Alternative Wastewater Treatment Systems for Farmworker Housing in Hawai‘i

Applied Policy Project
Prepared for The Kohala Center

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Acronyms

BOD	Biochemical Oxygen Demand
DOH	State of Hawai‘i Department of Health
EPA	Environmental Protection Agency
HAR	Hawai‘i Administrative Rules
IWS	Individual Wastewater System
NSF	Previously stood for National Sanitation Foundation
OWTS	On-site Wastewater Treatment Systems
RME	Responsible Management Entity

Executive Summary

Despite a year-round growing season, Hawai'i imports 90 percent of its food. Governor David Ige introduced a goal to double local food production by 2020 through his Sustainable Hawai'i Initiative. Essential to meeting this goal and increasing agricultural production in the state is providing adequate housing for farmers and farmworkers. There are many barriers that farmers face in establishing housing on their agricultural land, a prominent one being the difficulty in obtaining high-cost wastewater treatment systems that meet county and state requirements.

The State of Hawai'i requires that all legal dwellings that can't connect to county sewer systems have an approved wastewater management system. Typically, these approved systems are either aerobic systems or septic systems. The high capital and maintenance costs of these wastewater treatment systems are a barrier to developing dwellings to be used for farmworker housing. Farmers are interested in policy that would promote the development of low-cost alternative wastewater systems, such as composting toilets with greywater reuse systems.

The Kohala Center is a community-based nonprofit on Hawai'i island, also known as the Big Island, that carries out research, conservation, and education projects around food, water, place, and people. This report provides the Kohala Center with options to improve access to low-cost alternative wastewater treatment systems for farmworker housing in Hawai'i. These options include:

I. Status Quo
II. Lobby for a Wastewater Advisory Committee
III. Lobby for a Department of Health Waiver Program
IV. Lobby for the Extension of Act 120 and Act 125 Incentives
V. Produce a Study on Low-Cost Alternative Wastewater Treatment Systems for the Department of Health

These alternatives are evaluated on their administrative and political feasibility, effectiveness, public and environmental health risk, public support, and cost. After evaluating the options, this report recommends that the Kohala Center lobby at the county- and state-levels for Hawai'i county to establish a wastewater advisory committee. The report concludes by discussing considerations for the implementation of the recommended alternative.

Introduction

Hawai‘i is blessed with a year-round growing season and the natural resources necessary for a thriving agricultural sector. Despite these resources, Hawai‘i imports 90 percent of its food (Hughes, 2015). Hawai‘i needs to take many steps towards boosting its agricultural sector and supporting its farmers. Necessary for a thriving agricultural industry and continued food security is ensuring that farmers and farmworkers are able to live safely and healthily on their land.

There are many barriers to developing farmworker housing in Hawai‘i. A prominent barrier is meeting county and state requirements for wastewater treatment systems. The State of Hawai‘i requires that all legal dwellings that can't connect to sewer systems have an approved individual wastewater system (IWS). Farmers, requiring larger plots of land, live in more rural areas that are typically not connected to sewer systems. Thus, farmers rely on IWSs, the three most common of which are aerobic systems, septic tanks, and cesspools. Aerobic systems are the most expensive but most effective in treating wastewater. Aerobic units cost $25,000 to $40,000 in Hawai‘i and provide secondary levels of treatment. Septic systems cost $12,000 to $20,000 in Hawai‘i but only provide primary treatment of wastewater and present a high environmental and public health risk. Cesspools are excavations that receive untreated wastewater and provide no further treatment, presenting a very high environmental and public health risk.

The opportunity exists to apply for permits for advanced alternative systems that don't necessarily fit any of the three previous descriptions or may be a combination of aerobic and anaerobic systems. However, the administrative hassle and high cost of these systems make them largely infeasible for farmers.

When considered with all other costs of developing farmworker housing, the cost of an aerobic, alternative, or septic wastewater system is a large barrier for farmers, who make an annual wage of about $34,000. This results in many illegal systems that present high public and environmental health risks. The administrative and logistical systems are not in place for private companies to provide and the state government to approve low-cost alternative wastewater treatment systems that adequately protect public and environmental health.

The inability to certify and permit low-cost wastewater treatment systems has various consequences to farmers and society at large. The high cost barrier to developing formal farmworker housing leaves many farmworkers living in informal, illegal dwellings such as garages, barns, abandoned vehicles, rundown trailers, shacks, and tents (Villarejo, 2015). The social, health, and

economic risks of living in substandard housing are detrimental to not only the workers but the entire agriculture industry. In substandard dwellings, farmworkers face exposure to pesticides, lack of sewage and potable water, structural deficiencies, pest infestations, and overcrowding. This makes farmworkers vulnerable to infectious and intestinal disorders at rates much higher than the general population (Farmworker Justice, 2015). Healthy farmers are necessary for a healthy agricultural system. Failing to safely and healthily house farmworkers detracts from agricultural productivity and food security and sovereignty.

Problem Definition

The State of Hawai'i requires that all legal dwellings that can't connect to sewer systems have an approved wastewater management system, ideally in the form of aerobic systems but, for economic reasons, often in the form of septic systems. The high capital and maintenance costs of these wastewater treatment systems are a barrier to developing dwellings to be used for farmworker housing. Farmers are interested in policy that would promote the development of low-cost alternative wastewater systems, such as composting toilets with greywater systems.

Background and Literature Review

The Kohala Center

Founded in 2000, the Kohala Center is a community-based, independent center for research, conservation, and education on Hawai'i island, also known as the Big Island. The Kohala Center takes research and ancestral knowledge about food, water, place, and people and puts them into action. Some of the organization's active programs include Hawai'i Island School Garden Network, Beginning Farmer-Rancher Development Program, Hawai'i Public Seed Initiative, and a variety of academic programs. In addition to this programming, the Kohala Center supports and conducts independent research on topics such as affordable land and housing for farmers, organic farming, energy sustainability, tourism industry waste generation, and more (The Kohala Center, 2018).

Need for Affordable Farmworker Housing

The sustainability of Hawai'i's food and agriculture system depends on the labor of farmworkers. However, farmworkers are often geographically and socially hidden and their needs overlooked (Villarejo, 2015). The inability to provide affordable farmworker housing has negative implications for worker health and safety, community well-being, and the viability of the agricultural sector (Keim-Malpass, Johnson, Quandt, & Arcury, 2015). Farmers living on their agricultural land ensures production, which is necessary to meet Governor Ige's goal to double local food production by 2020 set forward in his Sustainable Hawai'i Initiative (Governor of the State of Hawai'i, n.d.). As mentioned, Hawai'i currently imports 90 percent of its food. The financial and environmental costs of such high levels of importation are staggering. It is estimated that replacing just 10 percent of the state's food imports would amount to $313 million that would stay in the state (Hawai'i Office of Planning, 2012). The government and private institutions recognize the need to bolster the agriculture industry and increase Hawai'i's food sovereignty.

Creating a strong and sustainable agricultural system requires providing safe, affordable housing for farmworkers. One of the main barriers to increasing local food production is the lack of farmers. Without guaranteed land and housing, people are less incentivized to enter the profession. Current housing for farmworkers in Hawai'i is inadequate. Many farmworkers live in informal dwellings, such as rundown trailers, shacks, tents, and treehouses. Zoning ordinances limit farmworker housing development, as many are concerned about the potential for gentlemen farms and vacation rentals. During the last three decades, many of Hawai'i's agricultural lands have been turned into gentlemen farms, which are large houses with minimal agricultural activity – perhaps a few mango trees or horses strewn about (Reid & Edmonds, 2017). Additionally, "1 in 24 homes in Hawai'i is a vacation rental, which is contributing to the state's" affordable housing crisis (U.S. News, 2018). These are a few of the reasons why the counties make it difficult to develop farmworker housing through restrictive zoning ordinances and planning policies.

The lack of legal and safe farmworker housing also leads to negative health outcomes for farmworkers. In substandard dwellings, farmworkers face exposure to pest infestations, overcrowding, lack of sewage and potable water, and structural deficiency that make farmworkers vulnerable to infectious and intestinal disorders at rates much higher than the general population (Farmworker Justice, 2015).

Finally, theft is likely to occur when farmers and farmworkers are unable to live on their land and protect their property. Agricultural theft has plagued the Big Island for decades (Finnerty, 2017). In September 2017, the Big Island hired a full-time agricultural investigator in an attempt to reduce agricultural theft (Associated Press, 2017). Legislation related to agricultural theft prevention programs is currently moving through the state Legislature and begins by stating:

> The legislature finds that agricultural theft and vandalism are a constant worry for farmers and ranchers…it is often difficult for farmers and ranchers to police their entire operations at all times. Furthermore, vigilance at night after work hours may be challenging because not all farmers and ranchers are able to live on or near the fields where they work. (HB 1883, 2018)

It is difficult to catch thieves, who act under the cover of darkness, and this task is made all the more difficult when farmers don't live on their land.

Introduction to Wastewater and Wastewater Treatment Systems

Domestic wastewater, which is the concern of this report, is wastewater generated by household showers, sinks, toilets, and laundry facilities. Wastewater is made up of solids, dissolved gases, and liquids, with the most prominent liquid being water. Wastewater is also made up of many chemicals and nutrients. High concentrations of nutrients can have adverse environmental and health effects and affect disinfection efficiency and suitability of wastewater reuse. Wastewater also contains microorganisms and pathogens. For wastewater to be returned to the environment without any adverse effects, it must be properly treated.

Wastewater treatment systems are either centralized or decentralized. Centralized treatment systems, such as sewer systems, consist of large wastewater collection systems that flow to a single wastewater treatment facility. Decentralized, or onsite wastewater treatment, systems typically encompass a single or several adjacent parcels and collect, treat, and dispose of domestic wastewater on the same premise that it was generated. Hawai'i's regulations use the term individual wastewater systems (IWSs) to describe decentralized or onsite wastewater treatment systems (WRRC, 2008).

The 2004 Clean Watersheds Needs Survey reports that 61.9 percent of Hawai'i residents are connected to a sewer system, whereas 38.1 percent of residents are served by IWSs (EPA, 2004). An IWS is a decentralized system that receives and disposes of no more than 1,000 gallons per day of domestic wastewater from one or multiple buildings that are not connected to a centralized wastewater treatment plant (State of Hawai'i, n.d.).

Currently, the three options on the State of Hawai'i Department of Health (DOH) IWS application form are cesspool, septic tank, and aerobic unit (Hawai'i State Department of Health, n.d.). Aerobic treatment unit systems are individual wastewater systems that require oxygen to treat wastewater. The units "use a mechanism to inject and circulate air inside the treatment tank", which requires electricity. Aerobic systems cost more money to operate and require more routine maintenance than septic systems (National Small Flows, 1996). As previously stated, the total cost of aerobic systems in Hawai'i, including installation, can range from $25,000 to $40,000 (D. Poma, personal communication, April 23, 2018).

Septic systems are a cheaper alternative, costing between $12,000 and $20,000 in Hawai'i, though remain financially unattainable for many farmers. Septic systems consist of a septic tank and a leach field. Through anaerobic processes, solids and floatable matter in the tank separate from the liquid, known as effluent. The effluent is released into the leach field, where the soil removes contaminants and impurities from the wastewater (EPA, 2016). The quality of the soil in the leach field will impact the quality of the effluent that is further released into soil and surface water. Many areas of Hawai'i have poor soil, meaning that in the state, "septic isn't much better than a cesspool" (D. Poma, personal communication, April 23, 2018).

Cesspools are underground holes or tanks that receive untreated wastewater from buildings. Solids are retained in the cesspool and liquids seep into the ground through the cesspool's perforated walls. A large-capacity cesspool is one that serves multiple dwellings or a non-residential location with the capacity to serve 20 or more persons per day (State of Hawai'i, n.d.). Virtually no treatment occurs in cesspools and the effluent quality is only slightly better than raw wastewater. The Environmental Protection Agency (EPA) prohibits the construction of large-capacity cesspools and Hawai'i recently passed legislation further restricting all cesspools, due to their environmental and public health risks (EPA, n.d.). Releasing untreated sewage into the ground through cesspools has the potential to pollute groundwater. Hawai'i relies on groundwater for over 90 percent of its drinking water (Hawai'i State Department of Health, 2017). Cesspools inject about 55 million gallons of untreated sewage into Hawai'i's groundwater every day, contaminating drinking water, streams, and oceans, and potentially spreading disease.

Aerobic systems provide the most effective treatment of wastewater. Septic systems and cesspools don't adequately treat wastewater and the effluent that these systems release into the ground risks contamination of nearby water sources. The high cost of aerobic and septic systems leads to a situation in which many agricultural buildings and dwellings use illegal wastewater systems,

such as cesspools or similar methods. These illegal systems present a serious health risk to the water used on these agricultural lands.

Current Wastewater Management in the State of Hawai‘i

In most urban settings in Hawai‘i, wastewater is collected and conveyed through a county's public sewer system.[1] The county typically treats the wastewater in a centralized facility. In areas where there are no public sewers, homeowners or developers must assume responsibility for wastewater management. The DOH is the regulatory agency responsible for decentralized wastewater treatment, i.e. all systems besides public sewer systems (WRRC, 2008). Counties have the regulatory responsibility for the areas serviced by public sewer systems (Hawai‘i State, 2009).

The Wastewater Branch of the DOH Environmental Management Division formulates and enforces all wastewater rules and regulations in the state. The regulations are codified in Hawai‘i Administrative Rules (HAR), Title 11, Chapter 22, "Wastewater Systems". The regulations cover all public wastewater treatment and disposal systems throughout the state as well as individual and on-site treatment and disposal systems. The preamble of the title clarifies the purpose and mission of the regulations and the DOH (Wastewater Systems, 2016):

> "The department of health seeks to ensure that the use and disposal of wastewater and wastewater sludge does not contaminate or pollute any valuable water resource, does not give rise to public nuisance, and does not become a hazard or potential hazard to the public health, safety, and welfare…The department of health seeks to advance the use of recycled water and wastewater sludge consistent with public health and safety and environmental quality. The state department of health acknowledges that when properly treated and used, all recycled water and wastewater sludge are valuable resources with environmental and economic benefits and can be used to conserve the State's precious resources."

Through this title the DOH states its commitment to protecting public and environmental health and to ensuring that Hawai‘i's residents can safely reuse and conserve the islands' vital resources.

[1] Hawai‘i's government structure is such that there are four local county governments: the City & County of Honolulu, which covers the entire island of O‘ahu; the County of Hawai‘i; the County of Maui; and the County of Kaua‘i. These four counties enjoy greater governing powers than many counties on the U.S. mainland (Ballotpedia, n.d.).

Cesspool Conversion

Hawai‘i has approximately 88,000 cesspools, far more than any other state, and until recently has been the only state in the U.S. to allow the development of new cesspools. Of the 88,000 cesspools in the state, nearly 50,000 are located on the Big Island.

In March 2016, Governor David Ige signed new Wastewater System rules proposed by the DOH. The rules ban new cesspools statewide, which will "stop the addition of pollution from approximately 800 new cesspools per year" (Governor of the State of Hawai‘i, 2016). The rules also implement Act 120, a 2015 law that provides a temporary income tax credit of up to $10,000 for the conversion from cesspools to sewer or septic systems up until 2020. The tax credit is available for owners of cesspools located within 200 feet of the ocean, marsh areas, streams, or drinking water sources (H.B. 1140, 2015). The breakdown of cesspools that meet this qualification can be seen in Appendix A. As of December 2017, the DOH processed 47 applications for the Act 120 tax credit, even though the program's budget allows for 500 cesspool upgrades per year (Hawai‘i State Department of Health, 2017). Nearly a dozen legislators expressed opposition to the proposed rule change. Many of the opposing lawmakers represent rural communities that rely on cesspools as opposed to high-cost septic tanks (Blair, 2016). Unless the tax credit is extended to construction of new septic tanks, as opposed to just the conversion from cesspools to septic tanks, the new policy does not provide a low-cost alternative for those interested in developing new dwellings. Whereas previously cesspools were a low-cost option for those looking to develop farmworker housing, they are now illegal and there is no financially comparable option.

In July 2017, Governor Ige signed Act 125, which requires that every cesspool in the state, unless exempted, "shall be upgraded or converted to a septic system or aerobic-treatment unit system, or connected to a sewage system" by January 1, 2050 (H.B. 1244, 2017). Act 125 also extends the tax credit eligibility to include cesspools located within 500 feet of the oceans, marsh areas, streams, or drinking water sources. The act allows for exemption from conversion for reasons such as small lot size, poor soils, steep topography, or accessibility issues. The DOH is responsible for reviewing and granting such exemptions. The act also tasks the DOH with investigating "the number, scope, location, and priority of cesspools statewide that require upgrade, conversion, or connection based on each cesspool's impact on public health" (H.B. 1244, 2017). The DOH report identified 14 critical areas with high concentrations of cesspools that should receive priority for replacement. More information on these priority areas, their priority level, the priority classifications, and the number of cesspools in each area is displayed in Appendix B. Regarding financing of such

conversion, the report stated that "thorough review of available funding and financing options is needed to assist homeowners" (Hawai'i State Department of Health, 2017).

Environmental and Public Health Risks

Cesspools present a serious risk to environmental and public health. As previously discussed, Hawai'i gets over 90 percent of its drinking water from groundwater. Hawai'i's 88,000 cesspools allow untreated wastewater to percolate into surrounding soil. Overflowing and leaking cesspools pollute groundwater, cause nearshore pollution, and present health risks to the people who come in contact with polluted water. University of Hawai'i at Hilo marine science researchers studied the connection between cesspools and nearshore pollution in Puaoka, a community on Hawai'i island that relies heavily on cesspools and septic tanks for wastewater and sewage disposal. The researchers found that sewage from cesspools could reach the coast in as little as nine hours, meaning there is little time for pathogens or nutrients to be lost or removed from the water. One of the researchers stated, "The shorter the travel time, the more similar it is to swimming in raw sewage" (Fujii, 2017).

While cesspools present the greatest risk, all treatment systems have the potential to introduce environmental and public health risks. A system's risk depends on the quality of its parts, the installation, and its maintenance. The system's performance can be compromised if any of these three aspects are neglected or substandard, introducing environmental and public health risks. For example, sewer systems, which are considered low-risk wastewater treatment systems, carry with them risks if they are not properly maintained. Sewage spills occur when wastewater treatment systems experience a mechanical fault, groundwater or rainwater enters the system through illegal connections or pipe defects, there is a point of rupture or overflow in the system, or a sewer main is broken or blocked (WA Department of Health, n.d.). In 2015, the DOH reported 19 sewage spills in Hawai'i, 11 of which affected coastal waters (Fujii, 2017).

IWSs, including septic tanks, also have the potential to pose environmental and public health risks. Septic tanks "that are poorly designed, installed, operated or maintained" can lead to disease-causing nitrates and pathogens leaching into ground water and surface water. They can also discharge an excess of nutrients into coastal waters. The effects of this discharge and leaching can include an overgrowth of algae and other disruptive aquatic plants, contamination of shellfish and filter feeding fish, and human disease through consumption of tainted fish, direct consumption, or recreational contact (EPA, 2017).

NSF International[2] is the leading organization for the development of public health standards, which many governments use to set benchmarks for testing, certification, and permitting. Hawai‘i DOH approves alternative wastewater systems that are tested to demonstrate that they meet the NSF Class I effluent standard. This standard states that the average biochemical oxygen demand (BOD), the amount of oxygen necessary to degrade organic matter, and total suspended solids, the total amount of suspended materials, for the system in a 30-day period cannot exceed 30 mg/L and that the average in any seven consecutive day period cannot exceed 45 mg/L. There are many other requirements to meet the Class I standard, including that the pH effluent must always be between 6.0 and 9.0, the system passes four stress tests, and the system has BOD removal of 85 percent. Between 1998 and 2006, the University of Hawai‘i’s Water Resources Research Center tested two aerobic treatment units that were able to meet the NSF standards and ultimately gain DOH approval (WRRC, 2008). The process of testing alternative treatment systems to ensure they meet NSF standards, and then getting the systems approved by the DOH, is time-consuming and resource-intensive. Though any engineering firm or wastewater treatment system developer can bring a technology to the University of Hawai‘i to get it tested and approved, it doesn’t happen often and requires active effort, usually on behalf of the government, to get the systems to Hawai‘i (D. Poma, personal communication, April 23, 2018).

Alternative Wastewater Systems

Under Hawai‘i Administrative Rules Title 11, Chapter 55 “National Pollutant Discharge Elimination System Permitting”, provisions exist for approval of “innovate and alternative technologies based on testing and monitoring on a case-by-case basis” (WRRC, 2008). IWSs must be designed by a Hawai‘i licensed professional engineer and the system must be installed by a licensed contractor. Plans for IWSs must be reviewed and approved by the DOH prior to construction and “once constructed, written authorization for use must also be obtained from the DOH” (WRRC, 2008, p. 2-5). Most of the approved alternative wastewater treatment systems in Hawai‘i are high-cost, aerobic systems. Greywater systems and composting toilets are two low-cost alternative wastewater systems in which Hawai‘i’s farmers have expressed interest.

[2] Since its founding in 1944, NSF stood for National Sanitation Foundation. However, in 1990 the organization changed its name to NSF International, as it expanded its services beyond sanitation (NSF, n.d.).

Greywater Systems

Greywater is water from non-kitchen and non-toilet sources and accounts for 60 to 80 percent of all household wastewater (Crites, Ono, & Izon, 2011). Based on rules established in HAR 11-62, the DOH allows the separation of greywater from black water—kitchen and toilet wastewater—and subsurface disposal of the greywater. The main difference between greywater and black water is the degree of organic loading. Sewage and kitchen wastewater are categorized as black water because they have relatively high levels of organic loading (Sustainable Earth Technologies, n.d.).

With proper treatment, greywater can be reused for a variety of purposes, including subsurface drip irrigation. Level of treatment and subsequent effluent quality determines the classification of the treated water as either be R-1, R-2, or R-3. The allowed uses for each classification of recycled water that are relevant to farmworker housing are displayed in Appendix C. A homeowner with the proper skills could install a greywater system for irrigation use for $200 to $300 in materials. Having a professional plumber install the system could cost between $1,000 and $3,000. Over time, homeowners will recoup this cost through water savings (Curry, n.d.).

For households with an IWS, Hawai‘ian counties have regulatory jurisdiction of the greywater system within the building and extending five feet from the building. The DOH has regulatory jurisdiction of the greywater system beginning from five feet away from the building. Thus, greywater system designs must be submitted to both the county and the DOH. The design of the greywater system must be certified by a licensed engineer. The Hawai‘i Legislature urged the DOH to establish greywater recycling guidelines to promote water reuse and sustainability. The guidelines include information on acceptable uses for greywater, greywater general requirements, greywater system design consideration, and greywater system maintenance (Hawai‘i State, 2009). The reuse of greywater for agricultural purposes requires a great deal of administrative work in the form of weekly testing and frequent reporting. Greywater reuse on agricultural land requires treatment systems that get the water to the R-1 level. Without this level of treatment, greywater can only be used for subsurface drip irrigation of non-root crops, crops that will not be eaten raw, or crops where the consumed portion of the plant does not rest on the ground. Greywater systems that treat the water to the R-1 level are costly and require perpetual maintenance. Another barrier for smaller-scale reuse of greywater is that greywater systems require 100 percent backup. If a property is recycling greywater for irrigation purposes, it may need a leach field or an exact duplicate greywater subsurface irrigation system in case the primary system fails (D. Poma, personal communication,

April 23, 2018). This means, essentially, that developing a greywater reuse system actually entails developing two water treatment and disposal systems.

Composting Toilets

Composting toilets use the natural processes of evaporation and decomposition to recycle human waste. The composting chamber, when managed properly, composts waste quickly and without odor, evaporates the liquid, and ensures that the finished compost is safe and easy to handle. Composted waste can then be used as fertilizer to enhance plant productivity and health (Grey water action, n.d.). Untreated composted waste, however, cannot be used for crops meant for human consumption and is restricted by HAR 11-62 (WRRC, 2008). To use composted waste as fertilizer, the waste must be treated using chemicals and other treatment technologies to comply with EPA Biosolids Rule, 40 CFR Part 503(4) (Hollyer, Brooks, & Castro, 2014).

NSF-approved composting toilets are legal in Hawai'i and can be used in place of a flush toilet in a residential dwelling. However, this has little practical or financial benefit for a homeowner because it does not waive the requirement for aerobic or septic systems (Karuna, 2011). If farmers are able to develop greywater systems and legal composting toilets, they still must properly dispose of black water, which may still require them to install a septic tank should no other solution be deemed feasible. A table of alternative treatment systems is presented in Appendix D. It is beyond the scope of this report to detail each type of system. It is important to note, though, that as presented in the table, all individual onsite systems require a septic tank.

Barriers to Development

As mentioned, IWSs are largely unattainable for small-scale farmers due to the relatively high costs and stringent regulations, which are necessary to protect public and environmental health. Of the various IWSs, septic tanks are typically the cheapest for households, yet cost between $12,000 and $20,000 to install in addition to the maintenance fees associated with pumping the tank. Depending on the size of the household and the septic tank, a homeowner may need to pump the tank every one to three years at a cost of $200-$900 (HomeAdvisor, n.d.). For local governments, IWSs are difficult to permit and establish due to the personnel and capital requirements in establishing the necessary regulatory systems. Even though governments that broadly permit or incentivize IWSs avoid the cost of having to extend sewer systems to rural households, they may have increased permitting, management, and transaction costs associated with establishing IWSs.

Local government is concerned with and responsible for appropriate wastewater treatment that protects public health and environmental resources. IWSs, if improperly designed or installed, may release discharges that cause water quality impairments such as degradation of groundwater and surface water by wastewater contaminants (Leverenz, Tchobanoglous, & Darby, 2002). The need to establish an effective management system for IWSs is a large logistical hurdle that state and county governments often don't have the capacity to overcome. Such a management system is often referred to as a Responsible Management Entity (RME) and provides services such as water quality monitoring; inspections and permits; location, design, and construction approvals; education; and database management (WERF, 2007). A review of on-site wastewater treatment systems (OWTS) in Western Australia found that despite established national and state guidelines regarding OWTS, a number of OWTS still perform poorly or fail. Poorly performing OWTS are often due to inadequate installation, groundwater and surface water ingress, poor public awareness, unsuitable soil type, inadequate maintenance, insufficient local authority resources, ongoing wastewater management issues, or inadequate adoption of standards, procedures, and guidelines. Poorly performing OWTS present environmental and public health hazards. Improving OWTS and avoiding health and safety hazards requires improved registration and regulation of OWTS, at a minimum (Gunady, Shishkina, Tan, & Rodriguez, 2015). County governments likely lack the funding necessary to establish RMEs to effectively regulate alternative treatment systems or IWSs.

Benefits of Individual Wastewater Systems

The two alternatives to IWSs are sewer systems or illegal and hazardous wastewater disposal, through cesspools or unauthorized alternative disposal systems. The benefits of IWSs relative to unauthorized wastewater disposal or treatment systems are obvious, the main benefit being the reduced public and environmental health risk.

IWSs also have many benefits relative to sewer systems. Extending sewer lines to rural communities is largely infeasible. Watson Okubo of the Hawai'i DOH Clean Water Branch says that there is not enough room to put a sewer line in every community. Where it is possible to extend sewer lines, it is tremendously costly. To install the infrastructure for sewer systems in Hawai'i's rural areas would cost millions of dollars, "and sewer fees collected in these areas would not be enough to pay for construction and maintenance" (Fujii, 2017).

The financial benefit to counties of supporting IWSs is the large amount of saved up-front capital investment necessary to extend sewer systems. Compared to this cost, IWSs distribute capital

costs across households, which typically means that communities need to incur less debt (Pinkham et al., 2004). IWSs are also beneficial to the county government for planning purposes, as they are a "build-as-you-go" system whereas sewer systems require accurate forecasting of population growth and density. Where such forecasting is inaccurate, the community will have "overbuilt capacity and a large debt load that must be spread across fewer than expected residents" (Pinkham et al., 2004, p. xxii).

Another important benefit of decentralized systems, or IWSs, is that they provide opportunities for cost-effective, on-site water reuse. Treating and reusing water on-site reduces wastewater load to IWSs and reduces water demand. Increased water reuse and reducing water demand is especially important as our climate and resources are increasingly threatened. The environmental and economic benefits of water reuse are felt even more strongly by farmers, who rely on Hawai'i's precious resources to grow their crops, earn an income, and feed their communities.

Constructed Wetland Systems

Constructed wetlands are artificial wetlands developed to treat wastewater, greywater, or stormwater runoff. Constructed wetlands utilize vegetation, gravel, soil, and a combination of naturally occurring physical and biological process to remove nutrients and other pollutants from water. Correctly designed and properly maintained wetlands should be completely subsurface to prevent problems such as odor, disease, and mosquitos. In these subsurface flow systems, all water flows below the surface, where "plant roots and gravel provide substrates for microorganism attachment" (Roth Ecological, n.d.).

Generally, constructed wetlands provide secondary treatment, following primary wastewater treatment in a septic tank or anaerobic digestor. While systems that utilize constructed wetlands for primary wastewater treatment exist, such systems are not cost effective or practicable due to the associated management and regulatory requirements. Constructed wetland systems were not explored as a potential option for alternative primary wastewater treatment systems in this report due to the fact that they still require the use of a septic or aerobic system. The only way to bypass using a septic or aerobic system with constructed wetlands is through high-cost engineering, design, and regulatory processes. Additionally, constructed wetlands are land-intensive. On agricultural land, the wetlands carry with them the opportunity cost of the land, which could represent added income for farmers. For these reasons, these systems do not represent a low-cost solution for farmers.

However, constructed wetlands could be beneficial in two other ways. First, they can be beneficial for use in multiple dwellings that share a septic or aerobic system. In addition to the benefits of water reuse, the constructed wetland could reduce the septic load and reduce septic maintenance costs. Additionally, constructed wetlands could be used as a greywater treatment system. While initial costs of development may be higher than installing traditional greywater treatment systems, the added benefits may incentivize use. Practical benefits of constructed wetlands are that treatment does not require external energy to operate and they produce valuable byproducts such as flowers and fodder. Additionally, constructed wetlands create "a natural habitat that is aesthetically pleasant, supports local wildlife and is suitable for recreational and cultural activities" (Ghermandi, 2005).

Wastewater Treatment Requirements in Other States

Hawai'i is not unique in its wastewater treatment requirements and regulations. All states require that households that are unable to connect to a sewer system have a septic tank or other qualified alternative system. Where states differ is their regulation surrounding alternative septic systems. There are no commonly accepted alternatives to septic systems altogether but there are variations on septic systems depending on the building site. For example, where soil is too dense, too permeable, or too shallow, mound systems are often built. Mound systems work largely in the same way that standard septic systems do but instead the septic drain field is raised above the natural grade (National Small Flows, 1999). Other systems include previously mentioned aerobic treatment systems or sand filters, both of which are similar in price to or more expensive than standard septic systems. Their advantages lie, however, in potentially smaller-sized systems and higher effluent quality.

Most states, like Hawai'i, review alternative IWSs on a case-by-case basis. Typically, these cases only arise and are considered when there are specific soil or groundwater constraints, as opposed to simple preference or financial constraints. In California, where counties have the regulatory authority for septic systems, "alternative" systems are typically those that provide additional treatment beyond the septic tank or are slight variations of standard septic systems, such as a mound system (Lassen County, 2016). In Lassen County, for example, there are approximately 6,200 properties served by septic systems and less than 10 properties served by alternative systems "designed to overcome specific soil or groundwater constraints" (Lassen County, 2016). Regarding greywater, California's code requires permits for the construction of all greywater systems except

washing machine systems in single family homes that follow 13 stated guidelines (Greywater Action, n.d.a).

In Oregon, there are various organizations that work to advance alternative sanitation systems and the state is considered relatively more open to alternative wastewater treatment systems. Even with this distinction, however, Oregon's regulations are not notably different than Hawai'i's. Oregon, like Hawai'i, permits NSF-certified composting toilets. Households with composting toilets are still required to connect to sewer system or have a septic tank (Benenati, 2017).

Florida also has similar regulations to Hawai'i in that households must be connected to sewer systems or have septic tanks, NSF-approved composting toilets are permitted, and greywater systems can also be permitted. As in many other states, Florida will review applications for alternative wastewater treatment systems on a case-by-case basis. In one situation, a household was able to obtain a permit to leave a septic tank out of the system. The system was approved by the county and the state. The system the household developed utilized a composting toilet, a greywater sink, and a dish washing sink. The greywater would be routed into a drain field through a surge tank and the drain from the dish-washing sink would be routed directly into a large outdoor compost bin. All household products that would end up in the compost pile would be non-bleached and bio-degradable. The state approved this system on the condition that the household would hold the state harmless should the system fail and that the household would allow inspections of the system (University of Florida, n.d.). Such a system could feasibly meet current regulations in Hawai'i but would need to be approved by the county and State.

Limitations to the Literature

This literature review focused on low-cost, easy-to-implement systems including greywater separation and composting toilets. Other high-cost systems, or those that would require significant funding and coordination by the county or State, were not included as they are not feasible options for farmers, who make an annual mean wage of $34,520, according to the Bureau of Labor Statistics (2017). Such systems include aerobic systems, the county sewering rural areas for treatment, or companies establishing clustered wastewater treatment systems.

While there is literature available on wastewater systems and regulations, there is little literature related specifically to the development of farmworker housing. As stated previously, farmers needs are inadequately addressed and infrequently made public. This contributes to a lack of substantial literature on the specific issues that farmers face in developing employee housing.

Policy Alternatives

Alternative 1: Status Quo

Under the current system, all dwellings that cannot connect to sewer systems must have an approved wastewater management system. Though they are difficult to establish for small-scale operations, where greywater systems are allowed, homes must still have a black water disposal system. This alternative has high environmental and public health risks, as there are currently tens of thousands of cesspools in the state. This alternative requires no additional resources or funding to implement but it makes no progress toward improving farmworker housing availability, affordability, and safety.

Alternative 2: Wastewater Advisory Committee

Under this alternative, the Kohala Center would lobby at the county- and state-levels for Hawai'i county to establish a wastewater advisory committee pursuant to §11-62-26 to create a formalized review process for small-scale, low-cost alternative wastewater treatment systems that is public and easily accessible to applicants and developers. §11-62-04 states that "the mayor of each county may request that the director form a county wastewater advisory committee, and the mayor may nominate its members, who may include representatives of the county water supply, public works, planning, and land utilization departments, labor, industry, environmental groups, and other interested people" (Wastewater Systems, 2016, p. 17). The committee's role is to review and make recommendations to the director of health regarding wastewater system matters that are unique to each county. The committee also has the ability to make recommendations to the director on proposals that are not specifically addressed in HAR 11-62.

The committee would first be tasked with developing guidelines, based on a thorough review of available information, for common alternative systems, including composting toilets, constructed wetland systems, mound systems, pressure distribution systems, and more, with a focus on low-cost systems. During the evaluation process, manufacturers, designers, developers, farmers, farmworkers and other interested parties can present information to the committee for consideration. If sufficient data exists to show that the wastewater treatment system will not present a public or environmental health risk, the committee will issue final guidance for a system or device. If sufficient data exists but

field-testing is limited, the committee can issue interim guidance and permit installation of a small number of the alternative system, which will be subsequently monitored and evaluated according to DOH-approved testing protocol.

The committee will also establish guidelines for experimental systems. Experimental systems can be defined as any alternative IWS that does not yet have guidelines established by the technical review committee or the DOH. If sufficient supportive theory and/or applied research exists, the DOH, under the recommendation of the committee, should grant a permit for the experimental system. Requirements for a permit include a detailed written proposal, to be reviewed by the committee, and a provision for monitoring of system performance. The DOH will be responsible for monitoring all permitted alternative and experimental systems and publishing the results in an annual report. Depending on how many alternative IWS applications are submitted and how many systems are eventually developed, such an alternative may require that the DOH hire more staff to manage and evaluate new IWSs.

Alternative 3: DOH Waiver Program

This alternative suggests that the Kohala Center propose and lobby, on the state-level, for a waiver program that gives the Hawai‘i DOH the authority to approve experimental, pilot, or demonstration projects proposed by counties. This option is modeled off of Section 1115 of the Social Security Act, which allows the Secretary of Health and Human Services to approve pilot and experimental projects that assist in promoting the objectives of Medicaid. This program gives states the flexibility to design and improve programs to better serve Medicaid populations.

A system similar to Medicaid Section 1115 demonstration projects can be established with the DOH and Hawai‘i counties regarding alternative and experimental wastewater treatment systems. The county's Department of Environmental Management, other relevant department, or a wastewater advisory committee can submit proposals to the DOH regarding experimental and pilot IWSs. This option would give the DOH the authority to approve experimental, pilots, or demonstration alternative IWSs so long as those systems meet NSF standards and promote the objectives of HAR 11-62. The relevant county department would then have the authority to carry out, manage, and maintain the proposed project. Under this option, demonstrations and experimental pilots must be budget neutral to the state government, meaning that during the course of the project, state expenditures will not be more than they would be without the demonstration.

Similar to Section 1115, the demonstrations will be approved for an initial five-year period and can be extended for an additional three to five years (Centers for Medicare & Medicaid, n.d.).

Alternative 4: Extension of Act 120 and Act 125 Incentives

Under this alternative, the Kohala Center could lobby at the state-level for Act 120 and Act 125 to be extended to new septic, aerobic, and alternative systems, not just cesspool to septic tank conversions. Act 120 provides a temporary income tax credit of up to $10,000 for the conversion to sewer or septic systems until 2020. Additionally, under this option, the Kohala Center will lobby for the tax credits to be extended to wastewater treatment systems beyond the 500-foot limit that currently stands. In 2017, the DOH processed 47 applications for the tax credit, representing less than 10 percent of the 500 cesspool upgrades that the program's budget allows for every year. The budget exists for this program to be extended and the need is present.

Though this paper does not argue that cesspools should remain legal, it is important that with the banning of cesspools, the government presents other affordable options for wastewater disposal and treatment systems. Due to cost considerations, cesspools were an attractive option compared to septic tanks and other wastewater treatment systems, which are relatively expensive in the state. In conjunction with banning cesspools and requiring conversion to aerobic or septic systems, the state should not only provide tax incentives for converting cesspools to septic systems, as it does through Act 120 and Act 125, but should also provide these tax incentives for new developments within the same time frame that the existing incentive is offered.

Opposition to the tax credit originally came from lawmakers that represent rural communities that rely on cesspools as opposed to high-cost septic tanks. These lawmakers would support extending the tax incentive to new septic tanks, as opposed to only cesspool to septic tank conversion, and could help the Kohala Center in its lobbying efforts associated with this option. 90 percent of the funding allocated to this program is going unused and can be better utilized be extending the tax incentive to new septic tank development as well.

Alternative 5: Produce a Study on Low-Cost Alternative Wastewater Treatment Systems for the DOH

This option proposes that the Kohala Center convene experts to produce and submit to the DOH a study on low-cost alternative wastewater treatment systems. The Kohala Center is a vital

source of information on Hawai'i's food, water, place, and people and often collaborates with the Hawai'i Department of Agriculture. As such, the Kohala Center is in a position to produce a report that can inform county and state policy regarding alternative IWSs. The Kohala Center staff can collaborate with manufacturers, developers, and other experts to write a comprehensive report detailing various low-cost alternative and experimental IWSs and their accompanying costs and benefits in the Hawai'ian context.

The Kohala Center will submit the report to the DOH and other relevant county authorities. The intention of the report is to provide the DOH with the information necessary to move forward with increased permitting of low-cost alternative and experimental IWSs. The report will include necessary data and evaluation reports to allow the DOH to feel confident permitting more low-cost and small-scale alternative IWSs. The report can also be utilized by farmers, developers, and anyone else interested in establishing alternative IWSs. These stakeholders can use the report to determine what best suits their needs and depending on the DOH's progress in the permitting process, either submit an application for a permit or lobby the DOH to approve their IWS.

Evaluative Criteria

Essential to a high-quality analysis is selecting criteria and weighting those criteria based on the specific goal of the policy. The goal of this report is to develop policy that will decrease the barriers to developing alternative wastewater systems to be used for farmworker housing. The criteria used to evaluate each alternative are administrative and political feasibility, effectiveness, public support, public and environmental health risk, and cost.

Administrative and Political Feasibility

This measure encompasses political, administrative, and logistical feasibility. The Kohala Center, as an independent nonprofit, often does work and research for the Hawai'i state government but doesn't have any formal ability, besides through lobbying efforts, to get the government to adopt policy. Alternatives that are less policy-focused still require administrative coordination and resources, which are measured under this category as well. Information that contributes to this criterion are all of the resources and efforts that are required of each alternative, the Kohala Center's

current resource base, and the political climate. Administrative and political feasibility will be identified as high, medium, or low.

Effectiveness[3]

Effectiveness measures the impact that the policy option will have on the affordability and accessibility of alternative wastewater treatment systems. This criterion considers not only how effective the Kohala Center will be in carrying out the alternative but also how well the alternative addresses the problem. The variation between options exists due to some options attempting to immediately and directly address the issue while others may create long-term movement and conversation around the issue. While there may be merit to both outcomes, one is more directly effective in solving the problem. Relative effectiveness will be identified as high, medium, or low.

Public and Environmental Health Risk

The various alternatives present different public and environmental health risks that the Kohala Center needs to consider. Much of the hesitation behind allowing alternative wastewater treatment systems is the potential for water contamination and the health risks that contamination presents. This criterion is determined using the literature on the various alternatives and NSF standards for wastewater treatment, such as levels of total suspended solids, nitrogen, fecal coliform, phosphorus, and biochemical oxygen demand. Public and environmental health risk is identified as low, medium, or high, where low is preferred.

Public Support

Public support refers specifically to the support of the intended program beneficiaries. The level of support from farmers who hope to develop farmworker housing is an important criterion in the feasibility of a solution but is separate from the prior feasibility category. It is necessary to separate these two categories as small-scale farmers in Hawai‘i may feel underserved and undervalued due to the history of agriculture policy favoring large-scale and commercial production. It is important to make clear that their opinions are highly valued in this decision-making process and they are adequately represented in the development of programs intended to support them.

[3] The nature of this issue, the proposed solutions, and the client's capacity makes effectiveness a qualitative measure rather than quantitative, precluding a cost-effectiveness analysis.

Additionally, a policy will be ineffective if the intended beneficiaries do not support or buy in to it. The farmers are the end users and without their support, a policy will not achieve its intended outcomes. Estimated levels of public supports will be identified as high, medium, or low.

Cost

Cost is a measure of the annual dollar costs to the Kohala Center. This number is established using an estimate of how many hours the Kohala Center staff will need to dedicate to carrying out the proposed alternative and a wage estimate for the staff that would be conducting the necessary work.

Cost Evaluation of Policy Alternatives

The quantitative measure used to evaluate the policy alternatives is cost to the Kohala Center. No alternative necessitates that the Kohala Center hires a new employee, only that currently employees devote a certain amount of their time to working on the proposed alternative. Current employees devoting their time to working on this project introduces the opportunity cost of other projects they could be conducting. Those alternative projects are not currently known and are not quantifiable. As such, opportunity cost is not included in the cost analysis but may still be important to note.

For this analysis, costs accrued to the Kohala Center are measured only in the estimated hours worked on implementing each alternative. Costs are calculated over a four-year period, with all future costs discounted at a rate of seven percent, a commonly used social discount rate. Using a social discount rate is appropriate in this scenario, as the Kohala Center is concerned about society at large, not only its own private utility (WERF, 2008).

The costs are calculated based on the assumption that three staff members will be assigned to this project. The three staff members will be those occupying positions akin to a director, a program manager, and a program coordinator. The average annual earnings for a nonprofit director are $62,000 (Payscale, 2018a). The average annual earnings for a nonprofit program manager are $50,000. The average annual earnings for a nonprofit program coordinator are $37,500 (Payscale, 2018b).

Calculations are made for two scenarios. In the first scenario, staff members spend a combined five hours a week on lobbying effort options and six hours a week on producing a study. In the second scenario, the staff members spend a combined ten hours a week on lobbying effort options and twelve hours a week on producing a study. The three lobbying alternatives are Wastewater Advisory Committee, DOH Waiver Program, and Extension of Act 120 and Act 125 Incentives. The project lifetime for all lobbying options is assumed to be four years, a time-frame established to mirror the term-length of state legislators. The project lifetime of producing a study is assumed to be two years.

The net present cost estimate for the lobbying alternatives, with a project lifetime of four years, is $22,576.48 if staff were to spend five hours a week on the project and $45,152.93 if staff were to spend ten hours a week on the project. The net present cost estimate for producing a study, with a project lifetime of two years, is $14,460.98 if staff were to spend six hours a week on the project and $28,921.96 if staff were to spend twelve hours a week on the project. While the assumptions made and the available information used may not be perfectly accurate, the relative costs of each option will remain the same. The full cost analysis is presented in Appendix E.

Qualitative Evaluation of Policy Alternatives

Using the evaluative criteria of administrative and political feasibility, effectiveness, public and environmental health risk, and public support, each option is evaluated qualitatively with the metrics of high, medium, or low.

Alternative 1: Status Quo

Carrying on with the status quo requires no administrative or political effort. Under this alternative, it is unlikely that farmers interested in developing farmworker housing will have increased access to low-cost alternative wastewater, as there is no other effort currently being conducted to reduce barriers to access. The status quo has high public and environmental health risks that will only increase over time. As Bruce Anderson, head of the Department of Land and Natural Resources' Division of Aquatic Resources, states, "This is going to go from bad to worse unless someone figures out how to deal with it" (Eagle, 2017).

Health officials state that while water is still safe to drink in Hawai'i and most areas are safe for swimming, "the risk of disease is expected to increase as cesspools deteriorate and become more prone to flooding as the sea level rises and storms intensify" (Eagle, 2017). The public does not support a system that doesn't adequately protect them and their environment from the risks associated with failing wastewater treatment systems. The damage that harmful wastewater nutrients does to coastal waters and coral is concerning for citizens. The public is also concerned about their own health and the quality of their drinking and swimming waters. Farmers would like to be able to establish legal, low-cost wastewater treatment systems that help them protect the health of their land, reuse vital resources, and establish housing for their farmworkers. However, because of the high costs associated with upgrading wastewater treatment systems, many homeowners and property owners with cesspools believe that the government should foot the bill for conversion to septic or other systems.

Alternative 2: Wastewater Advisory Committee

The administrative and political feasibility of this option is medium-high. Administratively, the Kohala Center's ability to lobby for this alternative will depend on its workload and capacity at the time of implementation. The administrative and lobbying efforts required for this alternative are feasible for the organization over the four-year project period. Politically, this option is relatively feasible, as the DOH is unlikely to oppose the formation of a county-level committee to further advance the work on this issue. The DOH administrative rules regulating wastewater have specific language that allows for the formation of such a committee.

The effectiveness for this alternative is ranked as medium-high. Committee effectiveness depends largely on the members of the committee, the committee chair, and the culture of the committee. Based on the nature of this issue, its relevance to a healthy agricultural system, and the experts on the Big Island who are eager to address this matter, the effectiveness of this committee is estimated to be medium-high. Cities and counties throughout the nation use commissions, committees, and boards to directly address specific issues as they are effective in gathering community input and achieving or making steps towards solutions.

This alternative presents a medium-low public and environmental health risk. The purpose of the committee is to thoroughly review low-cost alternative wastewater treatment systems and only issue guidance for or recommend those systems that do not present a public or environmental health risk. There does exist the small risk that any improperly installed or managed wastewater

treatment system carries with it. This risk can be mitigated through measures to ensure proper management systems are in place and certified engineers and contractors are responsible for the development and installation of the systems.

Public support for this alternative ranks high because it would give the public an opportunity to be active in the process. The committee will represent a diverse set of stakeholders. Additionally, the committee will welcome public input and comment during its review process. Farmers on the Big Island will also support the local nature of this solution, as it respects the local nature of the problem.

Alternative 3: DOH Waiver Program

Administrative and political feasibility for this option is medium-low. The Kohala Center's lobbying efforts will be dependent upon its workload, capacity, and priorities at the time of implementation. Over a four-year period, however, this lobbying effort is within reason and feasible. Political feasibility is a greater challenge with this option relative to the other lobbying options, as the DOH is unlikely to adopt this proposed program. The rules and regulations surrounding wastewater treatment systems are specific for public health purposes and the DOH is likely to see this option as an attempt to relax those rules and thus a threat to public health (M. Tomomitsu, personal communication, April 27, 2018).

Projected effectiveness for this alternative is low-medium. Because they have no legal requirement to establish IWSs, the counties are unlikely to take on this burden and propose experimental projects. To get counties to participate in this waiver program would require continual lobbying effort on behalf of interested parties, which is unlikely to be sustained. Even if counties successfully participated in the waiver program, the outcomes of such a program are uncertain. The Medicaid demonstration programs this option is modeled off of have not been properly evaluated, making it hard to determine whether or not the program is successful. As Joan Alker, executive director of the Georgetown University Center for Children and Families, stated, "It has been clear for some time that evaluations of Section 1115 waivers are not adequate. There is some good work going on in this space at the state level…but as the report makes clear state's evaluations are often incomplete and not rigorous enough" (Galewitz, 2018). Oregon's evaluation produced mixed results, with quality measures improving in three measured quality domains but remaining the same or worsening in four other domains. While the evaluation implies that the results of the program were generally positive, there were many caveats and the positive results were not uniform across all

populations (Kushner et al., 2017). These results indicate that a waiver program for alternative wastewater treatment systems, even if fully implemented, may produce mixed results and may not fully achieve its stated goals.

The public and environmental health risk of this option is medium-low. Any alternative systems would still need to meet NSF standards and comply with DOH regulations, meaning that they would present a low public and environmental health risk. There is, however, the opportunity for any alternative systems to present an environmental and public health risk if they are not properly installed, managed, or maintained. Such a program would need to ensure that there are proper management systems are in place to ensure the systems are performing well.

Public support for this alternative is medium. The impetus behind the Medicaid waiver program is that "traditional Medicaid approaches to serving [a] diverse and medically complex population have not always been effective at eliminating barriers to access and quality services" (Centers for Medicare & Medicaid Services, n.d.). Similarly, a waiver program for experimental wastewater treatment systems would ideally remove some of the barriers to acess for a group of farmers with diverse building plans and wastewater needs. Farmers would support such an attempt to eliminate barriers to access. Farmers and other stakeholders may be hesitant to support such an option, though, due to the fact that it requires significant action on the county level and the outcomes aren't guaranteed.

Alternative 4: Extension of Act 120 and Act 125 Incentives

Administrative and political feasibility for this option is medium. As with the other lobbying options, the administrative feasibility for the Kohala Center regarding this alternative depends on its workload, capacity, and priorities. Over a four-year period, the lobbying efforts required of this alternative will be within reason and feasible. Politically, it may be relatively difficult to get the legislature to support and implement this proposal. The intention of the original tax credit is to protect critical waters, which is why the legislation applies only to cesspools within 500 feet of a shoreline, perennial stream, wetland, or within a source water assessment program area. The legislator would need to be convinced that cesspools beyond this 500-foot limit also present a public health risk. This case is easier to make for agricultural land, where crops are grown for human consumption. The legislator would also need to be convinced that this incentive should be extended to new systems and not only conversions. Legislators may be hesitant to incentivize more development due to the possibility that these developments may just turn into vacation rentals. The

Kohala Center will need to make it clear to the legislator that the benefits of incentivizing increased farmworker housing outweigh the costs of the risk of increased vacation rentals or propose an added stipulation to the legislation.

Based on the outcomes of a similar incentive program, the federal solar tax credit, the effectiveness of this alternative would be projected to be medium or high. The solar tax credit, also known as the investment tax credit (ITC), allows homeowners to deduct 30 percent of the cost of installing a solar energy system from their federal taxes. GTM Research predicted that between 2016 and 2020, the ITC would result in $40 billion in incremental investment in solar and 25 gigawatts of additional solar capacity, which represents a 54 percent increase compared to a scenario in which there was no ITC (Munsell, 2015). Despite the effectiveness of solar tax incentives, the history of Act 120 and Act 125 indicate that the effectiveness of this alternative may actually rank low. Only 47 applications for cesspool conversion were submitted in 2017, despite the program having the capacity to provide the tax incentive for 500 conversions a year. This low rate is likely to do a lack of education about the incentives (D. Poma, personal communication, April 23, 2018). To increase effectiveness, the Kohala Center could supplement this alternative with an educational program to make more farmers aware of the process and requirements for obtaining the tax credit.

If the tax credits are extended and more people take advantage of them to install more effective wastewater treatment systems, the public and environmental health risk of wastewater treatment systems will decrease compared to current risk levels. The tax credits will incentivize farmers to install systems that are more effective than the cesspools and illegal systems that are currently in use. There still exists the risk inherent from improper installation or management of wastewater treatment systems.

Public support for this alternative is high. Many Hawai'i residents think that if the government is banning cesspools and requiring conversion to higher-quality treatment systems, it should be doing more to fund such conversions. As Rep. Nicole Lowen (D-North Kona) said, "We have an issue with affordable housing and we can't expect people already struggling to take out another mortgage or whatever it would take to pay for this." The public supports an alternative that would increase access to funding to install treatment systems that meet their needs and protect public and environmental health.

Alternative 5: Produce Study for DOH

The administrative and political feasibility of this option is high. This option requires that some of the Kohala Center staff devote their time and resources to producing this study but does not necessitate that the Kohala Center hire additional staff. One administrative challenge that this alternative presents is convening experts who are willing to devote their time to contributing to the study. Relative to the other lobbying alternatives, this alternative is more insular within the Kohala Center and requires less reliance on and coordination with outside parties, increasing administrative feasibility. Political feasibility for this alternative is high, as it does not require any effort on the behalf of the government. Collaboration with and input from relevant government authorities has the potential to improve the report's effectiveness but is not necessary.

Unless coupled with lobbying efforts once the study is complete, the effectiveness of this alternative is low. The study will generate more knowledge, conversation, and hopefully movement around the issue but unless the DOH is pressured to take action, the study is unlikely to result in immediate policy change.

Public and environmental health risk for this alternative is high. Producing a study does not address the immediate public and environmental health threat that the cesspools and illegal wastewater treatment systems in Hawai'i present. The intention of the study is to inform and advance state policy on alternative IWSs and as such will lead to more effective alternatives down the road. Over time, public and environmental health risk will decrease, but the effects will not be seen until the DOH uses the study to increase permitting of effective, low-cost alternative IWSs.

Public support for this option is medium. Farmers and other stakeholders would support increased knowledge creation around this issue while at the same time recognizing that this alternative would not present an immediate solution to the problem. Farmers interested in alternative IWSs and decreased barriers to access would be supportive of any movement regarding this issue, but their support would be lower relative to other alternatives that may present more immediate solutions.

Outcomes Matrix

	Status Quo	Wastewater Advisory Committee	DOH Waiver Program	Extension of Act 120 and Act 125 Incentives	Produce Study for DOH
Administrative and Political Feasibility	High	Medium-High	Low-Medium	Medium	High
Effectiveness	Low	Medium-High	Low-Medium	Low	Low
Public and Environmental Health Risk	High	Medium-Low	Medium-Low	Medium	High
Public Support	Low	High	Medium	High	Medium
Cost	$0	$22,576.48-$45,152.93	$22,576.48-$45,152.93	$22,576.48-$45,152.93	$14,460.98-$28,921.96

Criteria Weights

The criteria were assigned weights according to their relative importance for informing analysis. The relative weights correspond to the order in which the criteria are listed in the table. The weights, which add to one, are as follows: administrative and political feasibility (0.275), effectiveness (0.225), public and environmental health risk (0.2), public support (0.2), and cost (0.1).

Administrative and political feasibility is the most important criterion because, simply put, there is no point in proposing something that is infeasible. Nonprofits are limited in their resources, which means they are especially critical when determining which projects are worth their time and effort. Effectiveness receives the second highest weight because it is a practical measure of the impact of the alternative and whether or not an alternative achieves the goal of reducing barriers to establish alternative wastewater systems and thus more farmworker housing. Public and environmental health also weighs highly because the Kohala Center's main areas of focus are food, water, place, and people. Any proposed alternative must properly protect these assets. Public support ranks highly as well, because the Kohala Center is a nonprofit working for the people of

Hawai'i. With the people of Hawai'i as their main clients, the nonprofit deeply values their support. Lastly, cost is assigned the lowest weight. Although it is important, there are no additional resources required of the Kohala Center, only that they devote staff time to the project. Time and effort are important resources, but the nonprofit is driven more by mission than a bottom-line.

Recommendation

The Kohala Center should lobby at the county- and state-levels for Hawai'i county to establish a wastewater advisory committee. Though this option represents a relatively high cost for the Kohala Center in terms of resources and time spent on lobbying effort, the option ranks relatively highly across all other criteria. This option is politically and administratively feasible, effective, presents minimal risks, and is anticipated to be highly supported by the public. A county-level wastewater advisory committee will put in the leg work necessary for the DOH to approve more low-cost alternative systems that farmers are able to easily access when they are developing plans for farmworker housing.

The Kohala Center's main efforts will be in lobbying. The Kohala Center should utilize whatever existing relationships it has with the DOH in Honolulu and with Hawai'i County district health offices in Hilo, Kona, and Waimea. The Kohala Center should utilize these relationships to find a champion, or multiple champions, of the proposal for a committee. This champion within the government will aid in getting more members of the DOH on board with the proposal. Preliminary efforts should also be made to establish the committee and get movement on this issue to aid in lobbying efforts. The Kohala Center should utilize local radio and newspapers to advertise their efforts, gain public support, and get constituents to express their support to relevant legislators and government employees. The Kohala Center should also attempt to create partnerships with nonprofits such as the Kona Kai Ea and Hilo chapters of the Surfrider Foundation.

If the Kohala Center is unsuccessful in its lobbying efforts, it should instead focus its efforts on producing a study for the DOH. Though the alternative of lobbying for the extension of Act 120 and Act 125 incentives ranks second highest behind the wastewater advisory committee, it is not recommended that the Kohala Center implement another lobbying alternative after a failed lobbying effort.

If the Kohala Center is successful in its lobbying efforts, its work should shift to formally establishing the committee. To form the committee, the Kohala Center should hold a strategic planning session with its staff and relevant stakeholders to formally develop the structure and responsibilities of the committee. These stakeholders may represent potential committee members or will advise the Kohala Center on who should be included or may be interested in serving on the committee. One implementation challenge the Kohala Center will face is getting qualified volunteers to staff the committee. Additionally, it will be essential that the chair of the committee is one who can establish an effective working culture on the committee and inspire passion within committee volunteers to produce the necessary work.

In addition to being active on the committee, the Kohala Center should provide management support as necessary to ensure the committee is staying up to task and working effectively. If the committee is effective in proposing guidelines for and recommending more alternative wastewater treatment systems, it will also need to consider issues of effective management of these systems. The Water Research Foundation published a series of eleven fact sheets on effective management of decentralized wastewater systems that can aid in this effort (WERF, 2009). Proper management is essential to ensure that public and environmental health are not sacrificed with the expansion of low-cost alternative IWSs.

References

Agricultural Theft and Vandalism Pilot Project, H.B. 1883 H.D. 2, Twenty-Ninth Legislature (2018).

Associated Press. (2017, November 1). Big Island authorities plan crackdown on agricultural theft. Retrieved April 19, 2018 from http://www.chicagotribune.com/news/sns-bc-hi--crop-theft-20171101-story.html

Ballotpedia. (n.d.). Counties in Hawaii. Retrieved April 18, 2018, from https://ballotpedia.org/Counties_in_Hawaii

Benenati, K. (2017). *Considerations for Installing a Composting Toilet System*. Eugene, OR. Retrieved from http://www.oregon.gov/deq/FilterDocs/os-compostingtoilets.pdf

Blair, C. (2016, February 3). Lawmakers Oppose New Cesspool Ban. *Honolulu Civil Beat*. Retrieved February 28, 2018 from http://www.civilbeat.org/2016/02/lawmakers-oppose-new-cesspool-ban/

Bureau of Labor Statistics. (2017, March 31). May 2016 State Occupational Employment and Wage Estimates. Retrieved February 18, 2018, from https://www.sustainable.com.au/greywater-treatment.html

Centers for Medicare & Medicaid Services. (n.d.). About Section 1115 Demonstrations. Retrieved March 30, 2018, from https://www.medicaid.gov/medicaid/section-1115-demo/about-1115/index.html

Crites, R., Ono, P., & Izon, D. (2011). Decentralized Technologies for Rural Areas of Hawai'i. *Proceedings of the Water Environment Federation*, *2011*(14), 2829–2851. https://doi.org/10.2175/193864711802721046

Curry, P. (n.d.). Is a passive greywater system for you? *Houselogic*. Retrieved April 21, 2018, from https://www.houselogic.com/save-money-add-value/save-on-utilities/passive-greywater-system-you/

Devkota, J., Schlachter, H., Anand, C., Phillips, R., & Apul, D. (2013). Development and application of EEAST : A life cycle based model for use of harvested rainwater and composting toilets in buildings. *Journal of Environmental Management*, *130*, 397–404. https://doi.org/10.1016/j.jenvman.2013.09.015

Eagle, N. (2017, December 27). 'From Bad to Worse:' Hawaii's $1.75 Billion Cesspool Problem. *Honolulu Civil Beat*. Retrieved April 26, 2018, from http://www.civilbeat.org/2017/12/from-bad-to-worse-hawaiis-1-75-billion-cesspool-problem/

EPA. (2004). Clean Watersheds Needs Survey (CWNS) – 2004 Report and Data. Retrieved January 31, 2018, from https://www.epa.gov/cwns/clean-watersheds-needs-survey-cwns-2004-report-and-data

EPA. (2016). How Your Septic System Works. Retrieved April 24, 2018, from https://www.epa.gov/septic/how-your-septic-system-works

EPA. (2017). Septic Systems Overview. Retrieved April 23, 2018, from https://www.epa.gov/septic/septic-systems-overview

EPA. (n.d.) Cesspools in Hawai‘i. Retrieved February 18, 2018, from https://www.epa.gov/uic/cesspools-Hawai‘i

Farmworker Justice & The National Center for Farmworker Health. (2015, January). Farmworkers' health fact sheet. Retrieved from http://www.ncfh.org/uploads/3/8/6/8/38685499/fs-nawshealthfactsheet_jbs_approved.pdf

Finnerty, R. (2017, November 27). Hot Coffee: Agriculture Theft on Hawaii Island. *Hawai‘i Public Radio*. Retrieved April 18, 2018, from http://hawaiipublicradio.org/post/hot-coffee-agriculture-theft-hawaii-island

Fujii, N. (2017, January 4). Water Warning. *Hawaii Business Magazine*. Retrieved April 2, 2018, from https://www.hawaiibusiness.com/water-warning/

Galewitz, P. (2018, February 23). Evaluations of Medicaid Experiments By States, CMS Are Weak, GAO Says. *Kaiser Health News*. Retrieved April 27, 2018, from https://khn.org/news/evaluations-of-medicaid-experiments-by-states-cms-are-weak-gao-says/

Ghermandi, A. (2005). Evaluating functions and benefits of constructed wetlands. Retrieved April 21, 2018, from http://www.feem-web.it/ess/ess05/files/Ghermandi1.pdf

Governor of the State of Hawai‘i. (n.d.). Sustainable Hawai‘i Initiative. Retrieved February 1, 2018, from https://governor.Hawai‘i.gov/sustainable-Hawai‘i-initiative/

Governor of the State of Hawai‘i. (2016). DOH News Release: Hawai‘i Bans New Cesspools and Offers Upgrade Tax Credit. Retrieved February 28, 2018, from https://governor.hawaii.gov/newsroom/latest-news/doh-news-release-hawaii-bans-new-cesspools-and-offers-upgrade-tax-credit/

Greywater Action. (n.d.a). About composting toilets. Retrieved February 1, 2018, from https://greywateraction.org/composting-toilets/

Greywater Action. (n.d.b). California Greywater Regulations. Retrieved March 1, 2018 from https://greywateraction.org/requirements-for-no-permit-systems-in-california/

Gunady, M., Shishkina, N., Tan, H., & Rodriguez, C. (2015). A review of on-site wastewater treatment systems in Western Australia from 1997 to 2011. *Journal of Environmental and Public Health*, *2015*. https://doi.org/10.1155/2015/716957

Hawai'i Office of Planning. (2012). *Increased Food Security and Food Self-Sufficiency Strategy*. Honolulu, HI. https://doi.org/10.1017/CBO9781107415324.004

Hawai'i State Department of Health Wastewater Branch. (n.d.). IWS Filing. Retrieved March 1, 2018 from https://wastewater.ehawaii.gov/wastewater/app/welcome.html

Hawai'i State Department of Health Wastewater Branch. (2009). *Guidelines for the reuse of gray water*.

Hawai'i State Department of Health Wastewater Branch. (2015, August 12). Cesspools in Hawai'i: Proposed Amendments to Chapter 11-62 Wastewater Systems Rules. Retrieved February 28, 2018 from https://health.hawaii.gov/sdwb/files/2015/09/A02cesspooljointwaterconference-sina-bob.pdf

Hawai'i State Department of Health Environmental Management Division. (2017). *Report to the Twenty-Ninth Legislature Relating to Cesspools and Prioritization for Replacement*.

H.B. 1140, Twenty-Eighth Legislature. (2015).

H.B. 1244, Twenty-Ninth Legislature. (2017).

Hollyer, J.R., Brookers, F.E., & Castro, L. F. (2014). The Use of Human Wastes on Food Crops in Hawai'i: What Is Allowed and What Is Not. *Food Safety and Technology, 105*(April), 60-62.

HomeAdvisor. (n.d.) Clean Septic Tank. Retrieved March 1, 2018 from https://www.homeadvisor.com/cost/plumbing/clean-septic-tank/

Hughes, A. J. (2015, August 17). Why Does Hawaii Import Most of Its Food Yet Rank High on Locavore Index? *Seedstock*. Retrieved May 1, 2018, from http://seedstock.com/2015/08/17/why-does-hawaii-import-most-of-its-food-yet-rank-high-on-locavore-index/

Johnson, C. S., Quandt, S., Arcury, T., & Keim-Malpass, J. (2015). Perceptions of housing conditions among migrant farmworkers and their families: implications for health, safety and social policy. *Rural and Remote Health*, *15*(1), 1–16. Retrieved from https://www.rrh.org.au/journal/article/3076

Karuna, A. (2011). Composting toilets. Retrieved February 1, 2018, from http://Hawai'isustainablecommunity.org/composting-toilets-are-they-legal/

Kusher, J., Tracy, K., Lind, B., Renfro, S., Rowland, R., & McConnel, J. (2017, December 29). Evaluation of Oregon's 2012-2017 Medicaid Waiver. *OHSU Center for Health Systems Effectiveness*. Retrieved April 27, 2018, from http://www.oregon.gov/oha/HPA/ANALYTICS/Evaluation%20docs/Summative%20Medicaid%20Waiver%20Evaluation%20-%20Final%20Report.pdf

Lassen County Environmental Health Department. (2016). *Local Area Management Plan*. Retrieved from https://www.waterboards.ca.gov/lahontan/water_issues/programs/owts/docs/lamp_tracking/lassen_lamp_12_16.pdf

Leverenz, H., Tchobanoglous, G., & Darby, J. L. (2002). Review of technologies for the onsite treatment of wastewater in California, (2).

Munsell, M. (2015, December 16). Investment Tax Credit Extension Would Increase US Solar Installations 54% Through 2020. *Greentech Media*. Retrieved April 28, 2018, from https://www.greentechmedia.com/articles/read/investment-tax-credit-extension-will-increase-solar-installations-54-throug#gs.wnGdhNU

Neighborly. (n.d.). Septic vs Sewer: What You Need to Know. *Mr. Rooter Plumbing*. Retrieved April 22, 2018, from https://www.mrrooter.com/greater-syracuse/about-us/blog/2015/june/septic-vs-sewer-what-you-need-to-know/

National Small Flows Clearinghouse. (1996). Small Community Wastewater Issues Explained to the Public. *Pipeline*, *7*(1), 8. Retrieved from http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_WI96.pdf

National Small Flows Clearinghouse. (1999). Mounds: A Septic System Alternative. *Pipeline*, *10*(3), 1–8. Retrieved from http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_SU99.pdf

NSF. (n.d.). About NSF. Retrieved April 29, 2018 from http://www.nsf.org/about-nsf

Ono, P. R., & Izon, D. R. (2012). *North Shore Regional Wastewater Alternatives Plan*. Honolulu, HI. Retrieved from https://www.honolulu.gov/rep/site/env/wwm_docs/wwm_NSRWWAPFinalReport.20120103.pdf

Payscale. (2018a). Average Salary for Industry: Non-Profit Organization. Retrieved April 2, 2018, from https://www.payscale.com/research/US/Industry=Non-Profit_Organization/Salary

Payscale. (2018b). Director Non-Profit Organization Salary. Retrieved April 2, 2018, from https://www.payscale.com/research/US/Job=Director_Non-Profit_Organization/Salary

Pinkham, R. D., Hurley, E., Watkins, K., Lovins, A., Magliaro, J., Etnier, C., & Nelson, V. (2004). Valuing Decentralized Wastewater Technologies: A Catalog of Benefits, Costs, and Economic Analysis Techniques, 181. Retrieved from http://www.10xe.orwww.10xe.org/Knowledge-Center/Library/W04-21_ValuingDecentralizedWastewater

Reid, T. K. & Edmonds, J. (2017, November 26). Let's get serious about growing our own food. *The Garden Island*. Retrieved March 30, 2018, from http://www.thegardenisland.com/2017/11/26/business/lets-get-serious-about-growing-our-own-food/

Roth Ecological. (n.d.). Constructed Wetlands. Retrieved April 21, 2018, from https://www.rothecological.com/untitled-c20s3

State of Hawai'i Department of Health. (2002, May 15). Guidelines for the Treatment and Reuse of Recycled Water.

State of Hawai'i Department of Health. (n.d.). Wastewater. Retrieved February 28, 2018, from http://health.Hawai'i.gov/cwb/clean-water-branch-home-page/polluted-runoff-control-program/prc-Hawai'is-implementation-plan/wastewater/

Sustainable Earth Technologies. (n.d.) *Greywater Treatment*. Retrieved February 18, 2018, from https://www.sustainable.com.au/greywater-treatment.html

The Kohala Center. (2018, February 27). Retrieved April 19, 2018, from http://kohalacenter.org/

University of Florida. (n.d.). Wastewater System and Composting Toilet. Retrieved March 1, 2018 from http://www.phys.ufl.edu/~liz/waste.html

U.S. News. (2018, March 24). Report: Number of Hawaii Vacation Rental Homes Is Rising. Retrieved March 31, 2018, from https://www.usnews.com/news/best-states/hawaii/articles/2018-03-24/report-number-of-hawaii-vacations-rentals-is-rising

Villarejo, D. (2015, March 6). The status of farm labor housing. *California Institute for Rural Studies*.

WA Department of Health. (n.d.). Sewage spills. *HealthyWA*. Retrieved April 23, 2018, from http://healthywa.wa.gov.au/Articles/S_T/Sewage-spills

Wastewater Systems. H.A.R. §11-62. (2016).

Water Resources Research Center (WRRC). (2008). *Onsite wastewater treatment survey and assessment*. State of Hawai'i, Department of Health.

WERF. (2007). *Establishing Successful RMEs*. Alexandria, VA.

WERF. (2008). Choose discount rate method for Net Present Value. Retrieved April 2, 2018 from http://simple.werf.org/simple/media/documents/BCT/stepFourLinks/01.html

WERF. (2009). Responsible Management Entities Guidance Fact Sheets. Retrieved May 2, 2018, from http://www.werf.org/i/c/KnowledgeAreas/DecentralizedSystems/RMEsite/RMEs_2.aspx

Appendices

Appendix A: Cesspools Qualifying for a Tax Credit

Source: Hawai‘i State Department of Health Wastewater Branch, 2015

County	Near a Drinking Water Well	Within 200 ft of: A Perennial Stream	A Wetland	The Shoreline	Total Number of Qualifying Cesspools
Hawai‘i Total	787	1,069	6	307	2,102
Kaua‘i Total	391	883	40	246	1,497
Maui Co. Total	652	137	16	229	982
Honolulu Total	727	363	43	984	2,063
Statewide Total	**2,557**	**2,452**	**105**	**1,766**	**6,644**

Appendix B: Identified Priority Areas for Cesspool Conversion

Source: Hawai‘i State Department of Health, 2017

Name	Priority Level Assigned	Number of Cesspools	Effluent Discharge (million gallons/day)
Kea‘au Area of Hawai‘i Island	2	9,300	4.9
Hilo Bay Area of Hawai‘i Island	3	8,700	5.6
Coastal Kailua/Kona Area of Hawai‘i Island	3	6,500	3.9
Puako Area of Hawai‘i Island	3	150	0.6
Kapoho Area of Hawai‘i Island	3	220	0.12
Kapaa/Wailua Area of Kaua‘i	2	2,900	2.2
Poipu/Koloa Area of Kaua‘i	2	3,600	2.6
Hanalei Bay Area of Kaua‘i	3	270	0.13
Upcountry Area of Maui	1	7,400	4.4
Kahalu‘u Area of O‘ahu	1	740	0.44
Diamond Head Area of O‘ahu	3	240	0.17
Ewa Area of O‘ahu	3	1,100	0.71
Waialua Area of O‘ahu	3	1,080	0.75
Waimanalo Area of O‘ahu	3	530	0.35
Total		**42,730**	

Priority Definitions

Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters.

- Cesspools in these areas appear to contribute to documented impacts to drinking water or human health, and also appear to impact sensitive streams or coastal waters.

Priority 2: Potential to Impact Drinking Water.

- Cesspools in these areas are within the area of influence of drinking water sources, and have a high potential to impact those sources.

Priority 3: Potential Impacts on Sensitive Waters.

- Cesspools in these areas cumulatively represent an impact to an area that includes sensitive State waters or coastal ecosystems (coral reefs, impaired waterways, waters with endangered species, or other vulnerabilities).

Priority 4: Impacts Not Identified.

- Comprehensive health and environmental risks has not yet been assessed, or the risk of affecting public or environmental health currently appears low.

Appendix C: Reuse Guidelines, Summary of Suitable Uses for Recycled Water Relevant to Farmworker Housing

Source: State of Hawaii, Department of Health. Guidelines for the Treatment and Reuse of Recycled Water, May 15, 2002

Suitable Uses of Recycled Water	**R1**	**R2**	**R3**
IRRIGATION: (S)pray, (D)rip & Surface, S(U)bsurface, (A)LL=S, D & U, Spray with (B)uffer, (N)ot allowed, /=or			
Food crops where recycled water contacts the edible portion of the crop, including all root crops	A*	N	N
Parks, elementary schoolyards, athletic fields and landscapes around some residential property	A	U	N
Non-edible vegetation in areas with limited public exposure	A	AB	U
Sod farms	A	AB	N
Ornamental plants for commercial use	A	AB	N
Food crops above ground & not contacted by irrigation	A	U	N
Pastures for milking and other animals	A	U	N
Fodder, fiber, and seed crops not eaten by humans	A	AB	DU
Orchards and vineyards bearing food crops	A	D/U	DU
Orchards and vineyards not bearing food crops during irrigation	A	AB	DU
Timber and trees not bearing food crops	A	AB	DU
Food crops undergoing commercial pathogen destroying process before consumption	A	AB	DU
Supply to other uses: (A)llowed (N)ot allowed			
Flushing toilets and urinals	A	N	N
Washing yards, lots and sidewalks	A	N	N
High pressure water blasting to clean surfaces	A	N	N
Industrial Process without exposure of workers	A	A	N
Industrial Process with exposure of workers	A	N	N
Cooling or air conditioning system without tower, evaporative condenser, spraying, or other features that emit vapor or droplets	A	A	N
Cooling or air conditioning system with tower, evaporative condenser, spraying, or other features that emit vapor or droplets	A	N	N

*Allowed under the following conditions:
The turbidity of the influent to the filters is continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes. The UV disinfection unit must conform to Appendix K: UV Disinfection Guidelines for R-1 Water.

Appendix D: Toolbox of Collection, Treatment, and Disposal Technologies

Source: Crites, Ono, & Izon, 2011

Water Use Reduction	Water conservation devices Greywater separation
Non-Discharging Systems	Incinerating toilets Composting toilets Vault toilets and holding tanks
Individual Onsite Systems	Septic tanks and cesspools Septic tanks and leachfields Septic tanks and bottomless sand filters Septic tanks and pressure dosed absorption beds Septic tanks and drip irrigation Septic tanks and evapotranspiration beds
Collection Systems	Conventional gravity sewers Pressure sewers (grinder pumps) Septic tank effluent pumps (STEP) Septic tank effluent gravity (STEG) Vacuum sewers
Cluster Systems	Recirculating gravel filters Advantex biofilters Glendon biofilters Package aerobic systems Trickling filters
Natural Treatment Systems	Ponds Constructed wetlands Living Machines
Centralized Treatment Systems	Activated sludge Membrane bioreactors Sequencing batch reactors Trickling filters Moving bed bioreactors
Tertiary Filters and Disinfection	Rapid sand filters Cloth filters Fuzzy filters Membrane filters Chlorination Ultraviolet (UV)
Reuse	Landscape irrigation Crop irrigation Groundwater recharge Industrial cooling Dust control Car washing
Land Discharge	Rapid infiltration Seepage pits Injection wells

Appendix E: Cost Analysis

Discount Rate	0.07

Low-end estimates	2019	2020	2021	2022	
Year	0	1	2	3	Net Present Cost
Wastewater Advisory Committee (5hrs/week)	$6,229.17	$5,821.65	$5,440.80	$5,084.86	$22,576.48
DOH Waiver Program (5hrs/week)	$6,229.17	$5,821.65	$5,440.80	$5,084.86	$22,576.48
Extension of Act 120 and Act 125 (5hrs/week)	$6,229.17	$5,821.65	$5,440.80	$5,084.86	$22,576.48
Produce a Study (6hrs/week)	$7,475	$6,985.98	$0	$0	$14,460.98

High-end estimates	2019	2020	2021	2022	
Year	0	1	2	3	Net Present Cost
Wastewater Advisory Committee (10hrs/week)	$12,458.33	$11,643.30	$10,881.59	$10,169.71	$45,152.93
DOH Waiver Program (10hrs/week)	$12,458.33	$11,643.30	$10,881.59	$10,169.71	$45,152.93
Extension of Act 120 and Act 125 (10hrs/week)	$12,458.33	$11,643.30	$10,881.59	$10,169.71	$45,152.93
Produce a Study (12hrs/week)	$14,950	$13,971.96	$0	$0	$28,921.96