klipper Golf Course, where R-2 water has been used to irrigate the base golf course since 1966, and Hawai‘i Reserves, Inc., where R-1 water has been used to irrigate diversified agriculture and the athletic fields at the Brigham Young University Hawai‘i campus since 1995. The Army's Schofield WRF provides R-2 water to the Dole ditch where it is used for agricultural irrigation on the North Shore. Most of the growth in water reuse on O‘ahu has taken place in the ‘Ewa district of southwest O‘ahu, due to the Honolulu BWS's water recycling program. Of the City and County of Honolulu's eight WWTPs, the Honouliuli and Wahiawā WWTPs are under consideration for expansion. A third facility, the Waianae WWTP on the Leeward Coast, is under consideration for a future water reuse project.

**Desalination**

Desalination on a municipal scale has been considered intermittently in the past. In the 1960s, the Honolulu BWS conducted studies on the feasibility of desalination using seawater and brackish water. At that time, the estimated cost of desalting brackish water (water containing up to about 1,500 parts per million chloride) was $0.50 per 1,000 gallons, and for seawater, the cost was about $1.00 per 1,000 gallons.

In 2003, the Honolulu BWS completed construction and testing of a seawater-desalination pilot plant that could eventually produce 5 MGD of potable water. The plant is part of the BWS's strategy to diversify water sources, and it is located between Campbell Industrial Park and Barbers Point Naval Air Station in ‘Ewa Beach. The Honolulu BWS intends the desalination plant, which employs reverse osmosis technology, to provide water for drought mitigation and to meet projected water demands for the ‘Ewa and Kapolei areas. When completed, the $40 million facility will contain an administrative building and visitors center, a chemical storage building, a reverse osmosis building, injection and source wells, a brine pond, and parking, as well as an off-site electrical substation.

If brackish ground water is pursued for desalination, the sustainable yield of caprock-brackish water on Oʻahu is limited to probably not more than 15-20 MGD. For basal-brackish water, the supply is greater, but care must be exercised in the use of this source because of possible jeopardy to the basal ground water body and nearby wells.

### J.7.2.3 County of Kauaʻi

**Wastewater Reclamation**

The County of Kauaʻi has not formalized its water reuse program. R-2 recycled water from three of its facilities is provided at no cost to nearby projects. For years, effluent from County wastewater reclamation facilities was used to irrigate sugarcane. Transmission systems, consisting of ditches and reservoirs, were used to transport the effluent to the sugarcane fields. These same transmission systems are still used today to deliver R-2 water to the Kauaʻi Lagoons Resort and to Kikiaola Land Company. The County now has agreements in place with the Kauaʻi Lagoons Resort and Kikiaola Land Company to accept effluent from the Lihue and the Waimea WWRFs, respectively. The Wailua WWRF's effluent is reused at the adjacent Wailua Municipal Golf Course. This is a convenient situation for both the Wailua WWRF and the golf course, since the County of Kauaʻi owns both facilities. As these projects are the primary disposal sites for the effluent from the County wastewater facilities, the County has no plans at this time to charge for the recycled water.

Kauaʻi has abundant surface water resources, and water from rivers and streams has been diverted through ditch conveyance systems to provide non-potable irrigation water for many golf courses and agricultural projects. As a result, recycled water use at most of Kauaʻi's water reuse projects is considered more of a convenient wastewater effluent disposal option, rather than a water supply resource. A total of six projects utilize recycled water for golf course irrigation. A seventh project at Kikiaola Land Company blends R-2 recycled water from the Waimea WWRF with stream water for seed-corn irrigation.

There are no plans in place at this time to expand any of the County of Kauaʻi's recycled water distribution systems.

### J.7.2.4 County of Hawaiʻi

**Wastewater Reclamation**

The County of Hawaiʻi is developing a water reuse program, and currently provides R-2 recycled water to only one project, Swing Zone Golf Practice Facility in Kona. In this case, the owner of Swing Zone installed the recycled water distribution system from the County's Kealakehe WWRF to the practice facility at his own expense. The County's Wastewater Division is contemplating developing a distribution system to provide recycled water from its Kealakehe WWRF to a number of irrigation projects, including parks and future golf courses. Lack of available funding, however, has delayed implementation of these ideas. Technical-planning assistance has been provided to Hawaiʻi County by Reclamation, to plan and design a proposed constructed wetlands system that will utilize recycled water from the Kealakehe WWRF. Federal authorization is being pursued in Congress for funding of this project, along with two other county water reclamation projects (on Maui and Oʻahu). Federal funding shall be subject to authorization and subsequent Congressional approval for appropriation of funds on a cost-shared basis.

Water reuse on the Big Island mainly takes place at five private, resort developments where wastewater is treated at resort-owned wastewater reclamation facilities, and then blended with other water sources and reused for irrigation of the resorts' golf courses. Other projects include the State Department of Transportation's Keahole International Airport, where R-1 water is used for irrigation of the airport's landscaping, and at Parker Ranch, where R-3 water is used for pasture irrigation. Swing Zone is a unique reuse project, because the owner installed a recycled water transmission system at his own expense to convey 0.06 MGD of R-2 water to the Swing Zone property, where it is used to irrigate the facility's turf grass.

The County of Hawaiʻi's Wastewater Division is in the planning stages of developing a recycled water distribution system that will utilize recycled water from the Kealakehe WWRF. Phase one, which will satisfy the requirement of a consent decree for the County to use recycled water, involves constructing a pipeline to deliver recycled water to the Honokōhau Harbor for landscape irrigation. This phase was to be completed by June 2005, and could also serve a future development by the Department of Hawaiian Home Lands. Phase two is in the design stage, and involves the development of a pipeline and reservoir system that could deliver recycled water to a possible future golf course as well as a future development. The Wastewater Division will continue to attempt to obtain federal funding for a constructed wetlands system to upgrade the Kealakehe WWRF to produce an R-1- quality water system.

### J.7.3 Recommendations for Water Resource Augmentation Planning

The State Water Code states that CWRM shall plan and coordinate programs for the conservation and protection of water resources.[30] The Water Code also states that the Hawaiʻi Water Plan shall include programs to conserve, augment and protect the water resources.[31] Therefore, it is recommended that CWRM act in an advisory capacity, guiding policies and planning efforts for augmentation projects.

The State Water Code also enables CWRM, via conditions placed on water use permits, to require the use of dual line water supply systems in new industrial and commercial developments located in designated water management areas.[32] Under this provision, the county boards of water supply, in consultation with the DOH, must adopt standards for non-potable water distributed through the dual line water supply systems and rules regarding the use of non-potable water in order to protect existing water quality and public health and safety. As of

[30] HRS §174C-5(12).

[31] HRS §174C-31(d)(4).

[32] HRS §174C-51.5(a).

the date of this draft, standards and rules have yet to be adopted. CWRM should coordinate with county agencies to obtain regular updates for recycled-water service areas and capacities, and apply the dual line water supply system requirement to permit applications within the portions of water management areas served by recycled water distribution systems.

It is also recommended that CWRM explore partnerships with governmental agencies and stakeholders in order to coordinate resource augmentation planning and policies. Suggested agencies for involvement include, but are not limited to: water agencies, energy agencies, coastal-management agencies, natural-resource management agencies, economic-development agencies, and public-utility commissions. County water departments, county wastewater departments, county planning departments, DBEDT, DLNR, DOH, Coastal Zone Management program and Special Management Area program administrators, the Bureau of Reclamation, and the EPA should specifically be consulted. Environmental groups, private industry, and economic interests should also be invited to participate in creating a vision for the program. Furthermore, government agencies involved in resource augmentation planning should be encouraged to establish cooperative relationships with professional organizations like the American Water Works Association, the American Society of Civil Engineers, the American Public Works Association, the Water Environment Federation, the American Planning Association, the American Counsel of Engineering Companies of Hawaiʻi, and other such organizations that have extensive industry expertise and skilled, knowledgeable membership bases.

The water resource augmentation planning efforts and policies must be designed to complement the water conservation program recommendations in **Section J.2 Statewide Water Conservation Program**, and incorporate the intent of these recommendations whenever appropriate. A long-term goal for CWRM should be to establish a resource augmentation planning program and framework to identify augmentation goals, objectives, and priorities to promote the use of alternative water resources and to encourage the development of these supplies in an efficient and sensible manner. Reiterating the assertion noted in **Appendix H Existing and Future Demands** of the WRPP, land use planning and water resource planning should be accomplished with ongoing, mutual consultation in order to be successful and sustainable.

#### J.7.3.1 Recommendations for Wastewater Reclamation in Hawaiʻi

It is recommended that the goals and strategies discussed above, as well as the results of the *2013 Update of the Hawaiʻi Water Reuse Survey and Report,* should be used by the counties as a guidance document to assist county reuse initiatives. It is recommended that county governments examine the potential recycled water expansion and application projects identified in the *2013 Update of the Hawaiʻi Water Reuse Survey and Report*. Counties should use the report to help strategize ways to develop and expand water reuse within their jurisdictions.

Furthermore, counties should include their current water recycling program, or strategies for program development, into subsequent updates of the County WUDPs to maintain consistency with the WRPP.[33] County recycled water rates should be published or made available upon inquiry to users, potential customers, and the general public.

### J.7.3.2 Recommendations for Stormwater Reclamation in Hawai‘i

The amount of stormwater runoff from urban areas is indeed significant, as is evidenced by existing storm drain systems and flood control installations. This water could be captured, treated, and applied to beneficial uses; however, the feasibility of stormwater reclamation and reuse, on a small or large scale, remains to be assessed. Further study of the obstacles/constraints and opportunities to increase stormwater recharge statewide from mauka to makai should be undertaken.

Decision makers need to understand the risks, cost, and benefits of investing in stormwater reclamation and reuse as a viable water resource alternative. To enhance the viability of stormwater reuse, a report by the National Academy of Science identified five research themes that should be addressed: Risk and water quality, treatment technology, infrastructure, social science and decision analysis, and policy and regulatory issues[34]. The following paragraphs summarize and incorporate the recommendations from the report.

<u>Risk and water quality:</u>
The fate and occurrence of pathogens and chemical contaminants in stormwater can represent a significant risk in the application of reclaimed stormwater for non-potable uses. The DOH administers the National Pollution Discharge Elimination System and Total Maximum Daily Load programs that regulate the discharge of stormwater. However there are no guidelines or standards governing stormwater reclamation and reuse at the State or Federal level. Unlike wastewater, the characterization of stormwater is difficult because it is site specific and can vary with the land use of the contributing watershed. Further studies should be done to establish a methodology for determining standards and risk-based water quality guidance for various uses. Monitoring technology and strategies should also be developed to ensure compliance with any reuse criteria that is established.

<u>Treatment technology:</u>
In the absence of guidelines for the reclamation and reuse of stormwater, many types of technologies have been applied for various levels of treatment. The lack of a standardized guidance for treatment process may result in additional costs in the development and modification of any pilot projects. Demonstration projects should involve extensive data collection to synthesize findings into standard practices for treatment technologies.

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[33] HRS §174C-31(b)(1).

[34] The National Academies of Sciences, Engineering, and Medicine. 2015. *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*. Washington, DC: The National Academies Press.

Additionally, the long-term performance and reliability of systems at different scales needs to be understood. The needs of different types of stormwater reclamation systems should be understood to properly design operation and management strategies.

Infrastructure:
State and county government should encourage the use of stormwater reclamation and reuse measures that could be used to meet some of these program requirements.

The *2008 Appraisal of Hawai‘i Stormwater Reclamation and Reuse* report identified possible opportunities for stormwater reclamation. The accompanying *Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawai‘i*, describes stormwater reclamation technologies and practices, such as rain barrels, permeable pavement, and green roofs, which can be easily implemented at residences and scalable for different sized facilities. Landscape features, such as rain gardens for infiltration, can also be incorporated into building and parking lot design.

Therefore, it is recommended that county governments encourage the use of small-lot and source-reuse technologies to manage precipitation and runoff as close to the source as feasible, and to provide water for a variety of non-potable uses. Government facilities can provide excellent demonstration sites for these simple technologies. The county could also provide incentives, in the form of water credits or speedy-permit processing, to encourage the implementation of on-site stormwater reuse.

State and county agencies as well as non-government organizations should also examine the potential stormwater reclamation opportunities described in the *2008 Appraisal of Hawai‘i Stormwater Reclamation and Reuse* report for future implementation or adoption of the methods for assessing potential stormwater projects. Additionally, counties should look beyond the recommendations in the 2008 report when formulating potential local reclamation opportunities, and be able to contribute new or updated information to future report updates.

### J.7.3.3 Recommendations for Desalination Programs in Hawai‘i

Desalination plants are in use in other parts of the country, but it is only recently that technological developments have reduced the costs and energy requirements to be comparable to that of new well construction in many coastal areas of the continental United States. Coastal communities generally lack experience in evaluating the environmental impacts or public-resource issues associated with the construction and operation of desalination plants, and this remains a matter of concern as the number of desalination plants increase.

In 2004, approximately 24 desalination facilities were being planned for various locations along the California coast. Recognizing the need to anticipate information and evaluation requirements for proposed desalination plants, the California Coastal Commission published a report in March 2004 titled *Seawater Desalination and the California Coastal Act.* The report clearly emphasizes that the “concerns about desalination are due primarily to its potential to cause adverse effects and growth that are beyond the capacity of California's coastal resources." The purpose of the report is to provide information on issues related to desalination and its possible effects on coastal resources and coastal uses, describe existing and proposed facilities, identify and discuss policies of California's Coastal Act that apply to desalination programs, and identify information required during coastal development permit review for proposed facilities.

Many of the report's primary findings may be considered in terms of their applicability to water augmentation and desalination facility planning in Hawai'i. It is recommended that all permitting agencies address the potential negative impacts associated with desalination and that proposed county and private desalination facilities evaluate the potential impact on coastal resources and uses, including cultural uses and practices.

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