Pahala Large Capacity Cesspool Closure Project

Revised Preliminary Engineering Report

Prepared for

County of Hawaii, Department of Environmental Management

April 2023

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April 8, 2023
Ms. Brenda Iokepa-Moses
County of Hawaii Wastewater Division
108 Railroad Ave
Hilo, HI 96720 152964.704

Subject: Pahala Wastewater Treatment Plant Revised Preliminary Engineering Report

Dear Ms. Iokepa-Moses,

Brown and Caldwell (BC), in association with Engineering Partners, Inc. (EPI) is pleased to present the attached Revised Preliminary Engineering Report (PER) for the Pahala Large Capacity Cesspool (LCC) Closure Project. Preparation of a Revised PER is required by the Revised Administrative Order on Consent (AOC) that became effective on August 22, 2022. The need for a Revised PER was precipitated by several items:

- Geophysical and geotechnical investigations identified and confirmed a large subsurface lava tube under the proposed aerated lagoons, prompting the need for a wastewater treatment process with a smaller and shallower footprint. Mechanical treatment technologies in the form of package plants offer the opportunity to achieve these goals.
- The community has not been receptive to the aerated lagoon technology that was formerly proposed.
- The Revised AOC no longer requires secondary treatment, opening up the possibility of implementing individual wastewater systems (IWS) to close the LCCs.

The Revised AOC requires evaluation of four feasible options:

i. A package plant and new collection system.
ii. A package plant connected to the existing collection system.
iii. A maintenance contract model IWS program.
iv. An operating permit model IWS program.

This Revised PER consists of three parts:

- This introductory summary that provides comparisons of all four feasible options.
- Part A, by BC, which presents updated analysis of feasible options i and ii that are based on using a package plant-based wastewater treatment plant (WWTP) to service the Pahala community and close the LCCs. BC is a nation-wide environmental engineering firm with local Hawaii offices located in Kamuela, Wailuku, and Honolulu. For over 75 years BC has been planning and designing WWTPs throughout the United States.
- Part B, by EPI, which presents a detailed analysis of feasible options iii and iv that are based on using IWS to service the Pahala community and close the existing LCCs. EPI is a multi-discipline engineering and design firm based in Hilo. EPI has successfully designed IWS systems on Hawaii Island and is well-versed to address implementing IWS in the unique local soil and subsurface geological conditions in Pahala.

Throughout this Revised PER the following terms are used:

“Feasible options” refers to the four specific options (i, ii, iii, iv) listed above and in paragraph V.A.31.a of the Revised AOC.

“Alternatives” and “project alternatives” refer to various combinations of systems or technologies that are evaluated within this Revised PER to determine preferences for the feasible options.

1. Comparison of Feasible Options

The four feasible options are compared below,

1.1 Protection of Human Health and the Environment

Table 1 compares the four feasible options with respect to protection of human health and the environment. The State of Hawaii Department of Health (DOH) regulates both WWTPs and IWS. All four feasible options are protective of human health and the environment when implemented in accordance with the applicable Hawaii Administrative Rules (HAR). Additional discussion is provided in Parts A and B.

Table 1. Protection of Human Health and the Environment

Feasible Option	Regulatory Authority	Variances	Protective?
i. Package plant and new collection system	HAR 11-62 Subchapter 2	Variance granted by DOH for WWTP flow capacity	Yes
ii. Package plant connected to the existing collection system	HAR 11-62 Subchapter 2	Variance granted by DOH for WWTP flow capacity	Yes
iii. A maintenance contract model IWS program	HAR 11-62 Subchapter 3	Variances may be required for some lots for setback distances, etc.	Yes
iv. An operating permit model IWS program	HAR 11-62 Subchapter 3	Variances may be required for some lots for setback distances, etc.	Yes

1.2 Capital Cost Comparison of Feasible Options

Table 2 summarizes the capital costs for the four feasible options. Note that the IWS capital costs per lot are presented as ranges; greater precision will not be available until designs are complete due to the site-specific nature of IWS implementation on existing developed properties.

Table 2. Capital Cost Comparison

Feasible Option	Capital Cost	Cost per Lot
i. Package plant and new collection system	$37.3 million	$214,000
ii. Package plant connected to the existing collection system	$23.6 million	$136,000
iii. A maintenance contract model IWS program	$5.7 - $17.4 million	$33,000 - $100,000
iv. An operating permit model IWS program	$5.7 - $17.4 million	$33,000 - $100,000

As shown in the table the IWS feasible options incur significantly lower capital costs than the package plant alternatives.

1.3 Life-cycle cost comparison

A life-cycle cost comparison was prepared for the alternatives. The life-cycle cost is the net present value of cash flows required to implement the project over a 30-year planning period, including capital, operation, maintenance, and replacement costs. The life-cycle cost evaluation includes inflationary effects and the time value of money. Table 3 summarizes the life-cycle cost evaluation results. The IWS approaches assumed the maximum estimated capital costs presented above; the average cost per lot will likely fall between the two extremes shown in Table 2.

Table 3. Life-Cycle Cost Evaluation Results

Alternative	Capital Cost	O&M Costs	Life-Cycle Cost
i. Package plant and new collection system	$37.3 million	$19.7 million	$57.0 million
ii. Package plant connected to the existing collection system	$23.6 million	$21.6 million	$45.2 million
iii. A maintenance contract model IWS program	$17.4 million	$9.4 million [a]	$26.8 million
iv. An operating permit model IWS program	$17.4 million	$11.3 million [a]	$28.7 million

[a] *Includes replacement costs and IWS O&M costs paid directly by homeowners.*

Figure 1 shows the results graphically. The IWS alternatives have significantly lower life-cycle costs than the package plant alternatives.

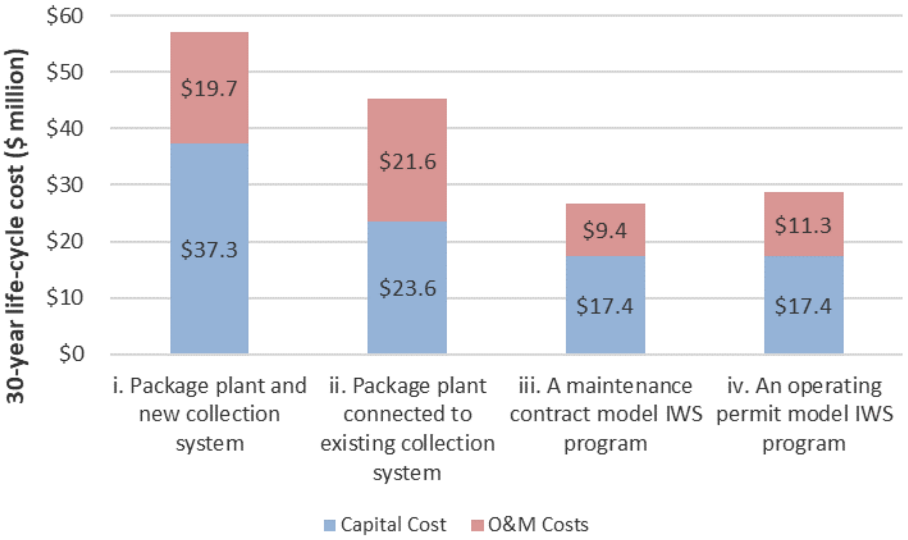

Figure 1. Life-Cycle Cost Comparison

1.4 Schedule

The Revised AOC requires the LCCs be closed no later than July 21, 2026. Parts A and B include preliminary assessments of implementation schedules. Table 4 provides a summary of the preliminary implementation schedule assessments. As discussed in Part A, it will be difficult to implement the WWTP approach to close the LCCs by the deadline, due to entitlement processes, environmental review, land acquisition, and materials supply challenges currently facing the Hawaii construction industry. A design/build approach could potentially reduce the implementation timeframe if equipment procurement and fabrication can occur in parallel with design. However, compliance with the Revised AOC deadline will be a significant challenge with Feasible Options i and ii. Per Part B, the IWS approach may be able to be implemented by the Revised AOC deadline. The IWS approach assumes that the County can address Hawaii Revised Statues (HRS) 343 environmental review requirement via an exemption, and that any alterations to County regulations deemed necessary by the County are achievable within the timeframe.

Table 4. Summary of Preliminary Implementation Schedule Assessments

Description	Feasible Options			
	i. Package Plant New Collection System	ii. Package Plant Existing Collection System	iii. Maintenance Contract Model IWS Program	iv. Operating Permit Model IWS Program
Entitlements and permitting	Q3 2024	Q3 2024	Q1 2024	Q1 2024
Design and construction	Q4 2027	Q4 2027	Q2 2026	Q2 2026
Estimated LCC closure	Q2 2027	Q2 2027	Q2 2026	Q2 2026
Revised AOC LCC closure milestone	July 21, 2026			
Risk of missing Revised AOC LCC closure milestone	High	High	Moderate	Moderate

Note: Q = quarter

2. Revised AOC References

The Revised AOC paragraph V.30.A.a lists information that must be included in this Revised PER. Table 5 provides references to the information within.

Table 5. Revised AOC Paragraph V.30.A.a Checklist

Revised AOC Paragraph V.30.A.a Description	Report Reference Section for Feasible Options			
	i. Package Plant New Collection System	ii. Package Plant Existing Collection System	iii. Maintenance Contract Model IWS Program	iv. Operating Permit Model IWS Program
Description of project details for each feasible option	Part A, § 2.2 and 8	Part A, § 2.4 and 8	Part B, § 1, pg. 3	
Planning area description	Part A, Figure 2-1	Part A, Figure 2-1	Part A, Figure 2-1	Part A, Figure 2-1
Planning period	Part A, § 7.2.3	Part A, § 7.2.3	Part A, § 7.2.3	Part A, § 7.2.3
Description of planning phases	Part A, § 7.2.3	Part A, § 7.2.3	Part A, § 7.2.3	Part A, § 7.2.3
Owner and operator of facilities	Part A, § 1-1	Part A, § 1-1	County /In-house or 3rd party service provider	Homeowner / 3rd party service provider
Location of facilities (including a map)	Part A, Figure 2-1	Part A, Figure 2-1	Part A, Figure 2-1	Part A, Figure 2-1
Design parameters for each feasible option	Part A, § 2.2 and 8	Part A, § 2.4 and 8	Part B, Table 1.1	Part B, Table 1.1
Major unit processes:	Part A, § 5	Part A, § 5	Part B, § 2 and 3	Part B, § 2 and 3
Flow diagram	Part A, Figure 8-2	Part A, Figure 8-2	Part B, Appendix J	Part B, Appendix J
Pipe lengths, sizes, and locations	Part A, Table 2-2	Part A, Table 2-2	Not applicable	Not applicable
Design criteria	Part A, § 8.3	Part A, § 8.3	Part B, § 3, Appendix J	Part B, § 3, Appendix J
Project costs	Part A, § 7	Part A, § 7	Part B, Table 1.2	Part B, Table 1.2

3. Recommended Approach

Based solely on the technical analysis presented in Part A and Part B of this report and considering the significantly lower capital and lifecycle costs and favorable implementation schedule associated with of the IWS option, we recommend the County pursue an IWS approach to close the LCCs by the Revised AOC deadline of July 21, 2026. Implementation and logistics of the IWS options (including issues not addressed in this report) are concurrently being investigated by the County. If the IWS approach is selected by the County and approved by the EPA, the next step will be for the County to develop an Implementation Plan that will include definition of the intended IWS management model.

Brown and Caldwell appreciates that the County has requested our services in assisting with this project. Should you have any questions, please do not hesitate to call Michelle Sorensen at 808.442.3306.

Very truly yours,

Brown and Caldwell

for

Michelle Sorensen, Project Manager
Kamuela, Hawaii

Craig Lekven, Project Director
Wailuku, Hawaii

PART A: WWTP Approach

Part A
Pahala Wastewater Treatment Plant
Revised Preliminary Engineering Report

Prepared for
County of Hawaii, Department of Environmental Management
April 2023

THIS WORK (PART A) WAS PREPARED BY ME OR UNDER MY SUPERVISION

April 30, 2024

Signature Expiration Date of the License

CRAIG CARSTEN LEKVEN
No. 13003-C

Brown AND Caldwell

Table of Contents – Part A

List of Figures

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List of Abbreviations

AB	aggregate base
AC	asphalt concrete
BMP	Best Management Practices
BOD_5	5-day biochemical oxygen demand
CCH	City and County of Honolulu
CDP	Kau Community Development Plan
cfs	cubic feet per second
CFR	Code of Federal Regulations
DNA	deoxyribonucleic acid
DEM	Department of Environmental Management
DOH	Department of Health
DWS	Department of Water Supply
ELLF	end-of-lamp-life
FIRM	Flood Insurance Rate Map
FOG	fats, oils, and grease
ft^3	cubic feet
FTE	full-time equivalent
GAC	granular activated carbon
gpm	gallons per minute
gpd	gallons per day
gpcd	gallons per capita per day
gpad	gallons per acre per day
H_2S	hydrogen sulfide
HAR	Hawaii Administrative Rules
HDPE	high density polyethylene
HELCO	Hawaii Electric Light Company
hp	horsepower
hp/Mgal	horsepower per million gallons
hr	hour
hp-hr	horsepower-hour
I/I	Infiltration and inflow
L	liter
lbs	pounds
LCC	large capacity cesspools
LPHO	low pressure high output
MBR	membrane bioreactor
Mg	milligrams
Mgal	million gallons
Mgd	Million gallons per day
mL	milliliter
MLSS	mixed liquor suspended solids
mm	millimeter
MSL	mean sea level
N	nitrogen
NPV	net present value
O&M	Operation and Maintenance
P	Phosphorus
psi	pounds per square inch
RNA	ribonucleic acid
ROW	right-of-way
scfm	standard cubic feet
SCS	Soil Conservation Service
SES	sand equivalent size
SR	slow rate
SRT	solids residence time
TSS	total suspended solids
UIC	Underground Injection Control
USEPA	United States Environmental Protection Agency
UV	ultraviolet
WQV	Water Quality Volume
WWTP	Wastewater Treatment Plant
WWRF	Wastewater Reclamation Facility

Section 1

Introduction

1.1 Background

The town of Pahala is located in the Kau district of the Island of Hawaii. According to the 2020 United States Census, the town population is approximately 1,400 persons.

The modern Pahala community was first established as the Pahala Plantation by Hawaiian Agriculture Company (HAC) in 1878 to support sugarcane production. A portion of the community is serviced by a sewer system that was privately built, owned, and operated by the C. Brewer Company, which merged with HAC in 1972. The wastewater collected by the sewer system discharges into large capacity “gang” cesspools. The County of Hawaii (County) Department of Environmental Management (DEM) assumed ownership of the sewer system on April 30, 2010.

In 1998, the U.S. Environmental Protection Agency (USEPA), promulgated regulations, 40 Code of Federal Regulations (CFR) 144.14, that require the elimination of large capacity “gang” cesspools (LCCs). Options to close the LCCs include construction of a new sewer collection system located within public right-of-way (ROW) and replacement of the existing LCCs with a wastewater treatment plant (WWTP) to address the wastewater treatment and disposal needs of the Pahala community. These centralized WWTP options are the subject of this report. A separate report is being concurrently prepared that evaluates additional options using individual wastewater systems (IWS) in lieu of a new collection system and WWTP to close the LCCs.

This report is a revision of the 2019 Preliminary Engineering Report (PER) for the Pahala WWTP and summarizes the proposed facilities needed to treat and dispose of wastewater flow that is currently discharged to the LCCs, plus additional sewer connections. The report presents the existing and estimated future flows and loads to the treatment plant, the proposed treatment processes, recommendation for the WWTP upgrades needed to meet the future treatment needs, and an initial opinion of the cost to construct the improvements project.

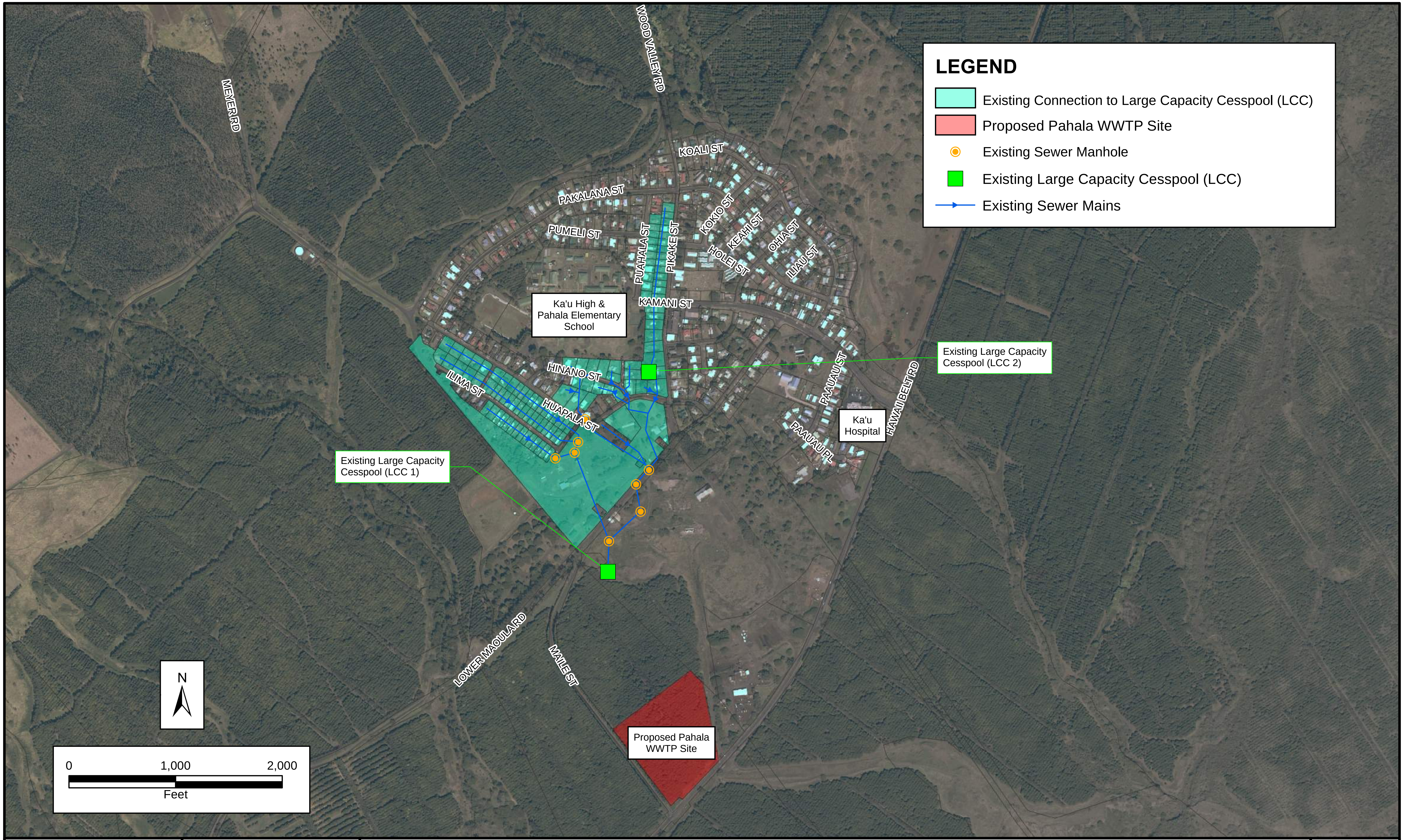
1.2 Existing System

The existing collection system is a network of gravity sewers that discharge to two existing LCCs. Figure 1-1 shows the collection system network and service areas for the LCCs. A detailed analysis of the existing wastewater collection system was completed by others (M&E Pacific, December 2004). The report concluded that the Pahala community existing sewer system consists of about 3,000 linear feet of 6-inch diameter and 10,000 linear feet of 4-inch diameter pipelines. Residential laterals connect to 4-inch sewers that discharge into 6-inch sewer mains, predominately found in easements on private property, which transmit wastewater to the LCCs. There are approximately 8 manholes in the sewer system. There are no pump stations, and the system is not designed to collect stormwater.

1.3 Report Contents

Section 2 presents the service area and alternative collection systems. Section 3 presents flow and load projections for the new WWTP. Section 4 evaluates effluent management options, and the treatment requirements for the preferred option. Section 5 presents evaluations conducted to develop the preliminary design of the proposed WWTP. Solids management is briefly presented in

Section 6, followed by discussion of alternative treatment options that were considered and evaluated in Section 7. Preliminary design of improvements is presented in Section 8. The report concludes with an implementation plan in Section 9.



Brown AND Caldwell

SCALE AS SHOWN

JOB NO.: 150440

PAHALA WASTEWATER TREATMENT PLANT

Pahala Existing Sewer Collection System and LCC Service Area

FIGURE

1-1

Section 2

Collection System

This section summarizes the alternative collection systems for the service area.

2.1 Service Area

Within the town of Pahala, there is an existing wastewater collection system that services approximately 109 properties. The collection system is currently located within easements in private properties and is treated and disposed through two LCCs. Figure 2-1 shows the service area for the new WWTP. The Kau Community Development plan indicates that the sewer system may eventually be expanded to service the entire community; however, the initial collection system and WWTP presented in this report will service the properties currently connected to the LCCs or located adjacent to the new collection system. Table 2-1 provides a summary of the WWTP service area, which includes the properties currently supplying wastewater to the LCCs and the properties that will be “newly accessible” to the wastewater collection system after the replacement collection system is constructed.

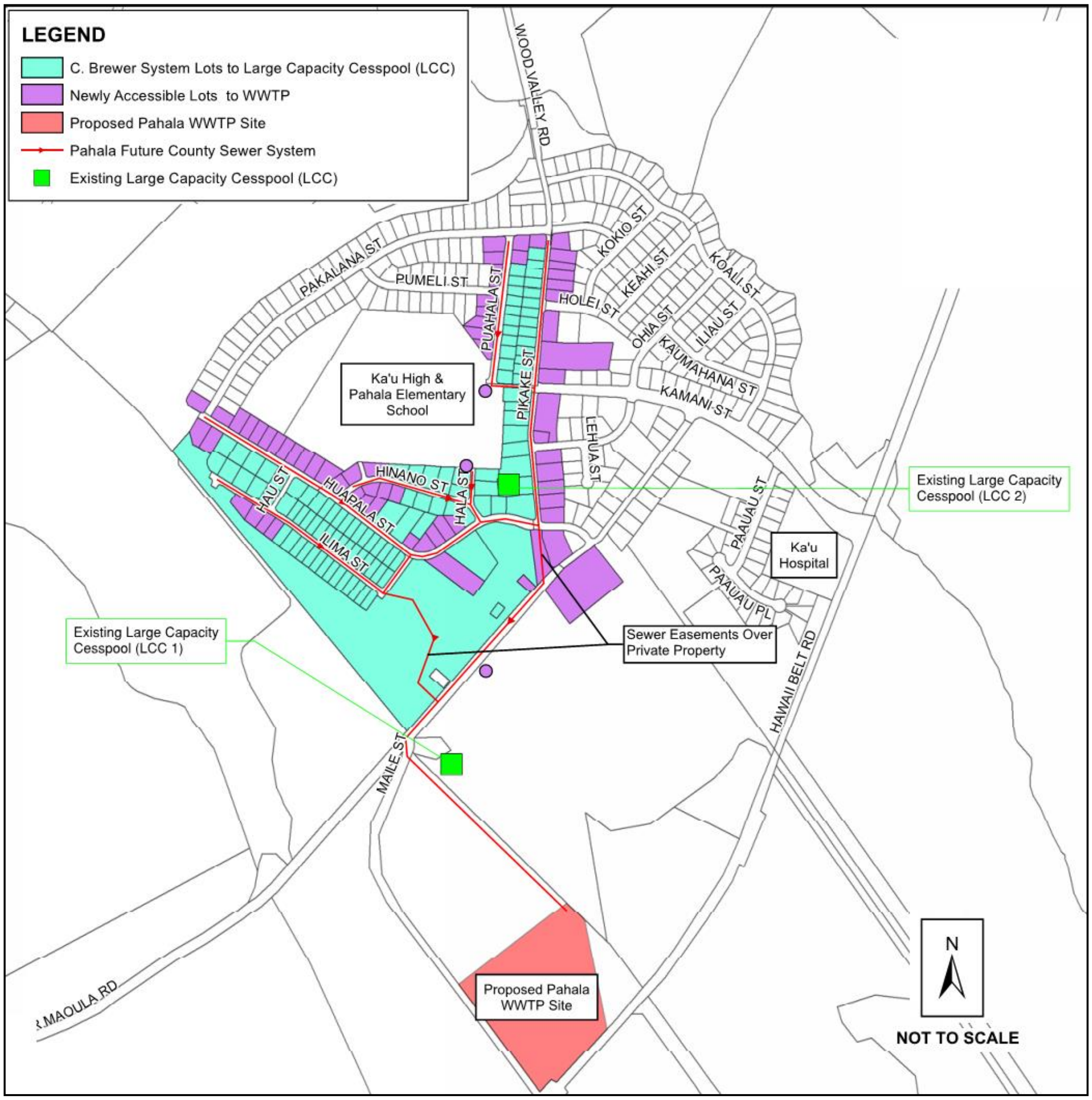


Figure 2-1. Pahala WWTP service area

Table 2-1. Pahala WWTP Service Area Summary	
Property Type	Number of Parcels
Residential	167
Commercial	4
School	1
Industrial	1
Commercial, industrial, and agricultural	1
Total	174

2.2 Conventional Gravity Sewers

A conventional gravity sewer collection system was designed for the Pahala service area shown in Figure 2-1 by Fukunaga & Associates, Inc., to be constructed in two phases. Phase 1 consists of both 8-inch and 12-inch diameter PVC sewer lines connecting the two LCCs along the South end of Pikake Street and continuing down Maile Street to the proposed WWTP. The Phase 1 collection system is designed to tie into Pahala's existing collection system infrastructure. Phase 2 consists of approximately 9,400 linear feet of 8-inch diameter PVC sewer mainlines with 6-inch diameter PVC county sewer laterals connecting the sewer mainline to property & easement lines. This Phase 2 collection system is designed to connect to the Phase 1 collection system. Table 2-2 provides a summary of the two projects.

Table 2-2. Summary of Pahala Gravity Collection System Projects

Description	Phase 1	Phase 2
Project title	Pahala Wastewater Collection System Improvements Phase 1	Pahala Wastewater Collection System Improvements Phase 2
Purpose	Connect existing collection system to WWTP easement. Close LCCs	New sewers in street to replace existing. Connect houses.
Scope summary	1,400 linear feet of 12-inch sewer 700 linear feet of 8-inch sewer 18 manholes Close 2 LCCs	9,391 linear feet of 8-inch sewer 83 manholes 158 County sewer laterals, 6-inch Connect houses.

2.3 Septic Tank Effluent Pumping (STEP) System

Typically, a STEP system includes a septic tank with filter screens and electric pumps to convey septic tank effluent to a force main located in the street. These force mains are small (2-inch minimum diameter), low-pressure mains that can be installed with minimum depth of cover and can follow the topography. Figure 2-2 is a schematic diagram of a STEP collection system,

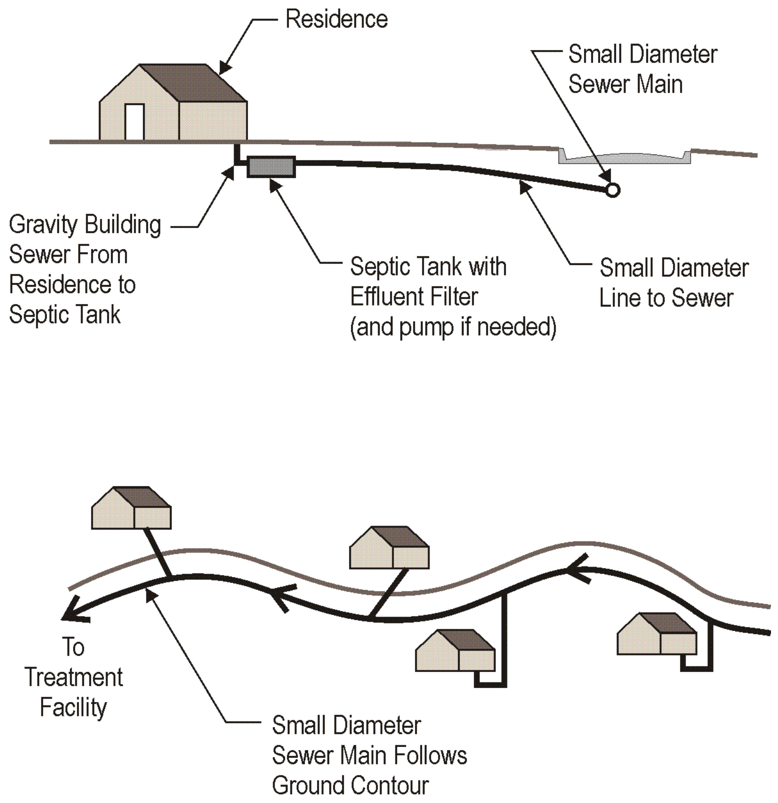


Figure 2-2. STEP Collection System

The major suppliers of these systems are Orenco and Zoeller. The STEP pumps are turbine style high-head pumps intended to pump effluent without solids. Solids, disposable wipes, and grease are all retained in the septic tank and are not pumped. By screening and retaining solids in the septic tank portion of the system, a reduced organic load to the WWTP would be realized.

STEP systems are often sold as a package system, including a septic tank or pretreatment/solids holding tank, screen, pump, and controls.

The pumps in STEP systems must be protected from solids by a screening system. It is recommended that STEP systems be inspected regularly to make sure the screen is functioning and there is not excessive solids or grease build up. Septic tanks associated with STEP systems require pumping to remove the accumulated solids.

Examples and illustrations of STEP system installations are provided below in Figures 2-3 to 2-6.

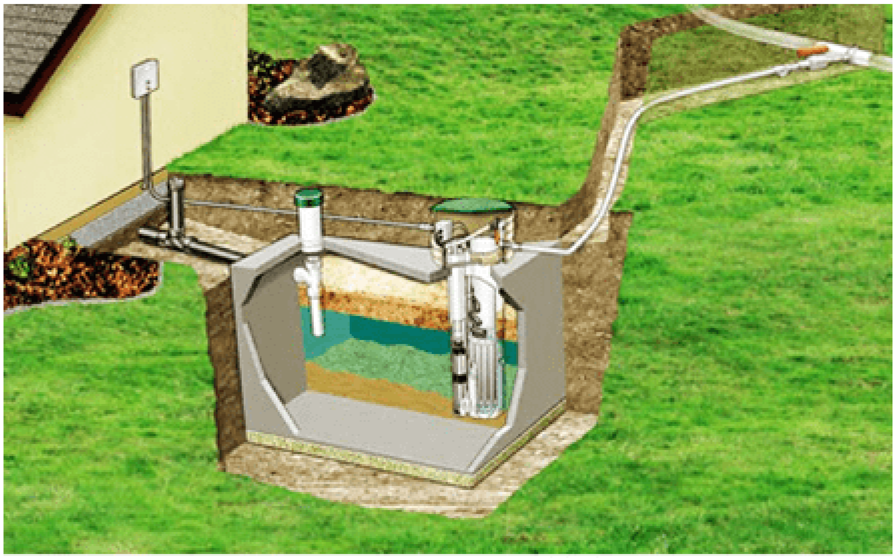


Figure 2-3. STEP Section View

Figure 2-4. Orenco Prelos™ System Tanks in the Field

Figure 2-5. Orenco STEP System Pump and Screen

Figure 2-6. Orenco Prelos™ System Cutaway

Advantages of STEP systems include:

- Solids and grease are retained in the tank at the home.

- Minimal infiltration and inflow (I/I) concerns.
- The small-diameter sewer mains can be installed at minimum depth of cover and can follow the surface terrain, reducing initial cost.

Disadvantages of STEP systems include the following:

- Homeowner still has a septic tank to maintain.
- Filter screens need to be inspected and cleaned periodically (annually or biannually recommended).
- Septic tanks need to be pumped out periodically (typically every 3 to 5 years).

The Pahala STEP collection system would align with the County sewer system layout depicted in Figure 2-1 and consist of PVC schedule 40 pipe ranging from 2-inch to 6-inch in diameter. Projected to service 174 parcels, this collection system would consist of approximately 4,200 linear feet of 2-inch diameter, 3,400 linear feet of 3-inch diameter, 3,500 linear feet of 4-inch diameter, and 2,000 linear feet of 6-inch diameter pipe.

2.4 Reuse Existing Collection System

In 2004, C. Brewer Company contracted M&E Pacific to perform a sewer system evaluation for the town of Pahala. The results of this investigation determined that the existing sewer lines and manholes do not conform to the County sewer design standards. The existing sewer system was not constructed in the streets, but instead runs through easements located on private properties, with many collection lines running adjacent to or beneath the houses. The results of a smoke test performed during the 2004 sewer system evaluation identified 14 locations of line breaks and/or pipe defects and 7 household units with defective sewer vents. In addition, the existing sewer system is over 80 years old, long surpassing its expected lifespan, and will require extensive repair and rehabilitation if chosen to be reused. The recommended alternative, which received overwhelming support from Pahala voters in 2004, consists of constructing a new sewer system in the streets to meet the County sewer standards and to allow the collection system to be owned and operated by the County (M&E Pacific, December 2004). Nearly 20 years have passed since the 2004 study was completed. In order to reuse the existing collection system into the future an updated condition assessment study is recommended to better identify system deficiencies. Substantial improvements will likely be necessary due to the age of the system. Reusing the existing collection system would require constructing the Phase 1 collection system project described above to tie into the WWTP and close the LCCs.

2.5 Cost Evaluations

A summary of the capital costs and life cycle costs for the alternative collection systems are presented in Table 2-3 for comparison. The life cycle costs consist of the 30-year net present value of the capital and O&M costs. Additional detail is included as Appendix A.

Table 2-3. Collection System Cost Summary			
Collection System Option	**Capital Cost**	**Annual O&M Cost**	**Life-Cycle Cost [a]**
New gravity sewers in streets	$21.0 million	$40,000/year	$22.0 million
STEP system	$18.6 million	$129,000/year	$22.2 million
Reuse existing collection system	$7.3 million	$120,000/year	$10.2 million

[a] *See section 7.2.3 for life-cycle cost assumptions.*

The life-cycle costs are shown graphically in Figure 2-7. Reusing the existing collection system has the lowest capital and life-cycle costs.

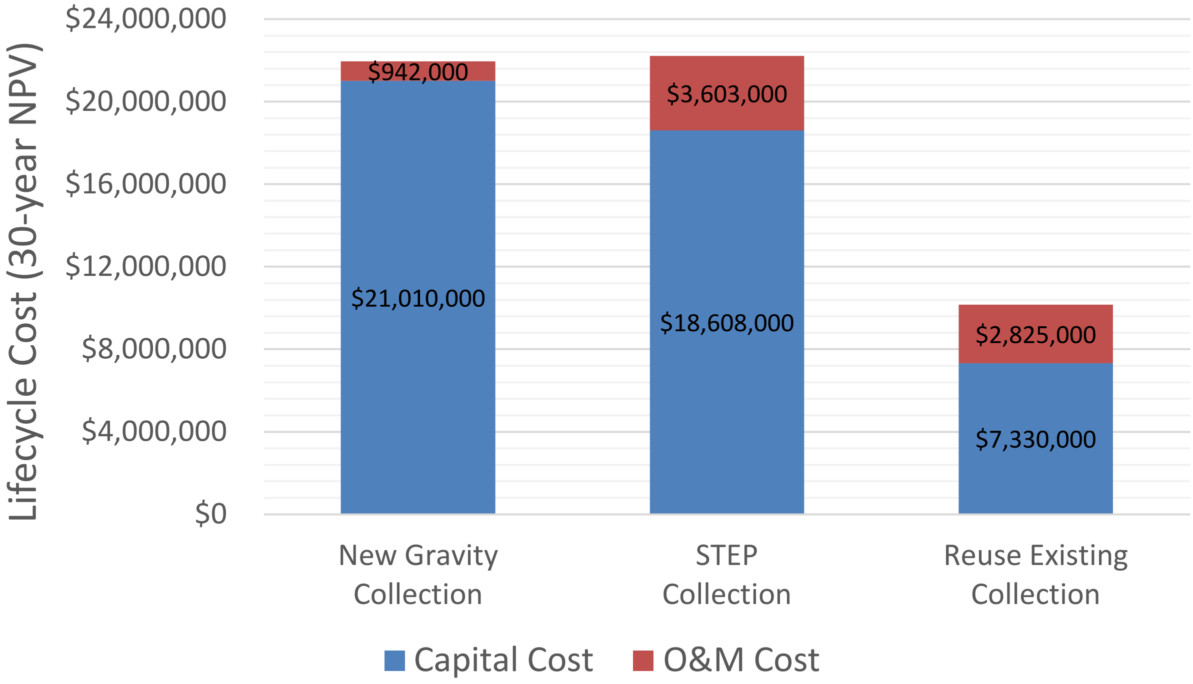


Figure 2-7. Life-Cycle Cost Comparison of Collection System Alternatives

2.6 Recommendation

Although reusing the existing collection system appears to incur lower life-cycle costs than the other alternatives it is not recommended for implementation. Due to the advanced age of the existing collection system the option would incur substantial financial and other risks to the County:

- The piping is at the end of its useful service life, and catastrophic failures are likely to increase in frequency, creating increased risk to public health and the environment.
- Most of the system is located in backyard easements, making it difficult to access and maintain.
- System expansion to accommodate sewering additional areas of the town (in accordance with the Kau CDP) would not be feasible.
- The option does not address the AOC requirement to connect additional properties, that are currently not connected to the collection system, to the WWTP.

A new conventional gravity sewer collection system constructed in the streets is a viable solution to meet the wastewater collection needs of the town of Pahala and is recommended for implementation.

Section 3

Flow and Load Projections

This section summarizes the wastewater flow and load projections for the new Pahala WWTP.

3.1 Flow Projections Based on City and County of Honolulu Standards

HAR section 11-62-24(b) requires Counties to use their adopted wastewater flow standards to develop flow projections for WWTPs. Counties are to use the City and County of Honolulu (CCH) flow standards if they have not adopted their own standards. The County of Hawaii has not adopted its own flow standards, so wastewater flow projections were developed using the current CCH (2017) wastewater standards. Table 3-1 summarizes the flow projections.

Table 3-1. Pahala WWTP Flows Based on 2017 CCH Standards

Description	Value
Average dry weather flow	190,000 gpd
Peak day dry weather flow	369,000 gpd
Peak day wet weather flow [a]	665,000 gpd
Peak hour wet weather flow	625 gpm (900,000 gpd)

[a] *Peak day wet weather flow is not part of the CCH standards but is an important WWTP design parameter. Peak day wet weather flow estimate was developed using an appropriate peaking factor.*

The CCH standards were established for a major metropolitan area that includes vast areas of residential, commercial, and industrial development, with significant proportions of service areas near sea level elevations. Wastewater generation rates are generally lower in rural areas than in urban areas. The County's experience with the CCH flow standards on other projects (e.g., Honokaa WWTP) has illustrated that the standards are very conservative for small rural communities located at higher elevations on Hawaii Island. Therefore, the current wastewater standards based on urban Honolulu are likely overly conservative for rural communities like Pahala.

3.2 Reduced Flows Based on Potable Water Records

The amount of wastewater generated within a residence will not exceed the amount of potable water used by the occupants. Therefore, potable water use records can be used to estimate wastewater generation rates within existing communities where no combined sewers are present. The County of Hawaii Department of Water Supply (DWS) provided potable water use records for the parcels located within the service area from January 2015 through June 2021. Analysis of the potable water use records indicates that a 40,000 gpd monthly wastewater generation rate would reflect the current needs of the service area. Using a 2.5 peaking factor to estimate the maximum wastewater flow into the collection system results in a maximum wastewater flow of 100,000 gpd.

3.2.1 Dry Weather I/I Allowance

Groundwater can infiltrate into wastewater collection systems during dry weather, increasing flows to the WWTP. The 2017 CCH standards specify a dry weather infiltration and inflow (I/I) allowance of 35 gallons per capita per day (gpcd). The previous CCH standards (dated 1993) specified a dry weather I/I allowance of 5 gpcd for properties located above the groundwater table. Through the County's experience at Honokaa evaluating dry weather I/I for a rural collection system located in Hawaii Island's well-drained geology, at elevations hundreds of feet above sea level and a significant distance from the shoreline, we conclude that continued use of the 1993 standard for dry weather I/I is appropriate for Pahala and using the 2017 standard would be overly-conservative.

3.2.2 Wet Weather I/I Allowance

The 2017 CCH standards specify a wet weather I/I allowance of 3,000 gallons per acre per day (gpad). Due to larger parcels within the Pahala service area, wet weather I/I estimates are modified as permitted by the 2017 CCH standards. The modified flows are based on a 50-foot-wide corridor of sewer laterals from existing or assumed building foundations on the property. These assumptions significantly reduce the wet weather I/I estimates for the collection system.

Evaluating the effluent flow records at the Honokaa WWTP provides an appropriate analysis of the wet weather peaking factors expected at the Pahala facility. The results of the Honokaa WWTP effluent flow analysis have determined that a peak day wet weather peaking factor of 6.5 is recommended for the Pahala WWTP design.

3.2.3 Reduced Flow Projections

Accurately quantifying flow projections for the Pahala community is necessary to design an appropriately sized wastewater treatment and disposal facility. The WWTP design will provide sufficient capacity for the existing parcels within the service area, including newly accessible parcels, reflecting current development. This will allow the County to close the LCCs. Furthermore, the design will provide sufficient area within the WWTP site for future expansion. Table 3-2 provides a summary of the calculated WWTP capacities for the reduced flow projections and for the flow projections for future development based on the 2017 CCH Standards.

Table 3-2. Pahala WWTP Calculated Flow Capacity

Description	Reduced Flow Projections	Flow Projections Based on 2017 CCH Standards
Base sanitary flow	40,000 gpd	119,000 gpd
Peak hour sanitary flow	100,000 gpd (PF=2.5)	298,000 gpd (PF = 2.5)
Dry weather I/I	8,000 gpd	71,000 gpd
Wet weather I/I	210,000 gpd	533,000 gpd
Average dry weather flow	48,000 gpd	190,000 gpd
Peak day dry weather flow	108,000 gpd	369,000 gpd
Peak day wet weather flow	312,000 gpd (PF=6.5)	665,000 gpd (PF=3.5)
Peak hour wet weather flow	221 gpm (318,000 gpd)	625 gpm (900,000 gpd)

HAR 11-62-23.1(i) requires the initiation of a facility planning process when the actual wastewater flows reach 75 percent of the design capacity of the WWTP, and implementation of the facility plan must be initiated when actual wastewater flows reach 90 percent of the design capacity. In anticipation of future development, we recommend the WWTP design be rated to treat an average dry weather flow of 95,000 gpd (approximately twice the projected average dry weather flow) to avoid the potential of having to initiate a facility plan shortly after the project is constructed. Note that the biological processes in the mechanical WWTP will need to be sized to treat the peak day dry weather flow of 108,000 gpd, not the average dry weather flow.

The proposed WWTP design capacity is based on actual water use data to establish wastewater generation rates, and rational assumptions to establish I/I allowances, and we believe it is appropriate for the existing conditions, while providing limited capacity for growth. Table 3-3 presents the recommended design capacity for the reduced flow projections.

Table 3-3. Recommended WWTP Capacity

Description	Value
Average dry weather flow	95,000 gpd
Peak day dry weather flow	108,000 gpd
Peak day wet weather flow	312,000 gpd
Peak hour wet weather flow	318,000 gpd (221 gpm)

3.2.4 Flow Variance

The County applied to DOH for a variance from HAR section 11-62-24(b) based on the above analysis. DOH granted the variance on January 26, 2022 (see Appendix B), and it must be renewed every five years. The variance contains the following conditions:

1. As a minimum, the Pahala Wastewater Treatment Plant (WWTP) shall be designed using an average dry weather flow of 95,000 gallons per day.
2. Plans for the proposed Pahala WWTP shall be designed in accordance with applicable requirements of Chapter 11-62, HAR and be submitted to the Wastewater Branch for review and approval. In addition, the WWTP shall be approved in writing before it may be used.
3. There is no automatic renewal. Should the applicant wish to renew this variance application, the applicant must submit an Application for Variance for renewal, 180 days prior to expiration date.

3.3 Influent Characteristics

The properties within the existing service area are primarily residential, but do include commercial, ,multi-family, and industrial zoned parcels. The wastewater characteristics of the WWTP influent are assumed to be similar to typical domestic wastewater. Table 3-4 provides a summary of the assumed influent characteristics.

Table 3-4. Summary of Assumed Influent Characteristics

Parameter	Value
5-day biochemical oxygen demand (BOD_5)	300 mg/L
Total suspended solids (TSS)	300 mg/L
Total nitrogen	40 mg/L
Total phosphorus	7 mg/L

Source: Crites and Tchobanoglous, 1998.

3.4 Influent Mass Loads

Table 3-5 summarizes the projected loads to the WWTP, based on the proposed peak day dry weather capacity of 108,000 gallons per day and the influent characteristics presented above.

Table 3-5. Projected Peak Dry Weather Day Influent Mass Loads

Description	Value
BOD_5	270 lbs./day
TSS	270 lbs./day
Total nitrogen	36 lbs./day
Total phosphorus	6 lbs./day

Section 4

Effluent Management Options and Regulatory Requirements

Effluent management options are evaluated in this section, followed by an assessment of regulatory requirements for the recommended effluent management system.

4.1 Effluent Management Options

Effluent management options are evaluated below.

4.1.1 Ocean Discharge

Ocean discharge of treated effluent is not considered a viable option for this small community due to the long distance to the shoreline (approximately 3 miles), high cost to construct an outfall, stringent receiving water quality standards, high receiving water monitoring cost, and difficulty and length of time required to secure the required permits.

The coastal waters in the Pahala area are classified as “AA” marine waters by DOH. HAR 11-54 does not allow zones of mixing in waters up to a distance of 300 meters (one thousand feet) offshore if there is no defined reef area and if the depth is greater than 18 meters (ten fathoms). The water quality criteria for nutrients for Class AA embayments are listed in Table 4-1. If a mixing zone is not provided, then a WWTP discharging to the coastal waters would be required to treat water to meet the applicable water quality criteria. Treatment to the specified levels is not feasible with current technologies. Therefore, ocean discharge is not feasible.

Table 4-1. Nutrient Water Quality Standards for Class AA Embayments

Parameter	Geometric mean not to exceed	Not to exceed the given value more than 10% of the time	Not to exceed the given value more than 2% of the time
Total nitrogen	200 µg/L	350 µg/L	500 µg/L
Ammonia nitrogen	6 µg/L	13 µg/L	20 µg/L
Nitrate + nitrate nitrogen	8 µg/L	20 µg/L	35 µg/L
Total phosphorus	25 µg/L	50 µg/L	75 µg/L

4.1.2 Subsurface Disposal via Injection Wells

Per Hawaii Administrative Rules (HAR), Title 11, Chapter 23, disposal to groundwater via an injection well is not allowed mauka of the State of Hawaii Department of Health (DOH) Underground Injection Control (UIC) line. Since the town of Pahala is located mauka of the UIC line, an injection well is not a viable option. In addition, per Environmental Protection Act 131, DOH is prohibited from issuing permits “for the construction of sewage wastewater injection wells unless alternative wastewater disposal options are not available, feasible or practical”. Therefore, subsurface disposal via injection wells is not feasible.

4.1.3 Water Recycling

An irrigation assessment was prepared to assess the viability of water recycling as the primary effluent management system, assuming the recycled water would be used to irrigate macadamia nut trees. Figure 4-1 presents a summary of the assessment, which shows there is typically no irrigation demand for six months of the year due to high rainfall. In addition, the DOH requires that all water recycling programs have a 100 percent backup disposal system in place to handle flow that does not meet recycled water quality standards or when recycled water supply exceeds demand. Therefore, water recycling is not a viable primary or sole effluent management strategy for the community at this time. However, water recycling treatment, storage, and distribution systems could be added in the future.

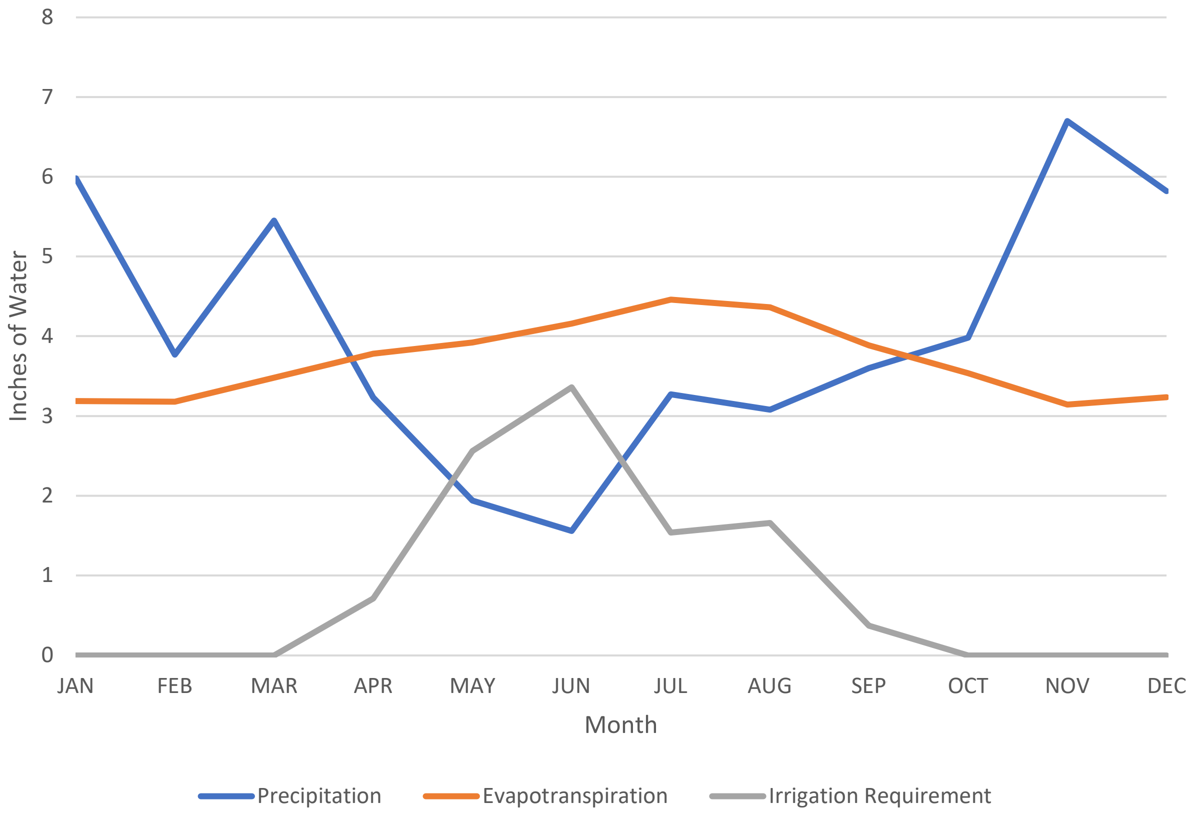


Figure 4-1. Irrigation Demand Assessment

4.1.4 Slow Rate Land Treatment

A potential project effluent management concept consists of Type 1 slow rate land treatment, which involves irrigation of vegetation with effluent. Type 1 slow rate land treatment differs from water recycling in that it is a disposal method, and effluent is typically applied in excess of the irrigation needs of the vegetation. The potential effluent management concept calls for removal of the existing macadamia nut trees at the site, grading the site to contain all precipitation, and planting native Hawaiian trees or replacement macadamia nut trees within the effluent disposal area. Effluent would be applied using surface (flood) irrigation techniques.

The effluent from the Pahala WWTP would be applied to land within the 14.9-acre WWTP parcel. Approximately 10 acres of the site is available for slow rate land treatment. The soil infiltration rate is a key factor in determining the land area requirements for a slow rate land treatment system. ASTM

D3385 double ring infiltrometer testing was conducted in January 2021 to assess the infiltration rate of the site soils. A total of 15 tests were conducted within the slow rate land treatment area; the results are summarized in Table 4-2.

Table 4-2. Pahala WWTP Soil Infiltration Test Results

Test Location	Test Depth (feet)	Geologic Unit	Infiltration Rate (inches/hour)
TP-1	1.2	Fill/tephra	4.2
TP-2	2.5	Weathered tuffaceous deposits	2.8
TP-3	2.0	Weathered tuffaceous deposits	4.5
TP-4	2.2	Fill/tephra	4.3
TP-5	1.3	Weathered tuffaceous deposits	0.6
TP-6	1.5	Fill/tephra	1.2
TP-7	3.8	Weathered tuffaceous deposits	4.1
TP-8	2.8	Weathered tuffaceous deposits	1.9
TP-9	1.0	Fill/tephra	1.0
TP-10	4.0	Weathered tuffaceous deposits	3.8
TP-11	1.0	Fill/tephra	2.6
TP-12	1.0	Fill/tephra	1.9
TP-13	1.2	Fill/tephra	1.3
TP-14	1.0	Fill/tephra	2.9
TP-15	1.0	Fill/tephra	1.4
		Average:	2.6

The results of the infiltration rate investigation confirms that the site will provide adequate land area to meet the both the current and future needs of the community using standard slow rate land treatment design criteria. A water balance was prepared for the reduced wastewater flow projections, assuming 10 acres of the site are used for slow rate land treatment. The site water balance includes effluent applied to the site, precipitation on the site, and anticipated evapotranspiration by the trees. Table 4-3 summarizes the results of the water balance.

Table 4-3. Pahala WTTP Effluent Disposal Water Balance

Month	Days	Effluent Application [a]		Average Precipitation [b] (inches)	Evapotranspiration [c] (inches)	Percolate [d] (inches)
		(mgal)	(inches)			
Jan	31	2.9	10.8	5.98	3.9	13.0
Feb	28	2.7	9.8	3.77	3.9	9.7
Mar	31	2.9	10.8	5.45	4.2	12.1
Apr	30	2.9	10.5	3.23	4.9	8.9
May	31	2.9	10.8	1.94	5.3	7.5
Jun	30	2.9	10.5	1.56	5.6	6.4
Jul	31	2.9	10.8	3.27	6.1	8.1
Aug	31	2.9	10.8	3.08	5.9	8.0
Sep	30	2.9	10.5	3.60	5.3	8.8
Oct	31	2.9	10.8	3.98	4.8	10.0
Nov	30	2.9	10.5	6.70	4.0	13.2
Dec	31	2.9	10.8	5.82	4.2	12.5
Totals	365	34.7	127.7	48.4	58.0	118.0

[a] *At ADWF capacity = 95,000 gpd.*

[b] *From Climatography of the United States No. 20, Monthly Station Climate Summaries, 1971-2000, Hawaii. National Oceanic and Atmospheric Administration, April 2005.*

[c] *Pan evaporation from Pan Evaporation: State of Hawaii, 1894-1983. Report R74. State of Hawaii Department of Land and Natural Resources, August 1985. Crop coefficients for macadamia nuts from Irrigation Water Requirement Estimation Decision Support Systems (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use Permitting in Hawaii. August 2013. State of Hawaii Commission on Water Resources Management, August 2013.*

[d] *Effluent application plus precipitation minus evapotranspiration.*

As shown in the table, effluent application and precipitation are expected to exceed the evapotranspiration of the macadamia nut crop during all months of the year. The maximum percolate volume shown in the table assumes all precipitation percolates into the soil.

An annual nutrient balance was also prepared for the site, based on the water balance shown in Table 4-3. The orchard of mature macadamia nut trees is expected to use up to 400 lbs. of nitrogen per acre per year (University of Hawaii Agricultural Experiment Station, January 1959). The effluent will supply approximately 289 lbs./acre/year of total nitrogen, assuming an effluent concentration of 10 mg/L. Although the nitrogen uptake of the orchard is expected to be greater than the total mass of nitrogen applied by the effluent, the predominant nitrogen species in the effluent is expected to be nitrate, which is soluble and readily transportable through the soil profile. The trees will only be able to use the nitrate contained within water that is transpired. The percolate volume shown in Table 4-3 is expected to contain approximately 8.5 mg/L of nitrogen as nitrate, because soil denitrification losses of 15 percent can be expected. Therefore, the land treatment system is expected to remove approximately 21 percent of the total nitrogen applied to the site with WWTP effluent.

4.1.5 Subsurface Drip Irrigation Disposal

Another effluent management concept is to retain the existing site topography along with the macadamia nut tree orchard and use subsurface drip irrigation technology to apply the effluent.

Subsurface drip irrigation would be used to apply effluent to the existing macadamia nut trees within the effluent disposal area. The use of subsurface drip irrigation technology to disperse effluent at the site will allow the County to retain the existing mature macadamia nut trees, and will significantly reduce the amount of clearing, grubbing, and grading required to construct the facility. In addition, retaining the existing mature orchard is expected to effectively block views of the facility from both the Hawaii Belt Road and Maile Street.

Drip irrigation technology has evolved to the point where non-clog emitters are available for subsurface applications of effluent. Non-clog subsurface emitters decrease the potential for the irrigation components to be clogged by roots. Figure 4-2 illustrates the subsurface drip concept. Drip tubing with integral emitters is buried 6 to 9 inches below ground. Effluent emitters are typically designed to operate at a flow rate of 1 gallon per hour (gph) and are typically spaced every 2 feet along a drip line. Pressure compensating drip systems typically operate under pressures ranging from 10 to 45 pounds per square inch (psi).

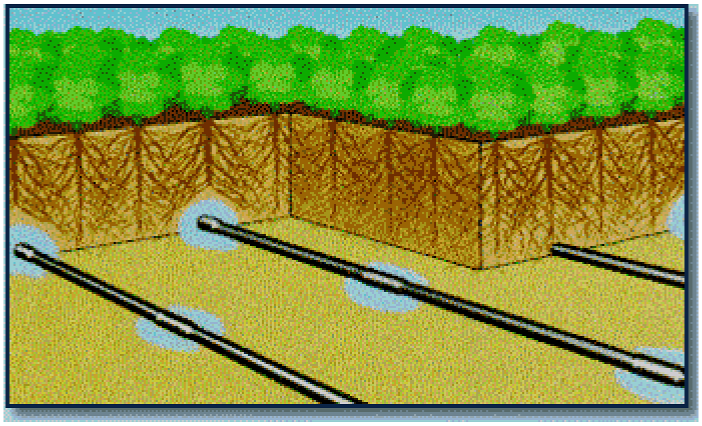


Figure 4-2. Subsurface Drip Irrigation Concept

(Courtesy of Geoflow, Inc.)

4.1.5.1 Operation and Maintenance (O&M) Needs

Subsurface drip irrigation technology incurs greater operation and maintenance than a surface irrigation system. The County will need to periodically flush the drip lines to remove debris. As described below, a significant number of drip lines will be necessary to accommodate peak flow rates. In addition, periodic chlorination will be required to remove biological growth from the drip lines. These O&M tasks will need to be completed on a regular schedule, because the drip system will be buried and not readily accessible or observable. During periods of dry soil conditions, the County will need to inspect the orchard for patches of wet soil that would indicate a localized failure that requires repair. Flow and pressure monitoring will also be useful tools for validating the status of the subsurface drip system. The land treatment area would be divided into multiple irrigation zones, allowing a zone to be taken out of service for maintenance purposes. A fence will be constructed around the site to deter entry by humans and ungulates.

4.1.5.1.1 Stormwater Runoff Considerations

The subsurface drip system would slowly disperse effluent 6 to 9 inches below the ground surface, therefore operating as a subsurface disposal system similar to a leach field. Effluent is not intended to surface with a properly operating subsurface drip system. Precipitation falling on the site will either percolate into the soil or run off as surface drainage. The water balance shown in Table 4-3 assumes all precipitation percolates into the site soil, which is a conservative assumption. The amount of runoff from the site will vary with the storm intensity; precipitation rates in excess of the infiltrative capacity of the site soils will result in runoff. The existing site is graded to drain to a culvert under the Hawaii Belt Road at Maile Street. The implementation of a subsurface disposal system will allow the existing grading to be retained, because stormwater runoff will not come into contact with, and therefore will not contain, effluent.

4.1.6 Leach Field

A leach field could potentially be constructed for subsurface disposal of treated effluent. Preliminary assessment of the concept based on the site soil characteristics indicate approximately 10,000 and 20,000 linear feet of drain field trench would be required to accommodate the anticipated flows for the phase 1 and phase 2 collection system, respectively. It would be difficult to evenly distribute effluent throughout a drain field of this size. In addition, DOH regulations require a redundant drain field for subsurface disposal systems, making this option expensive to implement. This option is considered impractical for the community.

4.1.7 Existing Cesspool Conversion

A previous study (SSFM, July 2007) suggested that the existing LCC located on the County-owned parcel TMK 9-6-002:024 could be converted to a seepage pit that would be regulated by DOH as an injection well. HAR 11-23-07 allows injection wells located mauka of the UIC line that were in existence prior to July 6, 1984 to continue to operate. However, the flow to the wells cannot increase, nor can a new well be constructed. Therefore, the earlier plan to convert the existing LCC to a seepage pit is not feasible for the following reasons:

- Closing LCC No. 2 that is located on private property would not be allowed, as it would increase the flow to LCC No. 1 (converted to a seepage pit that is regulated as an injection well) that is located on County property.
- The capacity, structure, and condition of the existing LCC No. 1 is not known. The LCC could either be a lava tube or a large conventional cesspool. A geotechnical investigation conducted on the site to depths of 30 to 35 feet did not reveal the presence of lava tubes (Masa Fujioka & Associates, January 9, 2007), therefore it is likely a large conventional cesspool. The County attempted to determine the structure and condition of the LCC via closed circuit TV inspection but could not ascertain either due to technological limitations. It is not known if the LCC could accommodate the flow from the existing service area if LCC No. 2 is closed.
- HAR 11-62-25 requires new and proposed effluent disposal systems to have a backup disposal system capable of handling the peak flow. A second seepage pit cannot be constructed to comply with the regulatory requirement because the site is located mauka of the UIC line. If the existing seepage pit were to fail, then a replacement cannot be constructed.
- The Kau Community Development Plan (CDP) requires the County to provide for eventual construction of sewers throughout the community. Providing sewers for the entire community will increase wastewater flows. Increasing flow to the existing LCC (converted to a seepage pit) would not be allowed. Therefore, the use of the existing LCC as a disposal system could prevent the County from providing the community’s desired future wastewater needs.
- The current AOC requires connection of 65 additional properties. This would increase the flow to the existing LCCs (converted to a seepage pit). Increasing flow to the existing LCC (converted to a seepage pit) would not be allowed.

For these reasons, converting the existing LCCs to a seepage pit is not considered to be a feasible option.

4.1.8 Recommendation

The results of the effluent management investigation have determined that a subsurface drip irrigation system is the recommended method of effluent disposal for the Pahala WTTP.

Recommended design criteria for the subsurface drip irrigation system are presented in Table 4-4. The disposal system will be sized to handle the peak day wet weather flow of 312,000 gpd. An irrigation equalization and control tank are proposed to equalize higher peak flows and to allow discrete dosing of the orchard in irrigation zones; constant application of water would be detrimental to the health of the trees.

HAR 11-62 requires a fully redundant subsurface disposal system. The design criteria shown in Table 4-4 are based on providing a subsurface drip system that is two times larger than needed in order to satisfy the HAR 11-62 requirement for redundancy. The drip system will be divided into two separate systems so that the peak day wet weather flow can be disposed on the site using one system while the second system is out of service for maintenance.

Table 4-4. Recommended Subsurface Drip Design Criteria

Description	Value
Average dry weather flow	95,000 gpd (66 gpm)
Peak day wet weather flow	312,000 gpd (217 gpm)
Irrigation equalization and control tank volume	20,000 gallons
Land treatment area	10 acres
Subsurface drip emitters	1 gallon per hour, pressure compensating
Number of emitters needed for peak day wet weather flow	13,000 emitters
Number of systems	2 (1 active, one redundant)
Number of emitters provided to provide 2x redundancy	26,000 total emitters
Emitter spacing	2 feet
Drip line length per system	26,000 feet
Total drip line length	52,000 feet
Drip line depth	6 to 9 inches
Number of irrigation zones	6 (3 per system)
Length of drip line per zone	8,667 feet
Flow per irrigation zone	72 gpm
Irrigation system monitoring	Flow meter(s) and pressure indicators

Figure 4-3 provides a conceptual view of the recommended Pahala subsurface drip system. The subsurface drip lines are to be located between the existing row of trees and spaced to disperse effluent evenly throughout the orchard. During high flow conditions the irrigation control system will open multiple irrigation zones to accommodate the disposal needs.

Additional drip lines will need to be added when the WWTP capacity is expanded. The minimum spacing between drip lines is 2 feet, so there will be sufficient space between the initial drip lines to add additional drip lines as part of future expansion project(s).

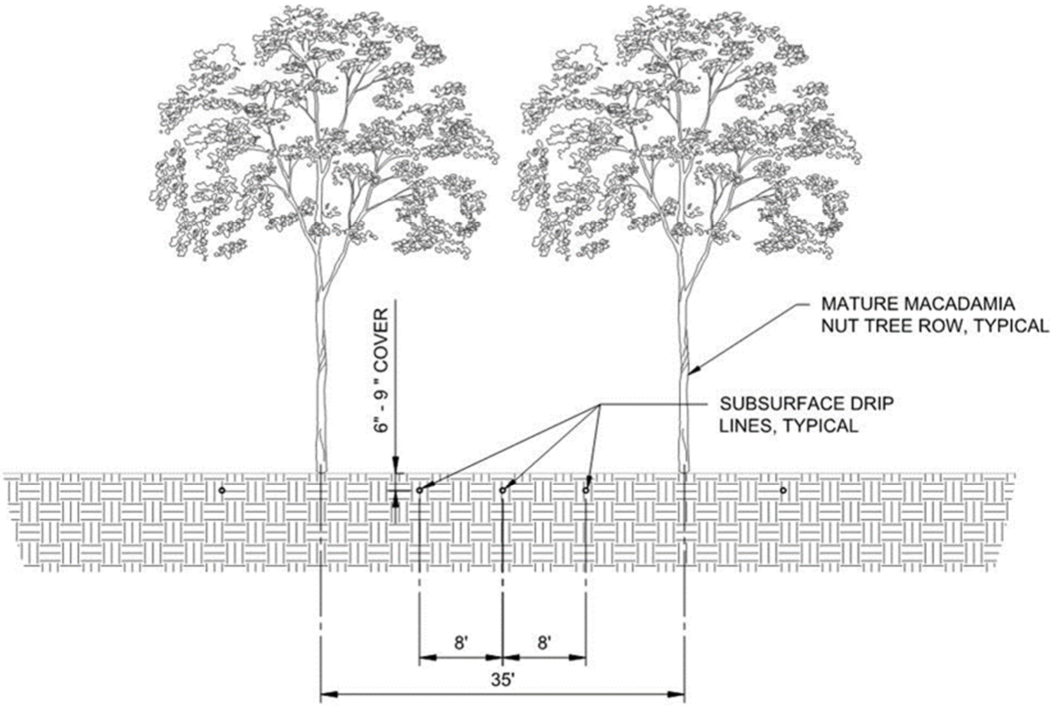


Figure 4-3. Conceptual Subsurface Drip Irrigation System at Pahala

4.2 Treatment Requirements

The DOH regulates subsurface drip irrigation disposal as “land disposal” per Hawaii Administrative Rules (HAR) 11-62. Table 4-5 lists the applicable effluent requirements for land disposal applicable to the project that were in effect at the time this report was prepared.

Table 4-5. Applicable HAR 11-62 Land Disposal Requirements

Description	Value	HAR Reference
BOD_5	30 mg/L monthly average 60 mg/L peak	11-62-26
TSS	30 mg/L monthly average 60 mg/L peak	11-62-26
Disinfection	Except for subsurface disposal systems, continuous disinfection of the treated effluent shall be provided	11-62-24
Setbacks	Treatment units shall be not less than 25 feet from property lines nor less than 10 feet from any building	11-62-23.1
Public accessibility control	6-foot-high fence surrounding treatment units	11-62-08

Section 5

Wastewater Treatment Evaluations

This section presents the evaluations conducted in development of the proposed WWTP.

5.1 Preliminary Treatment

The preliminary treatment system will include influent flow measurement, influent sampling equipment, screening, and grit removal.

5.1.1 Influent Flow Measurement

Influent flow measurement is recommended to allow assessment of flows and loads to the biological treatment process, and to assess the biological treatment process performance. A Parshall flume will be provided upstream of the screening system to continuously record influent flow rates. Parshall flumes work well for influent measurement because the flume can operate in an open-channel configuration, can accommodate wide ranges of flows, and is self-cleaning. A straight approach length of at least 20 times the flume throat width will be provided upstream of the flume to provide favorable hydraulic conditions.

5.1.2 Influent Flow Sampling

An automatic refrigerated composite sampler is recommended to allow influent composite samples to be collected. Influent composite samples, when combined with influent flow measurement, can be used to calculate influent mass loading rates to the WWTP to assess the treatment performance and optimization of aeration rates in the biological treatment process. Periodic influent sampling is also recommended to monitor for changes in the influent characteristics.

5.1.3 Screening

Screening is recommended to protect the downstream system operations from large objects, debris, wipes, and rags that can be present in wastewater. The industry trend is towards finer screening systems that remove greater amounts of debris from the waste stream; screens with 6-millimeter (mm) (¼-inch) openings are frequently used for activated sludge treatment systems. Finer screens are used upstream of membrane bioreactors to remove hair that can foul the membranes. The screenings volume at the Pahala WWTP is expected to be small, subsequently screenings disposal is expected to be infrequent; weekly at most. Therefore, the screenings must be washed of organic debris to prevent the accumulation of nuisance odors and flies in the screenings barrel or bag between screening disposal events.

5.1.3.1 In-channel cylindrical screen

We recommend an in-channel cylindrical screen for this installation. The in-channel cylindrical screen combines screening, screenings washing, dewatering, compacting, and bagging/disposal within a single unit. The screening portion consists of an inclined screen basket inserted into the wastewater channel. The screening basket can consist of bars, perforated plates or sieves, depending on the application and clear opening required. The controls can be set to allow a mat to build up on the screening surface, allowing finer screening of the wastewater. Controlled by head loss, a rake arm starts rotating within the screen basket, pushing the screenings off the rake and into a perforated screenings hopper located at the screen's central axis. A shafted auger along the screen axis conveys the screenings from the hopper through an inclined tube, which dewaters and compacts the screenings. The tube includes a perforated dewatering section. The discharged screenings are about 40-percent dry and can be discharged into a bin or directly into a bagging system. Figure 5-1 illustrates the process. Manufacturers include Lakeside and Huber. The key benefit to this system is the integrated screenings washing system, minimizing additional screenings handling and odor potential.

For this installation, the headworks will include one in-channel cylindrical screen, plus a bypass channel with manually cleaned bar rack.

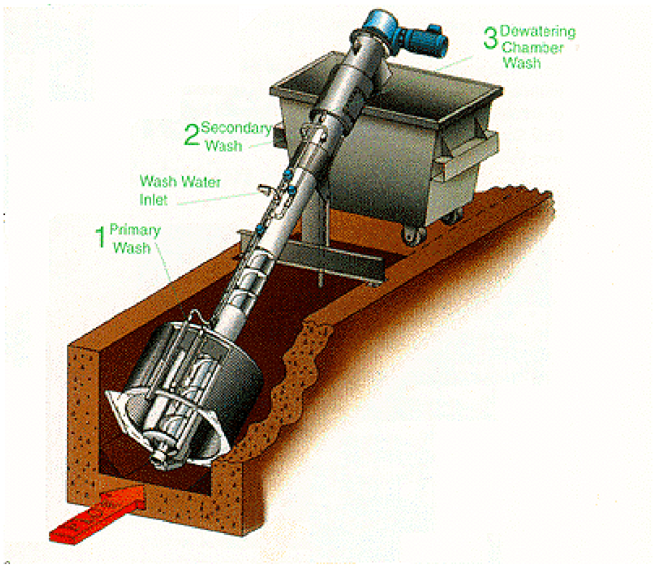


Figure 5-1. In-Channel Cylindrical Screen

5.1.4 Grit Removal

Grit is comprised of particles that are heavier than the organic biodegradable matter in wastewater. Grit particles can consist of sand, gravel, pebbles, silt, cinders, ground bone, eggshells, coffee grounds, and other materials. Grit in the wastewater collection and treatment system causes abrasive wear to mechanical equipment, piping, and appurtenances. Grit can also form deposits in pipelines, channels, and tanks, which reduces hydraulic capacity and can damage equipment. Removal of grit is very important to help prevent wear to downstream equipment, costly service interruptions and repair.

Grit removal systems usually are placed between screening and primary treatment. At this point, the largest materials have been removed by the screens and will not interfere with grit handling equipment.

There are several types of grit removal methods, including induced vortex grit removal, aerated grit chambers, and lamella plate settlers. The type of grit removal chosen is mainly dependent on the size of the incoming grit particles and the desired capture rate. Removed grit must be washed, dewatered, and disposed.

5.1.4.1 Induced Vortex Grit Removal

Historically, vortex grit removal or the circular grit chamber has been the most widely used method for grit removal in the U.S. Vortex grit removal relies on the principle that grit has a greater specific gravity than organic matter.

There are two configurations of vortex grit removal systems: a sloped bottom unit and a flat bottom unit. The sloped bottom unit relies on particle settling to remove grit. Flow enters the grit chamber tangentially to provide the longest flow path around the inside of the circular grit chamber. This longer flow path is designed to achieve a sufficient retention time to allow grit to settle. The sloped bottom funnels the settled grit into a hopper below the basin. A sloped bottom vortex grit unit cross section is shown in Figure 5-2.

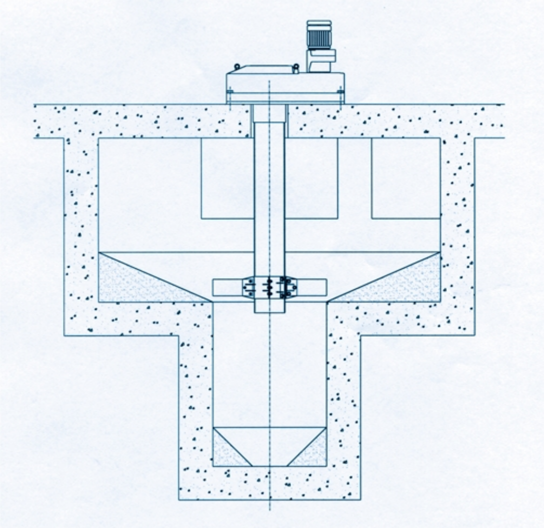


Figure 5-2. Sloped Bottom Vortex Grit Removal Cross Section

The flat bottom vortex system relies on hydraulic removal instead of specific gravity alone to remove grit from the wastewater stream. Flat bottom vortex systems use two paddles within the interior of the grit chamber that induce a toroidal flow pattern to move grit along the bottom towards the center. Once collected at the center of the grit chamber, a propeller forces excess grit down into the hopper. A flat bottom PISTA® Grit unit is shown in Figure 5-3.

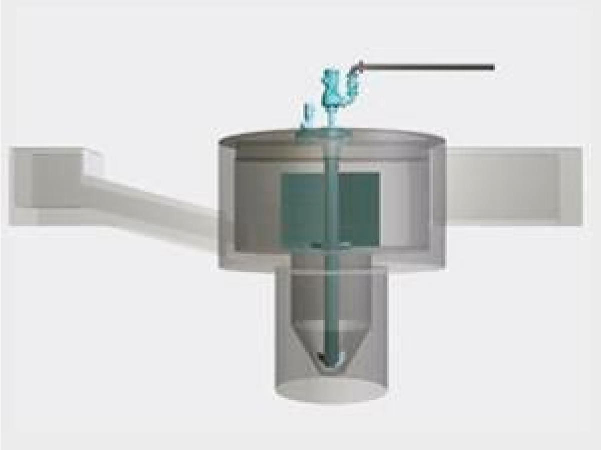


Figure 5-3. Flat Bottom PISTA® Grit Removal

5.1.4.2 Vortex Grit Removal Capture Rate

In Brown and Caldwell's experience it is necessary to de-rate vortex type grit removal units by a factor of 50 percent of the advertised capacity to achieve satisfactory performance, due to the short detention time in the chamber. At large flow rates, the small-chambered vortex type units tend to re-suspend smaller grit particles which become a problem for downstream processes.

Table 5-1 lists some advantages and disadvantages of the vortex type grit removal.

Table 5-1. Induced Vortex – Advantages and Disadvantages

Advantages	Disadvantages
Low maintenance	Re-suspends/low capture rate of fines
Low headloss	Poor capture efficiency
Small footprint	

5.1.4.3 Aerated Grit Removal

Aerated grit chambers are tanks that function specifically to remove inorganic solids from the wastewater stream. Aerated grit tanks are designed to induce sufficient vertical velocity in order to separate organic and inorganic solids. In theory, inorganic solids have a higher specific gravity than organic solids, and therefore require higher vertical velocities to keep them in suspension.

Air diffusers placed near one longitudinal tank wall induce a roll in the contents of the grit tank. This roll creates maximum velocities near the walls and lower velocities at the surface and bottom of the tank. The lower transverse horizontal velocities allow inorganic particles to settle out and be transported to the grit hopper by shear-induced currents.

Aerated grit chamber design is based on providing sufficient hydraulic detention time during peak wet weather flow (PWWF) conditions. In Brown and Caldwell's experience it is necessary to provide at least 10 minutes of detention time to achieve satisfactory grit removal.

Aerated grit tanks can provide excellent grit removal with minimal headloss, but the chambers themselves require a larger footprint than induced vortex systems. Proper operation of aerated grit tanks can be difficult under varying hydraulic loads due to the need to make fine adjustments to the air diffusers.

Figure 5-4 illustrates the particle settling action of an aerated grit chamber.

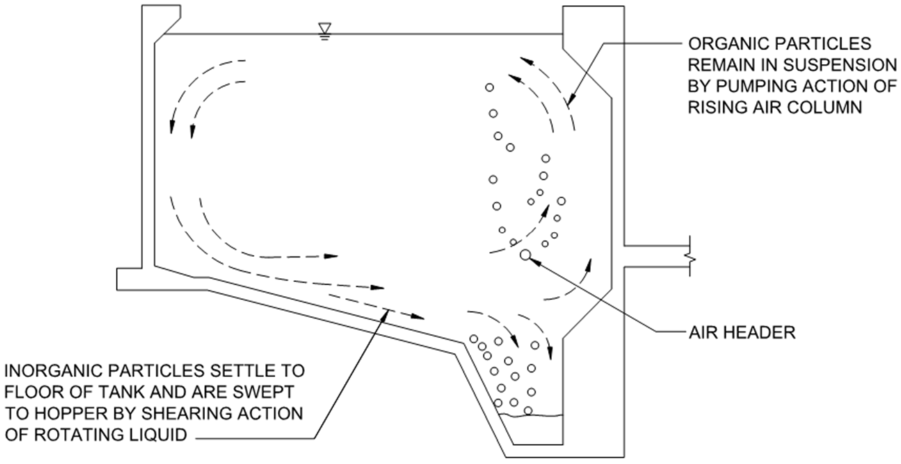


Figure 5-4. Aerated Grit Removal Schematic

Table 5-2 lists some advantages and disadvantages of aerated grit chambers.

Table 5-2. Aerated Grit Removal – Advantages and Disadvantages

Advantages	Disadvantages
Low headloss	Large footprint
Once airflow is dialed in, the maintenance is low	Requires fine tuning diffuser airflow for optimal performance
Effective removal of fines	High capital cost
Provides additional aeration; "freshens" sewage prior to primary clarification. Reduces denitrification in primary clarifiers.	High O&M cost due to blowers

A variation of aerated grit removal technology that can be used in small WWTPs like Pahala is an aerated grit trap. A small, aerated tank is provided to allow grit to settle. Aeration is provided to maintain organic solids in suspension and to "freshen" the influent. Accumulated grit is periodically removed using a Vactor truck.

5.1.4.4 Lamella Grit Removal

This proprietary technology from Eutek, called the HeadCell, consists of sloped trays stacked in deep tanks. Flow enters the tanks tangentially and establishes a vortex flow pattern. Solids settle onto each plate and fall toward an opening at the center of each plate. The grit collects at the cone shaped bottom of the tank where it is pumped to be washed and dewatered. Effluent flows out of the trays, over a weir, and into an effluent trough.

Grit capture is all done hydraulically and there are no moving parts. The headloss through each HeadCell is around one foot. HeadCells can be sized to provide up to 50 mgd of capacity within a single unit.

With the stacked tray design, the HeadCells can achieve a 95 percent capture rate of grit 75 microns and larger. The multiple trays provide a large surface area for settling multiple size particles. The treatment capacity of the HeadCell is greater than other technologies with the same footprint.

Figure 5-5 is an illustration of a section cut through the HeadCell process.

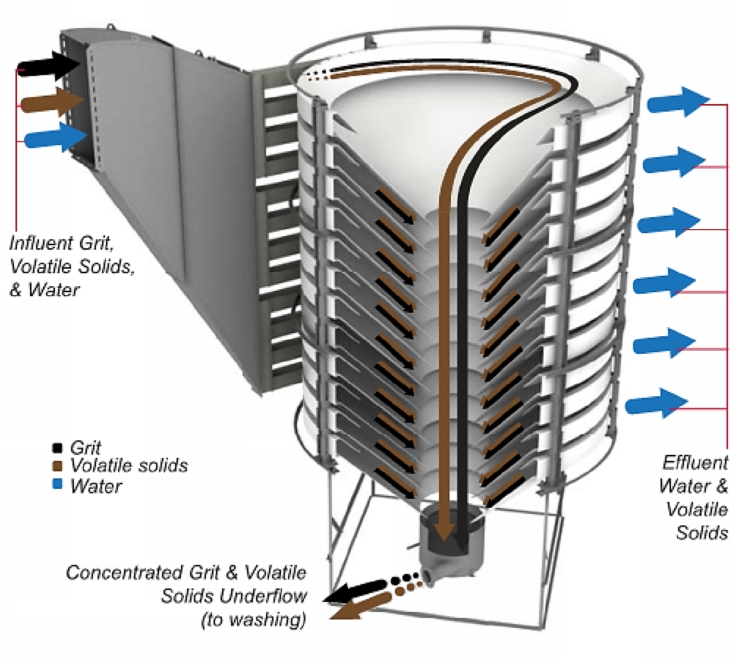


Figure 5-5. Headcell Process Schematic

Table 5-3 lists advantages and disadvantages of the Headcell.

Table 5-3. Lamella Plate Settling/HeadCell – Advantages and Disadvantages

Advantages	Disadvantages
Effective removal of fines	High capital cost
Small footprint	Short history of installations
No moving parts	
Low operating cost	

5.1.4.5 Grit Particle Size Considerations

Most grit technologies and literature assume that grit is a clean sand or silica particle with a specific gravity of 2.65. In reality, grit particles are often coated with fats, grease, and organic material that reduce the particle's specific gravity. Grit particles with lower specific gravity have lower settling velocities, behaving like lighter and smaller grit particles.

The sand equivalent size (SES) is the size of a clean sand sphere that exhibits the same settling velocity as the coated grit particles. For example, a grease coated grit particle with a physical size of 200 microns may settle and behave like a clean particle with an SES of 150 microns.

5.1.4.6 Efficiency comparison

Each of the alternatives claims a minimum particle size and capture rate. These claims are based on the ideal, clean grit particle. As previously discussed, in reality grit particles are coated with fats and grease and do not exhibit the behavior of ideal grit particles. The capture rates have to be derated to reflect the SES of the particles. Table 5-4 compares the claimed minimum particle size captured of the alternatives discussed.

Table 5-4. Grit Capture Size Comparison

Alternative	Targeted Particle Size
Induced Vortex	105 µm
Aerated Grit Removal	105 µm
HeadCell	75 µm

The Headcell is able to remove the finest particles, with up to 95 percent removal of particles with a physical size down to 75 microns.

5.1.4.7 Grit Removal Recommendation

A simple aerated grit trap located downstream of the screening process is recommended for the Pahala WWTP. Accumulated grit would be periodically removed using a Vactor truck, and dried onsite in a small drying bed. The dewatered grit would be disposed at the landfill.

An aerated grit trap provides adequate performance with a relatively uncomplicated process. Although a Headcell grit removal system could potentially provide a slightly increased grit capture rate, that benefit is not likely to surpass its significantly higher costs and operational complexity. The capture rate of an aerated grit trap is sufficient to protect the downstream processes recommended in this report. High levels of grit removal are particularly important for anaerobic digestors, which are not anticipated for this facility.

5.1.5 Odor Control

A notorious location for foul odor is the headworks of a wastewater treatment plant. This odor is caused by hydrogen sulfide (H_2S), which is formed under anaerobic conditions of the wastewater collection system. Due to H_2S low solubility in wastewater, when there is an excessive concentration of H_2S in the wastewater or if there is turbulence, H_2S gas escapes into the atmosphere. This release produces the distinct rotten egg smell. In addition to H_2S, there are other foul odorous compounds that can be released from wastewater, such as ammonia, amines, diamines, mercaptans, skatole, and organic sulfides.

Treatment of foul odors can be approached in two ways: preventing odors through liquid treatment or controlling odors in the gas phase. While liquid treatment provides control of odors prior to their release, gas phase treatment involves the collection and treatment of gases once they have been released from wastewater. Treatment methods can be aimed at one type of odor or can treat a range of odors.

5.1.5.1 Granular Activated Carbon

A granular activated carbon (GAC) scrubber is recommended for the Pahala WWTP headworks. A GAC scrubber passes odorous air through a bed of activated carbon, which adsorbs the odorous constituents within the pore spaces of the carbon.

Chemical oxidation or reduction of some compounds can also occur. As pore spaces become occupied, efficiency degrades, and the carbon must be replaced or regenerated. Carbon is most effective on higher molecular weight molecules such as the organic sulfur compounds, which makes it the technology of choice. Package GAC scrubbers are available for small headworks and vessels can be situated vertically, horizontally, or radially to optimize footprints and reduce structure elevation profiles. Figure 5-6 illustrates the process. The County currently operates GAC scrubbers at other facilities and purchases the GAC media in bulk to reduce costs.

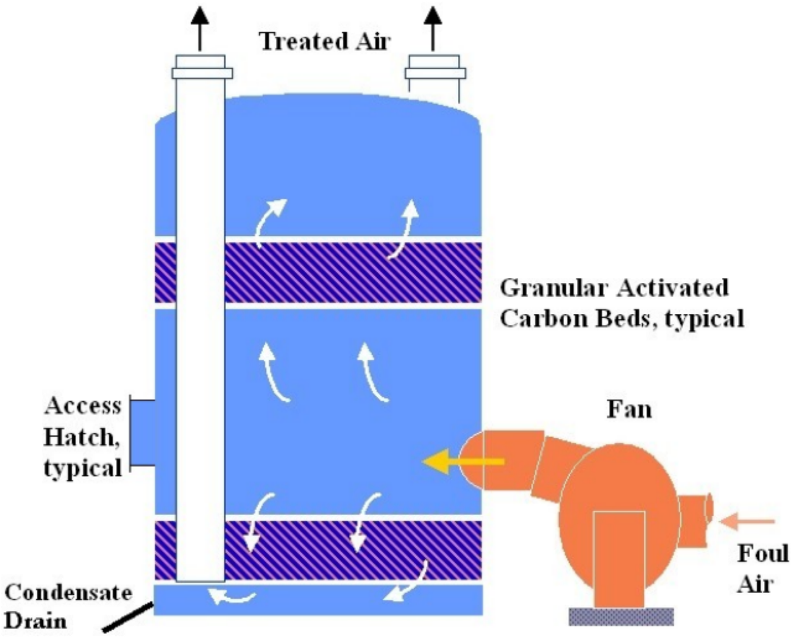


Figure 5-6. Activated Carbon Scrubber (GAC)

5.1.6 Recommendation

The following are recommended for the Pahala WWTP headworks:

- Parshall flume influent flow measurement.
- Refrigerated automatic composite sampler.
- In-channel cylindrical screen with integrated washer.
- Aerated grit trap.
- Covered channels with foul air collection and GAC scrubber

5.2 Secondary Treatment

Secondary treatment process provides BOD_5, TSS, and nutrient removal via biological treatment. This section provides descriptions of various secondary treatment options including advantages, disadvantages and applicability to the Pahala WWTP. The treatment options are then screened to identify technologies for further evaluation.

5.2.1 Membrane Bioreactor (MBR)

A membrane bioreactor (MBR) has the smallest footprint of the various biological treatment systems available and provides the highest quality effluent. An MBR basically combines an aeration basin with membrane filtration, eliminating the need for tertiary treatment if a very high-quality effluent is desired for water reuse purposes.

Membranes provide an absolute barrier to large particles; total suspended solids (TSS) concentrations of the effluent (also known as “filtrate”) are typically less than 1 mg/L. Effluent from an MBR process can meet stringent water recycling turbidity requirements without an additional filtration process.

The main difference between MBRs and other biological treatment technologies is the method of separating the bacteria from the clean water. MBRs have thin membranes with many thousands of micro-perforations. Depending on the manufacturer, these perforations are 0.04 to 0.2 microns (4 to 20 hundred-thousandths of a millimeter) in diameter, too small for the passage of most microorganisms or other particles present in the wastewater, but large enough to allow the passage of water molecules.

Figure 5-7 is an illustration of an MBR. Figure 5-8 shows submerged MBR membranes in clean water.

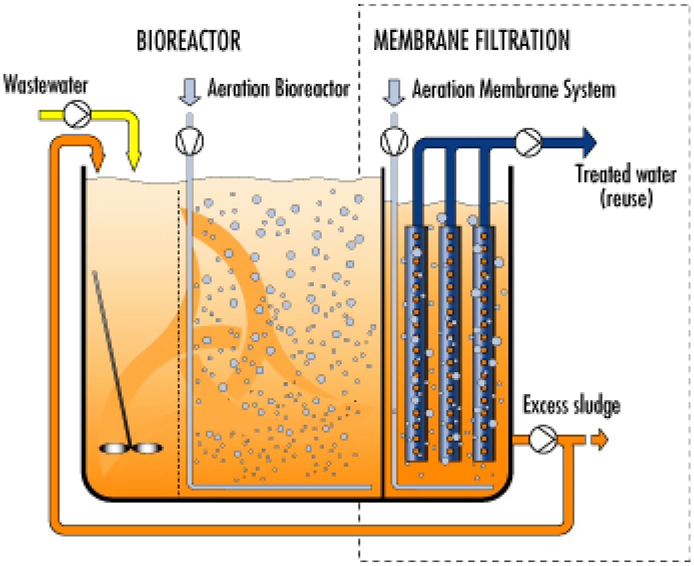


Figure 5-7. Membrane Bioreactor Illustration

Figure 5-8. Membrane Cassettes at Johns Creek Environmental Campus, Fulton County, GA

Important considerations of an MBR system include:

- Small capacity MBRs can be purchased as a packaged treatment system.
- MBRs can be designed and programmed to achieve nutrient reduction.
- The membranes cost is significant and membranes must be replaced every 10 to 15 years.
- Membrane fouling can occur with wastewater with high fats, oils, and grease (FOG) levels
- MBRs require the use of membrane cleaning chemicals, typically sodium hypochlorite and citric acid.
- The process requires a computer control system and is difficult to operate efficiently if the computer malfunctions.
- The process incurs high electrical power costs, relatively high costs for cleaning chemicals, and high overall O&M costs. Highly skilled labor is required for some of the O&M tasks.

The MBR process would produce an effluent that is of high quality and has a small footprint, but has high overall capital, O&M, and lifecycle costs. MBR is retained for further evaluation.

5.2.2 Sequencing Batch Reactor (SBR)

Sequencing batch reactors (SBRs) are fill-and-draw systems that combine the processes of activated sludge in a single reactor. The reactor is filled with wastewater, where aeration, settling, and decanting occurs. By combining these processes, the need for secondary settling is not required. Denitrification can be achieved by incorporating an anoxic fill step in the cycle or a separate anoxic zone. A minimum of two SBR reactors are typically used for the process.

SBRs are capable of producing high quality effluent and are potentially space saving in that separate secondary sedimentation is not needed. However, SBRs are operated by a proprietary computer control system, cannot be operated in manual mode, and may require influent and/or effluent equalization (and thus increasing the footprint requirements). Considering these challenges, SBRs will not be considered further.

5.2.3 Nereda (Granular Activated Sludge) Process

The Nereda technology is a granular activated sludge process that utilizes proprietary granules in an SBR. Features of the process include simultaneous fill and draw, fast settling, and approximately 1/5 the footprint of traditional activated sludge systems. The process was developed in Europe and most current full-scale applications are located in Europe. In the U.S., the process is marketed by Aqua Aerobic Systems, Inc, according to the supplier website, there are currently only two full-scale operating systems treating municipal wastewater in the United States. One is a demonstration facility, and the other is a 3.6 mgd facility in Alabama that began operation in early 2020. Figure 5-9 is a conceptual illustration of the Nereda process.

Due to the challenges listed for an SBR and the lack of long-term operational experience in the United States, the Nereda process is considered not appropriate for the Pahala WWTP application.

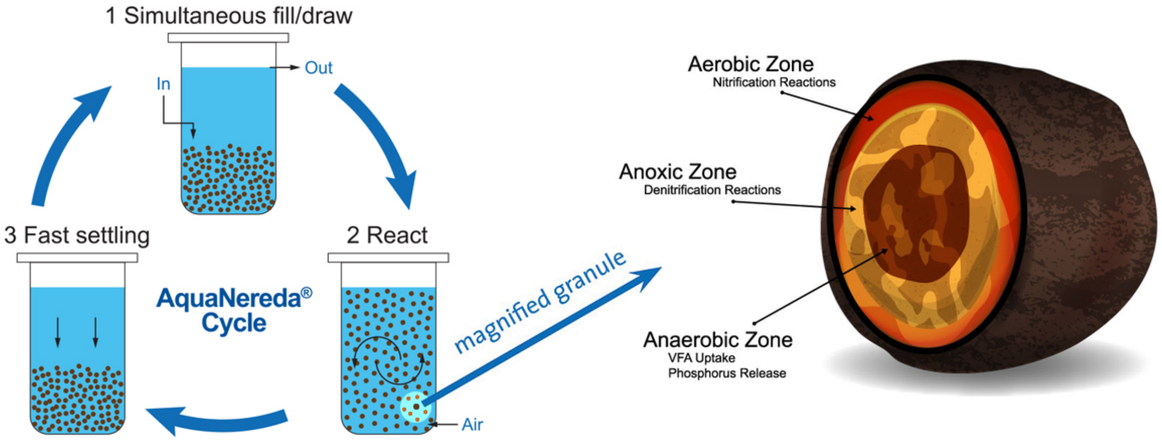


Figure 5-9. Nereda Process

Courtesy: Aqua Aerobic Systems

5.2.4 Oxidation Ditch

An oxidation ditch is a variation of the complete-mix extended aeration activated-sludge process. The process generally has a long solids residence time (SRT) and high mixed liquor suspended solids (MLSS) concentration, making it resilient to upset by peak organic loads. The typical SRT for oxidation ditches ranges from 15 to 30 days, and the MLSS is generally between 2,000 and 5,000 mg/L. Oxidation ditches are often oval in shape and have been called “racetrack” reactors. The depth of the ditch typically ranges from 4 to 12 feet. Mechanical aerators in the ditch provide aeration and mixing. Strategic placement of the aerators creates aerobic and anoxic zones within the oxidation ditch, for effective nitrification and denitrification. Biological phosphorus removal is also possible.

Oxidation ditches are usually preceded by preliminary treatment, such as screening and grit removal. Primary settling is typically not included upstream of oxidation ditch systems. Return activated sludge (RAS) is pumped from the secondary clarifier back into the ditch.

Figure 5-10 presents a schematic of an oxidation ditch. Typically, rotating brush or disc mechanical aerators are used to move mixed liquor around the tank and to provide aeration. The aerators help mix scum into the water column for treatment. The rigorous mixing action of the mechanical aerators can generate off-spray. Oxidation ditches are not available as packaged treatment systems. Because of the large footprint requirements and non-availability of packaged treatment units, the oxidation ditch process is eliminated from further evaluation.

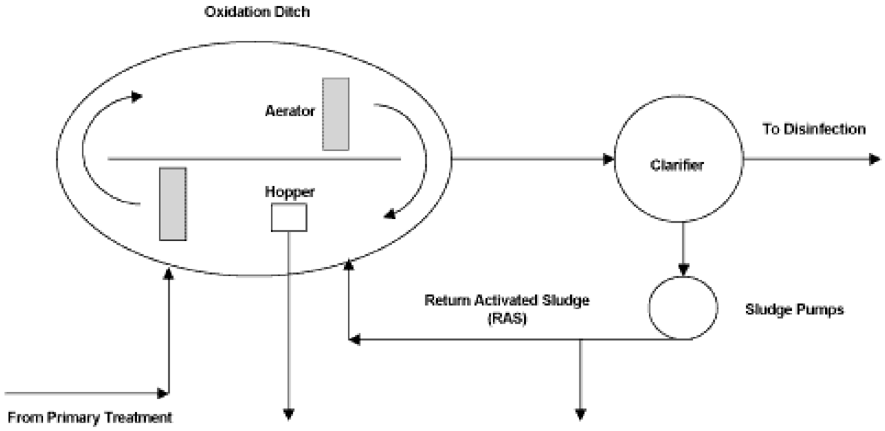


Figure 5-10. Typical Oxidation Ditch Schematic

5.2.5 Extended Aeration Activated Sludge Package Plant

Extended aeration is a less-complex system which can operate without primary treatment or anaerobic digestion. The treatment provides a completely mixed process operated at long hydraulic detention times and high sludge age. The process uses larger aeration tanks with extended solids retention times (SRTs) of over 20 days. Careful consideration needs to be given to the capacities of motors, pumps, and compressors in order to ensure the process can handle variations in flow. The basic extended aeration process schematic is shown in Figure 5-11.

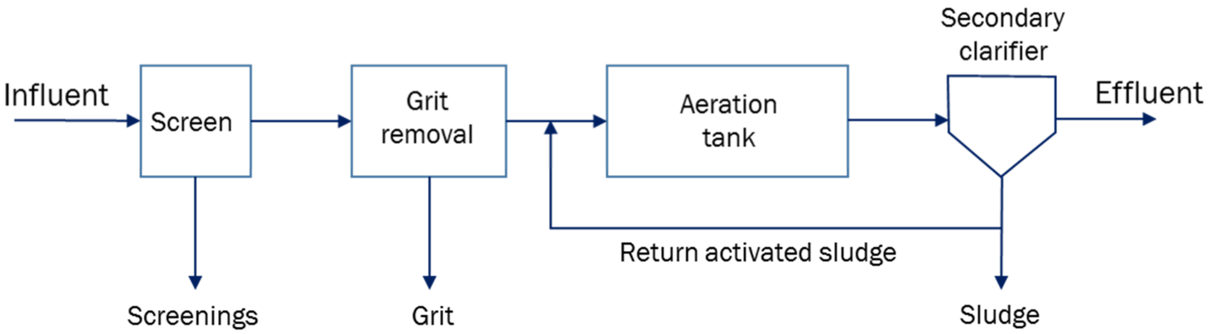


Figure 5-11. Extended Aeration Process Schematic

The process is generally limited to smaller WWRFs and is often used in prefabricated packaged plants. The range of typical SRTs on the mainland is 20 to 40 days, and the process generally operates with MLSSs between 2,000 and 5,000 mg/L. The long SRT and relatively high MLSS makes the process resistant to shock loading and stable but requires somewhat larger tanks and therefore incurs higher aeration costs for a given flow, compared to other forms of activated sludge. Sludge settling can be problematic in the tropics due to denitrification occurring in mixed liquor caused by the relatively high water temperatures. The process is similar to the oxidation ditch technology previously described but would use diffused aeration rather than mechanical aeration. The process is forgiving and resistant to shock loadings. Due to sludge settling challenges in the tropics this process will not be considered further.

5.2.6 Activated Sludge with Anoxic Selector

This process is similar to extended aeration but would employ a shorter SRT of less than 10 days and would operate at a MLSS concentration between 1,500 and 4,000 mg/L. Figure 5-12 shows a process schematic for this process. The Kihei WWRF and Wailuku-Kahului WWRFs on Maui operate with this process. The anoxic selector is typically sized to have a volume of approximately 10 to 30 percent of the total aeration basin volume. The process would not be as forgiving and resistant to shock loadings compared to the oxidation ditch and extended aeration processes due to the shorter SRT and lower MLSS concentration. But this option is available in a prefabricated package plants and would incur a smaller footprint than the oxidation ditch and extended aeration processes but would require operation and maintenance of blowers to provide air to the process. The fine bubble diffused aeration system would be more efficient than the mechanical aerators generally used in the oxidation ditch process. This process is retained for further evaluation.

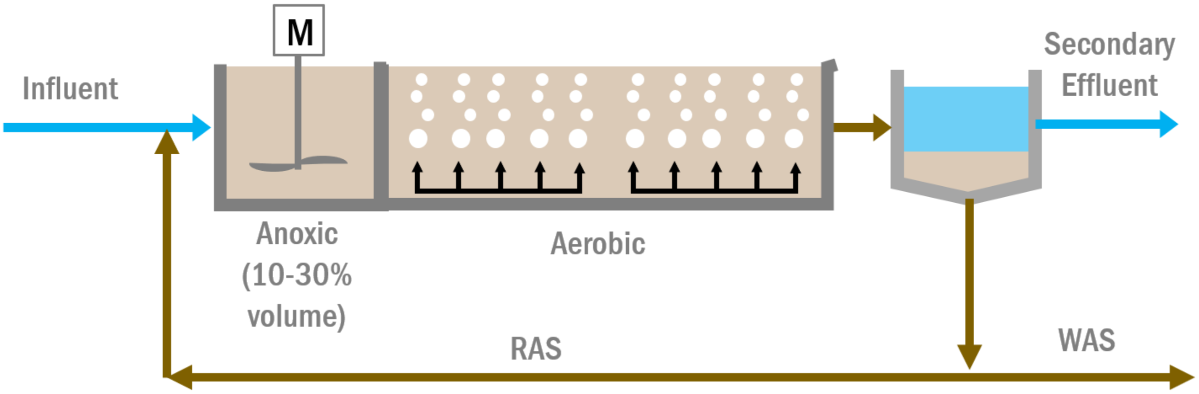


Figure 5-12. Activated Sludge with Anoxic Selector Process Schematic

5.2.7 Recirculating Gravel Filter

Recirculating gravel filter technology is an effective technology to treat septic tank effluent wastewater. After collection and conveyance, the wastewater is treated, in this case using a recirculating pea gravel filter (RGF). RGFs are a relatively simple, but effective means to treat wastewater from small communities. RGFs have been used to treat flow rates up to 1.0 mgd. RGFs typically produce a nitrified effluent that contains less than 10 mg/L of BOD5 and TSS (Crites and Tchobanoglous, 1998).

A schematic diagram of a RGF is shown in Figure 5-13. A septic tank is used to capture settleable and floatable solids. The septic tank effluent enters a recirculation tank. A dosing pump is used to apply wastewater in small doses to the top of the filter. The wastewater is treated as it percolates through the pea gravel media. A network of drainage piping collects the water at the bottom of the filter and returns it to the recirculation tank. A floating ball recirculation valve controls the return flow back to the recirculation tank or to the effluent disposal or reuse system. The dosing pump timer settings and recirculation tank volume are designed so that wastewater will typically flow through the filter for treatment an average of three to five times before being discharged. An example of a RGF system in use within a decentralized wastewater system can be found at the Stonehurst subdivision, located near Martinez, California (Crites, et. al. 1997). Effluent from the RGF is typically chlorinated for disinfection prior to discharge.

For a community system with conventional sewers and Imhoff tank can be used in lieu of a septic tank. Imhoff tanks are designed to remove floatable and settleable solids, and also provides for some digestion of the removed materials.

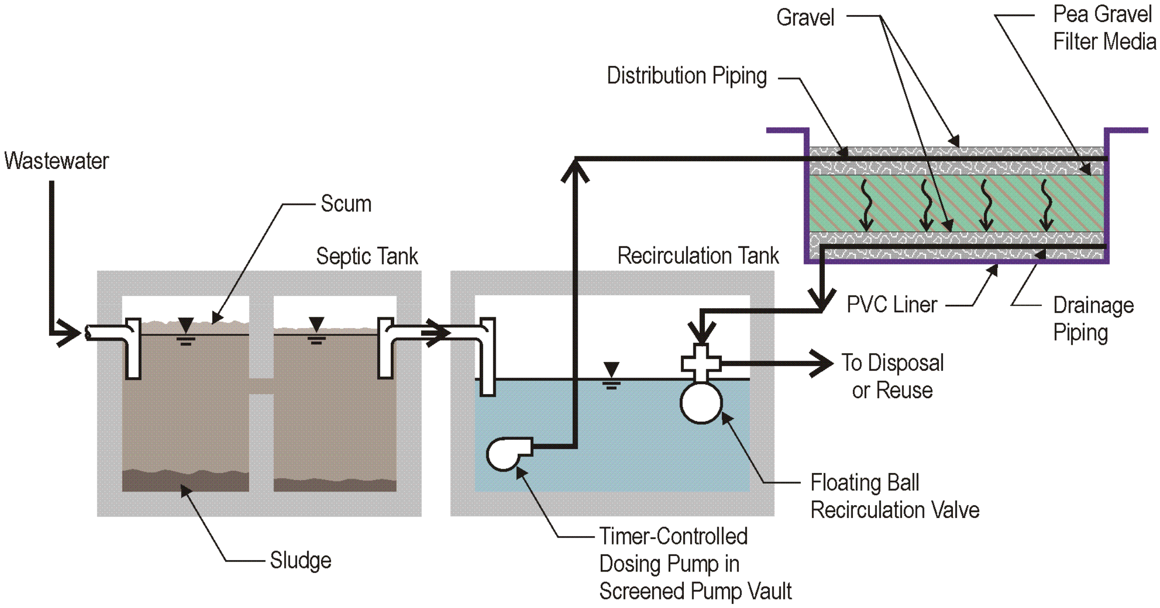


Figure 5-13. Recirculating Gravel Filter for Treatment of Septic Tank Effluent

5.2.8 Secondary Treatment Technology Screening

Table 5-5 provides a screening evaluation of the secondary treatment technologies described above. MBR, activated sludge with anoxic selector, and recirculating gravel filter are carried forward as project alternatives in Section 7.

Table 5-5. Screening of Secondary Treatment Options

Criterion	MBR	SBR	Nereda	Oxidation Ditch	Extended Aeration	Activated Sludge with Anoxic Selector	Recirculating Gravel Filter
$BOD_5 \leq 30$ mg/L	X	X	X	X	X	X	X
TSS ≤ 30 mg/L	X	X	X	X	X	X	X
Nitrification	X	X	X	X	X	X	X
TN < 10 mg/L	X	X	X	X		X	
Anoxic selector	X			X		X	
Appropriate for remote island location	X			X	X	X	X
Appropriate for tropical climate	X	X	X	X		X	X
Aeration tank size	Small	Moderate	Low	Large	Large	Moderate	Not applicable
Secondary clarifier size	None	None	None	Largest	Largest	Large	Not applicable
Energy requirement	Highest	Moderate	Moderate	Moderate	Higher	Moderate	Low
Operational complexity	High	High	Moderate	Moderate	Moderate	Moderate	Low
Available as packaged treatment system	X	X	X		X	X	
Fatal flaw		Proprietary control systems	Limited full scale installations in U.S.	Large footprint	Large footprint		
Carry forward in evaluations	X					X	X

5.3 Maintenance Chlorination

The proposed effluent management system (subsurface drip irrigation disposal) does not require a disinfection process to protect human health and the environment because the treated effluent is dispersed below the ground surface. However, periodic maintenance chlorination of the subsurface drip system will be required to reduce biofilm fouling within the drip lines.

Calcium hypochlorite is the solid form of hypochlorite used for disinfection. It can be found as a powder, granules, pellets, or as tablets in concentrations up to 70 percent. Calcium hypochlorite will degrade in strength at a rate of 3 to 5 percent per year. Once applied to the wastewater, the chemistry is similar to that for sodium hypochlorite. Calcium hypochlorite decomposes in an exothermic reaction if exposed to moisture.

The solid can be directly applied to wastewater at very small WWTPs. Figure 5-14 shows a typical calcium hypochlorite feed system.

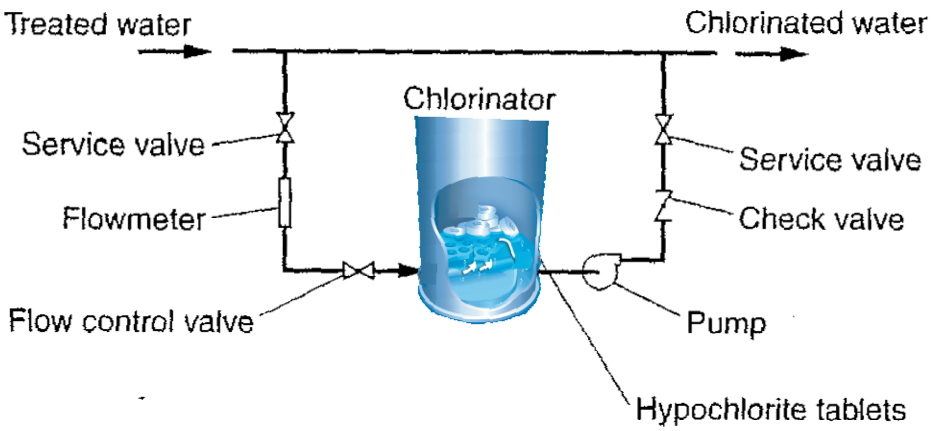


Figure 5-14. Typical Calcium Hypochlorite Feed System

The advantages of using calcium hypochlorite for disinfection at small, remote WWTPs is that it is available in concentrated form as powder, pellets, or tablets. This makes the transportation and storage of disinfectant optimal for small WWTPs.

Section 6

Solids Management

This section evaluates solids management options for the Pahala WWTP.

6.1 Aerobic Digestion with Decant Thickening

Aerobic digestion consists of aerating sludge in a tank for an extended period of time. Volatile solids are oxidized in the process, stabilizing the sludge and reducing the total mass of solids that must be managed by recycling or disposal. Pathogen densities are also reduced. The process does not produce biogas. The aerobic digestion process requires substantial energy input in the form of aeration blowers, and therefore is not typically used at larger (i.e., greater than 10 mgd) WWRFs.

Many small (less than 5 mgd) wastewater treatment plants in the United States use aerobic digestion to stabilize solids, due to its relatively low capital costs, simplicity, and compatibility with the certain liquid treatment processes.

Aerobic digestion with decant thickening is a two-stage process that can be achieved in the same basin. The first stage includes a period of aerobic digestion as described above. In the second stage the blowers are turned off for a period of time to allow sludge to settle and thicken. Supernatant is then decanted off the top. The blowers are turned back on to continue the aerobic digestion process. This process is repeated a few times until the sludge reaches approximately three percent solids. It is then pumped to the next process.

Aerobic digestion with decant thickening is recommended for the proposed Pahala WWTP due to its simplicity, low cost, and effectiveness for small WWRFs.

6.2 Anaerobic Digestion with Biogas Use

Anaerobic digesters are covered tanks equipped with mixing, heating, and biogas collection systems. Anaerobic bacteria in the digesters convert organic matter into methane, carbon dioxide, and water; pathogen densities are reduced; and a stabilized sludge is produced. Modern high-rate digesters are typically single-stage reactors. Mesophilic anaerobic digesters are typically operated at temperatures between 35 and 38°C. Mesophilic digestion systems produce a Class B biosolids product if the solids retention time (SRT) is greater than 15 days.

Two-stage mesophilic anaerobic digestion, where digesters are operated in series, improves process performance. The second-stage anaerobic digester generally has less SRT than the first stage. The advantages of this process configuration are slightly improved volatile solids reduction, a product with reduced pathogen content, and less product odor potential.

The anaerobic digestion process generates biogas that can be used for digester heating and generation of electricity.

The mesophilic anaerobic digestion process requires primary sludge to operate effectively. Therefore, primary clarifiers are required for an anaerobic digestion process. WWRFs that do not have primary clarifiers must use other digestion technologies.

Anaerobic digestion is cost effective for facilities larger than 5 to 10 mgd. Anaerobic digestion is not considered to be an appropriate technology for a facility the size of the Pahala WWTP.

6.3 Screw Press Dewatering

The screw press represents a relatively new technology for dewatering municipal wastewater solids, although the technology has been used successfully in industrial, pulp and paper production, chemical, and food processing applications.

Figure 6-1 is a diagram of a screw press. Thickened sludge, conditioned with polymer, is introduced to the machine in the head box at the inlet end. The mixture is conveyed from the inlet end to the outlet end of the press by the rotating screw. As the material is conveyed along the length of the press it is squeezed between the tapered screw shell and the screen drums. The dewatered solids exit the press at the discharge end and fall down the discharge box. The adjustable pressure cone provides back pressure within the machine, particularly when the machine is initially filled. For municipal wastewater solids applications, the pressure cone is typically not needed after the machine is filled; the dewatered sludge provides sufficient back pressure. The liquid that was forced out through the screens is returned to the liquid treatment process.

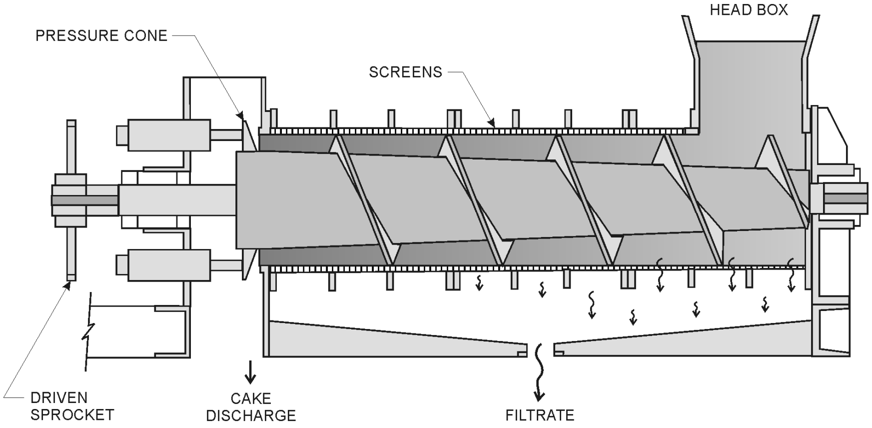


Figure 6-1. Screw Press Diagram

The screw press operates at a very slow rotational speed. The screw rotation is usually one-half of a revolution per minute or less for municipal wastewater solids. Water is slowly forced from the sludge by squeezing action – similar to a belt filter press – but for much longer periods of time. The solids retention time in a screw press can be on the order of two hours. The simplicity of screw presses makes them practical for small wastewater treatment plants, such as the Pahala WWTP.

6.4 Disposal

Dewatered solids, grit, and screenings would be trucked to the West Hawaii Landfill for disposal.

Section 7

Project Alternatives Evaluations

Project alternatives are developed and evaluated in this section.

7.1 Project Alternative Descriptions

Three Project Alternatives are developed below. All three include a new gravity collection system, WWTP, and subsurface drip effluent disposal system.

7.1.1 Project Alternative 1: Activated Sludge with Anoxic Zone Package Plants

Project Alternative 1 is an activated sludge process with anoxic zone provided in the form of packaged treatment systems. A typical packaged treatment system of this nature would include:

- Flow equalization
- Anoxic treatment zone
- Aerobic treatment zone
- Secondary clarifier
- Aerobic digester with decant thickening.

Figure 7-1 is a sketch of Project Alternative 1. Wastewater would receive preliminary treatment in the headworks before flowing into the packaged treatment system. Two package treatment units would be provided, each with 50,000 gpd capacity. Effluent would flow into an irrigation equalization tank before being applied to the subsurface drip disposal system.

Digested solids would be dewatered using a screw press prior to disposal at the landfill.

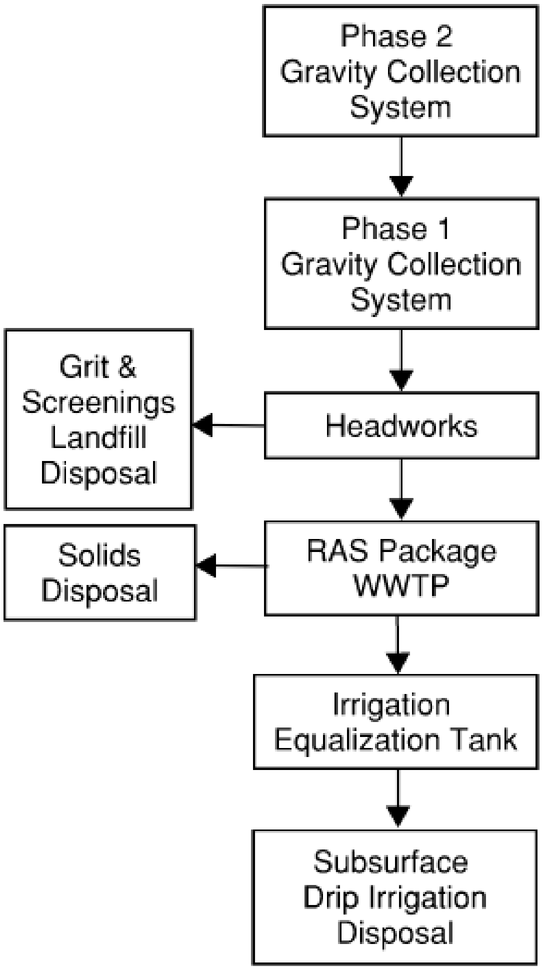


Figure 7-1. Project Alternative 1: Activated Sludge with Anoxic Zone Package Plants

7.1.2 Project Alternative 2: MBR Package Plants

Project Alternative 2 is similar to Project Alternative 1 but includes two MBR package plants to provide treatment. Figure 7-2 provides an outline of Project Alternative 2. The MBR technology would create effluent that could be recycled on nearby macadamia nut orchards, if desired in the future. However, recycled water distribution costs are not included in the evaluations below to allow all alternatives to be considered on an equal basis.

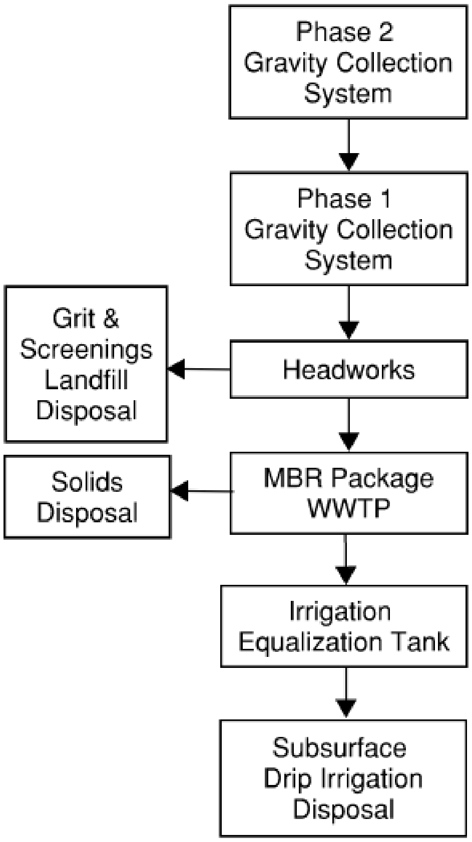


Figure 7-2. Project Alternative 2: MBR Package Plants

7.1.3 Project Alternative 3: Imhoff Tank / Recirculating Gravel Filter

Project Alternative 3 incorporates recirculating gravel filter treatment technology. Figure 7-3 provides a schematic of the project alternative. An Imhoff tank would be provided downstream of the headworks to remove grease and settleable solids prior to flowing into a recirculation tank. Recirculation pumps would distribute water from the recirculation tank over the surface of the pea gravel filter that provides secondary treatment. Water collected at the bottom of the filter would flow back to the recirculation tank. On average water would flow through the filter five times before disposal in the subsurface drip irrigation system as previously described.

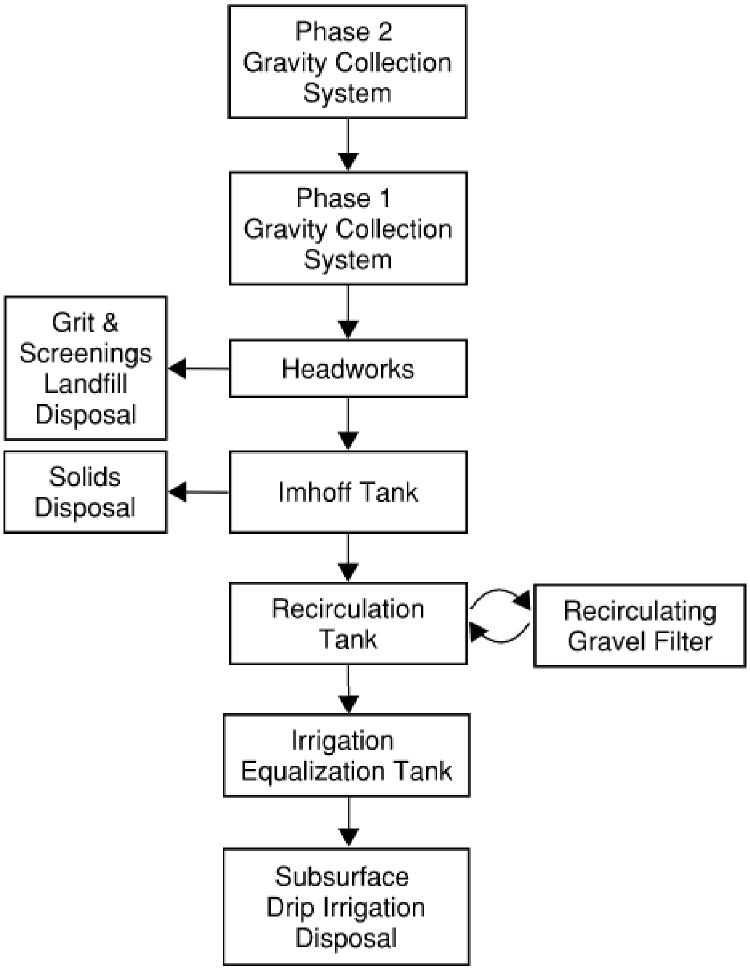


Figure 7-3. Project Alternative 3: Imhoff Tank/Recirculating Gravel Filter

7.2 Cost Evaluations

Capital, operations and maintenance (O&M), and life-cycle cost evaluations are presented in this section.

7.2.1 Capital Costs

Conceptual cost estimates were created for the three project alternatives. The cost estimates were developed using construction bids from similar projects, quantity take-offs, vendor quotes, and other sources. The costs were adjusted to account for economies of scale and construction inflation since the bid opening date. Where Hawaii costs were unavailable, U.S. mainland costs were used after adjustment to reflect Hawaii Island conditions.

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, these are Class 5 estimates. A Class 5 estimate is defined as a Conceptual Level or Project Viability Estimate. Typically, engineering is from 0 to 2 percent complete. Class 5 estimates are used to prepare planning level cost scopes or evaluation of alternative schemes, long range capital outlay planning.

Expected accuracy for Class 5 estimates typically ranges from -50 to +100 percent, depending on the technological complexity of the project, appropriate reference information and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

Table 7-1 provides a summary of capital cost assumptions used.

Table 7-1. Capital Cost Estimating Assumptions

Description	Value
Estimate date	February 2023
Engineering News Record 20-Cities Average Construction Cost Index	13,175
Electrical and instrumentation markup	25 percent
Estimating contingency for unknowns	20 percent

Table 7-2 provides a summary of the capital cost estimates, in current (February 2023) dollars. Detailed estimates can be found in Appendix A. Engineering costs were not included in the estimates.

Table 7-2. Capital Cost Estimates Summary

Description	Alternative 1: Activated Sludge Package Plants	Alternative 2: MBR Package Plants	Alternative 3: Imhoff Tank/RGF
Collection system	$21.0 million	$21.0 million	$21.0 million
Influent sewer	$1.0 million	$1.0 million	$1.0 million
WWTP	$13.9 million	$13.9 million	$14.8 million
Effluent disposal	$1.4 million	$1.4 million	$1.4 million
Totals	**$37.3 million**	**$37.3 million**	**$38.2 million**
AACE Class 5 estimate range	$18.7 – $74.6 million	$18.7 – $74.6 million	$19.1 – $76.4 million

As shown in the table, all three project alternatives have similar capital costs, and can be considered equal at this level of analysis.

7.2.2 Operation and Maintenance Costs

O&M costs estimates were developed for the three alternatives. The O&M cost estimates include collection system maintenance, plus estimates of labor, electricity consumption, chemicals, maintenance materials and solids disposal for the WWTP. O&M assumptions are listed in Table 7-3. The O&M estimates are based on the WWTP average dry weather flow capacity.

Table 7-3. O&M Cost Assumptions

Description	Value
Average dry weather flow	95,000 gpd
Labor cost, loaded	$100,000/year/full time equivalent
Electricity cost	$0.45/kWh
Landfill tip fee	$100/wet ton
Maintenance materials	2 percent of equipment capital cost/year

The O&M estimates for the three project alternatives are summarized in Table 7-4. Detail can be found in Appendix A. As shown in the table, Project Alternative 3: Imhoff Tank/Recirculating Gravel Filter incurs the lowest O&M cost, while Project Alternative 2: MBR Package Plants incurs the highest.

Table 7-4. O&M Cost Estimate Summary

Description	Annual Cost		
	Project Alternative 1: Activated Sludge Package Plants	Project Alternative 2: MBR Package Plants	Project Alternative 3: Imhoff Tank/RGF
Collection system	$40,000	$40,000	$40,000
Labor	$200,000	$200,000	$200,000
Electricity	$240,000	$270,000	$90,000
Chemicals	$20,000	$25,000	$20,000
Maintenance materials	$96,000	$96,000	$46,000
Solids disposal	$51,000	$51,000	$51,000
Totals	**$647,000**	**$682,000**	**$447,000**

7.2.3 Life-Cycle Costs

An economic evaluation was prepared to assess the potential life-cycle costs associated with each project alternative. The economic evaluation consists of a net present value comparison. The net present value analysis includes capital, O&M, and equipment replacement costs. An appropriate inflationary factor and discount rate are applied to obtain the net present value over a 30-year planning period. The analysis assumes the capital costs are incurred in year 1, followed by 29 years of O&M. The net present value of an alternative represents the amount of money that would need to be set aside today (at a given interest rate) to pay the costs associated with the alternative over the entire planning period. The alternative with the lowest net present value is considered the most attractive from an economic perspective. The evaluation results are included in Appendix A.

Table 7-5 summarizes the life-cycle cost evaluation assumptions.

Table 7-5. Life-Cycle Economic Assumptions

Description	Value
Year of analysis	2023
Planning period	30 years
Inflation rate	3.5 percent
Discount rate	5.0 percent
Equipment replacement cycle	20 years
Membrane replacement cycle	15 years

Table 7-6 summarizes the results of the life-cycle cost analysis.

Table 7-6. Life-Cycle Cost Analysis Summary

Description	Project Alternative 1: Activated Sludge Package Plants	Project Alternative 2: MBR Package Plants	Project Alternative 3: Imhoff Tank/RGF
Capital cost	$37.3 million	$37.3 million	$38.2 million
Annual O&M cost	$647,000	$682,000	$447,000
Equipment replacement cost (excluding membranes)	$4.8 million	$4.8 million	$2.3 million
Membrane replacement cost	N/A	$59,000	N/A
Life-cycle cost	$56.1 million	$57.0 million	$50.4 million
Comparison to lowest cost alternative	+11%	+13%	0%

Figure 7-4 shows the results in graphical form. As shown in the table and graph, the three project alternatives have similar capital costs. Alternative 3: Imhoff Tank/Recirculating Gravel Filter incurs the lowest life-cycle costs, largely due to lower O&M costs associated with the technology. Project Alternatives 1 and 2 incur similar lifecycle costs. At this level of analysis all three project alternatives can be considered to have similar lifecycle costs.

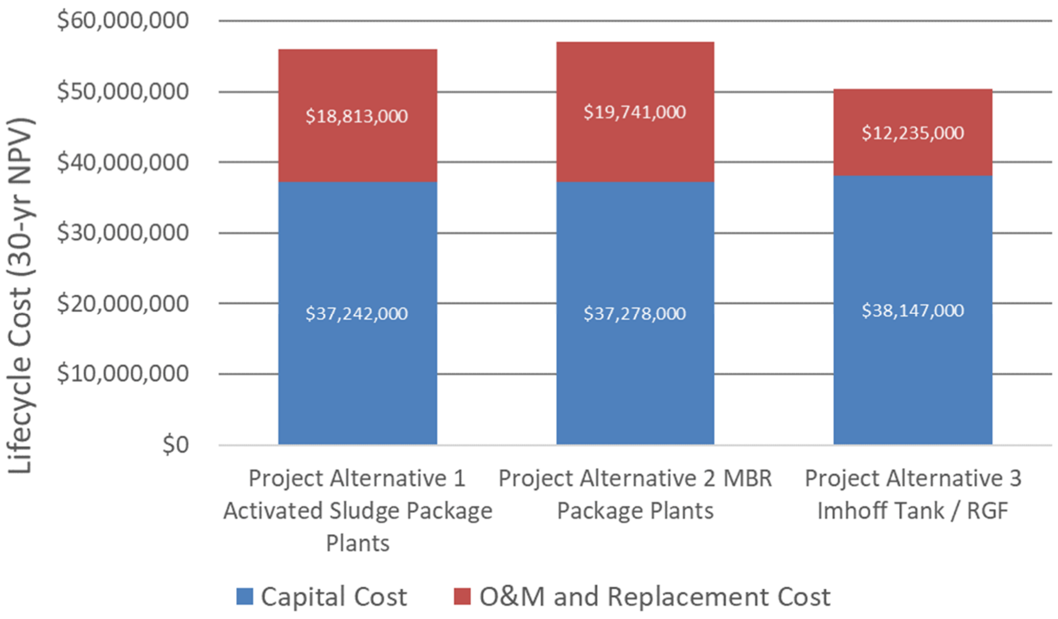


Figure 7-4. Life-Cycle Cost Evaluation Results

7.3 Non-Economic Evaluation

A non-economic evaluation was conducted to provide a qualitative comparison between the three alternatives.

7.3.1 Approach

Non-economic evaluations are generally subjective by necessity. Quantifiable measurements are used when available, but lack of information or difficulty and expense of obtaining information requires subjective assessments.

The project alternatives were scored in relation to one another and according to an evaluation matrix, described below. Each alternative was scored from 1 to 5 (5 = high/desirable, 1 = low/less desirable) for each evaluation criteria. The alternatives were not ranked in the scoring; alternatives could receive the same scores for any given criteria.

The evaluation criteria were weighted to reflect their overall significance for the project. The scores were multiplied by the criteria weights to develop a non-economic score for each alternative.

7.4 Non-Economic Evaluation Criteria

Table 7-7 shows the non-economic criteria chosen for comparing the three alternatives.

Table 7-7. Non-Economic Comparison Criteria

Category	Criteria	Description
Level of Service Measures	Effluent quality	The quality of the effluent produced with respect to BOD_5, TSS, nutrients, and turbidity.
	Potential for capacity expansion	Ability of the system to be expanded should additional capacity be required.
	Water recycling feasibility	The relative extent of modifications that would be needed to create R-1 recycled water to support a future water recycling program.
	Public perception / community concerns	The community's impression of the project and the perceived support.
Regulatory	Monitoring complexity	The relative difficulty of monitoring tasks required for the option chosen.
	Treatment adjustment potential	The ability to increase treatment to comply with future permit requirements and/or growth.
	Safety regulations complexity	The relative difficulty to comply with safety regulations including staff training, reporting, maintenance procedures.
	Environmental concerns	The extent of the project's potential environmental impacts should failures occur.
O&M Factors	Footprint	The physical space that the processes will occupy (affecting land acquisition, subdivision, and permitting).
	Safe work environment	Lost time accidents and the relative health and safety risk operation of given option will have on the employees; includes equipment access, chemical hazards, confined spaces, dust, etc.; the extent of measures required to ensure the health and safety of the employees.
	Maintenance complexity	The relative intensity of equipment maintenance requirements.
	Operations complexity	The relative intensity of the operations requirements.
Island Factors	Mainland delivery dependence	The relative dependence on regular deliveries of equipment, supplies, or spare parts from mainland sources.
	Mainland servicing dependence	The relative degree to which technology will require special servicing by mainland-based personnel.
	Power dependence	The relative degree to which the treatment processes depend on electrical power for operation.
	Chemical dependence	The relative dependence on chemical supplies, whether locally available or restricted by mainland delivery schedules and requirements.

The categories and criteria were developed using best engineering judgment and our understanding of the project, and the County of Hawaii Department of Environmental Management goals and concerns.

The weighting factors are listed in Table 7-8.

Table 7-8. Non-Economic Comparison Criteria

Category	Criteria
Level of Service Measures (25%)	Effluent quality (30%)
	Potential for capacity expansion (20%)
	Water recycling feasibility (30%)
	Public perception / community concerns (20%)
	Category Total (100%)
Regulatory (25%)	Monitoring complexity (25%)
	Treatment adjustment potential (25%)
	Safety regulations complexity (25%)
	Environmental concerns (25%)
	Category Total (100%)
Owner Factors (25%)	Footprint (30%)
	Safe work environment (25%)
	Maintenance complexity (25%)
	Operations complexity (20%)
	Category Total (100%)
Island Factors (25%)	Mainland delivery dependence (25%)
	Mainland servicing dependence (25%)
	Power dependence (25%)
	Chemical dependence (25%)
	Category Total (100%)
Overall Total 100%	

7.5 Non-Economic Evaluation Results

A score of 1 through 5 was given for each criterion, with 5 being the most favorable, and 1 representing the least desired option. The complete non-economic evaluation is included as Appendix C. The non-economic evaluation results are summarized in Table 7-9.

Table 7-9. Non-Economic Weighted Scores

Alternative	Score	Rank
Project Alternative 1: Activated Sludge Package Plants	3.80	2
Project Alternative 2: MBR Package Plants	3.96	1
Project Alternative 3: Imhoff Tank / Recirculating Gravel Filter	3.53	3

As shown in the table, Project Alternative 2: MBR Package Plants received the highest non-economic score. The higher score reflects the County's desire to standardize on MBR technology to provide the highest level of treatment at WWTP facilities and to facilitate future water recycling programs.

7.6 Conclusions and Recommendation

Figure 7-5 combines the economic and non-economic results into a single graph. As previously stated, the economic cost of the three project alternatives can be considered equivalent at this level of analysis. Project Alternative 2: MBR Package Plants has the highest non-economic score and is recommended for implementation if the County proceeds with a centralized sewer system and WWTP for the community.

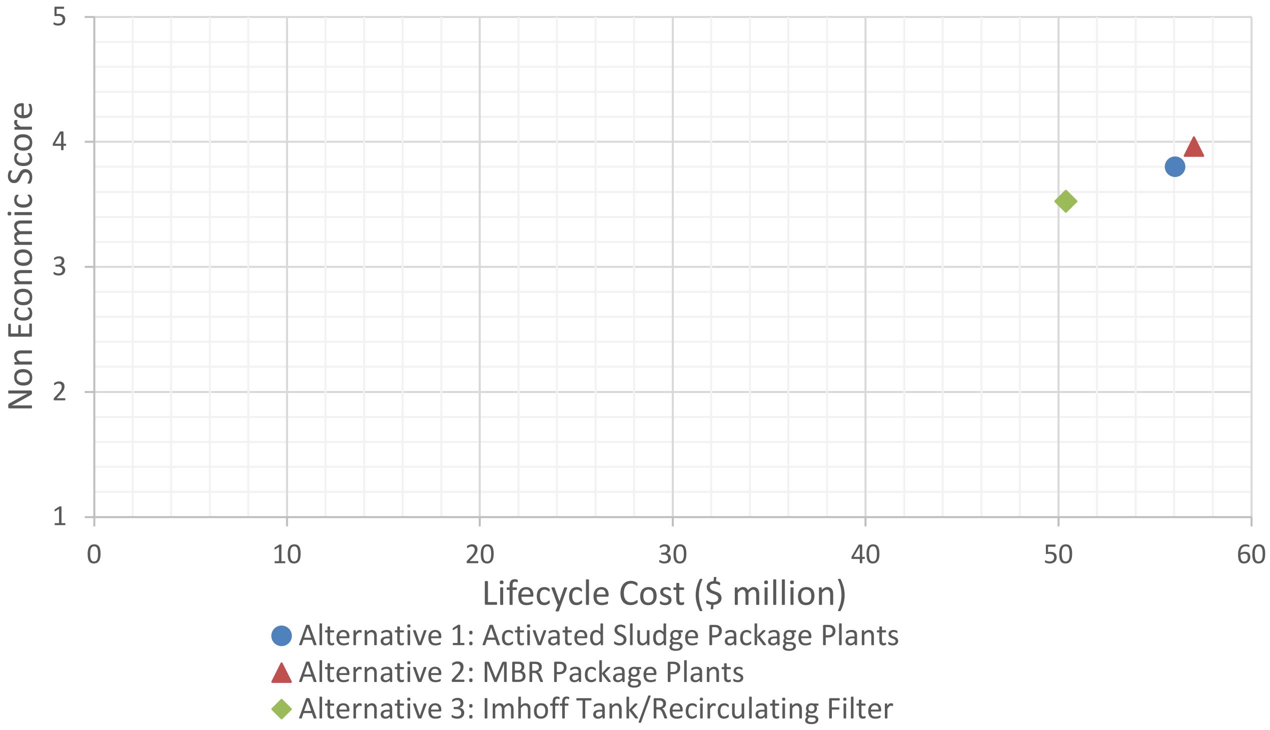


Figure 7-5. Combined Economic and Non-Economic Results

Section 8

Preliminary Design of Improvements

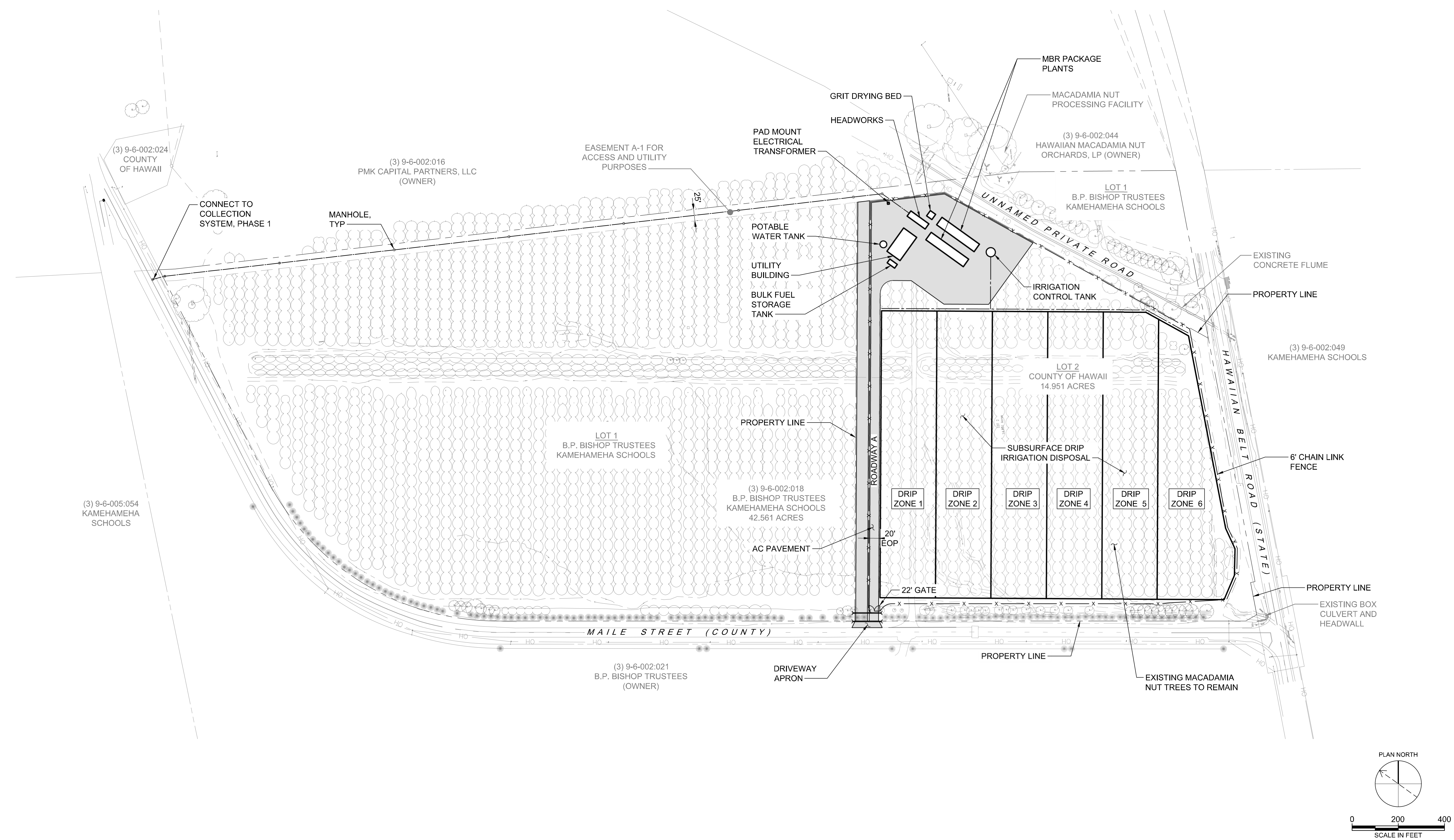
A preliminary design of the recommended project is discussed in this section.

8.1 Site Plan

Figure 8-1 is a preliminary site plan of the WWTP project.

8.2 Process Schematic

Figure 8-2 is a preliminary process schematic of the proposed WWTP.



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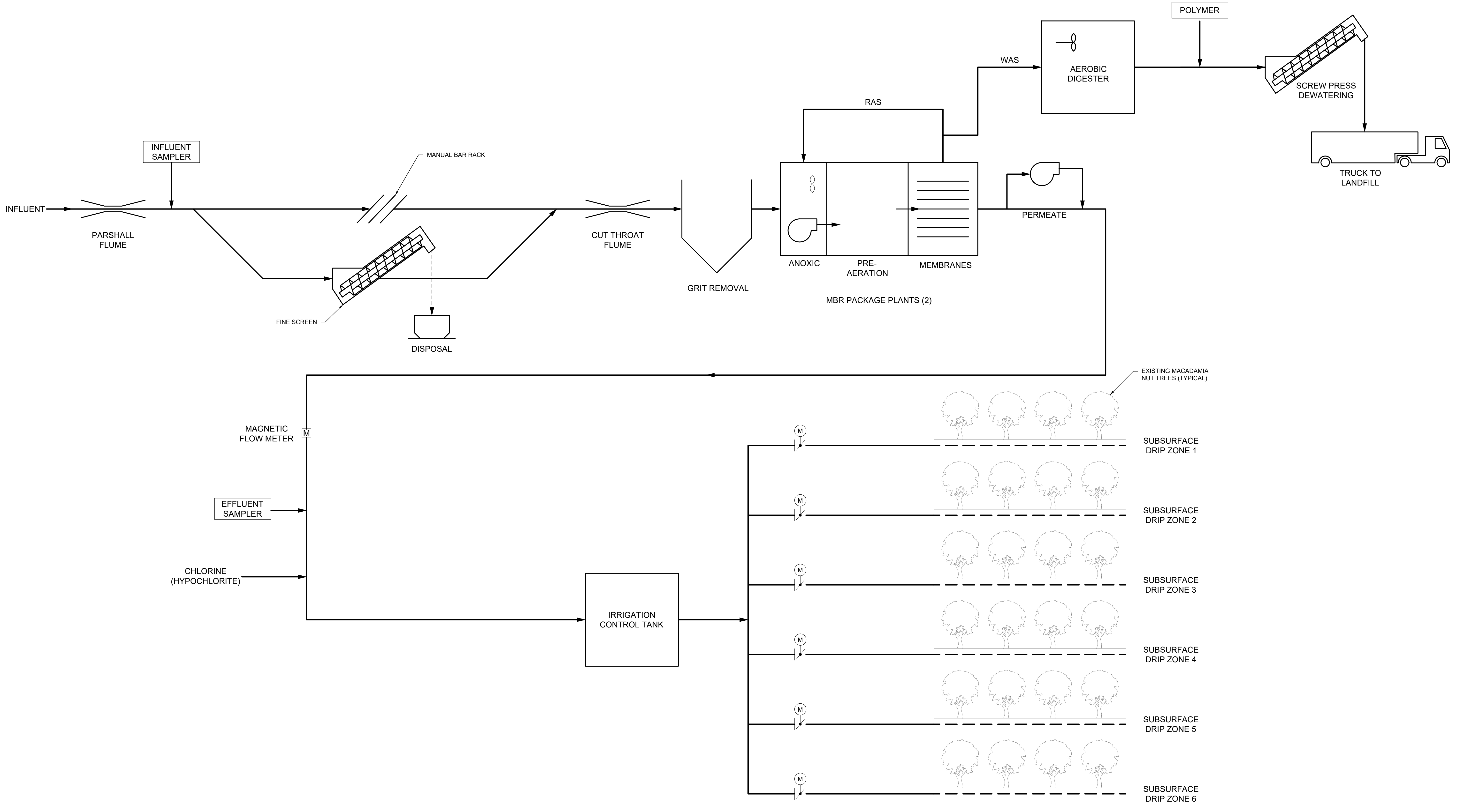
PAHALA WASTEWATER TREATMENT PLANT

OVERALL SITE PLAN

FIGURE

8-1



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Brown AND Caldwell

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JOB NO: 152964

PAHALA WASTEWATER TREATMENT PLANT

PROCESS SCHEMATIC

FIGURE
8-2

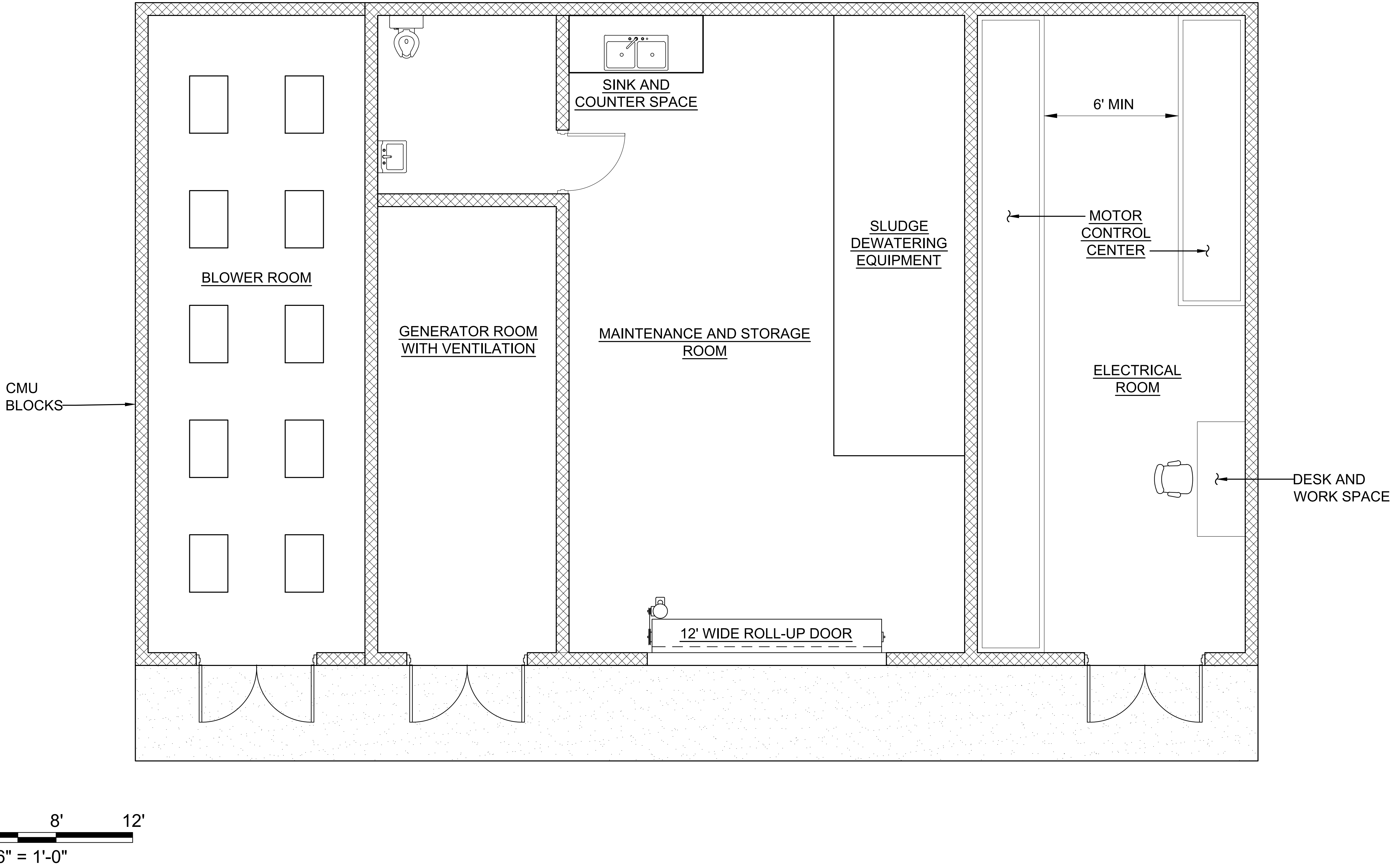
8.3 Preliminary Design Criteria

Table 8-1 lists preliminary design criteria for the proposed WWTP.

Table 8-1. Preliminary Design Criteria

Description	Value
Influent flow	
Average dry weather	95,000 gpd
Peak day wet weather	312,000 gpd
Peak hour wet weather	221 gpm
Influent characteristics	
BOD_5	300 mg/L
TSS	300 mg/L
TN	40 mg/L
Odor control – granular activated carbon	
Airflow rate	6 air changes per hour
H_2S Inlet concentration	1-10 ppm
H_2S removal efficiency	99%
Media type	High-capacity carbon
Mechanical screens	
Number of units	1
Type	In-channel cylindrical
Screen opening size	0.125 inch (3 mm)
Maximum flow rate capacity	Greater than 221 gpm
Screening washing	Integral
Screening compaction	Integral
Bypass screen	
Type	Manually-cleaned bar rack
Bar spacing	1 inch
Rake	Fabricated to Interlock with bars
Screenings receptacle	
Type	55-gallon drum or bags
Screenings volume per million gallons treated	5 ft^3/Mgal
Estimated screenings quantity	0.5 ft^3/day
Disposal frequency	1/week
Influent flow metering	
Type	Parshall flume
Maximum flow capacity	Greater than 221 gpm

Minimum straight upstream channel section	20 times the throat width
Influent flow sampling	Refrigerated automatic composite sampler
Grit chamber	
Number of units	1
Type	Aerated grit trap
Volume	2,805 gallons
Air supply	75 ft^3/minute
Removal	Vactor truck
Estimated average grit quantity	1.8 ft^3/day
MBR package plant	
Number of packaged treatment trains	2
Flow basis for biological design	50,000 gpd each
Anoxic tank working volume (excluding membranes)	2,000 gallons each
Aerobic working volume	7,000 gallons each
Design SRT	5 days
Waste sludge removal	1,500 gpd each
Design MLSS concentration in bioreactor	≤ 8,000 mg/L
Number of duty membrane blowers	1 per train
Number of duty process aeration blowers	1 per train
Aeration system type	Coarse bubble diffused aeration
Mixed liquor recirculation rate	4 x ADWF
Membrane cleaning dosing systems	Sodium Hypochlorite, Citric Acid, & Coagulant
Sludge management system	
Number of units	1
Type	Incline screw press
Screw press capacity	45 gpm
Polymer dose	20 lbs/dry ton
Annual polymer use	475 lbs
Average amount of dewatered sludge	0.54 wet tons/day
Disposal frequency	1/week
Maintenance Disinfection system	
Type	Chlorine
Form	Calcium hypochlorite tablets
Design chlorine dose	8 mg/L
Irrigation equalization (control) tank	
Number of units	1



Brown AND Caldwell

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PAHALA WASTEWATER TREATMENT PLANT

OPERATIONS BUILDING PRELIMINARY FLOOR PLAN

FIGURE

8-3

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Section 9

Implementation Plan

An implementation plan for the recommended WWTP project is presented is this section.

9.1 Implementation Approach

The WWTP and collection system projects could be implemented using either a traditional design/bid/build (DBB) approach or a design/build (DB) approach, as discussed below.

9.1.1 Design Bid Build (DBB) Approach

DBB is the traditional approach used by the County for implementing public works projects. The design is prepared by a consultant, and then bids are solicited from construction contractors. The County awards the contract to the lowest responsible bidder.

Advantages of the DBB approach are that the County retains maximum control over the design process, ensuring the project will meet its needs.

9.1.2 Design Build (DB) Approach

DB is an alternative delivery approach whereby the County would contract with an entity to both design and construct a facility that meets established project specifications. The combined WWTP and collection system projects are large enough monetarily for the County to consider a DB approach. The County would need to use a procurement process based on qualifications and cost to select the DB entity. The typical DB procurement process takes 9 – 12 months to complete. The DB bidders will need the County to complete the following prior to the DB procurement process:

- Complete geotechnical report.
- Environmental assessment.
- Land use entitlements.
- WWTP land purchase.

Advantages of DB implementation are:

- Possibility of reduced overall costs.
- Design and construction can occur simultaneously, potentially reducing implementation time.
- DB entity assumes the performance liability for the project, as defined in the project specifications.

Disadvantages of the DB approach are that the County has limited experience with it, and the County would not have as much control over how the project is designed.

9.2 Implementation Schedules

Planning level implementation schedules were developed for both approaches.

9.2.1 Recent Change in State of Hawaii Land Use Commission Policy

The State of Hawaii Land Use Commission (LUC) recently changed its policy regarding the use of Special Permits for non-conforming uses. The proposed WWTP site is located in the Agricultural

District as defined by the LUC. A WWTP is not an allowable land use in the Agricultural District. In the past the LUC has allowed Special Permits to be used for non-conforming uses. However, the LUC has recently changed its policy and now recommends that project proponents for permanent facilities (like a WWTP) pursue a District Boundary Amendment (DBA) from the LUC. The LUCs rationale is that permanent entitlement (i.e., a DBA) is more appropriate for a permanent facility like a WWTP, rather than a temporary entitlement like a Special Permit. Since the WWTP parcel is less than 15 acres the DBA can be processed by the County of Hawaii. However, the action will likely take longer to implement than a Special Permit.

9.2.2 Equipment Procurement Time to Impact Construction Schedule

The COVID-19 pandemic continues to impact the construction industry due to increased time to deliver equipment and other materials. Most significantly, the time for the MBR package plant supplier to manufacture their equipment was quoted at 48 weeks instead of a typical pre-pandemic time of approximately 26 weeks. Similar delays are being experienced on other construction projects in Hawaii, and it is reasonable to assume that other equipment suppliers will quote extended supply times. As a result, we now suggest that a construction schedule of two years is a reasonable expectation.

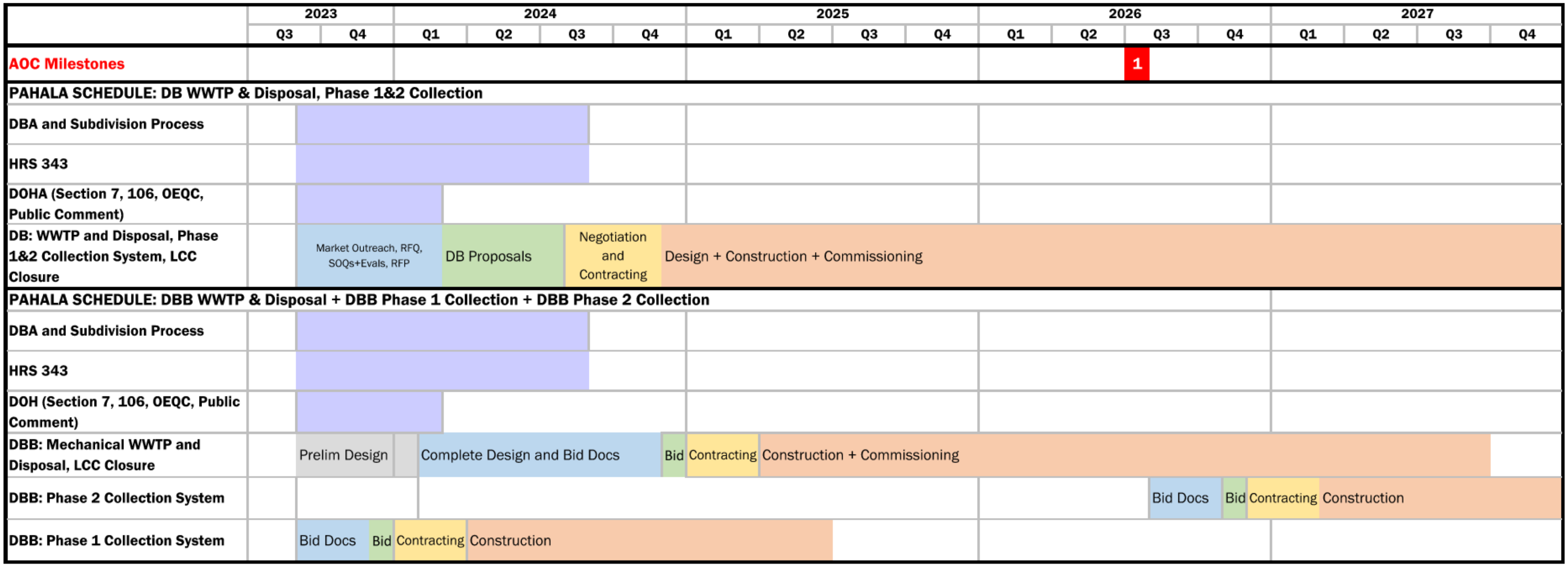
9.2.3 Implementation Schedules

Figure 9-1 presents implementation schedules for both approaches. At this time, both approaches may not enable the County to meet the AOC milestone schedule to close the LCCs. The DB approach offers greater potential to meet the milestone, because equipment procurement can possibly occur in parallel with design within a DB contract.

9.3 Recommendation

Given the equipment procurement time impact to construction schedule, and the recent change in LUC policy towards the use of Special Permits for permanent facilities, it is unlikely that the County will be able to meet the Revised AOC deadline to close the LCCs. Using a DB approach to implement the project may offer better opportunity to meet the deadline, because a DB entity could initiate equipment procurement while design activities progress.

Part B of this report evaluates using Individual Wastewater Systems to comply with the Revised AOC.



🟥 1 Revised AOC: Close LCCs

Section 10

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Appendix A: Cost Estimates

County of Hawaii DEM
Pahala Revised AOC PER
Alternatives Net Present Value Analysis

Agency: County of Hawaii DEM

Project/Problem: Pahala Revised AOC PER

		Risk Premium	Sensitivity Adjustments (%)			**Results**	
			Benefits	Capital Costs	Other Costs	Capital Cost	30-year NPV
Alternative 1	Package plant all new sewers					$37,278,000	($57,018,355)
Alternative 2	Package plant use old sewers					$23,598,000	($45,221,554)
Alternative 3	IWS management model 2A					$17,400,000	($26,445,670)
Alternative 4	IWS management model 2B					$17,400,000	($26,810,306)
Alternative 5	IWS management model 3A					$17,400,000	($26,605,508)
Alternative 6	IWS management model 3B					$17,400,000	($28,694,426)
Alternative 7							
Alternative 8							
Alternative 9							
Alternative 10							
Alternative 11							
Alternative 12							

Year of analysis: 2023
Escalation rate: 3.50%
Discount rate: 5.00%

Select one
● All entries in dollars
○ All entries in thousands of dollars

Note: "Status quo" refers to Alternative 1

Make entries in yellow cells only

County of Hawaii
Pahala WWTP Design-Post Design
Alternatives Net Present Value Analysis

Agency: County of Hawaii

Project/Problem: Pahala WWTP Design-Post Design

			Sensitivity Adjustments (%)			Results	
		Risk Premium	Benefits	Capital Costs	Other Costs	Capital Cost	30-year NPV
Alternative 1	RAS Package Plants / Subsurface Drip					$37,242,000	($56,054,039)
Alternative 2	MBR Package Plants / Subsurface Drip					$37,278,000	($57,018,355)
Alternative 3	Imhoff Tank / RGF / Subsurface Drip					$38,147,000	($50,381,465)
Alternative 4							
Alternative 5							

Year of analysis: 2023
Escalation rate: 3.50%
Discount rate: 5.00%

Select one
● All entries in dollars
○ All entries in thousands of dollars

Note: "Status quo" refers to Alternative 1

Make entries in yellow cells only

County of Hawaii
Pahala WWTP Design-Post Design
Alternatives Net Present Value Analysis

Agency:	County of Hawaii		Sensitivity Adjustments (%)			**Results**	
Project/Problem:	Pahala Collection System	Risk Premium	Benefits	Capital Costs	Other Costs	Capital Cost	30-year NPV
Alternative 1	New Gravity Collection System					$21,010,000	($21,951,599)
Alternative 2	STEP Collection System					$18,608,000	($22,210,229)
Alternative 3	Reuse Existing Collection System					$7,330,000	($10,154,798)
Alternative 4							
Alternative 5							

Year of analysis: 2023
Escalation rate: 3.50%
Discount rate: 5.00%

Select one
● All entries in dollars
○ All entries in thousands of dollars

Note: "Status quo" refers to Alternative 1

Make entries in yellow cells only

Pahala WWTP
Preliminary Engineering Report
Alternative Solutions Cost Summaries

Alternative #1 - RAS Package Plants / Subsurface Drip

Collection System TOTAL		**$21,010,000**
WWTP TOTAL		**$16,232,000**
ALTERNATIVE #1 CAPITAL COST TOTAL		***$37,242,000***
ANNUAL O&M COSTS		
Electricity	$240,000	
Labor	$200,000	
Chemicals	$20,000	
Solids disposal	$51,000	
Maintenance materials	$96,000	
Gravity mainline maintenance	$40,000	
Total Annual Operating Costs	***$647,000***	
EQUIPMENT REPLACEMENT COST (20 YEAR)	***$4,776,000***	

Alternative #2 - MBR Package Plants / Reuse / Subsurface Drip

Collection System TOTAL		**$21,010,000**
WWTP TOTAL		**$16,268,000**
ALTERNATIVE #2 CAPITAL COST TOTAL		***$37,278,000***
ANNUAL O&M COSTS		
Electricity	$270,000	
Labor	$200,000	
Chemicals	$25,000	
Solids disposal	$51,000	
Maintenance materials	$96,000	
Gravity mainline maintenance	$40,000	
Total Annual Operating Costs	***$682,000***	
MEMBRANE REPLACEMENT COST (15 YEAR)	***$59,000***	
EQUIPMENT REPLACEMENT COST (20 YEAR)	***$4,800,000***	

Alternative #3 - Imhoff Tank / RGF / Subsurface Drip

Collection System TOTAL		**$21,010,000**
WWTP TOTAL		**$17,137,000**
ALTERNATIVE #3 CAPITAL COST TOTAL		***$38,147,000***
ANNUAL O&M COSTS		
Electricity	$90,000	
Labor	$200,000	
Chemicals	$20,000	
Solids disposal	$51,000	
Maintenance materials	$46,000	
Gravity mainline maintenance	$40,000	
Total Annual Operating Costs	***$447,000***	
EQUIPMENT REPLACEMENT COST (20 YEAR)	***$2,283,000***	

Pahala WWTP Unit Cost Estimates

Electrical & Instrumentation	25.0%	
Contingency	20.0%	
ENR CCI	13175.03	January, 2023

Pahala WWTP Capital Unit Costs	**Units**	**Unit Cost**
Environmental protection, BMPs	ac	$11,000
Site clearing	ac	$20,000
Site roads, guard rails, pavement	ac	$92,000
Perimeter fence	LF	$150
Site grading	ac	$30,000
Site drainage improvements	ac	$18,000
Plant water catchment/collection system	LS	$75,000
Process yard piping	LS	$250,000
Headworks (includes site/civil, structures, equipment & piping)	LS	$1,011,000
Chlorine disinfection	LS	$150,000
RAS package plants	LS	$3,491,000
MBR package plants	LS	$3,515,000
Irrigation equalization tank	gal	$10
Subsurface drip irrigation line	LF	$10
Irrigation piping & valves	LF	$250
Imhoff tank	LS	$1,063,000
Recirculation tank	LS	$890,000
Recirculating gravel filter	LS	$2,541,000
Plant drainage system	ac	$40,000
Main generator (including process piping)	LS	$494,000
Maintenance/operations/electrical building	SF	$1,000
Influent sewer (16 inch) main along easement from Maile St	LF	$480
Phase 1 existing gravity collection system improve (Fukunaga)	LS	$4,880,000
Phase 2 new gravity collection system (Fukunaga)	LF	$16,130,000
Reuse existing gravity collection system	LS	$2,450,000
Sludge dewatering system	LS	$860,000

Pahala WWTP Operation, Maintenance, & Replacement Unit Costs	Unit Cost	Units
Equipment replacement cost	25%	of process capital cost
Package plant replacement cost	100%	of package plant captial cost
Maintenance materials	2%	of equipment capital cost
Gravity collection system maintenance cost	$16,000.00	per mi
Membrane replacement cost	$1,950.00	per module + SH & install
Solids disposal dumpster rental fee	$300.00	per week
Sanitary landfill tipping fee	$116.00	per wet ton
Hypochlorite tablet cost	$8.00	per lb
Dewatering polymer cost	$3.00	per lb
Diesel price	$6.22	per gallon

Pahala WWTP Lump Sum Cost Estimates

Imhoff Tank	***Units***	***Unit Cost***	***Number of Units***	***Cost***
Excavation	CY	$150	400	$60,000
Bedding & backfill	CY	$100	25	$2,600
Concrete	CY	$1,500	130	$195,700
Piping & valves	LS	$50,000	1	$50,000
Cover plates	SF	$200	70	$14,000
Odor control	LS	$500,000	1	$500,000
Epoxy Coating	SF	$80	3,000	$240,000
			TOTAL	**$1,063,000**

Recirculating Gravel Filter	***Units***	***Unit Cost***	***Number of Units***	***Cost***
RGF bed excavation	CY	$150	6,000	$900,000
Bed liner	SF	$8	40,000	$320,000
16 in PVC manifold pipe	LF	$160	300	$48,000
3 in PVC lateral pipe	LF	$30	7,100	$213,000
4 in PVC drainage & recirculation pipe	LF	$40	2,000	$80,000
Gravel media	CY	$150	6,000	$900,000
6 in sand media under liner	CY	$100	800	$80,000
			TOTAL	**$2,541,000**

Recirculation Tank	***Units***	***Unit Cost***	***Number of Units***	***Cost***
Recirculation tank excavation	CY	$150	1,000	$150,000
Bedding & backfill	CY	$100	200	$20,000
Concrete	CY	$1,500	200	$300,000
Handrail	LF	$100	200	$20,000
Pumps & valves	ea	$100,000	4	$400,000
			TOTAL	**$890,000**

Sludge Dewatering System	***Units***	***Unit Cost***	***Number of Units***	***Cost***
300 HP diesel dump truck	LS	$300,000	1	$300,000
Dewatering screw press	LS	$300,000	1	$300,000
Incline screw conveyor	LS	$80,000	1	$80,000
Polymer system	LS	$80,000	1	$80,000
Sludge feed pump & piping	LS	$100,000	1	$100,000
			TOTAL	**$860,000**

Reuse Existing Gravity Collection System	***Units***	***Unit Cost***	***Number of Units***	***Cost***
Inspection & cleaning	LS	$750,000	1	$750,000
Repair defects	LS	$1,500,000	1	$1,500,000
Archaeological monitoring	LS	$50,000	1	$50,000
BMPs	LS	$50,000	1	$50,000
Traffic control measures	LS	$50,000	1	$50,000
Pre- & post-construction inspections & documentation	LS	$50,000	1	$50,000
			TOTAL	**$2,450,000**

Alternative #1 - RAS Package Plants / Subsurface Drip

Capital Cost Estimate

Pahala WWTP Capital Cost Item Description	**Units**	**General Unit Cost**	**Number of Units**	**COST**
Influent Sewer				
16 inch sewer main along easement from Maile St	LF	$480	1,700	$816,000
			Subtotal	$816,000
			Contingency @ 20%	$164,000
			Influent Sewer Total	**$980,000**
Wastewater Treatment				
Environmental protection, BMPs	ac	$11,000	1.5	$16,500
Site clearing	ac	$20,000	1.5	$30,000
Site roads, guard rails, pavement	ac	$92,000	1.5	$138,000
Perimeter fence	LF	$150	3,000	$450,000
Site grading	ac	$30,000	1.5	$45,000
Site drainage improvements	ac	$18,000	1.5	$27,000
Plant water catchment/collection system	LS	$75,000	1	$75,000
Process yard piping	LS	$250,000	1	$250,000
Headworks (includes site/civil, structures, equipment & piping)	LS	$1,011,000	1	$1,011,000
Chlorine disinfection	LS	$150,000	1	$150,000
RAS package plants	LS	$3,491,000	1	$3,491,000
Plant drainage system	ac	$40,000	1.5	$60,000
Main generator (including process piping)	LS	$494,000	1	$494,000
Maintenance/operations/electrical building	SF	$1,000	2,150	$2,150,000
Sludge dewatering system	LS	$860,000	1	$860,000
			Subtotal	$9,247,500
			Electrical & Instrumentation @ 25%	$2,312,000
			Subtotal	$11,560,000
			Contingency @ 20%	$2,312,000
			Wastewater Treatment Total	**$13,872,000**
Effluent Disposal				
Irrigation equalization tank	gal	$10	20,000	$200,000
Subsurface drip irrigation line	LF	$10	52,000	$520,000
Irrigation piping & valves	LF	$250	800	$200,000
			Subtotal	$920,000
			Electrical & Instrumentation @ 25%	$230,000
			Subtotal	$1,150,000
			Contingency @ 20%	$230,000
			Effluent Disposal Total	**$1,380,000**
			Alternative #1 TOTAL	**$16,232,000**

Alternative #2 - MBR Package Plants / Reuse / Subsurface Drip

Capital Cost Estimate

Pahala WWTP Capital Cost Item Description	Units	General Unit Cost	Number of Units	COST
Influent Sewer				
16 inch sewer main along easement from Maile St	LF	$480	1,700.0	$816,000
			Subtotal	$816,000
			Contingency @ 20%	$164,000
			Influent Sewer Total	**$980,000**
Wastewater Treatment				
Environmental protection, BMPs	ac	$11,000	1.5	$16,500
Site clearing	ac	$20,000	1.5	$30,000
Site roads, guard rails, pavement	ac	$92,000	1.5	$138,000
Perimeter fence	LF	$150	3,000	$450,000
Site grading	ac	$30,000	1.5	$45,000
Site drainage improvements	ac	$18,000	1.5	$27,000
Plant water catchment/collection system	LS	$75,000	1	$75,000
Process yard piping	LS	$250,000	1	$250,000
Headworks (includes site/civil, structures, equipment & piping)	LS	$1,011,000	1	$1,011,000
Chlorine disinfection	LS	$150,000	1	$150,000
MBR package plants	LS	$3,515,000	1	$3,515,000
Plant drainage system	ac	$40,000	1.5	$60,000
Main generator (including process piping)	LS	$494,000	1	$494,000
Maintenance/operations/electrical building	SF	$1,000	2,150	$2,150,000
Sludge dewatering system	LS	$860,000	1	$860,000
			Subtotal	$9,271,500
			Electrical & Instrumentation @ 25%	$2,318,000
			Subtotal	$11,590,000
			Contingency @ 20%	$2,318,000
			Wastewater Treatment Total	**$13,908,000**
Effluent Disposal				
Irrigation equalization tank	gal	$10	20,000	$200,000
Subsurface drip irrigation line	LF	$10	52,000	$520,000
Irrigation piping & valves	LF	$250	800	$200,000
			Subtotal	$920,000
			Electrical & Instrumentation @ 25%	$230,000
			Subtotal	$1,150,000
			Contingency @ 20%	$230,000
			Effluent Disposal Total	**$1,380,000**
			Alternative #2 TOTAL	**$16,268,000**

Alternative #3 - Imhoff Tank / RGF / Subsurface Drip

Capital Cost Estimate

Pahala WWTP Capital Cost Item Description	Units	General Unit Cost	Number of Units	COST
Influent Sewer				
Influent sewer (16 inch) main along easement from Maile St	LF	$480	1,700	$816,000
			Subtotal	$816,000
			Contingency @ 20%	$164,000
			Influent Sewer Total	**$980,000**
Wastewater Treatment				
Environmental protection, BMPs	ac	$11,000	2	$22,000
Site clearing	ac	$20,000	2	$40,000
Site roads, guard rails, pavement	ac	$92,000	2	$184,000
Perimeter fence	LF	$150	3,000	$450,000
Site grading	ac	$30,000	2	$60,000
Site drainage improvements	ac	$18,000	2	$36,000
Plant water catchment/collection system	LS	$75,000	1	$75,000
Process yard piping	LS	$250,000	1	$250,000
Headworks (includes site/civil, structures, equipment & piping)	LS	$1,011,000	1	$1,011,000
Imhoff tank	LS	$1,063,000	1	$1,063,000
Recirculation tank	LS	$890,000	1	$890,000
Recirculating gravel filter	LS	$2,541,000	1	$2,541,000
Chlorine disinfection	LS	$150,000	1	$150,000
Plant drainage system	ac	$40,000	2	$80,000
Main generator (including process piping)	LS	$494,000	1	$494,000
Maintenance/operations/electrical building	SF	$1,000	1,645	$1,645,000
Sludge dewatering system	LS	$860,000	1	$860,000
			Subtotal	$9,851,000
			Electrical & Instrumentation @ 25%	$2,463,000
			Subtotal	$12,314,000
			Contingency @ 20%	$2,463,000
			Wastewater Treatment Total	**$14,777,000**
Effluent Disposal				
Irrigation equalization tank	gal	$10	20,000	$200,000
Subsurface drip irrigation line	LF	$10	52,000	$520,000
Irrigation piping & valves	LF	$250	800	$200,000
			Subtotal	$920,000
			Electrical & Instrumentation @ 25%	$230,000
			Subtotal	$1,150,000
			Contingency @ 20%	$230,000
			Effluent Disposal Total	**$1,380,000**
			Alternative #3 TOTAL	**$17,137,000**

Pahala WWTP
Preliminary Engineering Report
O&M Cost Estimates

Electricity cost

	$0.45	/kWh

Flow

ADWF:	0.095	mgd
	0.146987	cfs

Labor (common across all alternatives)

COH WWTP operator annual salary	$100,000	*including fringe benefits*
Number of employees/operators	2	*2 Shifts: Wed - Sat / Mon - Fri*
Annual labor cost:	**$200,000**	

Electricity

Load	Duty Unit Count	Motor Size (hp)	Use Factor	Equivalent Continuous Load (hp)	Annual Power (kWh)	Alt 1 RAS PP (kWh)	Alt 2 MBR PP (kWh)	Alt 3 RGF (kWh)
Headworks								
Screens	1	2	20%	0.4	2,613	2,613	2,613	2,613
Grit blower	2	5	100%	10	65,323	65,323	65,323	65,323
Process tanks								
Anoxic zone mixers	2	5	100%	10	65,323	65,323	65,323	N/A
Aeration blower (main)	1	27	100%	27	176,373	176,373	176,373	N/A
Aeration blower (flow equalization)	1	13	100%	13	84,920	84,920	84,920	N/A
Imhoff tank odor control	1	2	100%	2	13,065	N/A	N/A	13,065
Recirculation tank pump	1	5	100%	5	32,662	N/A	N/A	32,662
Secondary clarifier								
Clarifier mechanisms	2	1	100%	2	13,065	13,065	N/A	N/A
Membranes								
Membrane blower	2	5	30%	3	19,597	N/A	19,597	N/A
Permeate pumps	2	5	100%	10	65,323	N/A	65,323	N/A
Aerobic digestion								
Digester blowers	2	5	90%	9	58,791	58,791	58,791	58,791
Sludge dewatering								
Screw press feed pump	1	5	30%	1.5	9,798	9,798	9,798	9,798
Screw press	1	2	30%	0.6	3,919	3,919	3,919	3,919
Cake conveyor	1	2	30%	0.6	3,919	3,919	3,919	3,919

Miscellaneous								
Drainage return pumps	1	5	10%	0.5	3,266	3,266	3,266	3,266
Plant water pumps	1	5	100%	5	32,662	32,662	32,662	N/A
Fans	2	1	100%	2	13,065	13,065	13,065	13,065
					Annual electricity consumption kWh:	533,038	604,894	206,422
					Annual electricity cost:	**$240,000**	**$270,000**	**$90,000**

Chemicals

Hypochlorite Tablets

Daily chlorine demand @ ADWF	6.3	lbs/d	*assuming 8 mg/L dose, 15 min contact time @ PHWWF*
Annual hypochlorite demand @ ADWF	2,300	lbs/yr	
Hypochlorite tablet unit cost	$8	per lb	
Total annual hypochlorite tablet cost:	**$18,400**		*common across all alternatives*

Dewatering polymer

Daily dewatering polymer use	1.3	lbs/d	*assuming 20 lbs/dry ton dose*
Annual dewatering polymer use	475	lbs/yr	
Dewatering polymer unit cost	$3	per lb	
Total annual dewatering polymer cost:	**$1,500**		*common across all alternatives*

MBR cleaning chemicals

Sodium hypochlorite & citric acid cost:	**$5,000**	per yr	*Alternative #2 only*

Membrane replacement (Alt #2)

Membrane cost per module	$1,950	*material costs only*
Estimated additional costs per module	$500	*shipping & handling + installation costs*
Number of membrane modules	24	*modules (12 per unit)*
Membrance replacement cost:	**$59,000**	**15 year life expectancy**

Maintenance materials

	Alt 1 RAS PP	Alt 2 MBR PP	Alt 3 RGF	
Package plant capital cost	$3,491,000	$3,515,000	N/A	
Process equipment capital cost	$5,140,000	$5,140,000	$9,129,000	*not including package plant*
Equipment replacement cost factor	25.0%	25.0%	25.0%	*replace after 20 years*
process equipment replacement cost	$1,285,000	$1,285,000	$2,282,250	*not including package plant*
Total equipment replacement cost:	**$4,776,000**	**$4,800,000**	**$2,283,000**	*includes 100% package plant replacement*
Maintenance materials cost factor	2.0%	2.0%	2.0%	
Total annual maintenance materials cost:	**$96,000**	**$96,000**	**$46,000**	

Sludge disposal

Daily dewatering flow:	517	gpd	
Daily dewatered sludge mass	0.54	wet tons/d	
West HI sanitary landfill tipping fee	$116.00	per wet ton	
Onsite disposal roll off dumpster size	5.00	cu yds	
Dumpster rental fee	$300.00	per week	
Annual dumpster rental fee	$15,600.00		
Disposal frequency	7.00	days	*Requires weekly disposal (once every 7 days)*
Diesel price (dollar per gallon)	$6.22	per gallon	
Employee labor cost per hour	$48.08	per hour	*based on 100K annual salary*
Distance Pahala to Landfill (roundtrip)	189.4	mi	*per google maps*
Distance Pahala to Naalehu (roundtrip)	24.8	mi	*per google maps*
Dump truck fuel economy	5.00	mpg	

Annual sludge disposal cost (truck to landfill) alternative

Annual fuel cost	$12,300
Annual landfill tipping fee	$22,900
Annual Dumpster rental fee	$15,600
Total annual sludge disposal cost:	**$51,000**

Annual sludge disposal cost (No dewatering - truck sludge to Naalehu) alternative

Storage capacity of dump truck	2000	gal	
Weekly volume of sludge	3,619	gal	
Required trips to Naalehu per week	2	count	
Required trips to Naalehu per year	104	count	
Distance traveled per year	2,600	mi	
Annual sludge disposal fuel cost	$3,300		
No dewatering polymer	-$1,500		
Total annual sludge disposal cost:	**$1,800**		*For informational purposes only*

New collection system maintenance (common across all alternatives)

Gravity collection sewer mainline	2.5	mi
Gravity mainline maintenance cost	$16,000	
Total annual mainline maintenance cost:	**$40,000**	

Reuse existing collection system maintenance

Gravity mainline maintenance multiplier	3
Total annual mainline maintenance cost:	**$120,000**

Appendix B: DOH Variance

DAVID Y. IGE
GOVERNOR OF HAWAII

ELIZABETH A. CHAR, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:

WW 705 Final CL Pahala WWTP
Hawaii Island

January 26, 2022

Mr. Craig Lekven
Director
Brown and Caldwell
2261 Aupuni Street, Suite 201
Wailuku, Hawaii 96793

Dear Mr. Lekven:

Subject: **Variance Application No. WW 705 Docket No. 21-VWW-69 ID 690**
Final Decision Regarding Wastewater System for
County of Hawaii, Pahala Wastewater Treatment Plant
Pahala, Hawaii 96777 TMK (3) 9-6-002: 018

The Department of Health (Department) has granted your request for the subject variance per the enclosed Decision and Order dated January 26, 2022 for five (5) years. We are also enclosing the Department's Findings of Fact and Conclusions of Law.

If there are any questions relating to the variance, please contact Ms. Sina Pruder, Chief of the Wastewater Branch at our direct toll-free number (808) 974-4000 ext. 64294.

Sincerely,

Glen Wong
for
JOANNA L. SETO, P.E., CHIEF
Environmental Management Division

LM/SP:bk

Enclosures: Final Decision Documents

c: Agent: Mr. Craig Lekven, via mail & email: clekven@brwncald.com
Applicant: Mr. Ramzi Mansour, via email: cohdem@hawaiicounty.gov
Clean Water Branch, (AW) via email
Safe Drinking Water Branch, (DL, NU) via email
Wastewater Branch, Hilo (AC) Staff Engineer, via email
County of Hawaii, Department of Water Supply, via email: dws@hawaiidws.org
Hilo District Health Office, via email: eric.honda@doh.hawaii.gov
Ms. Sandra Demoruelle, via email: NaalehuTheater@yahoo.com
Mr. Richard J. Oba, via email: richoba10@gmail.com

STATE OF HAWAII

DEPARTMENT OF HEALTH

In the Matter of the Variance Application WW 705)
For Individual Wastewater System)
County of Hawaii)
Pahala Wastewater Treatment Plant)
Pahala, Hawaii 96777)
TMK (3) 9-6-002: 018)
)

Docket No. 21-VWW-69
ID 690

DECISION AND ORDER

Pursuant to Hawaii Revised Statutes (HRS), Chapter 342D and Hawaii Administrative Rules (HAR), Chapter 62 of Title 11, "Wastewater Systems," and based upon the application and staff review, the variance request from the provisions of HAR section 11-62-24(b) is hereby granted for five (5) years with the following conditions:

1. As a minimum, the proposed Pahala Wastewater Treatment Plant (WWTP) shall be designed using an average dry weather flow of 95,000 gallons per day.

2. Plans for the proposed Pahala WWTP shall be designed in accordance with applicable requirements of Chapter 11-62, HAR and be submitted to the Wastewater Branch for review and approval. In addition, the WWTP shall be approved in writing before it may be used.

3. There is no automatic renewal. Should the applicant wish to renew this variance application, the applicant must submit an Application for Variance for renewal, 180 days prior to expiration date.

DATED: Pearl City, Hawaii, January 26, 2022 .

Alan Wong

for JOANNA L. SETO, P.E., CHIEF
Environmental Management Division

STATE OF HAWAII

DEPARTMENT OF HEALTH

In the Matter of the Variance Application WW 705)
For Individual Wastewater System)
County of Hawaii)
Pahala Wastewater Treatment Plant)
Pahala, Hawaii 96777)
TMK (3) 9-6-002: 018)
)

Docket No. 21-WW-69
ID 690

FINDINGS OF FACT AND CONCLUSIONS OF LAW

Department of Health (Department) staff reviewed an application from Mr. Ramzi Mansour, Director of the County of Hawaii, Department of Environmental Management has applied for a variance for the maximum of five (5) years from section 11-62-24(b) of Hawaii Administrative Rules (HAR), Chapter 62 of Title 11, "Wastewater Systems."

A public notice of the application was printed in the December 1, 2021 issue of the *Hawaii Tribune Herald* newspaper. Four (4) agency comments and twenty-nine (29) public comments pertaining to the application were received during the 30 days following the publication of the public notice.

Findings of Fact

Mr. Craig Lekven, Director of Brown and Caldwell is the authorized agent to act for the applicant. The variance request is to use a reduced design flow capacity for the proposed Pahala Wastewater Treatment Plant (WWTP) located in Pahala, Hawaii 96777 and TMK (3) 9-6-002: 018.

Additional statements and information for this project have been provided in the variance application. Please contact the Wastewater Branch at (808) 586-4294 for a copy of the Application for Variance and all comments received during the 30 days public notice period.

The following agencies submitted the following comments:

1. The Clean Water Branch submitted that they will defer to the Wastewater Branch's final decision. Please call Mr. Alec Wong, Branch Chief of the Clean Water Branch at (808) 586-4309, if you have any questions or comments.

2. The Safe Drinking Water Branch submitted that they will defer to the Wastewater Branch's final decision. Please call Mr. Norris Uehara, Supervisor of the Safe Drinking Water Branch's Underground Injection Control Program at (808) 586-4258, if you have any questions or comments.

3. The Wastewater Branch submitted the following comments:

   A. As a minimum, the proposed Pahala WWTP shall be designed using an average dry weather flow of 95,000 gallons per day.

   B. Plans for the proposed Pahala WWTP shall be designed in accordance with applicable requirements of Chapter 11-62, HAR and be submitted to the Wastewater Branch for review and approval. In addition, the WWTP shall be approved in writing before it may be used.

C. Upon agreement of the conditions stated above, we recommend the granting of this variance.

4. The Hawaii Department of Land and Natural Resources submitted comments pertaining to this variance application. Should you wish to review them, please contact the Wastewater Branch at (808) 586-4294 or email doh.wwb@doh.hawaii.gov for a copy.

Conclusions of Law

Hawaii Revised Statutes Section 342D-7(c), states that in part, no variance shall be granted by the Department unless the application and supporting information clearly show that:

1. The continuation of the function or operation involved in the discharge of waste occurring or proposed to occur by the granting of this variance is in the public interest as defined in section 342D-6;
2. The discharge occurring or proposed to occur does not substantially endanger human health or safety; and
3. Compliance with the rules or standards from which the variance is sought would produce serious hardship without equal or greater benefits to the public.

Based upon the foregoing findings of fact, it is concluded that the above requirements have been met.

Comment and Recommendation

Based upon the foregoing findings of fact and conclusions of law, it is my recommendation that the variance request be granted for five (5) years with the following conditions:

1. As a minimum, the proposed Pahala WWTP shall be designed using an average dry weather flow of 95,000 gallons per day.
2. Plans for the proposed Pahala WWTP shall be designed in accordance with applicable requirements of Chapter 11-62, HAR and be submitted to the Wastewater Branch for review and approval. In addition, the WWTP shall be approved in writing before it may be used.
3. There is no automatic renewal. Should the applicant wish to renew this variance application, the applicant must submit an Application for Variance for renewal, 180 days prior to expiration date.

DATED: Pearl City, Hawaii, January 26, 2022.

for JOANNA L. SETO, P.E., CHIEF
Environmental Management Division

The foregoing findings of fact and conclusions of law are hereby adopted.

Appendix C: Non-Economic Evaluation

Pahala WWTP Alternative Solutions
Non-Economic Evaluation February 2023

Category	**Category Weight**	**Criteria**	**Criteria Weight**	**Raw Scores**			**Weighted Scores**		
				Alt #1 RAS	**Alt #2 MBR**	**Alt #3 RGF**	**Alt #1 RAS**	**Alt #2 MBR**	**Alt #3 RGF**
Level of Service	25%	Effluent quality	30%	3	5	3	0.90	1.50	0.90
		Potential for capacity expansion	20%	5	5	2	1.00	1.00	0.40
		Water recycling feasibility	30%	3	5	2	0.90	1.50	0.60
		Public perception / community concerns	20%	3	5	3	0.60	1.00	0.60
Regulatory	25%	Monitoring complexity	25%	4	3	5	1.00	0.75	1.25
		Treatment adjustment potential	25%	5	5	3	1.25	1.25	0.75
		Safety regulations complexity	25%	4	4	4	1.00	1.00	1.00
		Environmental concerns	25%	4	5	3	1.00	1.25	0.75
O&M Factors	25%	Footprint	30%	5	5	2	1.50	1.50	0.60
		Safe work environment	25%	4	3	4	1.00	0.75	1.00
		Maintenance complexity	25%	4	3	4	1.00	0.75	1.00
		Operations complexity	20%	4	3	5	0.80	0.60	1.00
Island Factors	25%	Mainland delivery dependence	25%	3	3	4	0.75	0.75	1.00
		Mainland servicing dependence	25%	3	3	4	0.75	0.75	1.00
		Power dependence	25%	3	3	5	0.75	0.75	1.25
		Chemical dependence	25%	4	3	4	1.00	0.75	1.00
						Overall Score:	**3.80**	**3.96**	**3.53**

****Note : 5 = high/desirable, 1 = low/not-desirable*

PART B: IWS Approach

PART B

Pāhala Individual Wastewater System Preliminary Engineering Report

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Prepared for
Brown and Caldwell
&
County of Hawai'i, Department of Environmental Management

March 2023

YEN WEN FANG
EXP. 4/30/24
No. 9361-C

THIS WORK (PART B) WAS PREPARED BY ME OR UNDER MY SUPERVISION

Yen Wen Fang
Yen Wen Fang

April 30, 2024
Expiration Date of the License

ENGINEERING
PARTNERS

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Section 1

Preliminary Considerations

1.1 Operational Considerations

An effective Individual Wastewater System (IWS) management strategy is crucial to ensuring distributed treatment systems are maintained and operated in a way that ensures they are functioning properly and effectively treating wastewater. This strategy may include but is not limited to:

- **Monitoring:** Regular inspections of system components, such as septic tanks and drain fields, ensure they are functioning properly and identify and address any issues that may arise.
- **Maintenance:** Proper maintenance of the system is also crucial, including regular pumping of septic tanks, cleaning and maintenance of the distribution systems, and proper maintenance of the treatment components. Regular maintenance can help prevent issues such as clogs and backups, which can lead to costly repairs and potential health hazards.
- **Regulatory Compliance:** Necessary permits and licenses are obtained for the system, and required inspection and reporting schedules are met with the local regulator.
- **Community Education:** Information and training on proper usage and maintenance of the systems are provided to homeowners, and any concerns or questions that may arise are addressed.

In Hawaiʻi, centralized wastewater treatment plants and cluster systems are regulated and inspected by the Department of Health (DOH) Wastewater Branch (Hawaiʻi Administrative Rules 11-62). State-licensed WWTP operators are required for oversight to ensure that systems are inspected, operated, and maintained as required. A similar regulatory requirement does not exist for IWS in Hawaiʻi. The State DOH Wastewater Branch is responsible for regulating IWS while operation and maintenance are currently the responsibility of the individual homeowner. If IWS were selected to serve Pahala Community, maintenance responsibilities could be distributed in a number of ways. In a 2003 resource, the EPA outlined five management models that can be used for the operation and maintenance of IWS (Figure 1.1).

When selecting an appropriate management model for a network of IWS it is important to take into account the regulatory and cultural framework within which the IWS are situated. As it stands in Hawaiʻi, IWS are currently managed using a combination of management Models 1 and 2 (DOH, 2016):

- **Model 1: Homeowner Awareness.** The DOH allows septic systems to be managed under this model. Homeowners own and operate their own IWS and are responsible for keeping the system in good working order.

- **Model 2: Maintenance Contracts.** The DOH requires that Aerobic Treatment Units (ATUs) are managed using this model. Homeowners are required to have an active service contract with a certified operator or factory certified representative, and a copy of that active service contract must be submitted annually to the DOH (DOH, 2016). Elevated regulation around the operation of ATUs is a reflection of their increased mechanical complexity and associated maintenance demands.

Figure 1.1: The five management models for IWS maintenance (EPA, 2003)

The Five Management Models				
Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Homeowner Awareness:	**Maintenance Contracts:**	**Operating Permits:**	**Responsible Management Entity (R:ME) Operation and Maintenance:**	**RME Ownership:**
specifies appropriate program elements and activities where treatment systems are owned and operated by individual property owners in areas of low environmental sensitivity. This program is adequate where treatment technologies are limited to conventional systems that require little owner attention. To help ensure that timely maintenance is performed, the regulatory authority mails maintenance reminders to owners at appropriate intervals.	specifies program elements and activities where more complex designs are employed to enhance the capacity of conventional systems to accept and treat wastewater. Because of treatment complexity, contracts with qualified technicians are needed to ensure proper and timely maintenance.	specifies program elements and activities where sustained performance of treatment systems is critical to protect public health and water quality. Limited-term operating permits are issued to the owner and are renewable for another term if the owner demonstrates that the system is in compliance with the terms and conditions of the permit. Performance--based designs may be incorporated into programs with management controls at this level.	specifies program elements and activities where frequent and highly reliable operation and maintenance of decentralized systems is required to ensure water resource protection in sensitive environments. Under this model, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance is performed.	specifies that program elements and activities for treatment systems are owned, operated, and maintained by the RME, which removes the property owner from responsibility for the system. This program is analogous to central sewerage and provides the greatest assurance of system performance in the most sensitive of environments.

The AOC stipulates that the County of Hawaiʻi must administer a more active management strategy than is typical in Hawaiʻi, either a Model 2 (Maintenance Contract) or Model 3 (Operating Permit) management strategy for a network of IWS at Pahala. These models reflect varying degrees of responsibility to the County and homeowner (Table 1.1). Four potential variations of these models are outlined here for implementation on this project:

- **Management Model 2A: Maintenance Contract with County In-House Staff**
  The County employs and trains an in-house IWS management team; purchases and maintains its own pumping/hauling equipment; and administers the management program. The homeowner pays a monthly sewer fee that covers a portion of the costs.
- **Management Model 2B: Maintenance Contract with Third-Party Service**
  The County administers the management program, keeps an operations and maintenance (O&M) schedule, and contracts out O&M activities to a third-party service provider. The homeowner pays a monthly sewer fee that covers a portion of the costs. Administration costs for this program can be mitigated with the use of an online asset management service.
- **Management Model 3A: Operating Permits with O&M by Users**
  The County issues an operating permit to the homeowner; keeps an O&M schedule; and sends out maintenance reminders to homeowners. The homeowner is responsible for contracting a third-party service provider to conduct maintenance. An online asset management service with a portal for approved maintenance professionals to log service events is strongly recommended for the County to track homeowner compliance and levy fines, as needed.
- **Management Model 3B: Operating Permits with O&M Voucher by County**
  The County issues an operating permit to the homeowner; keeps an O&M schedule; and sends out maintenance reminders with service vouchers to homeowners. The homeowner pays a sewer fee and is responsible for contracting a third-party service provider to conduct annual maintenance using the voucher. An online asset management service with a portal for approved maintenance professionals to log service events is strongly recommended for the County to track homeowner compliance and levy fines, as needed.

These management strategies presented here are required by the AOC but are also unique to Hawaiʻi and will present a number of barriers for implementation at the legislative, regulatory, and public levels. The Pahala Community and Hawaiʻi's stakeholders at large are accustomed to Management Model 1, which is the standard practice across the State of Hawaiʻi.

Table 1.1: County and homeowner responsibilities under variations of the EPA management models 2 and 3

Management Model	Brief Description of Management Model	County's Responsibility	Homeowner / User's Responsibility	Pros	Cons
2A	Maintenance Contract w/ County in-house staff	• Funds design and construction of IWS • Purchase equipment & train IWS operator • O&M of IWS including trouble calls • Keeping record of O&M log • Send out notices and reminders to homeowners • Submit IWS inspection reports and variance renewals to State DOH	• Report IWS problem to County • Cooperates and allows County staff to enter private property and provide maintenance of IWS • Maintain clearance to IWS for easy access	1. Best control on O&M schedule 2. Ensure best IWS performance	1. Highest cost 2. May not receive cooperation from some homeowners/users 3. Homeowner may have more trouble calls 4. Potential dispute between homeowner & County on plumbing repair cost & IWS repair cost
2B	Maintenance Contract w/ 3rd Party Service	• Funds design and construction of IWS • Select/prequalify certain 3rd party service provider (Pumper) • Issue PO to Pumper & plumber for annual inspection and trouble calls • Keeping record of O&M log • Send out notices and reminders to homeowners • Submit IWS inspection reports and variance renewals to State DOH	• Report IWS problem to County • Cooperates and allows service providers to enter private property and provide maintenance of IWS • Maintain clearance to IWS for easy access	1. Better control on O&M schedule 2. Ensure better IWS performance 3. Less County staff to train 4. No pumping/hauling equipment to purchase & maintain	1. Higher cost 2. May not receive cooperation from some homeowners/users 3. Homeowner may have more trouble calls 4. Potential dispute between homeowner & County on plumbing repair cost & IWS repair cost
3A	Operating Permits w/ O&M by Users	• Funds design and construction of IWS • Keeping record of O&M log • Send out notices and reminders to homeowners • Enforce rules and regulations • Issues permit to homeowner to use, operate & maintain the IWS	• Contracts with preferred pumper / plumber to maintain the IWS • Pay for the O&M service • Submit O&M record to County • Submit IWS inspection reports and variance renewals to State DOH	1. Least cost to County 2. No O&M staff or equipment 3. No trouble calls	1. Least control for IWS compliance & performance 2. Conflict with non-compliant homeowners 3. Highest cost to homeowner
3B	Operating Permits w/ O&M Voucher by County	• Funds design and construction of IWS • Keeping record of O&M log • Send out notices and reminders to homeowners • Enforce rules and regulations • Pre-select qualifying service providers • Issue vouchers to homeowners for annual inspections and pumping • Issues permit to homeowner to use, operate & maintain the IWS	• Contracts with preferred pre-qualified pumper / plumber to maintain the IWS • Pay for the annual O&M service with voucher • Submit O&M record to County by pumper • Submit IWS inspection reports and variance renewals to State DOH	1. Reasonable control on O&M 2. Reasonable IWS performance 3. Less County staff to train 4. No pumping/hauling equipment to purchase & maintain 5. Trouble calls to be paid for by homeowner	1. High cost to County 2. Less control of all IWS

1.2 Economic Considerations

When assessing the overall cost of a given system, it is important to consider the net present value lifecycle cost taking system lifetime and installation, maintenance, and operation costs into account. These costs can be affected by a variety of factors, including:

- **Type of treatment and disposal system:** The selection of different types of treatment systems such as traffic rated tanks or aerobic treatment significantly affect overall installed cost. For disposal, seepage pits are significantly lower cost than absorption fields when it is possible to convert an existing cesspool. Site specific conditions will control which options are required. For traditional residential IWS installations subject to State procurement regulations, capital costs per household are typically in the range of $30,000-$100,000 (Table 1.2).

Table 1.2: Installation cost estimates for a standard septic tank installed in conjunction with an absorption bed (left) and seepage pit (right). Figures are based on a 3-bedroom house and a percolation rate no slower than 5 min/inch.

	Standard Absorption Bed		Seepage Pit	
	Low (non-traffic)	High (Traffic Rated)	Low (non-traffic)	High (Traffic Rated)
Septic Tank	3,000.00	7,000.00	3,000.00	7,000.00
D-Box	750.00	2000 .00	–	–
Sewer pipe	250.00	250.00	250.00	250.00
Leach field-pipe/ chamber	500.00	3,000.00	–	–
Leach field-gravel	1,000.00	500.00	–	–
Cone. Ring	–	–	3,000.00	3,000.00
Cone. Cover	–	–	2,500.00	4,000.00
Soil replacement	1,500.00	1,500.00	–	–
Inspection ports	500.00	500.00	–	–
Misc. material	2,000.00	2,000.00	2,000.00	2,000.00
Material Total	**$ 9,500.00**	**$ 16,750.00**	**$ 10,750.00**	**$ 16,250.00**
Labor / Equipment	7,500.00	15,000.00	7,500.00	15,000.00
Remoteness	5,000.00	5,000.00	5,000.00	5,000.00
Trucking for spoils	3,000.00	3,000.00	3,000.00	3,000.00
Tight working space	3,000.00	10,000.00	3,000.00	10,000.00
Relocate/reinstall/ repair	5,000.00	50,000.00	5,000.00	50,000.00
TOTAL	**$ 33,000.00**	**$ 99,750.00**	**$ 34,250.00**	**$ 99,250.00**

- **Operations and Maintenance cost:** Operations and maintenance cost also play a big role in overall cost of IWS. Annual maintenance costs for a traditional septic system can typically run up to $400/year. Additional operations costs for aerobic treatment units are estimated to be $18,000/year to cover the electricity bill and contract operator cost.

Annual maintenance costs to the County and homeowner vary depending on the management strategy. Here it is estimated that bringing maintenance in-house is the most affordable option (Table 1.3). However, the use of an efficient asset management tool could bring down cost redundancy in the following strategies. Annual costs over a 20-year service lifetime are further expounded in Appendix C.

Table 1.3: The costs associated with four IWS management models, assuming septic systems with leach fields (Appendix A).

Management Model	**Average Annual Cost to County**		**Average Annual Cost to Homeowner**		**Net Annual Cost to County**	**Total Annual Dollars Spent**
	Third-Party Service Provider	In-House	Third-Party Service Provider	County Sewer Bill		
2A: Maintenance Contract w/ County in-house staff	–	($956)	-	$600[1]	($356)	($956)
2B: Maintenance Contract w/ 3rd Party Service	($783)	($572)	-	$600[1]	($755)	($1,355)
3A: Operating Permits w/ O&M by Users	–	($572)	($733)	-	($572)	($1,305)
3B: Operating Permits w/ O&M Voucher by County	($533)	($572)	-	$600[1]	($505)	($1,105)

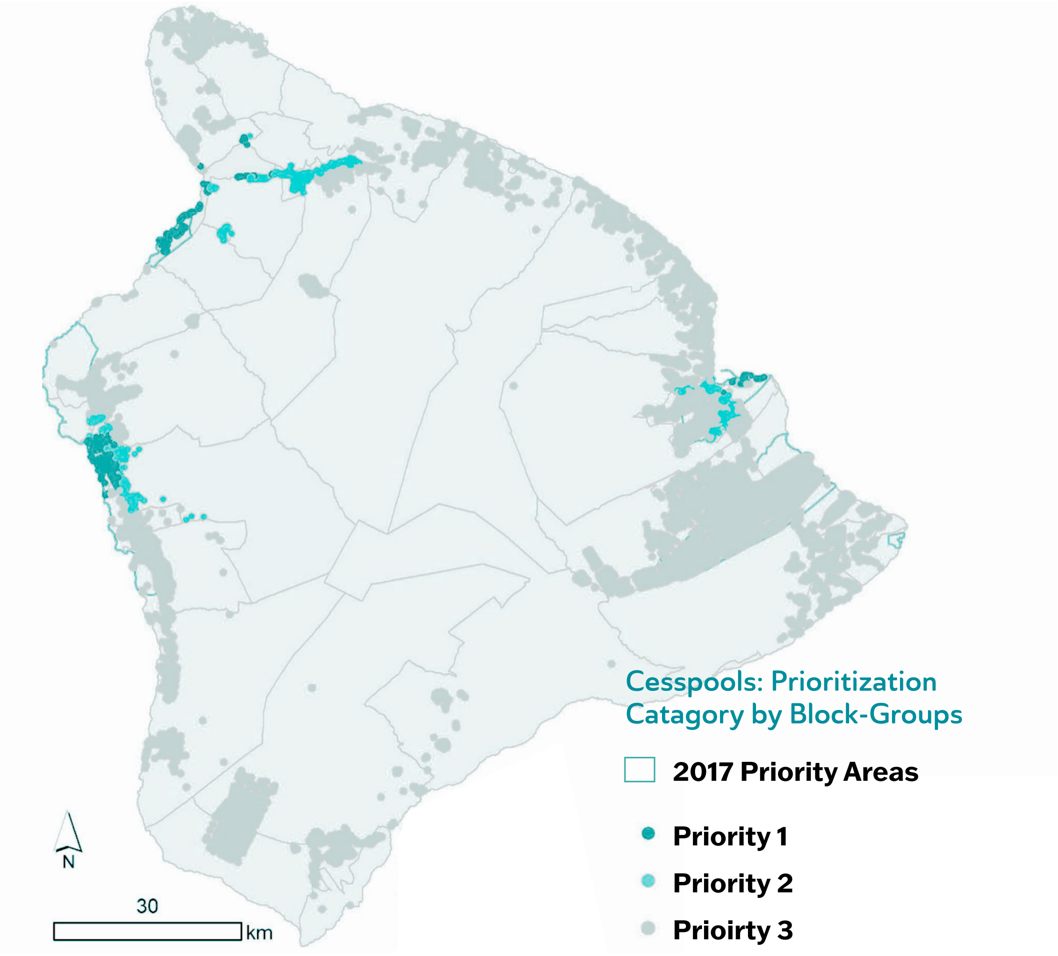
1.3 Environmental Considerations

Properly designed and operated IWS are an effective means of wastewater disposal at a fraction of the cost compared to a centralized treatment facility. Conversely, poorly designed and maintained IWS are failing at rates between 25-70% nationally (Mohamed, 2009). Approximately 168,000 viral and 34,000 bacterial illnesses each year in the US can be traced to failing septic tanks (Ibid.). Septic tanks are also the second most common contributor to groundwater pollution and a contributing source in one-third of all harvest-limited ocean growing areas (EPA, 2003). Consequently, care must be taken in both the technical design and management strategy of IWS.

The DOH Wastewater Branch has assigned priority levels to each of the 88,000 cesspools across the state of Hawaiʻi (DOH, 2017). These priority levels ranged from Priority 1: Significant Risk of Human Health Impacts, Drinking Water Impacts, or Draining to Sensitive Waters to Priority 4: Impacts Not Identified. Priority 1 and 2 areas would be required to upgrade sooner and to higher levels of treatment.

On Hawaiʻi Island, the Hilo Bay, Kona, Puakō, and Kapoho were identified as priority 3 areas while Kea'au was identified as priority 2. Pāhala meanwhile fell under priority 4, the lowest of those available, as an area for which health and environmental risks had not been assessed or appeared low. Subsequently, a more comprehensive 2021 study that explored Hawaiʻi's cesspool prioritization, factoring in a total of 15 risk factors, reached a similar conclusion (Mezzacapo & Shuler, 2021).

Figure 1.2: Prioritization of Hawaiʻi Island cesspools based on 15 site specific risk factors (Mezzacapo, 2022)



1.4 Constructability

IWS are designed to treat and dispose of wastewater generated by individual homes. The design of these systems must take into account a variety of technical considerations to ensure the system functions as intended and protects public health and the environment:

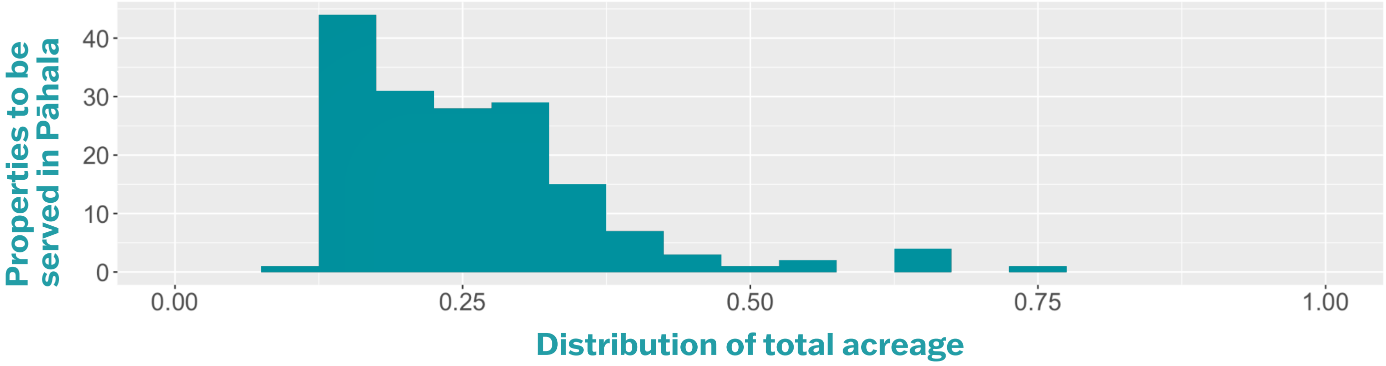
- **System Size:** The size of the system, including the number of bedrooms or the flow rate, can significantly affect the design of an IWS, particularly in space-constrained communities like Pāhala.
- **Site Conditions:** The soil type, slope, drainage patterns, and accessibility of the site can affect the design and cost of the system. For example, a site with poor soil conditions may require more expensive treatment methods or additional site preparation.
- **Location:** Factors such as labor and materials costs will increase due to the remoteness of the community and distance from major population and commercial centers.
- **Influent Characteristics:** Pollutant types and concentrations can vary significantly from property to property. Wastewater produced from a single-family household is quite different from that of a restaurant, for example.
- **Level of Treatment:** The desired level of treatment can also affect the design. If regulations require a higher level of treatment than a conventional septic system can provide, advanced treatment systems are required.

The following section outlines the impact of these considerations on the constructability of a system of IWS to serve the Pāhala community.

1.4.1 Available Space Per Property

Lots to be served in the community vary in size from 0.12 to 67 acres with a median size of 0.24 acres (Figure 1.3). Per Hawaiʻi Administrative Rules, HAR 11-62-31.1 (2)(A), 10,000 ft2 (0.23 acres) of usable land must be available for each IWS. Of the 170 properties to be served in this project, 81 have less than 10,000 ft2 of total area. Space available for IWS installation on these properties is further limited by the presence of both permitted and unpermitted structures.

Figure 1.3: Distribution of total acreage (x-axis) for properties to be served in Pāhala under this project.



The actual location of treatment and disposal infrastructure is limited by setback requirements. DOH-required setbacks are presented below (Table 1.4). From a system design perspective, it is recommended that systems should also be a minimum of 20 feet from any cut-face slopes present on a site to avoid surfacing of treated effluent. This is a particular constriction to heavily sloped sites.

Table 1.4: DOH required setbacks for wastewater systems per HAR 11-62.

Features	Treatment Unit (ft)	Seepage Pit (ft)	Soil Absorption System (ft)
Structure Wall Line	5	5	5
Property Line	5	9	5
Surface Water Body	50	50	50
Large Trees	5	10	10
Municipal Water Supply Well	1000	1000	1000

1.4.2 Site Slopes

Slopes vary from site to site but the project as a whole has roughly a 10% grade (Appendix D). This is likely to affect the constructability of absorption beds as a method of wastewater disposal. Per HAR

11-62-34, absorption beds shall not be installed on land with a slope gradient greater than 8%, while absorption trenches are permitted on a slope of up to 12%. .

1.4.3 Traffic Area

It is generally not good practice to install an IWS under a trafficked or otherwise concreted area. The presence of concrete or traffic compresses the soil in distribution systems and affects the accessibility of the system for maintenance. However, it is sometimes unavoidable on particularly spatially-constrained properties. In this event, a system may be installed underneath a driveway or patio provided the system is designed to that end and traffic rated treatment components are used. These may include products such as concrete septic tanks and/or H-20 traffic related chambered disposal beds.

1.4.4 Site Geology

The US Geology Survey was consulted for site soils information (Appendix E). The site is principally composed of Nāʻālehu medial silty clay loam and Puueo-Nāʻālehu complex. The surface of both compositions features silty loam, but the Puueo-Nāʻālehu complex gives way to lithic bedrock at a depth of approximately 20-40 inches.

This data was reinforced by the boring logs from a 2012 Ka'ū Gymnasium Foundation Investigation by Hirata & Associates and a 2021 Geotechnical Data Report by Yogi Kwong Engineers that found fresh to moderately weathered basalt extending to a depth of 15-25 feet.

From Hirata & Associates (Appendix F):

> *"The surface soil consisted of brown clayey silt derived from volcanic ash. Although the clayey silt/volcanic ash encountered in our borings appeared to be in a firm to medium stiff condition, laboratory testing indicated high compressibility characteristics. Underlying the surface volcanic ash at depths ranging from about 6 inches to 4.5 feet was gray, slightly to moderately weathered basalt. The basalt was in a medium hard to hard condition and extended to the maximum depths drilled (24.5 ft). A cavity was encountered within the basalt stratum in a boring at depths of about 11 feet, extending down to 14 feet"*

From Yogi Kwong Engineers (Appendix G):

> *Basalt lava flows were encountered underlying the Fill or Tephra Deposits at an initial depth ranging from approximately 1.0 to 5.5 feet bgs through the explored depths of approximately 15.0 to 25.1 feet bgs. The encountered basalt lava flows ranged from fresh to slightly*

weathered, medium hard to hard, intensely to occasionally fractured, and moderately vesicular to scoriaceous.

The underlying basalt found at the site will significantly increase the size and installation cost of IWS. Further, it will be important to exercise caution during excavation due to the potential to encounter underground cavities and lava tubes.

1.4.5 Percolation Test Results

IWS sizing is based on the percolation rate of the receiving soil. Percolation rates were estimated for the Pāhala community by two methods (Table 1.5):

- Preliminary percolation tests were conducted to a depth of 2-4 feet at four sites distributed across the project (Appendix H). A tightly bonded gray basalt and volcanic ash soil layer was encountered in three of the four tests limiting the depth of the test.
- 2012 records of percolation testing at the local Ka'ū Gymnasium were consulted (Appendix D). Similarly, gray basalt was encountered at a depth of 1-4 feet, however holes were drilled to a depth of five feet.

Table 1.5: Percolation test results

Measure	2022 EPI Pāhala LCC Replacement PER (min/in)	2012 Hirata & Associates Ka'ū Gymnasium Foundation Investigation (min/in)
Test 1	10 @ 4 ft	8.5 @ 5 ft
Test 2	10 @ 2 ft	18.5 @ 5 ft
Test 3	4 @ 2.5 ft	23 @ 5 ft
Test 4	10 @ 3 ft	16.5 @ 5 ft
Test 5	–	8.4 @ 5 ft

IWS traditionally take the form of a seepage pit or absorption field. Absorption fields disperse treated wastewater over a larger area using a buried network of gravity fed perforated pipes. Seepage pits, on the other hand, are deep holes, extending downward to achieve increased absorption area instead of horizontally. Absorption bed and seepage pit sizing for a typical three-bedroom home varies significantly with the percolation rate found on each property (Table 1.6).

Table 1.6: Percolation test results

Percolation Rate (min/in)	4	12	20
Infiltration Area Required (ft²)	345	525	630
Possible Absorption Field Length (ft) (W = 15 ft)	23	35	42
Possible Seepage Pit Dimension (Diameter = 6 ft)	12	19	22
Septic Tank Area Required (ft²)	60	60	60
Total Footprint with Absorption Field (ft²)	480	660	765
Total Footprint with Seepage Pit (ft²)	120	120	120

1.4.6 Proximity to Bodies of Water

An assessment for proximity to bodies of water found that all 170 of the properties in the Pāhala community exceed all required minimum DOH setbacks, avoiding any limitations to IWS installations (Table 1.7).

Table 1.7: Proximity to bodies of water for properties in Pāhala with an existing cesspool from the Hawaiʻi Risk Prioritization Tool (Mezzacapo & Shuler, 2021).

Measure	Min	Med	Max	DOH Setback
Distance to Surface Water (ft)	400	1145	2073	50
Distance to Groundwater (ft)	715	882	964	3
Distance to Municipal Well (ft)	1155	2952	4536	1000

1.4.7 Accessibility

The installation of an IWS can be a relatively invasive process requiring large equipment like excavators and cranes. Accommodating this equipment often requires the destruction of fencing, existing landscaping, and in some cases small structures. Building footprints as well as overhanging soffits must be considered in the design stage when approximating access path widths and selecting appropriate treatment system designs. Access should be considered for installation as well as future maintenance activities. Opportunities to resolve access issues include:

- **IWS Placement:** Front-yard installations are recommended for homes without sufficient path widths to accommodate equipment access into the backyard.
- **Lightweight or Cast-in-Place Technologies:** The use of a crane can be avoided by specifying cast-in-place concrete septic tanks instead of precast varieties for particularly inaccessible locations. Alternatively, plastic and fiberglass offer lightweight alternatives for simplified installation.
- **Alternate Access Routes:** A property backyard may be accessed from a neighbors property by temporarily removing a fence.

1.4.8 Landowner Engagement

The County of Hawaiʻi has held meetings in both Pāhala and Nāʻālehu in order to engage directly with community members about the status of the cesspool closure projects. Most recently, with the approval of the revised AOC, the County reinforced its commitment to the community and actively sought their engagement and support of the project. For example, all meetings follow important cultural protocols and are co-led by residents who are respected and speak on behalf of the community. Moreover, all meetings actively seek input from the community and provide updates on the project via PowerPoint presentations that provide a clear overview of new developments in the project. The following timeline provides an overview of important meetings and milestones that occurred in the past year:

- In March 2022, a community meeting was held in Pāhala to gauge potential for community support. The EPA acknowledged revisions are needed to the 2017 AOC and reopens negotiations with the County.
- In June 2022, the County signed the Proposed Revised AOC. DEM engages consultants.
- In July 2022, the EPA signed the Revised AOC and circulated a draft for public comment. DEM begins work on feasibility studies, public presentation, and the project website.
- On August 12, 2022, the website was launched.
- August 22, 2022 is the effective date of the final Revised AOC.
- On October 6, the first public meeting to discuss the final Revised AOC was convened.
- In February 2023, a meeting was held in Pāhala to share the progress of the County's most recent semi-annual report to the EPA. An update of the Feasibility Evaluation Report and the Preliminary Engineering Report are also shared via PowerPoint

presentation.

- The County recommits to the community by mailing notices to community members who have signed in. Notices are also posted to several local newspapers, the County webpage and the two community centers in Pāhala and Nāʻālehu.

Community buy-in is seen as especially important because the successful completion of this project necessitates that homeowners cooperate in the design and permitting process, the preparation of a simple floor plan, and of course during the construction process for access permission. On the surface, this project is a win for homeowners to be included in the project and the community. Their household cesspool or sewer connection will be upgraded to comply with the cesspool replacement mandate with government funding, a deal that most homeowners in Hawaiʻi are not being offered. However, there are a number of sacrifices that homeowners will face:

- **New Operations and Maintenance Costs:** Homeowners in Pāhala Community, currently connected to functioning individual cesspools, don't currently pay annual operation or maintenance costs. Homeowners connected to the LCC are currently paying a reduced sewer fee representing about 50% of the standard sewer rate (Hawaiʻi County, 2023). This project will either introduce a full-rate monthly sewer fee or a biannual bill for private maintenance of their new system. It is quite likely that some homeowners don't see a need to upgrade from the current system. However, initial opposition to the project has largely been addressed through the County's engagement efforts.
- **Property Destruction:** Many homeowners are protective of their property. Permission is not trivial for a project that poses a risk to their landscaping, fences, and buildings. Homeowner satisfaction with the project will be closely linked with the speed and care with which their properties are upgraded and restored to pre-construction conditions or better.

1.4.9 Availability of Resources and Contractors

As an island state, Hawaiʻi faces unique challenges when it comes to the availability of IWS. The entire IWS market in Hawaiʻi grew from 1192 units per year in 2018 to 1414 units per year in 2021. Based on permits issued, sourcing the 170 treatment units required for this project will require an increase in statewide treatment unit supply and workforce size by 14% (DOH, 2022). This will require advanced planning to overcome this logistic hurdle.

Locally-based septic manufacturers include Jensen Precast on Oʻahu and Chemtainer on Hawaiʻi Island. At present, Jensen produces approximately 40 concrete septic tanks per year. With that said, the company has stated that they have the capacity to build one septic tank per day to keep up with the needs of the project. The bottleneck to their current production rate has been cited as a shortage of inspectors, contractors, and engineers in the local market. Chemtainer manufactures polyethylene septic systems on Hawaiʻi Island but was unwilling to share their annual production rates. Mainland treatment system manufacturers like Orenco and Infiltrator have significantly higher production rates but will also face increased shipping costs in transporting the units to Hawaiʻi. In either scenario, it will be important to work with manufacturers from early in the design stage to reduce barriers and meet deadlines, and even then, it is possible that multiple suppliers will be required.

Section 2

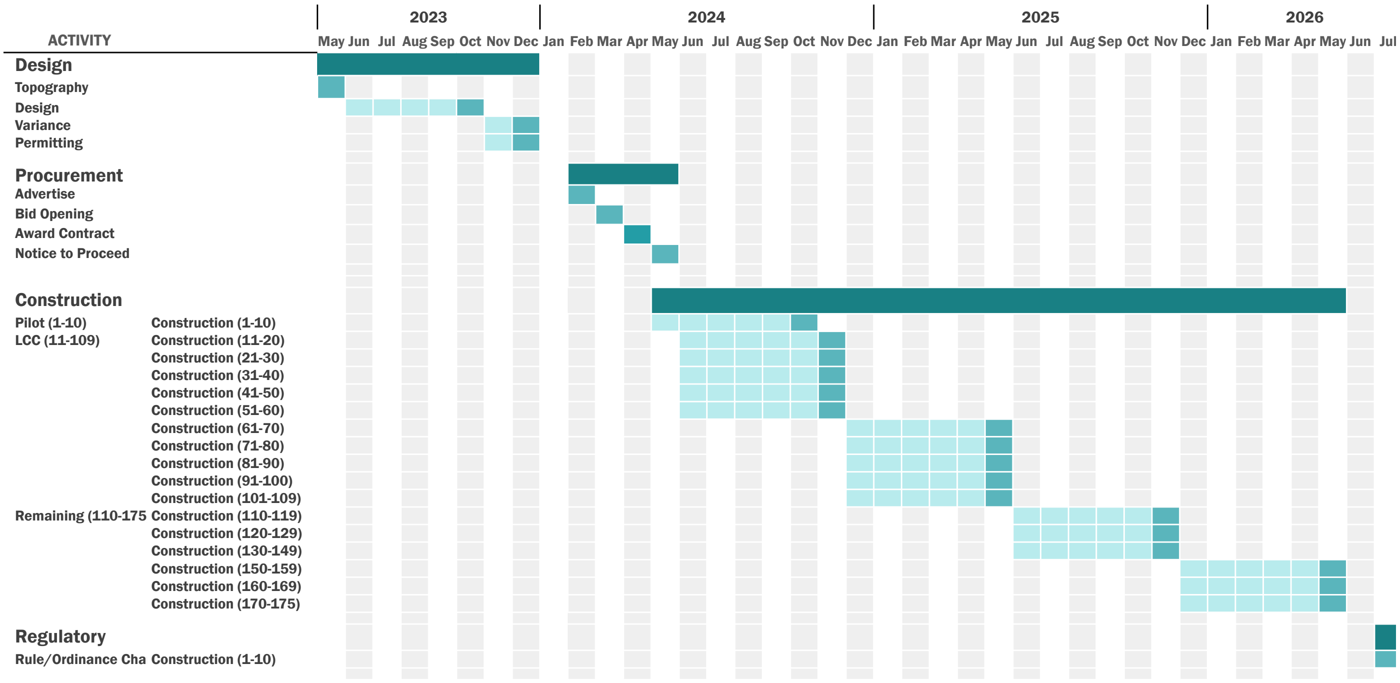
Project Timeline

2.1 Project Schedule

Phasing for this project should reflect deadlines as well as workforce and product availability. The AOC requires that the LCC be decommissioned and the 109 connected properties upgraded by the end of 2026, though the preliminary timeline projects completion by 2025. A 10-site pilot consisting of LCC connected properties is expected to be permitted and constructed by the end of 2023. Lessons learned will be integrated into the design and permitting of the next phase of 99 LCC connected properties, which will be completed before the end of 2024. Finally, the properties currently connected to individual cesspools should be permitted and constructed towards the end of 2024 and into 2025.

For a single contractor, cesspools the IWS can be installed at a rate of one site per week on simple sites per week on simple sites, and one site every two weeks where soil conditions and accessibility are less favorable. In order to increase the pace of the project, multiple contractors will be awarded construction contracts in 10-lot bundles that may be completed simultaneously (Table 2.1).

Table 2.1: Pāhala LCC Replacement Schedule



2.2 Typical IWS Permitting and Construction process

The permitting and construction process for IWS is largely standardized in the deliverables and timelines. First, the engineer prepares and submits a design package for DOH approval, which once received initiates the construction process. Once constructed, the engineer inspects the finished treatment system and files a final inspection report with the DOH. If everything is in order, the DOH returns an Approval for Use letter.

The Pāhala LCC Replacement project will deviate from the standard process in three principal ways:

- **Properties to be Permitted in Bulk:** The DOH has expressed the capacity to receive packages in groups of 10 or more properties. This will serve to expedite DOH review process.
- **Variance Requests:** Due to preliminary data on percolation rates and property sizing, it's expected that DOH variances to setback constraints will be required to accommodate absorption fields. Where space is still overly constrained, DOH variances will be required to allow for seepage pit installation. The procedure to receive a variance requires the rejection of the original design package and a subsequent variance application and review. This additional step usually adds approximately two months to the permitting process following design package review but the DOH has expressed willingness to allow the request for variance to be included with the initial design package.
- **Optioned Design:** The geological conditions present at a given site will not be known until construction on that site commences. These conditions will have a significant impact on the disposal system design. To accommodate this uncertainty in the design and facilitate permitting, an optioned design package shall be submitted to the DOH to allow for a field determination according to the actual percolation rates and soil composition encountered.

The timeline and deliverables for this procedure is outlined on the following page (Table 2.2).

Table 2.2: Hawai‘i Permitting and Construction Process

Step	Timeline	Party	Deliverables
Design Package + Variance Application Preparation	4-6 months	Engineer	• Site Evaluation/Percolation Test Result • IWS Calculation • Parcel map • Plot Plan • Simple Building Floor Plan for number of bedroom determination • IWS Layout • IWS Profile • IWS Details • Owner Certification form • $100 IWS Application Fee
Design Package Review	2-4 weeks	DOH	Letter of Approval
Variance Application Review	2 months	DOH	Letter of Approval for Construction
Construction	1-2 weeks/property	Contractor	Completed IWS
Inspection	1 day/property	Engineer	• Final Inspection Report (FIR) • As-Builts
FIR Review	1 month	DOH	Approval for Use

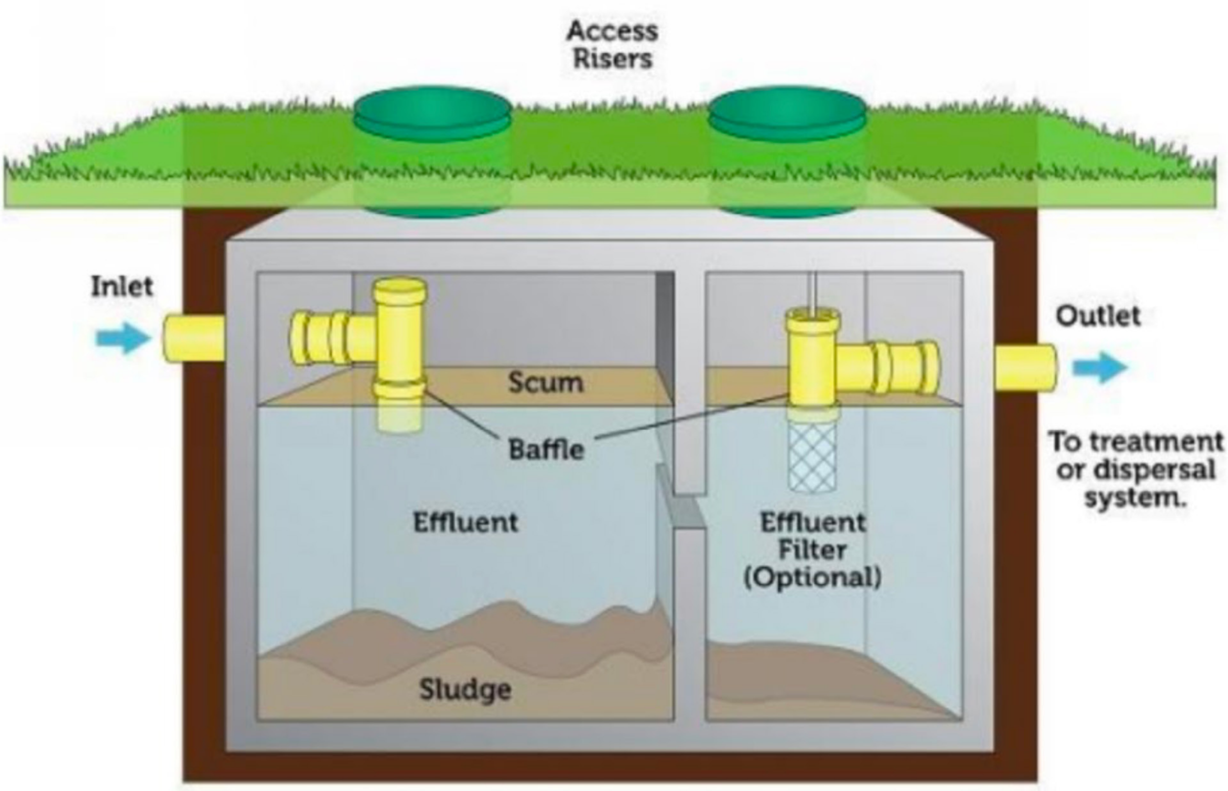
Section 3

Treatment Technologies

3.1 Septic Tanks

Septic tanks are the most common conversion treatment technology in Hawaiʻi. IWS contractors are familiar with the installation process and they operate without the need for electricity. A septic tank is an underground chamber made of concrete, fiberglass, or plastic, used for treating and disposing of household wastewater. The tank is filled with a mixture of wastewater and anaerobic bacteria, which break down the waste and separate it into three layers: a top layer of scum, a middle layer of liquid effluent, and a bottom layer of sludge (Figure 3.1). The liquid effluent flows out of the tank and into a means of disposal, where it is further treated and dispersed into the soil. The sludge and scum remain in the tank, and must be periodically pumped out by a professional septic service approximately once every two years, depending on usage.

Figure 3.1: Side-view of a typical two-chambered septic tank (Carollo, 2021).



Residential septic systems on their own remove about half of the organics in the wastewater stream and none of the nitrogen. The overall level of treatment is thought to be much higher when well-maintained and operating with a fully functional absorption bed (Table 3.1).

Table 3.1: Typical septic system performance in Hawaiʻi (Carollo, 2021).

Contaminant	Typical Raw Residential Wastewater [1]	Typical Septic Tank Effluent Quality [2]	Typical Effluent Quality Following Soil Absorption System [2]
Total Nitrogen, mg N/L [4]	14-40	39-82	~1
TSS (mg/L)	100-400	49-161	~4
BOD (mg/L)	100-400	132-217	<30
Fecal Coliform, MPN/100ml [3]	~10^6	1-10^6	~13

[1] From Table 2-1 (Water Resources Center (WRRC) University of Hawai'i-Manoa, 2008).
[2] From Table 4-1 in the Onsite Wastewater Treatment Survey and Assessment Study (WRRC, 2008).
[3] MPN/100mL = most probably number per 100 milliliters.

There are several septic tank providers commonly used in Hawaiʻi offering tanks of a variety of price points and materials. Septic tanks can be made from concrete, plastic, and fiberglass (Figure 3.2), each of which having its own set of pros and cons (Table 3.2). Where a septic tank is located beneath a vehicular traffic area, a traffic rated concrete septic tank can be used or a structural concrete slab designed for H-20 loading spanning a non-traffic tank may be used.

Figure 3.2: Common septic tank materials and shapes in Hawaiʻi (Carollo, 2021).

Rectangular, Concrete Tank Oval, Concrete Tank Cylindrical, Concrete Tank

Rectangular, Plastic Tank

Fiberglass, Oval Tank

Steel, Horizontal, Cylindrical Tank

Table 3.2: Advantages and Disadvantages of Septic Tank Materials (Carollo, 2021).

Septic Tank Material	Advantages	Disadvantages
Concrete	• Durable • Less susceptible to collapse and floatation • May be cast-in-place for custom shape	• Precast tanks can be more expensive than plastic or FRP due to shipping and installation costs • Typically requires use of a crane for installation • Concrete may corrode over time due to acidic sewer gases
Plastic (polyethylene)	• Less expensive than precast concrete tanks (lower shipping and installation costs) • Variety of manufacturers and sizes for desired footprint • Plastics are typically resistant to corrosion • May not require a crane for installation	• Plastic tanks may deform depending upon quality of the plastic and potential structural weaknesses of the material • If not installed properly, plastic tanks can float if flooded
Fiberglass-reinforced polyester (FRP)	• Less expensive than precast concrete tanks (lower shipping and installation costs) • Variety of manufacturers and sizes for desired footprint • Fiberglass is typically resistant to corrosion • May not require a crane for installation • More rigid and sturdy than plastic tanks	• Less structurally strong than concrete tanks • If not installed properly, fiberglass tanks can float if flooded

Ultimately, the choice of septic tank material will depend on availability, budget, and site constraints (Table 3.3). At a minimum, septic tanks in Hawai‘i must comply with International Association of Plumbing and Mechanical Officials (IAPMO) material and property standards for septic tanks. Further, sizing and installation criteria are regulated by HAR 11-62-33. The minimum septic tank capacity is 1,000 gallons for a household of 4 bedrooms or less and 1250 gallons minimum for households of 5 bedrooms. Septic tanks serving households greater than 5 bedrooms will require a variance from the DOH.

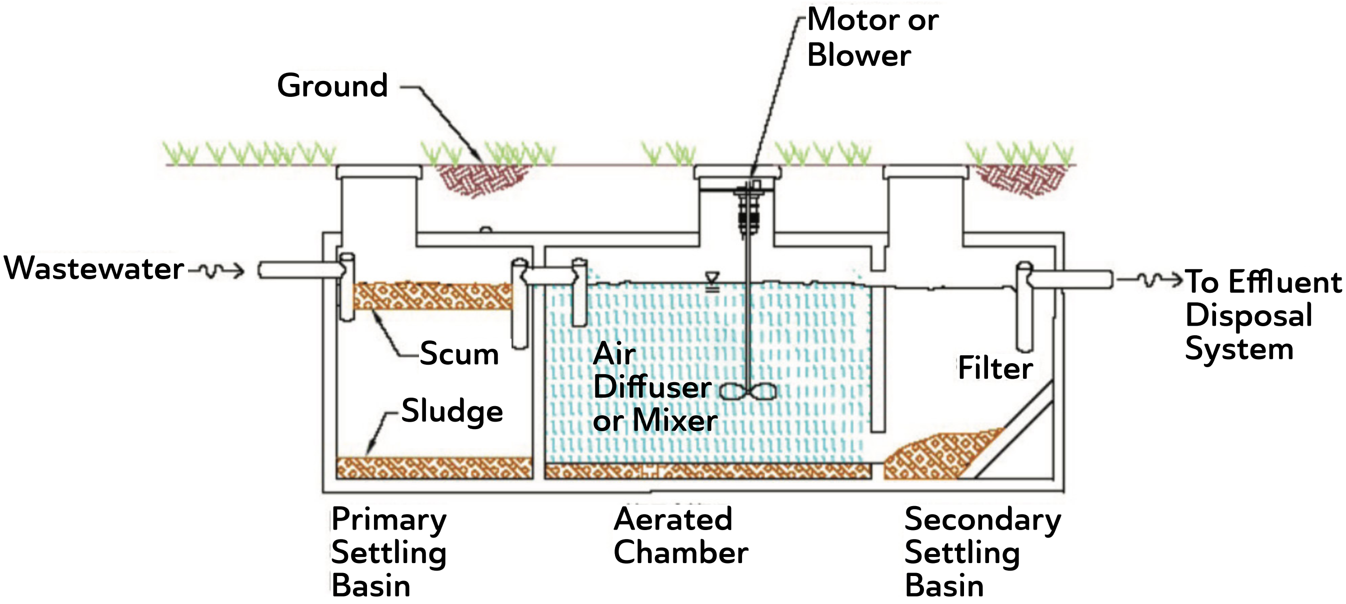
Table 3.3: Common single family home septic tank products in Hawai‘i.

Product	Material	Traffic Rated	Capacity (Gal)	Length (in)	Width (in)	Height (in)	Weight (lbs)	Local List Price
Chem-tainer	HDPE	No	1250	96	58	62	400	$3,189
Infiltrator (via Ferguson)	PP	No	1287	127	62.2	54.7	320	$2,863
Orenco (via Custom Concrete & Septic)	DCPD	No	1500	168	72	64.5	620	$6,850
Jensen Precast	Concrete	Yes	1250	138	70	57	16,700	$6,850

3.2 Aerobic Treatment Units

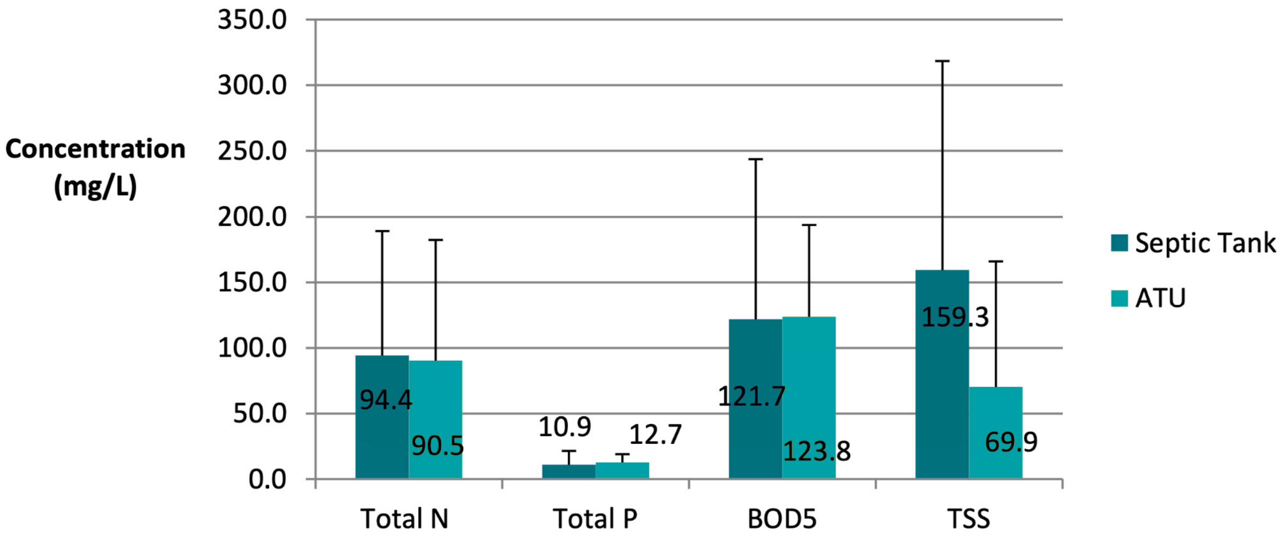
An ATU is a type of wastewater treatment system that utilizes oxygen and microorganisms to break down and treat household sewage. ATUs come in many proprietary shapes and sizes but at a minimum, systems typically include an aeration tank, where the wastewater is blended with air or oxygen while suspended microorganisms are able to grow and thrive and a settlement tank, where solids and other debris are allowed to settle out of the water (Figure 3.3).

Figure 3.3: Side-view of typical aerobic treatment unit (Carollo, 2021)



The added complexity of the ATU system is responsible for higher treatment organic and nutrient removal rates that make ATUs optimal for operation upstream of sensitive receiving environments. Conversely, the added mechanical and electrical componentry leads to more frequent system downtime. Without an effective maintenance strategy, the performance of ATUs in Hawaiʻi has been proven to be similar to septic tanks (Figure 3.4). ATUs are less affordable than septic tanks, as they have a higher up-front cost and a much higher O&M cost due to the requirement of contracting a certified wastewater treatment operator by the DOH. The ATU also expect a shorter service lifetime than septic systems due to its mechanical components (Babcock, 2019).

Figure 3.4: Effluent quality of septic systems vs. ATUs in Hawaiʻi (Babcock, 2012)



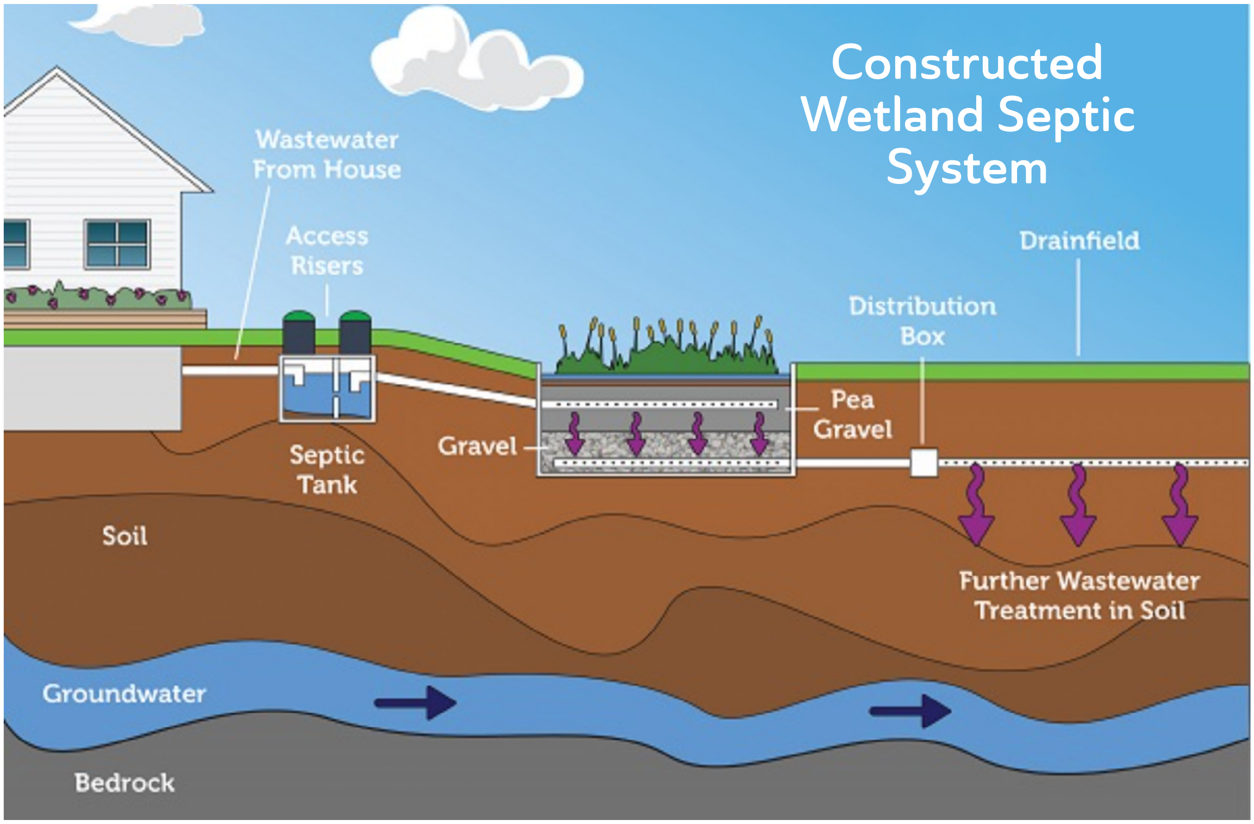
3.3 Passive Biofilters or Constructed Wetlands

A passive biofilter is a type of IWS that uses natural processes to treat and purify wastewater following a septic tank. It typically consists of a filter bed filled with a mixture of gravel, sand, and organic matter (such as wood chips or coconut fiber) that provides a habitat for microorganisms. These microorganisms break down the pollutants in the wastewater as it flows by gravity through the filter bed. The treated wastewater is then collected and can be safely discharged into the environment or reused for irrigation. Passive biofilters do not require electricity or mechanical parts, making them low-maintenance and cost-effective.

Constructed Wetlands are very similar to passive biofilters except they are planted with native flora (Figure 3.5). These systems achieve high levels of nitrogen removal prior to disposal and often have a positive aesthetic impact on the site. However, they may require more space. The vegetation must also be regularly harvested to promote continued nitrogen removal and prevent clogging of the system.

Both of these systems are considered secondary treatment works which the DOH requires to be operated and maintained by a certified wastewater treatment operator. Aside from the higher initial installation cost, the O&M cost can be up to 40 times that of the traditional IWS.

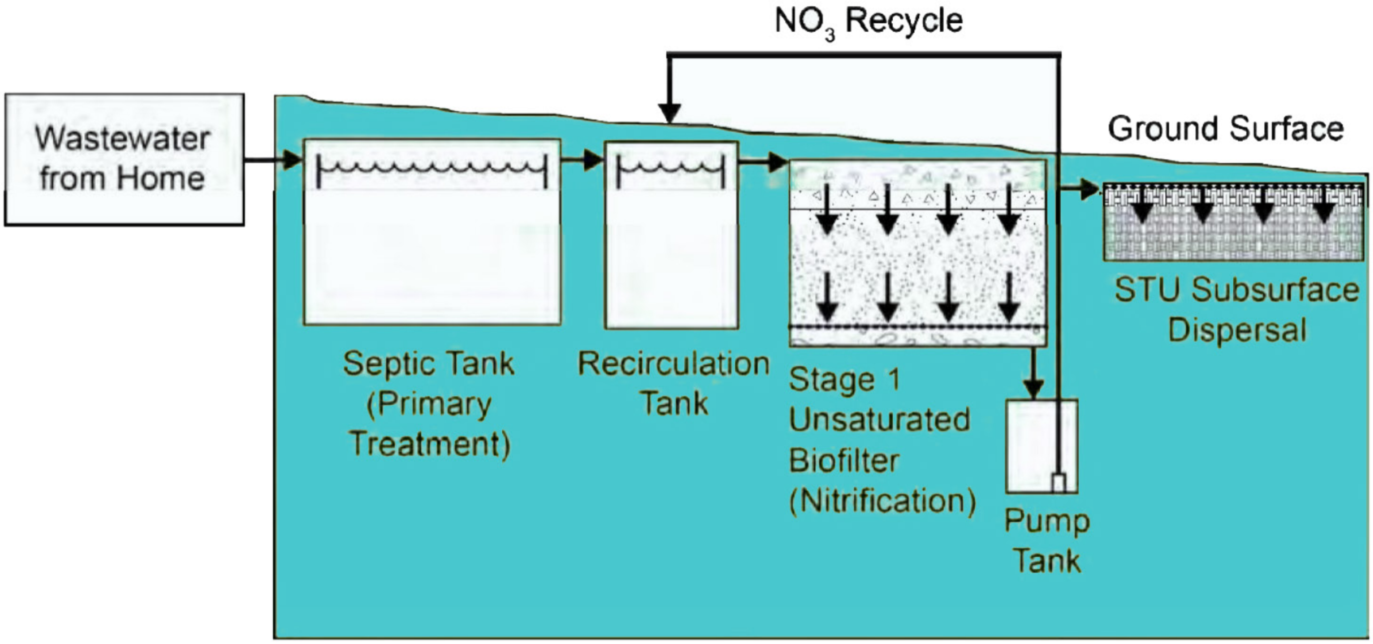
Figure 3.5: Side-view of a typical constructed wetland following a septic tank (EPA, 2023)



3.4 Recirculating Biofilter

Recirculating biofilters are very similar to passive biofilters except the water is recirculated through the biofilter multiple times (Figure 3.6). On the first pass through the biofilter, ammonia is converted to Nitrate through nitrification. Returning this nitrified wastewater to the anoxic recirculation tank provides favorable conditions for denitrification, converting nitrate to inert nitrogen gas for total nitrogen (TN) removal. Expected TN removal rates vary from 50-70% before discharge. This improved treatment comes at the cost of increased installation cost, maintenance requirements, and electricity demand.

Figure 3.6: Side-view of a typical recirculating biofilter following a septic tank (Babcock, 2019)



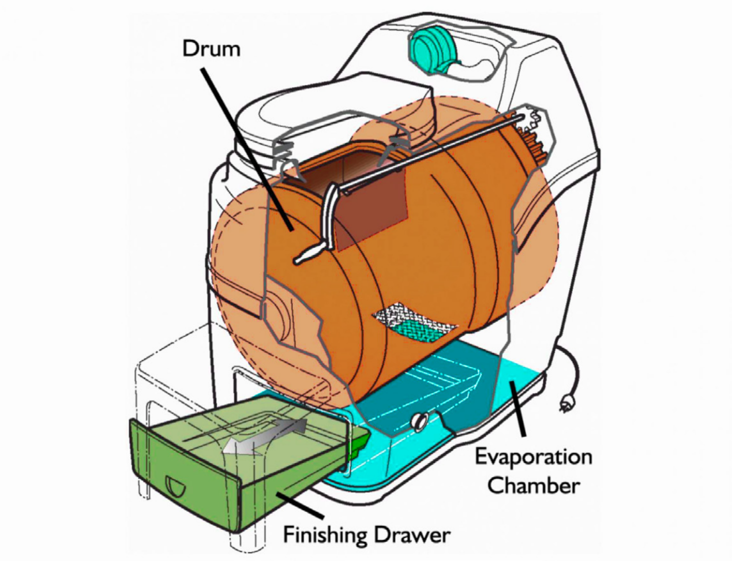
In response to a request for a provisional design request made to several large-scale treatment product manufacturers, E-Z Treat provided an estimate and provisional design for their recirculating synthetic media filter units to serve the Pahala Community. The unit adds an additional $7,500 to $8,500 per household of material cost to a traditional septic system and improves effluent to meet stringent NSF 350 wastewater reuse standards. This solution is presented Appendix I. Maintenance demands are cited as an annual visual inspection of the system as there are no chemicals to add, filters to clean, or aerators to replace. However, similar to many ATUs, there's limited precedent for the systems installation and performance in the State of Hawai‘i.

3.5 Composting Toilets

A composting toilet is a type of toilet that uses a combination of heat and aerobic microbial action to break down human waste into a nutrient-rich compost. Composting toilets typically come in three varieties:

- **Individual Composting Toilets:** These waterless toilets combine human waste with bulking material such as sawdust, leaves, or peat moss in a single chamber (Figure 3.7). The waste dries and composts in-situ until the container fills and is emptied into an outdoor composting pile to complete the composting process. Some composting toilets also use electrical or mechanical systems, such as an exhaust fan, to aid in the breakdown of waste and limit odors. These toilets do not require water or a connection to a sewer system, making them an eco-friendly alternative to traditional flush toilets.

Figure 3.7: Component view of a typical individual composting toilet (Sun-Mar, 2023)



- **Urine Diverting Toilets:** Urine diverting toilets typically have two chambers: one for urine and one for solid waste (Figure 4.8). The urine is typically stored and used as a fertilizer, while the solid waste is broken down into compost.

Figure 3.8: Top view of a typical urine separating toilet (Separett, 2023)

- **Central Composting Units:** These composters are installed outside the home and work in conjunction with pint-flush toilets. Toilet blackwater (along with a scoop of wood chips) flows through a 4” gravity sewer to the composter where its introduced to a horizontal drum that collects the solids and allows liquids to drain into the base of the enclosure (Figure 4.9). The drum must be rotated in the forward direction once every two days to fluff the retained solids and rotated in the reverse direction once every two months to drop the retained solids into an aging drawer where the composting process is completed. The outputs are a drawer of composted manure and the drained liquid. A single central composting unit can serve an entire home and solid wastes and any odors are kept entirely outdoors.

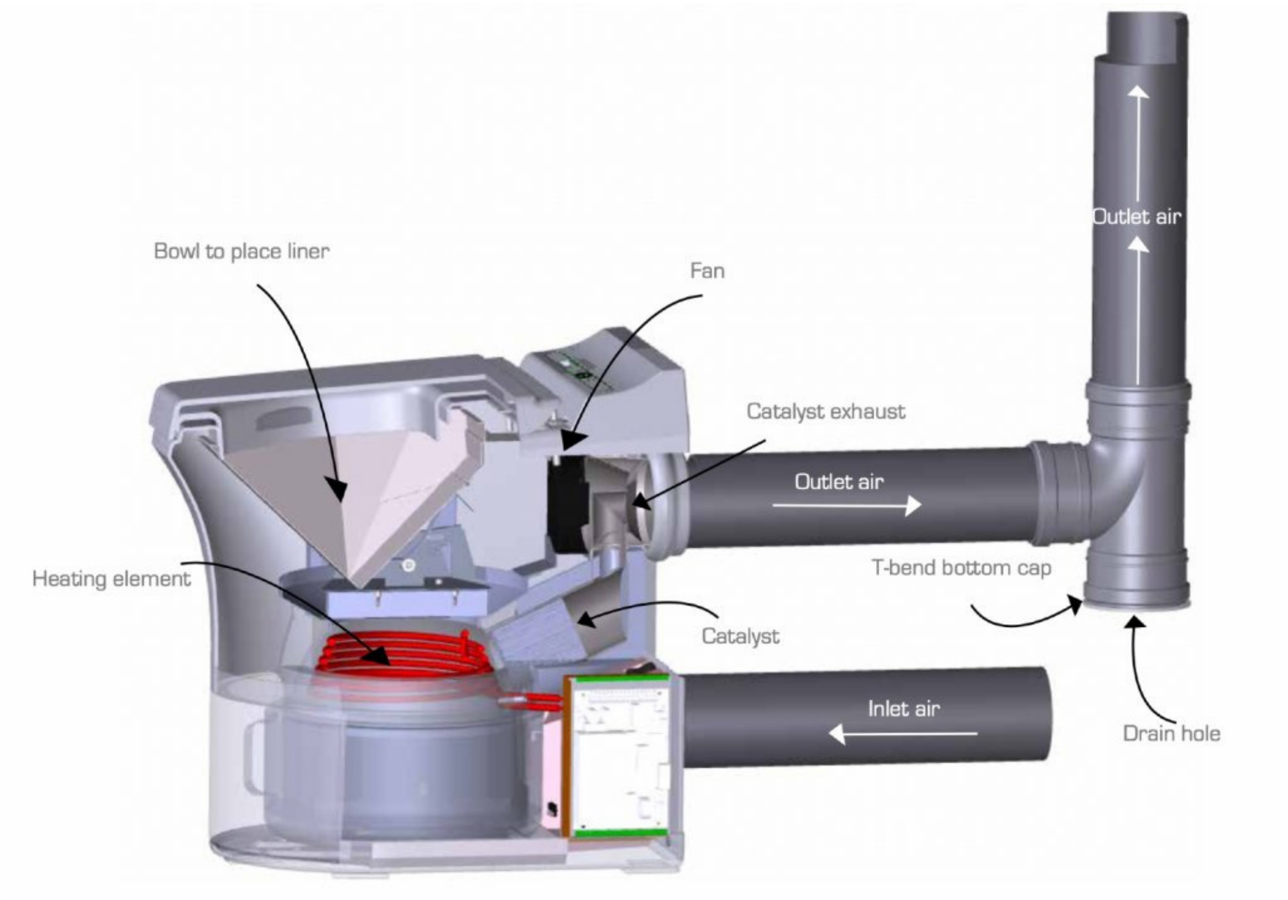
Figure 3.9: Top view of a central composting unit (Sun-Mar, 2023)

3.6 Incineration Toilets

An incineration toilet, also known as a thermal toilet, is a type of toilet that uses heat to turn human waste into ash (Figure 3.10). The waste is placed into a combustion chamber where it is heated to high temperatures, typically around 800-1000 degrees Fahrenheit, by a gas or electric burner. This process kills any harmful bacteria and viruses and reduces the volume of waste by up to 90%. The ash that is left can be safely disposed of in a landfill or used as a fertilizer. Incineration toilets do not require any water, making them suitable for remote locations or areas with limited water resources. They also produce very little smell and have no need for a septic system or connection to a sewer. However, they do require electricity or gas to operate, and can be relatively expensive to purchase and maintain. Further, they do not comprise a complete treatment solution. While the remaining household gray water can be disposed of with minimal treatment, a septic tank or other treatment unit is still required to treat kitchen blackwater, eliminating the economic advantage.

No matter the variety, composting toilets and incineration toilet technologies are significantly cheaper than septic tanks and other IWS. Unfortunately, they do not comprise a complete treatment solution. While the remaining household gray water can be disposed of with minimal treatment, a septic tank or other treatment unit is still required to treat kitchen blackwater, eliminating the economic advantage.

Figure 3.10: Side view of a typical incinerating toilet (Cinderella, 2023)



Section 4

Disposal Technologies

4.1 Absorption beds

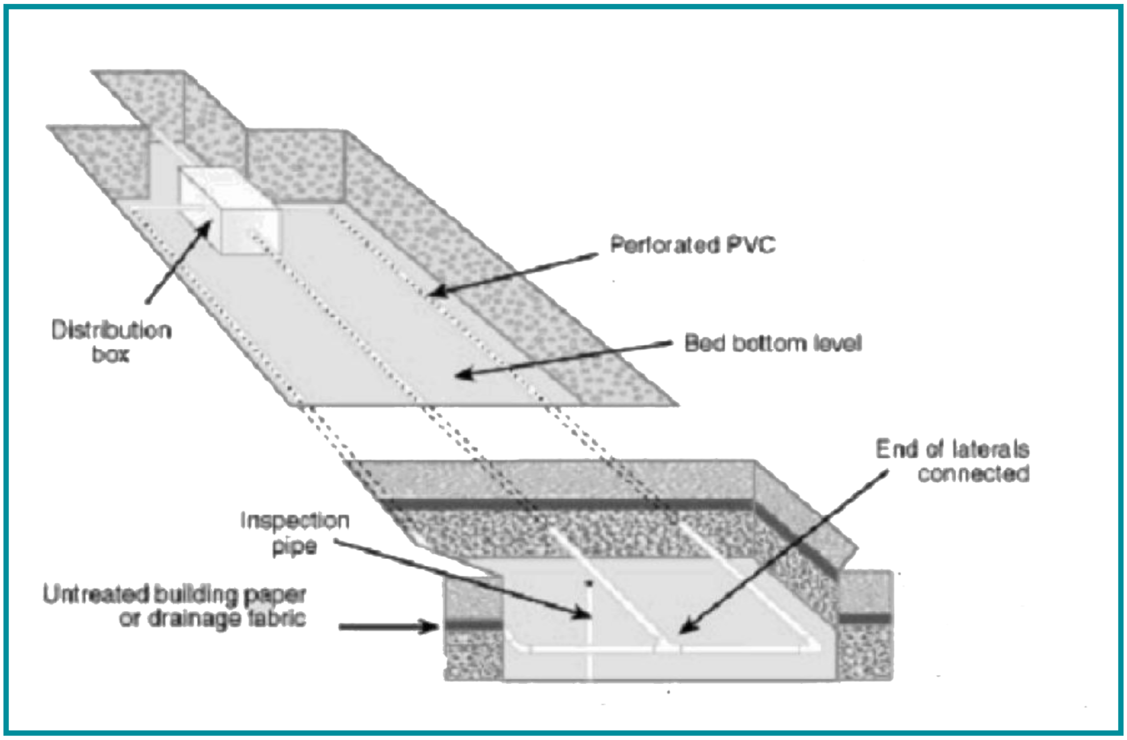
Absorption beds are the most common form of IWS installed in Hawai‘i today. They consist of a network of perforated pipes, each a maximum of 100 feet long and laid in trenches 1.5-3 feet below the finished grade 4-6 feet apart (Figure 4.1). Each line is laid level to allow the gravity dispersal of treated effluent through the length of the pipe before it filters out and percolates down into the soil. A minimum of 6 inches of gravel is provided below each pipe. If the percolation rate is faster than one minute per inch, a depth of 3-foot soil replacement shall be installed to underlay the entire absorption bed. Soil replacement shall be washed #4 sand or cinder-soil mix with a percolation rate not faster than one minute per inch.

These systems are easy to maintain when following an effective treatment system and microorganisms in the soil offer an added degree of treatment to the effluent as it filters through the upper oxic layers of the soil matrix. Absorption beds however have a significant space requirement with current Hawaiian regulations requiring a minimum of 350 sq ft for a 4-bedroom home. This space requirement increases with decreasing hydraulic conductivity of the soil as discussed in Section 4. Additionally, absorption beds can only be installed on a grade of less than 8%.

While conventional perforated pipe adsorption beds are not traffic rated, companies such as Infiltrator offer a chambered dispersion product with an H-20 load rating that can also reduce the absorption bed space requirement by 17%.

Usage Case: Used on typical lots without spatial, groundwater level, grade, or percolation rate constraints.

Figure 4.1: Typical absorption field installed following a septic tank (Babcock, 2019)



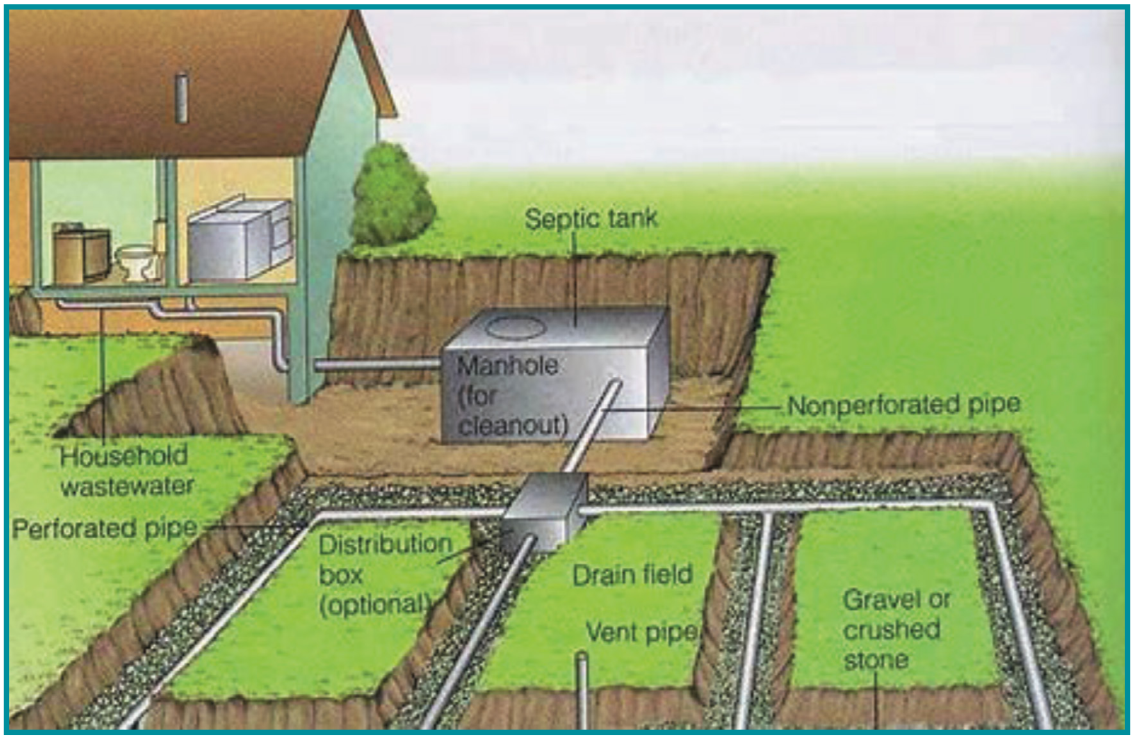
4.2 Absorption trench

An absorption trench is a type of subsurface wastewater disposal system that utilizes a trench filled with gravel or other porous material to filter and distribute household wastewater into the ground (Figure 4.2). Wastewater is distributed into the trench through a network of pipes, typically made of PVC or other durable materials. The gravel in the trench acts as a natural filter, allowing the water to slowly seep into the surrounding soil while also removing impurities with adsorbed beneficial bacteria. The trench may be lined with a layer of filter fabric to prevent the gravel from becoming clogged with soil or other debris.

The percolation area of the system is calculated as the combined bottom area of the trenches. Individual trenches must be between 18 and 36 inches, with trenches more than 6 feet apart and suitable for installation on slopes up to 12%.

Usage Case: Used on steeper lots with grades of 8-12%.

Figure 4.2: Typical absorption trench system installed following a septic tank (Carollo, 2021).



4.3 Combined Treatment and Disposal System

Combined Treatment and Disposal Systems (CTDS) combine chambered absorption beds with geo-textile fabric, and porous media to perform treatment and disposal in a single operation.

One example of these systems consists of special 10 ft long by 12” diameter pipes embedded in a specific type of sand. The pipes contain ridges, perforations with skimmers, geotextile fabric, green plastic fiber mat, and fabric to support biofilm development (Figure 4.3). These components facilitate the distribution of water and development of a biomat along the length of the pipes. Without using any electricity or replacement media, CTDS following a traditional septic tank can offer BOD, TSS, and ammonia removal on par with aerobic treatment units.

Unfortunately, there is little precedent for the use of CTDS in Hawai‘i to quantify their

performance, lifespan, and design requirements for the State of Hawai‘i. Furthermore, this type of system is considered a secondary treatment system which requires a DOH certified operator to perform O&M.

Usage Case: Used on lots with strict effluent quality requirements.

Figure 4.3: An example of a proprietary fixed-film CTDS (Infiltrator, 2023).

An alternative CTDS involves a “layer cake” filtration system of 18 inches of sand and 18 inches of a sand and sawdust mixture (Figure 4.4). Aerobic processes take place in the oxic sand layer while an anoxic environment is created in the sawdust layer. This sequence of oxic and anoxic stages promotes TN removal rates from 50-90%.

Figure 4.4: An example of a non-proprietary "layer cake" CTDS (Babcock, 2019).

4.4 Seepage pit

Seepage pits are a vertical means of achieving the percolation area requirements for a disposal system. These systems typically consist of a 15-30-foot-deep pit lined with stacked precast perforated concrete rings or CMUs, to an internal diameter of 6-8 ft. Seepage pits are both less area intensive and less expensive than absorption beds, if converted from an existing cesspool (Table 9.1). A seepage pit must include a cover which extends at least 12 inches beyond the seepage pit excavation or over a provided concrete lining. An access hatch must be provided in the concrete cover to allow inspection and maintenance of the pit. The seepage pit may be designed to be traffic rated by providing the sufficient strength required in the design of the concrete lining and cover.

The effective area of the seepage pit is equal to the vertical wall area corresponding to the effective depth of the pit. Slow percolation rates translate to a larger required absorption area and deeper pit (Appendix H).

While seepage pits are an approved means of disposal in Hawaiʻi, they are often only permitted when it can be demonstrated that an alternative means of disposal was not possible , i.e. insufficient land area, steep terrain (>12%) or very slow percolation rates (>60 min/inch). Where slow percolation rates present, seepage pits will need to be dug through the basalt rock layer to reach more porous soils or a variance will be required from HAR 11-62-34 d(1)b:

> *Seepage pits shall not be constructed in soils having a percolation rate slower than ten minutes per inch (weighted average) or where rapid percolation through such soils may result in contamination of water-bearing formations or surface water.*

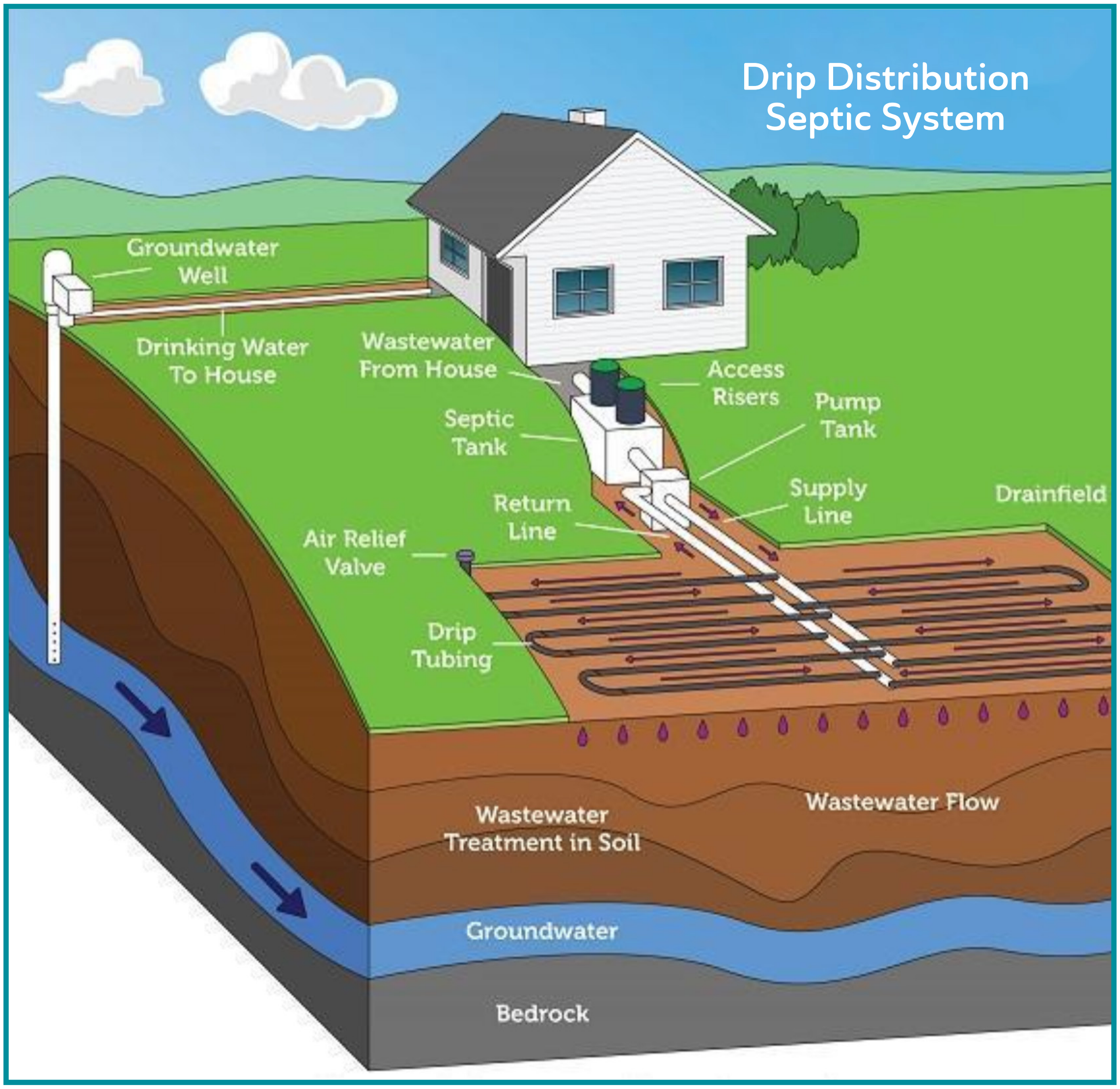
Usage Case: Used on highly spatially constrained, slope constrained, or geologically constrained lots where sufficient percolation rates can be achieved.

4.5 Subsurface drip irrigation

Subsurface drip irrigation is an extremely water efficient means of wastewater disposal, slowly delivering effluent into the shallow subsurface and biologically active root zone of plants, promoting efficient uptake of nutrients by the microbes and plants in the soil medium (Figure 4.5). Installation of subsurface systems often requires less disruption to the absorption area though in Hawaiʻi, they traditionally cost more. Regular maintenance is required to ensure the continued operation of the irrigation pump and manage biofouling in the distribution lines and the dripper clogs it causes. Disinfection is required following aerobic treatment as an added measure against biofouling and clogging of the distribution lines.

Usage Case: Used on lots that prioritize wastewater reuse, are served by an ATU, and have a robust maintenance strategy.

Figure 4.5: Typical subsurface drip irrigation installed following a septic tank (EPA, 2023)



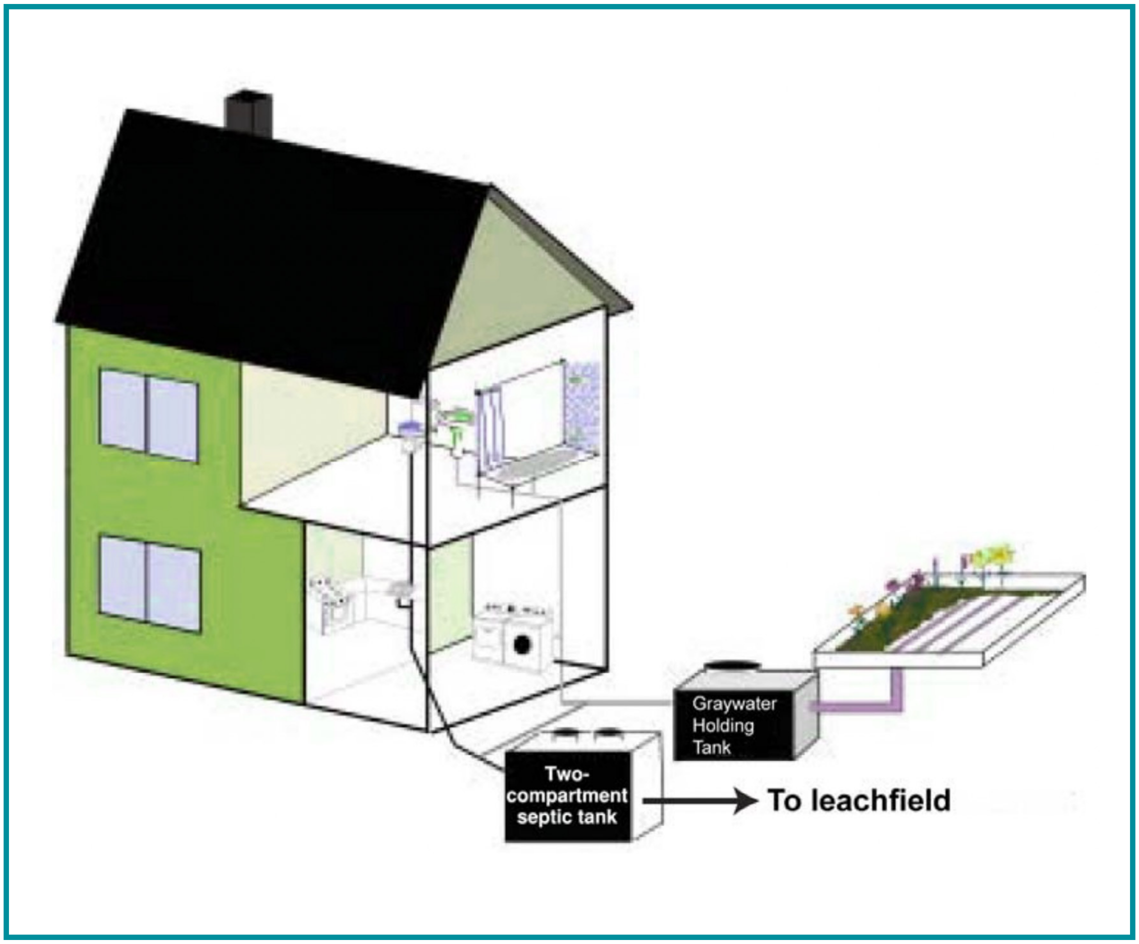
4.6 Greywater system

Greywater systems are systems that collect and reuse wastewater from sources such as sinks, showers, and laundry machines. The collected water is then treated and can be used for irrigation or other non-potable uses such as toilet flushing. The use of separated gray water systems can help reduce the load on wastewater treatment units and conserve water through reuse.

In Hawai‘i, the use of greywater systems is regulated by the State Department of Health, which sets guidelines for the treatment and reuse of greywater. Gray water systems can vary in complexity and cost. Simple systems, such as diverting water from a clothes washer to a garden, can be relatively inexpensive and easy to install (Figure 4.6). More complex systems may include treatment methods such as sand filtration, ultraviolet disinfection, or reverse osmosis. Overall, these systems are typically expensive to install and maintain as they are installed in addition to a traditional wastewater treatment system that's still required to treat household black water.

Usage Case: Used on lots with source separated plumbing that prioritize wastewater reuse.

Figure 4.6: Typical greywater reuse system installed in parallel with a septic tank (DOH, 2009)



5

Section 5

System Design

5.1 IWS Selection

In 2019, Dr. Roger Babcock and the team at the Water Resources Research Center (WRRC) put together a report investigating the viability of cesspool upgrade options for 12,000 homes in upcountry Maui. In total, 38 options were evaluated, half of which used exclusively IWS methodologies, while the other half considered partial or full sewering of the community. The most applicable are presented in the table below (Table 5.1). The lifetime net present value assessments were made over a 60-year period using a discount rate reflective of public sector investment (2.8%).

These treatment systems comprise a toolbox from which engineers can select site appropriate systems for individual property conditions. When making a selection, engineers should consider existing regulations, environmental concerns, site constraints, economics, and performance. Overall, each household IWS will cost $30,000-$100,000 to install and roughly $1,000 per year to operate and maintain.

Based on the compiled data, this report points to the installation of traditional septic tanks with standard absorption beds. Where space and grading constraints prevent the installation of an absorption bed, the existing cesspool shall be repurposed as a seepage pit for disposal. This solution was selected for three reasons:

- **Passive Operation:** The traditional septic IWS offers a passive operation with minimal O&M cost. While the ATUs offer the promise of improved performance, in practice in Hawaiʻi, the added mechanical and electrical complexity and the operator requirement results in higher than average O&M costs or facing the risk of falling into similar treatment performance comparable to septic tanks.
- **Adaptive to Small Lots:** The option of disposing to seepage pits allow septic systems to be installed particularly on spatially and geographically constrained lots.
- **Familiarity:** Hawaiʻi's engineers, regulators, contractors, and septic pumpers are familiar with septic tanks, absorption beds, and seepage pits. The ATU and CTDS, on the other hand, are less known. Furthermore, the lack of certified wastewater operators throughout the State will result in higher cost and reduced performance for ATU and CTDS options.

Table 5.1: An abridged selection of IWS options from cesspool replacement analysis of upcountry Maui community (Babcock, 2019)

Treatment	Disposal	Estimated Nitrogen Reduction	NPV Cost Per Property	O&M Burden	Usage Case			
					Effluent Criteria	**Slope**	**Perc Rate (min/in)**	**Area**
Septic	Seepage Pit	10%	Low	Low	Low	>12%	<10	Low
	Absorption Field	47%	Low	Low	Low	<8%	<60	High
	Absorption Trench	47%	Low	Low	Low	<12%	<60	High
	Constructed Wetland	53%	Med	Med	Med	<8%	<60	High
	“Layer Cake” CTDS	55%	Med	Low	Med	<8%	<60	High
	Fixed-Film CTDS	78%	Low	Low	Strict	<12%	<60	Med
Septic + Recirculating Biofilter	Seepage Pit	47%	High	Med	Med	>12%	<10	Low
	Drip Irrigation	69%	Very High	Med	Strict			High
	Absorption Field	84%	Low	Med	Strict	<8%	<60	High
ATU	Absorption System	53%	Very High	High	Med	<8%	<60	High
	Constructed Wetland	58%	Very High	High	Strict	<8%	<60	High
ATU + Disinfection	Seepage Pit	50%	Very High	High	Med	>12%	<10	Low
	Drip Irrigation	71%	Very High	High	Strict			High

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A

Appendix A - LCC Closure Properties

Pahala LLC Closure								Absorption Field				
TMK#	Owner	Address	Land Area (acres)	# of Buildings	# ofBedrooms	Est. WW Gen.	Septic Tank	1min/in.	2min/in.	Remarks		dwg
9-6-014-053	Michael Munnerlyn	96-1335 Huapala Street	0.3315	1	3	600	1000	210	255	ok		Y
9-6-014-054	Leroy Kenji Nagasako	96-1331 Huapala Street	0.3315	1	3	600	1000	210	255	ok		Y
9-6-014-055	Edwin Mitsunaga	96-1325 Huapala Street	0.3315	1	3	600	1000	210	255	ok		Y
9-6-014-056	Andrade Family Trust	96-1321 Huapala Street	0.3014	1	3	600	1000	210	255	ok		Y
9-6-014-057	Ferdinand Capiral Ramos	96-3210 Hau Street	0.2861	1	5	1000	1250	350	425	432	Traffic rated	Y
9-6-014-047	Domingo C Ramos JR	96-1305 Huapala Street	0.293	1	3	600	1000	210	255	ok		Y
9-6-014-046	John Katchmar	96-1297 Haupala Steet	0.2435	1	3	600	1000	210	255	ok		Y
9-6-014-045	Kandra Sanders	96-1289 Huapala Street	0.2479	1	3	600	1000	210	255	ok		Y
9-6-014-044	Faith Derasin	96-1287 Huapala Street	0.168	1	3	600	1000	210	255	not fit	fitted needs to be verified on site	Y
9-6-014-043	Ramona Ponce	96-1281 Huapala Street	0.1674	1	3	600	1000	210	255	ok		Y
9-6-014-042	Maria Hohnson	96-1277 Haupala Street	0.1674	1	3	600	1000	210	255	ok	fitted needs to be verified on site	Y
9-6-014-041	Kazuto Judalena	96-1275 Huapala Street	0.1681	1	3	600	1000	210	255	not fit	fitted needs to be verified on site	Y
9-6-014-040	Harold Kaneshiro	96-1271 Huapala Street	0.1666	1	3	600	1000	210	255	ok		Y
9-6-014-039	Alfredo Asistin	96-1269 Huapala Street	0.1658	1	3	600	1000	210	255	ok		Y
9-6-014-038	Dennis Andres	96-1265 Huapala Street	0.1658	1	3	600	1000	210	255	ok		Y
9-6-014-037	Kelly Keoki Galimba	96-1261 Huapala Street	0.1674	1	3	600	1000	210	255	ok		Y
9-6-014-036	Takeshi Kunihiro	96-1259 Huapala Street	0.1674	1	3	600	1000	210	255	ok		Y
9-6-014-035	Zoe Alexandra Eustathiades	96-1257 Huapala Street	0.1627	1	3	600	1000	210	255	ok		Y
9-6-014-034	Kenneth Yokota	96-1255 Huapala Street	0.1581	1	3	600	1000	210	255	ok		Y
9-6-014-033	Philip Becker	96-1253 Huapala Street	0.1576	1	3	600	1000	210	255	not fit	cut trees to fit	Y
9-6-015-006	Hajime Ueda Trust	96-1252 A Huapala Street	0.3464	1	4	800	1000	280	340	ok		Y
9-6-015-008	Sally Yamaguchi Trust	96-1258 Huapala Street	0.5667	1	3	600	1000	210	255	ok		Y
9-6-015-009	Gloria Camba	96-1266 Huapala Street	0.6415	1	0	0		0	0	ok		Y
9-6-014-052	Tsuruo Sumida	96-1334 Ilima Street	0.3073	1	3	600	1000	210	255	ok		Y
9-6-014-051	Michael Kawachi	96-1326 Ilima Street	0.3315	1	3	600	1000	210	255	ok		Y
9-6-014-050	Jeffrey Kekoa	96-1322 Ilima Street	0.3315	1	3	600	1000	210	255	ok		Y
9-6-014-049	Rodney Takaki	96-1320 Ilima Street	0.3014	1	3	600	1000	210	255	ok		Y
9-6-014-048	Estrella Ssuncion	96-3214 Hau Street	0.2861	1	5	1000	1250	350	425	ok		Y
9-6-014-017	Lilybeth Orcino	96-3215 Hau Street	0.3083	1	3	600	1000	210	255	ok		Y
9-6-014-018	Judy Jara	96-1300 Ilima Street	0.1609	1	3	600	1000	210	255	pls verify	fitted confirm structure backyard	Y
9-6-014-019	Longakit Family Trust	96-1298 Ilima Street	0.1561	1	3	600	1000	210	255	pls verify	fitted confirm structure near septic tank	Y
9-6-014-020	Stanley Lorenzo	96-1296 Ilima Street	0.1591	1	2	400	1000	140	170	ok		Y
9-6-014-021	Ralphielyn Gaston-Lovell	96-1294 Ilima Street	0.1654	1	3	600	1000	210	255	pls verify	have structures at the backyard	Y
9-6-014-022	Lillian Oliveira Estate	96-1292 Ilima Street	0.1654	1	3	600	1000	210	255	pls verify	have structures at the backyard	Y
9-6-014-023	Amy Siva (Deceased)	96-1290 Ilima Street	0.1652	1	3	600	1000	210	255	pls verify	have structures at the backyard	Y
9-6-014-024	Sixto Asuncion	96-1288 Ilima Street	0.1626	0	0	0		0	0	ok	N/A	
9-6-014-025	Saburo Fukunaga	96-1286 Ilima Street	0.1673	1	3	600	1000	210	255	ok		Y
9-6-014-026	Alfred Galiza	96-1284 Ilima Street	0.1646	1	3	600	1000	210	255	pls verify	have structures at the backyard	Y
9-6-014-027	Jerry Villa	96-1282 Ilima Street	0.1644	1	3	600	1000	210	255	ok		Y
9-6-014-028	Greg Mitsunaga	96-1280 Ilima Street	0.1673	1	3	600	1000	210	255	ok		Y
9-6-014-029	Newton Ito	96-1278 Ilima Street	0.1684	1	5	1000	1250	350	425	not fit	have structures at the backyard	Y

9-6-014-030	Iris Haugen	96-1276 Ilima Street	0.1641	1	3	600	1000	210	255	not fit	have structures & trees at the backyard based on map and st view	Y
9-6-014-031	Toshio Okamura	96-1274 Ilima Street	0.1626	1	3	600	1000	210	255	ok	need to cut trees	Y
9-6-014-032	CLH Trust	96-1272 Ilima Street	0.1615	1	3	600	1000	210	255	not fit	could not fit with the existing structure on the backyard	N
9-6-014-014	Frank Lorenzo J SR	96-1299Ilima Street	0.2154	1	3	600	1000	210	255	ok		Y
9-6-014-013	Elizabeth Stone	96-1295 Ilima Street	0.2503	1	3	600	1000	210	255	ok		
9-6-014-012	Steven Wroblewski	96-1293 Ilima Street	0.1814	1	3	600	1000	210	255	ok	Traffic rated septic tank	Y
9-6-014-011	Clement Andrade	96-1291 Ilima Street	0.1791	1	3	600	1000	210	255	not fit	fitted front yard traffic rated septic tank	Y
9-6-014-010	Patrick Kailiawa	96-1289 Ilima Street	0.1798	1	3	600	1000	210	255	not fit	fitted backyard verify structures	Y
9-6-014-009	Albert Ledergerber	96-1287 Ilima Street	0.1791	1	3	600	1000	210	255	ok		Y
9-6-014-008	Deisha-Lyn Nurial-Dacalio	96-1285 Ilima Street	0.1798	1	3	600	1000	210	255	ok	verify structures affected	Y
9-6-014-007	Malia Panglao	96-1283 Ilima Street	0.1741	1	3	600	1000	210	255	ok		Y
9-6-014-006	Young Elena Branch	96-1281 Ilima Street	0.1774	1	3	600	1000	210	255	ok		Y
9-6-014-005	Young Elena Branch	96-1279 Ilima Street	0.1764	1	3	600	1000	210	255	ok		Y
9-6-014-004	Sandra Polido	96-1277 Ilima Street	0.1798	1	3	600	1000	210	255	ok	best fit might need to cut trees	Y
9-6-014-003	Takamari Fukunaga	96-1275 Ilima Street	0.1781	1	3	600	1000	210	255	ok	best fit might need to cut trees	Y
9-6-014-002	Philip Alexander Becker Trst	96-1273 Ilima Street	0.1731	1	3	600	1000	210	255	ok	best fit might need to cut trees	Y
9-6-014-001	Barbara McBeath	96-1271 Ilima Street	0.1714	1	3	600	1000	210	255	ok	best fit might need to cut trees	Y
9-6-015-016	Ruby Manantan	96-1247 Hinano Street	0.2271	1	3	600	1000	210	255	ok		Y
9-6-015-017	Chuck Higashi	96-1243 Hinano Street	0.2939	1	3	600	1000	210	255	ok		Y
9-6-015-018	Hawaii Methodist Union	96-1239 Hinano Street	0.262	1	4	800	1000	280	340	ok		Y
9-6-015-019	Wayne Nahinu Dacalio	96-1235 Hinano Street	0.2006	1	3	600	1000	210	255	ok	fitted, need site verification	Y
9-6-015-001	Stephanie Kawaauhau	96-1224 Huapala Street	0.2438	1	3	600	1000	210	255	ok		Y
9-6-015-028	Keeane Kolekona Toriano	96-1250 Hinano Street	0.282	1	3	600	1000	210	255	ok		Y
9-6-015-027	Morgan Dacalio	96-1244 Hinano Street	0.2939	1	3	600	1000	210	255	ok		Y
9-6-015-026	Yokomizo Family Trust	96-1240 Hinano Street	0.3485	1	3	600	1000	210	255	ok	Traffic rated	Y
9-6-015-025	Kaitlin Marie Galimba	96-1236 Hinano Street	0.3829	1	3	600	1000	210	255	ok		Y
9-6-015-024	Ned Nobuo Nishimura	96-3198 Hala Street	0.2443	1	3	600	1000	210	255	ok		Y
9-6-015-023	Arthur Kaleohano	96-3196 Hala Street	0.3247	1	3	600	1000	210	255	ok		Y
9-6-015-022	Hisako Yoshimura	96-3193 Hala Street	0.2879	1	3	600	1000	210	255	not fit	best fit might need to cut trees	Y
9-6-015-021	ShandonTamondong	96-3197 Hala Street	0.3544	1	3	600	1000	210	255	ok		Y
9-6-015-020	Gary Tamondong	96-1218 Huapala Street	0.3253	1	3	600	1000	210	255	ok		Y
9-6-016-039	Evelyn Barbara Baran	96-1212 Huapala Street	0.3017	1	4	800	1000	280	340	ok		Y
9-6-016-040	Julia Neal	96-3186 Pikake Street	0.6606	1	5	1000	1250	350	425	pls verify	best fit might need to cut trees	Y
9-6-016-041	Bryan Davis-Natividad	96-3184 Pikake Street	0.6259	1	4	800	1000	280	340	ok		Y
9-6-016-042	Tasha Tho Kaapana	96-3174 Pikake Street	0.6402	2	0	0		0	0		N/A	
9-6-016-043	Don Francisco Dacalio	96-3172 Pikake Street	0.4293	1	4	800	1000	280	340	ok		Y
9-6-016-044	John Ah San	96-3168 Pikake Street	0.4253	1	3	600	1000	210	255	ok		Y
9-6-016-045	Julia Neal	96-3164 Pikake Street	0.3598	1	3	600	1000	210	255	ok		Y
9-6-016-046	Ann Bertellotti	96-3160 Pikake Street	0.2523	1	5	1000	1250	350	425	ok		Y
9-6-016-036	Michael Oldmen	96-3152 Pikake Street	0.4	1	4	800	1000	280	340	ok		Y
9-6-020-001	Edmund Olson	96-1206 Kamani Street	0.1907	1	3	600	1000	210	255	ok		Y
9-6-020-002	Michelle Ortega	96-3146 Pikake Street	0.184	1	3	600	1000	210	255	ok		Y
9-6-020-003	Frank Ryder	96-3144 Pikake Street	0.1856	1	3	600	1000	210	255	ok		Y
9-6-020-004	Pedro Gandalira	96-3142 Pikaka Street	0.1801	1	3	600	1000	210	255	ok		Y
9-6-020-005	Dawn Rosales	96-3140 Pikake Street	0.1787	1	3	600	1000	210	255	ok		Y
9-6-020-006	Rodrigo Evangelista	96-3138 Pikake Street	0.1789	1	3	600	1000	210	255	ok		Y
9-6-020-007	David Souza JR	96-3134 Pikaka Street	0.1768	1	3	600	1000	210	255	ok		y
9-6-020-008	Abdon Cabatingan	96-3132 Pikaka Street	0.1719	1	3	600	1000	210	255	ok		y
9-6-020-009	Florendo Fuerte	96-3130 Pikaka Street	0.1733	1	3	600	1000	210	255	ok		y
9-6-020-010	Edward Requlman	96-3128 Pikake Street	0.1699	1	3	600	1000	210	255	ok		y
9-6-020-011	Felipe Aderinto	96-3120 Pikake Street	0.1661	1	4	800	1000	280	340	ok		y
9-6-020-012	Wido Chalito Prtillo	96-3112 Pikake Street	0.1677	1	3	600	1000	210	255	ok		y
9-6-020-013	Lester Matt Iverson	96-3104 Pikake Street	0.1633	1	3	600	1000	210	255	ok		y
9-6-020-014	Sonny Gabini	96-3096 Pikake Street	0.203	1	2	400	1000	140	170	ok		Y
9-6-020-018	Tristan Kaileo Oliveros	96-3109 Puahala Street	0.2215	1	3	600	1000	210	255	pls verify	verify property line in front lawn	Y
9-6-020-019	Michael Baldonado	96-3111 Puahala Street	0.1549	1	3	600	1000	210	255	ok	verify property line in front lawn	Y
9-6-020-020	Teofilo Villa	96-3115 Puahala Street	0.1495	1	3	600	1000	210	255	ok	verify property line in front lawn	Y
9-6-020-021	Lenor Lorenzo-Oleyte	96-3117 Puahala Street	0.1609	1	3	600	1000	210	255	ok		Y
9-6-020-022	Dennis Santiago	96-3119 Puahala Street	0.1499	1	2	400	1000	140	170	ok		Y
9-6-020-023	Apolinario Cabudol	96-3121 Puahala Street	0.166	1	3	600	1000	210	255	ok		Y
9-6-020-024	Edward Andrade	96-3123 Puahala Street	0.1563	1	3	600	1000	210	255	ok		Y
9-6-020-025	Mariano Delos Santos	96-3127 Puahala Street	0.1592	1	3	600	1000	210	255	ok		Y
9-6-020-026	Freddie Penera	96-3131 Puahala Street	0.2018	1	3	600	1000	210	255	ok		Y
9-6-020-027	Albert Louis	96-3133 Puahala Street	0.2044	1	2	400	1000	140	170	ok		Y
9-6-020-028	James Yamaki	96-3137 Puahala Street	0.2079	1	3	600	1000	210	255	pls verify	best fit might need to cut trees & shrubs	Y

B

Appendix B - Additional Households

Pahala LLC Closure (additional properties)								Absorption Field			
TMK#	Owner	Address	Land Area (acres)	# of Buildings	# ofBedrooms	Est. WW Gen.	Septic Tank	1min/in.	2min/in.	Remarks	dwg
9-6-021-001	Candrie Pascubillo	96-3198 Pakalana St	0.3129	1	3						
9-6-014-072	Roy & Maybelle Okinishi		0.3777	1	3						
9-6-014-071	Robert Rosario	96-1339 Huapala St	0.3444	1	3						
9-6-014-015	Stanley Ballo	96-1303 Ilima St	0.2248	1	3						
9-6-014-016	Raymond Ballio		0.1906	1	3						
9-6-014-069	Berta Miranda	96-1315 Ilima St	0.2746	1	3						
9-6-014-070	Darleen Iida	96-1319 Ilima St	0.3051	1	3						
9-6-021-031	Vicki Paalulhi	96-1340 Huapala St	0.2924	1	2						
9-6-014-067	Louisa & Harold Paalu	96-1338 Huapala St	0.2928	1	3						
9-6-014-066	Carmelita Ferreira	96-1334 Huapala	0.241	1	3						
9-6-014-065	Rolando Lugtu	96-1330 Huapala St	0.241	1	3						
9-6-014-064	Jose Abalos	96-1326 Huapala St	0.241	1	3						
9-6-014-063	Felipe Aderinto	96-1322 Huapala	0.241	1	6						
9-6-014-062	Tiffany Poncy		0.241	1	3						
9-6-014-061	Gloria Camba	96-1314 Huapala St	0.241	1	3						
9-6-014-060	Brenda Tacardon-Ortiz	96-1310 Huapala St	0.2755	1	3						
9-6-014-059	Antonio Maltezo	96-1304 Huapala St	0.2755	1	3						
9-6-014-058	Larson Mondina	96-1296 Huapala St	0.3879	1	3						
9-6-015-031	Albert Galimba	96-1288 Huapala	0.2809	1	3						
9-6-015-030	Carmen Belledo Trst	96-3198 Hapu St	0.271	1	3						
9-6-015-029	Moses Espaniola	96-1256 Hinano St	0.3188	1	4						
9-6-015-012	Annie Kaapana	96-1269 Hinano St	0.2258	1	3						
9-6-015-011	Chris Kibler	96-1274 Huapala	0.2236	1	3						
9-6-015-010	Kavelle Silva	96-1270 Huapala	0.2709	1	3						
9-6-015-013	Patricia Pai	96-1259 Hinano St	0.1833	1	3						
9-6-015-014	Rose Navarro	96-1255 Hinano St	0.2191	1	1						
9-6-015-015	Prasert Chantrakul	96-1251 Hinano St	0.2271	1	3						
9-6-015-007	Stanley Mizuno	96-1252 Huapala St	0.1662	1	0						
9-6-015-005	Joyce Ibasan	96-1248 Huapala St	0.277	1	3						
9-6-015-004	Jack Moses	96-1242 Huapala St	0.2565	1	3						
9-6-015-003	Anderson Family Trst	96-1236 Huapala St	0.3								
9-6-015-002	Madito Tamayo	96-1230 Huapala St	0.227	1	3						
9-6-015-032	Huapala Lot 6 LLC		1.032								
9-6-015-034	Michael Worthington	96-3232 Maile St	0.118	1							
9-6-005-044	Edmund Olson		0.4937								
9-6-016-011	Edmund Olson	96-3208 Maile St	0.7503	1	4						
9-6-002-056	Julia Neal	96-3209 Maile St	3.421	1	5						
9-6-002-016	PMK Capital Partners,	96-3207 Maile St	66.719								
9-6-016-023	Rodney Freitas	96-3189 Pikake St	0.3437	1	3						
9-6-016-024	Kathy Andrade	96-3187 Pikake St	0.3803	1	3						
9-6-016-025	Paul Keim	96-3181 Pikake St	0.3522	1	3						
9-6-016-026	Bryan Albert	96-3179 Pikake St	0.4579	1	3						
9-6-016-027	Barry Beyer Trst	96-3175 Pikake St	0.3766	1	3						
9-6-016-035	HH & S Inc	96-3167 Pakake St	0.1758	1							
9-6-016-034	Edmund Olson	96-3163 Pikake St	0.9503	1							
9-6-017-001	Corinna Salmo	96-3147 Pikake St	0.3751	1	4						
9-6-017-002	Roman Catholic Churc	96-3143 Pikake St	2.022	1							
9-6-017-003	County of Hawaii		0.5257								
9-6-018-001	Edgar Sales	96-1174 Holei St	0.3054	1	3						
9-6-018-002	Hendrikus Dewaal	96-3133 Pikake St	0.2607	1	3						
9-6-018-003	Adelaide Malepe	96-3109 Pikake St	0.2754	1	3						
9-6-018-004	Martina Usman	96-3101 Pikake St	0.2476	1	4						
9-6-018-028	Aloha Maria Dameg Ga	96-3093 Pikake St	0.3271	1	3						
9-6-020-015	Barbara Lee	96-3087 Pakalana St	0.2236	1	3						
9-6-020-016	Joseph Aglia	96-3101 Puahala St	0.2478	1	3						
9-6-020-058	Charles Doyle	96-3102 Puahala St	0.3429	1	2						
9-6-020-057	Ernesto Abellera	96-3106 Puahala St	0.2465	1	2						
9-6-020-056	Florentina Penera	96-3112 Puahala Street	0.294	1	3						
9-6-020-017	Cristen Navarro-Vierra	96-3105 Puahala St	0.2208	1	3						
9-6-020-034	Nathan Ortega	96-3118 Pauhala St	0.2527	1	6						
9-6-020-033	Katherine Gacayan	96-3120 Puahala St	0.2255	1	3						
9-6-020-032	Lester Ibasan	96-3124 Puahala	0.3072	1	3						
9-6-020-031	Francis Woo	96-3126 Puahala	0.3139	1	3						
9-6-020-003	Leland Janes Martin	96-3132 Puahala St	0.2392	1	3						
9-6-005-008	State of Hawaii	96-3150 Pikake St	26.926								

C

Appendix C - Cost Calculations

IWS Management Model 2A County In-House Maintenance Cost

Year	Tasks		County O&M Staff Cost Capital Cost/Household
0	IWS Installation		
0	Pumping & Hauling equipment	$250,000.00	$ 1,470.59
0	Personnel Training	$ 50,000.00	$ 294.12
1	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
2	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
3	Septic sludge pumping & disposal by County staff		$ 1,250.00
4	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
5	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
6	Septic sludge pumping & disposal by County staff		$ 1,250.00
7	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
8	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
9	Septic sludge pumping & disposal by County staff		$ 1,250.00
10	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
11	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
12	Septic sludge pumping & disposal by County staff		$ 1,250.00
13	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
14	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
15	Septic sludge pumping & disposal by County staff		$ 1,250.00
16	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
17	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
18	Septic sludge pumping & disposal by County staff		$ 1,250.00
19	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
20	Absorption bed replacement		$ 30,000.00
20	Pumping & Hauling equipment Replacement	$250,000.00	$ 1,470.59
21	Annual Inspection by & Trouble Calls by County staff - one IWS Operator / Plumber		$ 822.00
	Average Annual Maintenance Cost		$ 956.44

IWS Management Model 2B Outsource Maintenance Cost

Year	Tasks	Outsource O&M Cost	County Admin Staff
0	IWS Installation	Capital Cost	
1	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
2	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
3	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
4	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
5	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
6	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
7	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
8	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
9	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
10	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
11	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
12	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
13	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
14	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
15	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
16	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
17	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
18	Septic sludge pumping & disposal	$ 1,250.00	$ 572.00
19	IWS annual inspection & Trouble Calls	$ 550.00	$ 572.00
20	Absorption bed replacement	$ 30,000.00	$ 572.00
21	IWS annual inspection (repeat as Year 1)	$ 550.00	$ 572.00
	Average Annual Maintenance Cost	$ 783.33	$ 572.00

County WWD Admin Personnel Cost for Record Keeping and administering	Based on $100000/175 = $572
Trouble calls, emergency repairs per IWS per year	$ 250.00

IWS Management Model 3A Operating Permit User O&M Cost

Year	Tasks	O&M Cost to Homeowner/User	County Admin Cost
0	IWS Installation	0	Capital Cost
1	IWS annual inspection & Trouble calls	$ 500.00	$ 572.00
2	IWS annual inspection	$ 500.00	$ 572.00
3	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
4	IWS annual inspection	$ 500.00	$ 572.00
5	IWS annual inspection	$ 500.00	$ 572.00
6	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
7	IWS annual inspection	$ 500.00	$ 572.00
8	IWS annual inspection	$ 500.00	$ 572.00
9	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
10	IWS annual inspection	$ 500.00	$ 572.00
11	IWS annual inspection	$ 500.00	$ 572.00
12	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
13	IWS annual inspection	$ 500.00	$ 572.00
14	IWS annual inspection	$ 500.00	$ 572.00
15	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
16	IWS annual inspection	$ 500.00	$ 572.00
17	IWS annual inspection	$ 500.00	$ 572.00
18	Septic sludge pumping & disposal	$ 1,200.00	$ 572.00
19	IWS annual inspection	$ 500.00	$ 300.00
20	Absorption bed replacement	$ -	$ 30,000.00
21	IWS annual inspection (repeat as Year 1)	$ 500.00	$ 572.00
	Annual Average Cost	$ 733.33	$ 572.00

O&M Cost to Homeowner / User includes trouble calls	$300 + $200 = $500
County admin staff to provide recording keeping, regulation and enforcing	Based on $100000/175

IWS Management Model 3B County Voucher O&M Cost

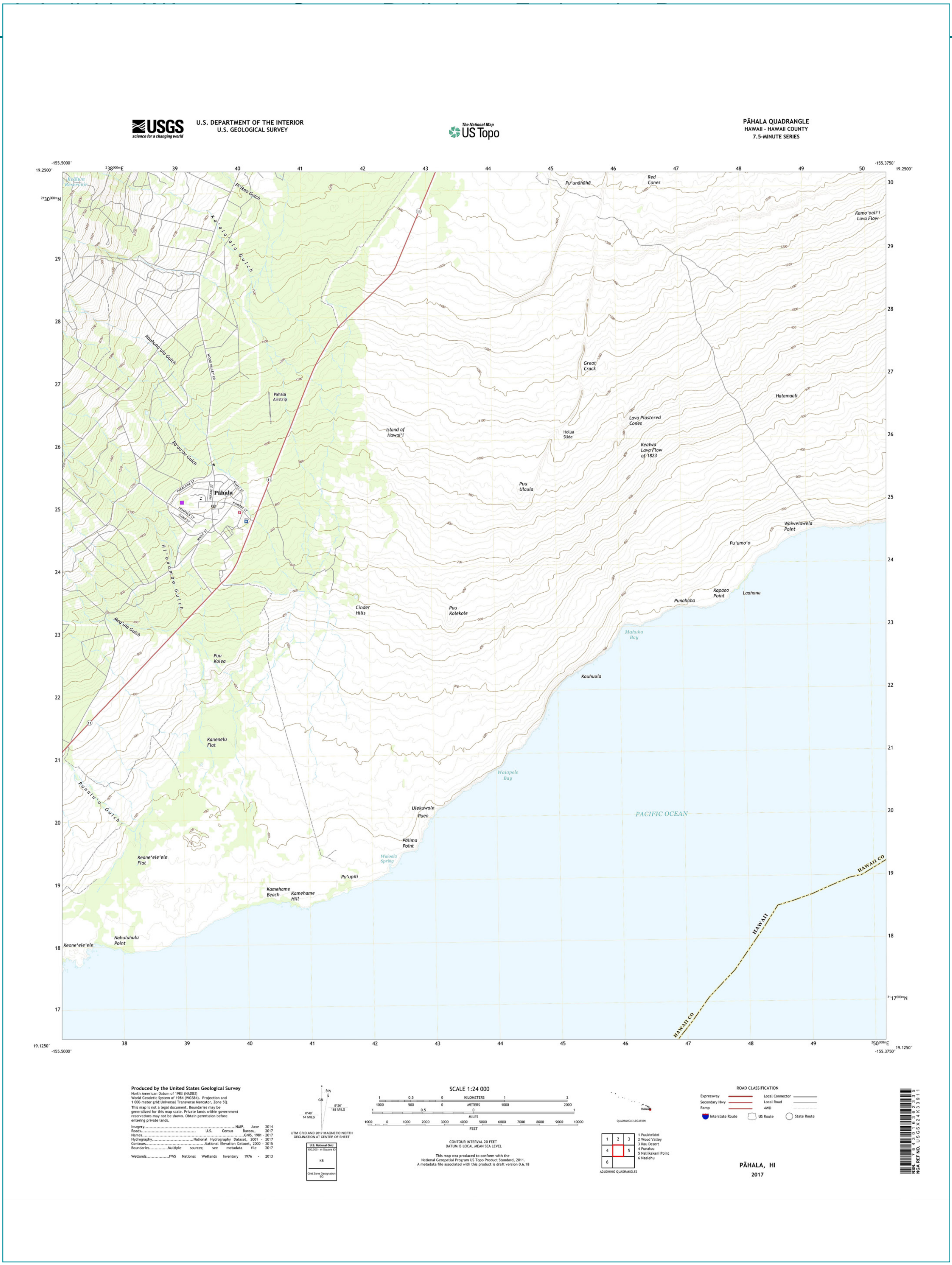
Year	Tasks	Trouble call Cost to Homeowner/User	County Voucher Cost (present value)
0	IWS Installation	0	Capital Cost
1	IWS annual inspection & Trouble calls	$ 600.00	$ 872.00
2	IWS annual inspection	$ 600.00	$ 872.00
3	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
4	IWS annual inspection	$ 600.00	$ 872.00
5	IWS annual inspection	$ 600.00	$ 872.00
6	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
7	IWS annual inspection	$ 600.00	$ 872.00
8	IWS annual inspection	$ 600.00	$ 872.00
9	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
10	IWS annual inspection	$ 600.00	$ 872.00
11	IWS annual inspection	$ 600.00	$ 872.00
12	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
13	IWS annual inspection	$ 600.00	$ 872.00
14	IWS annual inspection	$ 600.00	$ 872.00
15	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
16	IWS annual inspection	$ 600.00	$ 872.00
17	IWS annual inspection	$ 600.00	$ 872.00
18	Septic sludge pumping & disposal	$ 600.00	$ 1,572.00
19	IWS annual inspection	$ 600.00	$ 872.00
20	Absorption bed replacement	$ -	$ 30,000.00
21	IWS annual inspection (repeat as Year 1)	$ 600.00	$ 872.00
	Annual Average Cost	$ 600.00	$ 1,105.33

County voucher cost: $572 + $300
Based on $100000/175

D

Appendix D - Topography

Pāh



USGS science for a changing world
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
The National Map US Topo
PĀHALA QUADRANGLE
HAWAII - HAWAII COUNTY
7.5-MINUTE SERIES
Pāhala
Pahala Airstrip
Island of Hawai'i
Great Crack
Holua Slide
Lava Plastered Cones
Kealwa Lava Flow of 1823
Puu Ulaula
Red Cones
Pu'unāhāhā
Kamo'oali'i Lava Flow
Halemaoli
Waiwelawela Point
Pu'umo'o
Kapaoo Point
Punahaha
Laahana
Mahuka Bay
Kauhuula
Cinder Hills
Puu Kolekole
Puu Kolea
Kanenelu Flat
Waiapele Bay
PACIFIC OCEAN
Ulekuwale
Pueo
Pālima Point
Waioala Spring
Pu'upili
Kamehame Beach
Kamehame Hill
Keone'ele'ele Flat
Keone'ele'ele
Nahuluhulu Point
Ka'ala'ala Gulch
Pi'ikea Gulch
Kauhuhu'ula Gulch
Pa'au'au Gulch
Hi'onamoa Gulch
Moa'ula Gulch
Punalu'u Gulch
HAWAII CO
HAWAII
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DATUM IS LOCAL MEAN SEA LEVEL
ROAD CLASSIFICATION
Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route
Produced by the United States Geological Survey
ADJOINING QUADRANGLES
1 Puukinikini
2 Wood Valley
3 Kau Desert
4 Punaluu
5 Naliikakani Point
6 Naalehu
PĀHALA, HI
2017

E

Appendix E - USGS Soil Survey


238500
238800
239100
239400
239700
240000
240300
240600
° 12' 45" N
19° 12' 45
2126200
2125900
2125600
2125300
2125000
2124700
2124400
2124100
2123800
2123500
2123200
9° 11' 8" N
19° 11' 8"
Pikake St
Pakalana St
Keahi St
Ilima St
Maile St
Mill Rd
11
562
517
567
522
521
Soil Map may not be valid at this scale.
155° 29' 16" W
155° 27' 58" W
Map Scale: 1:14,700 if printed on A portrait (8.5" x 11") sheet.
Meters
0
200
400
800
1200
N

MAP LEGEND

Area of Interest (AOI)
- ▭ Area of Interest (AOI)

Soils
- ▭ Soil Map Unit Polygons
- 〰 Soil Map Unit Lines
- ■ Soil Map Unit Points

Special Point Features
- ⊙ Blowout
- ⊠ Borrow Pit
- ✱ Clay Spot
- ◇ Closed Depression
- ✕ Gravel Pit
- ∴ Gravelly Spot
- ⊚ Landfill
- ʌ Lava Flow
- ⩊ Marsh or swamp
- ⚒ Mine or Quarry
- ◉ Miscellaneous Water
- ◎ Perennial Water
- ∨ Rock Outcrop
- + Saline Spot
- ⁙ Sandy Spot
- ⊖ Severely Eroded Spot
- ◇ Sinkhole
- ⋗ Slide or Slip
- ø Sodic Spot
- ≋ Spoil Area
- ● Stony Spot
- ∞ Very Stony Spot
- ψ Wet Spot
- △ Other
- ⁃ Special Line Features

Water Features
- ∼ Streams and Canals

Transportation
- ╋╋╋ Rails
- 〰 Interstate Highways
- 〰 US Routes
- 〰 Major Roads
- 〰 Local Roads

Background
- ■ Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Hawaii Area, Hawaii
Survey Area Data: Version 15, Aug 30, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 3, 2019—Jun 28, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
517	Alapai hydrous silty clay loam, 10 to 20 percent slopes	0.5	0.1%
521	Naalehu medial silty clay loam, 3 to 10 percent slopes	163.8	18.0%
522	Naalehu medial silty clay loam, 10 to 20 percent slopes	178.1	19.6%
562	Akihi-Alapai complex, 10 to 20 percent slopes	0.0	0.0%
567	Puueo-Naalehu complex, 3 to 10 percent slopes	567.2	62.4%
Totals for Area of Interest		**909.5**	**100.0%**

Island of Hawaii Area, Hawaii

521—Naalehu medial silty clay loam, 3 to 10 percent slopes

Map Unit Setting

National map unit symbol: 2klhg
Elevation: 0 to 1,200 feet
Mean annual precipitation: 30 to 60 inches
Mean annual air temperature: 70 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Naalehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Naalehu

Setting

Landform: Ash fields on pahoehoe lava flows
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Basic volcanic ash over pahoehoe lava

Typical profile

Ap1 - 0 to 11 inches: medial silt loam
Ap2 - 11 to 17 inches: medial silt loam
Bw1 - 17 to 28 inches: hydrous silty clay loam
Bw2 - 28 to 37 inches: hydrous silty clay loam
2Bwb - 37 to 44 inches: hydrous silty clay loam
3Bwb - 44 to 59 inches: hydrous silty clay loam

Properties and qualities

Slope: 3 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: F161BY501HI - Kona Weather Ustic Forest
Hydric soil rating: No

Data Source Information

Soil Survey Area: Island of Hawaii Area, Hawaii
Survey Area Data: Version 15, Aug 30, 2022

Island of Hawaii Area, Hawaii

567—Puueo-Naalehu complex, 3 to 10 percent slopes

Map Unit Setting

National map unit symbol: 2kljm
Elevation: 0 to 1,200 feet
Mean annual precipitation: 35 to 47 inches
Mean annual air temperature: 70 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Puueo and similar soils: 65 percent
Naalehu and similar soils: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Puueo

Setting

Landform: Ash fields on aa lava flows
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Basic volcanic ash over aa lava

Typical profile

2C1/A1 - 0 to 7 inches: extremely cobbly medial silt loam
2C2/A2 - 7 to 18 inches: extremely cobbly medial silt loam
2C3 - 18 to 30 inches: cobbles
2R - 30 to 40 inches: bedrock

Properties and qualities

Slope: 3 to 10 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A
Ecological site: F161BY501HI - Kona Weather Ustic Forest
Hydric soil rating: No

Description of Naalehu

Setting

Landform: Ash fields on pahoehoe lava flows
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Parent material: Basic volcanic ash over pahoehoe lava

Typical profile

Ap1 - 0 to 11 inches: medial silt loam
Ap2 - 11 to 17 inches: medial silt loam
Bw1 - 17 to 28 inches: hydrous silty clay loam
Bw2 - 28 to 37 inches: hydrous silty clay loam
2Bwb - 37 to 44 inches: hydrous silty clay loam
3Bwb - 44 to 59 inches: hydrous silty clay loam

Properties and qualities

Slope: 3 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F161BY501HI - Kona Weather Ustic Forest
Hydric soil rating: No

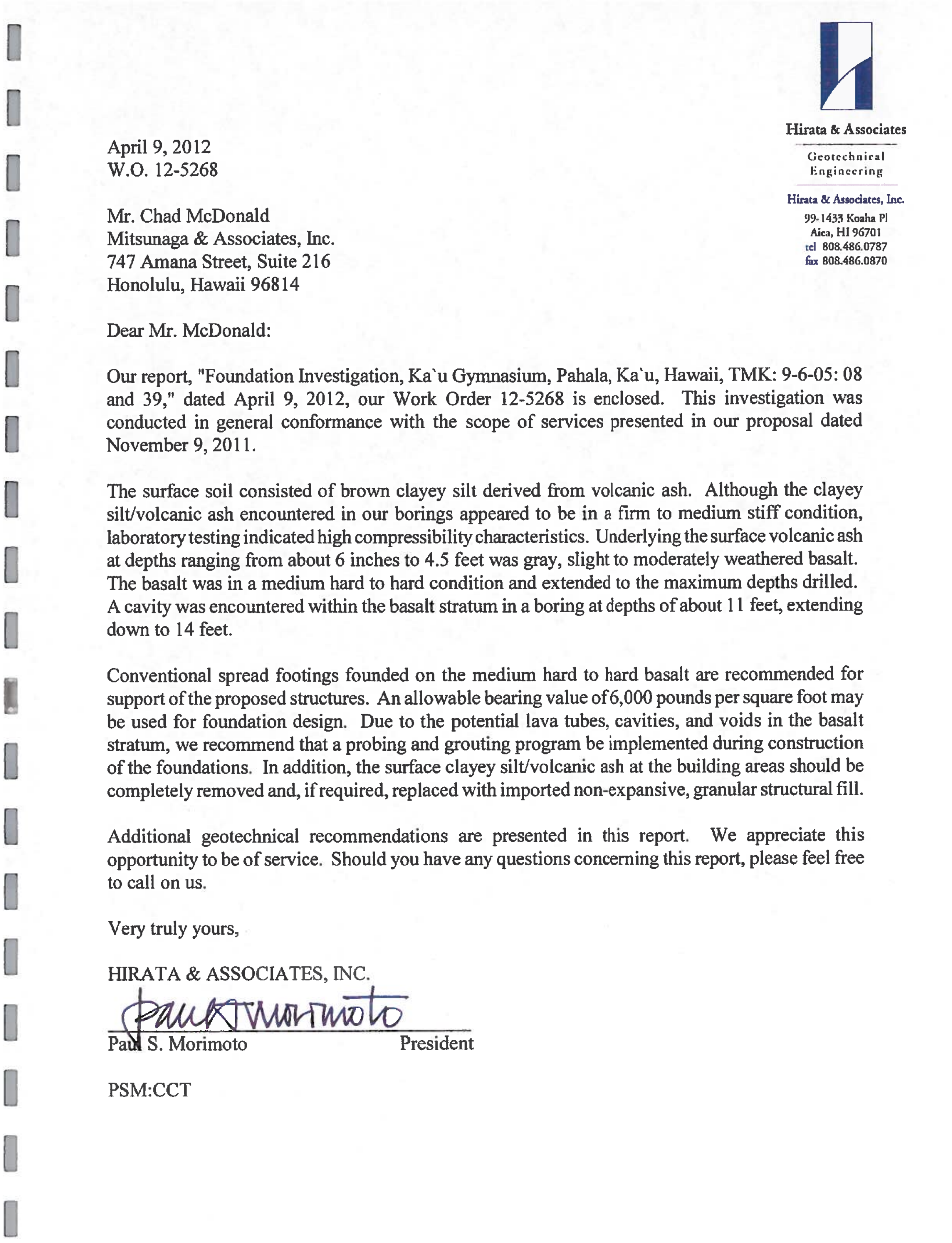
Data Source Information

Soil Survey Area: Island of Hawaii Area, Hawaii
Survey Area Data: Version 15, Aug 30, 2022

F

Appendix F - Ka'ū Gym Geotech Report

F



Hirata & Associates
Geotechnical
Engineering

Hirata & Associates, Inc.
99-1433 Koaha Pl
Aiea, HI 96701
tel 808.486.0787
fax 808.486.0870

April 9, 2012
W.O. 12-5268

Mr. Chad McDonald
Mitsunaga & Associates, Inc.
747 Amana Street, Suite 216
Honolulu, Hawaii 96814

Dear Mr. McDonald:

Our report, "Foundation Investigation, Ka`u Gymnasium, Pahala, Ka`u, Hawaii, TMK: 9-6-05: 08 and 39," dated April 9, 2012, our Work Order 12-5268 is enclosed. This investigation was conducted in general conformance with the scope of services presented in our proposal dated November 9, 2011.

The surface soil consisted of brown clayey silt derived from volcanic ash. Although the clayey silt/volcanic ash encountered in our borings appeared to be in a firm to medium stiff condition, laboratory testing indicated high compressibility characteristics. Underlying the surface volcanic ash at depths ranging from about 6 inches to 4.5 feet was gray, slight to moderately weathered basalt. The basalt was in a medium hard to hard condition and extended to the maximum depths drilled. A cavity was encountered within the basalt stratum in a boring at depths of about 11 feet, extending down to 14 feet.

Conventional spread footings founded on the medium hard to hard basalt are recommended for support of the proposed structures. An allowable bearing value of 6,000 pounds per square foot may be used for foundation design. Due to the potential lava tubes, cavities, and voids in the basalt stratum, we recommend that a probing and grouting program be implemented during construction of the foundations. In addition, the surface clayey silt/volcanic ash at the building areas should be completely removed and, if required, replaced with imported non-expansive, granular structural fill.

Additional geotechnical recommendations are presented in this report. We appreciate this opportunity to be of service. Should you have any questions concerning this report, please feel free to call on us.

Very truly yours,

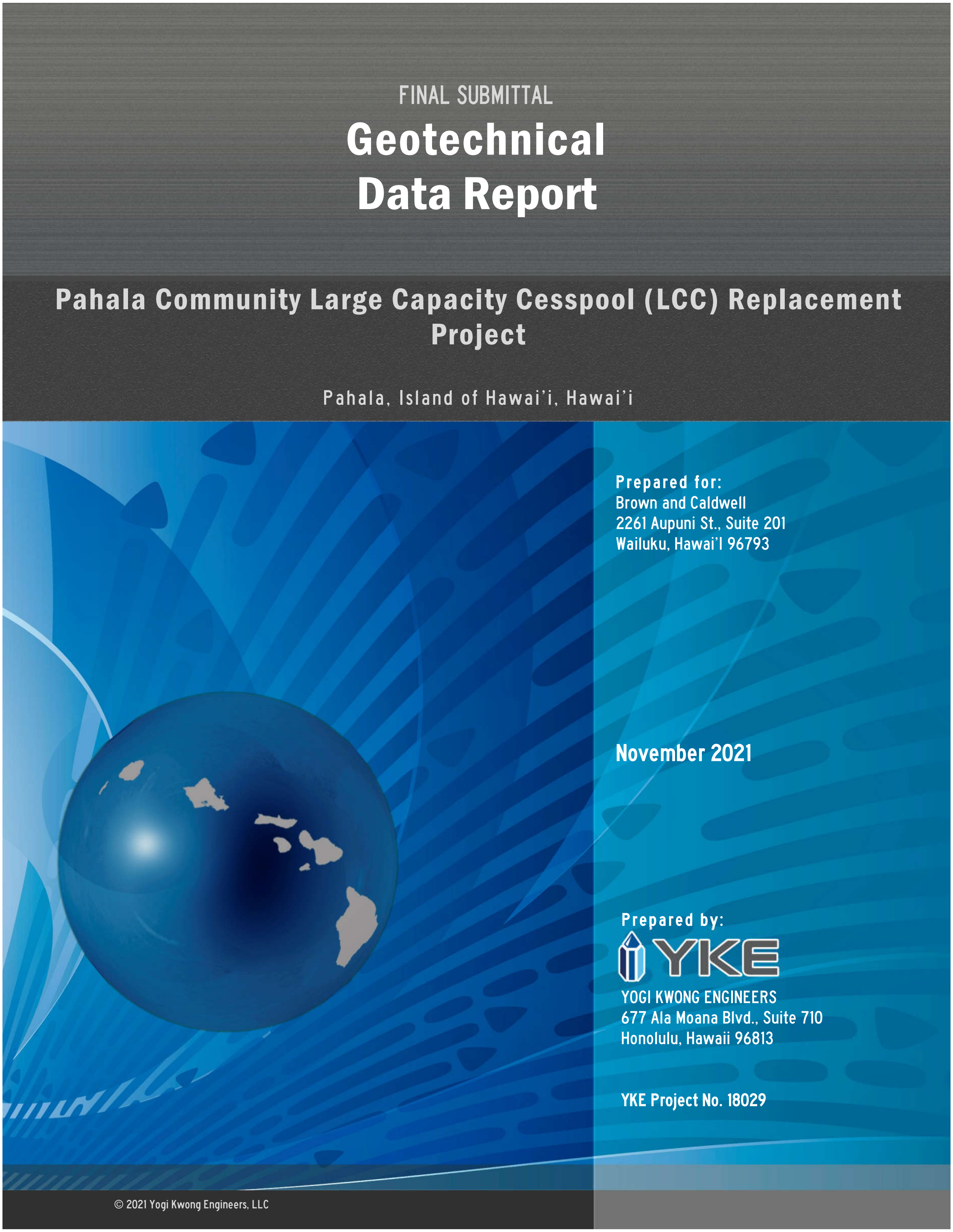
HIRATA & ASSOCIATES, INC.

Paul S Morimoto
Paul S. Morimoto President

PSM:CCT

G

Appendix G - YKE Geotechincal Data Report



FINAL SUBMITTAL

Geotechnical Data Report

Pahala Community Large Capacity Cesspool (LCC) Replacement Project

Pahala, Island of Hawai’i, Hawai’i

Prepared for:
Brown and Caldwell
2261 Aupuni St., Suite 201
Wailuku, Hawai’I 96793

November 2021

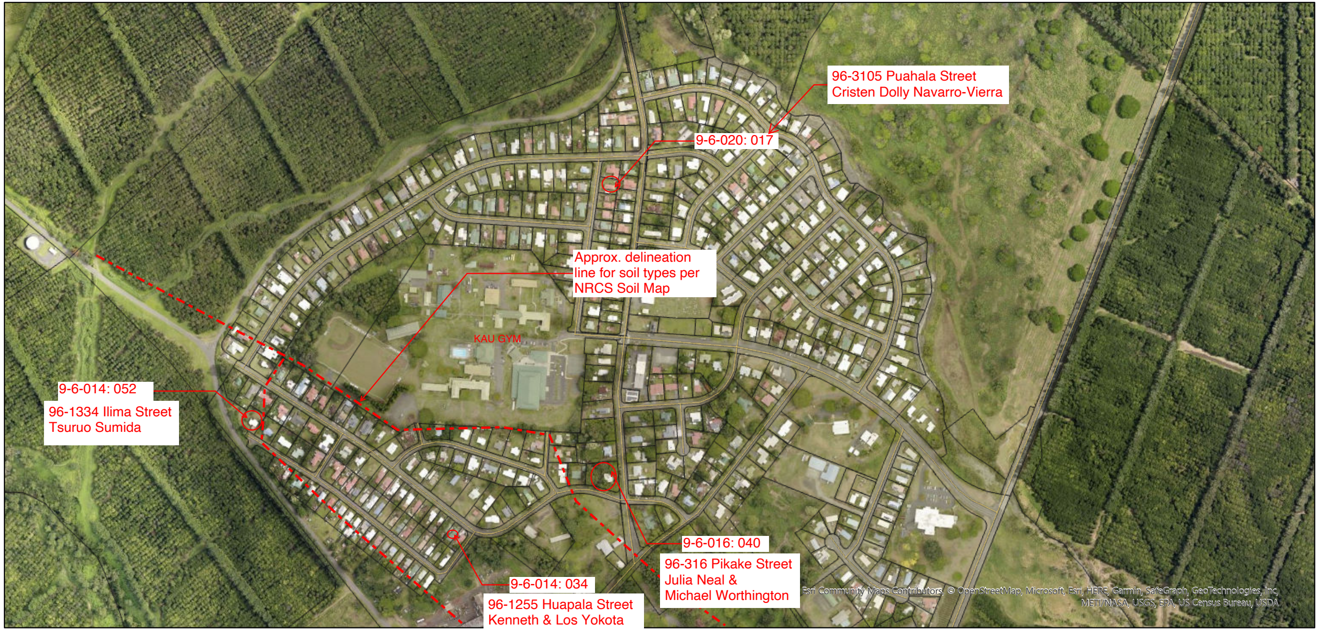
Prepared by:
YKE
YOGI KWONG ENGINEERS
677 Ala Moana Blvd., Suite 710
Honolulu, Hawaii 96813

YKE Project No. 18029

H

Appendix H - Percolation Test Results

Pahala - Percolation Test Sampling



Current Time: ~~10/19/2022 3:59 PM~~
Wastewater Staff Updated 11/03/22

1 inch equals 0 miles
Scale: 1:6,000

— Street Centerlines
▭ Parcels (current boundary lines)

4 lots are selected for the initial percolation sampling sites.
These sites were selected based on their representing soil type and relative elevations.
It is not critical to be on the exact lot selected.

DEPARTMENT OF HEALTH - WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS) - SITE EVALUATION / PERCOLATION TEST

Date / Time: 11/21/22 8:00am Test Performed by: Austin Ah Hee / Cres Rambayon

Owner: Cristen Dolly Navarro-Vierra TMK: (3) 9 - 6 - 020 : 017

Elevation: 976 feet

Depth to Groundwater Table: N/A feet below grade

Depth to Bedrock (if observed): N/A feet below grade

Diameter of Hole: 12 inches

Depth to Hole Bottom: 4 feet below grade

Depth, inches below grade	Soil Profile (color, texture, other)
0-24	Dense brown clay
24-48	Light brown clay

PERCOLATION READINGS:

Time 12 inches of water to seep away: 45 minutes

Time 12 inches of water to seep away: 53 minutes

Check one:

____ Percolation tests in sandy soils, recorded time intervals and water drops at least every 10 minutes for at least 1 hour.

X Percolation tests in no-sandy soils, presoaked the test hole for at least 4 hours. Recorded time intervals and water drops at least every 10 minutes for 1 hour of time for the first 6 inches to seep away in greater than 30 minutes record time intervals and water drops at lest every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval	Drop in Inches	Time Interval	Drop in Inches
10	1.5		
10	1.5		
10	1.5		
10	1		
10	1		
10	1		

YEN WEN FANG
No. 9361-C
Expires 04/30/24

Percolation Rate (time/final water level drop): 10 minutes/inches

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable. I also attest that three feet of suitable soil exist between the bottom of the soil absorption system and the groundwater table or any other limiting layer.

Yen Wen Fang

Engineer's Signature/Stamp

11/28/22

Date

DEPARTMENT OF HEALTH - WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS) - SITE EVALUATION / PERCOLATION TEST

Date / Time: 11/21/22 1:00pm Test Performed by: Austin Ah Hee / Cres Rambayon

Owner: Tsuruo Sumida TMK: (3) 9 - 6 - 014 : 052

Elevation: 965 feet

Depth to Groundwater Table: N/A feet below grade

Depth to Bedrock (if observed): N/A feet below grade

Diameter of Hole: 12 inches

Depth to Hole Bottom: 2 feet below grade

Depth, inches below grade	Soil Profile (color, texture, other)
0-6	Grey natural ash
6- 24	Very dense brown clay

Rock is encountered at 24" depth and cannot dig deeper. Digging is done using crowbar and shovel.
4 holes were dug at different locations in the property with similar result, encountering rock at 24 " depth

PERCOLATION READINGS:

Time 12 inches of water to seep away: 75 minutes

Time 12 inches of water to seep away: 75 minutes

Check one:

___ Percolation tests in sandy soils, recorded time intervals and water drops at least every 10 minutes for at least 1 hour.

X Percolation tests in no-sandy soils, presoaked the test hole for at least 4 hours. Recorded time intervals and water drops at least every 10 minutes for 1 hour of time for the first 6 inches to seep away in greater than 30 minutes record time intervals and water drops at lest every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval	Drop in Inches	Time Interval	Drop in Inches
10	1		
10	1		
10	1		
10	1		
10	1		
10	1		

Percolation Rate (time/final water level drop): 10 minutes/inches

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable. I also attest that three feet of suitable soil exist between the bottom of the soil absorption system and the groundwater table or any other limiting layer.

EN WEN FANG
LICENSED PROFESSIONAL ENGINEER
No. 9361-C
Expires 04/30/24

Engineer's Signature/Stamp

11/28/22
Date

H

DEPARTMENT OF HEALTH - WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS) - SITE EVALUATION / PERCOLATION TEST

Date / Time: 11/22/22 8:00am Test Performed by: Austin Ah Hee

Owner: Julia Neal and Michael Worthington TMK: (3) 9 - 6 - 016 : 040

Elevation: 886 feet

Depth to Groundwater Table: N/A feet below grade

Depth to Bedrock (if observed): N/A feet below grade

Diameter of Hole: 12 inches

Depth to Hole Bottom: 2.5 feet below grade

Depth, inches below grade	Soil Profile (color, texture, other)
0-24	Loose grey clay
24-30	Dense brown clay

Note: Large impermeable rock encountered at depth of 30".
Hole could not be dug deeper. Hole was dug with hand shovel and large crowbar.

PERCOLATION READINGS:

Time 12 inches of water to seep away: 37 minutes

Time 12 inches of water to seep away: 38 minutes

Check one:

☐ Percolation tests in sandy soils, recorded time intervals and water drops at least every 10 minutes for at least 1 hour.

☒ Percolation tests in no-sandy soils, presoaked the test hole for at least 4 hours. Recorded time intervals and water drops at least every 10 minutes for 1 hour of time for the first 6 inches to seep away in greater than 30 minutes record time intervals and water drops at lest every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval	Drop in Inches	Time Interval	Drop in Inches
10	3		
10	3		
10	3		
10	3		
10	3		
10	2.5		

YEN WEN FANG
No. 9361-C
Expires 04/30/24

Percolation Rate (time/final water level drop): 4 minutes/inches

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable. I also attest that three feet of suitable soil exist between the bottom of the soil absorption system and the groundwater table or any other limiting layer.

Yen Wen Fang
Engineer's Signature/Stamp

11/28/22
Date

DEPARTMENT OF HEALTH - WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS) - SITE EVALUATION / PERCOLATION TEST

Date / Time: 11/22/22 1:00 pm Test Performed by: Austin Ah Hee

Owner: Kenneth and Lois Yokota TMK: (3) 9 - 6 - 014 : 034

Elevation: 880 feet

Depth to Groundwater Table: N/A feet below grade

Depth to Bedrock (if observed): N/A feet below grade

Diameter of Hole: 12 inches

Depth to Hole Bottom: 3 feet below grade

Depth, inches below grade	Soil Profile (color, texture, other)
0- 36	Very dense brown clay

Note: Large impermeable rock encountered at a depth of 36". Test hole could not be dug any deeper. Hole was dug with a hand shovel and large crowbar.

PERCOLATION READINGS:

Time 12 inches of water to seep away: 75 minutes

Time 12 inches of water to seep away: 75 minutes

Check one:

____ Percolation tests in sandy soils, recorded time intervals and water drops at least every 10 minutes for at least 1 hour.

X Percolation tests in no-sandy soils, presoaked the test hole for at least 4 hours. Recorded time intervals and water drops at least every 10 minutes for 1 hour of time for the first 6 inches to seep away in greater than 30 minutes record time intervals and water drops at lest every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval	Drop in Inches	Time Interval	Drop in Inches
10	1.5		
10	1.5		
10	1.5		
10	1		
10	1		
10	1		

YEN WEN FANG
LICENSED PROFESSIONAL ENGINEER
No. 9361-C
HAWAII U.S.A.
Expires 04/30/24

Percolation Rate (time/final water level drop): 10 minutes/inches

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, "Wastewater Systems" and the results were acceptable. I also attest that three feet of suitable soil exist between the bottom of the soil absorption system and the groundwater table or any other limiting layer.

Yen Wen Fang
Engineer's Signature/Stamp

11/28/22
Date

I

Appendix I - EZ Treat Recirculating Biofilter

E-Z TREAT

PO Box 176
Haymarket, Virginia 20168

March 25, 2023

To: James Roberts, Owner, The Wai Home

From: Joelle Wirth, RS, E-Z Treat Incorporated

Re: Pāhala Large Capacity Cesspool (LCC) Replacement Project

EPA Grant XP-96942401

The following attachments are our proposals for the Pahala Large Capacity Cesspool Replacement Project.

The first proposal was to address the Large Capacity Cesspool Replacement. EZ Treat has looked at the proposals and decided that the 190,000 gpd system is too large for us to consider. We typically handle flows up to 100,000 gpd effectively and competitively but greater than 100,000 gpd the other options identified would be more cost effective.

I have included a flow diagram and a budget for a large system that can accommodate up to 53,300 gallons per day to give you an idea of the footprint and the associated cost for the equipment.

In addition, we have put together several configurations of our system for use with single family residences. EZ Treat is NSF 40, 245 and 350 Certified. The configurations and a brief description follow:

1. D141 this model can accommodate flows up to 600 gpd. It requires a septic tank that is in front of a recirculation tank with EZ Treat Pod set to the side. The discharge could be gravity to a rehabilitated cesspool per Hawaii DOH standards or a drain field.

Budget: $7450 includes freight

2 1000-gallon tanks $3500

2. D122 this model can accommodate flows up to 600 gpd. It requires a combination septic tank recirculation tank with the E-Z treat Pod set to the side and a pump discharging tank with EZ Treat Pod set to the side. The discharge could be gravity to a rehabilitated cesspool per Hawaii DOH standards or a drain field.

Budget: $7450 includes freight

1 1500-gallon tank $2500

3. D118 this model can accommodate flows up to 600 gpd. It requires a septic tank followed by a field dosing tank with EZ Treat Pod set to the side. The discharge is pressurized and could be directed towards a rehabilitated cesspool or a designated drain field.

Budget: $8472 includes freight

1 1000-gallon septic tank and 1 1500 gallon recirc/field dosing tank $4500

4. D149 this model can accommodate flows up to 600 gpd. It requires a septic tank that is in front of a recirculation tank with EZ Treat Pod set to the side. The discharge could be gravity to a rehabilitated cesspool per Hawaii DOH standards or a drain field. If pressurized a combination recirculation-pump tank could be utilized to discharge to a drain field.

Budget: $8472.00 includes freight

Tanks two 1000-gallon tanks $3500

Total per household 11,972.00

The configurations are attached for your review.

E-Z TREAT

PO Box 176
Haymarket, Virginia 20168

EZ Treat Technology

EZ Treat treatment technology is designed to solve septic problems on most difficult sites by cleaning wastewater to very high levels before discharge to a leach field.

E-Z Treat is a recirculating synthetic media filter. E-Z Treat is an affordable, high performing media filter. The media never needs to be replaced in comparison to other media such as peat, coco peat, foam or textile. The system is easy to install and has very low maintenance. E-Z Treat is one of the two black water onsite systems that tested and listed for NSF 350 through NSF. It is the 1st and only biological and non-chemical system approved for water reuse. NSF 350 allows for the reuse of treated effluent to be used inside residences and commercial facilities. Being able to produce a treated effluent that can now be used for expanded non potable activities such as toilet, flushing car washing, unlimited irrigation uses allows us the ability to rethink the water budget and be able to save and use water more efficiently.

Treatment Process

Septic tank treated effluent flows to the E-Z Treat Re-circulating Synthetic Filter where it receives passive biochemical treatment through and active bio-film matrix. The styrene media is very uniform providing ample surface area for biological growth. The styrene media contains many voids to accommodate optimum air and liquid flow.

The re-circulation chamber contains a float bypass valve and re-circulation pump. The bypass connects to the 4” return line from the E-Z Treat Pod. The by-pass valve allows the effluent to be continually re-circulated through the styrene media. Treated effluent exits the bypass valve and flows into a gravity drain field, rehabilitated cesspool, or into a pump chamber for dosing to LPP, drip irrigation or other pressurized and non-pressurized drain fields. Effluent is suitable for reuse. UV disinfection may be required.

Leach Field Reductions

In various states, EZ Treat has successfully requested and received approval for a reduction in the square footage of required leach field necessary to effectively dispose of EZ Treat-treated effluent. Approvals for reduction are based on empirical studies showing the correlation between acceptable loading rates and various soil types under a range of effluent quality, and the ability of time dosing to increase the infiltrative capacity of soils.

Leach fields are designed with water loading rates to fit a variety of soil types considering the daily flow volume, depth to limiting factor, and strength of the effluent. When pretreatment produces a highly treated water, such as of the quality that EZ Treat can achieve, numerous studies have demonstrated that there is virtually no biological mat formation and effluent loading rates can approach natural soil infiltration rates.

Residential Systems

EZ Treat's residential systems are available in a variety of sizes. Beginning with the residential models that treats up to three bedrooms and includes models that treat up to 6 bedrooms with one pod. Multiple pods may be used in series to acquire the desired flows. Residential systems also require a septic tank sized to existing state regulations.

Commercial & Engineered Systems

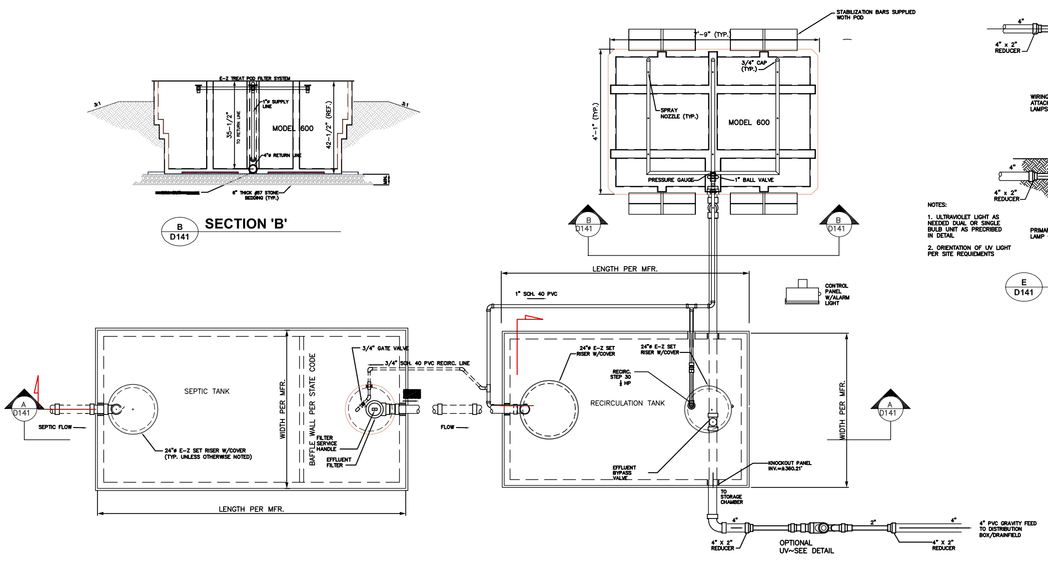
Commercial EZ Treat models include Models up to 5000 gpd per module. Commercial systems use the same treatment technology as the residential units and are set adjacent to reinforced concrete tanks sized according to flow volume and loading strength. EZ Treat has commercial systems installed and operating in schools, apartment buildings, restaurants, inns, retail stores, business parks, subdivisions, multiple-family housing units, breweries and more.

Maintenance

EZ Treat is designed to be operationally simple, the system is manufactured of non-corrodible materials and hardware, PVC piping, high-density polyethylene and fiberglass or precast concrete tanks, and industrial hardened electronics. All pumps have been selected to be of the highest quality and longest service life possible. There are no chemicals to add, filters to clean, or aerators to replace. As such, annual maintenance entails a review of the system, visual inspection of the treatment center and internal parts, a check of the effluent clarity to assure the system is operating at maximum efficiency, and a visual check of the disposal area.

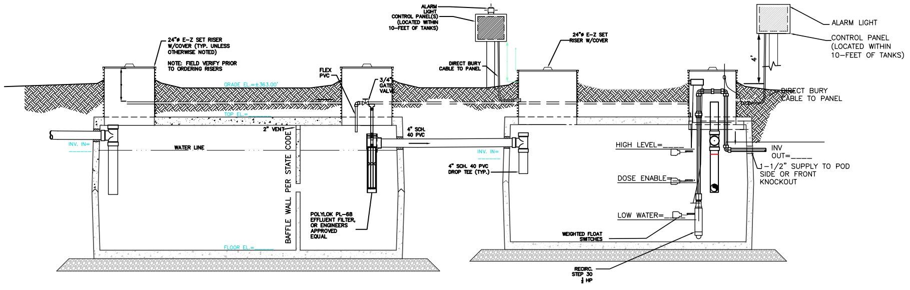
Experience

EZ Treat has installed systems serving thousands of facilities. These include systems with flows ranging from 200-gpd to 100,000-gpd. In 23 years of being in the business, we have not had to replace the media in our filters. We pride ourselves for our reputation for consistent high-level treatment, innovation, versatility, and customer-friendly solutions to wastewater problems, with highly dependable operation and service.

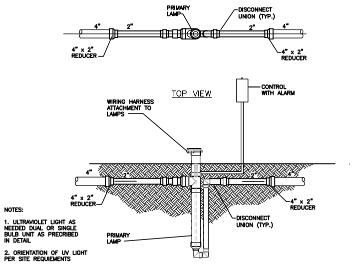


B D141 **SECTION 'B'**

1 D141 **SEPTIC AND RECIRCULATION/STORAGE TANKS**
NTS



D D141 **SEPTIC AND RECIRCULATION/STORAGE TANK SECTIONS**
NTS



NOTES:

1. ULTRAVIOLET LIGHT AS NEEDED DUAL OR SINGLE BULB UNIT AS PRECRIBED IN DETAIL
2. ORIENTATION OF UV LIGHT PER SITE REQUIEMENTS

E D141 **ULTRAVIOLET DISINFECTION UNIT**
NTS

NOTIFY UNDERGROUND UTILITIES LOCATOR PRIOR TO ANY EXCAVATION. CONTRACTOR IS RESPONSIBLE FOR COORDINATION OF ALL TRADES AND SUBCONTRACTORS. CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFYING ALL DIMENSIONS, ELEVATIONS, AND LOCATION OF ALL EXISTING CONDITIONS AND UTILITIES.

GENERAL NOTES:

1. ALL PIPING SHALL BE SCH 40 PVC UNLESS OTHERWISE NOTED ON PLANS. ALL PVC PIPES SHALL BE BURIED A MINIMUM OF 18" UNLESS SHOWN OTHERWISE.
2. CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE SOIL EROSION AND SEDIMENTATION CONTROL REQUIREMENTS.
3. CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE OSHA, aND OTHER RELATED SAFETY REQUIREMENTS.
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5. SYSTEM DESIGN SHALL BE PERMITTED BY APPICABLE AUTHORITIES PRIOR TO INSTALLATION.
6. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING ALL CONSTRUCTION DAMAGE EXPEDITIOUSLY AND AT NO ADDITIONAL COST TO THE OWNER.
7. ALL TANKS SHALL HAVE A MINIMUM 28-DAY CONCRETE STRENGTH OF 4500 PSI.
8. TANKS SHALL MEET REINFORCING REQUIREMENTS TO ACCOMMODATE 300 POUNDS PER SQUARE FOOT. EITHER STEEL REINFORCING WIRE, REBAR OR APPROVED FIBER MAY BE USED.
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10. ALL JOINTS (MID-SEAM, TOP-SEAM) SHALL BE SEALED USING CONCRETE SEALANTS BUTYL SEALANT # CS-141 OR EQUAL
11. TANKS SHALL BE LEAK-TESTED PRIOR TO SYSTEM START UP IN ACCORDANCE WITH ASTM STANDARDS AND AS REQUIRED BY LOCAL REGULATORY AUTHORITY
12. ALL PIPE PENETRATIONS THROUGH PRECAST CONCRETE TANKS SHALL BE PRESS-SEAL CAST-A-SEAL 402 RUBBER BOOTS OR EQUAL.
13. THE FILTER POD INVERT OUT SHALL BE 1/4-INCH PER FOOT SLOPE MINIMUM
14. ALL TANKS MUST MEET STATE OR LOCAL CODES.
15. U.V. SHALL BE INSTALLED AS REQUIRED BY LOCAL AND STATE CODE

PROJECT

CITY

COUNTY

ADDRESS

ENGINEER

P.O. BOX 176
HAYMARKET, VA 20168
PH. 703.763.4770
web: eztreat.net

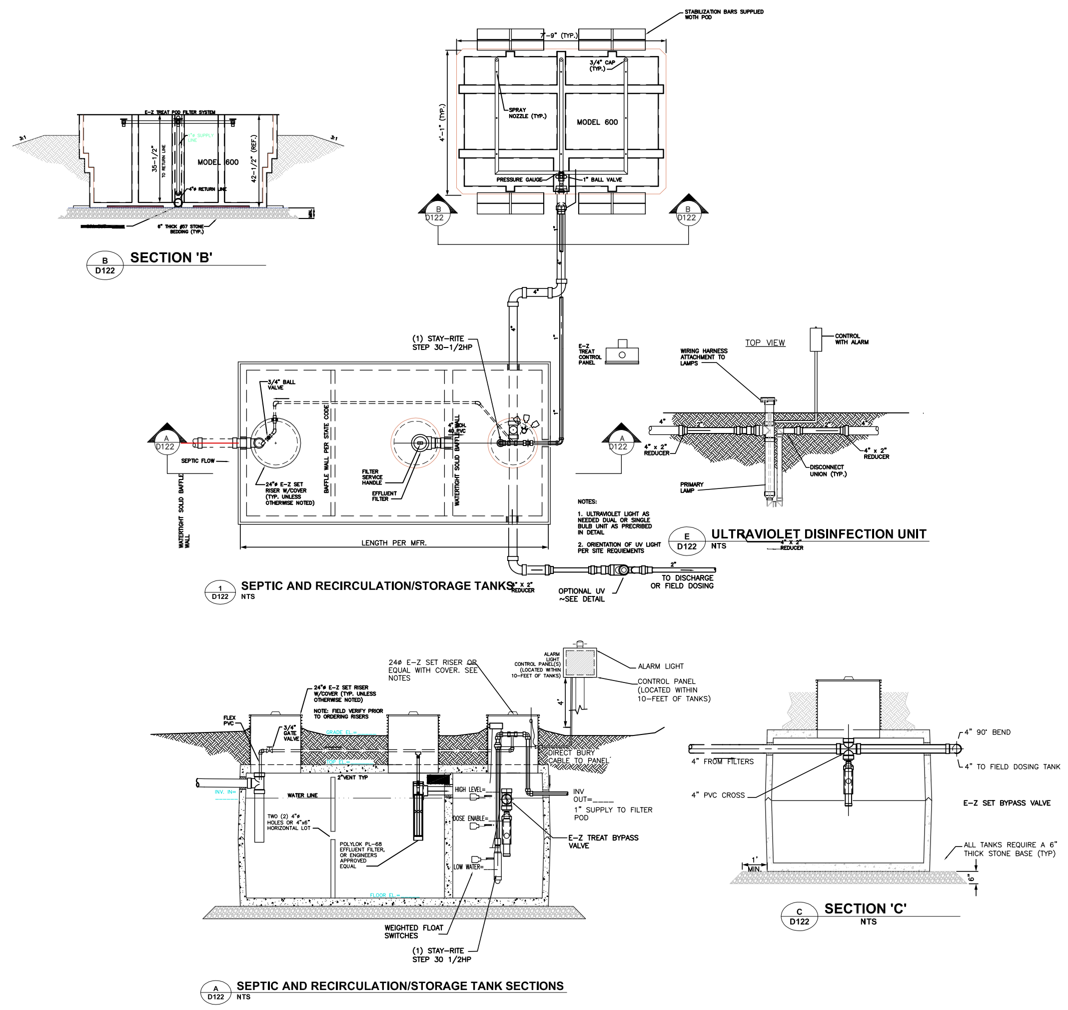
DESIGN		
DRAWN		
APPROVED		

SYSTEM CONFIGURATION

E-Z TREAT SYSTEM
SINGLE MODEL 600 POD,
TWO TANK WITH
OPTIONAL UV-GRAVITY
FEED

SHEET 1 OF 1

DWG NO. D141



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10. ALL JOINTS (MID-SEAM, TOP-SEAM) SHALL BE SEALED USING CONCRETE SEALANTS BUTYL SEALANT # CS-122 OR EQUAL
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12. ALL PIPE PENETRATIONS THROUGH PRECAST CONCRETE TANKS SHALL BE PRESS-SEAL CAST-A-SEAL 402 RUBBER BOOTS OR EQUAL.
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15. U.V. SHALL BE INSTALLED AS REQUIRED BY LOCAL AND STATE CODE

PROJECT

CITY

COUNTY

ADDRESS

P.O. BOX 176
HAYMARKET, VA 20168
PH. 703.763.4770
web: eztreat.net

DESIGN	
DRAWN	
APPROVED	

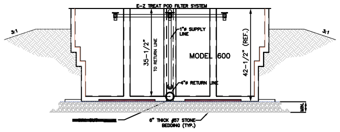
SYSTEM CONFIGURATION

E-Z TREAT SYSTEM
SINGLE MODEL 600 POD,
ONE TANK SIMPLEX
DESIGN
SEP. RECIRC. AND DOSE TANKS
PLAN AND SECTIONS

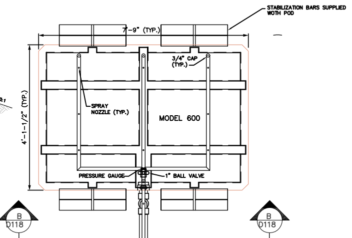
SHEET **1** OF **1**

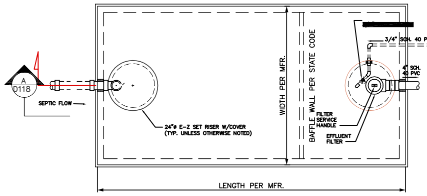
DWG NO. D122

ENGINEER

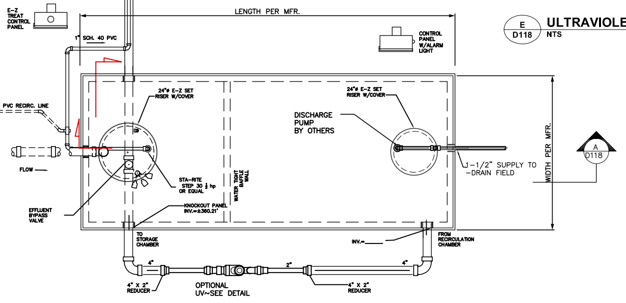


B D118 **SECTION 'B'**

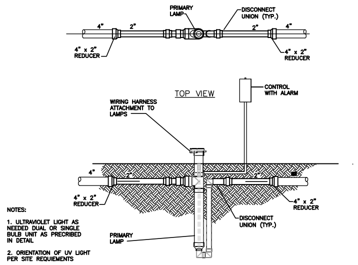




1 D118 **SEPTIC AND RECIRCULATION/STORAGE TANKS**
NTS



1 D118 **RECIRCULATION/FIELD DOSING TANKS**
NTS



NOTES:

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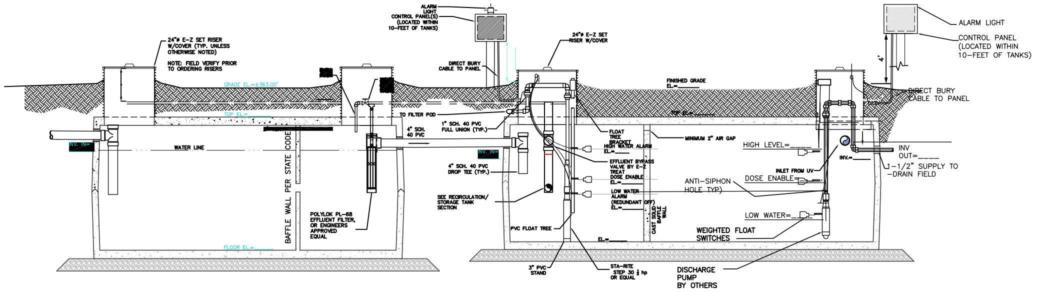

D D118 **SEPTIC AND RECIRCULATION/STORAGE TANK SECTIONS**
NTS

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PROJECT

CITY

COUNTY

ADDRESS

P.O. BOX 176
HAYMARKET, VA 20168
PH. 703.763.4770
web: eztreat.net

ENGINEER

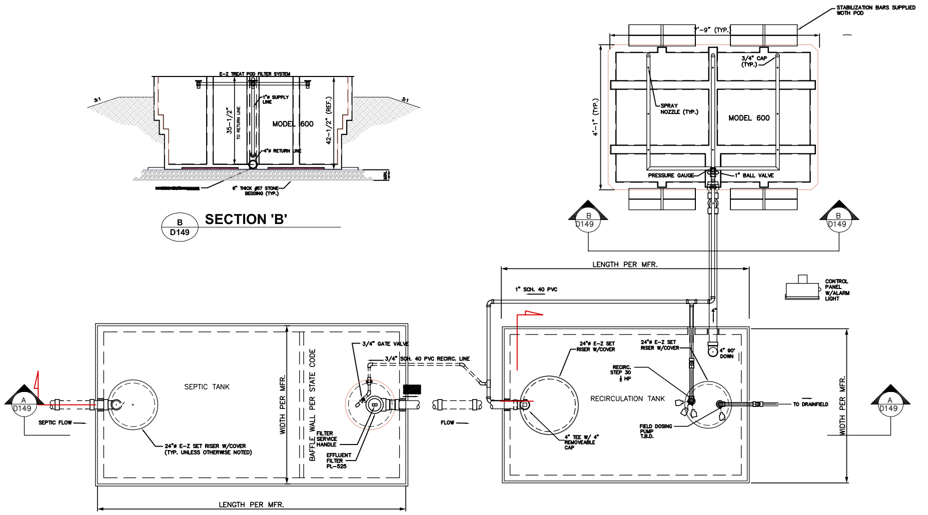
DESIGN	
DRAWN	
APPROVED	

SYSTEM CONFIGURATION

E-Z TREAT SYSTEM
SINGLE MODEL 600 POD,
TWO TANK SIMPLEX
DESIGN
SEP. RECIRC. AND DOSE TANKS
PLAN AND SECTIONS

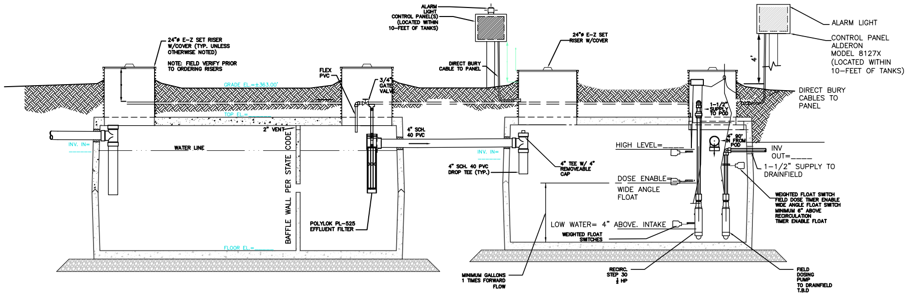
SHEET 1 OF 1

DWG NO. D118



B D149 **SECTION 'B'**

1 D149 **SEPTIC AND RECIRCULATION/STORAGE TANKS**
NTS



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NTS

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PROJECT

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COUNTY

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PH. 703.763.4770
web: eztreat.net

DESIGN

DRAWN

APPROVED

ENGINEER

SYSTEM CONFIGURATION

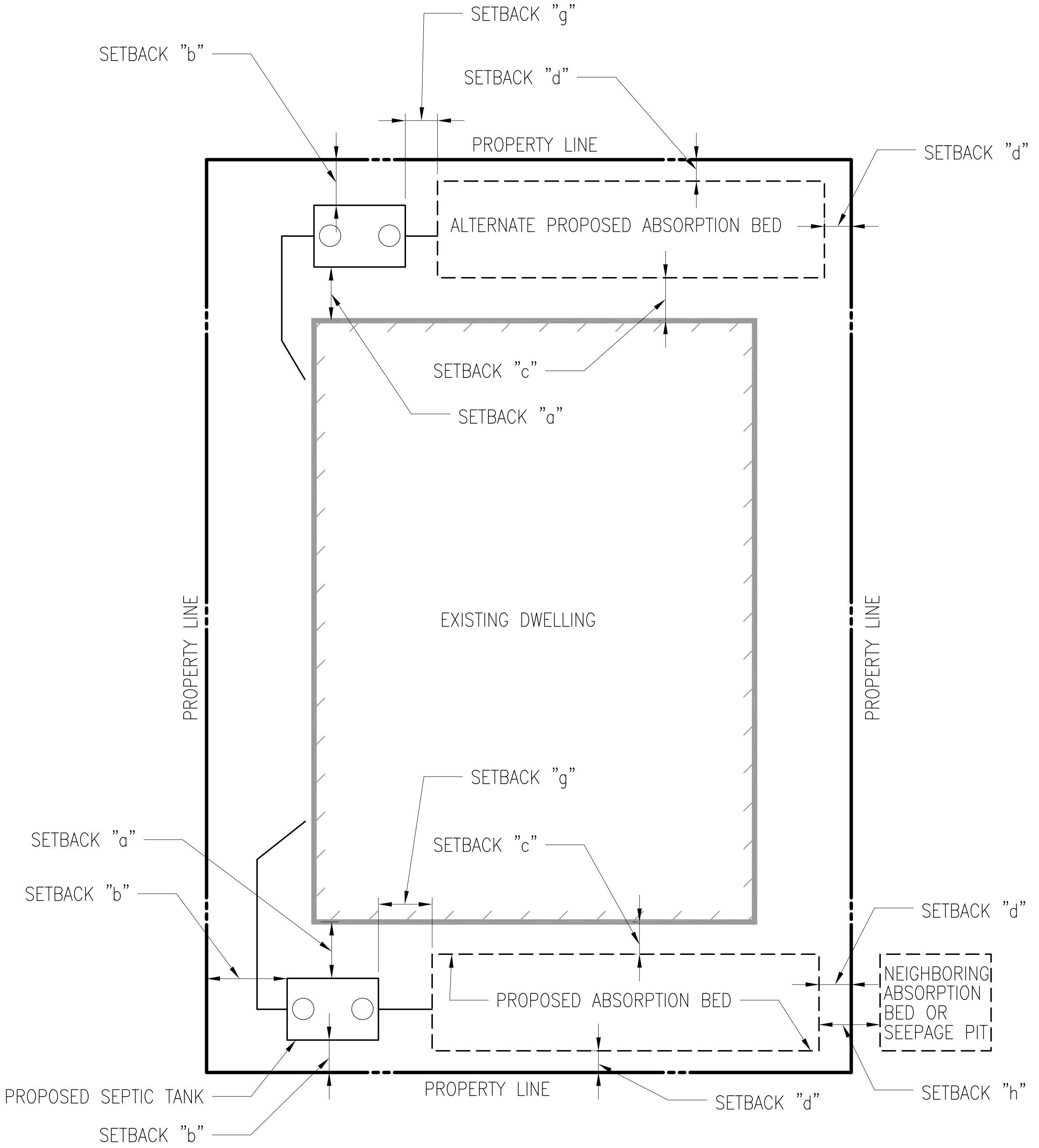
E-Z TREAT SYSTEM
SINGLE MODEL 600 POD,
TWO TANK 2 PUMP
COMBINATION

SHEET 1 OF 1

DWG NO. D149

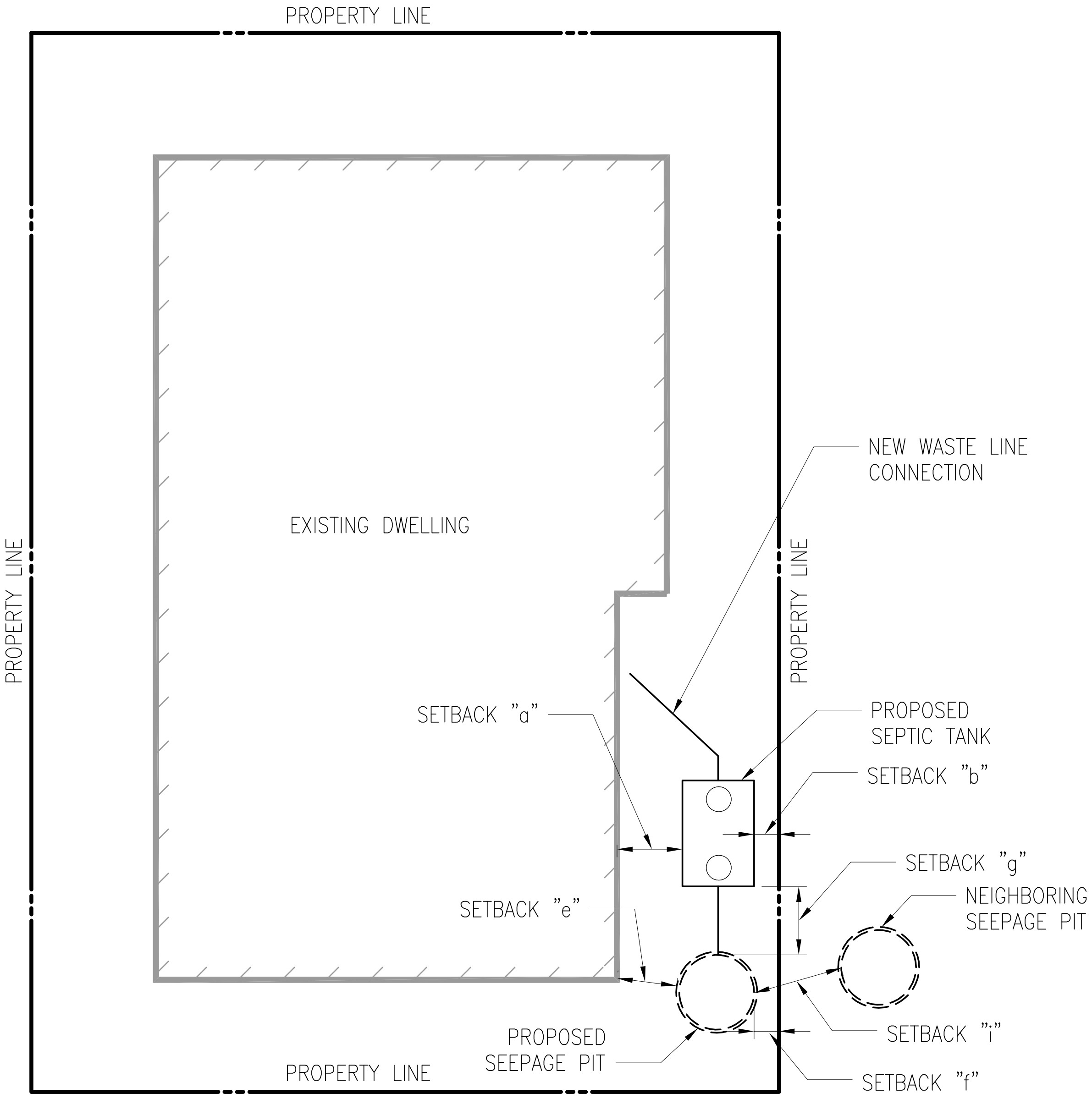
J

Appendix J - Typical IWS Layout



TYPICAL IWS LAYOUT W/ ABSORPTION BED

See Schedule A for Required Setback Dimensions and Variance Request



TYPICAL IWS LAYOUT W/ SEEPAGE PIT

See Schedule A for Required Setback Dimensions and Variance Request

SCHEDULE A

SETBACK TYPE	DESCRIPTION/MIN. PER DOH, TABLE II (SEE NOTE 1)	VARIANCE REQUEST (SEE NOTE 1)
”a”	DIST. BTW BLDG & SEPTIC TANK / 5’ MIN.	2’ < ”a” < 5’
”b”	DIST. BTW PROPERTY LINE & SEPTIC TANK / 5’ MIN.	1’ < ”b” < 5’
”c”	DIST. BTW BLDG & ABSORPTION BED / 5’ MIN.	2’ < ”c” < 5’
”d”	DIST. BTW PROPERTY LINE & ABSORPTION BED / 5’ MIN.	0 < ”d” < 5’
”e”	DIST. BTW BLDG & SEEPAGE PIT / 5’ MIN.	2’ < ”e” < 5’
”f”	DIST. BTW PROPERTY LINE & SEEPAGE PIT / 9’ MIN.	1’ < ”f” < 5’
”g”	DIST. BTW SEPTIC TANK & ABSORPTION BED / 5’ MIN.	2’ < ”g” < 5’
”h”	DIST. BTW NEIGHBORING ABSORPTION BEDS / 5’ MIN.	1’ < ”h” < 5’
”i”	DIST. BTW NEIGHBORING SEEPAGE PITS / 12’ MIN.	6’ < ”i” < 12’

ABSORPTION BED & SEEPAGE PIT SIZING

# OF BEDROMS SEPTIC TANK SIZE	NON–TRAFFIC RATED ABSORPTION BED SIZE (SEE NOTE 3)	TRAFFIC RATED ABSORPTION BED SIZE (SEE NOTE 3)	SEEPAGE PIT SIZE (SEE NOTE 4)
3 1000 GAL.	10’ X 24’ 12’ X 20’ 15’ X 16’	9’ X 24’ 12’ X 18’ 15’ X 16’	6’ø X 12’ DEEP
4 1000 OR 1250 GAL.	10’ X 32’ 12’ X 27’ 15’ X 22’	9’ X 30’ 12’ X 24’ 15’ X 18’	6’ø X 15’ DEEP 8’ø X 12’ DEEP
5 1250 GAL.	10’ X 40’ 12’ X 34’ 15’ X 27’	9’ X 40’ 12’ X 28’ 15’ X 24’	8’ø X 14’ DEEP
6 1250 GAL. PER DWS (SEE NOTE 2)	10’ X 48’ 12’ X 40’ 15’ X 32’	9’ X 48’ 12’ X 36’ 15’ X 28’	8’ø X 17’ DEEP
7 1250 GAL. PER DWS (SEE NOTE 2)	10’ X 56’ 12’ X 47’ 15’ X 38’	9’ X 52’ 12’ X 40’ 15’ X 32’	8’ø X 20’ DEEP

NOTES:

1. The request is for Variance from Section 11–62–22 Spacing of Individual Wastewater Systems, Table II in Appendix D and Section 11–62–31.1(1)(D) where states that one IWS cannot serve more than 5 bedrooms.
2. For dwellings with more than 5 bedrooms, we request a Variance to base the IWS design on the DWS water consumption record rather than based on number of bedrooms.
3. Absorption Bed for standard perforated pipe with gravel bed installation (non–traffice rated), a percolation rate of 2 min./inch is assumed. For gravel–less installation (Infiltrator Chambers) or traffic rated chambers, 17% reduction is taken for the required area of absorption bed.
4. For sizing of seepage pit, a percolation rate of 1 min./inch is assumed because the soil condition is likely to be granular or rocky type at that depth.