AECOM

FINAL

FACILITY PLAN

ADDITION OF WASTEWATER SERVICES FOR THE PUNA DISTRICT

County of Hawaiʻi
Department of Environmental Management
345 Kekuanaoʻa Street, Suite 41
Hilo, Hawaiʻi 96720

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October 2023

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Prepared for:

County of Hawaiʻi
Department of Environmental Management
345 Kekūanaōʻa Street, Suite 41
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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services
ALISH	Agricultural Lands of Importance to the State of Hawaiʻi
ATU	aerobic treatment unit
B	billion
BBBA	Build Back Better Act
BOD_5	Five-Day Biochemical Oxygen Demand
CAS	conventional activated sludge
CCH	City and County of Honolulu
CCWG	Cesspool Conversion Working Group
CDP	Community Development Plan
COH	County of Hawaiʻi
CWA	Clean Water Act
CWB	Clean Water Branch
CWRM	Commission of Water Resource Management
CWSRF	Clean Water State Revolving Fund
DBEDT	Department of Business, Economic Development and Tourism
DEM	Department of Environmental Management
ENR	Engineering News Record
EPA	Environmental Protection Agency
FCA	Financial Capability Assessment
ft	foot (feet)
ft/s	foot (feet) per second
GIS	geographic information system
GO	general obligation
GP	General Plan
gpcd	gallon(s) per capita day
gpd	gallon(s) per day
gpm	gallon(s) per minute
HAR	Hawaii Administrative Rules
HCPT	Hawaiʻi Cesspool Prioritization Tool
HDOH	State of Hawaiʻi Department of Health
HRS	Hawaiʻi Revised Statutes
ID	Improvement District
I/I	inflow and infiltration
IWS	individual wastewater system
K	thousand
LCC	life cycle cost
LPS	low pressure sewer
LSB	Land Study Bureau
LUPAG	Land Use Pattern Allocation Guide
M	million
MBBR	moving bed bioreactor
MBR	membrane bioreactor
mg/L	milligram(s) per liter
mgd	million gallon(s) per day

MHI	median household income
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operation and maintenance
OSDS	onsite sewage disposal system
PCB	polychlorinated biphenyl
PDR	Project Definition Report
SBR	sequencing batch reactor
SRF	state revolving fund
TSS	total suspended solids
UIC	Underground Injection Control
U.S.	United States
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
WIFIA	Water Infrastructure Finance and Innovation Act
WQS	water quality standard
WWTP	wastewater treatment plant
ZID	zone of initial dilution
ZOM	zone of mixing

EXECUTIVE SUMMARY

INTRODUCTION

The County of Hawaiʻi (COH) contracted with AECOM Technical Services to provide professional engineering services pursuant to Hawaiʻi Revised Status (HRS) 103D-304 for the preparation of a Programmatic Environmental Impact Statement (PEIS) and Wastewater Facility Plan for the Puna District communities. The Department of Environmental Management (DEM) Wastewater Division is managing the work performed for this PEIS and Wastewater Facility Plan contract.

REGULATORY REQUIREMENTS

During 2017, the Hawaiʻi State Legislature passed House Bill 1244, Act 125, to amend HRS 342D-72. This includes requirements for the replacement of all cesspools in Hawaiʻi by Year 2050. Act 125 directed HDOH to investigate the State's number, scope, location, and priority of cesspool replacements based on impact on public health. In 2022, Act 87 was approved, further amending HRS 342D-72 to generalize the options available for cesspool replacements.

This Puna Wastewater Facility Plan investigates various alternatives for treating wastewater. The wastewater treatment alternatives located in Puna District project area will be regulated by the HDOH Clean Water Branch (CWB) and Hawaii Administrative Rules (HAR). There are several options for effluent discharge considered for this Puna District Wastewater Facility Plan:

- Water reuse regulated by HDOH
- Land application regulated by HDOH
- Surface water discharge regulated by the United States (U.S.) Environmental Protection Agency (EPA) and administered by HDOH
- Injection wells/groundwater discharge regulated by HDOH

CURRENT SITUATION

There are no COH wastewater facilities that presently serve or are being planned for the Puna Project Area. Currently, individual wastewater systems (IWS) are used by the surrounding developed properties. These are classified as on-site sewage disposal systems (OSDS). Most of the wastewater in the Project Area is handled by Class IV OSDS (i.e., cesspools). Wastewater discharged from Class IV OSDSs is discharged directly into a seepage pit with no treatment.

There is a multi-unit aerobic onsite treatment system serving the Puna Kai Shopping Center in Pāhoa. The shopping center consists of retail, restaurants, and a new grocery store. The treatment facility consists of primary treatment, followed by aerobic trickling filters. The trickling filter effluent is then treated with a constructed wetlands system. Effluent is discharged to a leach field beneath the parking lot. The existing facility is designed to treat 16,000 gallons per day. The facility serves as a sustainable feature for the shopping center.

FUTURE SITUATION

The Puna District is located within the southeastern portion of the COH to the south of Hilo. The Puna District is experiencing the fastest growth of all COH districts. A community planning effort for the Puna District was last undertaken in 2008 through 2011. COH is currently working on several projects to plan future growth, including this report's project for wastewater services. To effectively plan wastewater services for Puna District project area, it is important to project the future direction and growth within the project area. This would help with design of the capacity and location of wastewater lines and facilities.

A key document containing the development goals within the Puna project area is the COH's 2008 Puna Community Development Plan (CDP) amended in 2010. The CDP initiative stems from COH's 2005 General Plan (2005 GP), which serves as a blueprint for long-term development on Hawaiʻi. The 2005 GP is the policy document for long range development on Hawaiʻi. Land use courses of action that pertain to Puna project area include the following:

- Centralization of commercial activities in the Puna District in established community centers (Volcano, Pāhoa, Keaʻau, etc.)

- Service oriented limited industrial and/or industrial-commercial uses may be permitted in the Puna project area although the areas may not be currently identified in the Land Use Pattern Allocation Guide LUPAG map

Building upon the 2005 and 2008 planning, COH recently released a draft General Plan 2045 (GP 2045) [1]. The future GP 2045 will update the 2005 and 2008 planning documents. Currently in progress, the draft GP 2045 includes a section on land use planning. The goals are similar to those of the CDP, such as directing growth towards urban and village centers. Policies and actions to achieve these objectives are outlined in the document and are under review by COH.

The draft 2045 GP depicts future land use designations. Several urban growth areas for the Puna project area have been designated. The northern portion within the Keaʻau area shows a mix of medium- and low-density urban, heavy industrial, and urban expansion reserve. A medium-density urban area is located within Hawaiian Paradise Park. The southern area near Pāhoa is mostly low-density urban with some medium-density urban and recreation and urban expansion reserve areas.

The Puna Wastewater Facility Plan is using a 30-year planning period, through year 2052. The Hawaiʻi Department of Business, Economic Development and Tourism (DBEDT) provides population forecast estimates through 2040. The Puna Wastewater Facility Plan extends another 12 years in order to cover the January 1, 2050 regulatory deadline for Hawaiʻi cesspool conversions.

The projected future populations described herein are multiplied by the per capita wastewater flows outlined in the previous Project Definition Report. This results in an estimated Year 2052 wastewater flow of 8.5 million gallons per day (mgd) for the full sewering for the projected future population within the Puna project area. A lesser projected future flow of approximately 6 mgd is estimated if all properties located in zoning areas larger than 1 acre are assumed to utilize onsite or IWS for wastewater treatment.

CONCEPTUAL DESIGN

For this Study, COH is using the City and County of Honolulu Wastewater Design Standards for the conceptual-level hydraulic analysis of the sewers.

ALTERNATIVES

Wastewater collection, treatment, and disposal system alternatives are discussed in this Study. Alternatives reviewed include:

- Alternative 1: IWS or Decentralized Systems
  - Alternative 1A: IWS for All Residential and Decentralized Treatment for Commercial/Institutions
  - Alternative 1B: Both Decentralized Treatment and Low Pressure Sewers
- Alternative 2: Urban Sewering (6 mgd) with Subregional Wastewater Treatment (4 treatment plants)
  - Alternative 2A: All Conventional Gravity Sewers and Pump Stations in Existing Roadways
  - Alternative 2B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers
  - Alternative 2C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements
- Alternative 3: Urban Sewering (6 mgd) with Subregional Wastewater Treatment (3 treatment plants)
  - Alternative 3A: All Conventional Gravity Sewers and Pump Stations in existing Roadways
  - Alternative 3B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers
  - Alternative 3C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements
- Alternative 4: Urban Sewering (6 mgd) with Regional Wastewater Treatment (1 treatment plant)
  - Alternative 4A: All Conventional Gravity Sewers and Pump Stations in existing Roadways
  - Alternative 4B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers
  - Alternative 4C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements
- Alternative 5: Full Sewering (8.5 mgd) with Regional Wastewater Treatment (1 treatment plant)
  - Alternative 5A: All Conventional Gravity Sewers and Pump Stations in existing Roadways
  - Alternative 5B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers

  - Alternative 5C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements
- Alternative 6: Urban Sewering (6 mgd) with flow to Hilo treatment plant (expand to 11 mgd)
  - Alternative 6A: All Conventional Gravity Sewers and Pump Stations in existing Roadways
  - Alternative 6B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers
  - Alternative 6C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements
- Alternative 7: Full Sewering (8.5 mgd) with flow to Hilo treatment plant (expand to 13.5 mgd)
  - Alternative 7A: All Conventional Gravity Sewers and Pump Stations in existing Roadways
  - Alternative 7B: Both Conventional Gravity Sewers and Pump Stations and Low-Pressure Sewers
  - Alternative 7C: Conventional Gravity Sewers and Pump Stations with Cross-Country Sewers in Easements

EVALUATION OF ALTERNATIVES

The alternatives were evaluated using various criteria, including estimated cost, environmental impacts, and technical considerations. The estimated conceptual level project capital cost prepared for this Facility Plan are shown in August 2023 dollars. (ENR20 Cities Index = 13,473).

Estimated costs were compared between collection and treatment costs, and between homeowners and managing entities. The estimated cost impacts of the collection system option, design average flow, number of WWTPs, sending Puna flows to Hilo WWTP, and lava hazard zones were also evaluated.

The following is an estimate of the Puna area wastewater collection and treatment capital costs (initial construction cost) for each alternative. Due to the rolling terrain in the project area, it appears that options using low pressure sewers (LPSs) have lower estimated capital costs than those using all conventional gravity sewers and pumping stations. As discussed later in Section 7.2, the estimated operation and maintenance (O&M) costs are higher for options with LPSs. Still, the estimated overall life cycle costs are lower when using LPSs.

- Alternative 1: IWS or Decentralized Systems:
  - Alternative 1A: **$2.8 billion (B)**
  - Alternative 1B: **$4.1B**
- Alternative 2: Urban Sewering with Subregional Wastewater Treatment (4 treatment plants)
  - Alternative 2A: **$8.7B**
  - Alternative 2B: **$7.7B**
  - Alternative 2C: **$8.6B**
- Alternative 3: Urban Sewering with Subregional Wastewater Treatment (3 treatment plants)

  - Alternative 3A: **$9.0B**
  - Alternative 3B: **$7.9B**
  - Alternative 3C: **$8.8B**
- Alternative 4: Urban Sewering with Regional Wastewater Treatment (1 treatment plant)
  - Alternative 4A: **$9.7B**
  - Alternative 4B: **$8.7B**
  - Alternative 4C: **$9.5B**
- Alternative 5: Full Sewering with Regional Wastewater Treatment (1 treatment plant)
  - Alternative 5A: **$10.2B**
  - Alternative 5B: **$9.2B**
  - Alternative 5C: **$10.0B**
- Alternative 6: Urban Sewering with flow to Hilo treatment plant
  - Alternative 6A: **$10.8B**
  - Alternative 6B: **$9.8B**
  - Alternative 6C: **$10.6B**
- Alternative 7: Full Sewering with flow to Hilo treatment plant
  - Alternative 7A: **$11.5B**
  - Alternative 7B: **$10.5B**
  - Alternative 7C: **$11.3B**

The alternatives were compared based on the following criteria:

- Estimated Construction Cost
- Estimated Annual O&M Cost
- Operational Ease and Maintainability
- Flexibility to meet Potential Future Requirements
- Utilization and Acquisition of Land
- Environmental Concerns/Regulatory Permitting

Feedback from DEM and HDOH indicate Alternative 1A as the most favorable alternative, especially in estimated construction cost, operational ease and maintenance, utilization and acquisition of land, and environmental concerns/regulatory permitting. The selection of an alternative also needs to include Countywide assessments of the improvements required for cesspool conversions and other required improvements. COH is currently in the process of planning for multiple areas and beginning a Countywide plan for implementation. Selection of the best alternative for Puna should include input from this countywide process.

FUNDING AND FINANCING CONSIDERATIONS

To allow development of operating plans for this feasibility plan, the existing COH institutional arrangement should be reviewed, and a financial program should be developed after selection of a plan and design. The operating plans should include preliminary allocation of the costs among various users of the wastewater system. Feasibility of the plan requires agreement among participating entities (COH) and stakeholders (ratepayers) on the implementation requirements.

Affordability is an essential metric for developing a wastewater management plan. A homeowner is typically financially burdened if the average monthly cost exceeds 2% of their annual income.

SUMMARY AND CONCLUSIONS

Based on the overall evaluation criteria, Alternative 1A is seen as the most favorable. As discussed earlier, COH is working on a Countywide master plan, which will allow cross-prioritization of capital projects across the various districts. Thus, rankings are preliminary and will be updated pending review by COH, DEM and other project stakeholders.

1.0 INTRODUCTION

The County of Hawaiʻi (COH) contracted with AECOM Technical Services (AECOM) to provide professional engineering services pursuant to Hawaiʻi Revised Status (HRS) 103D-304 for the preparation of a Wastewater (WW) Facility Plan and Programmatic Environmental Impact Statement (PEIS) for analyzing the potential environmental impacts of the addition of wastewater services for the Puna District, Hawaiʻi Island, for the COH. The Department of Environmental Management (DEM) Wastewater Division is managing the work performed for this WW Facility Plan contract.

1.1 STUDY PURPOSE AND SCOPE

The Puna WW Facility Plan is being prepared to study the cost effectiveness of providing wastewater collection and treatment facilities within the Puna District. The purpose of the WW Facility Plan is to evaluate various alternatives to provide wastewater infrastructure to help reduce risks to human health and the environment resulting from the current reliance on cesspools in the Project Area. The WW Facility Plan also reviews alternatives to provide wastewater infrastructure to support the economic recovery in the Project Area.

AECOM prepared a Project Definition Report (PDR) as a basis for establishing parameters for the Puna WW Facility Plan. The Puna WW Facility Plan assessment will be based on the requirements of the Hawaiʻi Department of Health (HDOH) Clean Water Branch (CWB) regulations and COH wastewater design basis on City and County of Honolulu (CCH) guidelines. The following topics are addressed in this Puna WW Facility Plan report:

- Introduction
- Regulatory Requirements
- Current and Future Situations
- Conceptual Design
- Alternatives
- Evaluation of Alternatives
- Funding and Financing Considerations
- Summary and Conclusions

1.2 PLANNING AREA

The Project Area boundary for the Puna WW Facility Plan was established in the Project Definition Report. The Puna District is located on the windward side (east side) of the island and borders the South Hilo district on the north, the Kaʻū district on the west, and the Pacific Ocean on the east. The overall land area of the Puna District is approximately 320,000 acres (or approximately 500 square miles). The Puna Community Development Plan (CDP) planning area, which encompasses Council Districts 4 and 5, also includes portions of Council Districts 3 and 6. The Puna District (herein referred to as the Project Area) is used for planning wastewater services.

The Project Area includes the following proposed Regional Village Centers, Community Centers, and Neighborhood Centers:

- Keaʻau/W.H. Shipman Business Park
- Mountain View/Kurtistown
- Glenwood
- Volcano/Volcano Golf Course
- Kaimū/Pohoiki
- Leilani Estates
- Kapoho
- Nānāwale Estates
- Pāhoa
- Hawaiian Beaches Parks and Shores
- Hawaiian Paradise Park
- Makuʻu
- ʻĀinaloa/Orchidland/Hawaiian Acres

See Figure 1-1 for a map showing the boundaries of the study area used for this Puna WW Facility Plan.

Community Development Plan Boundary
Project Area

N
0 5 10 Miles

Sources: Esri, 2022; Hawai‘i Statewide GIS, 2022; County of Hawai‘i, 2022

Figure 1-1
Puna Project Area Boundary Map

2.0 REGULATORY REQUIREMENTS

A regulatory review was performed for the Puna WW Facility Plan. Regulatory requirements impacting the Puna WW Facility Plan are described in this Chapter.

2.1 WASTEWATER TREATMENT AND DISPOSAL REQUIREMENTS

During 2017, the Hawaiʻi State Legislature passed House Bill 1244, Act 125, to amend Hawaiʻi Revised Statutes (HRS) 342D-72. This legislation included requirements for the replacement of all cesspools in Hawaiʻi by Year 2050. Act 125 directed HDOH to investigate the State's number, scope, location, and priority of cesspool replacements based on impact on public health. In 2022, Act 87 was approved further amending HRS 342D-72 to generalize the options for cesspool replacements.

According to the latest HRS 342D-72, before January 1, 2050, every cesspool in the State of Hawaiʻi is required to be

- "Upgraded or converted to a director-approved wastewater system" or
- "Connected to a sewerage system."

A "director-approved wastewater system" refers to the options described in the following articles:

- Hawaiʻi Administrative Rules (HAR) 11-62-33 for treatment systems
- HAR 11-62-34 for disposal systems
- HAR 11-62-35 for other individual wastewater systems like composting toilets or innovative systems.

2.2 EFFLUENT LIMITATIONS

There are several options for effluent discharge:

- Water reuse regulated by HDOH
- Land application regulated by HDOH
- Surface water discharge regulated by the United States (U.S.) Environmental Protection Agency (EPA) and administered by HDOH
- Injection wells/groundwater discharge regulated by HDOH

The following paragraphs describe regulatory requirements for each potential treated wastewater effluent discharge alternative.

2.2.1 HDOH Water Reuse

HDOH regulates the treatment and use of recycled water. These regulations provide the public with protections so that human health and water resources are not compromised. Use of recycled water has become more significant due to Hawaiʻi's growing population, limited potable water resources, and other wastewater disposal issues.

Since increasing the safe use of recycled water will help meet the State's growing water needs, the Guidelines for the Treatment and Use of Recycled Water (hereafter referred to as the "Reuse Guidelines") outline the planning, design, and permit application processes for use of recycled water. The Reuse Guidelines consist of two volumes:

- Volume I: Recycled Water Facilities addresses technical requirements.
- Volume II: Recycled Water Projects covers the application process for a recycled water system.

There are different grades of recycled water depending on the level of treatment that the wastewater receives. Typical uses for each grade are listed in Section 6.3.1.2.

- R-1 is the highest grade of recycled water. The wastewater undergoes oxidation, filtration, and disinfection.
- R-2 is the next highest grade of recycled water. The wastewater undergoes oxidation and disinfection.
- R-3 is the lowest level of treatment that is permissible. The wastewater only undergoes oxidation.

The following is a summary of the approval process for construction or major modification of a wastewater recycling facility that intends to produce recycled water:

- Application Submittal: The application submittal consists of an engineering report and construction plans. The engineering report includes the design basis, treatment processes, and other information to demonstrate compliance with applicable requirements.

- Approval to Construct: Once the application submittal is reviewed and found to be acceptable, HDOH will issue an approval to construct. When construction of the facility is substantially complete, the applicant should provide at least two weeks' notice to HDOH so that HDOH can schedule and conduct a final inspection.

- Approval to Use: HDOH will inspect the project for consistency with the application submittal and compliance with requirements. Conditional approval may be given until pilot testing or test results demonstrate compliance with requirements. If the facility is found to be acceptable and all required documents have been received, HDOH will issue an approval to use.

Once HDOH has determined that the application submittal conforms to HAR 11-62 and the Reuse Guidelines, HDOH will issue an Approval to Construct to the owner, with a copy to the engineer who prepared the application submittal.

An irrigation assessment was prepared to assess the viability of water recycling as the preferred effluent management system, assuming the recycled water would be used to irrigate agricultural water customers in the area. In Hawaiʻi, irrigation is not normally required on a year-round basis due to high rainfall from November through March. There also are no other potential users (e.g., industrial) in the area. In addition, HDOH 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 may not be an economical alternative as the preferred effluent management strategy for the Puna project area.

2.2.2 HDOH Land Application

Discussions with HDOH have indicated that the land application systems would be regulated as land disposal via requirements in HAR 11-62. Each site would need to obtain an “Authority to Construct” from HDOH. This application generally requires submission of plans, specifications, design data, and other information describing the project. If HDOH finds the project satisfactory, a letter approving construction will be issued. Upon completion of the project, HDOH will inspect the site for compliance.

The HAR 11-62 regulations require secondary treatment (Five-Day Biochemical Oxygen Demand (BOD_5) and total suspended solids (TSS) less than 30 milligram(s) per liter (mg/L)) and disinfection prior to surface land application of wastewater effluent and establishes minimum monitoring, record-keeping, and reporting requirements. The HDOH director can establish more stringent requirements for systems, if needed, on a case-by-case basis. Groundwater monitoring is commonly required at land application systems to allow assessment of the groundwater impacts and system efficacy. Typical groundwater monitoring systems consist of three wells:

- One well located upgradient of the land treatment system
- Two wells located downgradient of the land treatment system

Groundwater monitoring would typically consist of quarterly or semi-annual testing for nutrients (nitrogen and phosphorus), salts, and other parameters. The wells should be installed several months prior to starting wastewater effluent land application operations. This allows background data to be collected before operations commence. It is possible that HDOH and/or the community may request some form of monitoring in advance of approvals to assess the assimilative capacity of the land application system. Monitoring requirements would generally be established at the time that the draft permit requirements are first issued.

Table 2-1 highlights typical effluent characteristics for land application systems. See HAR 11-62 for additional requirements.

Table 2-1 Typical Effluent Characteristics for Land Application

Parameter	Value	Regulatory 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	Continuous disinfection except with subsurface disposal	11-62-24

Parameter	Value	Regulatory Reference
Setback Requirement	25 feet from property line 10 feet from on-site buildings	11-62-23.1
Access Control	6-foot height fence around entire site	11-62-08

2.2.3 EPA Surface Water Criteria

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the Waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, and was amended in 1972 to what is now the CWA. The CWA is codified in Title 33 (Navigation and Navigable Waters) of the United States Code from Sections 1251 - 1388 (33 U.S.C §1251 - §1388). The objective is to restore and maintain the chemical, physical, and biological integrity of Waters of the United States. One of the primary goals is to achieve "fishable and swimmable" waters wherever it is feasible.

Under the CWA, the EPA has implemented pollution control programs such as setting wastewater standards for industry. EPA has also developed national water quality criteria recommendations for pollutants in surface waters. The CWA outlaws discharge of any pollutant from a point source into navigable waters unless a permit has been obtained.

The National Pollutant Discharge Elimination System (NPDES) is one of the pollution control programs established by CWA. This program provides a regulatory framework for managing pollution in the nation's waterways. It was established in 33 U.S.C. §1342 (also referred to as Section 402 of the CWA) and prohibits the discharge of pollutants from certain sources to waters of the United States without an NPDES permit.

The CWA allows EPA to authorize states, territories, and tribes to administer the NPDES program in that entity's jurisdictional area, under oversight from the EPA. This process is called the "state authorization program". The HDOH was first authorized to administer the NPDES permitting program within the State in 1974.

The Hawaiʻi NPDES permitting program is a regulatory mechanism to control water pollution through the issuance of permits. The purpose of issuing an NPDES permit is to implement federal and State water pollution control requirements to help protect human health and the environment. A permit does this by imposing restrictions and requirements on discharges of pollutants from permitted sites/facilities. Permittees are legally obligated to comply with the requirements specified in the issued permit. Violation of permit requirements may be punishable by requiring specific changes to the facility or operations, fines, or other enforcement actions based on the nature of the violation.

The NPDES permit is a document that outlines requirements to control water pollution. NPDES permits contain limits on what can be discharged, monitoring and reporting requirements, and other provisions to allow discharges to achieve published water quality standards.

There are two types of NPDES permits:

- Individual Permits
- General Permits

Individual permits are facility-specific permits that are issued to a specific permittee, after submittal of an NPDES permit application. The maximum period of permit coverage is five years, with the opportunity to renew coverage to continue discharge, provided that there is a public notice and public comment period to comment on the proposed permit. Due to the need to draft a facility-specific permit and the public comment period, processing and issuance of an individual permit is typically a time-consuming process. Once issued, the permit may be modified either by HDOH or by the permittee upon request, following a public notice and public comment period for the proposed modifications. The following are key considerations related to individual NPDES permits:

- One Permit - One Permittee
- For Any Type of Discharge
- Facility-Specific Permit Conditions
- Submit NPDES Permit Application
- Public Notice of Proposed Permit
- 5-Year Maximum Coverage Term
- Issued NPDES Permit
- Can be Modified After Issuance Following Another Public Notice of Proposed Permit Changes

General permits are not issued to a specific permittee and are instead written to address a specific type of activity or discharge. Any number of facilities or projects can request to be covered under a general permit, provided they can meet the requirements outlined in the specific general permit. If a facility or project has multiple types of discharges, they may separately request coverage under multiple general permits for their facility or project (e.g., a construction project may request coverage for construction storm water and dewatering discharges).

NPDES permits apply to discharges from regulated point sources to surface waters, including discharges through drainage systems such as storm drains that outlet to a surface water. A point source is any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft. This term does not include return flows from irrigated agriculture or agricultural storm water runoff, except return flows from agriculture irrigated with reclaimed water.

All other activities and actions, including, but not limited to, land use decisions, whether (or not) construction or industrial activities should be allowed, business operation, zoning, and non-point source pollution are not authorized or approved by NPDES permits. Determining the validity or merits of an activity are outside the scope of any NPDES permit. Issuance of an NPDES permit does not convey any other rights, authorizations, approvals, or any other ability not specified in the permit.

Discharges of treated domestic wastewater, cooling water, and other wastewaters to surface waters need to have an individual NPDES permit to discharge.

A consideration impacting surface water discharges is the need to meet published water quality standards at the point of discharge. Hawaiʻi water quality standards are described in HAR 11-54. Per HAR 11-54, the nearshore coastal waters surrounding the Puna project area are Class AA.

The objective for Class AA waters is to remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. Note that “zones of mixing (ZOM)” are not permitted for discharges into Class AA waters:

- Within a defined reef area, in waters of a depth less than 10 fathoms (18 meters)
- In waters up to a distance of 300 hundred meters (1,000 feet) offshore (if there is no defined reef)

Moving further offshore, the water quality classification is Class A out to the three-mile boundary line for Hawaiʻi State Waters. The objective for Class A waters is to protect their use for recreational purposes and aesthetic enjoyment. Other uses are permitted, as long as they are compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters.

Table 2-2 presents water quality standards for Class A and AA discharges to the coastal waters in the vicinity of the Puna project area (HAR 11-54, Appendix D).

Table 2-2 Water Quality Standards for Discharges to Coastal Waters

Water Quality Parameter	Not to Exceed Geometric Mean Value	Not greater than listed value 10% of the time	Not greater than listed value 2% of the time
Total Nitrogen	110 to 150 µg/L	180 to 250 µg/L	250 to 350 µg/L
Nitrate + Nitrite Nitrogen	3.5 to 5 µg/L	10 to 14 µg/L	20 to 25 µg/L
Ammonia Nitrogen	2 to 3.5 µg/L	5 to 8.5 µg/L	9 to 15 µg/L
Total Phosphorus	16 to 20 µg/L	30 to 40 µg/L	45 to 60 µg/L
Chlorophyll A	0.15 to 0.3 µg/L	0.5 to 0.9 µg/L	1 to 1.75 µg/L
Turbidity	0.2 to 0.5 NTU	0.5 to 1.25 NTU	1 to 2 NTU
Light Extinction Coefficient	0.1 to 0.2 k units	0.3 to 0.5 k units	0.55 to 0.85 k units

Notes: Lower values represents “dry” criteria that receive less than three million gallons per day of fresh-water discharge per shoreline mile. Upper values represent “wet” criteria that receive more than three million gallons per day of fresh-water discharge per shoreline mile.

µg/L: microgram(s) per liter

NTU: Nephelometric Turbidity unit

k unit: Kelvin unit

For discharges into Class A waters, a zone of initial dilution (ZID) and/or ZOM area is allowed where the treated effluent and receiving waters undergo a mixing process. A ZOM/ZID is defined as the limited areas around an outfall that allow for the initial dilution of wastewater effluent discharges. The ZOM can provide assimilation of domestic, agricultural, and industrial discharges that have received the best possible degree of treatment or control. ZID/ZOM allow for dilution of wastes before compliance with the applicable water quality criteria must be met. ZID are a subset of ZOM that are applied to toxic pollutants.

A regulatory ZID/ZOM allows for certain numeric water quality criteria to be exceeded. However, the blended effluent and receiving waters must meet the published water quality standards at the boundary of the ZID/ZOM. The regulatory ZID/ZOM is defined based on regulations and implementation policies and must be established first in order to calculate numerical effluent discharge concentration limits for surface water discharges.

According to HAR 11-55-41, a ZID/ZOM should be determined concurrently with the corresponding NPDES Permit. This would be done though a ZID/ZOM dilution study, assimilative capacity assessment and antidegradation analysis with the following objectives:

- Develop appropriate dilution ratios for implementation within NPDES permit.
- Develop appropriate ZID/ZOM boundary for implementation within permit.
- Determine whether dilution study is adequately protective.

After regulatory review and approval, the conditions of a ZID/ZOM may be incorporated as a condition of the NPDES permit. The studies, and application for a ZID/ZOM need to be submitted to HDOH with the required forms. HDOH will establish the ZID/ZOM taking into account the environmental impacts such as:

- The protected uses of the body of water
- Existing natural conditions of the receiving water
- Character of the effluent
- Design adequacy of the outfall and diffuser system to achieve maximum dispersion and assimilation of the treated or controlled waste with a minimum of undesirable or noticeable effect on the receiving waters

The ZID/ZOM requires HDOH to document the following:

- The granting of the ZID/ZOM is in the public interest.
- The proposed discharge does not substantially endanger human health or safety.
- Compliance with the existing water quality standards.
- The proposed discharge does not violate the basic standards applicable to all waters, will not unreasonably interfere with any actual or probable use of the water areas for which it is classified, and has received best available treatment.
- The discharge will receive the best degree of treatment or control.
- The receiving water has assimilative capacity to handle potential pollutants at the location that the ZID/ZOM is requested.

2.2.4 HDOH Injection Wells/Groundwater Disposal

The Underground Injection Control (UIC) program was established to protect the quality of Hawaiʻi's underground sources of drinking water from chemical, physical, radioactive, and biological contamination that could originate from discharges to injection wells.

Underground injection wells are used for injecting water or other fluids into a groundwater aquifer. HAR 11-23 provides conditions governing the location, construction, and operation of injection wells so that injected fluids do not migrate and pollute underground sources of drinking water. The rules also establish criteria for classifying aquifers as follows:

- Underground water that is a source of drinking water
- Underground water that is not a source of drinking water (exempted)

The boundary between exempted aquifers and underground sources of drinking water is generally referred to as the "UIC Line". Restrictions on injection wells differ, depending on whether the area is inland (mauka) or seaward (makai) of the UIC line. UIC Maps depict the UIC lines on all major islands. These maps are meant for general informational purposes only. HDOH maintains the official UIC maps containing information about the UIC Line.

The UIC maps are coded as follows:

- Code 1 (below or makai of the UIC line)
    - Underlying aquifer not considered drinking water source
    - Wider variety of wells allowed
    - Injection wells need UIC Permit or Permit Exemption
    - Permit limitations are imposed
- Code 100 (above or mauka of the UIC line)
    - Underlying aquifer considered drinking water source
    - Limited types of injection wells allowed
    - Injection wells need UIC Permit or Permit Exemption
    - Permit limitations are imposed, and requirements are more stringent

For regulatory purposes a vast majority of the Puna project area is located above (or mauka) of the UIC line.

3.0 CURRENT SITUATION

This section summarizes the current circumstances of Puna, including demographics, land use, and wastewater management.

3.1 PLANNING AREA DESCRIPTION

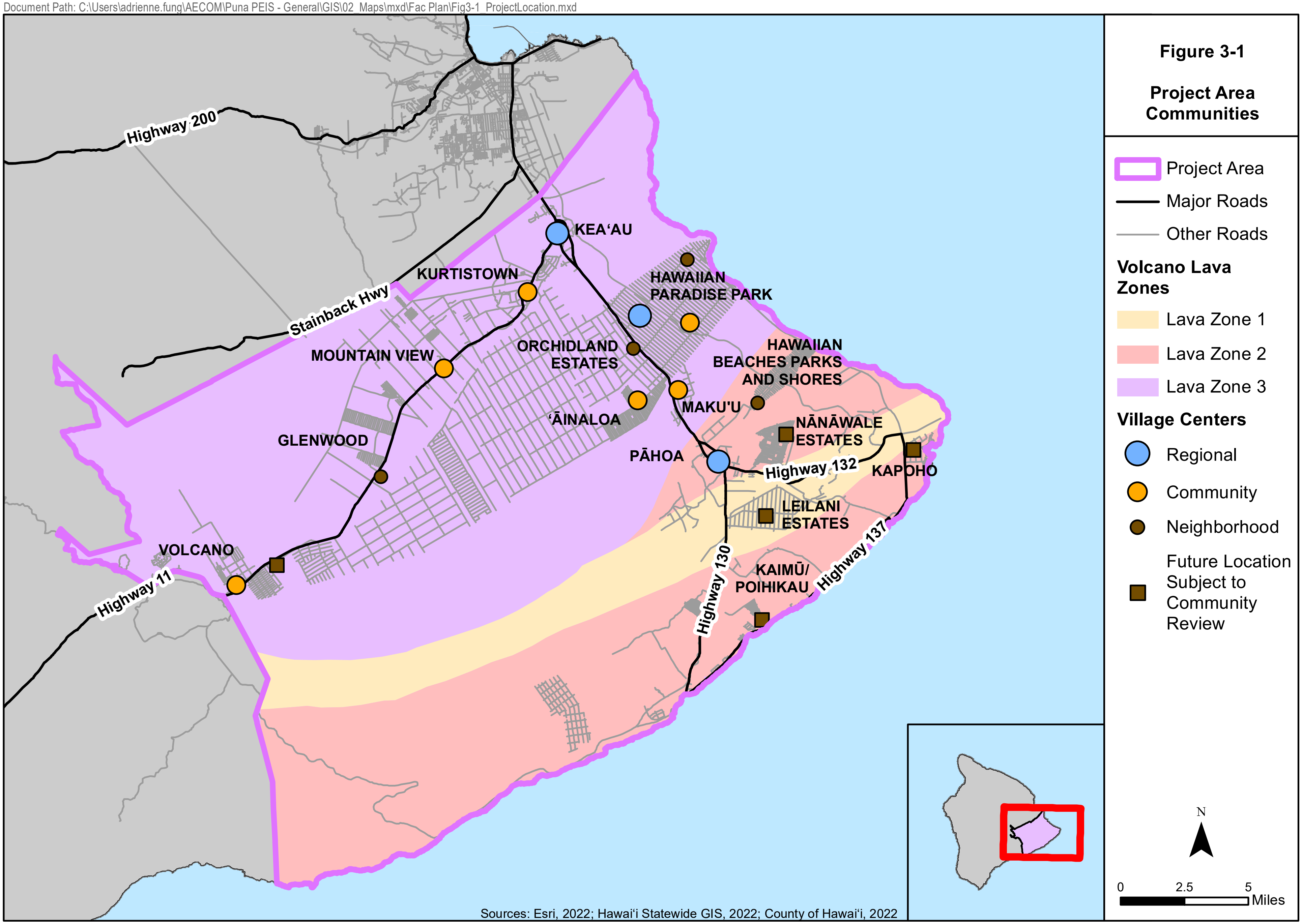
The Puna Project Area is located on the windward side (east side) of the island and borders the South Hilo district on the north, the Kaʻū district on the west, and the Pacific Ocean on the east (Figure 3-1). Puna's natural environment consists of volcanic activity, unique geological events and formations, and various plant communities that nurture native species. Continuous eruptions of Kīlauea and nearby Mauna Loa continue to shape Puna's ecology, not to mention the land itself. Rain is higher on the windward slopes of Kīlauea, while the leeward slopes are relatively arid. The wetter side is covered by thick forests and ferns as shown by the numerous forest reserves in Puna. In areas with the youngest lava flows, cleared land, or on the drier side of Kīlauea, vegetation is more open, exposing the underlying geology of volcanic rock [2].

The earlier days of Puna in the 18th and 19th centuries saw growths in cattle ranching and agriculture, such as sandalwood, coffee, sugarcane, macadamia nuts, and papaya production. Presently, Puna supports at least 40 different agricultural products. Since the 1950s, Puna has experienced patterns of residential development and population growth, causing widespread land subdivision. The northeast quadrant of Puna and the vicinity of Volcano have been undergoing the highest rates of population growth. Overall, Puna exhibits the fastest growth rate in all COH districts, with about 45% of the State's total subdivided lots. Therefore, one of COH's visions is to reshape the development pattern by forming village and town centers to develop supporting infrastructure for populated areas, give residents better access to public and commercial services, stimulate local employment opportunities, and preserve natural and cultural resources by limiting the spread of development [2].

Puna has a few main highways that pass through major population centers (Figure 3-1). Highway 11 runs northeast-southwest through Volcano, Glenwood, Mountain View, Kurtistown, and Keaʻau. Highway 130 runs northwest-southeast, passing through Hawaiian Paradise Park (HPP), Orchidland Estates, ʻĀinaloa, Makuʻu, Hawaiian Beaches, and Pāhoa. In Pāhoa, Highway 130 continues south to Leilani Estates and Kalapana. Highway 132 also begins eastbound, connecting to Nānāwale Estates before ending at Kapoho near the coast. Additional details of the Puna project area are described in the following sections.

Figure 3-1

Project Area Communities



Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

3.2 Organizational Context

COH has established an agency to oversee sewer systems. The DEM has the responsibility for matters relating to sewer operation and maintenance (O&M) of nine sewer systems (Kealakehe, Honokaʻa, Kaloko, Kapehu, Kulaʻimano, Pāpaʻikou, Hilo, Pāhala, and Nāʻālehu); solid waste disposal and landfill programs; vehicle disposal; and all other environmental projects, including recycling programs of COH. The Wastewater Division within DEM is responsible for the O&M of COH's wastewater collection and treatment facilities. Presently, COH does not provide any wastewater collection and treatment facilities in the Project Area.

There are existing sewer rates established by COH. The purpose of COH's Sewer Service Charges ordinance is to increase wastewater service charge rates to cover the costs of providing those services. These increases will reduce the Wastewater Division's dependence on the General Fund and provide for improved maintenance and repair of the facilities. Ordinance No. 19 21, which became effective April 1, 2019, set monthly charges for residential, multi-residential, nonresidential, private haulers, and gang cesspools for five years. The monthly charge for residential was increased from $48 to $52, as of April 1, 2023.

3.3 Land Use Data

There are various land use mapping systems for Puna. As described in the 2008 CDP, there are three different ones. The Land Study Bureau (LSB) soil classifications are enforced through the HRS. However, this system is still based on the historical pattern of plantation agricultural use in Hawaiʻi. The State Department of Agriculture has developed maps of Agricultural Lands of Importance to the State of Hawaiʻi (ALISH), which more accurately reflect the value of existing agricultural lands. There are approximately 75,000 acres in the Puna District that are considered prime or other important agricultural land. COH's Land Use Pattern Allocation Guide (LUPAG) stems from the General Plan and adopts a mapping system similar to ALISH.

The 2005 GP depicts the LUPAG zones of the Project Area (Figure 3-2 through Figure 3-5) [3]. In the areas near and within Mountain View, the lands are primarily zoned as conservation and agricultural lands, with residents in the areas zoned as rural (Figure 3-2). Moving into Keaʻau, zones for low density urban and urban expansion are observed (Figure 3-2). In Figure 3-3, HPP, Orchidland Estates, and ʻĀinaloa are zoned as rural, and Nānāwale Estates is zoned as low density urban. Hawaiian Beaches is primarily low density urban with a small portion of medium density urban. Pāhoa is a mix of urban expansion and low and medium density urban. Figure 3-4 illustrates the Volcano region as rural, where inhabited (such as volcano Golf Course, Volcano Mauka, Volcano Makai, and near Old Volcano Road), and conservation elsewhere. In Figure 3-5, Leilani Estates is zoned as rural, with agricultural and conservation zones nearby.

One of the goals in the Puna CDP is to encourage development of regional town centers, community village centers, and neighborhood village centers. These are described in Section 4.3, along with maps of the proposed town or village center boundaries. Existing zoning is also presented in those maps (Figure 4-2 through Figure 4-12).

The Hawaiʻi Statewide Geographic Information System (GIS) Program map was developed by the COH Planning Department and created from various district and urban zone maps (Figure 3-6). The zones are based on the COH Land Use Zoning Designations in the Hawaiʻi County Code, Chapter 25, Zoning Code. Most of the areas in Puna are zoned as agricultural in this map, with a mix of commercial or residential zones in some locations such as Volcano Golf Course, Volcano Mauka, Volcano Makai, Kurtistown, Keaʻau, Pāhoa, and Nānāwale Estates.

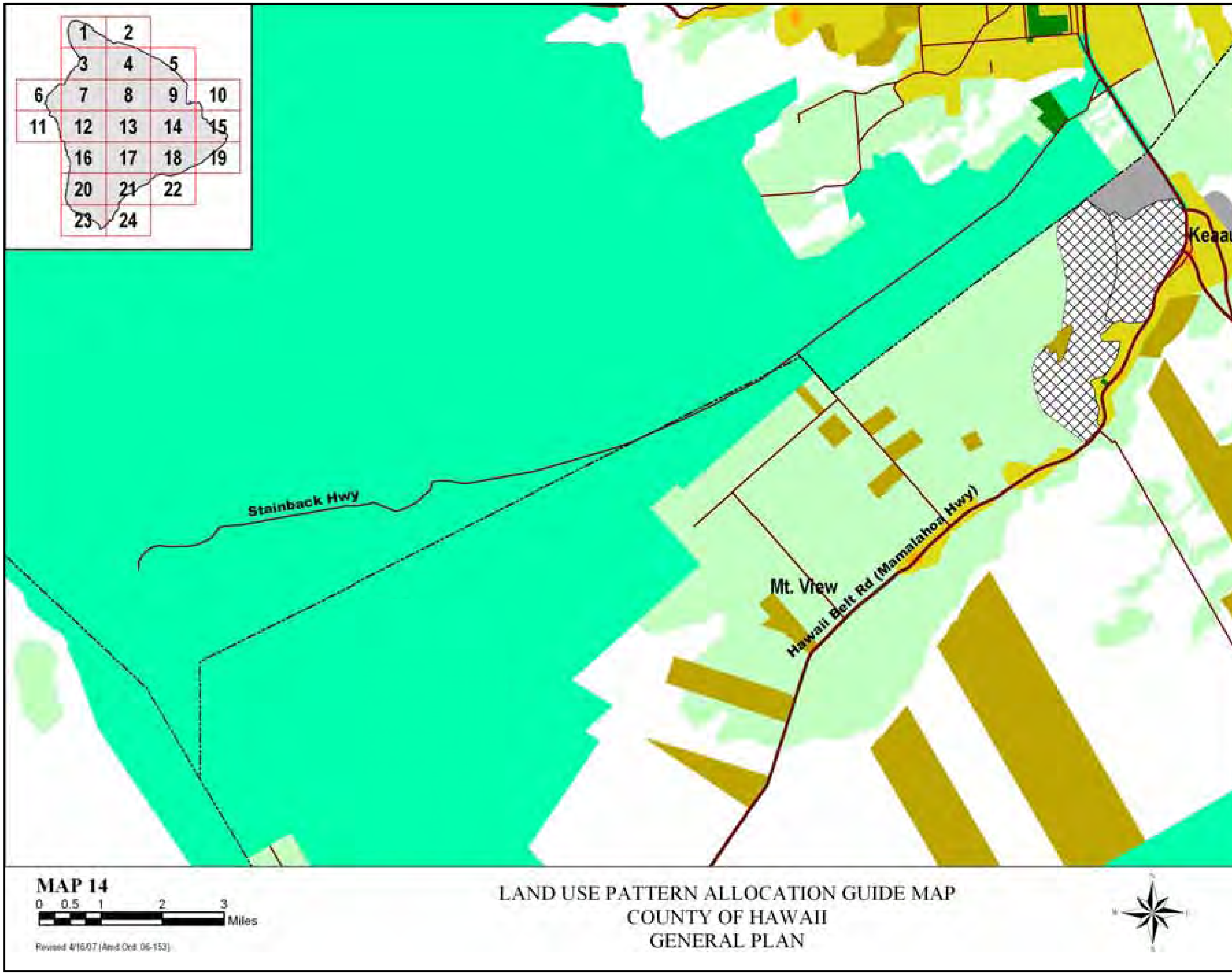


Figure 3-2

LUPAG Land-Use for Mountain View and Keaʻau Areas

Source: County of Hawaiʻi General Plan, February 2005 (As Amended)

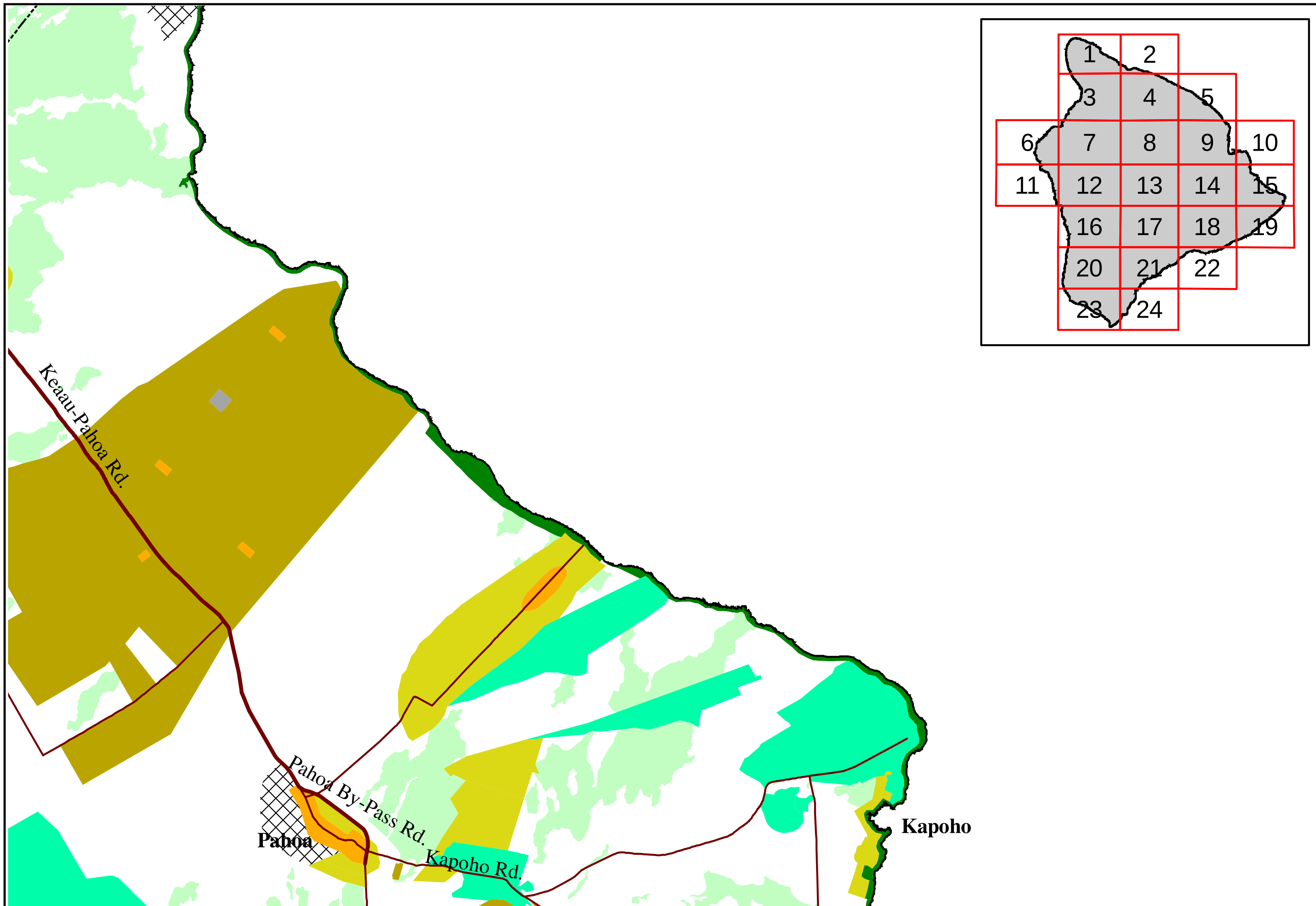
Legend

- District
- Collectors
- Arterials
- Conservation
- Extensive Agriculture
- High Density Urban
- Industrial
- Low Density Urban
- Medium Density Urban
- Open Area
- Important Ag. Lands
- Resort Node
- Rural
- Resort
- Urban Expansion
- University Use
- Orchards

Figure 3-3

LUPAG Land-Use for HPP and Pāhoa Areas

Source: County of Hawaiʻi General Plan, February 2005 (As Amended)



Legend

- District
- Collectors
- Arterials
- Conservation
- Extensive Agriculture
- High Density Urban
- Industrial
- Low Density Urban
- Medium Density Urban
- Open Area
- Important Ag. Lands
- Resort Node
- Rural
- Resort
- Urban Expansion
- University Use
- Orchards

MAP 15

0 0.5 1 2 3 Miles

LAND USE PATTERN ALLOCATION GUIDE MAP
COUNTY OF HAWAII
GENERAL PLAN

N W E S

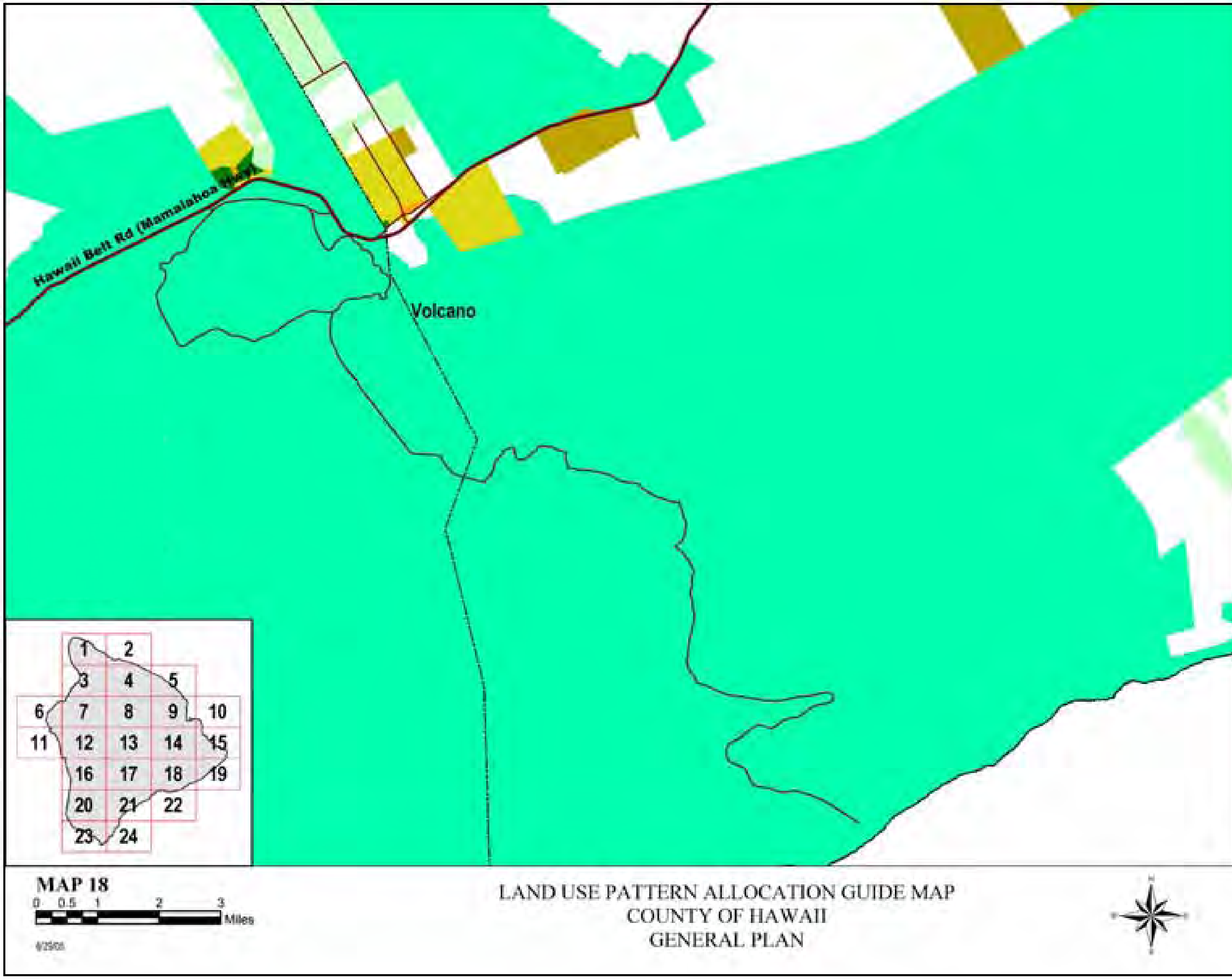


Figure 3-4

LUPAG Land-Use for Volcano Area

Source: County of Hawaiʻi General Plan, February 2005 (As Amended)

Legend

- District
- Collectors
- Arterials
- Conservation
- Extensive Agriculture
- High Density Urban
- Industrial
- Low Density Urban
- Medium Density Urban
- Open Area
- Important Ag. Lands
- Resort Node
- Rural
- Resort
- Urban Expansion
- University Use
- Orchards

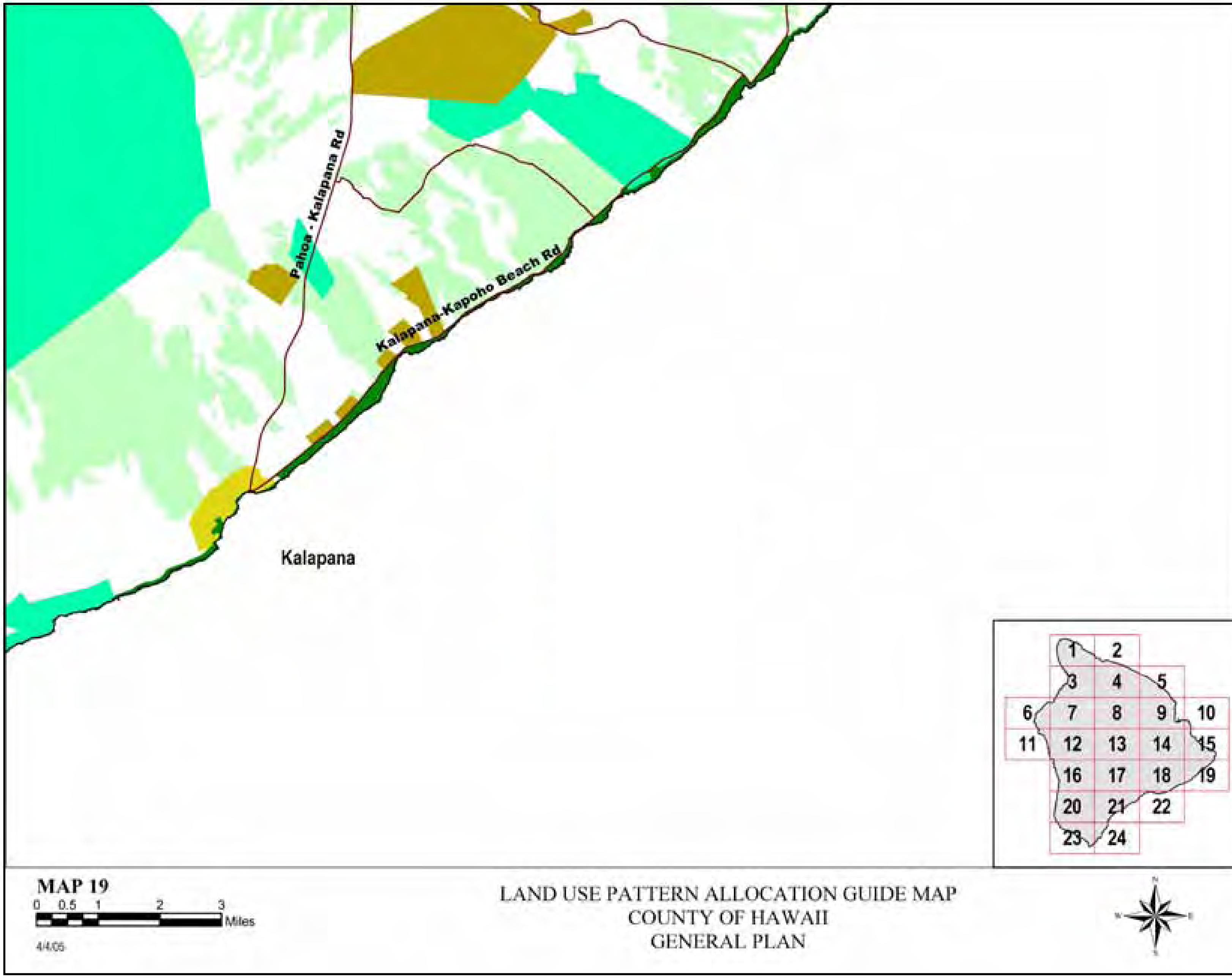


Figure 3-5

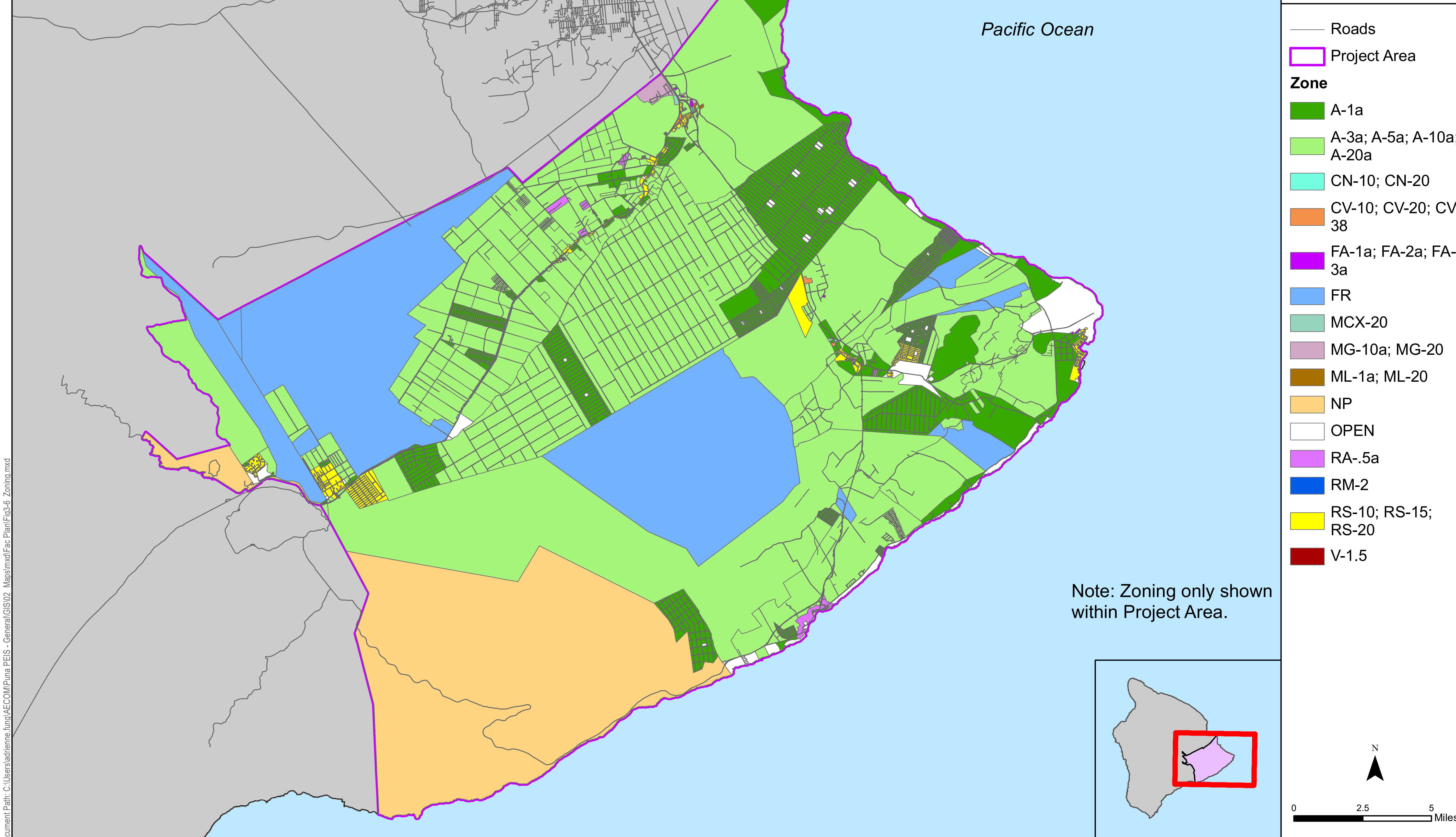
LUPAG Land-Use for Leilani Estates Area

Source: County of Hawaiʻi General Plan, February 2005 (As Amended)

Legend

- District
- Collectors
- Arterials
- Conservation
- Extensive Agriculture
- High Density Urban
- Industrial
- Low Density Urban
- Medium Density Urban
- Open Area
- Important Ag. Lands
- Resort Node
- Rural
- Resort
- Urban Expansion
- University Use
- Orchards

Figure 3-6
Land Use Presented by the COH Department of Planning



3.4 DEMOGRAPHICS

Census data related to population, households, employment, and poverty are presented in Table 3-1 through Table 3-4. Areas that are not listed do not have a specific set of census results.

Table 3-1 Census Data on Population

UNITS:		[age]	[people]	[%]	[%]	[%]	[%]	[%]	[%]
Census Tract	**Area**	**Median Age**	**Total Pop.**	**Pop. < 18 y/o**	**Pop. 18 - 44 y/o**	**Pop. 45 - 64 y/o**	**Pop > 65 y/o**	**Foreign-born**	**Hawai'i-born**
210.03	ʻĀinaloa	35.4	3609	35.6	28.5	22.2	14	6.9	77.9
	Tiki Gardens	45.9	555	12.4	21.7	22.3	43.5	0	76.6
210.11	Volcano Golf Course	45	363	13	33.6	31.1	22.3	2.5	37.7
	Volcano	57.7	736	13.6	24.6	24.1	37.8	5.5	54.2
210.11, 210.13, 210.16, and 210.17	Mountain View	33.1	4215	37.6	24.7	22.5	15.2	1.8	84.5
210.13	Kurtistown	49.8	2515	22.4	20.9	31.4	25.5	14.3	72.4
	Keaʻau	49.5	1195	23.3	23.6	26.6	26.5	31.3	59.4
210.03, 210.13, 210.14, and 210.15	HPP	44.3	14,957	24.3	27.3	25	23.4	13.4	55.6
210.03 and 210.13	Orchidland Estates	47.9	3165	20.1	27.8	33.7	18.3	17.6	38.9
210.03, 210.13, and 210.16	Hawaiian Acres	51.1	3426	18.9	24.4	34.8	21.6	10.3	41.6
210.16	Fern Acres	44.3	1965	19.2	31.4	31.9	17.7	3.5	59.6
210.17	Mauna Loa Estates	63	1057	2.5	2.3	50.2	45	5.2	32
	Royal Hawaiian Estates	29.8	790	38.7	26.1	19.4	15.9	5.9	76.6
	Fern Forest	52.1	1150	14.3	29.3	33.3	23.2	4.6	47.4
	Eden Roc	45.2	1386	23	26.6	42.2	8.3	3.9	45.9
211.01	Leilani Estates	49.2	1139	17.9	26.3	30.9	24.8	4.5	28.3
	Kamāʻili	61.6	157	0	19.2	47.9	33	16.2	28.1
	Seaview	52.7	512	0	20.3	61.3	18.5	19.4	0
211.07	Black Sands	57.1	416	0	0	81.2	18.9	0	61.5
211.01 and 211.07	Kalapana	64	167	0	0	50	50	0	0
211.01, 211.07,	Pāhoa	43.8	924	16.7	33.5	34.9	15	28.4	63.1

UNITS:		[age]	[people]	[%]	[%]	[%]	[%]	[%]	[%]
Census Tract	**Area**	**Median Age**	**Total Pop.**	**Pop. < 18 y/o**	**Pop. 18 - 44 y/o**	**Pop. 45 - 64 y/o**	**Pop > 65 y/o**	**Foreign-born**	**Hawai‘i-born**
and 211.08									
211.08	Nānāwale Estates	40.8	1652	20.1	31.3	27.2	15.8	5.5	57
	Hawaiian Beaches Parks and Shores	41.3	3976	22.6	32.3	25.9	19.1	8.9	35.2

Notes:
Pop.: population
y/o: years old

Table 3-2 Census Data on Households

Units:		[%]	[%]	[%]	[%]	[%]	[%]
Census Tract	**Census Designated Place**	**Married Households**	**Cohabiting Couples**	**Male Householder**	**Female Householder**	**Households with 1 or more people < 18 y/o**	**Households with 1 or more people > 65 y/o**
210.03	‘Āinaloa	34.8	14.4	23.7	27.1	45	33
	Tiki Gardens	0	0	37.9	62.1	37.9	91.1
210.11	Volcano Golf Course	76	8.6	0	15.4	25.2	42.2
	Volcano	47.3	1.8	21.6	29.3	11.5	69.5
210.11, 210.13, 210.16, and 210.17	Mountain View	41.9	5.7	25.9	26.5	37.5	34.1
210.13	Kurtistown	66.5	8	8	17.5	39.8	56.6
	Kea‘au	41.5	2.8	22.5	33.2	33.4	60.5
210.03, 210.13, 210.14, and 210.15	HPP	64	11.9	11.9	12.3	34.1	44.1
210.03 and 210.13	Orchidland Estates	46.4	4.5	26.7	22.3	26.8	38.1
210.03, 210.13, and 210.16	Hawaiian Acres	39.3	4.7	26.9	29.1	17.8	45.1
210.16	Fern Acres	40.7	7.4	23.1	28.9	24.6	35.8
210.17	Mauna Loa Estates	27.1	7.4	26	39.5	5.2	41
	Royal Hawaiian Estates	27.8	19.4	6.7	46.1	43.4	37.4
	Fern Forest	37.4	10.3	30.2	22.1	14.5	39.1

Units:		[%]	[%]	[%]	[%]	[%]	[%]
Census Tract	**Census Designated Place**	**Married Households**	**Cohabiting Couples**	**Male Householder**	**Female Householder**	**Households with 1 or more people < 18 y/o**	**Households with 1 or more people > 65 y/o**
	Eden Roc	41.4	2.6	30.6	25.4	19.2	16.6
211.01	Leilani Estates	33.6	13.4	33.1	19.9	15.7	41.8
	Kamāʻili	52.5	0	47.5	0	0	25.3
	Seaview	14.2	18.5	36.4	30.9	0	25.9
211.07	Black Sands	0	47	19.3	33.7	0	33.7
211.01 and 211.07	Kalapana	0	62.5	0	37.5	0	100
211.01, 211.07, and 211.08	Pāhoa	43.2	4	36.4	16.4	25.7	27.6
211.08	Nānāwale Estates	34.5	14.3	38.5	12.7	24.3	35.1
	Hawaiian Beaches Parks and Shores	46.5	3.7	23.8	26.1	25.5	37.7

Notes:
Male or female householder: no spouse/partner present
y/o: years old

Table 3-3 Census Data on Employment

Units:		[%]	[%]	[%]	[%]	[%]	[%]	[%]	[min]
Census Tract	**Census Designated Place**	**In the Labor Force**	**Not in the Labor Force**	**Private wage/ salary**	**Federal, State, or Gov.**	**Self-employed***	**Workers who drive alone**	**Workers who carpool**	**Avg. time to get to work**
210.03	ʻĀinaloa	56.5	43.5	63.6	18.3	6.6	69.4	23	34.9
	Tiki Gardens	41	59	34.9	65.1	0	65.1	34.9	Insuf. Data
210.11	Volcano Golf Course	51	49	19	60.8	13.1	15	12.2	Insuf. Data
	Volcano	61.2	38.8	35.5	17.8	35.5	48.8	23.2	29
210.11, 210.13, 210.16, and 210.17	Mountain View	55.1	44.9	52.5	29	13.8	80.3	15.8	44.4
210.13	Kurtistown	54	46	62.8	20.6	9.3	77.9	13.6	32.3
	Keaʻau	58.8	41.2	64.6	22	7.5	67.8	19.8	30.7
210.03, 210.13, 210.14, and 210.15	HPP	61.6	38.4	53	23.1	8	83.1	9.9	29.3

Units:		[%]	[%]	[%]	[%]	[%]	[%]	[%]	[min]
Census Tract	**Census Designated Place**	**In the Labor Force**	**Not in the Labor Force**	**Private wage/ salary**	**Federal, State, or Gov.**	**Self-employed***	**Workers who drive alone**	**Workers who carpool**	**Avg. time to get to work**
210.03 and 210.13	Orchidland Estates	48.5	51.5	50.7	24.1	14.6	86.4	2.6	31.6
210.03, 210.13, and 210.16	Hawaiian Acres	50.7	49.3	45.4	26.7	13.9	60.2	21.6	34.8
210.16	Fern Acres	46.8	53.2	73.8	15.6	9.5	76.3	11.2	30.1
210.17	Mauna Loa Estates	64.5	35.5	17.7	36.5	17.9	65.2	23	21.2
	Royal Hawaiian Estates	80.4	19.6	52.6	24.2	5.1	74.8	3.2	Insuf. Data
	Fern Forest	40.5	59.5	38.5	22.3	25.3	84.7	6.1	42.6
	Eden Roc	48.9	51.1	47.9	15.5	7	80.3	7	44.5
211.01	Leilani Estates	52.4	47.6	57.6	16	18.6	72	16.6	27.7
	Kamāʻili	47.9	52.1	0	0	100	18.8	0	Insuf. Data
	Seaview	45.2	54.8	15.6	0	53.3	65.8	0	Insuf. Data
211.07	Black Sands	19.6	80.4	0	100	0	100	0	Insuf. Data
211.01 and 211.07	Kalapana	20	80	Insuf. Data	Insuf. Data	Insuf. Data	Insuf. Data	Insuf. Data	Insuf. Data
211.01, 211.07, and 211.08	Pāhoa	49.8	45	60.8	37.5	1.7	94.5	2.8	28.3
211.08	Nānāwale Estates	47.3	52.7	60.6	22.7	10.4	50.8	25.6	39.5
	Hawaiian Beaches Parks and Shores	49.9	50.1	57.6	8.6	14.5	69.5	4	39

Notes:
Gov.: government
Insuf. Data: insufficient data (amount of sample cases)
*: in own (not incorporated) business

Table 3-4 Census Data on Poverty

UNITS:		[%]	[%]	[%]	[%]
Census Tract	**Area**	**Pop. in poverty**	**< 18 y/o**	**18 - 64 y/o**	**> 65 y/o**
210.03	ʻĀinaloa	26	33.4	24.6	14.5
	Tiki Gardens	59	100	64.7	41.6
210.11	Volcano Golf Course	2.3	0	4	0

UNITS:		[%]	[%]	[%]	[%]
Census Tract	**Area**	**Pop. in poverty**	**< 18 y/o**	**18 - 64 y/o**	**> 65 y/o**
	Volcano	3.3	0	0.5	8
210.11, 210.13, 210.16, and 210.17	Mountain View	32.1	49.2	27.4	4.4
210.13	Kurtistown	10.9	17	10.7	7
	Keaʻau	16	16.5	14.6	18.9
210.03, 210.13, 210.14, and 210.15	HPP	5.1	4	5.9	4.1
210.03 and 210.13	Orchidland Estates	22.8	35.7	21.8	12.4
210.03, 210.13, and 210.16	Hawaiian Acres	25.2	20.3	29.1	17.5
210.16	Fern Acres	12.8	15.7	11.1	16.8
210.17	Mauna Loa Estates	10.2	0	19.5	0
	Royal Hawaiian Estates	4.1	0	9.1	0
	Fern Forest	26	31.9	28.5	15.9
	Eden Roc	23.5	23.4	24.5	14.3
211.01	Leilani Estates	36.9	60.6	35.9	22.4
	Kamāʻili	41.9	0	13.4	100
	Seaview	35.5	0	29.9	60
211.07	Black Sands	61.5	0	75.9	0
211.01 and 211.07	Kalapana	50	0	100	0
211.01, 211.07, and 211.08	Pāhoa	29.7	45.1	30.6	8.6
211.08	Nānāwale Estates	21.9	19.4	21.1	28.5
	Hawaiian Beaches Parks and Shores	15.9	32.1	13.9	3.6

Notes:
Pop.: population
y/o: years old

3.5 WATER QUALITY AND USES

3.5.1 Groundwater

An assessment was performed on current groundwater quality and uses. Based on the Commission of Water Resource Management (CWRM) database, there are about 635 wells in the Puna project area (Figure 3-7). Of these, six wells are municipal and owned and operated by COH Department of Water Supply. These are located within Mountain View, Kurtistown, Keaʻau, Pāhoa, and Kalapana and all are combined systems for both potable water and fire flow. Most of the project area seems to be on catchment, except for HPP, which has about 500 domestic use wells. There are also some domestic use wells in Kurtistown and along the shoreline. Wells elsewhere in the project area are categorized for agricultural, industrial, irrigation, and other municipal uses. There are also about 60 abandoned or unused wells.

Water quality data for these wells is limited. With the presence of cesspools nearby and upstream of these wells, there is potential for cesspool effluent to impact the drinking water quality at these wells. CWRM collects groundwater data for certain wells. These data include other characteristics such as quantity pumped, chloride, conductivity, temperature, and groundwater elevation. Analytical data for private wells are not available for public use, though it's possible that these wells could potentially be impacted. For municipal wells, COH Department of Water Supply performs water sampling for both compliance and monitoring. Samples are analyzed for parameters such as volatile organic compounds, pesticides, polychlorinated biphenyls (PCBs), metals, and water quality metrics (alkalinity, chloride, nitrogen, phosphorus, turbidity, total dissolved solids, and others). In recent water quality data, there have not been exceedances detected in contaminants associated with septic tanks or cesspools. Annual water quality reports are published here:

https://www.hawaiidws.org/waterquality/

Construction activities could potentially impact groundwater if encountered during the proposed work. Also, dewatering may be necessary for construction below the groundwater table, which would be conducted in accordance with applicable regulations.

3.5.2 Surface Water

All of Puna's coastal waters are classified as "AA" waters, as described in Section 2.2.3.

The Hawaiʻi Island has highly pervious and permeable land cover limiting the number of perennial streams. The Puna project area spans about 20 different watersheds but does not contain any perennial streams. The Puna project area includes the ʻŌlaʻa Stream located east of Keaʻau, Keaʻau Stream located south of Mountain View/Kurtistown extending from the western side of Route 11 Volcano Highway, to the eastern side of Route 130, Keaʻau-Pāhoa Road, and Keonepoko Stream located north of Pāhoa (Figure 3-8). These streams and their associated branches are categorized as "non-perennial" by the State of Hawaiʻi Division of Aquatic Resources. The National Hydrography Database categorizes Keaʻau Stream and Keonepoko Stream as "intermittent." ʻŌlaʻa Stream is not listed in this database. CWRM Stream Protection and Management Branch manages general surface water reporting on flow rates, but there are no stream diversions nor gauges in the CWRM network for these three streams. The Atlas of Hawaiian Watersheds and their Aquatic Resources lists Keaʻau Stream but with no potential historic or biotic importance. The other two streams are not listed in this atlas.

Water quality data for these streams is limited. HDOH CWB occasionally receives external stream data for their biennial water quality assessment report to U.S. EPA. However, they have not received data on the ʻŌlaʻa Stream, Keaʻau Stream, and Keonepoko Stream. HDOH monitoring resources typically focus on the coastline and beaches to provide public water quality notifications and advisories.

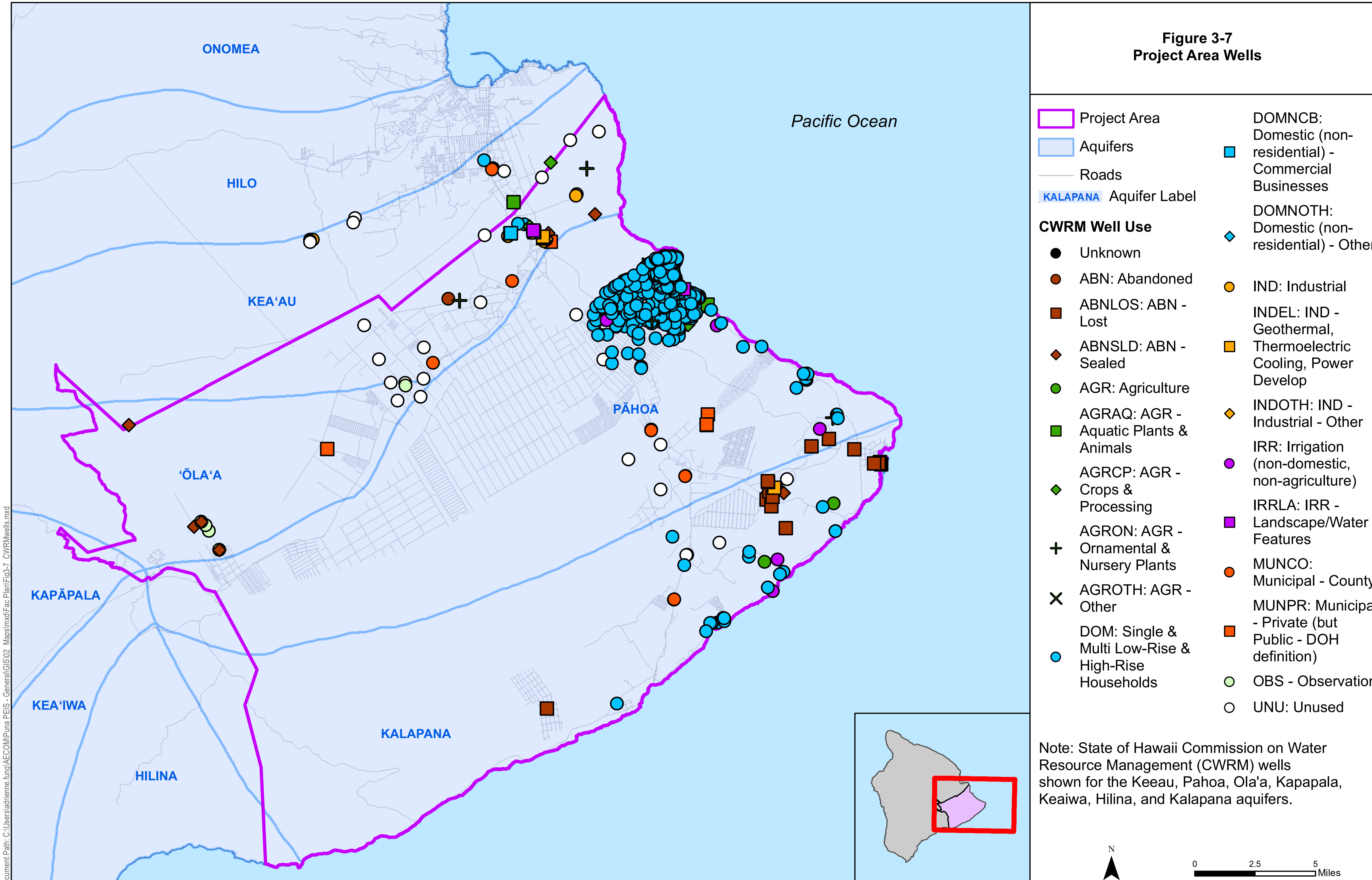
From the State of Hawaiʻi Department of Land and Natural Resources database, there are several areas within and near Keaʻau that contain potential wetlands (Figure 3-8). As shown in the Section 6.5 sewering figures, sewers are not planned for these areas, so these wetlands would not be disturbed by future wastewater projects. Furthermore, most of these wetlands appear dry and may be isolated seasonal wetlands. These wetlands are not Designated Critical Habitats though, so they are not specifically protected under the Endangered Species Act. During the design phase of a wastewater project, a jurisdictional determination from the U.S. Army Corps would help with identifying any requirements. However, these wetlands would not be part of the sewering network, as they are located far from town centers and residential or commercial areas.

One of the wetlands is located near the coast. Therefore, it is tidally influenced and considered a Water of the United States and under U.S. Army Corps Jurisdiction. Work in, over, or under this coastal wetland would require wetland delineation, permitting, and possibly compensatory mitigation. Fortunately, it is highly unlikely for any sewering project to occur here, since it is far from the Keaʻau center and other residential or commercial establishments.

If constructing a new IWS or sewer system, excavation and land disturbance may contribute to sedimentation and runoff into streams and other nearby water bodies, and accidental release of construction equipment fluids also could contaminate surface waters. Construction controls required by NPDES permits would reduce the risk of sediment and construction-related contaminants reaching surface and coastal waters. For construction using the conventional open trench method, shoring and dewatering techniques would be employed to mitigate potential impacts.

Following construction of a new IWS, polluted runoff can occur when the system does not adequately treat wastewater due to improper siting, inadequate maintenance, leaks, or if the system does not adequately treat, or clean, the wastewater. Accumulated sludge and scum must be removed on a regular basis; otherwise, these materials could move into downstream soil infiltration systems, causing clogging and leading to the failure of these systems. Therefore, it is important to design and construct the IWS properly, and also educate homeowners on maintenance. HDOH Clean Water Branch manages permits, monitoring, and enforcement to protect streams and in general, coastal and inland water resources.

Figure 3-7
Project Area Wells



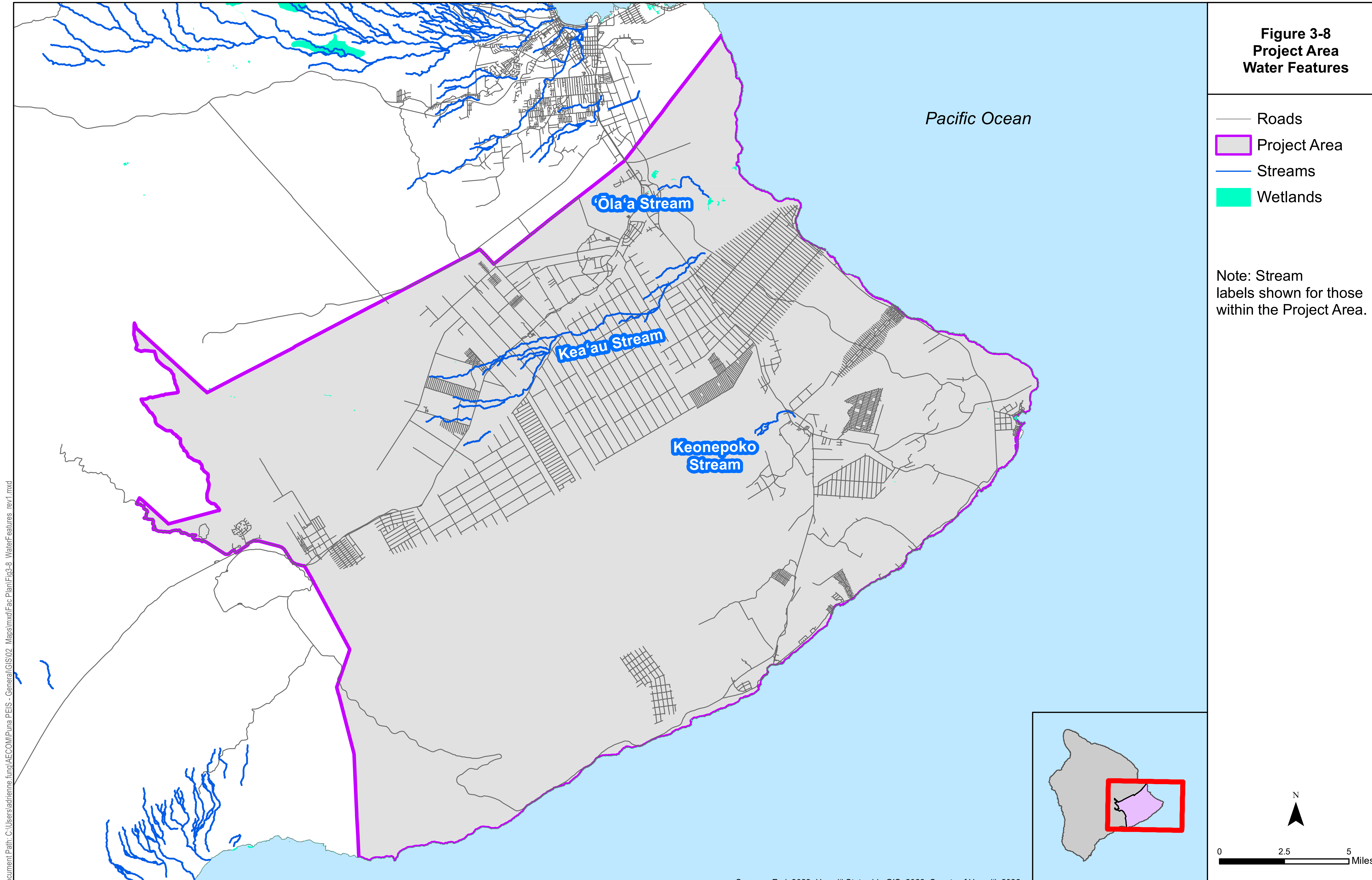


Figure 3-8
Project Area
Water Features

3.6 ENVIRONMENT

The Puna project area in the eastern portion, or the windward side, of Hawaiʻi Island. The topography consists of rocky shorelines on the northeast and southeast coasts which gradually rise to higher elevations and rainforests to the western side of the district. The elevation change from sea level along the coastline to the Hawaiʻi Volcanoes National Park in the west is approximately 5,800 ft with the highest elevations in the northwestern corner. The residential areas are in areas ranging from about 10 feet above mean sea level (MSL) along coastal areas up to about 4,000 feet MSL along the western boundaries of the Project Area.

Eruptions of Mauna Loa and Kīlauea continue to shape the ecology of the region and the land itself with lava flows in the project area as most recent as 2018. Numerous eruptions over the past two centuries along Kīlauea's East Rift Zone have inundated substantial portions of the land in and around Pāhoa. The Project Area lies within the three highest risk volcano lava risk zones identified in the June 2020 COH Volcanic Risk Assessment and in the September 2020 COH Multi-Hazard Mitigation Plan as follows:

- Communities including Kapoho and Leilani Estates are in lava flow Hazard Zone 1 (highest hazard)
- Communities including Kaimū/Pohoiki, Kapoho, Nānāwale Estates, Pāhoa, Hawaiian Beach Parks and Shores are in lava flow Hazard Zone 2 (lower hazard)
- Communities including Keaʻau/W.H Shipman Business Park, Mountain View/Kurtistown, Glenwood, Hawaiian Paradise Park, Makuʻu, ʻĀinaloa/Orchidland/Hawaiian Acres, Volcano/Volcano golf course are in lava flow Hazard Zone 3 (lower hazard)

As a result of the volcanic activity within majority of the Project Area, there are typically only a few feet of soil covering the underlying volcanic deposits. The geology of the Project Area is dominated by Holocene and Pleistocene Basalts associated with the Kīlauea and Mauna Loa volcanoes. There are roughly 70 soil types within the Project Area which include but are not limited to various lava flow complexes, cobbly hydrous loams, ashy silt loams, cinder land, decomposed plant materials, Urban Land complexes, hydrous silty clay, hydrous silt loams, and hydrous highly organic loam. The dominant soil types and approximate areas within the Project Area are as follows:

- Soil symbol 653: Keaukaha, highly decomposed plant material, 2 to 10 percent slopes (74 square miles)
- Soil symbol 651: Keʻei, slightly decomposed plant material, 3 to 10 percent slopes (65 square miles)
- Soil symbol 12: Lava flows, pāhoehoe, 2 to 20 percent slopes (56 square miles)
- Soil symbol 735: Puhimau ashy silt loam, 2 to 10 percent slopes (38 square miles)

These classifications are provided by the U.S. Department of Agriculture Natural Resources Conservation Service.

Soil percolation is a measure of how quickly water moves through soil and is useful in determining the effectiveness of an onsite treatment system. Soil percolation is determined by soil hydraulic conductivity which has been mapped in the Project Area. Conductivities reach up to about 150 feet per day, with a majority of the Project Area ranging from 3 to 10 feet per day.

Subsurface geologic features located in the Project Area include lava tube caves. Some areas within the Project Area have been designated as geothermal sub-zones for development of geothermal energy. The geothermal resource area is mapped along the Kīlauea southwest Rift zone and the East Rift zone within the Puna district. In addition, the Mauna Loa Northeast rift zone high temperature resource area may also extend into the northwest portion of the Project Area.

3.7 EXISTING WASTEWATER FLOWS AND TREATMENT SYSTEMS

3.7.1 Existing Population

Wastewater flows generated from Puna are estimated from the current population. Resident population is defined as the number of persons residing within the County of Hawaiʻi during a given year. Persons are counted as residents if they live within the County for a minimum of five months of the year. The resident population includes part-time residents. However, it excludes visitors (tourists), non-resident students, and military personnel stationed in the County of Hawaiʻi who maintain a home of record outside the County of Hawaiʻi. The number of residents of the County may differ from time to time during the year and is typically represented as an “average” population count for a given year and is normally set at mid-year (as of July 1st of each year). Census data for the year 2020 is used as the starting point to establish population. Overall, the 2020 census population within the Project Area is estimated to be approximately 51,700. Table 3-5 shows the estimated 2020 population for Puna.

Table 3-5: Estimated Year 2020 Project Area Census Population

Area Name [1,2]	Census Tract Number	Estimated 2020 Census Tract Population
ʻĀinaloa/Orchidland Estates/Tiki Gardens	210.03	7,423
Volcano Golf Course/Volcano/Glenwood/Mountain View	210.11	4,388
Kurtistown/Keaʻau	210.13	4,820
Hawaiian Paradise Park (N)	210.14	8,402
Hawaiian Paradise Park (S)	210.15	6,080
Hawaiian Acres/Fern Acres	210.16	5,525
Mauna Loa Estates/Royal Hawaiian Estates/Fern Forest/Eden Roc	210.17	4,572
Leilani Estates/Pohoiki/Kapoho/Kamāʻili/Seaview	211.01	2,793
Pāhoa/Black Sands/Kalapana/Kaimū	211.07	1,365
Nānāwale Estates/Hawaiian Beaches Parks and Shores/Makuʻu	211.08	6,336
Total Population		51,704

Notes:
[1]Area names of census tracts and COH Zoning/Community Development do not match exactly.

[2]It is possible that certain locations/areas extend to multiple census tracts. The census tract number listed corresponds to the area where the majority of each named location is found.

3.7.2 Existing Wastewater Flows

To get average dry weather wastewater flows for current condition, the estimated 2020 population numbers are multiplied by the per capita flow of 105 gallons per capita per day (gpcd). This flow rate is based on the CCH Wastewater System Design Standards, which the COH is using for this facility plan. The 105 gpcd is summed from 70 gpcd of estimated daily per capita sewage flow and 35 gpcd dry weather infiltration which was based on the average of the low nighttime flows per day for the same period as the average dry weather flow, minus significant industrial or commercial nighttime flows. The total estimated 2020 average dry weather wastewater flow is 5.43 million gallons per day (mgd). See Table 3-6 for Year 2020 average dry weather wastewater flow estimates for the project area.

Table 3-6: Estimated Year 2020 Project Area Wastewater Flow

Area Name [2]	Census Tract Number	Estimated 2020 Average Dry Weather Wastewater Flow (mgd) [1]
ʻĀinaloa/Orchidland Estates/Tiki Gardens	210.03	0.779
Volcano Golf Course/Volcano/Glenwood/Mountain View	210.11	0.461
Kurtistown/Keaʻau	210.13	0.506
Hawaiian Paradise Park (N)	210.14	0.882
Hawaiian Paradise Park (S)	210.15	0.638
Hawaiian Acres/Fern Acres	210.16	0.580
Mauna Loa Estates/Royal Hawaiian Estates/Fern Forest/Eden Roc	210.11	0.480
Leilani Estates/Pohoiki/Kapoho/Kamāʻili/Seaview	211.01	0.293
Pāhoa/Black Sands/Kalapana/Kaimū	211.07	0.143
Nānāwale Estates/Hawaiian Beaches Parks and Shores/Makuʻu	211.08	0.665
Total		5.429

Notes:
[1]Based on 105 gpcd and 100% of the current Project Area population served by the sewers.
[2]It is possible that certain locations/areas extend to multiple census tracts. The census tract number listed corresponds to the area where the majority of each named location is found.

3.7.3 Existing Wastewater Treatment Systems

3.7.3.1 Onsite Sewage Disposal Systems

Currently there is no public sewer system for wastewater generated in Puna. Residential wastewater is currently treated via onsite sewage disposal systems (OSDSs). Based on the Hawaii Statewide GIS Program, there is one private WWTP within project area, Mauna Loa Macadamia Nut Corporation WWTP, as of August 2018. However, since August 2018 there is a newly constructed WWTP at the Puna Kai Shopping Center in Pāhoa Town for onsite flows.

There is a total of approximately 20,000 OSDSs in Puna region (Figure 3-9). Of the 20,000 OSDSs, 3,500 are Class I OSDSs, 100 are Class II OSDSs, 20 are Class III OSDS, and 16,000 are class IV OSDSs (cesspools, which are required to be converted under Acts 125 and 87).

HDOH definitions of the four OSDS classes are listed below.

- Class I: any system utilizing soil as a treatment medium
- Class II: a septic tank discharging to a seepage pit
- Class III: an aerobic treatment system discharging to a seepage pit
- Class IV: wastewater discharged directly to a seepage pit with no treatment (i.e., cesspool)

Note that the count of 16,000 cesspools is from the Hawaii Statewide GIS Program database, developed in 2010. In the 2022 Hawaiʻi Cesspool Hazard Assessment & Prioritization Tool report, the count within Puna is about 14,800 cesspools [4]. This value reflects cesspool closures or conversions and additional changes based on more recent permitting data, county tax records, dwelling database information, and other updates.

3.7.3.2 Puna Kai Shopping Center WWTP

Designed to serve the community of Pāhoa, the Puna Kai Shopping Center is a new retail/commercial facility that features a local grocery store and restaurants on 10 acres parkland. Without access to a nearby sanitary sewer, the shopping center constructed a WWTP to capture, treat, and discharge all its effluent onsite. The facility was planned to generate approximately 16,800 gallons per day of wastewater effluent that requires treatment prior to discharge [5].

The wastewater treatment system is currently in operation. It is a secondary treatment process consisting of primary tanks, an equalization tank with aerator, trickling filters, a pump basin, constructed wetlands, and drain field disposal. Constructed wetlands are lined, engineered systems designed to mimic the ecological processes that occur in natural wetlands. They are a nature-based wastewater treatment solution designed to filter and remove pollutants such as organic matter, nutrients, and heavy metals as water passes through the rock media and roots of the plants. This treatment process helps to protect from pollutants entering underlying groundwater supplies and coastal areas.

A map showing the site plan and a field photo showing the constructed wetland are shown in Figure 3-10 [5] and Photo 3-1, respectively.

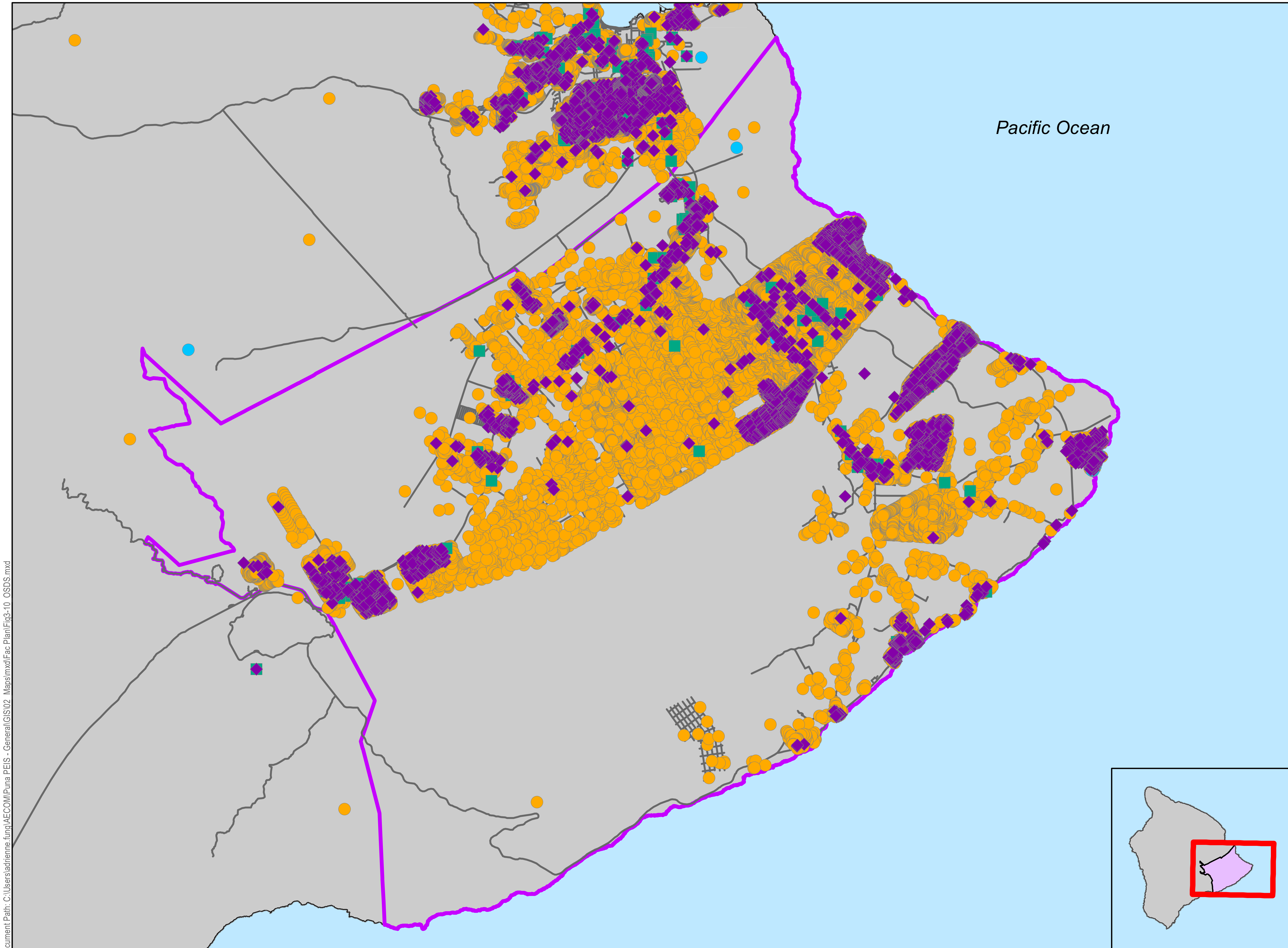


Figure 3-9
OSDS within Puna

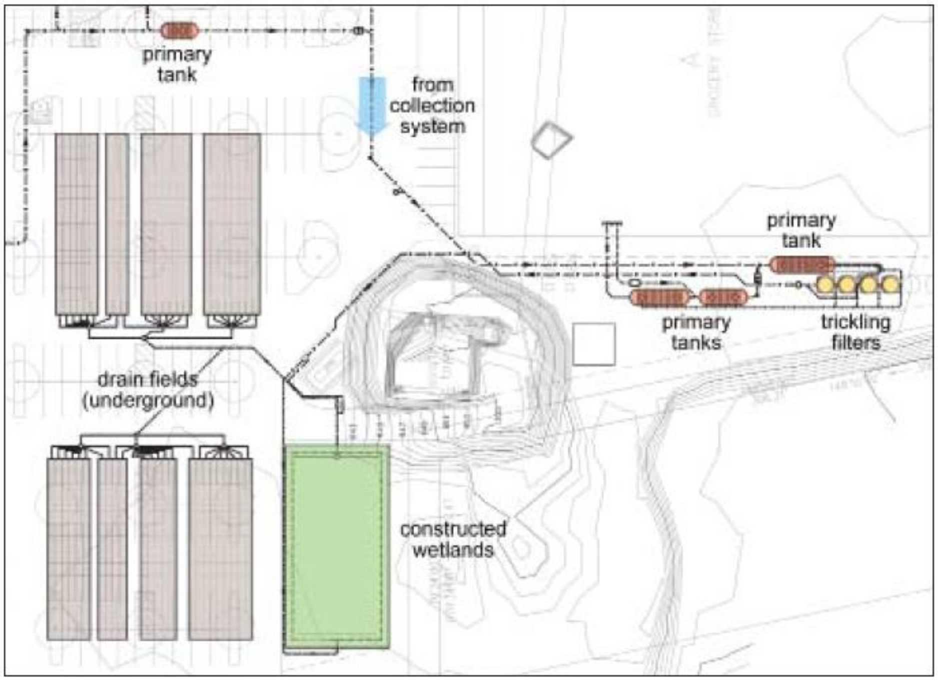
Project Area
Roads
Onsite Sewage Disposal System (OSDS)
OSDS Class I
OSDS Class II
OSDS Class III
OSDS Class IV

Note: Some locations have multiple OSDS classes. The overlappinng points are shown in order of Class I, Class II, Class III, and Class IV.

N

0 2.5 5 Miles

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Fig3-10_OSDS.mxd



Source: Image by Biohabitats [6]

Figure 3-10 Site Plan of Puna Kai Shopping Center WWTP

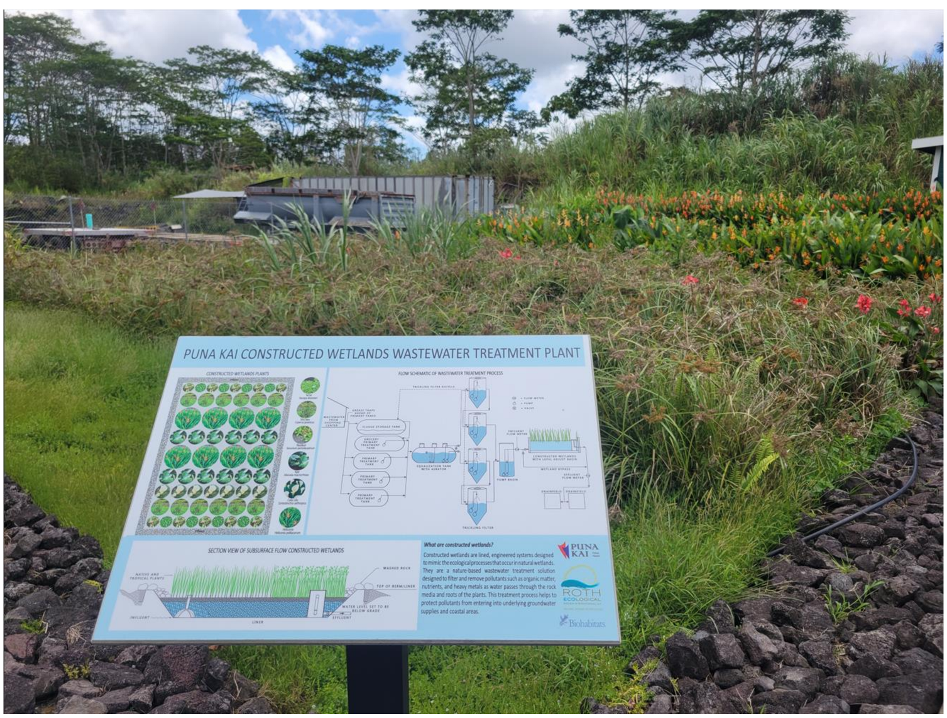


Photo 3-1 Constructed Wetland at Puna Kai Shopping Center WWTP

3.8 Current Infiltration and Inflow

The total wastewater flow that is used for sizing and designing a wastewater system would include wet weather inflow and infiltration (I/I) allowances. Inflow and infiltration are separate flows, as defined below:

- Inflow: water other than sanitary flow that enters a sewer system from sources which include, but are not limited to, area drains, cross connections between storm sewers and sanitary sewers, stormwater, surface runoff, or drainage. Inflow is generally measured during wet weather.
- Infiltration: water that infiltrates a sewer system through defective pipes, pipe joints, connections, or manholes. Infiltration is generally measured during seasonally high ground water conditions, during rainy events.

Due to the absence of public sewer systems in Puna, I/I from long sewer laterals and sewer mains that are typical to a public sewer system currently are not an issue. It is still possible for I/I to enter laterals connecting to existing OSDSs. However, it is anticipated that the OSDSs are designed to account for on-site I/I flow.

3.9 Performance of Existing Systems

The Mauna Loa Macadamia Nut Corporation WWTP is privately owned, operated, and maintained by the Corporation. The plant is located remotely from residential communities. Main flows to the plant would be industrial process wastewater. Since it is mainly to treat industrial wastewater, no further investigation was conducted.

The Puna Kai Shopping Center WWTP is privately operated and maintained. A site visit was conducted for the Puna Facility Plan study. The site visit team observed an abundance of thriving plants in the constructed wetland that receives treated effluent.

Wastewater elsewhere in Puna is treated and disposed of through OSDSs. OSDS Class IV (cesspools) make up about 80% of the OSDSs in Puna. They are considered inadequate methods to treat sewage due to human health and environmental concerns [7]. With the passing of Acts 125 and 87 to amend HRS 342D-72, OSDS Class IV systems are required to be converted, upgraded, or decommissioned. Therefore, the performance of the existing system can be improved through achieving higher levels of treatment with more effective OSDSs or through sewering.

4.0 FUTURE SITUATION

To plan wastewater services for Puna, it is important to project the area's future direction and growth. This would help with design of the capacity and location of wastewater lines and facilities.

Puna is experiencing the fastest growth of all COH districts [2]. This facility plan will help COH evaluate potential wastewater management options to support this growth. COH's vision is to redirect subdivision sprawl to formation of village and town centers, described in later sections.

A key player in guiding the development goals is COH's 2008 Puna CDP. The CDP initiative stems from COH's 2005 General Plan (2005 GP), which serves as a blueprint for long-term development on Hawaiʻi. The COH is developing a General Plan 2045 (GP 2045) and released a draft in September 2023 for public comments. The following sections describe potential future circumstances of Puna, including the case where Puna is not sewered, and general forecasts for land use, demographics, economics, population, and wastewater flows.

4.1 FUTURE ENVIRONMENT – NO PROJECT ALTERNATIVE

In the event of no COH sewering project, there would be a "no project" alternative. This would consist of property owners individually complying with HRS 342D-72, which set a deadline of January 1, 2050 for all cesspools to be "upgraded or converted to a septic system or aerobic treatment unit system" or "connected to a sewerage system" [8].

4.1.1 General Process for Compliance with HRS 342D-72

A general flowchart is presented in Figure 4-1 to help the homeowner comply with HRS 342D-72 as amended by Acts 125 and 87. The starting step is for a licensed engineer to evaluate the site, as required by HAR 11-62-31.2 [9]. A list of licensed engineers is provided by HDOH: see Step 1 of the link below.

https://health.hawaii.gov/wastewater/home/iws/

The engineer will perform a site assessment, such as identifying soil types or determining land slope. Based on this information, the homeowner would decide one of three options:

- Connection to a nearby sewer (if applicable). The homeowner would apply for this through COH DEM.
- Apply for an exemption allowed by HRS 342D-72. This may be granted if the property owner applies for an exemption and presents documentation showing a "legitimate reason that makes it infeasible to upgrade, convert, or connect the cesspools…[A] legitimate reason shall include but not be limited to:
    - Small lot size;
    - Steep topography;
    - Poor soils; or

    - Accessibility issues." [8]

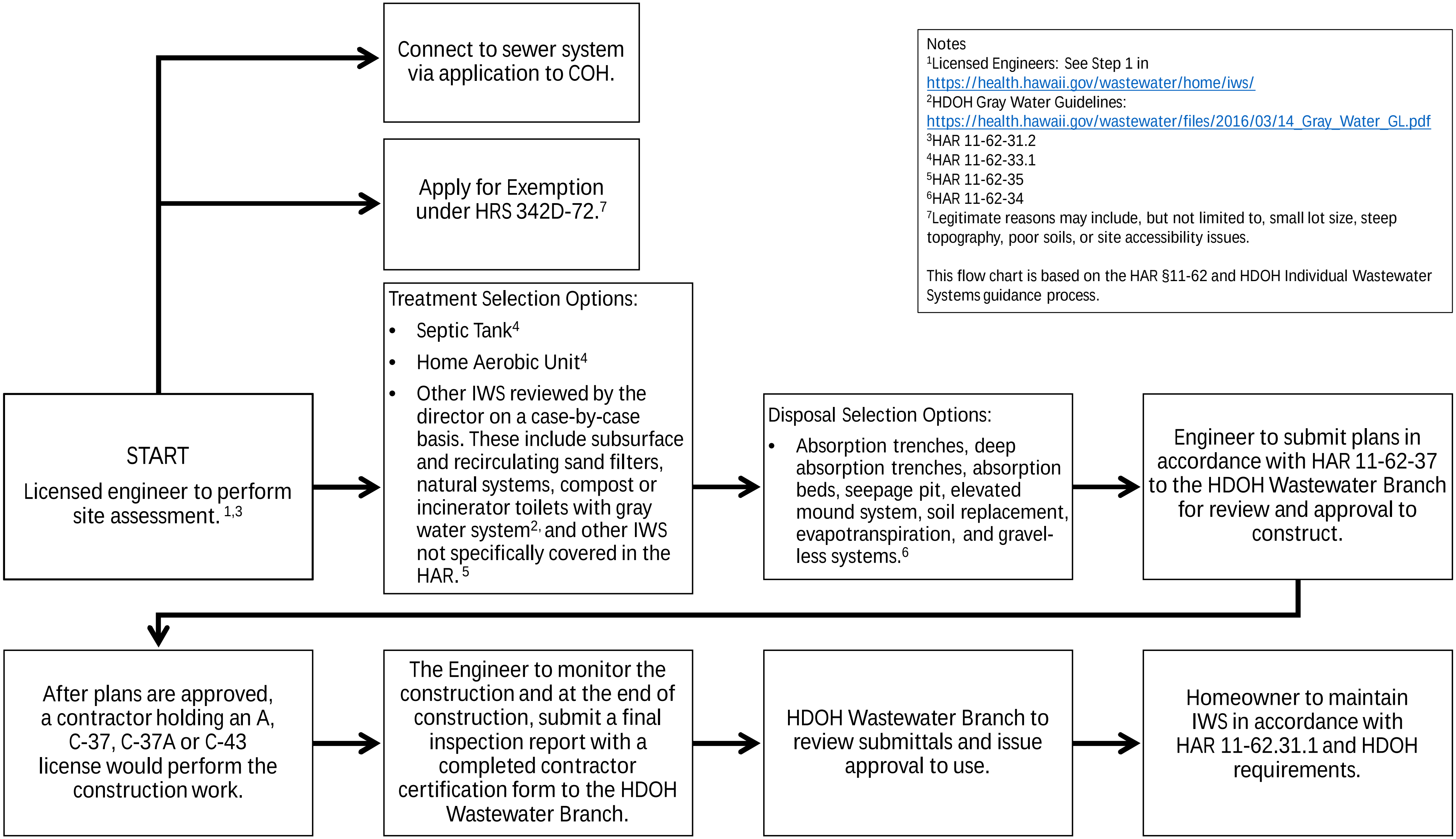
- Proceed to select a treatment and disposal method for the IWS. The engineer would develop and submit the plans to the HDOH Wastewater Branch, following the requirements in HAR 11-62-37.

  After approval, a contractor holding an A, C-37, C-37A, or C-43 license would be needed to construct the IWS or upgrade the cesspool. While the construction takes place, the licensed engineer must monitor the construction of the IWS.

  When construction is complete, the engineer would submit a final construction inspection report and a contractor certification form to the HDOH Wastewater Branch. The Wastewater Branch will issue an approval letter if there are no disparities between the construction inspection report and the contractor certification form.

  The homeowner should maintain the installed IWS and disposal system, as needed, in accordance with HAR 11-62.31.1 and HDOH requirements.

Figure 4-1 General Flow Chart for Compliance with HRS 342D-72



Notes

[1]Licensed Engineers: See Step 1 in https://health.hawaii.gov/wastewater/home/iws/

[2]HDOH Gray Water Guidelines: https://health.hawaii.gov/wastewater/files/2016/03/14_Gray_Water_GL.pdf

[3]HAR 11-62-31.2

[4]HAR 11-62-33.1

[5]HAR 11-62-35

[6]HAR 11-62-34

[7]Legitimate reasons may include, but not limited to, small lot size, steep topography, poor soils, or site accessibility issues.

This flow chart is based on the HAR §11-62 and HDOH Individual Wastewater Systems guidance process.

4.2 PLANNING PERIOD

This facility plan is based on a 30-year planning period, through year 2052. The Hawaiʻi DBEDT provides population forecast estimates through 2040. The facility plan evaluation extends another 12 years from this in order to obtain a 30-year horizon that will include the January 1, 2050 deadline in Acts 125 and 87. These acts mandate every cesspool in the State to be "upgraded or converted to an HDOH director-approved wastewater system; or connected to a sewerage system" by year 2050 (Section 4.1).

4.3 LAND USE

COH's goals for growth management include re-shaping the pattern of future development to prevent further sprawl and creating new village or town centers with community activities and more convenient access to services. These village and town centers are the model on which future land use patterns in the Puna District will be based.

The Puna CDP proposed three types of village centers to provide varying levels of services based on location and size: regional town centers, community village centers, and neighborhood village centers (Figure 3-1).

Regional town centers would be located at Puna's largest existing urban settlements: Keaʻau, HPP, and Pāhoa. These would host a wide range of services and amenities.

Community village centers would provide a more limited range of services for smaller existing urban settlements that are experiencing high growth rates. These are planned for Volcano, Mountain View, Kurtistown, Makuʻu, ʻĀinaloa, and also HPP.

Neighborhood village centers would serve smaller or more remote communities with relatively smaller lot sizes. These are projected for Glenwood, Orchidland Estates, Hawaiian Beaches, Nānāwale Estates, Leilani Estates, Kapoho, and HPP as well.

Overall tools that COH may use to help reshape future land use in Puna are summarized in the following:

- Pooling to form village centers and grow town centers while preventing sprawl development.
- Adjustments to COH and State tax codes to discourage land speculation and provide tax relief for long-time homeowners and renters and to provide incentive for removing development rights from property.
- District-wide rezoning and tighter restrictions on variances from subdivision standards to prevent future subdivision of properties that are not within designated village/town centers.
- Amendments to COH zoning code to reduce excessive lot clearance and speculative building practices.

Land use projections for individual settlements of Puna are summarized from the Puna CDP and described below [2]. Maps from the CDP, where available, are also provided [2].

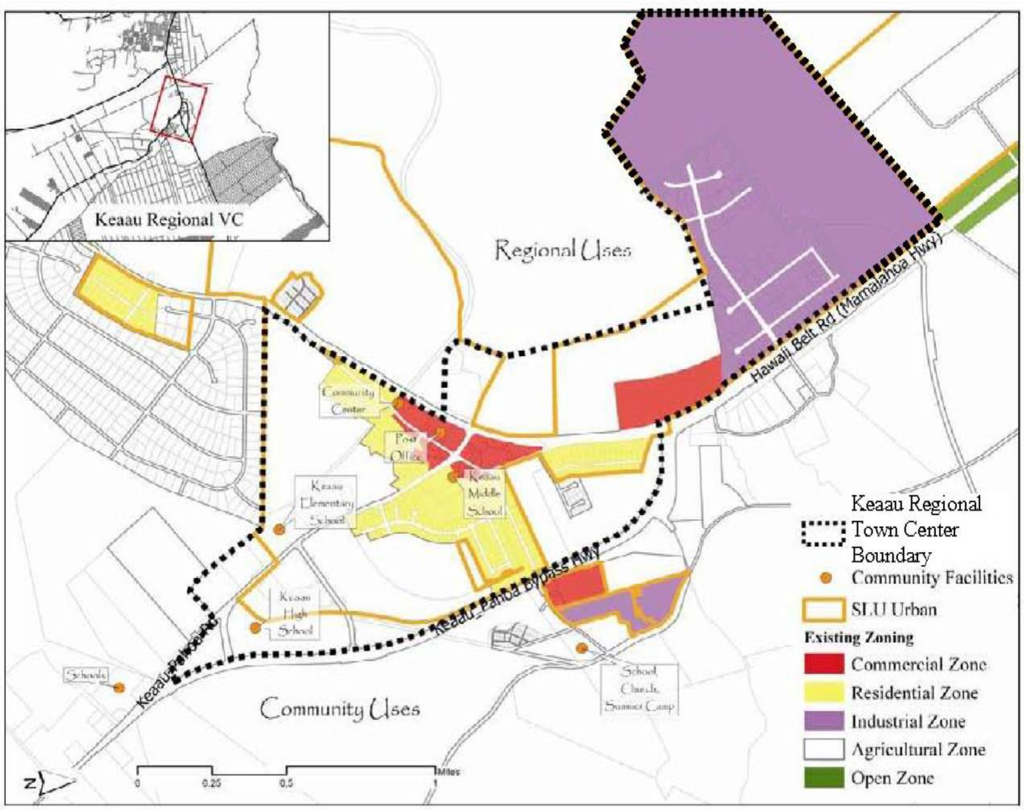
4.3.1 Future Regional Town Centers

4.3.1.1 KEAʻAU/W.H. SHIPMAN BUSINESS PARK

Keaʻau is one of Puna's largest existing urban settlements and has the foundation to serve as a regional town center (Figure 4-2). Keaʻau has roots as a plantation town, but many of the buildings and other physical features of that era no longer exist. Nevertheless, it retains some of the character of an older rural town with the informal arrangement of buildings and scale, roof forms, exterior materials and building colors. It also includes some notable landscape features, including mature canopy trees and line of towering roadside palms between ʻŌlaʻa Community Center and Keaʻau High School. These will likely be preserved into the future. [2]

Most of the land in Keaʻau is held by a single owner, W.H. Shipman, Ltd. The landowner developed a master plan with community participation where development of the area within the designated town center extends to the Shipman lands. COH and AECOM met with representatives of W. H. Shipman, Ltd. in 2022 and agreed to share proposed development plans and maps to gather insights on potential locations of sewering and other wastewater facilities. [2] COH should maintain close contact with W.H. Shipman as the project moves from the PEIS/facility planning phase into the implementation phase to leverage wastewater infrastructure improvements and benefit community and commercial interests.

Keaʻau is a candidate for Special Design District treatment, but is capable to carry out an integrated design theme without adopting the treatment as the landowner has retained planning and design consultants who are presently engaged in developing design guidelines.



Source: Puna Community Development Plan **[2]**

Figure 4-2 Keaʻau Regional Town Center

4.3.1.2 HAWAIIAN PARADISE PARK

Hawaiian Paradise Park contains 8,804 parcels; 99% of which are 1 acre or less in size. The subdivision is developing at a relatively rapid rate because of its proximity to Hilo and the affordability of the parcels. Six 40-acre areas of land were set aside by the original subdivider for potential future community and commercial uses. Three of the 40-acre areas have been identified for development as a town or village center (Figure 4-3). The three sites are distributed in a triangular pattern to optimize their accessibility within the subdivision, and all are adjacent to one of the principal mauka-makai streets in the subdivision. [2]

The site closest to Highway 130 is designated as a regional town center primarily because of the high rate of growth in that quadrant of the subdivision. Land pooling and transfer of development rights to promote greater clustering of residential dwellings near the town center is encouraged. The other two sites are designated for the development of a community and neighborhood village center. [2]

For future plans, the intention is to have all services and community uses located either in the town center or in one of the two village centers to reserve the outlying areas for residential and agricultural use, to create activity centers for community and commercial uses, and to promote greater efficiency in travel and infrastructure development. [2]

Source: Puna Community Development Plan **[2]**

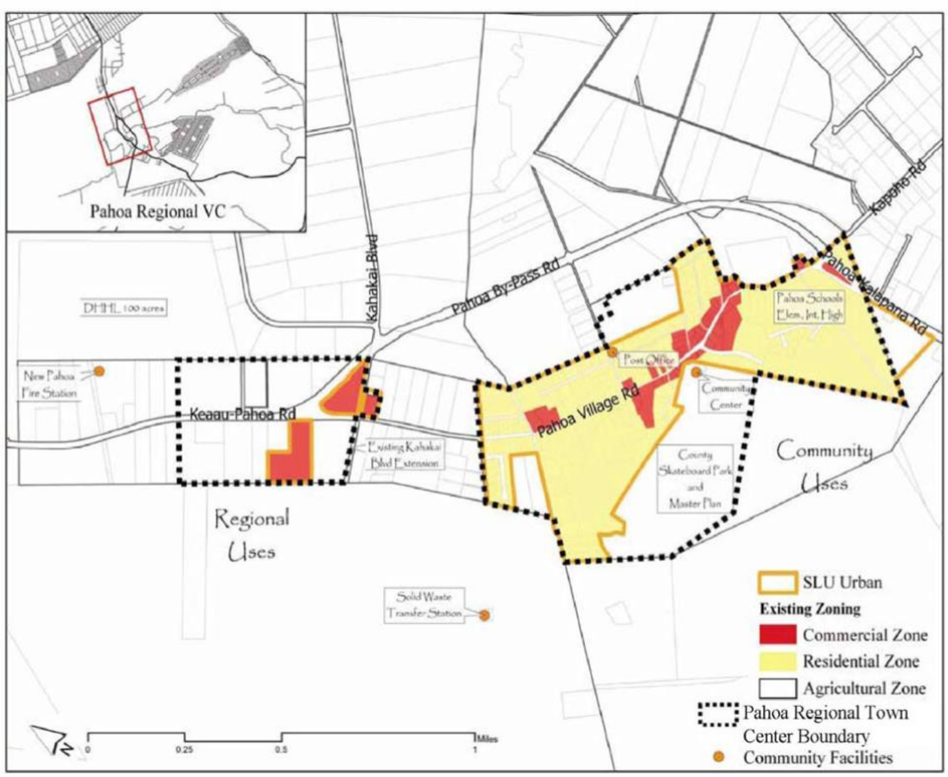
Figure 4-3 HPP Regional Town and Village Centers

4.3.1.3 PĀHOA

Pāhoa is one of the locations proposed for possible Special Design District treatment, which provides more detailed design guidance on the development of village centers exhibiting historic development patterns that ascribe to them a unique "sense of place." [2]

Like Keaʻau, Pāhoa's village center is divided into two parts. The northern portion straddling Highway 130 at the intersection with the Bypass Road is intended for regional uses and services, and includes areas already zoned for commercial and light industrial uses; proposed new police, fire, and ambulance facilities; and the proposed transit hub. The area straddling Pāhoa Village Road from ʻApaʻa Street to the intersection of Kapoho Road and Pāhoa-Kalapana Road is primarily residential-oriented to serve residents of Pāhoa community, except for the post office in the center of town and intermediate and high school at the southern tip of the town, which are considered region-serving facilities. Together, the two areas would make up the Pāhoa regional town center (Figure 4-4). Nearly all the designated regional town center is within the State Urban District. [2]

COH has recently acquired a 50-acre parcel near the center of town, which presents a good opportunity to expand the regional park and provide other facilities to stimulate the development of the town core. When headed south from Keaʻau, a short distance before Pāhoa and near the water spigots area, the Puna Community Medical Campus is in development, organized by the Puna Community Medical Center Foundation. The campus will include a hospital; dental center; women's health center; and a medicinal plant garden and Hawaiian Healing Center, which are Phase 1 of the project. The foundation is looking into leasing an additional 12 acres for a future solar farm and WWTP, among other things. [2]



Source: Puna Community Development Plan **[2]**

Figure 4-4 Pāhoa Regional Town Center

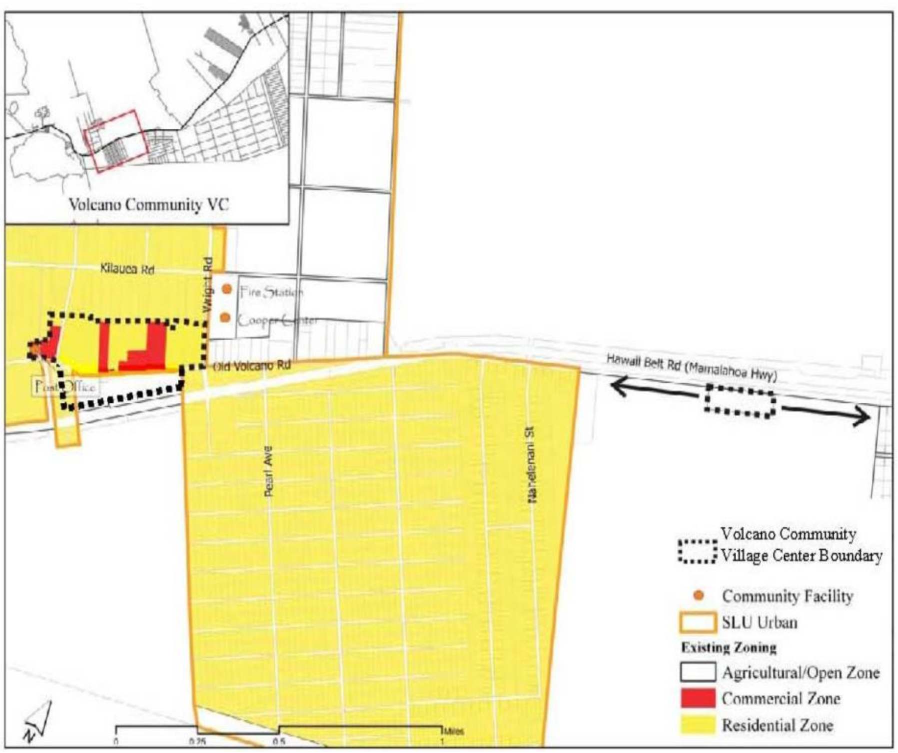
4.3.2 Future Community Village Centers

4.3.2.1 VOLCANO/VOLCANO GOLF COURSE

Volcano Village is one of the locations proposed for possible Special Design District treatment, which would provide more detailed design guidance on the development of village centers exhibiting historic development patterns that ascribe to them a unique "sense of place." Presently, Volcano Village has a small, legally recognized historic district. According to a 1993 inventory by the Hawaiʻl State Historic Division, Volcano has a high concentration of historic structures, which are mostly residential dwellings. Most of the historic structures, however, are outside the designated historic district. Any future decisions about the boundaries of the Special Design District and the design parameters for development, including disposition of the historic structures, will affect growth of Volcano Village. [2]

A community village center is projected for Volcano (Figure 4-5). The Volcano Community Association suggested splitting the village center into two locations. The larger of the two sites would be located along the Old Volcano Highway between Haunani Road and Wright Road and within the historic center of Volcano. Roughly 43 acres, it would lie entirely within the State Urban District. Portions of the site would be designated COH commercial zone. In the community association's Vision 2020 Update, the creation of a Rural Commercial (CR) district was proposed with specific design guidelines to preserve Volcano's historic character. The CR zoning is based on criteria similar to that for a village center. [2]

The4-8rojecnd smaller site would be located at a presently undeveloped site on the other side of Highway 11 between the Royal Hawaiian Estates and ʻŌhiʻa Estates subdivisions and is intended for more service-oriented businesses. [2]



Source: Puna Community Development Plan **[2]**

Figure 4-5 Volcano Community Village Center

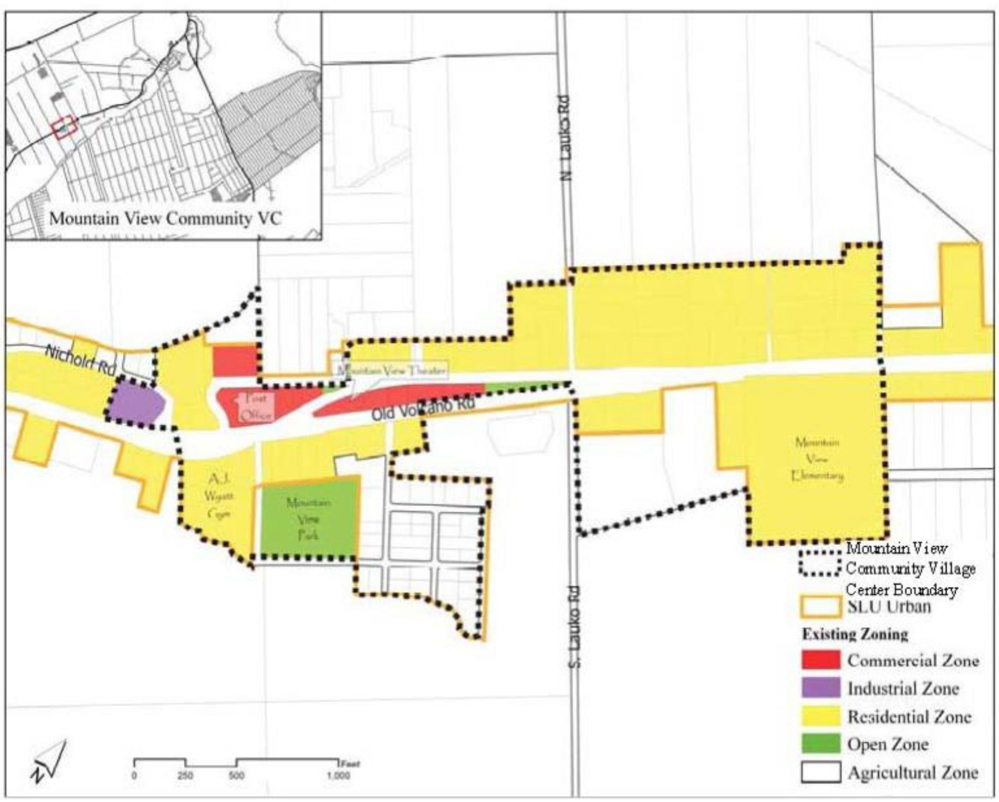
4.3.2.2 MOUNTAIN VIEW/KURTISTOWN

The Mountain View/Kurtistown corridor includes small settlements dating back from plantation days and earlier with historical connections to Volcano and Kea'au by way of transport routes. Some buildings and small areas still exist, showing evidence of a historic development pattern. These may be preserved into the future. [2]

Mountain View/Kurtistown is one of the locations proposed for possible Special Design District treatment, which would provide more detailed design guidance on the development of village centers exhibiting historic development patterns that ascribe to them a unique "sense of place." [2]

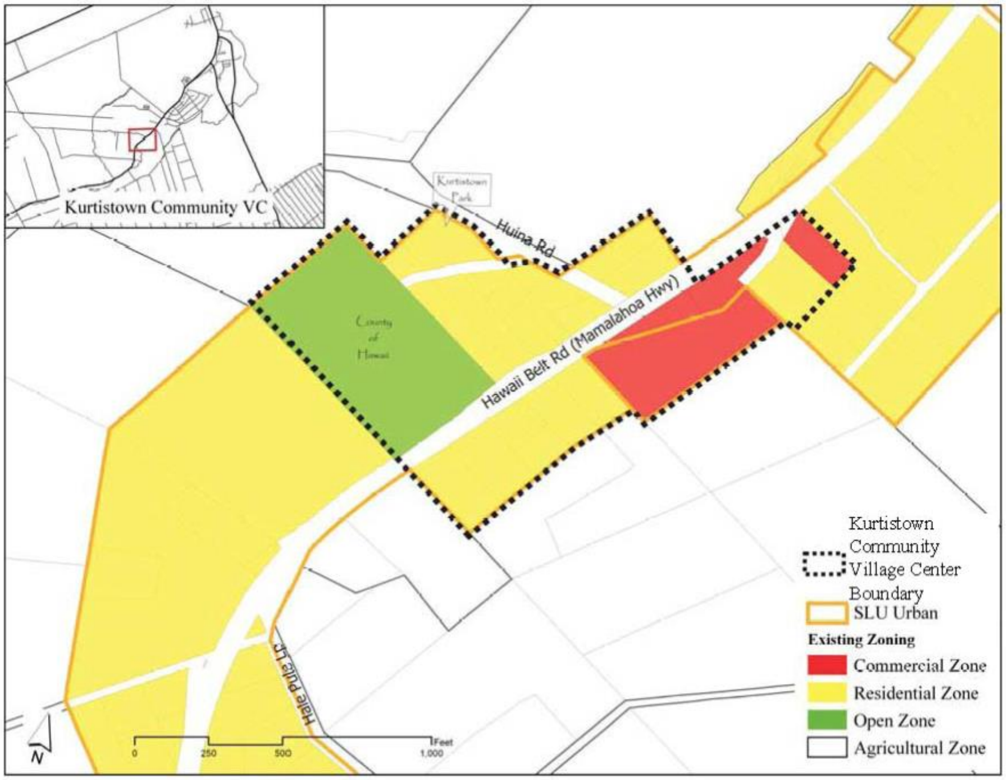
Mountain View already has a commercial zone of more than 3 acres, which would serve as the future core of the village center (Figure 4-6). The area for the village center, as shown in the CDP, is approximately 85 acres and encompasses, other than the commercial zone, an elementary school, community park, the Historical Mountain View Theater, A.J. Wyatt Gym and some relatively small residential lots. [2]

The Kurtistown Community Village Center (Figure 4-7), aligned along Highway 11, would encompass approximately 35 acres. Of that, approximately 15 acres or 44% of the area is already developed. Roughly half of the designated area lies within the State Urban District. A little more than 15 acres is zoned for residential use and is occupied by single family dwellings; approximately 9.5 acres is zoned for commercial use; and nearly 7 acres, the largest parcel, is owned by COH. [2]



Source: Puna Community Development Plan **[2]**

Figure 4-6 Mountain View Community Village Center



Source: Puna Community Development Plan **[2]**

Figure 4-7 Kurtistown Community Village Center

4.3.2.3 HAWAIIAN PARADISE PARK

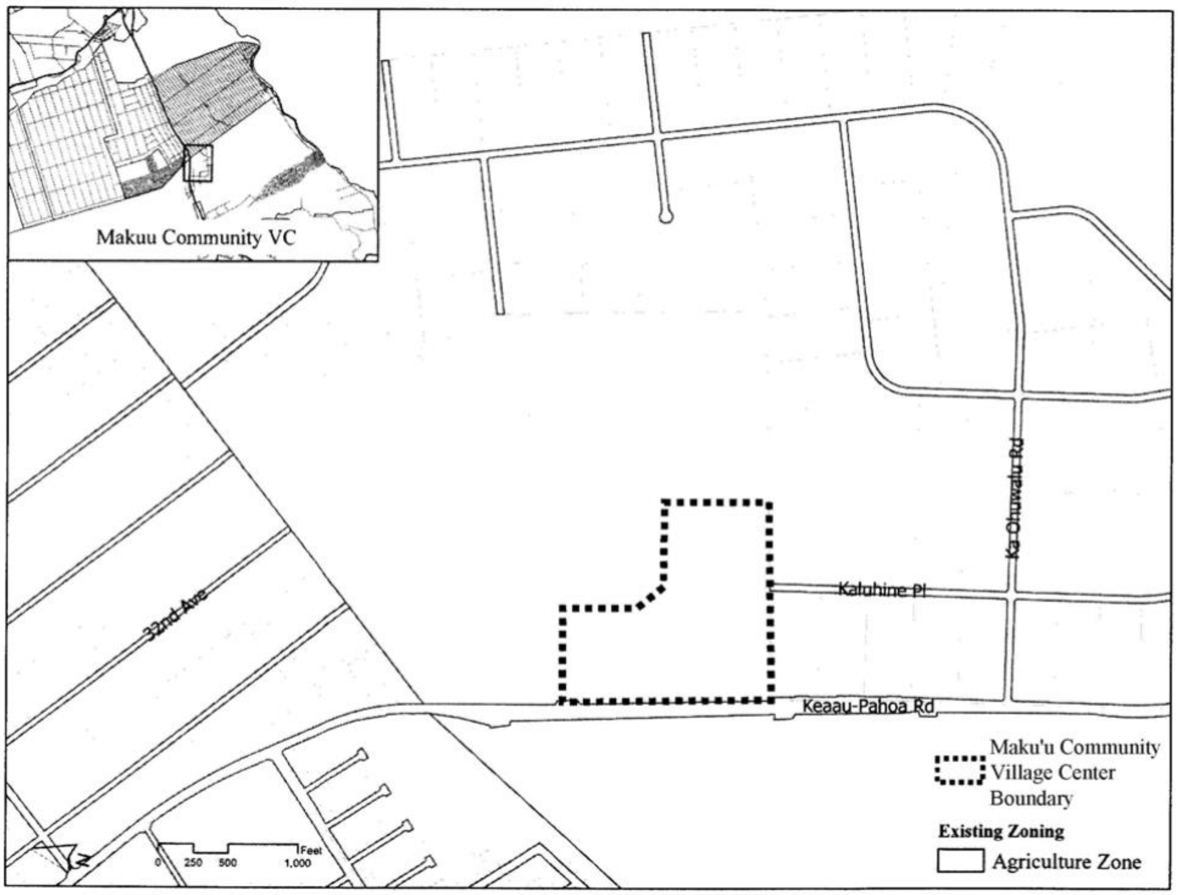
A portion of HPP is planned for designation as a community village center. See Section 4.3.1.2 for additional information.

4.3.2.4 MAKUʻU

The Department of Hawaiian Home Lands (DHHL) created a Hawaiʻi Island Plan with a comprehensive assessment of its 116,963 acres on the island of Hawaiʻi. The Plan includes an assessment of and recommendation for future uses of Hawaiian homelands. The primary instrument by which DHHL promotes the well-being and economic self-sufficiency of its beneficiaries is the 99-year homestead lease. DHHL classifies tracts of land as priority or non-priority. Priority tracts are lands considered most suitable for priority development based on environmental factors, land uses, and the needs of beneficiaries. The Project Area includes two tracts of DHHL property, both considered non-priority. The Makuʻu area lands are approximately 2,000 acres, separated into a makai tract of 500 acres and a mauka tract of 1,500 acres. The makai tract is mauka of the Beach Road extension, with a portion extending across the Ala Hele o Puna Road extension to the coastline. It lies adjacent to HPP to the west and state lands to the south and east. Access is provided by an extension of Ala Hele o Puna Road and Kaʻaahi Road, which is adjacent to the mauka boundary. The lands are recommended for General Agriculture Use. [2]

The Makuʻu mauka tract is recommended for homestead residential, subsistence agriculture, community, and cultural uses. The tract is about three miles from Pāhoa. Tiki Gardens, Orchidland Estates, and Paradise Park subdivisions are to the east of the tract. State lands surround the tract to the north, west, and south. The Keaʻau-Pāhoa Road bisects the tract into an 868-acre parcel, developed into 5-acre agricultural lots, and a 637-acre parcel, developed into 2-acre agricultural lots. About 181 acres of the larger parcel is designated for a Federal Aviation Administration (FAA) radio tower and support facilities. Significant infrastructure issues will need to be addressed prior to development of the tract. [2]

The designation of Makuʻu as a community village center (Figure 4-8) includes the Makuʻu Farmer's Market site and existing and planned Department of Hawaiian Homes subdivisions mauka and makai of Highway 130.



Source: Puna Community Development Plan **[2]**

Figure 4-8 Makuʻu Community Village Center

4.3.2.5 ʻĀINALOA

The ʻĀinaloa Community Association owns three 8.25-acre sites distributed evenly within the subdivision. Two of the sites are vacant. The most central site is proposed for the community village center. The site consists of two parcels, a 5.5-acre parcel and a 2.75-acre parcel, which are separated by a road. The typical lot size in the subdivision is 0.275 acre. Since all the lots immediately surrounding the proposed village center are vacant, the village center could be expanded without displacing homeowners. [2]

As part of the development of the village center (Figure 4-9), a pedestrian way could be constructed, which can also be used for bicycles, to provide better access to the village center. The pedestrian way could be created by acquiring a 5-foot to 10-foot-wide easement from properties along their common boundaries. [2]

Source: Puna Community Development Plan **[2]**

Figure 4-9 ʻĀinaloa Community Village Center

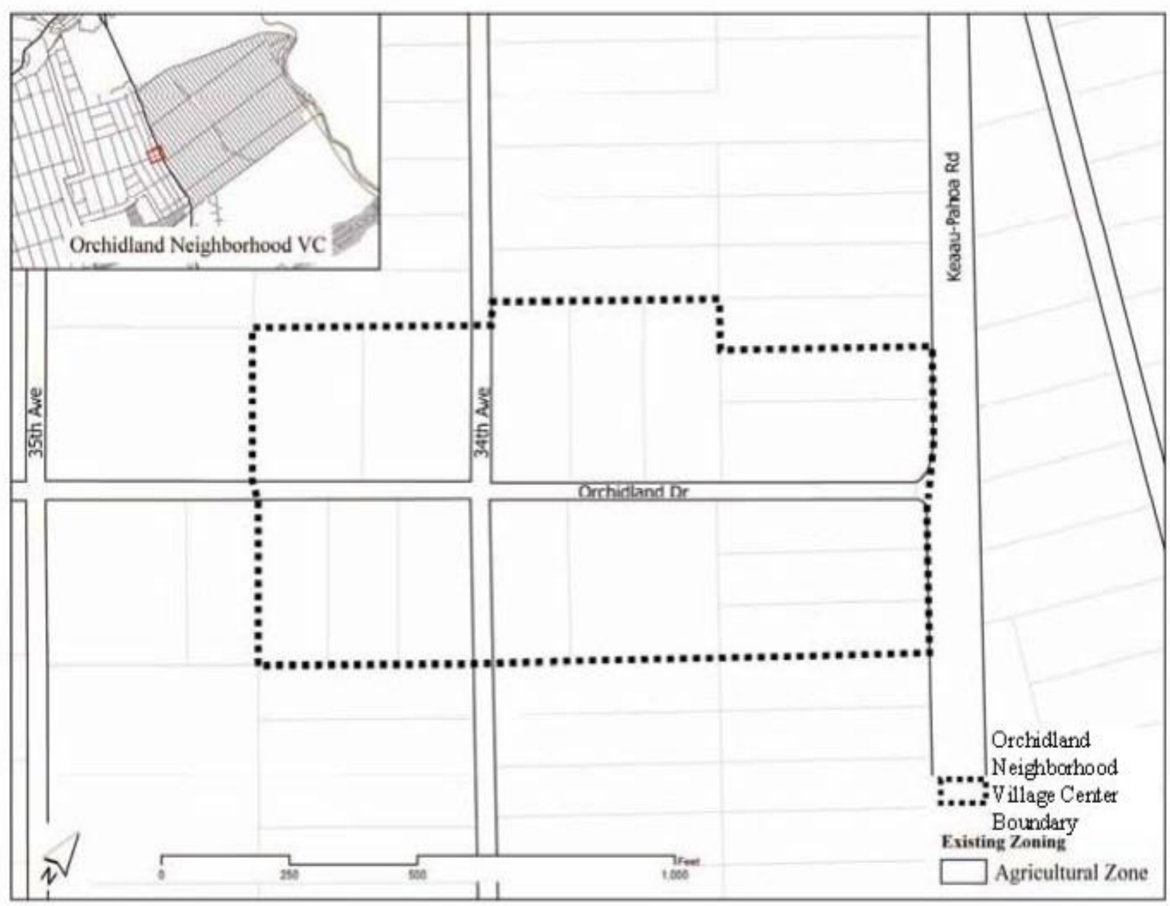
4.3.3 Future Neighborhood Village Centers

4.3.3.1 GLENWOOD

Glenwood, planned as a neighborhood village center, is intended to remain for public/civic use, single- and multi-family residential use, and/or small-scale commercial use for a neighborhood-oriented village to serve the needs of village residents. [2]

4.3.3.2 ORCHIDLAND ESTATES

The Orchidland neighborhood village center location (Figure 4-10) was identified by the community association to be "located along Orchidland Drive from Highway 130 to halfway between 3[4t]h and 3[5t]h Avenues," which would encompass 15 parcels and an area of about 16 acres. The area is outside the State Urban District. [2]



Source: Puna Community Development Plan **[2]**

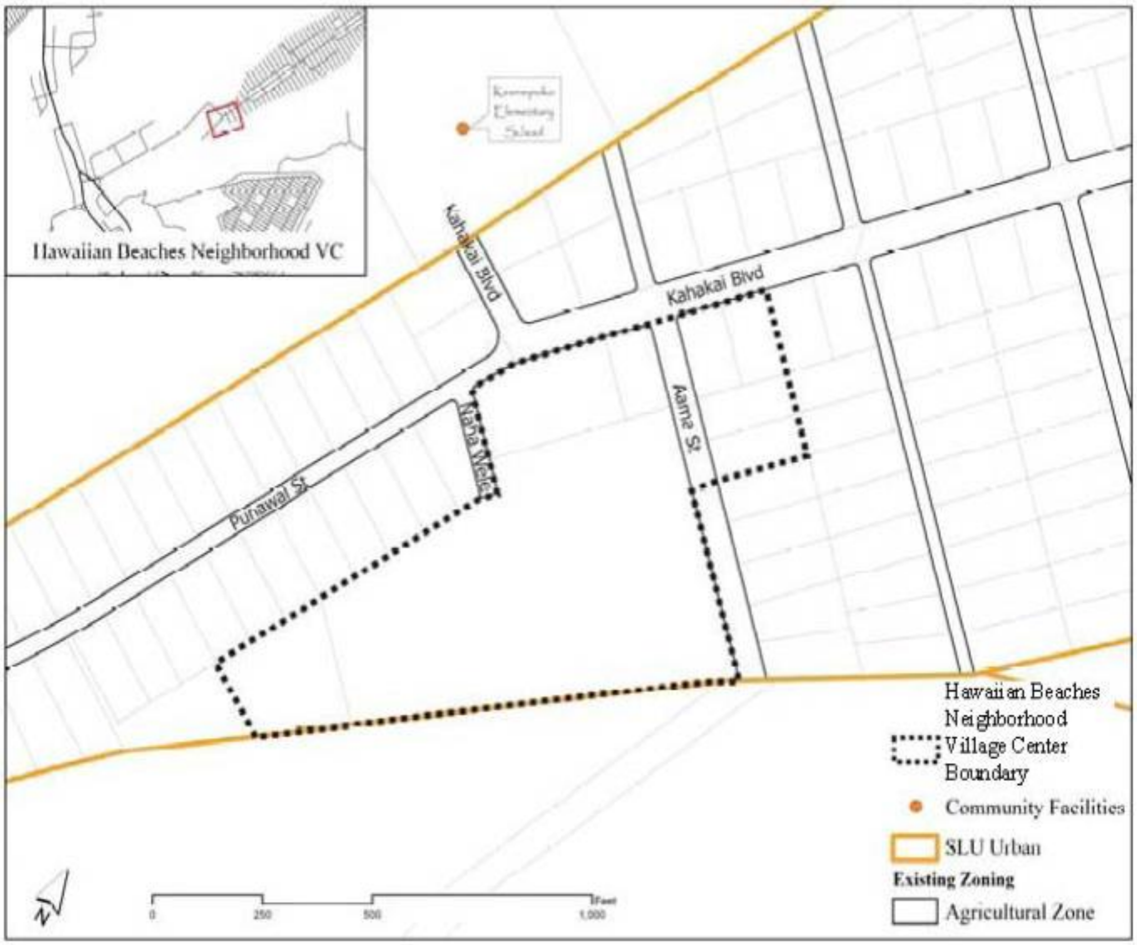
Figure 4-10 Orchidland Estates Neighborhood Village Center

4.3.3.3 HAWAIIAN PARADISE PARK

A portion of HPP is planned for designation as a neighborhood village center. See Section 4.3.1.2 for additional information.

4.3.3.4 HAWAIIAN BEACHES PARKS AND SHORES

The Hawaiian Shores Community Association owns nearly 12 acres at the entrance to the subdivision across the street from the Keonepoko Elementary School. The Association's largest parcel contains a 2,304-square-foot building that is used as a community center. The combined 12-acre area is suitably sized and situated for a neighborhood village center. Four vacant parcels across ‘A‘ama Street totaling 2.19 acres could be acquired for expansion of the village center (Figure 4-11). The entire site is within the State Urban District. [2]



Source: Puna Community Development Plan **[2]**

Figure 4-11 Hawaiian Beaches Neighborhood Village Center

4.3.3.5 NĀNĀWALE ESTATES

The Nānāwale Community Association owns a vacant parcel, 23.23 acres, at the center of the subdivision, which is adequate to serve as a neighborhood village center. Access to the parcel is provided on all four sides of the parcel. The only special use permitted within the subdivision is a church/school facility located in the northwest corner of the subdivision. Majority of parcels within the subdivision are less than a quarter acre in size. The road network through the subdivision is extensive, making the proposed village center accessible and convenient. The proposed village center (Figure 4-12) lies within the State Urban District. [2]

Source: Puna Community Development Plan **[2]**

Figure 4-12 Nānāwale Estates Neighborhood Village Center

4.3.3.6 LEILANI ESTATES

Leilani Estates is located near the eastern tip of the island of Hawaiʻi and would serve as a neighborhood village center. According to the United States Census Bureau, the Leilani Estates neighborhood has a total land area of approximately 4 square miles. Leilani Estates is located directly on a stretch of the lower East Rift Zone of Kīlauea volcano. [2]

4.3.3.7 KAPOHO

The CDP proposes Kapoho as a future neighborhood village center. The Kapoho area is currently uninhabited, unincorporated area. Originally destroyed by an eruption at Kīlauea in 1960, it was rebuilt as a community of private homes and vacation rentals. A 2018 Kīlauea eruption largely destroyed the entire residential area with lava covering both the area and adjacent bay. The new lava now extends several thousand feet out into the ocean. [2]

4.4 DEVELOPMENT GOALS

The process of planning and implementing immediate, near-term, and long-term recovery actions following COH's Kīlauea Eruption has been ongoing since late 2018. Four main categories from the Kīlauea Eruption Recovery planning process are identified as priorities: town and village centers, infrastructure, natural and cultural resource management, and health and well-being. Related to this facility plan, the infrastructure objective is "to restore, improve, and expand adequate and affordable utilities (water, wastewater, energy, phone, and internet services) where needed and infrastructure is lacking."

In the Puna CDP, overall development goals consist of the following:

- Puna retains a rural character while it protects its native natural and cultural resources.
- The quality of life improves and economic opportunity expands for Puna's residents.
- Services and community facilities are more accessible in village/town centers that are distributed throughout the region, including the underserved subdivisions that have been experiencing higher levels of development growth.
- Exposure to high risk from natural hazards situations is reduced.
- Inappropriate and disproportionate County zoning can be adjusted in order to maintain and increase the quality of life and to preserve valued natural and cultural resources in the district.
- Native vegetation, coastal and historic resources are provided new forms of protection.
- Reduced overall number of buildable lots in Puna.
- Incentives, disincentives, regulations and other methods are used to diminish land speculation in Puna.

4.5 FUTURE ZONING

COH is currently reviewing and updating its zoning and subdivision codes (Chapters 25 and 23 of the 1983 Hawaiʻi County Code). The code updates are intended to implement the General Plan, promote smart growth principles, and incorporate best practices in land use and zoning [10]. The project is in the drafting process, and a final draft for public review is planned towards the end of 2023.

The draft 2045 GP depicts future land use designations (Figure 4-13 and Figure 4-14). There are urban growth boundaries mainly designated in Mountain View, Keaʻau, HPP, and Pāhoa. Low density urban and recreation zones are proposed for Mountain View. Keaʻau, HPP, and Pāhoa contain potential zones for low and medium density urban and recreation.

Some smaller boundaries are also seen near Mountain View and in Orchidland Estates, ʻĀinaloa, and Hawaiian Beaches with proposed designations of low and/or medium density urban.

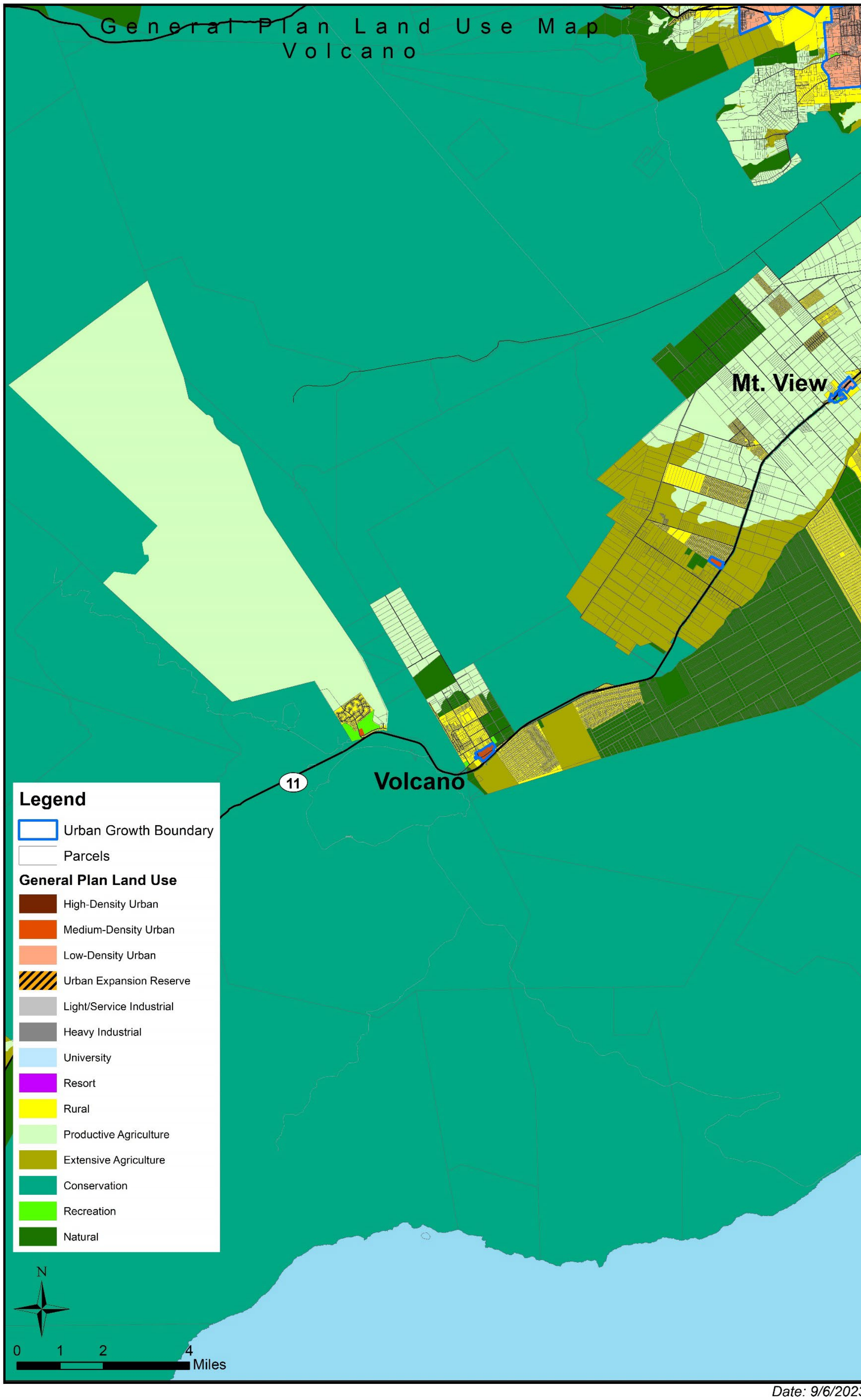
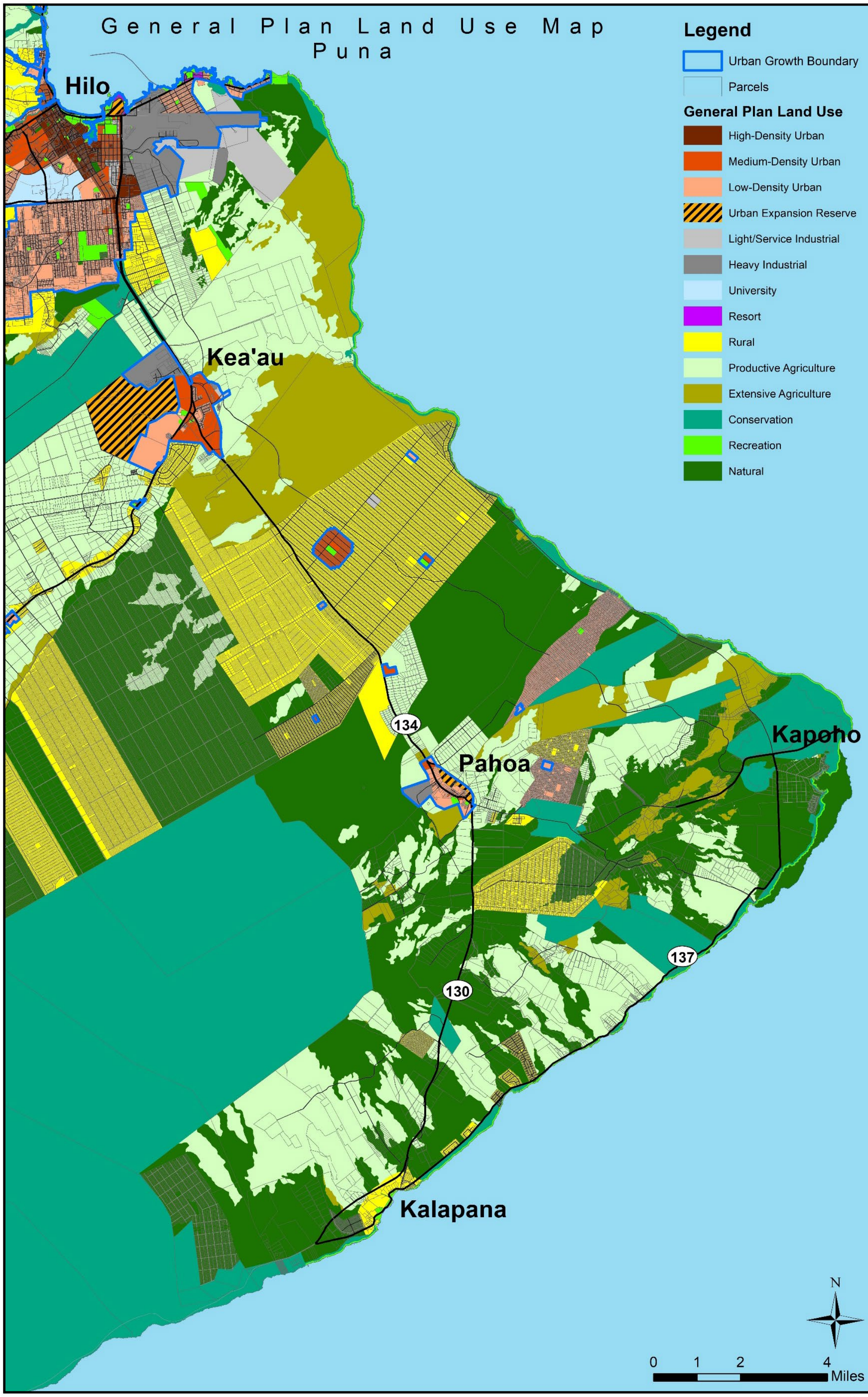


Figure 4-13

Future Land-Use Data - Western Project Area

Source: County of Hawaiʻi Draft General Plan 2045, September 2023



Date: 9/6/2023

Figure 4-14

Future Land-Use Data - Eastern Project Area

Source: County of Hawai‘i Draft General Plan 2045, September 2023

4.6 Demographic and Economic Projections

Demographic projections are summarized from the draft GP 2045, since that contains information more recent than the 2005 GP. About 60% of Hawaiʻi County's population lives in rural areas, and minimal change to this is expected through 2045. Population density is relatively low but expected to gradually increase with the curbing of sprawl development and establishment of village and town centers. Over the next 25 years, however, Hawaiʻi County's population growth rate is expected to decline from an average 2.3% per annum to about 0.9% per annum. Job growth averages 1.4%, mirroring population trends, and is expected to remain at that level for the next several decades. "Senior tsunami" is imminent, since by 2025, the large middle cohort will be retiring. This will present a variety of opportunities and challenges for housing, economic development, and public services.

As regional and village centers develop, these will further grow the economy, drawing businesses and consumers. There is an upward trend in visitor arrivals, which will likely increase through 2045 [11]. With emerging interest in native Hawaiian culture and nature, the Puna district, and especially the Hawaiʻi Volcanoes National Park, have been drawing more visitors. Economic activity is expected to grow as agricultural tourism and eco-tourism become more popular [2]. These provide community-based services while still protecting and nurturing natural and cultural systems.

COH goals in the CDP include promoting agricultural use and other "green" employment, as well as the use of renewable energy [2]. Therefore, new employment is projected within "green" industries such as alternative energy research and development and natural resources management.

4.7 Forecasted Population

Forecasted growth rates are provided in the draft GP 2045 and include high overcrowding rates for towns within Upper Puna. For the Puna population forecast, the DBEDT annual "residential" growth rates are applied until Year 2040. For the remaining planning period to 2052 (see Section 4.2 on planning period), the annual average growth rate is extrapolated from the graphed data ending in Year 2040 [12]. Table 4-1 shows the estimated future population projections for each census tract in the Puna Project Area, with a total population of 80,529.

Table 4-1: Projected Project Area Population Estimates (2052)

Area Name [1, 2]	Census Tract Number	Projected Future Population (2052)
ʻĀinaloa/Orchidland Estates/Tiki Gardens	210.03	11,561
Volcano Golf Course/Volcano/Glenwood/Mountain View	210.11	6,834
Kurtistown/Keaʻau	210.13	7,507
Hawaiian Paradise Park (N)	210.14	13,086
Hawaiian Paradise Park (S)	210.15	9,470
Hawaiian Acres/Fern Acres	210.16	8,605

Area Name [1, 2]	Census Tract Number	Projected Future Population (2052)
Mauna Loa Estates/Royal Hawaiian Estates/Fern Forest/Eden Roc	210.11	7,121
Leilani Estates/Pohoiki/Kapoho/Kamāʻili/Seaview	211.01	4,350
Pāhoa/Black Sands/Kalapana/Kaimū	211.07	2,126
Nānāwale Estates/Hawaiian Beaches Parks and Shores/Makuʻu	211.08	9,868
Total Population		80,529

Notes:
[1]Area names of census tracts and COH Zoning/Community Development do not match exactly.
[2]It is possible that certain locations/areas extend to multiple census tracts. The census tract number listed corresponds to the area where the majority of each named location is found.

4.8 FORECASTED FLOWS AND LOADINGS

The projected future populations described in Section 4.7 are multiplied by the per capita wastewater flows from Section 3.6. Table 4-2 lists projected future Year 2052 wastewater flow estimates for the census tracts in the Puna Project Area, with a total flow of 8.5 mgd.

Table 4-2: Estimated Future Year 2052 Project Area Wastewater Flow

Area Name [1, 2]	Census Tract Number	Estimated 2052 Wastewater Flow (mgd) [3]
ʻĀinaloa/Orchidland Estates/Tiki Gardens	210.03	1.21
Volcano Golf Course/Volcano/Glenwood/Mountain View	210.11	0.72
Kurtistown/Keaʻau	210.13	0.79
Hawaiian Paradise Park (N)	210.14	1.37
Hawaiian Paradise Park (S)	210.15	0.99
Hawaiian Acres/Fern Acres	210.16	0.90
Mauna Loa Estates/Royal Hawaiian Estates/Fern Forest/Eden Roc	210.11	0.75
Leilani Estates/Pohoiki/Kapoho/Kamāʻili/Seaview	211.01	0.46
Pāhoa/Black Sands/Kalapana/Kaimū	211.07	0.22
Nānāwale Estates/Hawaiian Beaches Parks and Shores/Makuʻu	211.08	1.04
Average Wastewater Flow (total)		8.46

Notes:
[1]Area names of census tracts and COH Zoning/Community Development do not match exactly.
[2]It is possible that certain locations/areas extend to multiple census tracts. The census tract number listed corresponds to the area where the majority of each named location is found.
[3]Based on 105 gpcd and 100 percent of the future Project Area population served by sewers.

4.9 FUTURE IMPACTS TO THE ENVIRONMENT

In accordance with the HAR 11-200, COH is required to consider the significance of potential environmental effects of a proposed Puna wastewater project. This would include evaluation of all phases of the proposed project, its potential impacts on the quality of the environment, and potential mitigation measures.

Potential future impacts associated with wastewater improvement projects are described in the final Puna District Programmatic Environmental Impact Statement [13]. These are based on general planning level details of an infrastructure study. When individual projects within Puna are selected and designed, separate project-specific HRS Chapter 343 documents will be prepared as appropriate, including site-specific environmental surveys and documentation. The development of wastewater design details will also better inform the assessment of impacts on the environment.

4.9.1 Air Emissions/Odor Control

Nuisance odors are a common occurrence at WWPSs, WWTPs and biosolids processing facilities. Wastewater collection systems with WWPSs that have long detention times can result in septic conditions throughout the WWTP and subsequent odor problems in biosolids handling and end use. Biosolids processors are faced with odors during thickening, digestion, dewatering, conveying, storage, truck loading, air drying, composting, heat drying, alkaline stabilization, and/or incineration.

Odors can have detrimental effects on aesthetics, property values, and the quality of life in the community. Odor complaints at operating facilities can also lead to long term problems. Therefore, odor control would be included in the design of all wastewater collection and treatment facilities to meet HAR 60.1 – Air Pollution Control.

4.9.2 Short-term Impacts

Short-term impacts associated with construction of wastewater systems include use of water, energy, fuel, and other resources. Further, impacts on water resources, flora and fauna, and health, safety, and well-being could be expected. Use of water would be expected during construction and removal of cesspools would improve the surface and groundwater resource quality. Construction would require clearing of vegetation, depending on the specific locations selected. Construction may also affect certain neighborhoods with noise, dust, and traffic, although not expected to be significant nor long-term. Construction worker employment and material acquisition are other short-term impacts.

4.9.3 Long-term Impacts

Impacts on resources could be long-term. For example, a WWTP would require use of fuel and energy for operation. Commitment of the land for the facility could involve the loss of land resources, clearing of trees and vegetation, and use of materials to construct the facility. Beneficial impacts would include direct and indirect employment and support of current and future economic activities and development and growth in the service area. Other probable impacts include air quality (odor and dust), soils (through excavation and possible accidental and planned release of contaminants), visual and aesthetic resources, noise, and transportation (largely vehicular traffic impacts during construction),

5.0 CONCEPTUAL DESIGN

The following outlines the main design criteria and assumptions that support the conceptual design of the proposed pipe network and WWTP and WWPS locations in Section 6.0.

5.1 DESCRIPTION OF DESIGN

Design of the proposed wastewater collection system shall be in accordance with CCH Wastewater Design Standards, since there are currently no COH wastewater design standards.

5.1.1 Gravity Sewer and Force Main Design Criteria

A summary of the key design standards is summarized below.

- Gravity Sewer Design Criteria
    - Gravity sewer hydraulic capacity: not to exceed 85% of pipe's full flow capacity
    - Minimum velocities and slope: gravity sewers shall be designed with the following minimum slopes for each pipe size in order to provide minimum mean velocities of 2.5 feet (ft) per second (s) (ft/s).
        - 8-inch: 0.0052 ft/ft
        - 10-inch: 0.0039 ft/ft
        - 12-inch: 0.0031 ft/ft
        - 16-inch: 0.0021 ft/ft
        - 18-inch: 0.0018 ft/ft
        - >18-inch: 0.0016 ft/ft
    - Maximum velocity: generally, no more than 10 ft/s is permitted
    - Depth of sewer: in general, sewers should be designed with sufficient depth to serve properties within the tributary area. Properties that are not able to be served by gravity flow due to insufficient sewer depth shall use a pump to discharge to the gravity sewer.
    - Minimum ground cover above gravity sewers: 4.0 ft
    - Easement widths and access:
        - 15 ft for 6-inch and 8-inch lateral and branch sewers
        - 15 ft for trunk and interceptor sewers 8-inch to 16-inch
        - 25 ft for trunk and interceptor sewers larger than 16-inch
        - 40 ft easement is used for the Facility Plan to account for permanent easement requirement and construction requirement

- Force Main Design Criteria
    - Velocities in force mains:
        - Minimum: 3.0 ft/sec (desirable)
          1.75 ft/sec (absolute)
        - Maximum: 10.0 ft/sec
    - Total dynamic head: maximum of 100 ft

5.1.2 Low Pressure Sewer Design Guidelines

Key criteria of the CCH Low Pressure Sewer (LPS) Design Guidelines are summarized below.

- Pump Station
    - Pump Station Basin
        - The pump station basin shall be watertight and consist of a dry well and wet well section in order to facilitate maintenance duties without confined space entry.
    - Appurtenances
        - A gravity operated flapper-type check valve and flapper-type anti-siphon valve, and isolation valve shall be included within the LPS system pump station basin.
- Pump and Motors
    - Type of Pumps:
        - Semi-positive displacement type grinder pump
        - All LPS system pump types are to be the same in a single LPS system
    - Pump and Motor Performance
        - A minimum of 14 gallons per minute (gpm) against total dynamic head (TDH) of 0 ft
        - A minimum of 7 gpm against TDH of 185 ft
        - Capable of operating at negative TDH without overloading the motor
        - Pump motors: 1 horsepower, motor speed not exceeding 1,750 rotations per minute
- LPS System Lateral
    - Design
        - Minimum diameter: 1-1/4-inch
        - Velocity: 2–6 ft/sec
        - Minimum cover: 12-inch

- LPS Main
  - Design
    - Diameter: 1-1/4 to 4 inch
    - Velocity: 2 – 6 ft/sec
    - Minimum cover: 4 ft
    - Velocities shall be determined based on the maximum anticipated number of simultaneous LPS system pump stations in use given in Table 5-1.

Table 5-1 Maximum Number of LPS System Pump Stations Operating Simultaneously

Total Number of LPS System Pump Stations	Assumed Maximum Number of LPS System Pump Stations Operating Simultaneously
1	1
2-3	2
4-9	3
10-18	4
19-30	5
31-50	6
51-80	7
81-113	8
114-146	9
147-179	10
180-212	11
213-245	12
246-278	13
279-311	14
312-344	15

  - Appurtenances
    - Air valves shall be placed at high points
    - Flushing stations: in-line flushing stations at intervals of at most 1,000 ft for straight runs of pipe, at bends of 45 degrees or greater, where a main joins another main, and at the upstream terminal end of any main
- Other Design Considerations
  - Retention time
    - Preferred to be less than 8 hours to minimize risk of odor
  - System with negative heads

- Anti-siphon check valves provide for negative head pumping. The use of combination air/vacuum release valves should be considered for systems with negative heads of 25-30 ft or more.

5.1.3 Design Assumptions

A topographic survey for Puna has not been performed at this planning phase. Based on a site visit, the project area was observed to have rolling terrain in some areas, such as ʻĀinaloa, Hawaiian Acres, and Hawaiian Paradise Park. There are also neighborhoods sloping downwards from the road.

The conceptual design for the collection system was largely based on Google Earth elevation data and GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission. In general, it is acceptable for digital elevation model data to be used for preliminary studies [14]. This information was used to identify the proposed gravity sewer, low pressure sewer (LPS), and FM routes. At this level of planning, these locations are not specific and should be updated during the final design.

The noted areas that will likely need pumps to send flow to receiving gravity sewers are identified with "Neighborhood Pump Station" in Section 6.5 figures. During design, topographic survey information would be obtained and could indicate additional areas that may need to pump wastewater to a branch or trunk sewer.

The open cut method is assumed for sewer installation, with a maximum depth of approximately 25 to 30 ft. In areas with rolling terrain, the gravity sewer depth could exceed this 30-ft limit. However, sewer tunneling does not appear to be cost effective, given Puna's unique subsurface geologic formation that is comprised of lava rock. Therefore, if gravity sewer depths exceed 30 ft due to rolling terrain conditions, "Regional Pump Stations" are proposed to pump wastewater from upstream lower ground elevations to downstream higher ground elevations, allowing flow by gravity to continue farther downstream.

LPS systems for each clustered package treatment plant are based on key hydraulic design considerations such as TDH and flow velocity for this report. Some additional design considerations are necessary for the final design, including odor control for potential long wastewater retention time, and the need for combination of air/vacuum relief valves to accommodate topography and existing utility interferences.

At the WWTP's described in this facility plan, stormwater management design would be included for the treatment plant sites. WWTP site stormwater would be handled/disposed of onsite. Collection system improvements would be designed so existing drainage systems aren't impacted. Drainage issues in a sewer service area would need to be resolved independently by COH under a separate program outside of the wastewater program described in this report.

5.1.4 Conceptual Design

Conceptual design of a proposed centralized wastewater system is based on the design criteria and assumptions described in this chapter. The preliminary pipe network and WWTP and WWPS locations are presented in Section 6.5.

6.0 ALTERNATIVES

Currently there are no public wastewater collection and treatment systems for Puna. Wastewater generated in individual lots are continuously treated and disposed of by OSDS of different classes. However, by 2050, all Class IV OSDS (i.e., cesspools) are required by HRS 342D-72 to be converted, upgraded, or decommissioned.

Various alternatives were developed based on combinations of treatment, flow amounts, collection, and disposal. The alternative components are listed below and will be described in Section 6.1 for collection, Section 6.2 for treatment, Section 6.3 for disposal or reuse, and Section 6.4 for projected 2052 design average flows.

- **Collection System**
  - Gravity sewers in existing roads
  - Low pressure sewers (LPS)
  - Cross-country gravity sewers in new easements
- **Treatment System**
  - IWS
  - Decentralized cluster system
  - Centralized treatment
- **Disposal System**
  - Onsite (as part of IWS or decentralized system)
  - Disposal (land application or ocean outfall at Hilo WWTP) or reuse
- **Projected 2052 Design Average Flow**
  - Urban sewering
  - Full flow

The alternatives are listed below and described in Section 6.5.

- Alternative 1: All IWS or Decentralized Systems
- Alternative 2: Four Subregional Treatment Plants – Urban Sewering (6.0 mgd)
- Alternative 3: Three Subregional Treatment Plants – Urban Sewering (6.0 mgd)
- Alternative 4: One Regional Treatment Plant – Urban Sewering (6.0 mgd)
- Alternative 5: One Regional Treatment Plant – Full Flow Sewering (8.5 mgd)
- Alternative 6: Flow to Hilo WWTP – Urban Sewering (11.0 mgd)
- Alternative 7: Flow to Hilo WWTP – Full Flow Sewering (13.5 mgd)

They are mostly differentiated by the treatment system, either decentralized or centralized. Alternative 1 uses onsite collection and decentralized treatment and collection systems, while Alternatives 2 through 7 are based on centralized treatment and collection systems.

Within the centralized options, Alternatives 2 through 4 consist of new WWTPs in Puna with flows based on urban sewering. Alternative 5 is similar to Alternative 4, but assumes full flows across Puna. Alternatives 6 and 7 are based on sending Puna flows to Hilo. For each of the centralized alternatives, there are also three different methods of wastewater collection (see list above).

Table 6-1 Summary of Alternative Descriptions

Wastewater Treatment						Flow Scenario		Collection System						Disposal
Alternative Code	**Alternative Description**	Decentralized Treatment	Centralized Treatment	IWS in Unsewered Areas	IWS in Sewered Areas	Urban Sewering	Full Flow Sewering	Alternative Sewer Options[3, 4]	Gravity Sewer in Existing Roadway	Regional PS	Neighbor-hood PS	LP Sewers	Cross-Country Gravity Sewer	
1A	**All IWS + Decentralized Treatment**	✓	x	✓	✓	x	x	x	x	x	x	x	x	Onsite
1B	**Decentralized On-Site Treatment–- Low Pressure Sewer (LPS)**	✓	x	x	x	N/A	8.5 mgd	LPS	x	x	x	✓	x	
2A	**4 Subregional Treatment Plants–- Urban Sewering (6.0 mgd)**	x	✓	✓	x	6.0 mgd	N/A	Gravity Sewers	✓	✓	✓	x	x	Water Reuse and Land Application (Ocean outfall at Hilo WWTP)
2B		x	✓	✓	x			Gravity & LPS	✓	✓	x	✓	x	
2C		x	✓	✓	x			Cross Country	✓	✓	✓	x	✓	
3A	**3 Subregional Treatment Plants–- Urban Sewering (6.0 mgd)**	x	✓	✓	x	6.0 mgd	N/A	Gravity Sewers	✓	✓	✓	x	x	
3B		x	✓	✓	x			Gravity & LPS	✓	✓	x	✓	x	
3C		x	✓	✓	x			Cross Country	✓	✓	✓	x	✓	
4A	**1 Regional Treatment Plant–- Urban Sewering (6.0 mgd)**	x	✓	✓	x	6.0 mgd	N/A	Gravity Sewers	✓	✓	✓	x	x	
4B		x	✓	✓	x			Gravity & LPS	✓	✓	x	✓	x	
4C		x	✓	✓	x			Cross Country	✓	✓	✓	x	✓	
5A	**1 Regional Treatment Plant–- Full Flow Sewering (8.5 mgd)**	x	✓	x	x	N/A	8.5 mgd	Gravity Sewers	✓	✓	✓	x	x	
5B		x	✓	x	x			Gravity & LPS	✓	✓	x	✓	x	
5C		x	✓	x	x			Cross Country	✓	✓	✓	x	✓	
6A	**Flow to Hilo WWTP–- Urban Sewering (11.0 mgd [1])**	x	✓	✓	x	6.0 mgd + 5.0 mgd	N/A	Gravity Sewers	✓	✓	✓	x	x	
6B		x	✓	✓	x			Gravity & LPS	✓	✓	x	✓	x	
6C		x	✓	✓	x			Cross Country	✓	✓	✓	x	✓	
7A	**Flow to Hilo WWTP–- Full Flow Sewering (13.5 mgd [2])**	x	✓	x	x	N/A	8.5 mgd + 5.0 mgd	Gravity Sewers	✓	✓	✓	x	x	
7B		x	✓	x	x			Gravity & LPS	✓	✓	x	✓	x	
7C		x	✓	x	x			Cross Country	✓	✓	✓	x	✓	

[1]Total flow to Hilo WWTP is 11.0 mgd. Flow from Puna is 6.0 mgd. Current design capacity of Hilo WWTP is 5.0 mgd.
[2]Total flow to Hilo WWTP is 13.5 mgd. Flow from Puna is 8.5 mgd. Current design capacity of Hilo WWTP is 5.0 mgd.
[3]Intent of the Gravity & LPS option is to use LPS systems to replace neighborhood PSs and associated branch sewers and force mains.
[4]Intent of the New ROW or Easement sewer option is to install gravity sewers in easements to replace a considerable amount of neighborhood PSs (regional PSs as well in some situations) and associated force mains.

6.1 Collection System

For the alternatives using decentralized treatment, use of LPS was evaluated. For the alternatives involving centralized systems, three different collection system methods were evaluated: conventional gravity sewers in existing roads, gravity sewers in combination with LPS in certain areas, and gravity sewers in new rights-of-way (easements) in certain areas.

6.1.1 Conventional Gravity Sewers in Existing Roads

Conventional gravity wastewater collection systems are the most popular method to collect and convey wastewater. Pipes are installed on a slope, allowing wastewater to flow by gravity from a house to the treatment facility.

Typically, 4-inch and 6-inch on-lot laterals collect wastewater from each lot and connect to a branch sewer in the road. The largest sewer size that allows for lateral connection is 16-inch based on CCH Wastewater Design Standards (there are currently no COH wastewater design standards). Manholes will be installed at all changes in pipe grade, size, or alignment, and at all points where sewer mains intersect for maintenance purposes. The branch sewer mains flow to a larger trunk sewer or interceptor sewer that will transport wastewater to a central WWTP.

Gravity sewers will be installed by open cut method with a maximum depth of approximately 25 to 30 ft. At this depth in the project area, majority of trench excavation work will be in bedrock. According to the Keaʻau Village Master Plan, backhoe trench excavation investigation at 10 locations in the Keaʻau area indicated that bedrock was found generally to be approximately 3 ft below surface [15]. Where the rolling terrain does not allow for gravity sewer installation, “regional WWPSs” are proposed (Section 6.1.4). If some streets or a small neighborhood are located at lower elevations that prevent wastewater flow by gravity to the trunk sewer, “neighborhood WWPSs” could be used to pump wastewater from the neighborhood to the trunk sewer (Section 6.1.4).

6.1.2 Gravity Sewers and Low Pressure Sewers

If using conventional gravity sewers, neighborhood WWPSs are proposed for small neighborhoods or selected streets that are located at lower elevations that prevent wastewater flow by gravity to the trunk sewer. A potential solution to address these circumstances is the use of LPS.

LPS uses small diameter force main pipelines, usually constructed of plastic or polyethylene material, which are shallowly buried, and laid in a manner following the surface terrain. LPS diameters range from 1.5 inch to 4 inches, where the smaller diameter lines join at main junctures. The piping network can extend for many thousands of feet at a total dynamic pumping head of up to 185 feet.

Each home uses a small pump, either a septic tank effluent pump (STEP) or a grinder pump, in an underground vault to discharge sewage to the main line. Existing septic tanks that are in good condition can be converted to connect to LPS by adding a STEP. If existing septic tanks are not in good condition or if the home does not have an existing septic tank, a new septic tank with an effluent pump could be an option. One benefit of the STEP system is to convey only liquid wastewater to LPS pipes and the receiving WWTP. Solids will remain in the septic tank, to be pumped out when needed. Another benefit of the STEP system is that the LPS system using STEP might provide a higher hydraulic capacity, since flow velocities in LPS pipes could be less than the required scouring velocity of 2 ft/s for solids containing wastewater.

Another type of a LPS system pump is the grinder pump, which will reduce all forms of sanitary waste to a slurry and pump it to the LPS pipes and WWTP. In this option, typical maintenance is required for the pumps and pump basins, but no septic tank and solids will need to be maintained by the homeowner. The grinder pump could be a centrifugal type or semi-positive displacement, progressing cavity type. The progressing cavity grinder pump would provide a more predictable flow over a wide range of typical system pressures. Due to rolling terrain in the project area, the LPS system might operate under negative TDH, and combination air/vacuum release valves would be needed.

6.1.3 Cross-Country Sewers (in New Easements)

To reduce the number of WWPSs, especially neighborhood ones, gravity sewers could be installed along easements. This could be in a new right-of-way behind or next to a row or set of houses located downhill from a trunk sewer. The gravity sewer in the easement could join another gravity sewer that flows to a trunk sewer, or it could discharge to a single WWPS. This would involve coordination with landowners to approve COH to establish easements for installing and maintaining the associated sewer lines.

6.1.4 Neighborhood and Regional WWPSs

If a smaller neighborhood is located downhill from the trunk sewer, then neighborhood WWPSs could be used to pump the wastewater uphill. Neighborhood WWPSs would be submersible with outdoor electrical controls in weatherproof enclosures, 2 constant speed pumps (1 duty + 1 standby), small self-enclosed standby generator, and odor control.

If a larger area was subject to undulating terrain, a regional WWPS could be used. Regional WWPSs are6-5roject6-5l/drywell configuration with electrical/control building with indoor standby generator, 3 variable speed pumps (2 duty + 1 standby) and odor control.

All WWPS would have security fencing and perimeter landscaping to match the surrounding properties.

6.2 TREATMENT SYSTEM

The different options for wastewater treatment consist of IWS, decentralized, and centralized systems.

6.2.1 IWS

IWS are regulated by HAR 11-62 Subchapter 3. Requirements include that the total wastewater flow for an IWS shall not exceed 1,000 gallons and each IWS should have at least 10,000 feet of land area. The following sections describe the IWS treatment and disposal systems that are listed in HAR.

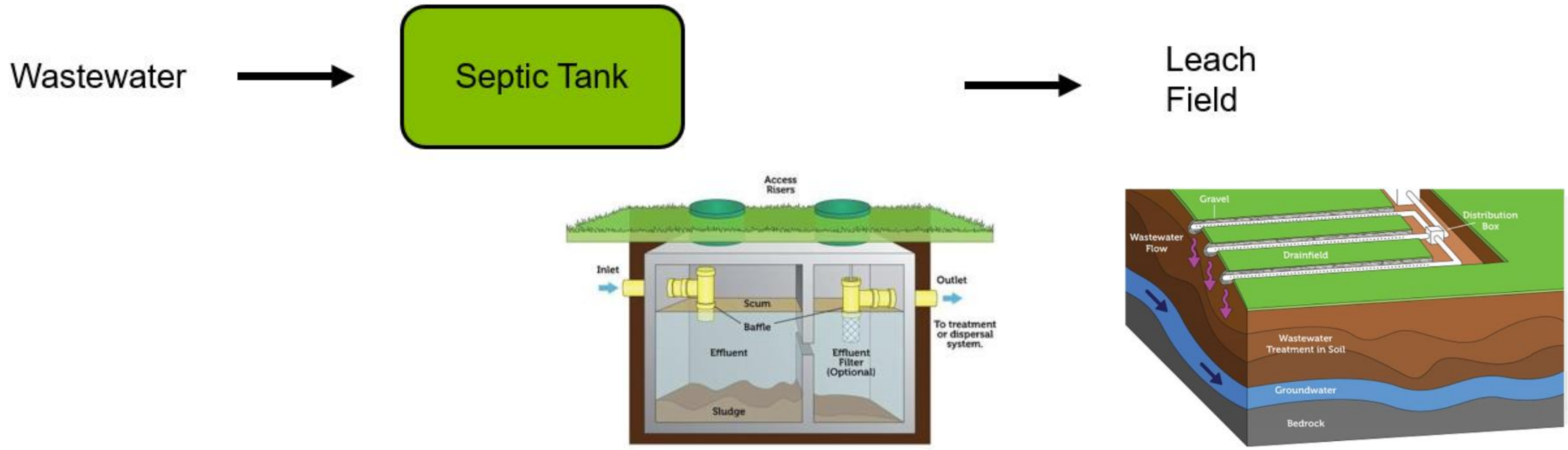
6.2.1.1 SEPTIC TANK AND LEACH FIELD

Septic tanks and leach fields are now fairly common in Hawaiʻi. A septic tank is a holding tank manufactured of polyethylene plastic, fiberglass reinforced plastic, or pre-cast reinforced concrete. Its primary function is to provide adequate holding time for the separation of suspended solids and floatable matter from the wastewater. Diagram 6-1 shows a flow schematic of a septic tank and leach field system [16] [17].

Wastewater flows through the septic tank by gravity. The tank employs no mechanical parts. Some anaerobic bacterial decomposition of the settled sludge occurs in the tank, converting organic wastes to gases over time and reducing the solids volume. Septic tanks may be designed with one or two compartments. In either design, the separated liquid is drawn off in the zone between the floating scum and the settled sludge layers.

Biological treatment of the clarified effluent from the septic tank principally occurs during disposal in the leach field. Nutrients in the wastewater promote the formation of a biological growth mat (biomat) which accounts for most of the nitrogen reduction within the leach field.

Maintenance checks must be made regularly to determine when the floatables and sludge in the septic tanks need to be pumped out to prevent excessive buildup. Such buildup causes scum and sludge to escape to the leach field and plug the pipe openings leading to the leach field.



Source: EPA **[18]**

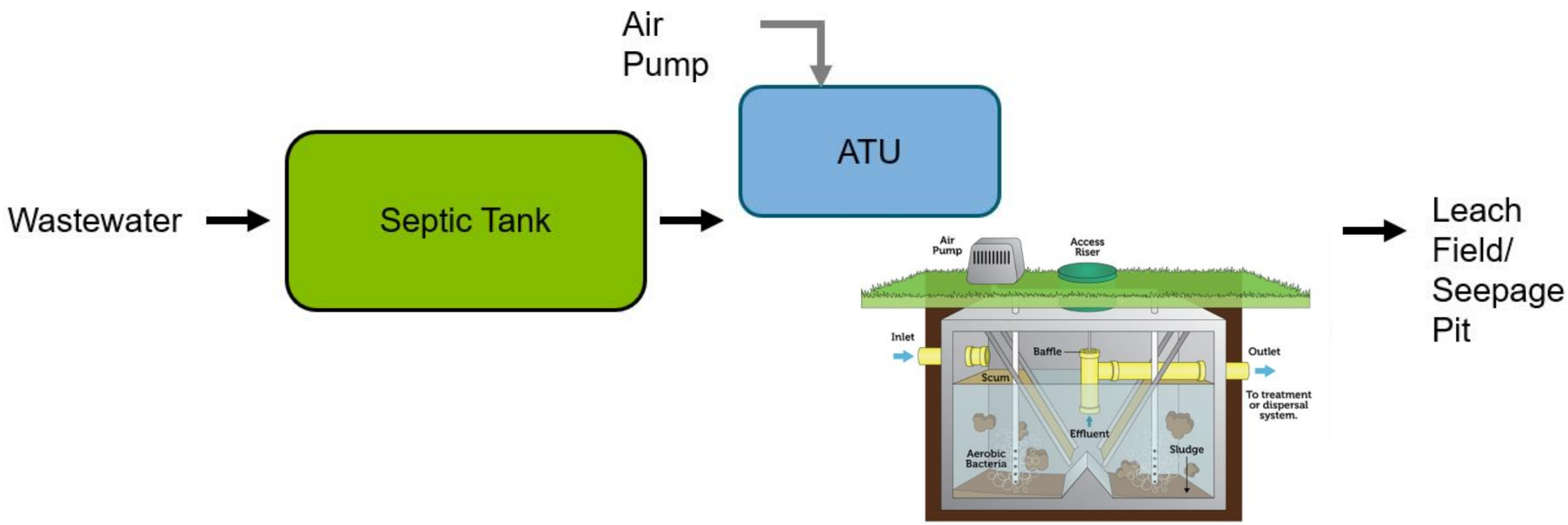
Diagram 6-1 Septic Tank and Leach Field

6.2.1.2 Aerobic Treatment Unit and Leach Field

Aerobic treatment units (ATUs) come in a variety of forms. The basic design consists of a single tank that is separated into chambers to permit entering wastewater to be treated in special stages (Diagram 6-2 [19]). The initial chamber is a settling compartment for the removal of heavy solids and floatable matter. The wastewater then flows to a second chamber, where it undergoes aerobic biological decomposition, typically with air pumped in from an external source. ATUs generally use a flow-through design with no moving parts, except for an external air pump to supply oxygen to a submerged aerator to sustain biological treatment.

Packaged ATUs achieve a high degree of wastewater treatment and can be customized with add-on treatment chambers for enhanced nutrient removal or for filtration of particles. Additionally, after biological treatment, calcium hypochlorite tablets may be stacked in a partially submerged capsule to impart chlorine disinfection of the effluent prior to seepage pit disposal.

An ATU operates effectively as long as the tank is aerated to promote biological degradation of organic matter. Buildup of biological solids occurs at a slower pace than in septic systems due to sustained decay of bacterial matter itself in an aerobic environment. Sludge pumping schedules are typically longer than two years.

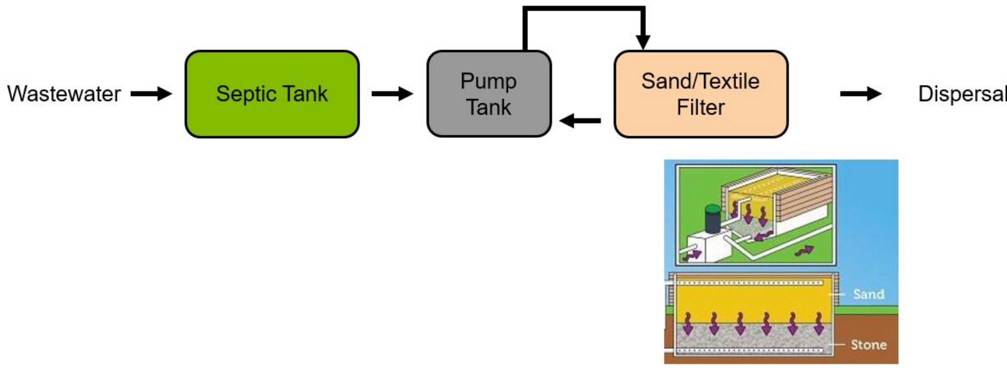


Source: EPA **[18]**

Diagram 6-2 ATU System

6.2.1.3 Subsurface and Recirculating Sand Filters

Subsurface and recirculating sand filters are listed in the HAR to be reviewed by HDOH on a case-by-case basis. A recirculating filter is a treatment technology in which septic tank effluent percolates through a bed of sand or textile material, undergoing further biological treatment. Carbon oxidation, nitrification, and denitrification can all occur. A portion of the percolated water is pumped back to the pump chamber or the treatment process, and another portion passes on to a dispersal system, such as drip irrigation or a seepage pit. The nitrate in the recirculated water undergoes denitrification under anaerobic conditions. See Diagram 6-3 for an illustration of recirculating filters.



Source: EPA **[18]**

Diagram 6-3 Recirculating Sand Filter

6.2.1.4 Alternative Toilets and Innovative Treatment and Disposal Options

Alternative toilets including composting toilets and incinerator toilets were developed for use in locations where water or electricity is scarce. In Hawaiʻi, household gray water (not from toilets and kitchen sinks) must have an overflow pathway to a wastewater treatment and disposal system in accordance with HDOH gray water reuse guidelines [20]. Therefore, if an alternate toilet is installed, it must be in combination with a wastewater and disposal treatment unit. Diagram 6-4 shows a flow schematic of the components that must be installed for an alternative toilet system. The HAR states that HDOH shall review composting toilets and incinerator toilets. For other emerging technologies in the research phase or undergoing pilot testing, such as nano membrane toilets (“Gates toilet”), they are also reviewed and approved by the HDOH director on a case-by-case basis.

HAR 11-62-35 states that innovative wastewater systems may be approved if:

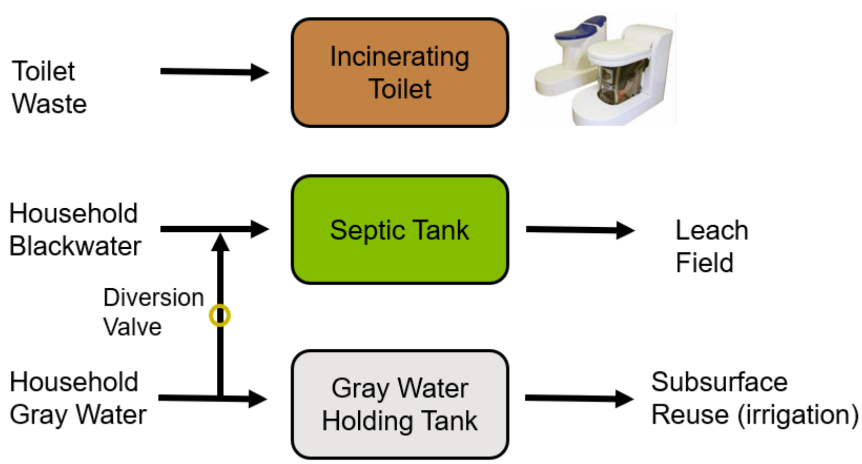
1. The innovative design provides or may benefit the people of the State.

2. The owner of the innovative system shall agree that for up to twelve months after the initiation of the operation of the creative design, operational data shall be gathered and submitted to the director.

3. The owner shall submit a written agreement stating that if the director finds the operation of the innovative system unsatisfactory at any time, the owner shall promptly repair or modify the system or replace it with another acceptable system.

In general, HDOH will base the approval on appropriate testing standards by the National Sanitation Foundation (NSF). NSF 40 and NSF 245 are the most accepted standards for IWS. HDOH also recognizes testing done by the University of Hawaiʻi at Mānoa when using NSF protocols for certification of acceptance in Hawaiʻi.

However, the NSF only certifies commercial products by specific manufacturers. The wastewater system must have a standardized pre-engineered product commercially available for purchase by a company that can legally do business. NSF does not certify technologies that can't be commercially sold. Rather, these technologies would need to have design criteria in HAR 11-62 to be used in Hawaiʻi or continue to be evaluated according to HAR 11-62-35.



Source: Incinerating Toilets, Inc. **[21]**

Diagram 6-4 Alternative Toilet System

6.2.2 Decentralized Treatment System

Per HAR regulation, if total development of an area exceeds 50 single family dwelling units or if flow exceeds 15,000 gallons per day for buildings other than dwellings, an IWS may not be used. In these situations, decentralized cluster packaged treatment units would be an option.

Available cluster wastewater treatment technologies include extended aeration activated sludge, membrane bioreactors (MBRs), attached growth bioreactors, moving bed bioreactors (MBBRs), and other package treatment plants. These treatment technologies are available in pre-engineered, self-contained treatment units of various specific treatment capacities. Installation generally would involve pouring of a concrete pad for the system, bringing in power supply, influent and effluent piping and disposal system, and possibly seeding with a source of bacteria. The system would then be ready to start operations.

Available effluent disposal methods include leach fields for smaller flows or other methods (see Section 6.3.1) for larger flows. For solids handling at decentralized cluster systems, it may be more economical for biosolids to be hauled to an existing larger WWTP for further processing.

6.2.2.1 Extended Aeration Activated Sludge

This is a variation of the conventional activated sludge (CAS) process, but uses longer aeration time and longer sludge age to provide removal of biodegradable organic wastes under aerobic conditions without primary settling. The long aeration time means a larger aeration tank than CAS. The process has a high BOD removal efficiency and generates less sludge than CAS.

6.2.2.2 Sequencing Batch Reactor

Sequencing Batch Reactor (SBR) systems are designed for batch treatment of wastewater. An SBR is typically used for sewer systems that have a wide range of inflow and/or organic loadings. The SBR system requires limited operator attention. The SBR systems generally produce a stable, high quality effluent. SBR plants can be designed to be mechanically simple, flexible and easy to operable. The biochemistry in the SBR process is similar to the extended aeration AS process. Aeration, un-aerated mixing, settling, decanting effluent, and solids wasting are all accomplished within a single pair of tanks. While one tank is filling with wastewater and running through the un-aerated mixing, and aeration cycles the other tank is idle with no flow entering it while the solids settle, effluent is decanted, and the waste sludge is removed. At the end of the cycle the tanks alternate. After the waste sludge pumping cycle is completed, the influent valves switch to begin filling the tank that had been decanted, and the other tank that was in the react mode would be put into “idle” mode allowing the solids settle, the effluent to be decanted, and the waste sludge to be removed.

6.2.2.3 Membrane Bioreactor

Membrane Bioreactor (MBR) is an activated sludge process that uses membrane filtration instead of a secondary clarifier to separate mixed liquor from treated effluent. Fine screening is an essential pre-treatment step to protect the membranes from damaging debris and particles. Fine screens extend the membrane life, reduce operating costs, and guarantee a higher sludge quality. MBR systems nearly always have an anoxic tank and internal pumping of mixed liquor to facilitate nitrogen removal via denitrification. An MBR is a recommended process for water reuse applications, since the membranes provide a barrier to many pathogens. Better effluent quality does come with higher capital, operation, and energy costs, which may present hurdles to implementing MBR systems for cluster systems.

6.2.2.4 Aerated Lagoons

Aerated lagoons can be used to treat municipal and industrial wastewaters that are low (100 to 200 mg/L BOD5 and TSS concentration) to medium (200 to 300 mg/L BOD5 and TSS concentration) strength. Aerated lagoons require a relatively large amount of land compared to other alternatives. O&M requirements are typically less than those required for extended aeration AS, SBR, or MBR technologies considered for this report. Aerated lagoons typically include lining systems, inlet and outlet structures, hydraulic controls, aeration equipment, and aeration system anchorage/restraint cables. For secondary treatment applications effluent filters are suggested for effluent polishing to remove suspended solids/algae from the effluent as needed to meet HDOH effluent limits for BOD and TSS (typically 30 mg/L) .

6.2.2.5 Attached Growth Bioreactors

These take advantage of biological treatment by promoting biological mass to grow as a biofilm on the surface of a media or disk, as opposed to suspended flocculated biomass in an activated sludge process. The media should have a large surface area to volume ratio to support microbial growth and form biofilms. Some versions of the process eliminate secondary clarifiers, decreasing associated cost and space requirements.

6.2.2.6 Moving Bed Bioreactor

This process is a combination of activated sludge (suspended growth) and attached growth processes. It uses plastic floating media within an aeration basin to carry attached growth on biofilms. Pre-treated (settled) influent enters the aeration basin for treatment and may enter a second basin for further treatment (full nitrification). Fine-bubble aeration with high oxygen transfer efficiency is commonly used for mixing/suspension. In order to keep the carrier media in the tank, there is a strainer attached to the aeration basin effluent pipe. The aeration effluent, which contains sloughed biofilm and suspended solids, is conveyed either to a secondary settling tank or, more commonly, to a dissolved air flotation separator.

6.2.3 Centralized Treatment System

In a centralized treatment system, wastewater is collected by a network of sewer lines that discharge to a WWTP. The WWTP would consist of facilities and equipment for pretreatment (e.g., screens, grit chambers, and/or equalization basin), primary treatment (e.g., primary clarifiers), biological (secondary) treatment (e.g., activated sludge, SBR, MBR, attached growth process such as trickling filters, aerated lagoon, moving bed reactor etc.), and tertiary treatment (e.g., filtration, disinfection). Innovative and sustainable treatment options may also be available, such as algae-based wastewater treatment to produce algae for later use as fertilizer or biofuel.

The treated wastewater would continue to disposal (see Section 6.3.1 on disposal options). Solids would be processed (e.g., dewatering, thickening, and stabilization) (Section 6.2.3.1) and sent to disposal or reuse (Section 6.3.2). Odor control would be provided at all centralized WWTP (see Section 4.9.1) (e.g., chemical addition, air treatment such as activated carbon, chemical scrubbers, biofilters, biotrickling filters). A typical WWTP conceptual site layout is shown on Diagram 6-5.

6.2.3.1 SOLIDS HANDLING

Dewatering and Thickening

Dewatering and thickening is the process by which biosolids are condensed to produce a concentrated solids product and a relatively solids-free supernatant. Thickening of wastewater solids reduces the volume of residuals, improves operation, and reduces costs for subsequent storage, processing, transfer, end use or disposal. Thickening is often used before anaerobic digestion or lime stabilization to reduce capital costs of stabilization equipment. There are several different methods for thickening biosolids, including belt filter press, centrifugal thickening, gravity belt thickening, and heat drying.

Belt Filter Press: A belt filter dewaters by applying pressure to the biosolids to squeeze out the water. Biosolids sandwiched between two tensioned porous belts are passed over and under rollers of various diameters. Increased pressure is created as the belt passes over rollers which decrease in diameter. Belt filter presses can be used to dewater most biosolids generated at municipal WWTPs and are a common type of mechanical dewatering equipment. Using mechanical equipment to dewater solids may not be the most cost-effective alternative for WWTPs operating at less than about 4 mgd. In these situations, it may be less expensive to haul liquids to another facility, such as Hilo WWTP, for dewatering and processing or disposal rather than installing dewatering equipment [22].

Centrifuge Thickening and Dewatering: This is a high speed process that uses the force from rapid rotation of a cylindrical bowl to separate wastewater solids from liquid. Thickening before digestion or dewatering reduces the tankage needed for digestion and storage by removing water. Centrifugal thickening can be cost effective for small plants. WWTPs that must landfill wastewater solids may benefit from the use of a centrifuge [23].

Gravity Thickening: This uses the natural tendency of higher-density solids to settle out of liquid to concentrate the solids. Gravity thickeners consist of a circular tank (usually with a conical bottom) that is fitted with collectors or scrapers at the bottom. Primary and/or secondary solids are fed into the tank through a center well, which releases the solids at a low velocity near the surface of the tank. The solids settle to the bottom of the tank by gravity, and the scrapers slowly move the settled, thickened solids to a discharge pipe at the bottom of the tank. A v-notch weir located at the top of the tank allows the supernatant to return to a clarifier [24].

Heat Drying: In this process, heat from direct or indirect dryers is used to evaporate water from wastewater solids. A major advantage of heat drying versus other biosolids improvement methods is that heat drying is ideal for producing Class A biosolids (see Section 6.3.2 for the different classes of biosolids). Heat drying does require a substantial capital investment and a large amount of energy [25].

Stabilization

Wastewater solids need to be processed or stabilized before they can be beneficially used. Stabilization helps to minimize the potential for odor generation, destroys pathogens (disease causing organisms), and reduces the material's vector attraction potential. One method of stabilization is to add alkaline materials to raise the pH level to make conditions unfavorable for the growth of organisms (such as pathogens).

Alkaline stabilization can achieve the minimum requirements for both Class A and Class B biosolids (see Section 6.3.2 for the different classes of biosolids) with respect to pathogens, depending on the amount of alkaline material added and other processes employed. Generally, alkaline stabilization meets the Class B requirements when the pH of the mixture of wastewater solids and alkaline material is at 12 or above after 2 hours of contact. Class A requirements can be achieved when the pH of the mixture is maintained at or above 12 for at least 72 hours, with a temperature of 52°C maintained for at least 12 hours during this time.

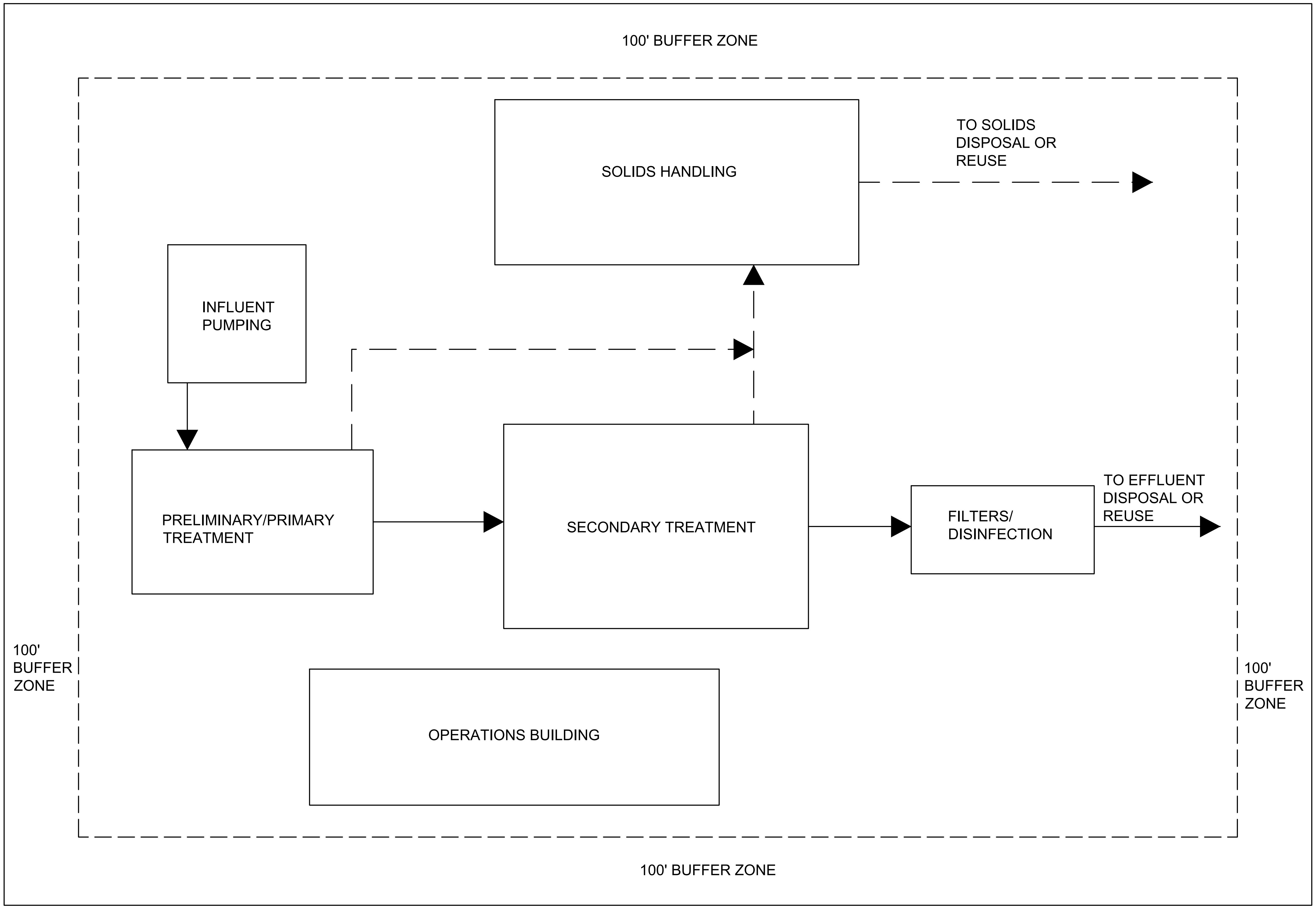
Where lime or another alkaline additive (for example, recycled kiln dust), is relatively inexpensive, alkaline stabilization is often the most cost-effective process for wastewater solids stabilization. Alkaline stabilization is also practical at small WWTPs that store wastewater solids for later transportation to larger facilities for further treatment [26].

Anaerobic Digestion

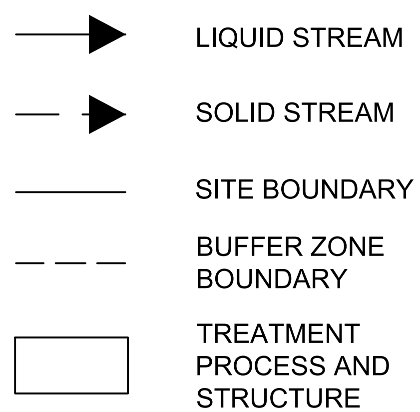
Anaerobic digestion is a naturally occurring biological process in which large numbers of anaerobic bacteria convert organic matter into methane and carbon dioxide (a mixture called biogas) in the absence of air. It is a widely used biological process for treating wastewater solids. This process stabilizes the organic matter in wastewater solids, reduces pathogens and odors, and reduces the total solids/sludge quantity by converting part of the volatile solids fraction to biogas. Anaerobic digestion results in a product that contains stabilized solids, as well as some available forms of nutrients such as ammonia-nitrogen [27].

Diagram 6-5

Conceptual Site Layout of WWTP



LEGEND



Notes:
Illustration not to scale.
See table to the right for estimated site area, including buffer zone.

Description	Approximate Size Area (acres)
Pahoa Subregional WWTP	5
HPP Subregional WWTP	15
Kea'au Subregional WWTP	5
Volcano Subregional WWTP	5
Regional WWTP (Kea'au)	20

6.3 Disposal or Reuse Options

In the IWS and decentralized system alternative, disposal would occur onsite (see Section 6.2.1).

After wastewater treatment in the centralized system alternatives, the effluent and solids would have to be disposed of or reused appropriately. The subsections below describe these different disposal or reuse options.

6.3.1 Effluent Disposal or Reuse

For a WWTP, available effluent disposal options include land application, water reuse, underground injection well, and surface water discharge. A meeting with HDOH Clean Water Branch (CWB) was conducted to discuss what disposal options are available for the Puna district. Primary methods that will be considered for effluent disposal are:

- Land Application
- Recycled Water
- Existing Ocean Outfall at Hilo WWTP

Disposal by injection wells/groundwater discharge is also possible and discussed below.

6.3.1.1 Land Application

Land application refers to an effluent disposal system in which treated wastewater is applied to land using infiltration basins. Infiltration is typically a shallow (about 6 feet deep) earthen depression with an inlet pipe and berm around its perimeter. Water disposal occurs by seepage, evaporation, and plant transpiration. During seepage, effluent undergoes further treatment as it percolates through the soil matrix to the groundwater. Wastewater that is applied to land generally must have passed through both primary and secondary treatment at a minimum.

There are other types of land application for effluent disposal, such as slow-rate land application. This can provide additional treatment in removing nutrients as wastewater effluent percolates through plant root zones and soil. However, land area requirements for slow-rate land application are significantly greater than infiltration basins.

For regulatory requirements on effluent limitations, see Section 2.2.2.

6.3.1.2 Recycled Water

There are three types of recycled water regulated by the HAR and HDOH: R-1, R-2, and R-3. For regulatory requirements on effluent limitations, see Section 2.2.1. It is important to keep in mind that water reuse is not considered a disposal method; therefore, a backup disposal system, such as land disposal, is required. Below is a list of suitable uses for recycled water that are potentially applicable to Puna:

- R-1 Water (oxidized, filtered, and disinfected effluent) is applicable to all landscape and agricultural irrigation; drinking water for livestock and poultry with the exception of dairy animals that produce milk for human consumption; supply to restricted recreational impoundments; dust control; washing aggregate and concrete manufacturing; and industrial processes and industrial cooling.

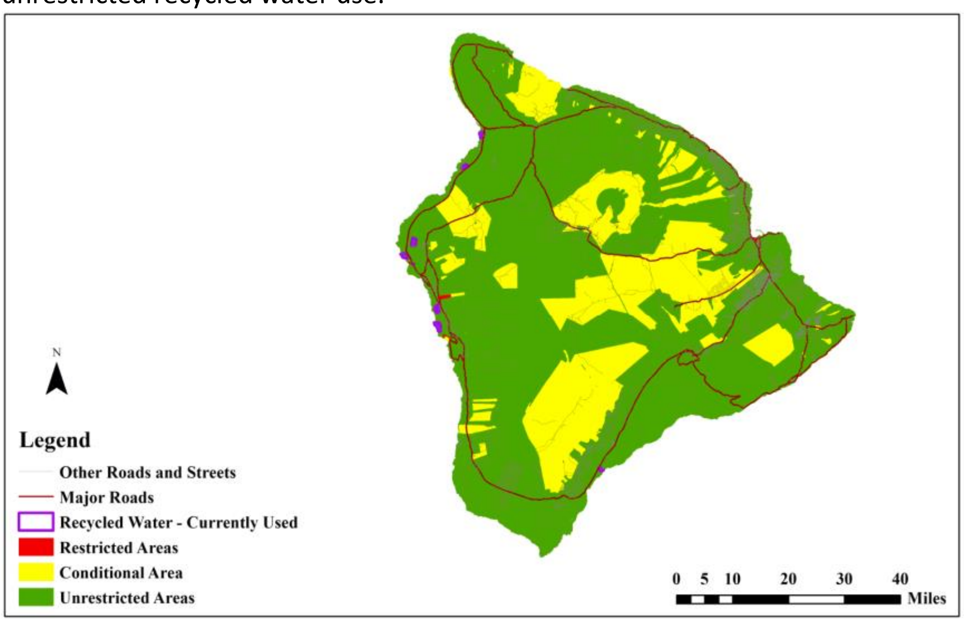
- R-2 Water (oxidized and disinfected effluent) is applicable to subsurface drip irrigation for golf course and landscaping, and surface drip or subsurface drip irrigation for non-edible vegetation in areas with limited public access.
- R-3 Water (oxidized wastewater effluent) is applicable to drip or subsurface drip irrigation for non-edible vegetation in areas with limited public access.

According to HDOH Reuse Guidelines, recycled water shall only be applied (e.g., sprayed) in approved areas. Three categories of areas are designated by the Reuse Guidelines:

- Unrestricted Areas: recycled water application is unconditionally allowed.
- Conditional Areas: recycled water application is currently allowed, but may, in the future, be subject to monitoring requirements or restrictions.
- Restricted Areas: recycled water application is prohibited.

Areas on Hawaiʻi designated for unrestricted, conditional and restricted use of recycled water are shown in Figure 6-1 **[28].**

The Puna project area includes areas regulated as either conditional or unrestricted for recycled use. The locations that are conditional for recycled use are forest reserves. Since these are protected natural resource areas with restrictions on access and activities, recycled water use would not be applicable. Elsewhere in the project area, locations are allowed unrestricted recycled water use.



Source: HDOH **[28]**

Figure 6-1 Recycled Water Use on the Island of Hawaiʻi

When considering water reuse for agricultural or landscaping irrigation, a soil water balance should be evaluated to prevent surface runoff from the applied recycled water. The fate of water that is added to the ground, either by rainfall or irrigation, is determined in a shallow layer of soil at the surface. The rainfall or irrigation water will either evaporate to the atmosphere through direct evaporation; be absorbed by plants and later transported to the atmosphere through transpiration; or percolate through soil and recharge the underlying groundwater aquifer. The remaining water will impact soil moisture or surface flow through runoff. The soil water balance can be summarized by the following equation:

Rainfall + Irrigation = Transpiration + Recharge + Change in Soil Moisture + Runoff

Mean annual rainfall and evapotranspiration for the Island of Hawaiʻi are shown in Figure 6-2 and Figure 6-3.

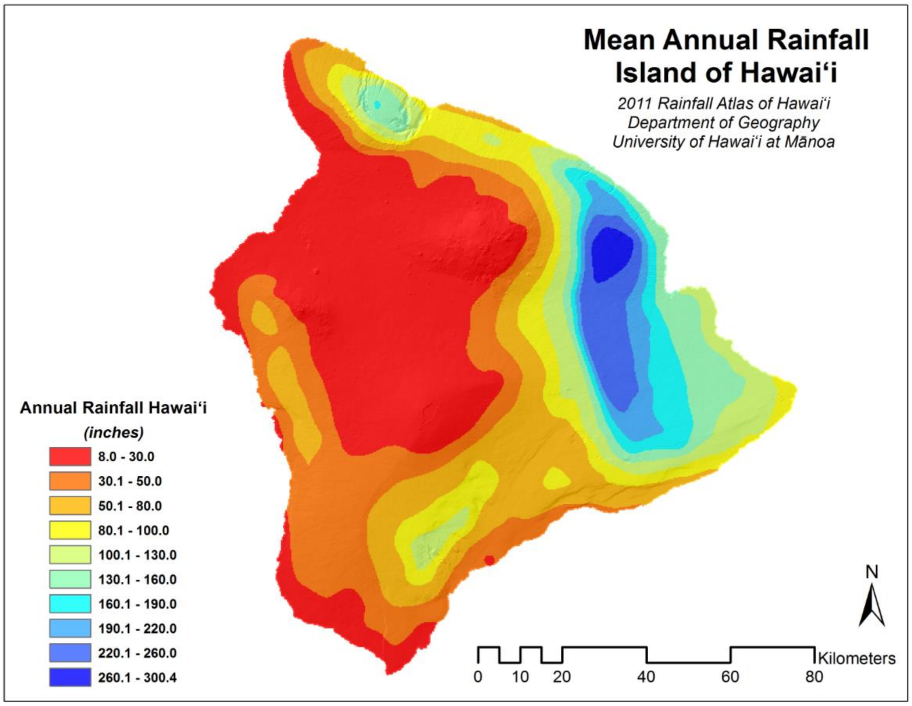


Figure 6-2 Mean Annual Rainfall for Island of Hawaiʻi

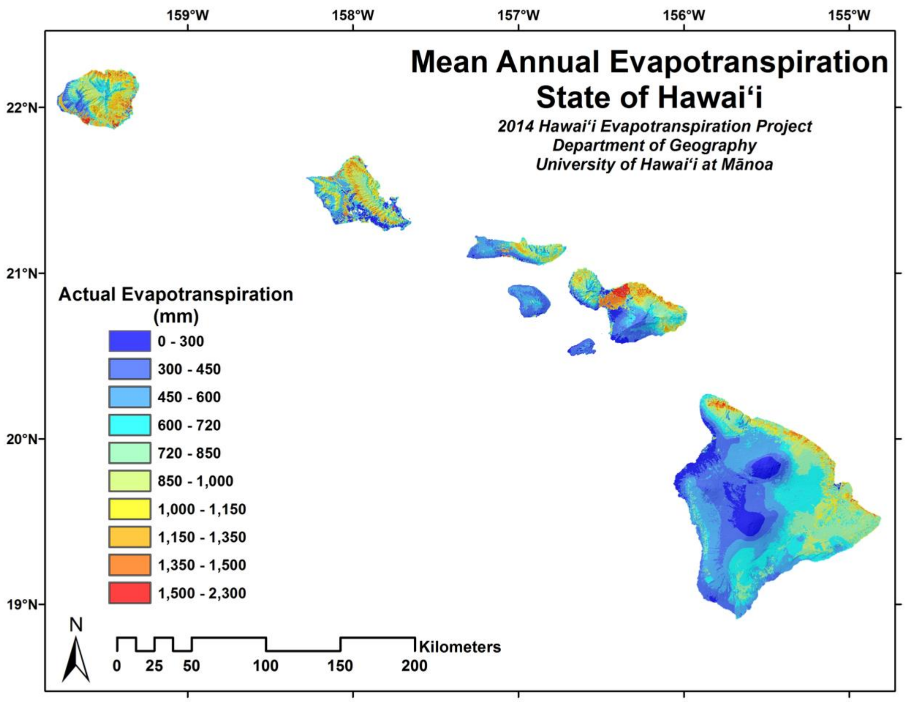


Figure 6-3 Mean Annual Evapotranspiration for State of Hawaiʻi

6.3.1.3 Ocean Outfall at Hilo WWTP

Discharge to state surface waters is regulated by the NPDES program under the federal CWA. For regulatory requirements on effluent limitations, see Section 2.2.3. In alternatives where Puna flows are sent to Hilo WWTP, effluent would be discharged through the existing ocean outfall at Hilo WWTP.

Surface water discharge within Puna is not an option, since there are no suitable surface water bodies in the project area to receive treated effluent. If routing to the coast for a new outfall, siting and permitting would be expensive and time-consuming. Moreover, HDOH recommends exhausting options for reuse or land application prior to considering other methods.

6.3.1.4 Injection Wells/Groundwater Discharge

Underground injection wells are used for injecting water or other fluids into a groundwater aquifer. HAR 11-23 regulates the location, construction, and operation of injection wells so that injected fluids do not migrate and pollute underground sources of drinking water. Section 4 of HAR 11-23 describes the criteria for classifying aquifers as those that are designated as underground sources of drinking water and those that are not. The boundary between exempted aquifers and underground sources of drinking water is generally referred to as the "UIC Line". Aquifers designated as sources of drinking water are above the UIC line and in areas not allowed to have underground injection wells. Additional regulatory information is provided in Section 2.2.4.

Figure 6-4 shows the UIC line for the Island of Hawaiʻi. Most of Puna is located mauka of the UIC line, which is approximately 1 mile inland. Therefore, the associated aquifer below Puna is considered a source of drinking water. Underground injection wells could technically be located near the coastal areas of HPP and Hawaiian Acres, but the proposed WWTPs are situated further inland in order to receive flow from other Puna neighborhoods. In addition, HDOH recommends exhausting options for reuse or other disposal methods before considering injection wells. Therefore, injection wells or groundwater discharge are unlikely to be applicable to the project area.

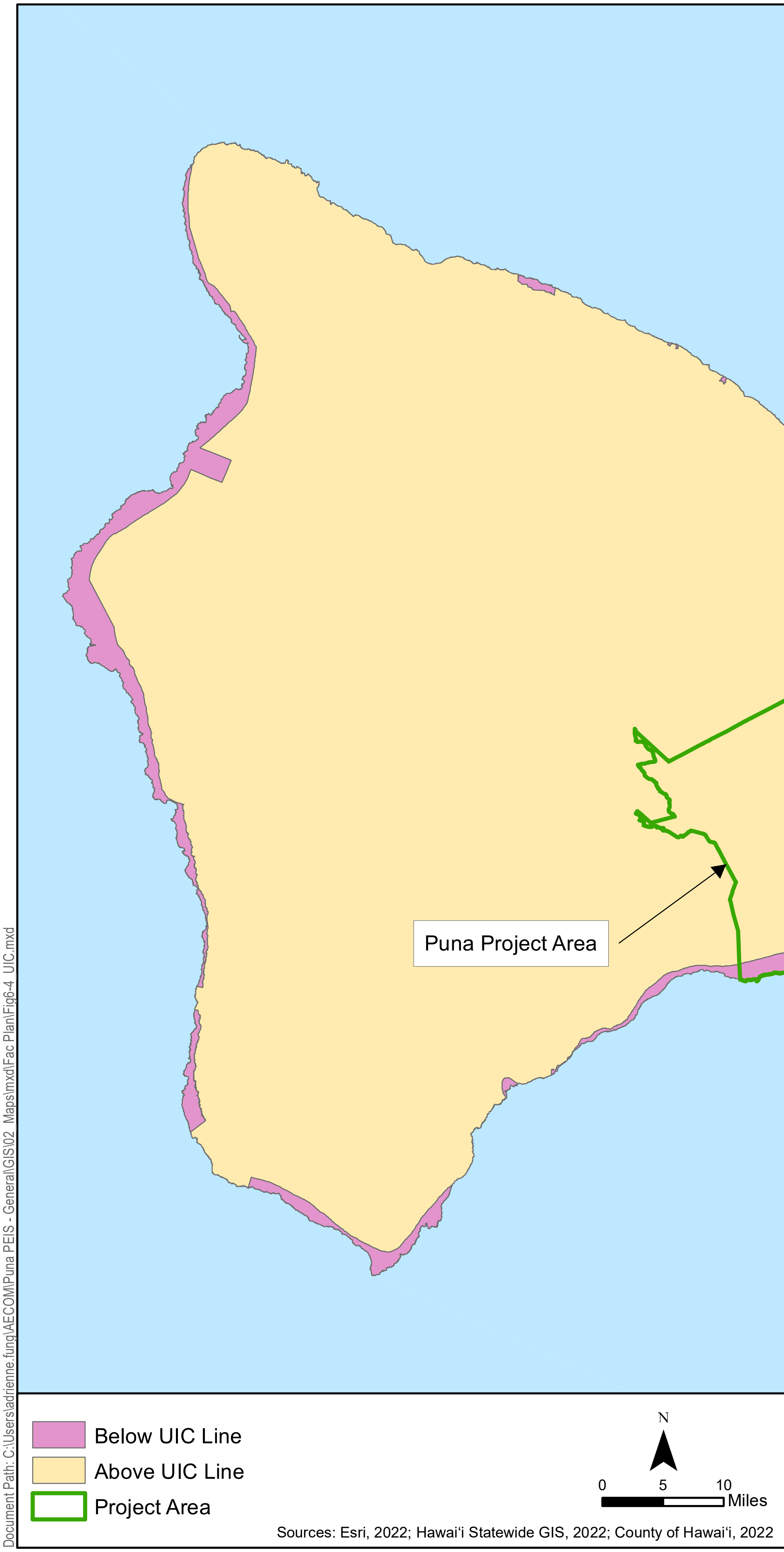


Figure 6-4
UIC Line for Hawai‘i County

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6.3.2 Solids Disposal or Reuse

Options for wastewater sludge disposal or reuse for the centralized system alternatives are discussed in this section. It may also be economical for biosolids to be hauled to another WWTP, such as Hilo WWTP, for further processing.

Processed biosolids can be either disposed of by landfill or reuse with land application of Class A or Class B biosolids.

EPA's 40 CFR Part 503, Standards for the Use and Disposal of Sewage Sludge, (the Part 503 Rule) defines two types of biosolids with respect to pathogen reduction: Class A (no detectable pathogens) and Class B (a reduced level of pathogens). Both classes are considered safe, but additional requirements are necessary with Class B biosolids. Class A biosolids are not subject to use restrictions and can generally be used like any commercial fertilizer [29].

Biosolids landfilling options include disposal in a6-23rojectl (a landfill that accepts only WWTP biosolids), or in a co-disposal landfill (a landfill that combines biosolids with municipal solid waste) [30].

If reused with land application, biosolids may be utilized in home gardening, commercial agriculture, silviculture, greenways, recreational areas and reclamation of drastically disturbed sites such as those subjected to surface mining [31]. Biosolids are often rich in nutrients such as nitrogen and phosphorus, and contain valuable micronutrients.

For centralized WWTPs, the facility plan assumes biosolids stabilization to meet Class B criteria, followed by thickening and dewatering. This will allow the material to be beneficially reused on restricted sites or disposed in a landfill. For decentralized WWTPs, cost estimates include thickening and hauling of sludge to the Hilo WWTP for stabilization and dewatering. Future upgrades or expansion at the Hilo WWTP may be needed to provide reliable and effective sludge treatment as decentralized WWTPs are developed and installed.

6.4 PROJECTED 2052 DESIGN AVERAGE FLOW

For the alternatives involving centralized systems, two different flow scenarios were used to size the collection system: urban sewering and full flow sewering.

6.4.1 Urban Sewering

As recommended in the Puna Project Definition Report, sewering is proposed for these zoning areas (Figure 6-5) [12]:

- Lot sizes 1 acre and smaller
- Institutional (schools, hospitals, etc.)
- Commercial
- Industrial

In the alternatives with urban sewering, sewer lines were conceptually routed to serve those areas listed above. There were also some additional locations included if they are populated, subdivided into smaller lots (even though the zone is larger than 1 acre), and close to an interceptor sewer or urban sewering zone. The later descriptions of the alternatives (Section 6.5) will include the estimated 2052 design average flows per subregion.

Due to their lower development density, the following zones are likely more appropriate for using IWS and are not included in urban sewering: national parks, forest reserve, community parks, and agricultural zoning 2 acres or larger.

6.4.2 Full Flow Sewering

In the full flow scenario, all Puna residences are assumed to connect to a sewer line. Therefore, there would be no IWS. In this situation, the zones mentioned above as excluded from “urban sewering” are included in “full flow sewering.” In this Puna Facility Plan, the interceptor sewers were sized to account for full flow. In regard to the collection system sewers, it is assumed that future developers would construct those as part of the new developments (in the light gray areas of Figure 6-5) and request connections to the COH sewer. Trunk and interceptor sewers along highways are included in this Facility Plan and will be constructed by COH.

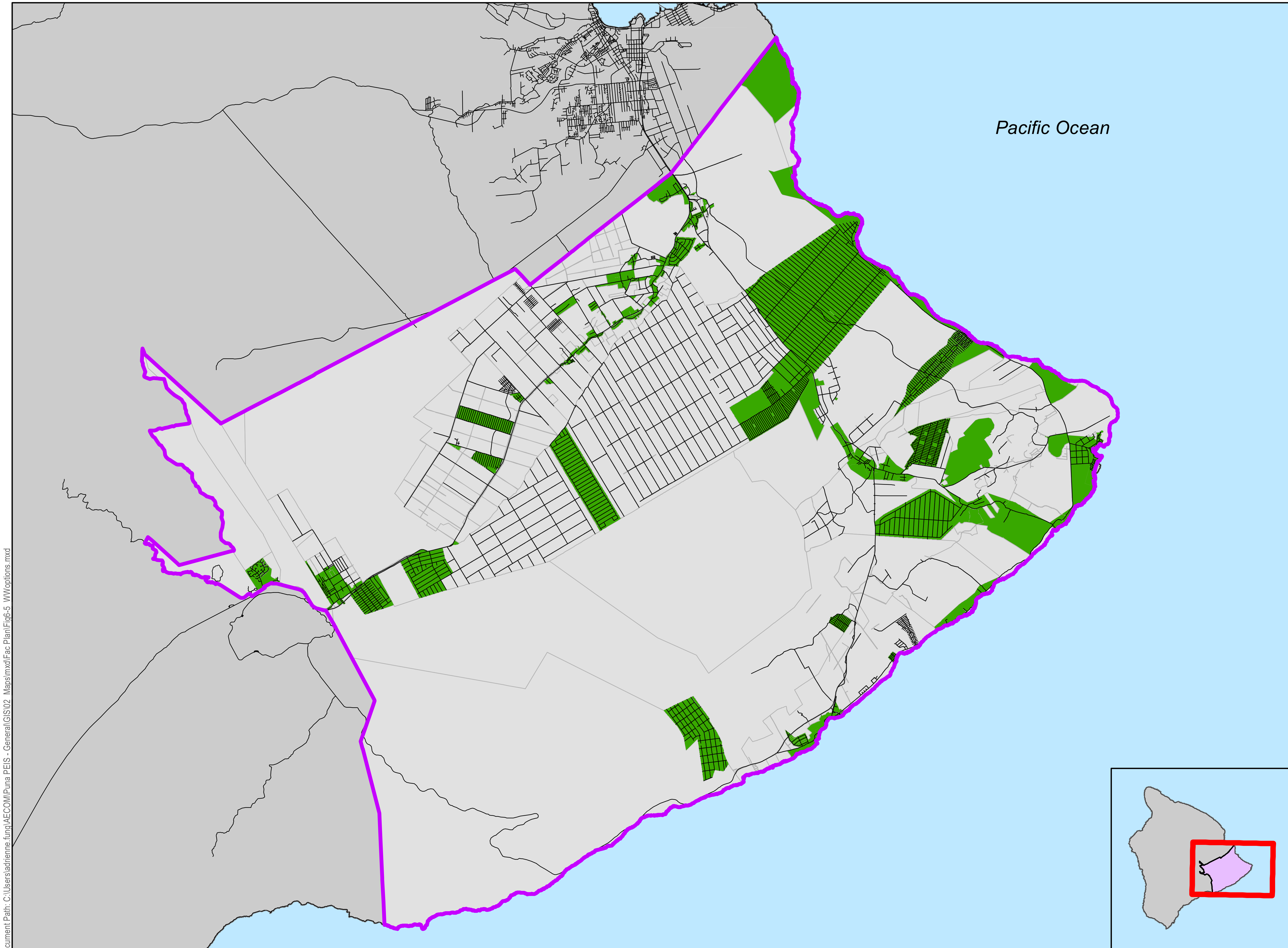

Figure 6-5

Proposed Wastewater Management Options

Project Area

Roads

Potential Wastewater Options

Potential Municipal Sewering

Onsite Wastewater Alternatives

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6.5 DESCRIPTIONS OF ALTERNATIVES

This section describes the different alternatives listed at the beginning of Section 6.0.

6.5.1 Alternative 1 – All IWS or Decentralized Systems

In this alternative, there would be no publicly owned wastewater collection, treatment, and disposal system (i.e., the "no project" alternative in Section 4.1). Wastewater generated within Puna would continue to be treated and disposed of through the current and future (cesspool conversions) onsite residential IWS and current and future decentralized clustered WWTPs. These decentralized package plants are based on existing and potential future locations of schools, hospitals, and malls; and commercial or industrial zoning.

There are 2 variations of Alternative 1: Alternatives 1A and 1B. In Alternative 1A (Figure 6-6), all residential lots will use IWS for on-site treatment and disposal and 22 decentralized package plants are proposed for commercial areas and schools. Alternative 1A can be considered as "no action" because there are no COH capital improvement projects. There are currently approximately 20,000 OSDS in Puna, 16,000 of which are Class IV (cesspools) (brown dots in Figure 6-6). Under this alternative, these Class IV OSDS would need to be decommissioned and converted to a HDOH-approved system (see HAR 11-62) by 2050 to comply with Acts 125 and 87. Current cesspools may or may not qualify for conversion to seepage pits, depending on HDOH approval. Requirements include justification to show that there is insufficient land space for a leach field, slopes exceeding 12%, or percolation rates slower than 60 minutes per inch.

To prevent cumulative impacts of cesspool conversions, the HAR 11-62 requirements should be followed. These include limiting IWS to no more than one per acre. If a development has a maximum of 50 dwellings, then each dwelling may have an IWS if there is at least 10,000 square feet of land area per dwelling lot. For an existing lot less than 10,000 square feet and created and recorded before August 30, 1991, one IWS is allowed per lot.

In the future, additional IWS or private decentralized treatment systems would be required to support population growth. It is anticipated that the number of additional IWS or decentralized treatment systems will increase proportional to the population growth. Therefore, in the future approximately 11,000 additional IWS or decentralized treatment systems would be needed, for a total of about 30,625 IWS (red dots in Figure 6-6).

In Alternative 1B (Figure 6-7), both LPS and decentralized treatment plants (package plants) are proposed across the project area. LPS collection systems are proposed to convey wastewater from residential and commercial properties to a total of 84 package plants with flows ranging from 15,000 gpd to 250,000 gpd. The HAR 11-62-31.1 sets 15,000 gpd as the threshold, below which, an IWS would be allowed. Above this flow, a package plant would be needed. The typical maximum flow for a package plant is approximately 250,000 gpd.

By using the LPS system, Alternative 1B avoids the need for neighborhood WWPSs and force mains, regional WWPSs and force mains, and large interceptor sewers between subregions communities and subregional WWTPs. However, the COH construction and maintenance requirements of the in-street low pressure pipes, valves and package treatment plants are expected to be more involved than conventional gravity sewers and pump stations. The benefit of Alternative 1B is that treated effluent will be higher quality compared to IWS disposal on each lot. Since the treated effluent from the package plants would be of higher quality than septic tank effluent it may be suitable for recycling/water reuse. LPSs are also more accommodating of lots that are too small for an IWS and can help mitigate negative cumulative impacts of cesspool conversions for the project area.

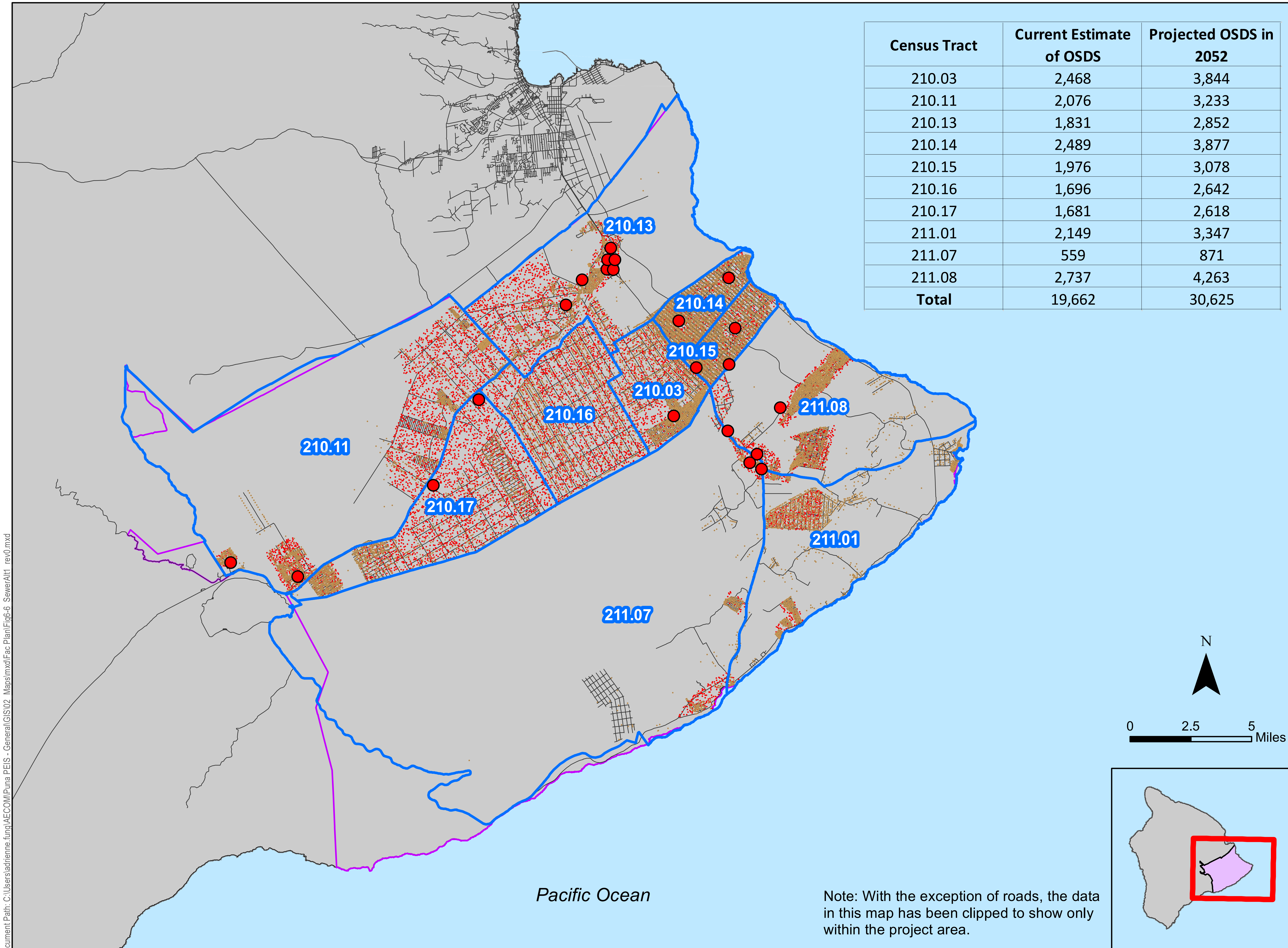
Table 6-2 shows the collection and treatment components for Alternatives 1A and 1B.

Table 6-2 Collection and Treatment System Comparison for Alternative 1

Alternative	Sewer Type	Length (ft)	Decentralized Treatment	
			# of IWS	# of Package Plant
1A	NA	NA	30,625	22
1B	LPS	3,175,000	NA	84

Figure 6-6

Alternative 1A: All IWS or Dentralized Systems



Census Tract	Current Estimate of OSDS	Projected OSDS in 2052
210.03	2,468	3,844
210.11	2,076	3,233
210.13	1,831	2,852
210.14	2,489	3,877
210.15	1,976	3,078
210.16	1,696	2,642
210.17	1,681	2,618
211.01	2,149	3,347
211.07	559	871
211.08	2,737	4,263
Total	19,662	30,625

Project Area
Roads
2020 Census Tract

Alternative 1

Existing OSDS
Potential Future OSDS
Potential Package Plant Location

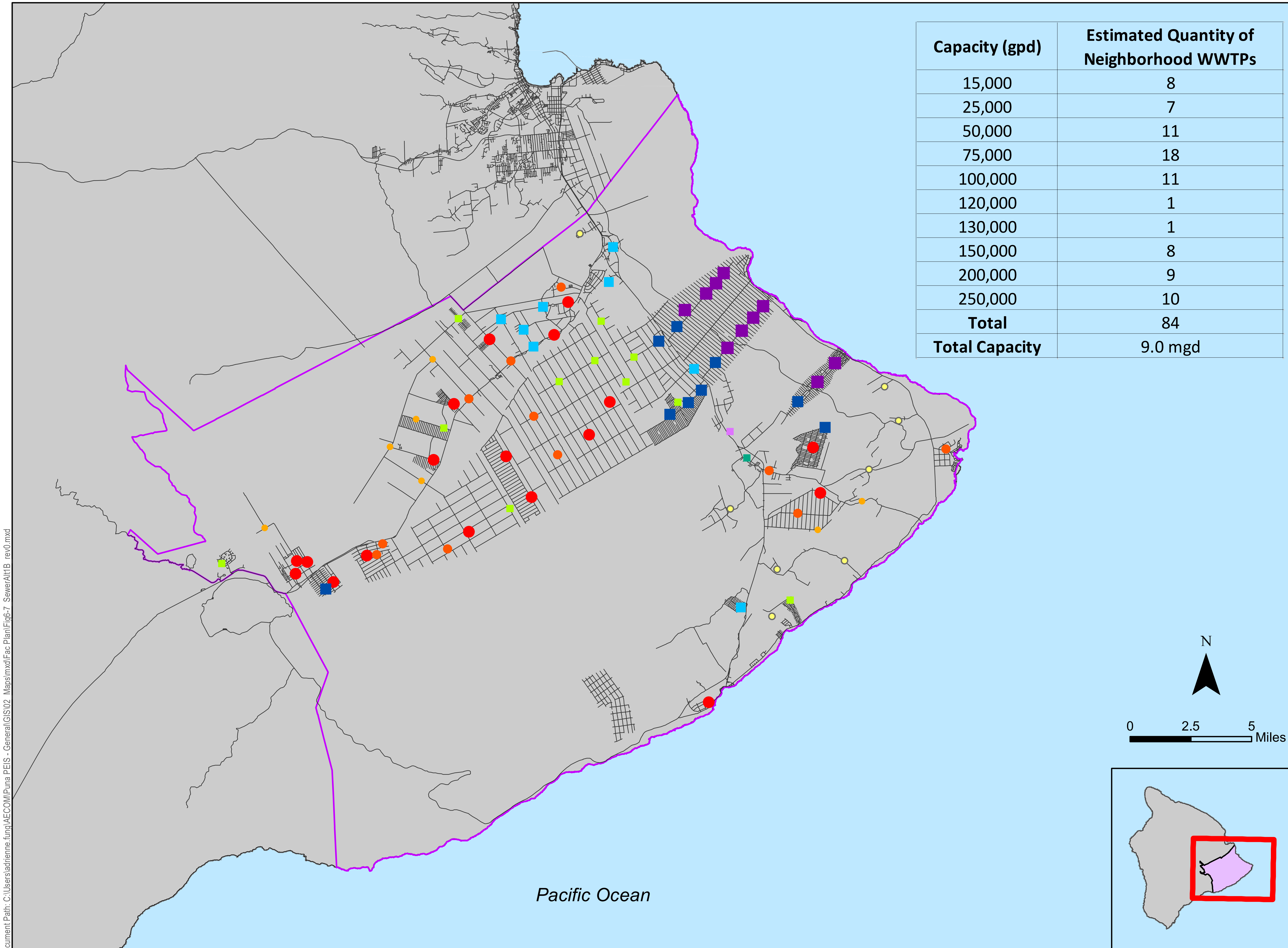
Map presents locations of existing OSDSs in brown.

See above table for 2052 projections of the potential increases in OSDSs.

OSDS: onsite sewage disposal system

Figure 6-7

Alternative 1B: Decentralized Package Plants and LPS



Capacity (gpd)	Estimated Quantity of Neighborhood WWTPs
15,000	8
25,000	7
50,000	11
75,000	18
100,000	11
120,000	1
130,000	1
150,000	8
200,000	9
250,000	10
Total	84
Total Capacity	9.0 mgd

Project Area
Roads

Potential Neighborhood WWTPs

Capacity (gpd)

- 15,000
- 25,000
- 50,000
- 75,000
- 100,000
- 120,000
- 130,000
- 150,000
- 200,000
- 250,000

Note: LPS would typically be installed primarily along neighborhood roadways, where properties will be sewered for the potential package WWTPs.

6.5.2 Alternative 2 – Four Subregional WWTPs with Urban Sewering

This alternative is based on having a sewer system and four subregional centralized WWTPs. These are proposed for the Volcano, Keaʻau, HPP, and Pāhoa areas. These four subregions would be sewered, while IWS will be used in remaining unsewered areas. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall subregional map is presented in Figure 6-8, with maps of individual areas in Appendix A.

The projected 2052 design average flow is based on urban sewering. The estimated flows per subregion are shown in Table 6-3, with a total of 6 mgd.

There are 3 variations of Alternative 2: "base" alternative 2A, 2B, and 2C. Under base Alternative 2A, the collection system would consist of conventional gravity sewers within existing roadways. Lengths of sewer for this scenario are shown in Table 6-3. Neighborhood and regional WWPSs are also proposed where potentially necessary due to land slope.

In Alternative 2B, LPS will be used to replace neighborhood WWPSs (Table 6-3). Approximately 400,000 feet of LPS could replace the 160 neighborhood WWPSs. The lengths of gravity sewers and force mains are also reduced using this method.

In Alternative 2C, cross-country sewers in new easements could help with reducing the number of neighborhood and regional WWPSs and associated force mains (Table 6-3). For the HPP WWTP service area, 46 neighborhood WWPSs are proposed for the HPP neighborhood in base Alternative 2. Most of these could be eliminated by 43,000 ft of gravity cross-country sewers. A significantly decreased number of neighborhood WWPSs is also observed for the Pāhoa subregion.

Table 6-3 Collection System Comparison for Alternative 2

Alternative	Sewer Type	Subregional WWTP			
		Volcano (0.65 mgd)	**Keaʻau** (0.93 mgd)	**HPP** (3.18 mgd)	**Pāhoa** (1.23 mgd)
2A	Gravity Sewer (ft)	274,967	472,101	924,256	554,726
	Force Main (ft)	39,579	48,586	200,719	151,113
	Neighborhood WWPS	28	32	46	54
	Regional WWPS	5	7	19	26
2B	Gravity Sewer (ft)	240,481	431,049	722,671	425,354
	LPS (ft)	34,485	41,052	201,585	129,372
	Force Main (ft)	11,500	20,694	78,420	66,211
	Neighborhood WWPS	0	0	0	0
	Regional WWPS	5	7	19	26
2C	Gravity Sewer (ft)	284,290	489,460	969,878	572,304
	Force Main (ft)	18,512	25,674	83,268	85,145
	Neighborhood WWPS	10	12	6	9
	Regional WWPS	3	3	17	26

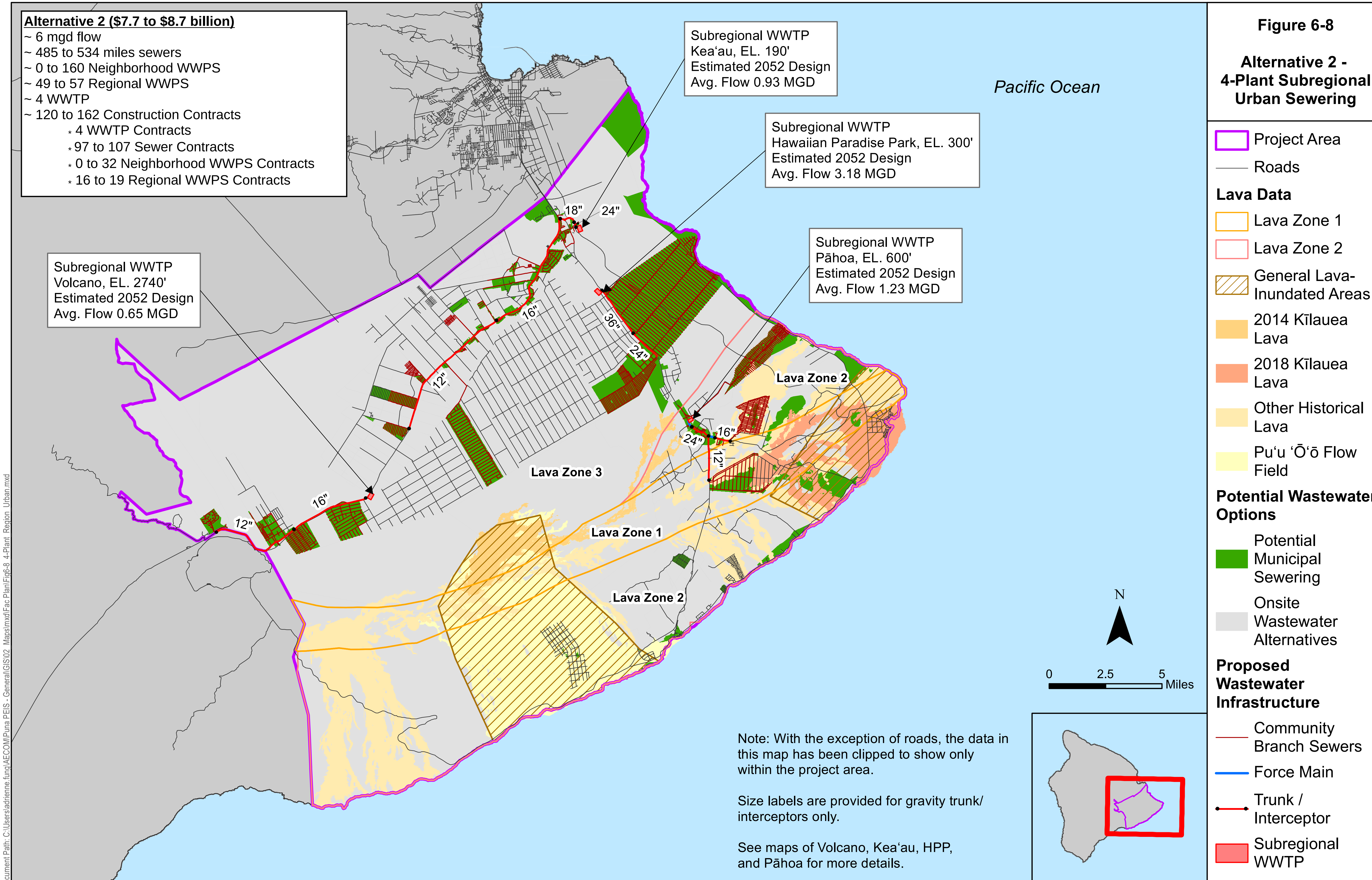


Figure 6-8

Alternative 2 - 4-Plant Subregional Urban Sewering

6.5.3 Alternative 3 – Three Subregional WWTPs with Urban Sewering

This alternative is based on having a sewer system and three subregional centralized WWTPs. These are proposed for the Volcano, Keaʻau, and HPP areas. This is similar to Alternative 2 with the four subregional plants, but with Pāhoa flows sent to the HPP WWTP. These three subregions (Pāhoa included in the HPP subregion) would be sewered, while IWS will be used in remaining unsewered areas. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall map is presented in Figure 6-9, with maps of individual areas in Appendix A.

The projected 2052 design average flow is based on urban sewering. The estimated flows per subregion are shown in Table 6-4, with a total of 6 mgd.

There are 3 variations of Alternative 3: "base" alternative 3A, 3B, and 3C. Under base Alternative 3, the collection system would consist of conventional gravity sewers within existing roadways. Lengths of sewer for this scenario are shown in Table 6-4. Neighborhood and regional WWPSs are also proposed where potentially necessary due to land slope.

In Alternative 3B, LPS will be used to replace neighborhood WWPSs (Table 6-4). Similar to Alternative 2B, approximately 400,000 feet of LPS could replace the 160 neighborhood WWPSs. Lengths of gravity sewers and force mains are also reduced using this method.

In Alternative 3C, cross-country sewers in new easements could help with reducing the number of neighborhood and regional WWPSs and associated force mains (Table 6-4). Similar to Alternative 2C, cross-country sewers can be used to eliminate most of the neighborhood WWPSs in the HPP neighborhood in base Alternative 3A. For example, in Hawaiian Beaches, 45 neighborhood WWPSs can be replaced by about 18,000 ft of cross-country sewers.

Table 6-4 Collection System Comparison for Alternative 3

Alternative	Sewer Type	Subregional WWTP		
		Volcano (0.65 mgd)	**Keaʻau** (0.93 mgd)	**HPP** (4.41 mgd)
3A	Gravity Sewer (ft)	274,967	472,101	1,478,982
	Force Main (ft)	39,579	48,586	351,832
	Neighborhood WWPS	28	32	100
	Regional WWPS	5	7	45
3B	Gravity Sewer (ft)	240,481	431,049	1,148,025
	LPS (ft)	34,485	41,052	330,957
	Force Main (ft)	11,500	20,694	144,631
	Neighborhood WWPS	0	0	0
	Regional WWPS	5	7	45
3C	Gravity Sewer (ft)	284,290	489,460	1,542,182
	Force Main (ft)	18,512	25,674	168,413
	Neighborhood WWPS	10	12	15
	Regional WWPS	3	3	43

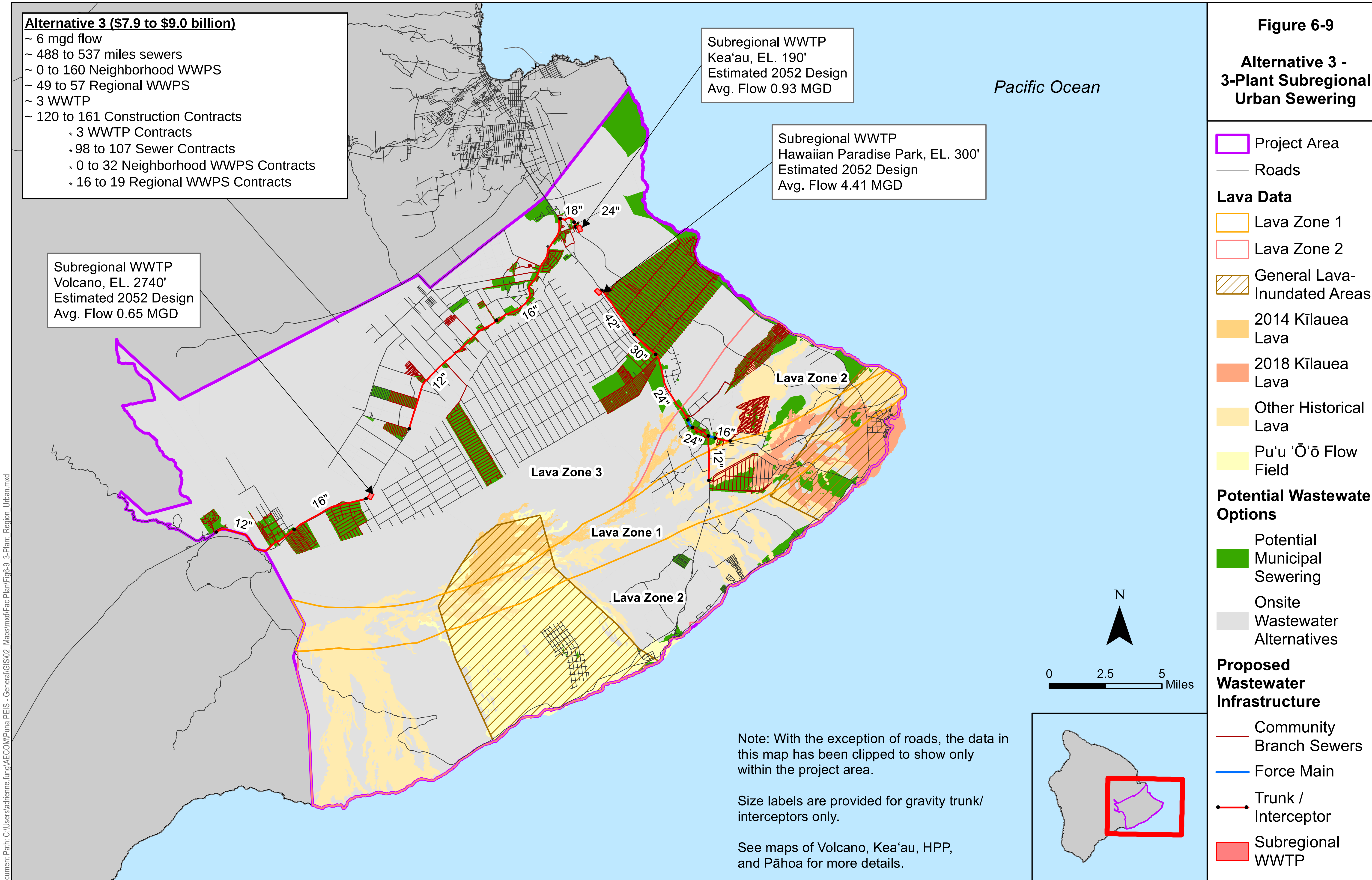


Figure 6-9

Alternative 3 - 3-Plant Subregional Urban Sewering

6.5.4 Alternative 4 – One Regional WWTP with Urban Sewering

This alternative is based on having a sewer system and one regional centralized WWTP in Keaʻau. This WWTP would receive flows from Volcano, HPP, and Pāhoa areas, which would be sewered, while IWS are used in remaining unsewered areas. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall map is presented in Figure 6-10, with maps of individual areas in Appendix A.

Th6-34rojectcted 2052 design average flow is based on urban sewering (Section 6.4.1). The estimated flows per subregion are shown in Table 6-5, with a total of 6 mgd.

There are 3 variations of Alternative 4: "base" alternative 4A, 4B, and 4C. Under base Alternative 4A, the collection system would consist of conventional gravity sewers within existing roadways. Lengths of sewer for this scenario are shown in Table 6-5. Neighborhood and regional WWPSs are also proposed where potentially necessary due to land slope.

In Alternative 4B, LPS will be used to replace neighborhood WWPSs (Table 6-5). Similar to Alternatives 2B and 3B, approximately 400,000 feet of LPS could replace the 160 neighborhood WWPSs. Lengths of gravity sewers and force mains are also reduced using this method.

In Alternative 4C, cross-country sewers in new easements could help with reducing the number of neighborhood and regional WWPSs (Table 6-5). Overall, about 100,000 ft of gravity cross-country sewers can be used to reduce the number of neighborhood WWPSs from 160 to 37 and regional WWPSs from 57 to 49, especially in the HPP and Pāhoa areas, as seen in Alternatives 2C and 3C. Due to a smaller number of WWPSs, the lengths of force mains are also considerably reduced from the base alternative 4A.

Table 6-5 Collection System Comparison for Alternative 4

Alternative	Sewer Type	Regional WWTP at Keaʻau (6 mgd)
4A	Gravity Sewer (ft)	2,226,050
	Force Main (ft)	439,997
	Neighborhood WWPS	160
	Regional WWPS	57
4B	Gravity Sewer (ft)	1,819,555
	LPS (ft)	406,494
	Force Main (ft)	176,825
	Neighborhood WWPS	0
	Regional WWPS	57
4C	Gravity Sewer (ft)	2,315,932
	Force Main (ft)	212,519
	Neighborhood WWPS	37
	Regional WWPS	49

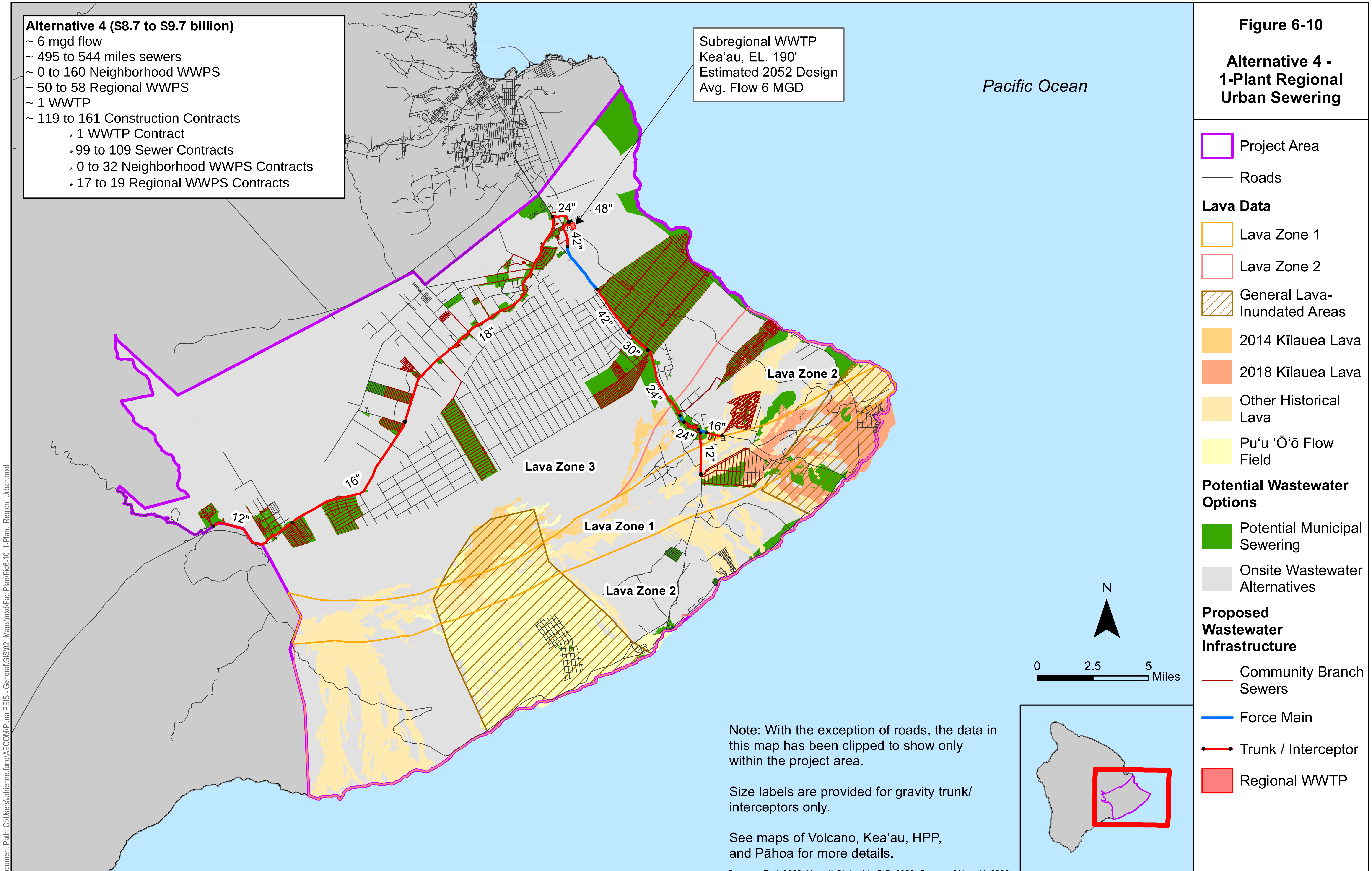


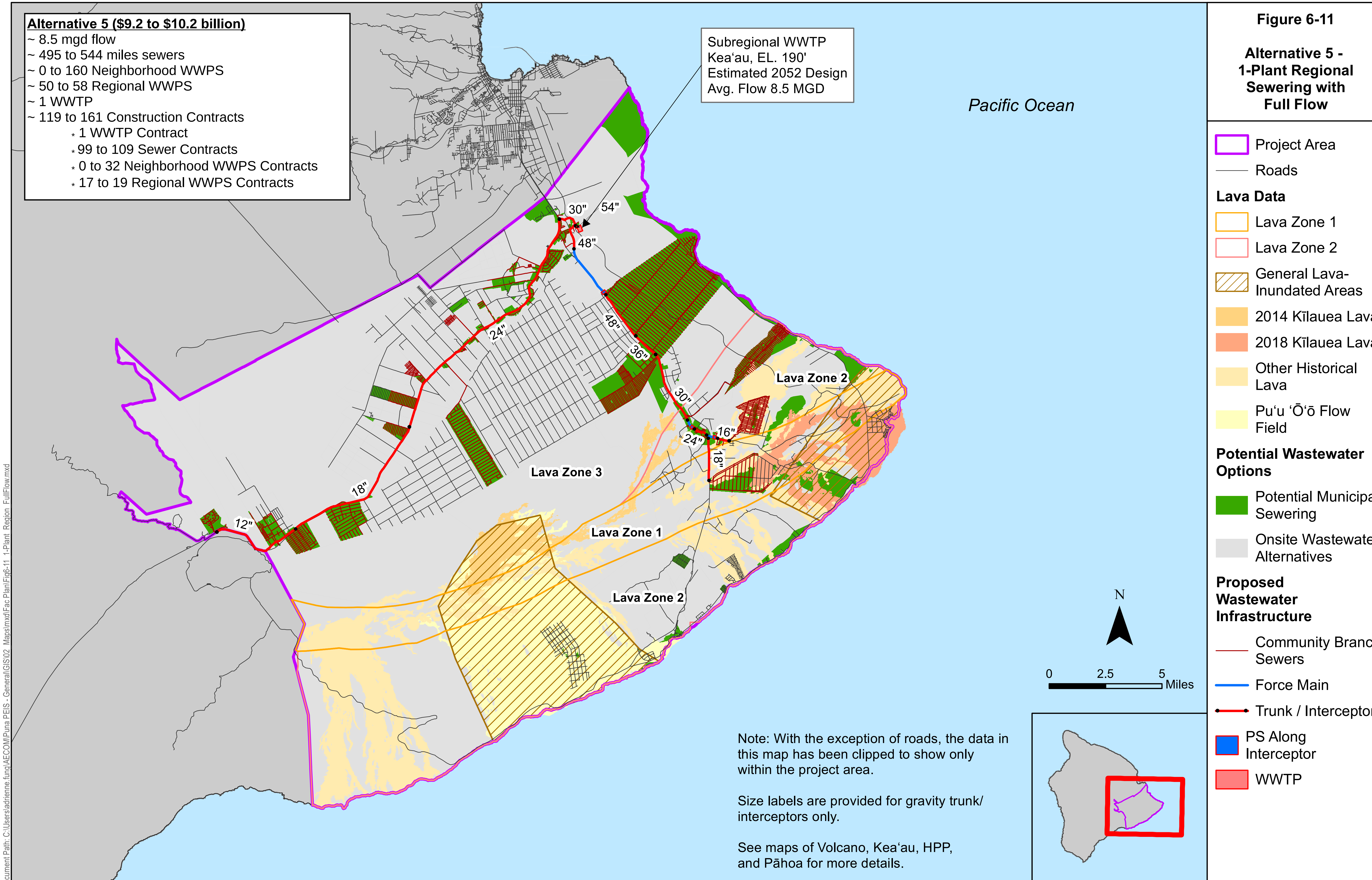
Figure 6-10
Alternative 4 - 1-Plant Regional Urban Sewering
Alternative 4 ($8.7 to $9.7 billion)
~ 6 mgd flow
~ 495 to 544 miles sewers
~ 0 to 160 Neighborhood WWPS
~ 50 to 58 Regional WWPS
~ 1 WWTP
~ 119 to 161 Construction Contracts
* 1 WWTP Contract
* 99 to 109 Sewer Contracts
* 0 to 32 Neighborhood WWPS Contracts
* 17 to 19 Regional WWPS Contracts
Subregional WWTP
Keaʻau, EL. 190'
Estimated 2052 Design
Avg. Flow 6 MGD
Pacific Ocean
24"
48"
42"
18"
42"
30"
24"
16"
24"
12"
16"
12"
Lava Zone 2
Lava Zone 3
Lava Zone 1
Lava Zone 2
N
0
2.5
5
Miles
Project Area
Roads
Lava Data
Lava Zone 1
Lava Zone 2
General Lava-Inundated Areas
2014 Kīlauea Lava
2018 Kīlauea Lava
Other Historical Lava
Puʻu ʻŌʻō Flow Field
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Wastewater Infrastructure
Community Branch Sewers
Force Main
Trunk / Interceptor
Regional WWTP
Note: With the exception of roads, the data in this map has been clipped to show only within the project area.
Size labels are provided for gravity trunk/interceptors only.
See maps of Volcano, Keaʻau, HPP, and Pāhoa for more details.
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022

6.5.5 Alternative 5 – One Regional WWTP with Full Flow Sewering

This alternative is similar to Alternative 4 with a sewer system and one regional WWTP at Keaʻau, but with the projected 2052 design average flow based on full flow, for a total of 8.5 mgd. The scenario is based on the urban sewering community collection system from Alternative 4, but with upsized interceptor sewers and increased WWTP capacity. The urban sewering collection system would cover the majority of the flow, and the upsized interceptor sewers and increased WWTP capacity would accommodate the full flow. In this scenario, there would be no IWS, and each residential or commercial unit would be connected to the sewer. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall map is presented in Figure 6-11, with maps of individual areas in Appendix A.

There are 3 variations of Alternative 5: "base" alternative 5A, 5B, and 5C. Under base Alternative 5A, the collection system would consist of conventional gravity sewers within existing roadways. Neighborhood and regional WWPSs (Table 6-5 plus additional ones to serve areas outside the "urban sewering" zones and future development) are also needed depending on land slope.

In Alternative 5B, LPS will be used to reduce the number of neighborhood WWPSs and associated force mains. In Alternative 5C, cross-country sewers in new easements will lower the number of neighborhood and regional WWPSs and associated force mains.



Alternative 5 ($9.2 to $10.2 billion)
~ 8.5 mgd flow
~ 495 to 544 miles sewers
~ 0 to 160 Neighborhood WWPS
~ 50 to 58 Regional WWPS
~ 1 WWTP
~ 119 to 161 Construction Contracts
* 1 WWTP Contract
* 99 to 109 Sewer Contracts
* 0 to 32 Neighborhood WWPS Contracts
* 17 to 19 Regional WWPS Contracts
Subregional WWTP
Keaʻau, EL. 190'
Estimated 2052 Design
Avg. Flow 8.5 MGD
Pacific Ocean
30"
54"
48"
24"
48"
36"
30"
16"
24"
18"
18"
12"
Lava Zone 2
Lava Zone 3
Lava Zone 1
Lava Zone 2
N
0
2.5
5
Miles
Note: With the exception of roads, the data in this map has been clipped to show only within the project area.
Size labels are provided for gravity trunk/interceptors only.
See maps of Volcano, Keaʻau, HPP, and Pāhoa for more details.
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022
Figure 6-11
Alternative 5 - 1-Plant Regional Sewering with Full Flow
Project Area
Roads
Lava Data
Lava Zone 1
Lava Zone 2
General Lava-Inundated Areas
2014 Kīlauea Lava
2018 Kīlauea Lava
Other Historical Lava
Puʻu ʻŌʻō Flow Field
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Wastewater Infrastructure
Community Branch Sewers
Force Main
Trunk / Interceptor
PS Along Interceptor
WWTP

6.5.6 Alternative 6 – Flow to Hilo WWTP with Urban Sewering

For this alternative, flows in the Puna project area would be sent to the existing Hilo WWTP via a gravity interceptor sewer along Highway 11, from Keaʻau to Airport Road, and then by force main to the Hilo WWTP. The flow from Puna would be 6 mgd, based on urban sewering. Adding the Hilo WWTP's design capacity of 5 mgd, the Hilo WWTP would need to be upgraded to accommodate at least 11 mgd for average daily flow. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall map is presented in Figure 6-12, with maps of individual areas in Appendix A.

There are 3 variations of Alternative 6 for different collection system methods: "base" alternative 6A, 6B, and 6C. Under base Alternative 6A, the collection system would consist of conventional gravity sewers within existing roadways. Lengths of sewer for this scenario would be the same as Alternative 4 (Table 6-5). Neighborhood and regional WWPSs (Table 6-5) are also needed depending on land slope.

In Alternative 6B, LPS will be used to reduce the number of neighborhood WWPSs and associated force mains. In Alternative 6C, cross-country sewers in new easements will reduce the number of neighborhood and regional WWPSs and associated force mains.

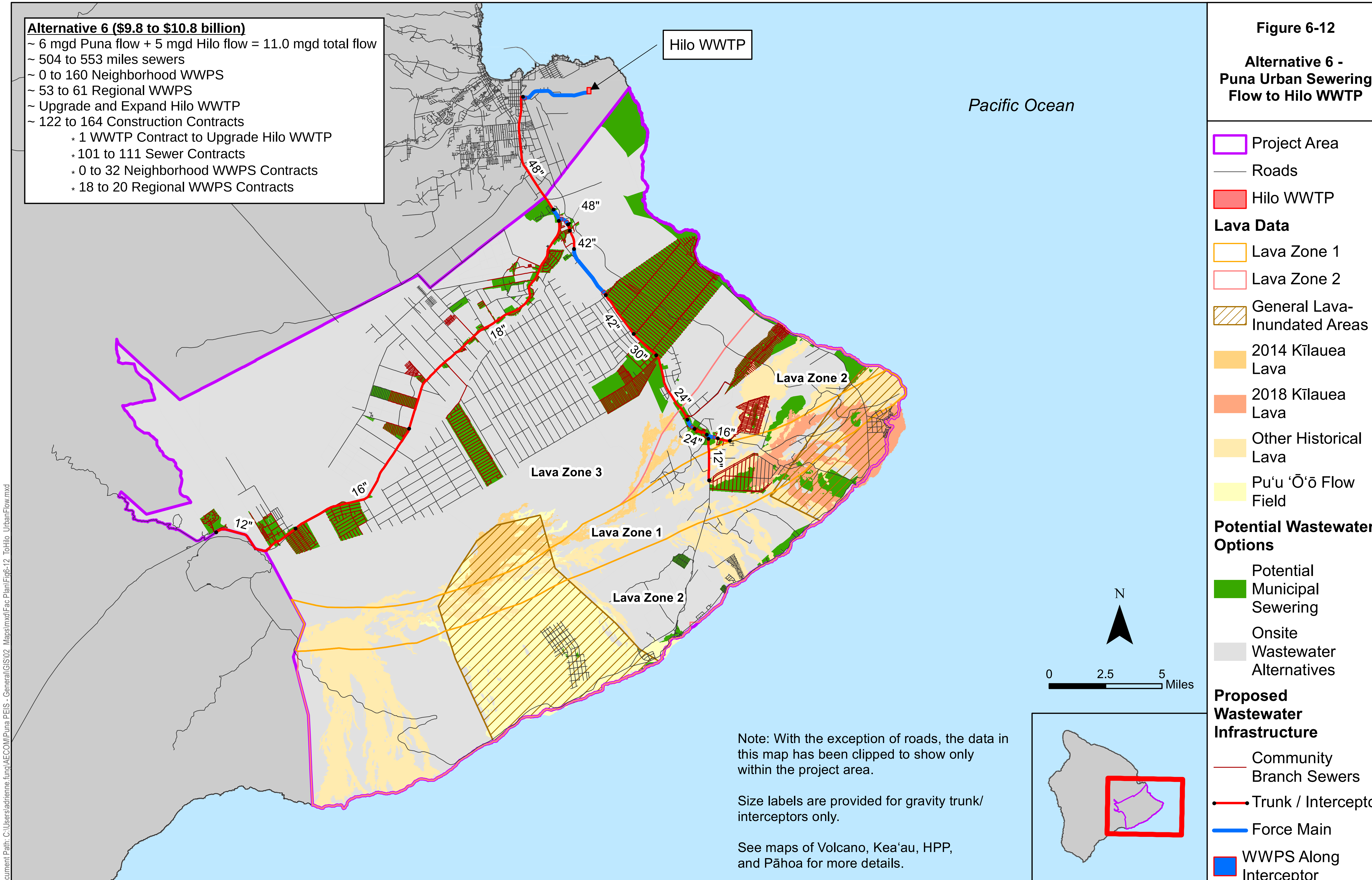


Figure 6-12

Alternative 6 - Puna Urban Sewering Flow to Hilo WWTP

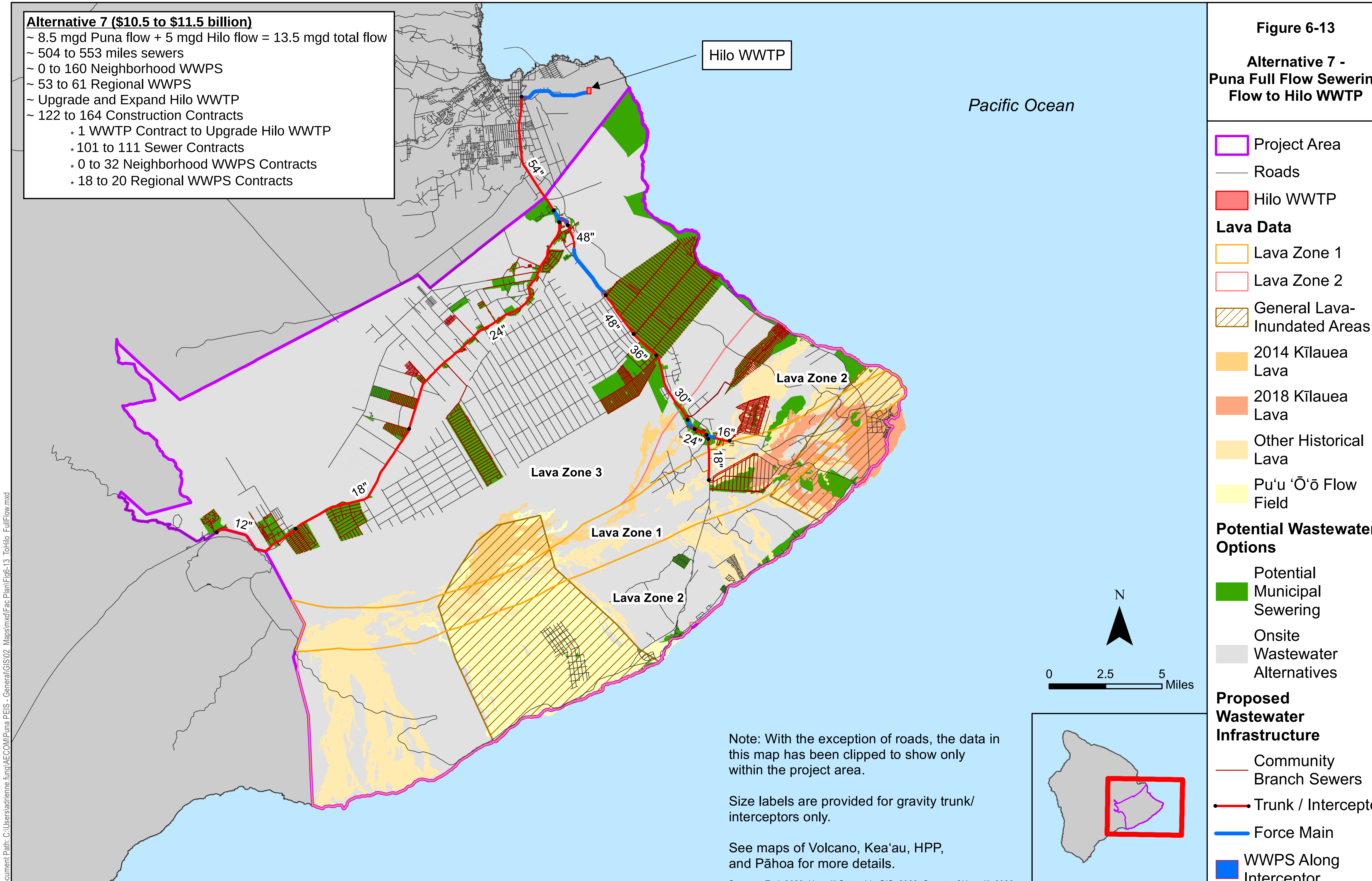
6.5.7 Alternative 7 – Flow to Hilo WWTP with Full Flow Sewering

This alternative is similar to Alternative 6 with sending Puna flows to the existing Hilo WWTP, but with the projected 2052 design average flow based on full flow, for a total of 8.5 mgd. The scenario is based on the urban sewering community collection system from Alternative 6, but with upsized interceptor sewers and increased WWTP capacity. The urban sewering collection system would cover the majority of the flow, and the upsized interceptor sewers and increased WWTP capacity would accommodate the full flow.

Adding the Hilo WWTP's design capacity of 5 mgd, the Hilo WWTP would need to be upgraded to accommodate at least 13.5 mgd. The centralized treatment (Section 6.2.3) and effluent and solids disposal or reuse options (Section 6.3) would apply. An overall map is presented in Figure 6-13, with maps of individual areas in Appendix A.

There are 3 variations of Alternative 7: "base" alternative 7A, 7B, and 7C. Under base Alternative 7A, the collection system would consist of conventional gravity sewers within existing roadways. Neighborhood and regional WWPSs (Table 6-5 plus additional ones to serve areas outside the "urban sewering" zones and future development) are also needed depending on land slope.

In Alternative 7B, LPS will be used to reduce the number of neighborhood WWPSs and associated force mains. In Alternative 7C, cross-country sewers in new easements will decrease the number of neighborhood and regional WWPSs and associated force mains.



Alternative 7 ($10.5 to $11.5 billion)
~ 8.5 mgd Puna flow + 5 mgd Hilo flow = 13.5 mgd total flow
~ 504 to 553 miles sewers
~ 0 to 160 Neighborhood WWPS
~ 53 to 61 Regional WWPS
~ Upgrade and Expand Hilo WWTP
~ 122 to 164 Construction Contracts
* 1 WWTP Contract to Upgrade Hilo WWTP
* 101 to 111 Sewer Contracts
* 0 to 32 Neighborhood WWPS Contracts
* 18 to 20 Regional WWPS Contracts
Hilo WWTP
Pacific Ocean
Figure 6-13
Alternative 7 - Puna Full Flow Sewering Flow to Hilo WWTP
Project Area
Roads
Hilo WWTP
Lava Data
Lava Zone 1
Lava Zone 2
General Lava-Inundated Areas
2014 Kīlauea Lava
2018 Kīlauea Lava
Other Historical Lava
Puʻu ʻŌʻō Flow Field
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Wastewater Infrastructure
Community Branch Sewers
Trunk / Interceptor
Force Main
WWPS Along Interceptor
54"
48"
48"
36"
30"
24"
16"
24"
18"
18"
12"
Lava Zone 2
Lava Zone 3
Lava Zone 1
Lava Zone 2
N
0 2.5 5 Miles
Note: With the exception of roads, the data in this map has been clipped to show only within the project area.
Size labels are provided for gravity trunk/ interceptors only.
See maps of Volcano, Keaʻau, HPP, and Pāhoa for more details.
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022

6.6 SCHEDULE CONSIDERATIONS

The work related to all wastewater alternatives would need to be executed in the following steps:

- Preliminary Design
- Environmental assessments/environmental impact statements
- Final Design and permitting
- Right-of-way acquisition
- Bidding and Award
- Construction of wastewater improvements
- Startup and Commissioning

The preliminary design and environmental assessments/environmental impact statements would require approximately 2 years to complete. Final design, permitting, and right-of-way acquisition would begin after the preliminary design is complete and require approximately 2-3 years to complete.

Alternative 1 implementation schedules would be managed by each individual property owner. The implementation schedules for Alternatives 2 to 7 would be managed by the COH and may be impacted by the following items:

- The time needed to procure, fabricate, and deliver major systems and equipment
- The ability to receive the shop drawings from the Contractor in a timely manner for the review and approval of the major equipment
- Any demolition and renovation work required for the new facilities
- The number of project/contract estimates for each alternative are based on the following assumptions:
    - 1 WWTP project/contract for each WWTP
    - An average of 3 regional WWPS for each regional WWPS project/contract
    - An average of 5 neighborhood WWPS for each neighborhood WWPS project/contract
    - An average of 5 miles of pipeline/sewer for each pipeline project/contract
    - A completion time ranging from 3 to 5 years for each project/contract
    - Based on the above assumptions each project/contract would be estimated to be in the $40 to $50 million (M) range.
- Assuming the first construction contracts start around 2027 and the last contracts are awarded around 2047 (20 years) COH would need to bid and award 6 to 8 contracts every year from year 2027 to year 2047 for all construction to be completed by the year 2052.
- Capital outlay would range from $350M to $400M per year for the 20 year period from year 2027 through year 2047 with the last 6 to 8 contracts completed by year 2052.

6.6.1 Alternative 1A – All IWS or Decentralized Systems

Based on the State of Hawaiʻi GIS data there are currently nearly 20,000 IWS (of these, about 16,000 are cesspools) within the Puna project area that would require replacement with new IWS. Replacements are for either cesspool conversions or other IWS at the end of their service life (typically 30 to 50 years). The projected future population projections indicate that nearly 11,000 additional IWS would be needed by year 2052. If Alternative 1A is implemented, about 31,000 new IWS are estimated within the Puna project area by year 2052 (20,000 replacements plus about 11,000 new IWS).

Implementation of Alternative 1A–- IWS or Decentralized Systems is anticipated to be spread over the 27-year period from now until the Year 2050 Act 125 deadline. Based on this, approximately 600 to 700 cesspool conversions per year would be required. In addition, all new development would need to incorporate IWS into the construction. An estimate of approximately 400 to 450 new IWS per year would be needed in the Puna project area during the planning period through year 2052. This equates to construction of 1,000 to 1,150 IWS per year in the Puna project area. Note that the more densely developed areas (retail/commercial, schools etc.) would utilize decentralized treatment plants serving the properties. Alternative 1A is considered as “no action” because there are no COH capital improvement projects.

6.6.2 Alternative 1B – Both LPS and Decentralized Treatment Systems

The Preliminary Construction Schedule for Alternative 1B is based on the following assumptions:

- There would be a preliminary engineering/environmental assessment phase requiring approximately 2 years
- Final design bid packages would be prepared for the following types of improvements:
    - Decentralized WWTPs (assumes 5 WWTP per contract or approximately 16 contracts) The final design and permitting for each bid package would require approximately 1 year
    - LPS force mains (assumes 160 contracts with approximately 20,000 LF of LPS in each contract). Each LPS final design package would require approximately 2 years including permitting
    - It is anticipated that the on-site grinder pumps for each property would be included in the design of each LPS subarea. Approximately 200 grinder pumping units and on-site piping connections would be included in each LPS contract.
- Bids for the decentralized treatment for each subarea would be advertised/awarded first. One decentralized WWTP contract per year (5 WWTP in each) are anticipated.
- After the decentralized treatment plant construction for each subarea has begun the pressure sewer contracts for these subareas would be bid/awarded. Approximately 8 to 10 pressure sewer and grinder pump contracts would be bid/awarded each year approximately 1.5 months apart.

- All of the construction contracts would be planned to have a 2-year time of completion

It is anticipated that the implementation of this program would require approximately 25 years based on the above-mentioned assumptions.

6.6.3 Alternative 2 – Urban Sewering (6.0 mgd) Four Subregional Treatment Plants

The Preliminary Construction Schedule for the Alternative 2–- Urban sewering (6 mgd) with subregional wastewater treatment (4 treatment plants) is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years
- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:
    - Approximately 485 to 534 miles of sewers and force mains (97 to 107 contracts based on contracts that are approximately 5 miles each)
    - 49 to 57 regional WWPS (16 to 19 contracts)
    - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
    - Wastewater Treatment (assumes 4 contracts)
    - Total of approximately 120 to 162 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion
- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

6.6.4 Alternative 3 – Urban Sewering (6.0 mgd) Three Subregional Treatment Plants

The Preliminary Construction Schedule for Alternative 3–- Urban Sewering (6 mgd) with subregional wastewater treatment (3 treatment plants) is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years
- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:

  - Approximately 488 to 537 miles of sewers and force mains (98 to 107 contracts based on contracts that are approximately 5 miles each)
  - 49 to 57 regional WWPS (16 to 19 contracts)
  - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
  - Wastewater Treatment (assumes 3 contracts)
  - Total of approximately 120 to 161 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion
- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

6.6.5 Alternative 4 – Urban Sewering (6.0 mgd) One Regional Treatment Plant

The Preliminary Construction Schedule for Alternative 4–- Urban Sewering (6 mgd) with one regional wastewater treatment is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years
- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:
  - Approximately 495 to 544 miles of sewers and force mains (99 to 109 contracts based on contracts that are approximately 5 miles each)
  - 50 to 58 regional WWPS (17 to 19 contracts)
  - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
  - Wastewater Treatment (assumes 1 contract)
  - Total of approximately 119 to 161 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion
- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

6.6.6 Alternative 5 – Full Flow (8.5 mgd) One Regional Treatment Plant

The Preliminary Construction Schedule for Alternative 5 – Full sewering (8.5 mgd) with one regional wastewater treatment is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years

- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:
    - Approximately 495 to 544 miles of sewers and force mains (99 to 109 contracts based on contracts that are approximately 5 miles each) Note that the interceptors are larger capacity than Alternative 4 due to the higher wastewater design flow
    - 50 to 58 regional WWPS (17 to 19 contracts) Note that some of the main WWPS are larger capacity than Alternative 4 due to the higher wastewater design flow
    - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
    - Wastewater Treatment (assumes 1 contract) Note that the WWTP design capacity for Alternative 5 is greater than Alternative 4
    - Total of approximately 119 to 161 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion
- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

6.6.7 Alternative 6 – Urban Sewering (6 mgd) to Hilo WWTP (11.0 mgd total)

The Preliminary Construction Schedule for Alternative 6–- Urban Sewering (6 mgd) with flow conveyed to the existing upgraded Hilo WWTP and no wastewater treatment plants in Puna is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years
- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:
    - Approximately 504 to 553 miles of sewers and force mains (101 to 111 contracts based on contracts that are approximately 5 miles each) Note that a major 48-inch interceptor sewer is needed to convey wastewater flow from the Puna project area (near Keaʻau) to the Hilo WWTP
    - 53 to 61 regional WWPS (18 to 20 contracts) Note that three additional major WWPS are required compared to the alternatives with local Puna wastewater treatment plants
    - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
    - Wastewater Treatment (assumes 1 contract) Note that the Hilo WWTP requires significant upgrades/expansion to handle the wastewater flows

from the Puna project area. Flow equalization would be added at the Hilo site to prevent overloading the existing ocean outfall which is sized to handle 13 mgd peak flow.

    - Total of approximately 122 to 164 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion
- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

6.6.8 Alternative 7 – Full Flow (8.5 mgd) to Hilo WWTP (13.5 mgd total)

The Preliminary Construction Schedule for Alternative 7 – Full sewering (8.5 mgd) with flow conveyed to the existing upgraded Hilo WWTP and no wastewater treatment plants in Puna is based on the following assumptions:

- There would be an initial preliminary engineering/environmental assessment phase requiring approximately 2 years
- The final design and permitting for each bid package would require approximately 2 years
- Multiple final design bid packages would be prepared for the following types of improvements:
    - Approximately 504 to 553 miles of sewers and force mains (101 to 111 contracts based on contracts that are approximately 5 miles each) Compared to Alternative 6, a larger sized 54-inch interceptor sewer is needed to convey the increased full wastewater flow from the Puna project area (near Keaʻau) to the Hilo WWTP
    - 53 to 61 regional WWPS (18 to 20 contracts) Note that three additional major WWPS are required compared to the alternatives with local Puna wastewater treatment plants and these WWPS are larger design capacity compared to Alternative 6.
    - 0 to 160 neighborhood WWPS (assumes 0 to 32 contracts). The low-pressure sewer alternative eliminates all of the neighborhood WWPS
    - Wastewater Treatment (assumes 1 contract) Note that the Hilo WWTP requires a more significant upgrade/expansion to handle the wastewater flows from the Puna project area compared to Alternative 6. A larger volume flow equalization system would be needed at the Hilo site and some sewer rehabilitation/replacements may be needed in the existing sewer system to accommodate the full flow from the Puna project area compared to Alternative 6. These improvements would be needed to prevent overloading the existing ocean outfall which is sized to handle 13 mgd peak flow.
    - Total of approximately 122 to 164 contracts
- Bids would be advertised/awarded approximately 1.5 to 2 months apart
- All of the bid packages would have a 3 to 5 year time of completion

- COH would need to bid and award 6 to 8 projects every year for the 25-year construction program

It is anticipated that execution of the construction program would require approximately 25 years to fully complete based on the above-mentioned assumptions.

7.0 EVALUATION OF ALTERNATIVES

The text below outlines the estimated cost and non-monetary considerations for evaluating the wastewater management alternatives described in Section 6.5.

7.1 EVALUATION CRITERIA

Evaluation criteria for the wastewater collection and treatment options include estimated costs and non-monetary factors. Alternatives with low initial construction cost may merit higher consideration, but it is also important to consider non-monetary factors. These include O&M challenges and social and environmental impacts of the alternatives that may actually favor another alternative.

7.2 BASIS OF CONSTRUCTION COST ESTIMATES

The American Association of Cost Engineers (AACE) guidelines were used for development of opinions of probable project and construction costs (referred to as cost estimates). A conceptual level construction cost estimate and a 30-year life cycle cost (LCC) analysis were conducted for the alternatives evaluated in Section 6.5. The LCC consists of the initial capital costs, as well as recurring annual O&M costs and equipment replacement costs at the end of their design life (typically 20 years for electrical and motorized equipment and 50 years for hydraulic structures, piping, and valves, and 75 years for sewers).

The Facility Plan cost estimates are AACE Class 4, which are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. These estimates include all costs for the alternatives, although they may not be borne by the same funder. This is to allow an overall alternative comparison.

Main cost estimate assumptions are listed below, with additional ones provided in Appendix G-1. These apply to each of the alternatives. Parameters that are more specific to the type of wastewater system (e.g., decentralized or centralized) are described in the following sections.

- 10 year average discount rate (nominal) of 3.11% (based on 30-year Treasury interest rates for different maturities, as of 2023)
- Annual escalation rate (nominal) of 3.37% (based on 10 year average of ENR cost index)
- Effective interest rate (real) of -0.26% was calculated from nominal discount rate and nominal escalation rate
- 30-year period of analysis
- Estimated power cost based on $0.44 per kilowatt-hour [32]
- Estimated operation and maintenance costs including inflation (see subsections below for specific components)

A 20 percent contingency was applied to the estimated construction cost estimates to account for uncertainties and undefined work that will be quantified as the project proceeds. A 20 percent allowance for project services was also included in the project cost estimates to cover engineering and other implementation costs as follows:

- Preliminary design +/- 2 percent
- Final design and permitting +/- 8 percent
- Construction engineering and inspection +/- 9 percent
- Legal and fiscal expenses +/- 1 percent

7.2.1 Cost Estimating for Decentralized Treatment System

Conceptual level costs were used for the following components of a decentralized treatment system: IWS, LPS, and package plants. The values are detailed in Appendix G, so a summary of their basis is presented here.

7.2.1.1 COST ESTIMATES OF CESSPOOL CONVERSIONS

From the Hawaiʻi Cesspool Conversion Working Group (CCWG)'s Final Report to the 2023 Regular Session Legislature, costs of cesspool upgrades range from "$9,000 to $60,000 or more depending on the wastewater system capacity (based on bedroom count), technology, and location or site constraints" [7]. These cited costs are in 2020 dollars, so escalating to 2023 dollars, the range becomes $11,000 to $69,000.

To determine which estimate to use for the Puna Facility Plan, the geological conditions of Puna were considered. The U.S. Geological Survey maps depict roughly 80% of the Puna project area as having hydraulic conductivity (which affects soil percolation rates) between 0 to 2 feet per day. This can be translated to 60 minutes/inch or slower. This also appears to be confirmed by the Keaʻau Village Master Plan, which involved excavating test pits in the Keaʻau area. These test pits indicate bedrock at about 29 to 47 inches below ground surface. This is not ideal for leach field design, since HAR 11-62 requires absorption trenches/beds to have a minimum vertical separation of 36 inches to bedrock. Therefore, due to the prevalence of underlying rock and high groundwater across most of the Project Area, cesspool conversions in Puna may be closer to the higher end of $69,000 in the cost range as cited by the CCWG.

Furthermore, based on a wastewater feasibility study in Kapoho [33], the 2023 cost estimates are between $25,000 for a system with a leach field and $50,000 for a system with off-site granular soils. Based on the Puna geology, it is more appropriate to use the upper end of the cost estimating range ($50,000). Ultimately, $60,000 per cesspool conversion was calculated by averaging and rounding the CCWG report estimate of $69,000 and the Kapoho report estimate of $50,000. To verify the cost estimates listed in the CCWG report and Kapoho report, AECOM obtained quotes in April 2023 for various types of IWS from a local Hawai'i IWS supplier and obtained invoices through October 2023 for IWS submitted to HDOH.

It may also be worth mentioning that the Statewide estimate from the CCWG report excludes engineering, permitting, and land acquisition [34]. As described in Section 7.2, the Facility Plan cost estimates include project services, land acquisition costs, and contingency to account for uncertainties and undefined work as the project proceeds.

In the cost estimate for O&M of IWS, $900 was used as the annual basis, which was scaled from the Kapoho feasibility study. This includes labor, electricity, and maintenance.

7.2.1.2 Cost Estimates of LPS

To estimate the cost for LPS, the Kapoho feasibility study and recent LPS vendor information were used. This resulted in $25,300 per lot to cover the on-lot costs. To verify this estimate, AECOM obtained quotes in April 2023 for installing LPS from a local Hawai'i vendor. Their cost estimates closely match with the $25,300.

Estimated unit costs per linear foot are used for in-street LPS. These range from $300 to $600, depending on the pipe size. This Facility Plan does not determine the specific entity (private or public) that will cover these costs, as this will depend on future coordination among homeowners, developers, and COH.

In the cost estimate for LPS, the O&M of in-street LPS is included in the unit costs mentioned above. On-lot LPS O&M are roughly $500 per lateral kit, which includes all components typically needed to connect an on-lot pump to the in-street sewer main. These O&M values were scaled from the Kapoho feasibility study.

7.2.1.3 Cost Estimates of Decentralized Cluster Plants

A cluster plant with a capacity of 15,000 gpd (the starting limit based on 11-62-31.1) was estimated to cost $2 million, using previous projects in the area, such as the Kapoho feasibility study and Pāhoa's Puna Kai Shopping Center WWTP. To set the upper capacity limit of a cluster plant, 250,000 gpd is an acceptable industry standard of the breakeven point between a cluster (package) plant and an in-ground constructed WWTP. This was estimated at $12 million, based on $40 per gallon of wastewater treated (from similar previous projects; see Appendix G-2) with another $2 million for odor control, buffer zone, and other costs. For estimated costs of cluster plants with capacities between 15,000 gpd and 250,000 gpd, interpolation calculations between the $2 million (for 15,000 gpd) and $12 million (for 250,000 gpd) were used.

The estimated O&M costs for decentralized cluster plants include power costs, labor and materials. Power costs are based on $0.44 per kilowatt-hour and depend on how much plant capacity needs to be pumped. Labor and materials costs are based on historical local WWTP costs.

7.2.2 Cost Estimating for Centralized Treatment System

Preliminary conceptual site plans were prepared for sewers, force mains, WWPS and WWTPs using available GIS topography. Field observations of the project area were conducted to observe conditions of roads and identify existence of potential existing utilities.

Sewer and force main cost estimates are based on available bidding costs for recent water, sewer, and force main projects on O'ahu and Hawai'i islands, including in Pauka'a and Lono Kona (Appendix G-1). Average costs from within the last ten years for six COH bids and five CCH bids were used. COH projects had smaller pipe diameters, and CCH projects involved larger pipe diameters. Estimated costs were prorated for sizes that were not used in those past projects.

The cost estimates also account for an outer island factor. COH costs include fewer large contractors and less competition, higher costs for shipping and material delivery, and more rural project settings with less traffic control requirements. On the other hand, CCH cost factors account for more large-scale contractors with more competition, lower costs for shipping and material delivery, and urban project sites with rigorous traffic control and utility relocations. In summary, the CCH costs were lower than COH in terms of competition and shipping factors, but higher than COH costs in terms of traffic control. These effects may cancel each other out, so the CCH costs for these particular projects could be used as they were without further adjustment.

Estimated costs were escalated from the bid date to present (year 2023) using the Engineering News Record (ENR) Construction Cost Index (CCI). The ENR CCI used for the cost estimates is 13,473 (August 2023). Estimated construction costs for the overall project are summarized below (details are in Appendix G-2):

- Gravity sewer project cost estimates range from $1,600 to $19,500 per linear foot depending on the sizes, which range from 8-inch to 54-inch diameter pipes.
- Force main project cost estimates range from $600 to $17,400 per linear foot for pipe sizes of 4-inch to 48-inch diameter.
- LPS project cost estimates range from $300 to $600 per linear foot for 2-inch to 4-inch diameter pipes.

Treatment plant cost estimates include treatment to produce R-1 recycled water, but do not include recycled water pumping and distribution systems.

Estimated O&M costs for a centralized treatment system include inspections, cleaning, and maintenance of the collection system sewer lines and WWTP and WWPS equipment and materials. These differ depending on the alternative's design, average flow, and plant capacities. For the alternatives that send wastewater flow from Puna to the Hilo WWTP, the cost estimates include capital costs for an expansion of the Hilo WWTP. They also include estimated O&M costs for the expanded WWTP. These O&M costs could be borne by both Puna and Hilo wastewater customers.

7.2.3 Validation of Cost Estimates with CCWG Report

The CCWG report presents some of the latest and most comprehensive cost estimates for Hawaiʻi. These values were used to validate the cost estimates used in this facility plan.

- Overall cesspool conversion cost estimate
  - CCWG Report: $9,000 to $60,000 per conversion
  - Puna Facility Plan: $60,000, based on escalating the CCWG report costs to 2023 dollars and accounting for Puna geology (see Section 7.2.1.1). This is close to the higher end of the CCWG Report range, due to anticipated shallower depth to bedrock in Puna.

- O&M cost estimate of IWS
  - CCWG Report: $400 to $1,300
  - Puna Facility Plan: $900, based on historical cost estimates in Puna. This is close to the average of $850 from the CCWG Report.
- Sewering cost estimate
  - CCWG Report: While specific costs are not identified, the report notes the following regarding feasibility of sewering:
    - "…there are significant capital investments required by counties of private developers, and connections to centralized systems may not be feasible for many cesspool conversions."
    - "Within the rural areas of Hawaiʻi, which are extensive, the costs to dig and construct long sewer systems from remote locations to a centralized treatment facility are substantial."
    - "Since many of the cesspools are in rural areas without centralized wastewater systems, conversion to Onsite Wastewater Treatment System and disposal may still be the most cost-effective option for some homeowners, as long as permitted engineering for disposal is possible."
  - The CCWG report also compares typical average monthly sewer bills ($40 for a single family in COH) to monthly cesspool conversion costs (between $94 and $339 for low and high cost scenarios, respectively). From this, it appears that monthly cesspool conversion costs are higher than monthly sewer bills. However, it is key to consider that the monthly sewer bills are for areas that already have sewers in place, many funded by grants. The construction cost for new sewers would not be reflected in the current sewer bills. Therefore, it does not mean that sewering would cost less than cesspool conversions. As the CCWG report mentions, it would be "reasonable to assume that additional funding will be required to make conversions affordable for most residents."
  - Puna Facility Plan: while there are no CCWG Report costs to compare with, estimated sewering costs for this Facility Plan are based on local Hawaiʻi utility construction bids, including projects in Paukaʻa and Lono Kona.

7.3 COMPARISON OF COST ESTIMATES

A summary of the LCC analysis for the alternatives is shown in Table 7-1. Supporting calculations are included in Appendix G. Findings from comparing the alternatives' cost estimates are summarized below.

The estimated LCC is calculated by estimated Total Capital Cost plus Net Present Value of O&M minus the Residual Value. The Total Capital Cost is the estimated construction and installation cost of the IWS, sewer lines, WWPS, and/or WWTP. Net Present Value of O&M is the 30-year period total of estimated O&M in present day dollars. Residual Value is the remaining value of the equipment, materials, and/or sewer lines at the end of the 30-year period. (30 years is used as this facility plan's period of analysis; see Section 4.2.) Therefore, the LCC is the cost of a system over its full life. It is only realized at the end of the system's life, hence its name as "life cycle."

7.3.1 Breakdown of Estimated Capital Costs between Collection and Treatment Costs

Table 7-2 is a summary of the estimated initial capital cost distribution between different types of wastewater infrastructures (piping, pump station, and WWTP). Additional details are included in Appendix G. For decentralized Alternative 1A (all IWS for residential and decentralized treatment for commercial areas and schools), 100% of the estimated initial capital cost is for wastewater treatment. For decentralized alternative 1B (on-site treatment and LPS), approximately 78% of the estimated initial capital cost is for the LPS collection system and 22% is for treatment. For all the centralized alternatives 2A through 7C, about 98% of the estimated initial capital cost is for the collection system, with piping cost ranging from 89% to 93% and WWPS cost ranging from 5% to 10%. The remaining costs, less than 2% of the initial capital cost, are from wastewater treatment.

7.3.2 Breakdown of Estimated Life Cycle Costs between Homeowners and Managing Entities

The estimated costs in Table 7-1 are broken down in Table 7-3 to show potential costs to homeowners and the managing entities (e.g., COH or a neighborhood association). In general, homeowners would be responsible for what is on their lot, and managing entities would be responsible for the collection system and treatment. It is also possible for a managing entity to cover what is on a homeowner's lot as well, but the costs here assume the former case.

In Alternative 1A, the LCC per homeowner includes installation and O&M of their IWS, while the LCC to managing entities is to cover the decentralized plants. In Alternative 1B, homeowners are assumed to pay for the on-lot portion of the LPS. The LCC to the managing entities would be for the in-street LPS network and decentralized package plants. Since Alternatives 2 through 7 are based on having a sewer collection system and centralized WWTP, the costs to homeowners would be for initial connection and their monthly sewer bill. Estimated costs to the managing entities would be those listed in Table 7-1.

7.3.3 Alternative with the Lowest Estimated Costs

Alternative 1A, the IWS/Decentralized alternative, has the lowest estimated capital cost and LCC. This agrees with the CCWG report's finding that cesspool conversions may be the most cost-effective solution, given that most cesspools are in rural areas without centralized wastewater systems. The CCWG report states, "Hawaiʻi County also has the greatest proportion of households, without centralized sewers than any other county (71%), indicating that connection to a centralized sewer system is unlikely to be available for most properties. Without options to connect to an existing sewer, the only option for many cesspool owners in Hawaiʻi County is likely the installation of an approved onsite system." Alternative 1A is also considered as "no action" because there are no COH capital improvement projects.

The estimated cost for Alternative 1A in Table 7-1 assumes replacement of about 20,000 existing IWS (either cesspool conversions or replacement of IWS at the end of their service life) and installation of about 11,000 new IWS to accommodate projected growth and development. Additional analysis was performed to evaluate conversion of just the existing 16,000 cesspools, and these estimated costs are presented in Table 7-4.

7.3.4 Impact of Collection System Option on Cost Estimates

Comparing the collection system options within each alternative (A, B, and C variations), the LCC decreases from the base scenario A (all conventional gravity sewers/force mains in existing roadways) to C (cross-country sewers in new easements) to B (both gravity sewers and LPS). See Sections 6.1 and 6.5 for details on comparing the different collection systems within each alternative.

Higher LCCs for the base alternatives are mainly due to high excavation costs for deep sewers within lava rock and also construction of multiple pump stations to account for the rolling terrain in Puna. For this size project, the WWTP costs in the centralized system alternatives are a relatively small percentage of the overall wastewater program cost. The majority of the costs are from laying the sewer collection network.

Compared to the base scenario, the cross-country sewer options have lower estimated capital costs and LCCs. The cross-country sewers would run in new easements, helping to reduce the number of neighborhood pump stations and associated force mains.

The sewer options with LPS have further lower estimated capital costs and LCCs due to the smaller sizes and shallower depths of LPS and elimination of additional neighborhood pump stations. These sewer options do have higher estimated O&M cost due to maintenance of pressure pumps and valves within each lot.

7.3.5 Impact of Design Average Flow on Cost Estimates

Comparing urban sewering and full flow sewering alternatives, the LCCs are higher for the latter. Larger pipes are needed to accommodate the increased flow in the full flow sewering scenarios. The estimated capital costs do not include the additional sewers and pump stations required to serve the areas outside the urban sewering areas, as these are assumed to be paid by the area developer.

7.3.6 Impact of Number of WWTPs on Cost Estimates

In the alternatives with urban sewering and new Puna WWTPs, LCCs increase as the alternatives range from 4 subregional plants (Alternative 2 group) to 3 subregional plants (Alternative 3 group) to 1 regional plant (Alternative 4 group). This is primarily due to additional sewer line lengths to connect subregions in the collection system. For example, the Alternative 3 group does not have the Pāhoa WWTP. Therefore, Pāhoa flows are brought to HPP by adding sewers between the two subregions. The same applies to the Alternative 4 group, where added sewer lines carry Volcano flows east to Keaʻau and HPP flows north to Keaʻau.

7.3.7 Impact of Puna Flows Going to Hilo WWTP

It can also be observed that the LCCs are higher when sending flows to Hilo, compared to constructing new WWTPs in Puna. This is due to an additional approximate ten-mile interceptor sewer to convey Puna WW flow to Hilo.

7.3.8 Impact of Lava Hazard Zone on Cost Estimates

Hawaiʻi Island is divided into nine lava hazard zones as defined by the U.S. Geological Survey [35]. Zone 1 is the most hazardous, including summits and rift zones of Kīlauea and Mauna Loa, where vents have been repeatedly active. Zone 2 covers areas adjacent to and downslope of Zone 1. Therefore, there is increased risk of lava flow and destruction of future sewer systems in Zones 1 and 2. In the event that occurs, it is also possible for disaster financial assistance to support the re-construction of the sewer system.

For comparison, Table 7-5 presents cost estimates without sewering in Zones 1 and 2. This would only affect Alternatives 2 through 7, which include region-wide collection systems and centralized WWTPs. Zones 1 and 2 consist of the Pāhoa and Hawaiian Beaches subregion and areas south of those communities towards the coast, including Nānāwale Estates and Leilani Estates (Figure 3-1). Between Table 7-1 and Table 7-5, the estimated capital costs of the wastewater management program are reduced by approximately $2B if no public sewers or centralized WWTP are installed in Zones 1 and 2.

7.3.9 Estimated Cost Summary Tables

Table 7-1 Puna Wastewater Management Alternatives Estimated LCC Analysis Summary

Alternative No.	Description	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
1A	IWS for All Residential + Decentralized Treatment for Commercial/Institutions	**$2.8B**	**$0.9B**	**$0.8B**	**$2.8B**
1B	Both LPS and Decentralized Treatment Systems	**$4.1B**	**$1.0B**	**$1.5B**	**$3.5B**
2A	Subregional Plants (6 mgd)— 4 plants— Urban Sewering – All Gravity Sewers/WWPS				
	Keaʻau	$1.9B	$0.04B	$0.8B	$1.1B
	HPP	$3.5B	$0.14B	$1.5B	$2.1B
	Pāhoa	$2.3B	$0.11B	$1.0B	$1.4B
	Volcano	$1.1B	$0.03B	$0.5B	$0.6B
	2A Total	**$8.7B**	**$0.3B**	**$3.8B**	**$5.3B**
2B	Subregional Plants (6 mgd)— 4 plants— Urban Sewering— Both Gravity Sewers & LPS				
	Keaʻau	$1.7B	$0.04B	$0.8B	$1.0B
	HPP	$3.1B	$0.17B	$1.3B	$1.9B
	Pāhoa	$1.9B	$0.12B	$0.8B	$1.2B
	Volcano	$1.0B	$0.03B	$0.4B	$0.6B
	2B Total	**$7.7B**	**$0.4B**	**$3.3B**	**$4.7B**
2C	Subregional Plants (6 mgd)— 4 plants— Urban Sewering – Cross-Country Sewers				
	Keaʻau	$1.8B	$0.02B	$0.8B	$1.0B
	HPP	$3.5B	$0.12B	$1.5B	$2.1B
	Pāhoa	$2.2B	$0.10B	$0.9B	$1.3B
	Volcano	$1.0B	$0.02B	$0.5B	$0.6B
	2C Total	**$8.6B**	**$0.3B**	**$3.7B**	**$5.1B**
3A	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – All Gravity Sewers/WWPS				
	Keaʻau	$1.9B	$0.04B	$0.8B	$1.1B
	HPP (w/ Pāhoa)	$6.0B	$0.25B	$2.6B	$3.7B

Alternative No.	Description	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
	Volcano	$1.1B	$0.03B	$0.5B	$0.6B
	3A Total	**$9.0B**	**$0.3B**	**$3.9B**	**$5.4B**
3B	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – Both Gravity Sewers & LPS				
	Keaʻau	$1.7B	$0.04B	$0.8B	$1.0B
	HPP (w/Pāhoa)	$5.3B	$0.25B	$2.3B	$3.3B
	Volcano	$1.0B	$0.03B	$0.4B	$0.6B
	3B Total	**$7.9B**	**$0.4B**	**$3.4B**	**$4.9B**
3C	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – Cross-Country Sewers				
	Keaʻau	$1.8B	$0.02B	$0.8B	$1.0B
	HPP (w/Pāhoa)	$6.0B	$0.2B	$2.6B	$3.6B
	Volcano	$1.0B	$0.02B	$0.5B	$0.6B
	3C Total	**$8.8B**	**$0.3B**	**$3.8B**	**$5.2B**
4A	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – All Gravity Sewers/WWPS	**$9.7B**	**$0.3B**	**$4.2B**	**$5.8B**
4B	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – Both Gravity Sewers & LPS	**$8.7B**	**$0.4B**	**$3.8B**	**$5.3B**
4C	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – Cross-Country Sewers	**$9.5B**	**$0.3B**	**$4.1B**	**$5.6B**
5A	Regional Plants (8.5 mgd)—- 1 plant–- Full Flow – All Gravity Sewers/WWPS	**$10.2B**	**$0.4B**	**$4.4B**	**$6.1B**
5B	Regional Plants (8.5 mgd)—- 1 plant–- Full Flow – Both Gravity Sewers & LPS	**$9.2B**	**$0.4B**	**$4.0B**	**$5.6B**
5C	Regional Plants (8.5 mgd)—- 1 plant–- Full Flow – Cross-Country Sewers	**$10.0B**	**$0.3B**	**$4.4B**	**$5.9B**
6A	Flow to Hilo WWTP (11 mgd)—- Urban Sewering – All Gravity Sewers/WWPS	**$10.8B**	**$0.4B**	**$4.7B**	**$6.5B**
6B	Flow to Hilo WWTP (11 mgd)—- Urban Sewering – Both Gravity Sewers & LPS	**$9.8B**	**$0.4B**	**$4.3B**	**$6.0B**
6C	Flow to Hilo WWTP (11 mgd)—- Urban Sewering – Cross-Country Sewers	**$10.6B**	**$0.4B**	**$4.7B**	**$6.3B**
7A	Flow to Hilo WWTP (13.5 mgd)— Full Flow – All Gravity Sewers/WWPS	**$11.5B**	**$0.4B**	**$5.0B**	**$6.9B**
7B	Flow to Hilo WWTP (13.5 mgd)— Full Flow – Both Gravity Sewers & LPS	**$10.5B**	**$0.4B**	**$4.6B**	**$6.4B**
7C	Flow to Hilo WWTP (13.5 mgd)— Full Flow – Cross-Country Sewers	**$11.3B**	**$0.3B**	**$5.0B**	**$6.7B**

Notes:
B: billion
NPV: net present value
Collection system options for Alternative 2 thru 7: alternatives ending with "A" use conventional gravity sewers in existing roadways; alternatives ending with "B" use both gravity sewers and LPS; and alternatives ending with "C" use cross-country sewers in new easements.

Table 7-2 Breakdown of Estimated Capital Costs between Collection and Treatment Costs

Alternative	Collection System Costs as Percent of Capital Cost	Treatment Costs as Percent of Capital Cost
1A	0%	100%
1B	78%	22%
2 through 7	98% [1]	2%

Note:
[1]Within the collection system costs, piping costs range from 89% to 93% of the capital cost, and WWPS costs range from 5% to 10% of the capital cost.

Table 7-3 Breakdown of Estimated Costs between Homeowners and Managing Entity

Alternative	Capital Cost to Homeowners		Capital Cost to Other Entities[3]	Capital Cost to COH	Total Capital	Notes
	Total[1]	Per Homeowner [2]				
1A	$2B[4]	$60K[4]	$92M	$0	$2.8B	IWS Conversion
1B	$1.1B	$37K	$2.9B	$0	$4B	Low Pressure Sewers
2 through 7	$153M[4]	$5K[4] for Gravity Sidesewers	$0	Varies depending on alternative	$7.7B to $11.5B	Varies depending on alternative
	$1.1B	$37K for Low Pressure Sewers	$0			

Notes:
[1] Includes all costs for treatment and collection systems
[2]To estimate the total LCC per homeowner, the total LCC to homeowners is divided by 30,625, which is the total of existing and projected number of IWS in 2052.
[3]Entities may include institutions (schools) or private commercial developments.
[4]Does not include markups for contingency and project costs, which are included in overall Capital Costs.
B: billion, M: million, K: thousand

Table 7-4 Alternative 1A Estimated Costs of Only Existing Cesspool Conversions (no growth)

Capital Cost	Capital Cost per Homeowner[1]
$1B	$60K

Note:
[1] To estimate the cost per homeowner, the total cost is divided by 16,000 existing cesspools.

Table 7-5 Puna Wastewater Management Alternatives Estimated LCC Analysis Summary (Excluding Sewering in Lava Hazard Zones 1 and 2)

Alternative No.	Description	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
2A	Subregional Plants (6 mgd)— 4 plants— Urban Sewering – All Gravity Sewers/WWPS				
	Kea'au	$1.9B	$0.04B	$0.8B	$1.1B
	HPP	$3.5B	$0.14B	$1.5B	$2.1B
	Volcano	$1.1B	$0.03B	$0.5B	$0.6B

Alternative No.	Description	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
	2A Total	**$6.5B**	**$0.22B**	**$2.8B**	**$3.9B**
2B	Subregional Plants (6 mgd)— 4 plants— Urban Sewering— Both Gravity Sewers & LPS				
	Kea'au	$1.7B	$0.04B	$0.8B	$1.0B
	HPP	$3.1B	$0.17B	$1.3B	$1.9B
	Volcano	$1.0B	$0.03B	$0.4B	$0.6B
	2B Total	**$5.8B**	**$0.24B**	**$2.5B**	**$3.5B**
2C	Subregional Plants (6 mgd)— 4 plants— Urban Sewering – Cross-Country Sewers				
	Kea'au	$1.8B	$0.02B	$0.8B	$1.0B
	HPP	$3.5B	$0.12B	$1.5B	$2.1B
	Volcano	$1.0B	$0.02B	$0.5B	$0.6B
	2C Total	**$6.4B**	**$0.17B**	**$2.8B**	**$3.8B**
3A	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – All Gravity Sewers/WWPS				
	Kea'au	$1.9B	$0.04B	$0.8B	$1.1B
	HPP	$3.5B	$0.14B	$1.5B	$2.1B
	Volcano	$1.1B	$0.03B	$0.5B	$0.6B
	3A Total	**$6.5B**	**$0.22B**	**$2.8B**	**$3.9B**
3B	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – Both Gravity Sewers & LPS				
	Kea'au	$1.7B	$0.04B	$0.8B	$1.0B
	HPP	$3.1B	$0.17B	$1.3B	$1.9B
	Volcano	$1.0B	$0.03B	$0.4B	$0.6B
	3B Total	**$5.8B**	**$0.24B**	**$2.5B**	**$3.5B**
3C	Subregional Plants (6 mgd)— 3 plants— Urban Sewering – Cross-Country Sewers				
	Kea'au	$1.8B	$0.02B	$0.8B	$1.0B
	HPP	$3.5B	$0.12B	$1.5B	$2.1B
	Volcano	$1.0B	$0.02B	$0.5B	$0.6B
	3C Total	**$6.4B**	**$0.17B**	**$2.8B**	**$3.7B**
4A	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – All Gravity Sewers/WWPS	$7.3B	$0.2B	$3.2B	$4.4B
4B	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – Both Gravity Sewers & LPS	$6.6B	$0.3B	$2.9B	$4.0B
4C	Regional Plants (6 mgd)–- 1 plant— Urban Sewering – Cross-Country Sewers	$7.2B	$0.2B	$3.2B	$4.2B
5A	Regional Plants (8.5 mgd)— 1 plant–- Full Flow – All Gravity Sewers/WWPS	$7.8B	$0.2B	$3.4B	$4.7B
5B	Regional Plants (8.5 mgd)— 1 plant–- Full Flow – Both Gravity Sewers & LPS	$7.4B	$0.4B	$3.2B	$4.6B
5C	Regional Plants (8.5 mgd)— 1 plant–- Full Flow – Cross-Country Sewers	$7.7B	$0.2B	$3.4B	$4.5B
6A	Flow to Hilo WWTP (11 mgd)— Urban Sewering – All Gravity Sewers/WWPS	$8.4B	$0.3B	$3.7B	$5.0B
6B	Flow to Hilo WWTP (11 mgd)— Urban Sewering – Both Gravity Sewers & LPS	$7.7B	$0.3B	$3.4B	$4.6B
6C	Flow to Hilo WWTP (11 mgd)— Urban Sewering – Cross-Country Sewers	$8.3B	$0.2B	$3.6B	$4.9B

Alternative No.	Description	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
7A	Flow to Hilo WWTP (13.5 mgd)— Full Flow – All Gravity Sewers/WWPS	$9.0B	$0.3B	$3.9B	$5.4B
7B	Flow to Hilo WWTP (13.5 mgd)— Full Flow – Both Gravity Sewers & LPS	$8.3B	$0.3B	$3.6B	$5.0B
7C	Flow to Hilo WWTP (13.5 mgd)— Full Flow – Cross-Country Sewers	$8.9B	$0.2B	$3.9B	$5.2B

Note: Alternatives 1A and 1B are not part of this analysis because they do not include region-wide collection systems and centralized WWTPs.

7.3.10 Ranking Based on Estimated Costs

The alternatives evaluated in Section 6.5 are compared and ranked in Table 7-6 based on the estimated conceptual level capital cost with considerations of O&M. Alternatives with low initial construction cost merit most consideration. The alternative with the highest-ranking value is assigned “1”. With a much lower capital cost and LCC, Alternative 1A with IWS and decentralized wastewater systems is ranked highest as the most favorable alternative in terms of estimated cost, followed by Alternative 1B with both LPS and decentralized treatment systems.

Table 7-6 Puna Wastewater Management Alternatives Estimated LCC Ranking

Alternative No.	Description	Ranking [1]
1A	IWS for All Residential + Decentralized Treatment for Commercial/Institutions	1
1B	Both LPS and Decentralized Treatment Systems	2
2A	Subregional Plants (6 mgd)–- 4 plants–- Urban Sewering – All Gravity Sewers/WWPS	7
2B	Subregional Plants (6 mgd)–- 4 plants–- Urban Sewering – Both Gravity Sewers & LPS	3
2C	Subregional Plants (6 mgd)–- 4 plants–- Urban Sewering – Cross-Country Sewers	5
3A	Subregional Plants (6 mgd)–- 3 plants–- Urban Sewering – All Gravity Sewers/WWPS	9
3B	Subregional Plants (6 mgd)–- 3 plants–- Urban Sewering – Both Gravity Sewers & LPS	4
3C	Subregional Plants (6 mgd)–- 3 plants–- Urban Sewering – Cross-Country Sewers	6
4A	Regional Plants (6 mgd)–- 1 plant–- Urban Sewering – All Gravity Sewers/WWPS	12
4B	Regional Plants (6 mgd)–- 1 plant–- Urban Sewering – Both Gravity Sewers & LPS	8
4C	Regional Plants (6 mgd)–- 1 plant–- Urban Sewering – Cross-Country Sewers	10
5A	Regional Plants (8.5 mgd)–- 1 plant–- Full Flow – All Gravity Sewers/WWPS	15
5B	Regional Plants (8.5 mgd)–- 1 plant–- Full Flow – Both Gravity Sewers & LPS	11
5C	Regional Plants (8.5 mgd)–- 1 plant–- Full Flow – Cross-Country Sewers	13

Alternative No.	Description	Ranking [1]
6A	Flow to Hilo WWTP (11 mgd)–- Urban Sewering – All Gravity Sewers/WWPS	18
6B	Flow to Hilo WWTP (11 mgd)–- Urban Sewering – Both Gravity Sewers & LPS	14
6C	Flow to Hilo WWTP (11 mgd)–- Urban Sewering – Cross-Country Sewers	16
7A	Flow to Hilo WWTP (13.5 mgd)–- Full Flow – All Gravity Sewers/WWPS	20
7B	Flow to Hilo WWTP (13.5 mgd)–- Full Flow – Both Gravity Sewers & LPS	17
7C	Flow to Hilo WWTP (13.5 mgd)–- Full Flow – Cross-Country Sewers	19

Note:
[1]Alternatives with lower estimated LCCs are ranked with lower numbers.

7.4 ALTERNATIVES RATING

A relatively simple six criteria rating system (Table 7-7) has been prepared to evaluate the alternatives and assist with the selection of a preferred treatment alternative. The rating system allows the comparison of each alternative. The following rating scale is used:

3 = Excellent
2 = Good
1 = Fair

7.5 RATING CRITERIA

The following criteria were identified and reviewed to compare the various wastewater treatment and collection system alternatives for Puna described in Section 6.0. The six criteria are:

- Estimated Construction Cost
- Estimated Annual O&M Cost
- Operational Ease and Maintainability
- Flexibility to meet Potential Future Requirements
- Utilization and Acquisition of Land
- Environmental Concerns/Regulatory Permitting

The following sections describe each criterion. Ratings are discussed based on the COH DEM perspective.

Table 7-7 Puna Wastewater Management Alternatives Rating Matrix

Criteria	Alternative							
	Alt 1A: All IWS or Decentralized Systems	Alt 1B: Decentralized On-Site Treatment and LPS	Alt 2: 4 Subregional Treatment Plants – Urban Sewering	Alt 3: 3 Subregional Treatment Plants – Urban Sewering	Alt 4: 1 Regional Treatment Plant – Urban Sewering	Alt 5: 1 Regional Treatment Plant – Full Flow Sewering	Alt 6: Flow to Hilo WWTP – Urban Sewering	Alt 7: Flow to Hilo WWTP – Full Flow Sewering
	Score	Score	Score	Score	Score	Score	Score	Score
Estimated Construction Cost								
Estimated Annual O&M Cost								
Operational Ease and Maintainability								
Ability to meet Potential Future Requirements								
Utilization and Acquisition of Land								
Environmental/Regulatory Permitting								
Total Score								

Notes:
- 3 is the most favorable alternative, 1 is the least favorable alternative.
- The highest total score is the most favorable alternative.
- Scores are preliminary. May be updated pending review by DEM and other project stakeholders.

7.5.1 Estimated Construction Cost

This criterion includes the estimated cost of the capital improvement, including labor and materials as well as indirect costs to design and construct the wastewater WW system; constructability (ease or efficiency that the facility can be built) which makes it more economical; construction implementation schedule.

The most favorable Alternative is Alternative 1A: All IWS or Decentralized Systems because it has the lowest estimated construction cost of all alternatives.

7.5.2 Estimated Annual O&M Cost

This criterion is the annual cost of labor, consumables, and energy to operate the wastewater system. This criterion includes a comparison of how much energy is required for different options to provide the same service. Smaller treatment facilities would require less energy to operate than larger treatment facilities. However, factors such as the length of pipe between structures and the difference in topography would also have an impact on the energy efficiency of the facilities.

The most favorable alternatives based on lowest O&M cost are Alternatives 2, 3, and 4. From the DEM perspective, the county's responsibility for O&M of subregional plants and a regional plant treating urban sewering only are the lowest NPV of O&M costs. The county would likely not provide O&M for Alternative 1A: All IWS or Decentralized Systems because individual IWS would be operated and maintained by each individual homeowner.

7.5.3 Operational Ease and Maintainability

This criterion is the ease with which the wastewater system can be kept functioning in a safe and reliable manner. Operational ease is the capability to keep the wastewater treatment equipment and systems functioning in a safe and reliable manner in accordance with the prescribed operating requirements. Systems that are more complex or have more processes and/or functions are more difficult to operate than simpler systems.

This criterion includes operator availability (if certified operators are required), and the level of skills needed to operate and maintain systems. For example, maintenance of IWS will be handled by each homeowner and maintenance of a centralized wastewater treatment plant will be handled by the County.

Maintainability is the probability that a successful repair action can be performed within its designated allowable time schedule. Maintainability measures the ease and/or speed with which a system can be restored to operational status after a failure occurs. Systems that have more equipment or devices are more difficult to maintain than smaller scale systems. Maintainability is also impacted by the work setting, lighting, size, and available space around the equipment. One factor is the concept of "carry your own kuleana". This refers to the maintenance responsibility to keep a wastewater system functioning if it is kept closer to the user versus the flushing of problems "away" and some other community handling it.

The most favorable alternatives are Alternative 1A: All IWS or Decentralized Systems and Alternative 4: One Plant with Regional Urban Sewering. Maintenance would be managed by each individual property owner in Alternative 1A. The wastewater/septic waste would still require COH participation for treatment (example: trucking septage to the Hilo WWTP which is the closest facility to the project area). However, one facility that will operate and handle the wastewater or septic tank waste and it will be maintained by the County of Hawaiʻi. Similarly, the operational ease and maintainability of one centralized plant would favor this one plant alternative over alternatives with numerous treatment plants.

7.5.4 Flexibility to meet Potential Future Requirements

This criterion is the ability to meet potential future regulation changes including wastewater treatment levels and effluent disposal/use; sustainable solids handling strategy; ability to meet future demands and ability to meet future water quality requirements. All wastewater treatment options will produce additional quantities of solids compared to the current situation of using cesspools as the primary method of handling wastewater in Pāhoa. The quantity of additional solids, along with the operating complexity of solids producing processes, are considered.

Also considered is the Lava Zones designated by the County. The county is considering an infrastructure policy for areas in lava zones 1 and 2.

The resilience of an alternative to climate change is a consideration. Resiliency is the ability of an infrastructure system to adapt to and withstand various climate-related stressors: which may include lava, earthquakes, floods, droughts, wildfires, etc. Resilient infrastructure is planned, designed, built and operated in a way that anticipates, prepares for, and adapts to changing climate conditions. It can also withstand, respond to, and recover rapidly from disruptions caused by these climate conditions.

“Recycled water” is treated wastewater that is intended, or used, for beneficial purposes. HDOH advocates the use of recycled water if public health and water resources are not compromised. The use of recycled water may become more significant due to COH’s growing population, limited potable water resources, and wastewater disposal issues. The ability to produce recycled water and the operating complexity of the recycled water treatment systems impact the comparison of the alternatives.

Having separate decentralized treatment plants would make it easier to distribute and reuse the water throughout the Project Area. The alternatives with a single water reclamation facility make it more difficult to distribute the water to the more remote areas away from the facility.

In 2016, the HRS were amended by Act 248, which added a new section related to wastewater treatment. The new section prohibits the discharge of treated or raw sewage into state waters after December 31, 2026, unless the wastewater treatment systems produce “clean energy.” Therefore, the quantity of clean energy and the operating complexity of energy producing systems play a role in comparing alternatives if the alternative discharges into state waters.

The flexibility to meet and adapt to future regulations, along with resilience and ability to handle solids favors Alternative 1A: all IWS or Decentralized Systems. Alternative 1B: Both Decentralized On-Site Treatment and LPS is similarly a favorable alternative. If the potential use and distribution of recycled water is given more importance, then Alternative 1B is the most favorable alternative, since the decentralized treatment units would be located throughout the community, allowing reuse distribution networks to be smaller and able to adjust for each area.

7.5.5 Utilization and Acquisition of Land

This criterion considers site acquisition; site layout efficiency; availability of county land; ability to obtain easements for collection system; impact on land use during construction; ease in meeting security requirements to prevent unauthorized entry and vandalism.

One factor is the difficulty in obtaining easements over private lands for the collection system. Many of the subdivisions in Pāhoa are on private lands, including private roadways where the trunk lines may be.

The most favorable Alternatives are Alternative 1A: All IWS or Decentralized Systems, Alternative 6: Urban Sewering and Flow to Hilo WWTP, and Alternative 7: Full Flow Sewering and Flow to Hilo WWTP. All three alternatives do not require COH property acquisition for the treatment facilities, thus making these three alternatives more easily implementable.

7.5.6 Environmental Concerns/Regulatory Permitting

This criterion evaluates the environmental concerns and regulatory permitting requirements for each alternative. The alternative ranking evaluates the difficulty in permitting the project for construction, implications for the design and construction, and ability to mitigate impacts such as odor and vector control. The environmental concerns include evaluation of the State prioritization of areas for cesspool, potential impact on drinking water due to existing cesspools and future use of effluent. Other environmental impacts include air quality, water quality, biological resources, archaeological, historic and cultural resources, aesthetic resources, noise and vibration, transportation, other public services, and socioeconomic factors. The Puna Programmatic PEIS describes the impacts and mitigation at a programmatic level for all alternatives considered for the Puna District (including Pāhoa).

The most favorable alternatives are Alternative 1A: All IWS or Decentralized Systems, Alternative 2: 4-plant with Urban Sewering, Alternative 3: 3-plant with Urban Sewering, Alternative 4: 1-plant with Urban Sewering, and Alternative 5: 1-plant with Full Flow Sewering. Environmental impacts of small discrete IWS are less concerning than impacts due to larger treatment plants and the attendant air, water, biological, archaeological, historical and cultural resources. All alternatives other than Alternative 1A would likely require environmental assessments for the treatment plant(s) and collection systems. However, permitting the treatment plant(s) is less onerous than permitting and addressing the environmental concerns for a treatment plant as well as a transmission main and pump stations from Puna to Hilo.

7.5.7 Overall Rating Results

The above criteria have been used to evaluate the alternatives for Puna; however, the selection of an alternative also needs to include countywide assessments of the improvements required to meet the cesspool conversion and other required improvements. The County is currently in the process of planning for multiple areas and beginning a countywide plan for implementation. Selection of the best alternative for Puna should include input from this countywide process.

Table 7-8 shows a summary comparison of the multi-criteria ratings for the alternatives using DEM's perspective.

Of the seven overall alternatives for Puna, Alternative 1A received the highest total score and thus is the most favorable alternative. It received an excellent rating for Construction costs, operational ease and maintainability, Flexibility to meet Potential Future Requirements, Utilization and Acquisition of Land, and Environmental/Regulatory Permitting. Similarly, the Department of Health Wastewater Division also ranked Alternative 1A as the highest-ranking alternative. As discussed earlier, the county is working on a county-wide master plan which will allow cross prioritization of capital projects across the various districts. Thus, scores are preliminary and will be updated pending review by the County, DEM, and other project stakeholders.

In evaluating the alternatives, all six criteria were weighted the same. It is interesting to note that during the October 21, 2023, Revitalize Puna, 39 members of the public participated in a "game" designed to solicit community feedback on what they thought were the three most important criteria. The results were (numbers of "votes" in parentheses):

- Estimated Construction Cost (20)
- Estimated Annual O&M Cost (24)
- Operational Ease and Maintainability (17)
- Flexibility to meet Potential Future Requirements (16)
- Utilization and Acquisition of Land (16)
- Environmental Concerns/Regulatory Permitting (24)

Criteria weighting could be a tool to compare proposed alternatives. The weights from this Revitalize Puna sample could be applied to the alternatives evaluation to determine the highest-ranking alternative. When the weights from Revitalize Puna were applied to the DEM rating, it resulted in this prioritization of the alternatives: 1) the top alternative was alternative 1A, 2) Alternative 4 came in second place, and 3) Alternative 5 was ranked third. There was not enough of a difference between the weights of the criteria to change the DEM prioritization of the alternatives.

Table 7-8 Puna Wastewater Management Alternatives Rating from DEM Perspective

Criteria	Alternative							
	Alt 1A: All IWS or Decentralized Systems	Alt 1B: Decentralized On-Site Treatment and LPS	Alt 2: 4 Subregional Treatment Plants – Urban Sewering	Alt 3: 3 Subregional Treatment Plants – Urban Sewering	Alt 4: 1 Regional Treatment Plant – Urban Sewering	Alt 5: 1 Regional Treatment Plant – Full Flow Sewering	Alt 6: Flow to Hilo WWTP – Urban Sewering	Alt 7: Flow to Hilo WWTP – Full Flow Sewering
	Score	Score	Score	Score	Score	Score	Score	Score
Estimated Construction Cost	3	2	1	1	1	1	1	1
Estimated Annual O&M Cost	1	1	3	3	3	2	2	2
Operational Ease and Maintainability	3	2	1	1	3	2	2	2
Ability to meet Potential Future Requirements	3	3	2	2	2	2	1	1
Utilization and Acquisition of Land	3	1	1	1	2	2	3	3
Environmental/Regulatory Permitting	3	2	3	3	3	3	2	2
Total Score	**16**	**11**	**11**	**11**	**14**	**12**	**11**	**11**

Notes:

- 3 is the most favorable alternative, 1 is the least favorable alternative.
- The highest total score is the most favorable alternative.
- Scores are preliminary. May be updated pending review by DEM and other project stakeholders.

8.0 FUNDING AND FINANCING CONSIDERATIONS

This section covers institutional and financial support for implementing cesspool conversions, and recommends strategies to consider.

8.1 INSTITUTIONAL STRUCTURE

To allow development of a plan of operation for this feasibility plan, the existing institutional arrangement should be reviewed, and a financial program should be developed after selection of a plan and design. The plan of operation should include preliminary allocation of the costs among various users of the wastewater system. Feasibility of the plan requires agreement among participating entities and stakeholders on the plan implementation. Preparation of a plan of operation is critical, which should include the staffing, management, training, operation, maintenance, and analysis to ensure effective operation of the infrastructure.

8.1.1 Existing Regulations

In the State of Hawaiʻi, there are currently 81,425 documented cesspools. Hawaiʻi Island is estimated to have 48,596 cesspools releasing an estimated 27.3 million gallons of effluent daily [36]. Property owners and operators must comply with all federal and state requirements for cesspools. Act 125, which came into effect in 2017, mandates that all cesspools in Hawaiʻi must be upgraded, converted, or closed by January 1, 2050. Act 132, established in 2018, created a CCWG attached to the Department of Health (DOH), which will develop a plan for cesspool conversion statewide by 2050. The final report was required to be provided to the State of Hawaiʻi legislature no later than 60 days before the 2023 legislative session. The CCWG submitted it November 2022.

The HDOH Wastewater Branch oversees and permits all onsite wastewater systems, including cesspools. Act 125 directed HDOH to evaluate residential cesspools in the state, develop a Report to the Legislature that includes a prioritization method for cesspool upgrades, and work with the Department of Taxation on possible funding options to reduce the financial burden on homeowners. As the CCWG continued to develop a conversion plan, additional research and planning progressed, including reports on conversion or upgrade alternatives, prioritization of locations, and financing options.

Act 87 was passed in 2022, amending Act 125 by broadening the upgrade or conversion options that are available for cesspools.

COH DEM oversees sewer O&M. See Section 3.2 for more information.

8.2 PRIORITY AREAS

Understanding prioritization of areas for cesspool conversions may help with formulating a plan for funding and scheduling wastewater projects. HDOH has prioritized cesspools for corrective action based on the risk the cesspools pose and existing infrastructure such as nearby sewer mains to receive wastewater flows. Also considered are the density of cesspools in an area; soil characteristics; proximity to drinking water sources, streams, and shorelines; other groundwater inputs including agriculture and injected wastewater; and the physical characteristics of coastal waters that may compound the impacts of wastewater on bays and inlets. In the 2017 Report to the Twenty-Ninth Legislature, the HDOH proposed that cesspool replacement efforts be focused by geographic area, and prioritized using four broad categories [36]: Priority 1: Significant risk of human health impact, drinking water impacts, or draining to sensitive water; Priority 2: Potential to Impact Drinking Water; Priority 3: Potential Impacts on Sensitive Waters; and Priority 4: Impacts not Identified.

In 2021, the Hawaiʻi Cesspool Prioritization Tool (HCPT) was released, which provided the CCWG and its Data and Prioritization Subgroup with updated information and data to help make informed decisions. An updated HCPT was published in 2022 [4]. The HCPT identifies a comprehensive list of factors that assisted in the creation of a new cesspool prioritization and hazard assessment. Every cesspool in the state was assessed and prioritized. The tool is designed for the purpose of categorizing cesspools based on potential or realized harm to humans and the environment. A site-based process was used to evaluate factors, determining if a cesspool at a given location has a higher or lower potential to cause negative social and environmental impacts. It is a geographic information system (GIS) tool and examined and categorized previously uncategorized (i.e., Priority Level 4 from the previous 2017 prioritization) cesspools.

The HCPT uses the following criteria (risk factors) to calculate a geographic prioritization score:

1. Distance to municipal or domestic drinking water wells;
2. Well capture zones;
3. Distance to streams and wetlands;
4. Distance to coastline;
5. Sea level rise zones;
6. Precipitation;
7. Depth to groundwater;
8. Groundwater flow paths;
9. Soil characteristics;
10. Cesspool density;
11. Coral cover;
12. Fish biomass/recovery potential;
13. Beach user-days;
14. Proximity to lifeguarded beach; and
15. Coastal ocean circulation proxy

The HCPT prioritization method places each geographic area into three Prioritization Categories that include:

1) Priority Level 1: Greatest contamination hazard.
2) Priority Level 2: Significant contamination hazard.
3) Priority Level 3: Pronounced contamination hazard.

Based on the HCPT, in Puna, there are 14,778 cesspools and they are all Priority Level 3. (This is about 1,200 fewer than the 16,000 cesspools, which are based on the Hawaii Statewide GIS Program database and used in the alternatives analysis for a more conservative approach). The tract name and ID along with the cesspool count from the HCPT is shown in Table 8-1. Every cesspool in the inventory was assigned a priority ranking, on the basis that none were exempt from conversion. However, rather than reviewing every single system individually, the tool results are consolidated into prioritization areas using census boundaries at multiple resolutions.

Table 8-1 Cesspools by Census Tract

Tract Name	Tract ID	Cesspool Count
Hawaiian Paradise Park	97	4,187
Pāhoa	95	2,135
Keaʻau	110	1,515
Kalapana-Kapoho	75	1,175
Orchidland-ʻĀinaloa	96	1,663
Volcano-Mountain View	114	1,371
Upper Puna (Puna Mauka)	111	2,651
Kaʻū	112	81

Note: Tract name, ID, and counts are as printed in the HCPT report [4].

The HCPT tool is a starting point for assessing the areas with the most significant hazards and is meant to support the development of a cesspool conversion plan. The tool is not meant to inform cesspool conversion prioritization timelines. However, the hazard categories provide a framework to prioritize cesspool conversions by the CCWG.

8.3 CESSPOOL CONVERSION IMPLEMENTATION

Generally, options for upgrade or closure include:

- Closure and connection to an existing nearby sewer system with available capacity.
- Closure and connection to a new private or public sewer system.
- Closure and connection to a community-scale package wastewater treatment system.
- Upgrade to an onsite septic tank and/or aerobic treatment unit system.

Regarding resources required, this is from the 2017 HDOH Report to the Legislature [36]:

> *Replacement of each existing cesspool with an improved treatment method could cost $20,000 or more per system, for a total cost around **$1.75 billion** for the 87,900 currently inventoried cesspools (an average construction investment of $54.7 million per year from*

> *2018 through 2049). However, costs may vary from this amount if other options such as connecting to existing sewage treatment systems, joining multiple homes in small-scale community package sewer or joint septic systems, or constructing new larger-scale sewage treatment systems are considered.*

A subsequent 2021 report prepared by Carollo Engineers for HDOH stated the following [37]:

> *Historical costs of cesspool upgrades to approved systems range widely from approximately $9,000 to $60,000 or more depending on the wastewater system capacity (based on bedroom count), technology, and location or site constraints. Assuming an average conversion cost of $23,000, the potential magnitude of the financial burden to convert all 88,000 cesspools is over two billion dollars. (2020 dollars)*

Cesspool conversion costs will be a financial burden to many residents in Hawaiʻi. The Legislature tasked the Cesspool Conversion Working Group to develop a strategy to aid the funding and financing of the cesspool upgrades.

8.3.1 Financing Available to Individual Homeowners

Options for cesspool conversion funding mechanisms include tax credits or rebates, federal, state, or county grants, and private/mortgage loans (affordability is described in Section 8.4 [38]:

- Private/Mortgage Loans
- State Tax Credits or Rebate Programs: Act 120, the temporary tax credit program, expired on December 31,2020
- Grants and Loans: most programs require a public entity or agency as the applicant, but sub loans may be possible.
- Clean Water State Revolving Fund (CWSRF) Program: low interest loans provided to public entities, and counties could funnel funding to individuals.

In June 2022, the following bills related to financing were adopted into law:

- Act 183 HB2088 HD3 SD2: creates the commercial property assessed financing program. The Counties may authorize the Hawaiʻi green infrastructure authority to offer commercial property assessed financing utilizing a non-ad valorem special tax assessment to pay the cost of qualifying improvements.
- Act 153 HB2195 HD2 SD1 CD1: establishes a Cesspool Compliance Pilot grant project to assist low- and moderate-income property owners to upgrade or convert a cesspool (in priority levels 1 or 2). HDOH shall grant awards not to exceed $20,000. The Bill also appropriated $5 million from the general fund for the fiscal year 2022-2023.

  Although Act 153 does not affect cesspools in Puna (no priority levels 1 or 2 cesspools in Puna), it could be useful for other locations on the Island of Hawaiʻi. In March, 2023, the HDOH communicated procedures and held informational meetings to assist the public in applying for the Cesspool Compliance Pilot Grants. A flowchart describing the process is included in Appendix H.

8.3.2 Financing Alternatives for County of Hawaiʻi

Potential funding options, recommendations, and benefits and limitations are included in the following, and further information on funding opportunities can be found in the Financing Cesspool Conversions in Hawaiʻi report [38].

8.3.2.1 BONDS

General obligation (GO) bonds are backed by the general revenue of COH. Revenue bonds are supported by a specific revenue source, such as income from sewer fees.

8.3.2.2 GRANTS

EDA

The U.S. Economic Development Administration grants help to fulfill regional economic development strategies designed to accelerate innovation and entrepreneurship, advance regional competitiveness, create higher-skill, living-wage jobs, generate private investment, and fortify and grow industry clusters. COH received an EDA Grant in 2021 for Puna District non-construction projects, and is currently utilizing it for economic adjustment assistance, short term planning, and technical assistance programs under Sections 203, 207 and 209 of the Public Works and Economic Development Act of 1965, as amended, 42 U.S.C. §§ 3143, 3147 and 3149.

Eligible applicants for EDA grants include states, political subdivisions of states, district organizations, institutions of higher education, and non-profits working with a political subdivision of a state. To apply, specific criteria and requirements must be met, such as meeting economic distress criteria (e.g., higher unemployment rate or lower per capita income compared to national averages) or demonstrating a "special need" as determined by the EDA. Proposals should be based on a locally developed comprehensive economic development strategy or an equivalent document. Cost sharing or matching is generally required, with the EDA's investment not exceeding 50% of the total project cost. Applications can be submitted through the Federal government's official grant website or the appropriate EDA regional office. EDA accepts applications at any time and evaluates proposals based on investment policy guidelines and funding priorities. Although specific to the grant program and guidelines set by the EDA, grant money can often be used for planning, design, and construction. Per the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA), EDA evaluates how the proposed project could impact the environment and historic properties.

USBR

The U.S. Bureau of Reclamation (USBR) WaterSMART program awards grants to water districts and other project sponsor seeking to reuse water and add to water supplies. The Title XVI/WIIN Water Reclamation and Reuse grant aims to identify and explore opportunities to reclaim and reuse wastewaters, as well as impaired ground and surface water. The program provides as much as 25 percent of construction costs with a maximum of $20 million. From 1992 through 2017, it awarded about $715 million. About $703 million went towards construction projects that recycled water. The DEM is currently submitting a USBR Grant application to fund some of the Kealakehe WWTP R-1 improvements.

Under Title XVI, USBR provides funding support for planning, designing, and constructing water recycling and reuse projects in collaboration with local government entities. Projects must meet specific criteria to be eligible for funding, including complying with the National Environmental Policy Act (NEPA) and having a completed Feasibility Study that the USBR has reviewed. The Feasibility Study must fulfill all the Reclamation Manual Release WTR 11-01 requirements. Additionally, the findings of USBR's review must be officially transmitted to Congress for authorization. Once the project is considered eligible for funding, it is recommended in the President's annual budget request by the USBR.

EPA Technical Assistance

The EPA has several programs to provide technical assistance. The following describes examples of programs that may be available for COH.

- Urban Waters Small Grants program: fund research, investigations, experiments, training, surveys, studies, and demonstrations that will advance the restoration of urban waters by improving water quality through activities that also support community revitalization and other local priorities. The Urban Waters Small Grants are completed and awarded every two years. Eligible applicants include States, local governments, Indian Tribes, public and private universities and colleges, public or private nonprofit institutions/organizations, intertribal consortia, and interstate agencies. Projects should meet the following four program objectives: address local water quality issues related to urban runoff pollution, provide additional community benefits, actively engage underserved communities, and foster partnership. The EPA Pacific Southwest (Region 9) office should be contacted for more information on the pre-application/pre-proposal process.
- Water Infrastructure and Resiliency Finance Center: works with on-the-ground partners to provide financial technical assistance to communities. The organization provides financial advice to help communities make informed decisions on funding drinking water, wastewater, and stormwater infrastructure projects. Utilities may also access tools to help with financing decisions to meet local infrastructure needs. In November 2022, EPA selected the Hawaiʻi Community Foundation (HCF) as an Environmental Finance Center to provide technical assistance and help communities develop and submit project proposals, including State Revolving Fund (SRF) applications for Bipartisan Infrastructure Law funding. The finance center will support underserved communities with technical assistance to identify sustainable infrastructure solutions. It will provide states, Tribes, and local governments with technical assistance services to advance equitable health and environmental protection.
    - HCF recently established the Hawaiian Islands Environmental Finance Center (HIEFC) as an EPA Finance Center to address water infrastructure needs in Hawaiʻi. HIEFC and its partners plan to collaborate to identify innovative and actionable projects focused on sustainability and water resilience, mainly promoting equity in disadvantaged communities. They will assist in federal funding applications, guiding partners through project visioning, conceptual

design, grant writing, and other project development and management aspects. They will also engage with key stakeholders through training, exploratory design, and planning while contributing technical content to funding proposals and other written materials. Additionally, they will support HIEFC partners with federal funding awards, including post-award processes, project management, and hands-on project implementation. For comprehensive details regarding future applications/requests for the proposal process, it is advised to contact the HCF. They can provide further information and guidance about the application requirements and procedures.

USDA Rural Development Loan and Grant Assistance

The U.S. Department of Agriculture (USDA) forges partnerships with rural communities, funding projects that bring housing, community facilities, business guarantees, utilities, and other services to rural America. USDA Rural Development works with low-income individuals, State, local, and Indian tribal governments, as well as private and nonprofit organizations and user-owned cooperatives. The USDA Rural Development has a Water and Environmental Program that provides loans, grants, and loan guarantees for drinking water, sanitary sewer, and storm drainage facilities in rural areas, cities, and towns with populations of 10,000 or less. Public bodies, non-profit organizations, and recognized Indian tribes may qualify for assistance.

Grant funds can be allocated towards financing various aspects of sewer infrastructure, including the acquisition, construction, and improvement of sewer collection, transmission, treatment, and disposal systems. Additionally, in certain instances, funding may cover expenses such as legal and engineering fees, land acquisition, water and land rights, permits, equipment, start-up operations, and maintenance costs. It is important to note that this program operates under the regulations outlined in 7 CFR, Part 1780 and 1782, and Section 306 of the Consolidated Farm and Rural Development Act. Funding applications are accepted throughout the year, and applicants can file electronically via RD Apply or through their local RD office. Information can be accessed online through the official RD website for further program details and resources.

U.S. Department of Housing and Urban Development, Community Development Block Grants

The U.S. Department of Housing and Urban Development provides funds for long-term community needs, including rehabilitation, construction, or purchase of public facilities and infrastructure for water treatment and centralized and decentralized wastewater systems.

The County of Hawaiʻi currently administers a Community Development Block Grant (CDBG) program to foster viable communities' development. This program strives to provide decent housing, create suitable living environments, and expand economic opportunities for individuals with low to moderate incomes. CDBG funds are allocated to the County of Hawaiʻi annually through a formula-based approach, enabling the county to address high-priority housing and community development needs outlined in its 5-year Consolidated Plan, primarily focusing on benefiting low- and moderate-income individuals. Each project that receives funding must fulfill one of the following national objectives:

- Principally benefiting low- and moderate-income persons.
- Aiding in the prevention or elimination of slums or blight.
- Addressing a need of urgency is known as an urgent need.

CDBG funds are allocated through a thorough Request for Proposal (RFP) process, wherein projects are meticulously evaluated and awarded based on a weighted point system. The Application Packet includes the specific Project Evaluation and Rating System employed. Eligible applicants for CDBG funding encompass non-profit agencies, government agencies, and community-based development organizations (CBDO), as outlined in Title 24 CFR 570.204. To ensure compliance, it is essential to refer to the federal and state regulations (cross-cutters) available on the County of Hawaiʻi's Office of Housing and Community Development website.

Build Back Better Act

The Build Back Better Act (BBBA) established key priority areas for local governments and included programs to support workforce development, increase housing affordability and improve climate resilience. The version that passed the House also included grant funding for five critical water infrastructure programs: 1) Lead Remediation, 2) Assistance for Low-Income Water Users, 3) Alternative Water Source Project Grants ($125 million to support investment in alternative water source projects, including projects for groundwater recharge and potable reuse), 4) Sewer Overflow and Stormwater Reuse Municipal Grants ($1.850 billion to invest in sewer overflow and stormwater reuse projects, as well as for a greater federal cost share of projects that serve financially distressed communities), and 5) Individual Household Decentralized Wastewater Treatment System Grants ($150 million for the installation, repair, or replacement of domestic septic systems, including investment in connecting households with failing septic systems to public sewer systems). This last of the five programs targets half of the investment to low-income households that lack access to sewage treatment technologies, including households that currently use cesspools to capture sewage. Monitoring should be conducted of the mechanisms to execute these programs and which specific programs the County of Hawaiʻi may be able to utilize.

Water Pollution Control Grants Program (Section 106 of the Clean Water Act)

Under Section 106 of the Clean Water Act (33 U.S. Code §1256), EPA provides federal assistance to States, Territories, the District of Columbia, Indian Tribes, and Interstate Agencies to establish and implement ongoing water pollution control programs. Section 106 funds can be used for water quality monitoring and assessment, water quality standards and Total Maximum Daily Load Development and Implementation, National Pollutant Discharge Elimination System permitting and enforcement, source water protection, and ground water protection. A possible program would be to identify and protect the public water system from contaminant sources or activities within the source water protection area (watershed).

Preapplication coordination is a necessary step. Providing environmental impact information is not mandatory for this program. To learn about the application process required by the State of Hawaiʻi for seeking assistance, the applicant should consult an EPA office or an official designated as the single point of contact. Informal meetings are scheduled as necessary between the regional office, State, territorial, and Indian tribe applicant agencies during the development of the work plan. The grant agreement should accurately represent the priorities outlined in the EPA Strategic Plan and any State/EPA Agreements. Unless the Agency has approved limited circumstances, all initial funding applications must be submitted by applicants through the Federal government's official grant website.

8.3.2.3 LOANS

EPA Funding of Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) Program assists in financing the construction of water pollution control projects necessary to prevent contamination of our groundwater and coastal water resources and to protect and promote the health, safety, and welfare of the citizens of the State of Hawaiʻi. The CWSRF uses federal, state, and other program funds to provide low-interest loans to communities for water quality projects. States may customize loan terms to meet the needs of small, disadvantaged communities, which typically have fewer financing options. To be included in the annual priority list, projects must submit an Intended Use Plan (IUP). Applications are available online on the DOH Wastewater Branch website for this purpose.

Projects Eligible for CWSRF Funding include point source projects such as:

- New, expanded, or rehabilitated wastewater treatment plants.
- Publicly-owned water reuse systems and distribution lines.
- New or rehabilitated collector, trunk, and interceptor sewers.
- Sludge reuse, treatment, and disposal facilities.
- Septage handling, marine vessel pump out, and treatment facilities.

Non-Point Source Projects eligible for funding include:

- Watershed planning/assessment or implementation of projects needed to restore NPS impaired waters.
- Cesspool replacement with septic tanks, aerobic units, constructed wetlands, or treatment plants.
- Brownfield projects involving site assessments, underground storage tank removal and disposal, contaminated soil or sediment removal and disposal, capping wells, soil remediation, controlling stormwater runoff, and monitoring groundwater and surface water for contaminants.

The DOH is responsible for conducting an environmental review of projects funded through the CWSRF, as mandated by the Code of Federal Regulations (CFR). This review process follows the EPA-approved State Environmental Review Process. Furthermore, the

State must adhere to the Federal cross-cutting authorities outlined in 40 CFR §35.3145 specifically for the CWSRF.

WIFIA

The Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) established the WIFIA program, a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. Eligible borrowers are:

- Local, state, tribal, and federal government entities
- Partnerships and joint ventures
- Corporations and trusts
- Clean Water and Drinking Water State Revolving Fund (SRF) programs

The WIFIA program can fund development and implementation activities for eligible projects, such as those eligible for the CWSRF. These activities include:

- Development phase activities, including planning, preliminary engineering, design, environmental review, revenue forecasting, and other pre-construction activities.
- Construction, reconstruction, rehabilitation, and replacement activities.
- Acquisition of real property or an interest in real property, environmental mitigation, construction contingencies, and acquisition of equipment.
- Capitalized interest necessary to meet market requirements, reasonably required reserve funds, capital issuance expenses and other carrying costs during construction.

The WIFIA application process involves two phases. In the first phase, prospective borrowers submit letters of interest to the EPA, providing information about project eligibility, creditworthiness, feasibility, and alignment with EPA's priorities. EPA selects projects based on these reviews and invites them to proceed. Starting from FY 2022, letters of interest can be submitted on a rolling basis for year-round access to funding. In the second phase, invited applicants apply for the WIFIA loan, undergo a detailed financial and engineering review, and negotiate terms and conditions with the WIFIA program. Approval from the EPA Administrator and the Office of Management and Budget is required before closing. At closing, the borrower signs the credit agreement to receive WIFIA funds. Some environmental cross-cutters include Environmental Justice Executive Order 12898, the National Preservation Act, and the Endangered Species Act.

Special Improvement Financing

COH has several regulations enabling creation of Special Improvement Districts or Community Facility Districts. A Sewer System Improvement District is an area that has been designated by COH as an Improvement District (ID). A district may be established to finance the purchase, construction, installation, expansion, improvement, or rehabilitation of any real or other tangible property with a useful life estimated by the council to be five years or longer.

Wastewater systems are an example of special improvements that may be financed by a district. An example of this is the Lono Kona Sewer Improvement District in North Kona (6). It was a Special Improvement District specifically created to address the EPA's requirement to close large-capacity cesspools. This program funded the connection of 110 parcels to the COH wastewater system. A similar funding mechanism could be employed for funding a neighborhood's cesspool conversions.

A tax is levied on property owners within the ID who will benefit from sewer improvements. This tax is used to pay the bond costs for the improvements and is different from a general tax because it is only levied on properties that will receive a special benefit from the improvements.

For example, if COH decides to install new sewer infrastructure in a neighborhood, the cost of the project may be divided among the property owners in the area. Each property owner would be assessed a certain amount based on the size and value of their property, or perhaps based on expected sewer flows. This assessment would be used to pay for the installation of the new sewer lines.

The infrastructure will subsequently be dedicated to COH. The ID funds do not cover the private hookup portions or any other private construction. The coordination and cooperation between the responsible director, the participating departments, and the landowners in the ID is critical. COH would manage the improvements, so the construction needs to be according to codes and standards.

There are four ways to initiate an ID:

1. Initiation by Council: by resolution and passage by one reading, Council can direct the DEM Director to prepare and submit to Council a report on the improvements proposed, method of assessment, surveys, lands to be acquired, costs, plans, details, specs.

2. Initiation by petition by 60% of owners: If a petition is filed by 60% (or greater) of the owners requesting the construction of special improvements, then Council may reject or accept the petition. The petition must include the surveys, maps, plans and other preliminary data and estimates mentioned previously.

3. Petition by 20% of owners: If the owners of at least 20% based on frontage along any street, alley or highway designated by them or of twenty percent of the area of land designated by them as a proposed ID, file a petition with Council requesting the construction of special improvements. The petition, together with the surveys, maps, plans and other preliminary data and estimates mentioned earlier, may be rejected or accepted by Council.

4. Petition by owners of 100% of frontage or area: If a petition is filed by 100% of the owners of the proposed ID, the notice and hearing requirement is unnecessary. The petition with the surveys, maps, etc., may be rejected or accepted by Council.

Council may, by resolution, propose the making of an ID, requiring one reading for adoption of the proposed ID process.

The resolution fixes a date for the public hearing on the proposed improvement, giving at least 15 days' notice in at least one newspaper of general circulation in the county. The duration of the notice is longer for petitions with only 20% of owners.

Council may adopt the plans and estimates, which shall be incorporated by reference in the resolution.

After adoption of the resolution fixing the date for the public hearing, the COH clerk publishes notices of the public hearing (newspaper, post copies, mail notices) to all owners who may be assessed.

Decision Making: Should 51% or more of the owners of the assessment units fail to object prior to or at the hearing, the proposed improvement by assessment shall be approved by Council passing a resolution requiring one reading for its adoption. However, no ID shall be approved unless:

1. The assessed valuation for taxation purposes of the assessment units to be improved is at least twice the estimated costs of the proposed improvement; or

2. The council finds the appraised value of such assessment units as improved is at least twice the estimated cost of the proposed improvement. The appraisal shall be conducted in accordance with prevailing standards for appraisals used by banks for loans.

3. No ID shall be approved unless the council finds that such improvement is in the public interest.

The owner of an assessment unit may file any protest, objection, or suggestions. If the owners of assessment units which are proposed to have 50% or more of the total assessments (whether such assessments are to be assessed by frontage, area or otherwise) file written protests, duly acknowledged by such owners, against making all or part of the proposed improvements or against the methods by which such assessments are to be made, or the inclusion of certain costs therein, then the improvements or methods of assessment shall not be made contrary to the written protests.

Upon a final decision, Council fixes the cost assessment against the assessment units and owners by ordinance.

8.3.2.4 New Sources of Revenue

New Fees

Current COH wastewater rates are in 5 user categories:

1. Single Unit Residential: monthly charge per unit
2. Multi-Unit Residential: monthly charge per unit
3. Nonresidential: monthly base rate charge per unit plus monthly usage charge per 1000 gallons
4. Private Haulers Discharge Fee: fee per 500 gallons, with a minimum charge per load

5. Gang Cesspools: monthly charge per unit

Possible fees to consider adding would include pumping of septic tanks, repair and maintenance of the customer's system, impact fees, high-strength and industrial wastewater surcharges, and outside-city rate differentials. Customer service charges like connection fees, late payment penalty, and account activation fees could be considered. It could be possible to add fees to all usage charges that are costs incurred by COH DEM and benefit the entire community like environmental protection fee and fuel surcharge fee.

Consider changing the rate structure by billing on a flat base rate plus volumetric basis depending on the amount of water the customer has used. This two-part billing includes: a sewer base charge (based on fixed cost associated with operating and maintaining the municipal sewer system) and a sewer usage charge (based on water consumption and representing the variable cost of transporting and treating the wastewater). Honolulu has a flat base charge plus a usage-based charge, and the usage-based charge collects the costs to collect and treat an average return of 80% of the water used back to the sewer system.

A rate study should be done to determine if these changes will recover all the costs of COH DEM.

Conversion of cesspools to IWS and regular maintenance of the IWS would probably increase the volume of septage to be received and treated at the Hilo WWTP, increasing income to COH. Future upgrades or expansion may be needed to provide reliable and effective treatment as flows and loadings increase. Estimating the quantity of septage depends on factors such as the frequency of septic tank pumping (EPA recommends every three years), the growth of IWS over time (assumed to be straight line growth and conversions over 30 years), and volume pumped (assumed to be 1,000 gallons per IWS). Using these assumptions, the initial year income (at 2023 COH rates) would be $48,537, for a total volume of 379,198 gallons, with the 2051 estimate (assuming 3% inflation on the septage receiving charges) of $4,132767 for a total volume of 11,818,580 gallons.

For comparison, the total billed in 2022 for Hilo (at the old rate of $58 per 500 gallons) was $270,616, meaning that the estimated income from the Puna area would add approximately 18% to the existing income in the first year. Some unknowns are the capacity of the Hilo WWTP to handle additional septage volumes or costs to upgrade the WWTP, the actual implementation schedule of cesspool conversions, the frequency of pumping, and the level of existing septage hauling from the Puna area. The initial yearly charges from Puna would likely be a small percentage of the likely capital costs if major solids projects are required at the Hilo WWTP.

Reclaimed Water

DEM has prepared a Feasibility Study for Kealakehe WWTP R-1. A plan is under preparation for funding the proposed water reclamation project's construction, operation, maintenance, and replacement costs. According to the 1999 Kealakehe Effluent Reuse Master Plan, typical funding sources that support a water reuse program are reclaimed water rates, wastewater discharge fees, developer fees, and potable water sales revenue. DEM is also evaluating simpler, cheaper alternatives like producing R-2 water instead, which has more restricted use for golf courses and agricultural irrigation.

The COH study for R-1 has determined that O&M costs would be funded through user fees; R-1 user fees will be projected between 80% to 90% of the current water supply charges (of the agricultural rate). For context purposes, usage rates per 1000 gallons is $1.14 for COH Department of Water Supply. The essential needs or Tier 1 usage rates per 1000 gallons is $4.46 for the Honolulu Board of Water Supply on Oʻahu. However, recycled water is rarely charged at the equivalent rate of municipal water, due to its more limited uses.

The value of the reclaimed water is dependent on having year-round customers and a system to distribute reclaimed water to the customers. COH will also need to adopt administrative rules to obtain the authority and framework to charge fees for reclaimed water.

8.4 AFFORDABILITY

8.4.1 Water Affordability and Clean Water Act Implementation

Investments to meet federal wastewater requirements can impose a significant financial burden on the community. The intent of the EPA’s affordability criteria is to indicate when mandates would cause economic distress in a community. This is from the Affordability Assessment Tool for Federal Water Mandates prepared for the U.S. Conference of Mayors [39]:

> *With the intention of providing a mechanism for relieving undue economic stress in the face of wastewater-related mandates, EPA has developed “affordability” criteria to indicate when such mandates would cause substantial and widespread economic distress in the community. In the case of undue economic stress caused by wastewater requirements, the Agency might be willing to exercise some flexibility in the mandate by allowing a longer timeframe to achieve compliance or by relaxing compliance standards. (from Affordability Assessment Tool for Federal Water Mandates, Stratus Consulting, Boulder, Colorado, c. 2013, U.S. Conference of Mayors, AWWA and WEF)*

EPA’s view is that EPA would consider a combined annual water and wastewater bill of less than 4.5% of median household income (MHI) to be “affordable.” The breakdown is 2.5% for water plus 2% for wastewater services and combined sewer overflow controls [40].

EPA issued its Proposed 2022 CWA Financial Capability Assessment (FCA) Guidance for public comment in February 2022. The proposed guidance outlines strategies for communities to support affordable utility rates, while planning investments in water infrastructure that are essential for CWA implementation.

There are two alternatives that communities can use under the FCA. Alternative 1 involves evaluating a NPDES permittee’s financial capability to fund CWA controls by calculating Residential Indicator and Financial Capability Indicators. Another metric, the Lowest Quintile Poverty Indicator (LQPI) Score, was added. Alternative 2 involves analyzing financial and rate models in addition to calculating the LQPI Score and performing a Financial Alternatives Analysis.

The FCA Guidance is used by municipalities when devising plans to dramatically reduce discharges. During that process, municipalities and EPA negotiate schedules with specific timeframes for implementation. The 2023 FCA Guidance describes the financial information and formulas the agency intends to use to evaluate the financial resources a community has available to implement control measures and timeframes associated with implementation.

The Final 2023 FCA replaced the 1997 FCA Guidance to evaluate a community's capability to fund CWA control measures in both the permitting and enforcement context. The 2023 FCA also supplements the public sector sections of the 1995 Water Quality Standard (WQS) Guidance to assist states and authorized tribes in assessing the degree of economic and social impact of potential WQS decisions.

Under the FCA guidance, if a municipality is concerned that clean water compliance costs would drive unaffordable rate increases for low-income households, it must seek to mitigate cost burdens on low-income households without dragging out compliance.

EPA provides a checklist of "financial alternatives" for utilities to consider, which can reduce burdens on low-income households. These include creating "lifeline" rates with a low charge for an initial amount of usage to meet essential needs; capping water bills for low-income households at a percentage of income; offering bill discounts to low-income households; helping low-income customers repair plumbing leaks and replace old, water-guzzling toilets; charging non-residential properties for their fair share of stormwater costs; securing grants and subsidized loans to reduce the costs of capital improvements for all ratepayers; and ensuring that ratepayer revenues aren't diverted to non-utility purposes.

8.4.2 Statewide Affordability

A homeowner is financially burdened if the average monthly cost exceeds 2% of their annual income [38]. The DOH Cesspool Conversion Finance Research Report [38] calculated the potential monthly financial impacts to homeowners to convert cesspools. The estimated average total monthly cost was $210, assuming the following: 1) using information from DOH on historical installation costs for septic tank and aerobic treatment unit treatment and disposal; 2) a 20-year loan at 4.0% annual interest rate, and 3) estimated monthly O&M costs for various onsite treatment options. Assuming $210 (capital and O&M) is the estimated average monthly cost to convert a cesspool to an approved OSDS, homeowners with an annual income of less than $126,000 would realize a financial hardship by the cost to convert. If a hypothetical $10,000 rebate for the conversion were provided to homeowners, the estimated average monthly cost to convert would drop to $150. This would lower the threshold so that homeowners with an annual income of less than $90,000 per year would be financially burdened. (CCWG Final Report).

Approximately 97% of all residents with cesspools in Hawaiʻi have an income less than $126,000 and thus would be financially burdened by the cost to convert. If a $10,000 rebate were provided to each household, approximately 85% would be financially burdened. The 2021 estimated median household income for the State of Hawaiʻi was $84,857.

Hawai'i County, with the most cesspools of all counties, has the greatest affordability challenges.

8.4.3 Affordability in the County of Hawaiʻi and Puna

With approximately 48,596 cesspools, COH has the largest number of cesspools in the State [38]. COH also has the most residents facing affordability challenges. It has the greatest proportion of households without centralized sewers than any other county (71%).

The median income of households in COH was $65,401 (2020 Census) and $69,473 per the Census 2021 estimates. The Census 2021 estimates showed 7.6 percent of households had income below $10,000 a year and 10% had income over $200,000 or more. There were 72,194 households in COH.

The Puna District cesspool count totals 14,699. The total number of households in Puna from the 2021 Census estimates is 17,244. The combined median income for the Puna area is approximately $53,875. The median incomes for the 23 subareas (Census Designated Places) that are within the Puna Study area range from a low of $18,301 to a high of $123,101. The median incomes for all tracts in Puna are shown in Table 8-2.

Table 8-2 Median Household Incomes by Census Designated Place

Census Designated Place	# Households	2021 Estimated MHI
ʻĀinaloa	1,388	$ 43,150
Black Sands	83	* -
Eden Roc	307	$ 25,956
Fern Acres	637	$ 56,964
Fern Forest	358	$ 34,167
Hawaiian Acres	1,201	$ 48,828
Hawaiian Beaches	1,584	$ 49,559
Hawaiian Paradise Park	4,236	$ 74,741
Kalapana	24	* -
Kamāʻili	99	* -
Keaʻau	395	$ 75,756
Kurtistown	957	$ 80,601
Leilani Estates	764	$ 30,481
Mauna Loa Estates	620	$ 50,380
Mountain View	1,082	$ 47,857
Nānāwale Estates	589	$ 37,220
Orchidland Estates	1,036	$ 58,750
Pāhoa	411	$ 57,188
Royal Hawaiian Estates	479	$ 65,890
Seaview	162	$ 18,611
Tiki Gardens	169	$ 18,301
Volcano Golf Course	325	$ 123,101
Volcano	338	$ 80,000

Note:
* - indicates that no median or mean incomes are provided by the Census data.

A homeowner is financially burdened if the average monthly cost exceeds 2% of their annual income **[38]**. Figure 8-1 shows the variability in income for the combined Puna area (each bar represents the % of Puna households with that income level), the 2% affordability for each income level and the median household affordability level.

Table 8-3 shows the calculated affordable monthly rates (using the 2% threshold) for the State, County, and Puna district based on the median household income data (calculations shown in Appendix B).

Figure 8-1 Puna Combined Income and Affordability (2021)

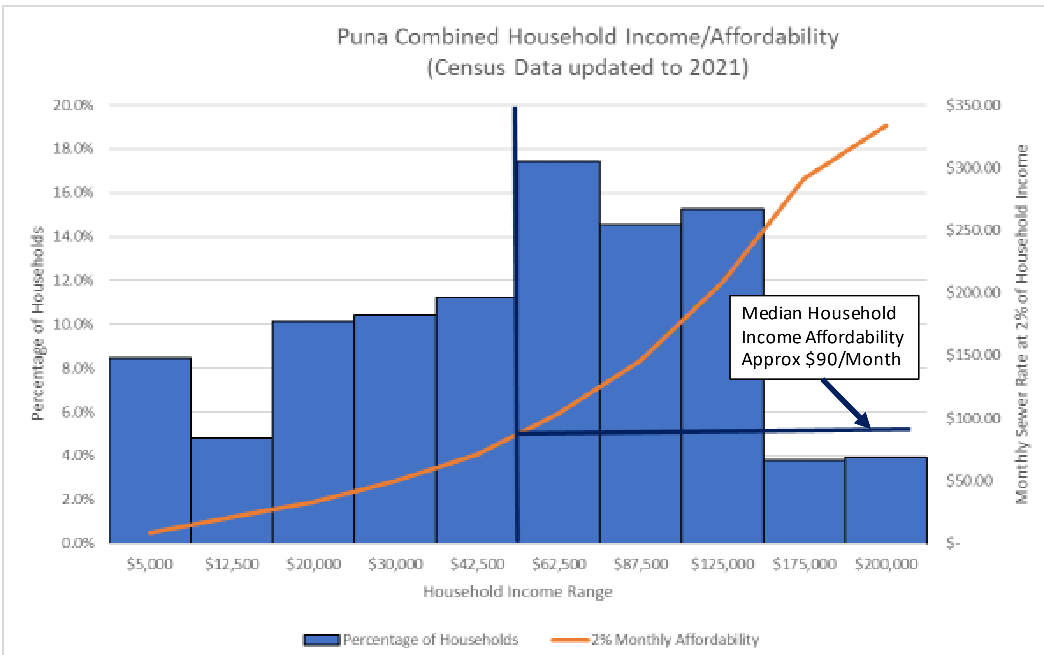


Table 8-3 Median Household Incomes and Affordable Monthly Rates

Area	2021 Census Estimated Median Household Income	Affordable Monthly Sewer Rate
State of Hawaiʻi	$84,857	$141.29
County of Hawaiʻi	$69,473	$115.79
Puna District	$53,875	$89.79

8.5 COUNTY OF HAWAIʻI RATE IMPACTS

Ordinance No. 19 21, effective April 1, 2019, amended the Hawaiʻi County Code to establish wastewater service charges for the years 2019 through 2023. Current COH wastewater rates are in 5 user categories: single family residential units, multi-unit residential, nonresidential, private haulers discharge fee, and gang cesspools.

Current rates assume debt service for CIP was carried by the county through the issuance of GO bonds and the debt paid by all community members. The current rates cover just operating cost of the department's activities. There currently is no connection fee.

DEM could consider an enterprise-fund type of system like the CCH. An enterprise fund is a self-supporting government fund that sells goods and services to the public for a fee. CCH Department of Environmental Services can issue revenue bonds and establish sewer rates to cover the cost of the enterprise. Revenues are segregated into a sewer fund that can be used only for that purpose, with financial statements separate from other government activities.

A rate model was developed by DEM and was used to calculate options for rates for wastewater alternatives described in this facility plan. Alternatives 1A and 1B would not incur COH costs as these would likely be fully borne by each homeowner. However, these were included in the rate increase analysis to enable comparison of financial impacts as one factor which will ultimately be borne by COH residents.

Scenarios were run for the lowest and highest estimated cost alternatives described in Section 4 using the costs as described in Section 7. This included:

1. Options which would treat the Puna area separately (independent) from the rest of the county using only the future rate payers from the Puna area
2. Options which included all the existing COH costs and rate payers

For each of these options, options were developed addressing capital costs in two different ways:

3. Rates to carry O&M only for the lowest and highest alternatives with no debt service (assuming the County continues with the County carrying CIP thru GO bonds)
4. Rates for the lowest and highest alternatives (assuming an enterprise fund model and all capital and O&M costs are carried).

Each of the above was also analyzed with a variety of potential funding mechanisms:

1. Monthly Flat Rate
2. Monthly Flat Rate and Connection Fee
3. PAYGO Method followed by Monthly Rate (based on option discussed by Cesspool Conversion Working group) where monthly payments will be collected for a period of time before connection and following connection the monthly flat rate would be charged
4. PAYGO, Monthly flat rate plus Connection Fee
5. All of the above with and without a grant of 80% covering Capital Costs (to determine potential impact of grant funding)

The preliminary rate analysis results shown in Table 8-4 are based on number of connections, which were assumed based on the population projections in Section 4. The Puna area does include some nonresidential zoned properties that could be higher water users, and therefore could be charged a higher sewer rate with monthly usage charges per Hawaiʻi County Code Section 21-36.1. The small percentage of non-residential users is unlikely to be significant in this preliminary rate analysis but should be considered in formal rate analysis.

The “No Debt Service” options include costs for operation and maintenance of the proposed improvements, and in the countywide options include operations and maintenance costs of the existing COH system. The “With Debt Service” options include the above costs as well as the financed interest and principal payments for the Capital improvement costs for the proposed improvements. The current sewer rates for DEM customers do not include the Debt Service costs as the capital improvements are funded by COH General Obligation bonds, repaid by taxes.

Table 8-4 Preliminary Rate Analysis Results

<table>
<tr><th colspan="10">NO CONNECTION FEES</th></tr>
<tr><th rowspan="3">Alternative</th><th rowspan="3">Rate or Fee Type</th><th colspan="4">No Grants</th><th colspan="4">80% Grant $ [a]</th></tr>
<tr><th colspan="2">Independent Costs</th><th colspan="2">Countywide</th><th colspan="2">Independent Costs</th><th colspan="2">Countywide</th></tr>
<tr><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th></tr>
<tr><td>1A</td><td>Monthly Sewer Fee</td><td>$117</td><td>$700 [b]</td><td>$126</td><td>$575</td><td>$117</td><td>$250</td><td>$126</td><td>$315</td></tr>
<tr><td rowspan="2">1A PAYGO [c]</td><td>Monthly Flat Sewer Rate</td><td>$83</td><td>$430</td><td>$100</td><td>$250</td><td>$83</td><td>$135</td><td>$100</td><td>$225</td></tr>
<tr><td>PAYGO Payment (10 yrs)</td><td>$100</td><td>$500</td><td>$200</td><td>$2,000</td><td>$100</td><td>$150</td><td>$200</td><td>$225</td></tr>
<tr><td>7</td><td>Monthly Sewer Fee</td><td>$135</td><td>$21,000 [b]</td><td>$117</td><td>$3,300</td><td>$135</td><td>$5,000 [b]</td><td>$117</td><td>$850</td></tr>
<tr><td rowspan="2">7 PAYGO [c]</td><td>Monthly Flat Sewer Rate</td><td>$55</td><td>$9,200</td><td>$71</td><td>$2,500</td><td>$55</td><td>$1,800</td><td>$71</td><td>$700</td></tr>
<tr><td>PAYGO Payment (10 yrs)</td><td>$55</td><td>$12,000</td><td>$650</td><td>$3,000</td><td>$55</td><td>$2,500</td><td>$650</td><td>$700</td></tr>
<tr><th colspan="10">WITH CONNECTION FEES</th></tr>
<tr><th rowspan="3">Alternative</th><th rowspan="3">Rate or Fee Type</th><th colspan="4">No Grants</th><th colspan="4">80% Grant $ [a]</th></tr>
<tr><th colspan="2">Independent Costs</th><th colspan="2">Countywide</th><th colspan="2">Independent Costs</th><th colspan="2">Countywide</th></tr>
<tr><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th><th>No Debt Service</th><th>With Debt Service</th></tr>
<tr><td rowspan="2">1A</td><td>Monthly Sewer Fee</td><td>$60</td><td>$580</td><td>$95</td><td>$544</td><td>$60</td><td>$165</td><td>$95</td><td>$278</td></tr>
<tr><td>Connection Fee</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td></tr>
<tr><td rowspan="3">1A PAYGO [c]</td><td>Monthly Flat Sewer Rate</td><td>$55</td><td>$400</td><td>$80</td><td>$211</td><td>$55</td><td>$95</td><td>$80</td><td>$167</td></tr>
<tr><td>PAYGO Payment (10 yrs)</td><td>$80</td><td>$500</td><td>$100</td><td>$2,000</td><td>$80</td><td>$200</td><td>$100</td><td>$225</td></tr>
<tr><td>Connection Fee</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td><td>$10,000</td></tr>
<tr><td rowspan="2">7</td><td>Monthly Sewer Fee</td><td>$55</td><td>$20,000 [b]</td><td>$106</td><td>$3,000</td><td>$55</td><td>$4,000 [b]</td><td>$106</td><td>$800</td></tr>
<tr><td>Connection Fee</td><td>$2,500</td><td>$10,000 [b]</td><td>$10,000</td><td>$20,000</td><td>$2,500</td><td>$10,000 [b]</td><td>$10,000</td><td>$1,000</td></tr>
<tr><td rowspan="3">7 PAYGO [c]</td><td>Monthly Flat Sewer Rate</td><td>$45</td><td>$8,500</td><td>$56</td><td>$2,500</td><td>$45</td><td>$1,500</td><td>$56</td><td>$600</td></tr>
<tr><td>PAYGO Payment (10 yrs)</td><td>$45</td><td>$12,000</td><td>$200</td><td>$2,500</td><td>$45</td><td>$2,200</td><td>$200</td><td>$700</td></tr>
<tr><td>Connection Fee</td><td>$1,000</td><td>$20,000</td><td>$10,000</td><td>$20,000</td><td>$1,000</td><td>$20,000</td><td>$10,000</td><td>$20,000</td></tr>
</table>

Notes:
[a] Grants apply to capital costs only
[b] Negative cash flow for initial years (Expenses exceed income as sewer service starts)
[c] Assume existing cesspools start paying but don't connect for 10 years
[d] All rates inflate at 3%

The results from these preliminary rate analyses indicate that very few of the options will be affordable based on the 2% of median household income criteria especially if they need to cover the debt service for the capital costs. It should be noted that these are preliminary results but provide an indication of the need to address the gaps between affordability and the high capital costs of these alternatives. The original County rate spreadsheet utilized 20-year financing. Using a 40-year capital loan period reduces monthly rates between 20 to 33%. However, it does not achieve affordable rates.

The key to a solution for the COH will be to search out funds from a variety of sources, but especially grants or legislative funds that will not require repayment. The high costs of any wastewater alternative and the affordability estimates for the county residents necessitate financial assistance.

8.6 Implementation Strategy

The feasibility of sewer projects in Puna should consider the following:

- Whether cost should be the highest priority criterion for prioritization of alternatives or should other environmental and social considerations be used to prioritize alternatives.
- Consider setting rate increases at some % of median income, and funding only the CIP within the allowable rate increase. E.g., If the cost per household is limited to 75% of median, x% of the households could manage it, although the rest would need to be subsidized with $y per month.
- Thorough assessment of all financing options for sewer systems and for IWS to lower costs to each household as much as possible. For example, evaluate if financing by an agency like HDOH's SRF could be transformed into per household financing for individual cesspool conversion.
- Work to obtain EPA or HDOH support for grants to assist residential homeowners. Support HDOH in promulgating rules to administer the grant program in Act 153 to assist COH and/or residential homeowners.
- Assess funding opportunities for the County to pilot projects utilizing alternative treatment systems with non-standard options for reuse of solids and water with lower impacts.
- Discuss with EPA and HDOH extending the Act 87 deadline for Priority 3 (Section 8.4.1) cesspool conversions by using the FCA guidance applied to individual small communities.
- Revise the rate structure to better match the cost of service. Consider establishing a connection fee.
- Develop a plan to maximize the use of all funding and financing options. Optimize the application of financing options for the municipality as well as individual cesspool owners to maximize benefits for all.

9.0 SUMMARY AND CONCLUSIONS

9.1 SUMMARY OF FINDINGS

This facility plan evaluated various wastewater management alternatives for Puna, differing by decentralized or centralized treatment systems, projected 2052 design average flows, and collection system methods:

- 1A – IWS for All Residential and Decentralized Treatment for Commercial/Institutions
- 1B – Both Decentralized Treatment and LPS
- 2A – Subregional Plants (6 mgd) – 4 plants – Urban Sewering – All Gravity Sewers/WWPS
- 2B – Subregional Plants (6 mgd) – 4 plants – Urban Sewering – Both Gravity Sewers & LPS
- 2C – Subregional Plants (6 mgd) – 4 plants – Urban Sewering – Cross-Country Sewers
- 3A – Subregional Plants (6 mgd) – 3 plants – Urban Sewering – All Gravity Sewers/WWPS
- 3B – Subregional Plants (6 mgd) – 3 plants – Urban Sewering – Both Gravity Sewers & LPS
- 3C – Subregional Plants (6 mgd) – 3 plants – Urban Sewering – Cross-Country Sewers
- 4A – Regional Plants (6 mgd) – 1 plant – Urban Sewering – All Gravity Sewers/WWPS
- 4B – Regional Plants (6 mgd) – 1 plant – Urban Sewering – Both Gravity Sewers & LPS
- 4C – Regional Plants (6 mgd) – 1 plant – Urban Sewering – Cross-Country Sewers
- 5A – Regional Plants (8.5 mgd) – 1 plant – Full Flow – All Gravity Sewers/WWPS
- 5B – Regional Plants (8.5 mgd) – 1 plant – Full Flow – Both Gravity Sewers & LPS
- 5C – Regional Plants (8.5 mgd) – 1 plant – Full Flow – Cross-Country Sewers
- 6A – Flow to Hilo WWTP (11 mgd) – Urban Sewering – All Gravity Sewers/WWPS
- 6B – Flow to Hilo WWTP (11 mgd) – Urban Sewering – Both Gravity Sewers & LPS
- 6C – Flow to Hilo WWTP (11 mgd) – Urban Sewering – Cross-Country Sewers
- 7A – Flow to Hilo WWTP (13.5 mgd) – Full Flow – All Gravity Sewers/WWPS
- 7B – Flow to Hilo WWTP (13.5 mgd) – Full Flow – Both Gravity Sewers & LPS
- 7C – Flow to Hilo WWTP (13.5 mgd) – Full Flow – Cross-Country Sewers

The components of each alternative (e.g., collection, treatment, and disposal) are described in Section 6.0. Estimated costs were compared between collection and treatment costs (Section 7.3.1), and between homeowners and managing entities (Section 7.3.2). The cost impacts of the collection system option, design average flow, number of WWTPs, sending Puna flows to Hilo WWTP, and lava hazard zones were also evaluated (Sections 7.3.4 through 7.3.8, respectively).

Based on capital and O&M costs, and environmental criteria Alternative 1A with IWS and decentralized treatment for commercial areas and large institutional properties (example: schools, hospitals etc.) is the most favorable. The majority of the costs for the centralized sewer alternatives is from laying the sewer collection network, compared to the WWTP costs. Therefore, the higher costs are primarily from excavation for sewers within lava rock.

9.2 RECOMMENDATIONS

As community development occurs in the future, Alternative 1A can evolve into Alternative 1B by adding LPS to expand the service area of the commercial/institutional decentralized treatment plants. If further wastewater collection/treatment needs to occur, Alternative 1B can evolve further into Alternative 2 by expanding the collection system service area using various other alternatives such as gravity sewers (in roads), low pressure sewers, and cross-country sewers. The package plant in the area would also be expanded into a subregional facility if demand for wastewater collection and treatment in the area is sufficient to support the upgrade/expansion.

Other alternatives can be given low priority and deferred from further consideration based on the following:

- Alternative 3: Three Subregional Treatment Plants – Urban Sewering (6.0 mgd) can be eliminated because it includes larger capacity in the interceptors to the HPP subregional facility than is actually needed if the COH decides not to develop infrastructure in Lava Zones 1 and 2.
- Alternative 4: One Regional Treatment Plant – Urban Sewering (6.0 mgd) can be eliminated because it includes larger capacity in the interceptors to the Keaʻau regional facility than is actually needed.
- Alternative 5: One Regional Treatment Plant – Full Flow Sewering (8.5 mgd) can be eliminated because it includes larger capacity in the interceptors and at the Keaʻau subregional facility than is actually needed.
- Alternative 6: Flow to Hilo WWTP – Urban Sewering (6.0 mgd) can be eliminated because it includes large interceptors (+/- 10 miles) to the Hilo facility and takes up capacity at the Hilo WWTP that would otherwise be used to serve the community that it was originally designed to serve.
- Alternative 7: Flow to Hilo WWTP – Full Flow Sewering (8.5 mgd) can be eliminated because it includes large interceptors (+/- 10 miles) to the Hilo facility that take up capacity at the Hilo WWTP that would otherwise be used to serve the community that it was originally designed to serve.

When planning for any of these alternatives, it is important to assess future development goals, population and flow forecasts, and potential impacts on the environment (Section 4.0). A fundamental component of implementation is also funding and financing (Section 8.0). The research and findings in this feasibility study will be used by COH to assess and later select a wastewater management plan to support the growth of Puna and the overall island.

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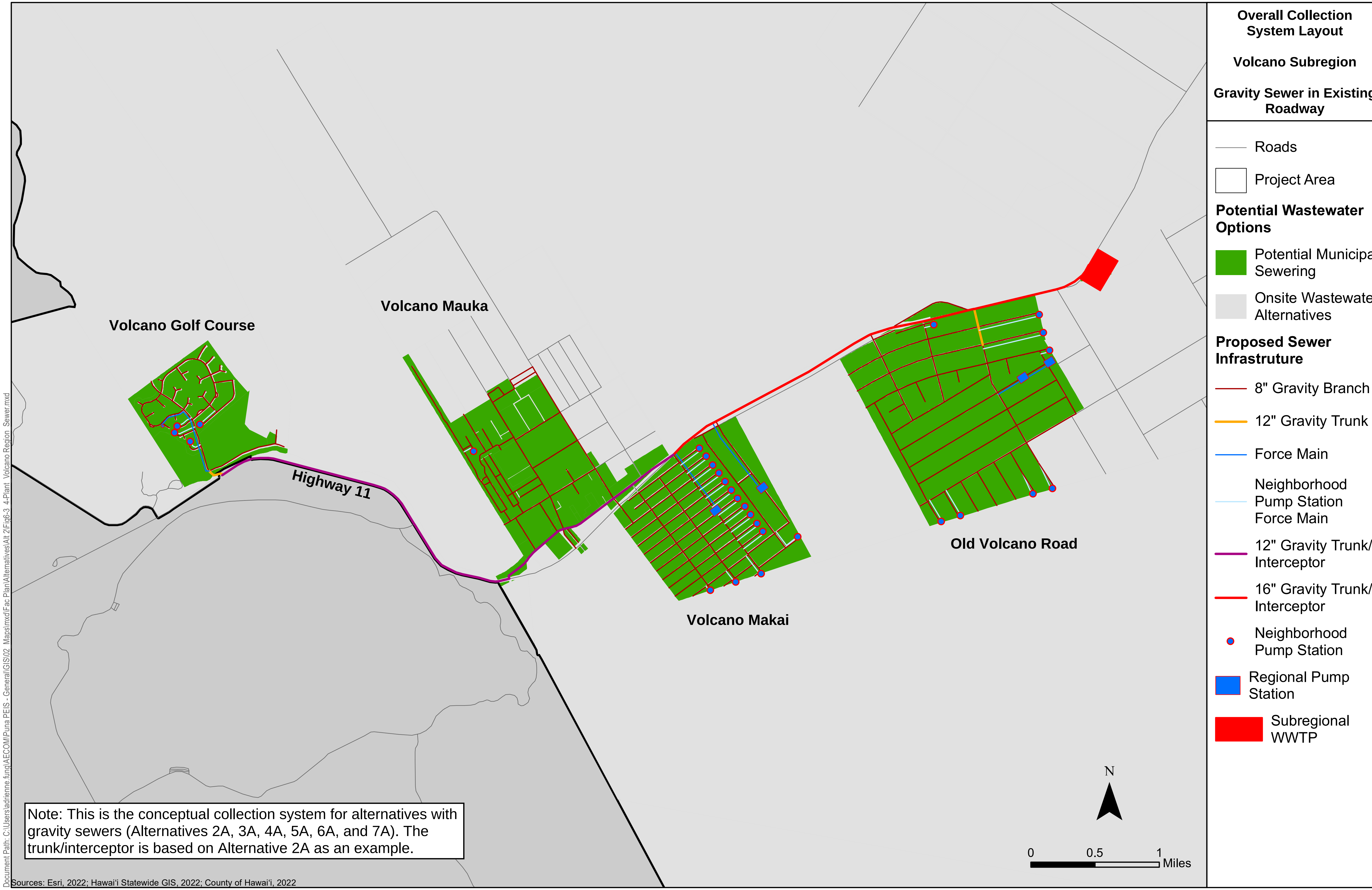
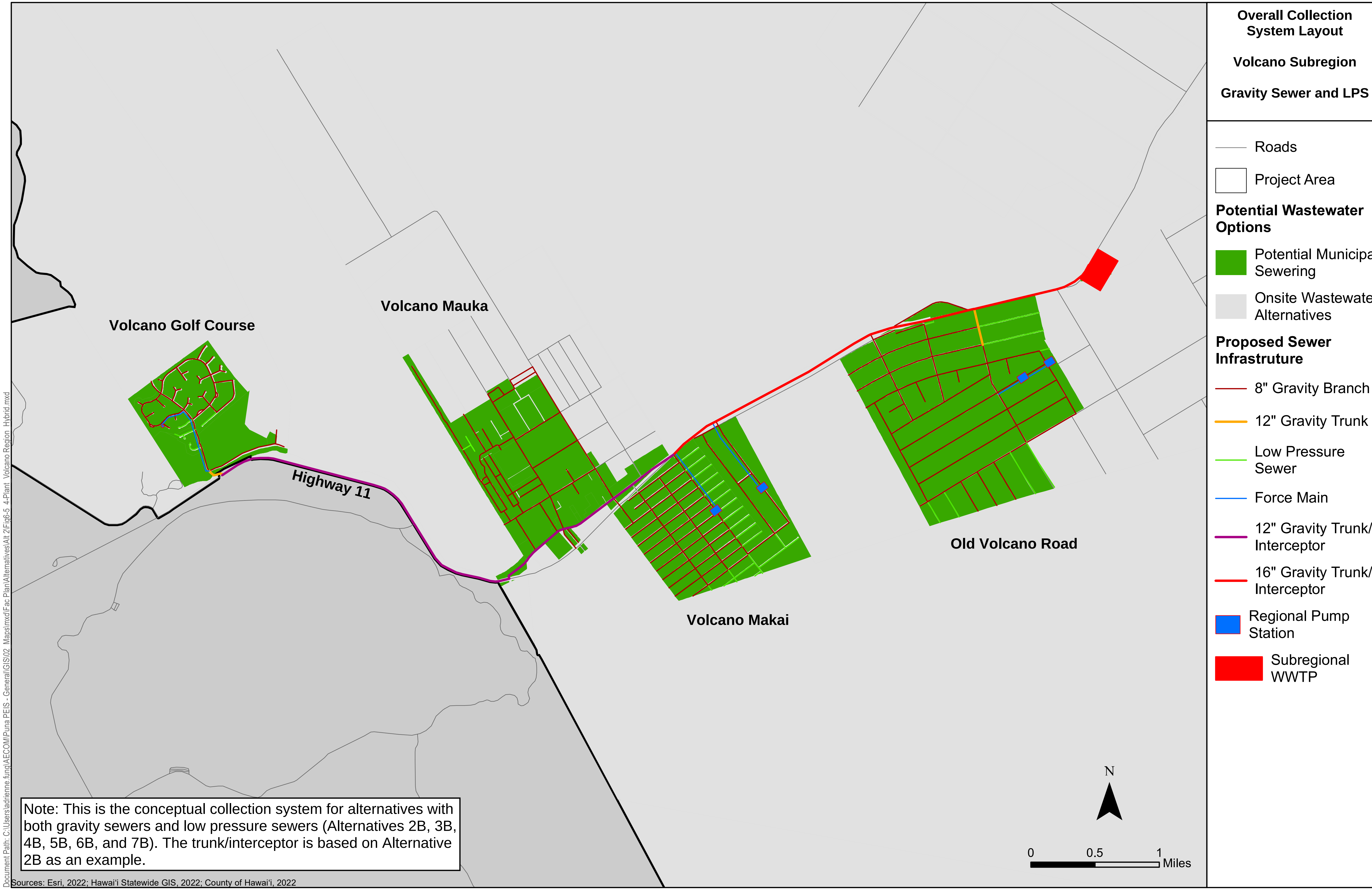
Appendix A Collection System Layout Maps and Hydraulic Calculations

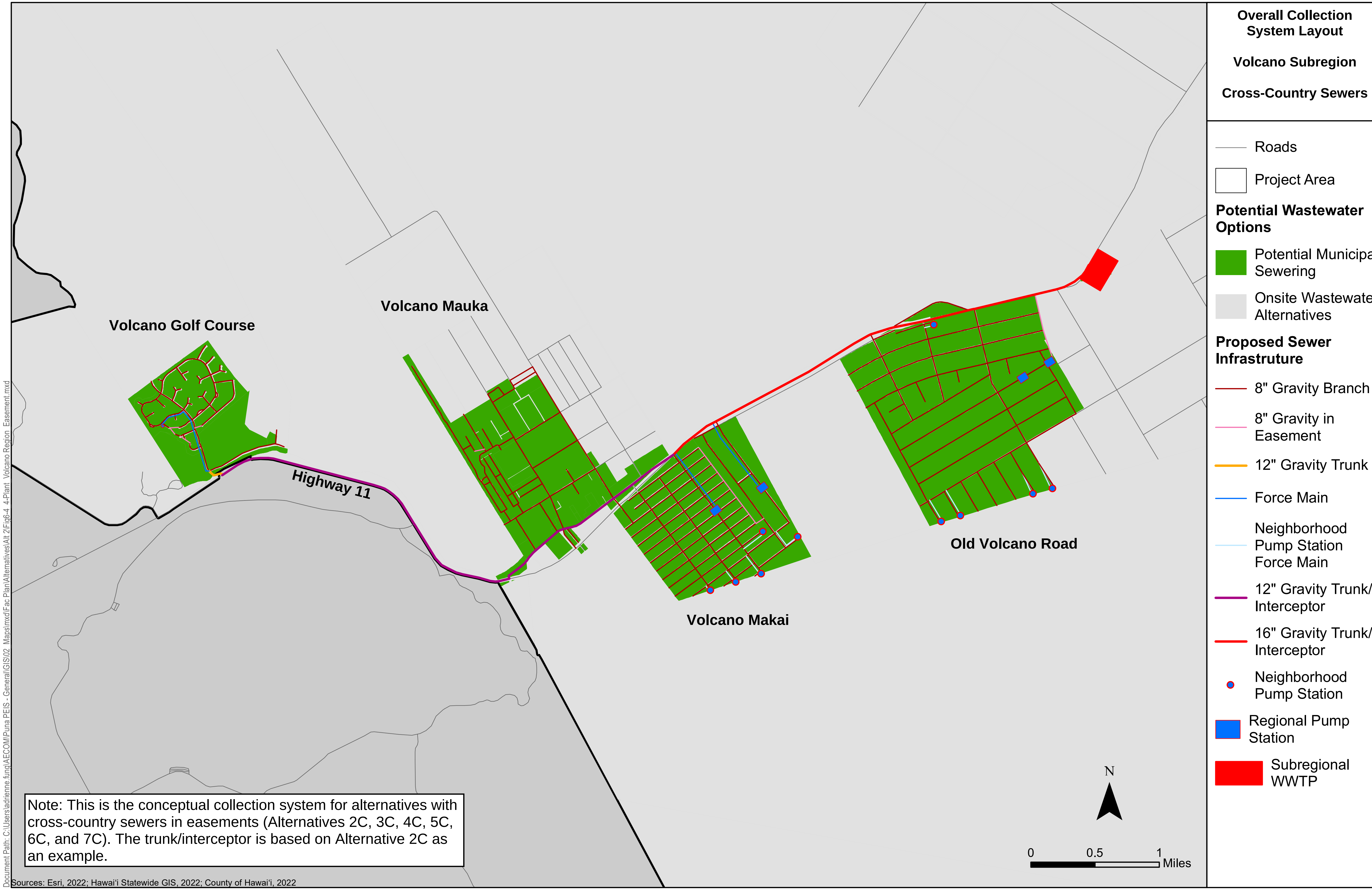
Volcano Subregion

A-1: Overall Collection System Layout Map
A-2: Community Collection System Layout Maps
A-3: Sewer Hydraulic Calculations
A-4: Pump Station and Force Main Hydraulic Calculations
A-5: Contour Maps (Basis for Collection System Layout and calculation)

A-1: Overall Collection System Layout Map

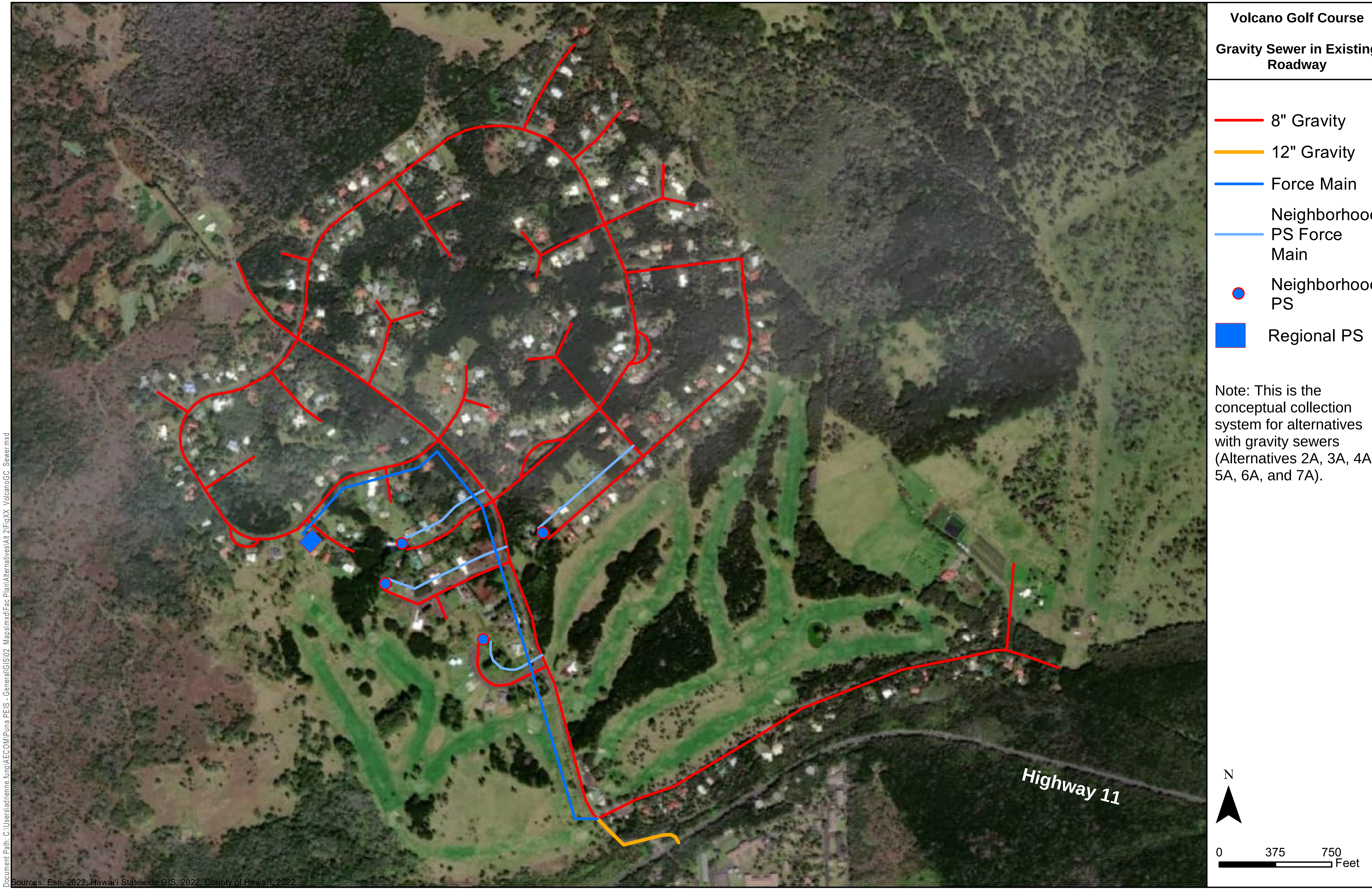

Overall Collection System Layout
Volcano Subregion
Gravity Sewer in Existing Roadway
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastruture
8" Gravity Branch
12" Gravity Trunk
Force Main
Neighborhood Pump Station Force Main
12" Gravity Trunk/ Interceptor
16" Gravity Trunk/ Interceptor
Neighborhood Pump Station
Regional Pump Station
Subregional WWTP
Volcano Golf Course
Volcano Mauka
Highway 11
Volcano Makai
Old Volcano Road
N
0
0.5
1
Miles
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A). The trunk/interceptor is based on Alternative 2A as an example.
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022


Overall Collection System Layout
Volcano Subregion
Gravity Sewer and LPS
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastruture
8" Gravity Branch
12" Gravity Trunk
Low Pressure Sewer
Force Main
12" Gravity Trunk/ Interceptor
16" Gravity Trunk/ Interceptor
Regional Pump Station
Subregional WWTP
Volcano Golf Course
Volcano Mauka
Highway 11
Volcano Makai
Old Volcano Road
N
0
0.5
1
Miles
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B). The trunk/interceptor is based on Alternative 2B as an example.
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022


Overall Collection System Layout
Volcano Subregion
Cross-Country Sewers
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastruture
8" Gravity Branch
8" Gravity in Easement
12" Gravity Trunk
Force Main
Neighborhood Pump Station Force Main
12" Gravity Trunk/ Interceptor
16" Gravity Trunk/ Interceptor
Neighborhood Pump Station
Regional Pump Station
Subregional WWTP
Volcano Golf Course
Volcano Mauka
Highway 11
Volcano Makai
Old Volcano Road
N
0
0.5
1
Miles
Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C). The trunk/interceptor is based on Alternative 2C as an example.
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

A-2: Community Collection System Layout Maps

Gravity Sewer in Existing Roadways


Volcano Golf Course
Gravity Sewer in Existing Roadway
8" Gravity
12" Gravity
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
Highway 11
N
0
375
750
Feet
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022, County of Hawaii, 2022

Volcano Mauka

Gravity Sewer in Existing Roadway

8" Gravity

12" Gravity

Neighborhood PS Force Main

Neighborhood PS

Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).

N

0 0.125 0.25 Miles

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_VolcanoMauka_Sewer.mxd

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_VolcanoMakai_Sewer.mxd

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_OldVolRd_Sewer.mxd

A-2: Community Collection System Layout Maps

Gravity Sewer and LPS

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_VolcanoGC_Sewer_LPS.mxd

Volcano Mauka

Gravity Sewer and LPS

- 8" Gravity
- 12" Gravity
- LPS

Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).

N

0 0.125 0.25 Miles

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_VolcanoMauka_Sewer_Hybrid.mxd

Volcano Makai
Gravity Sewer and LPS
8" Gravity
16" Gravity
LPS
Force Main
Regional PS
Other Sewers
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).
Highway 11
N
0
0.1
0.2
Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_OldVolRd_Sewer_Hybrid.mxd

A-2: Community Collection System Layout Maps

Cross-Country Sewers in New Easements

Volcano Golf Course
Cross-Country Sewer
8" Gravity
8" Gravity Sewer in Easement
12" Gravity
Force Main
Regional PS
Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C).
Highway 11
N
0
375
750
Feet
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022, County of Hawaii, 2022

Volcano Mauka

Cross-Country Sewer

8" Gravity

8" Gravity Sewer in Easement

12" Gravity

Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C).

N

0 0.125 0.25 Miles

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_VolcanoMakai_Sewer_Easement.mxd

Old Volcano Road

Cross-Country Sewer

- 8" Gravity
- 8" Gravity Sewer in Easement
- 16" Gravity
- Neighborhood PS Force Main
- Neighborhood PS
- Regional PS

Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C).

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_OldVolRd_Sewer_Easement.mxd

A-3: Sewer Hydraulic Calculations

Computation of Wastewater Flow for Volcano Golf Course Sewering

Sewer: Volcano Golf Course districts
District: Volcano Golf Course
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: February 1, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Volcano Golf Course																												
Volcano Golf Course 1		97	97	355	768	768	0	0	0	0	768	768	0.054	2.5	0.13	0.027	0.081	0.16	97	0.291	0.45	8	0.52	2.50	0.56	0.80	2.77	5.4
Volcano Golf Course 2		12	109	45	98	866	0	0	0	0	98	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Area 1 flows to the regional PS.
3. Regional PS and Area 2 flow to 12" gravity sewer and highway.
4. Relatively flat along 12" gravity sewer to highway.

Computation of Wastewater Flow for Volcano Mauka Sewering

Sewer: Volcano Mauka districts
District: Volcano Mauka
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: February 2, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population										Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																		
				Homes			Apartment																						
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Volcano Mauka																													
Volcano Golf Course 2		12	109	45	98	866	0	0	0	0	98	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51							
Volcano Mauka 1		4	113	14	33	33	0	0	0	0	33	899	0.063	2.5	0.16	0.031	0.094	0.19	113	0.340	0.53	12	0.31	2.53	1.28	0.41	2.40	5.4
Volcano Mauka 2		32	32	123	287	287	0	0	0	0	287	287	0.020	2.5	0.05	0.010	0.030	0.06	32	0.097	0.16	8	0.52	2.50	0.56	0.28	2.15	2.9
Volcano Mauka 3		3	148	10	23	343	0	0	0	0	23	1209	0.085	2.5	0.21	0.042	0.127	0.25	148	0.444	0.70	12	0.31	2.53	1.28	0.54	2.58	6.3
Volcano Mauka 4		19	19	72	168	168	0	0	0	0	168	168	0.012	2.5	0.03	0.006	0.018	0.04	19	0.057	0.09	8	0.52	2.50	0.56	0.16	1.83	2.2
Volcano Mauka 5		11	178	41	95	606	0	0	0	0	95	1473	0.103	2.5	0.26	0.052	0.155	0.31	178	0.533	0.84	12	0.31	2.53	1.28	0.66	2.69	7.1
Volcano Mauka 6		37	37	142	331	331	0	0	0	0	331	331	0.023	2.5	0.06	0.012	0.035	0.07	37	0.112	0.18	8	0.52	2.50	0.56	0.32	2.22	3.1
Volcano Mauka 7		31	31	118	275	275	0	0	0	0	275	275	0.019	2.5	0.05	0.010	0.029	0.06	31	0.093	0.15	8	0.52	2.50	0.56	0.27	2.11	2.8
Volcano Mauka 8		3	71	12	29	634	0	0	0	0	29	634	0.044	2.5	0.11	0.022	0.067	0.13	71	0.214	0.35	8	0.52	2.50	0.56	0.62	2.63	4.6
Volcano Mauka 9		6	255	22	52	1293	0	0	0	0	52	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	12	1.00	4.54	2.30	0.53	4.60	6.2

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Area 1 receives flow from Volcano Golf Course (0.51 mgd).
3. Areas 1 and 2 flow to area 3. Areas 3 and 4 flow to area 5.
4. Areas 6 and 7 flow to area 8. Areas 5 and 8 flow to area 9.
5. Total flow is Volcano Golf Course (0.51 mgd) + Volcano Mauka (0.71 mgd) = 1.22 mgd

Computation of Wastewater Flow for Volcano Makai Sewering

Sewer: Volcano Makai districts
District: Volcano Makai
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 2, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Volcano Makai																												
Volcano Makai 1		81	81	263	780	780	0	0	0	0	780	780	0.055	2.5	0.14	0.027	0.082	0.16	81	0.242	0.41	8	0.52	2.50	0.56	0.72	2.72	5.1
Volcano Makai 2		59	59	194	576	576	0	0	0	0	576	576	0.040	2.5	0.10	0.020	0.060	0.12	59	0.178	0.30	8	0.52	2.50	0.56	0.53	2.54	4.2
Volcano Makai 3		25	25	82	244	244	0	0	0	0	244	244	0.017	2.5	0.04	0.009	0.026	0.05	25	0.075	0.13	8	0.52	2.50	0.56	0.22	2.03	2.6
Volcano Makai 4		60	60	196	581	581	0	0	0	0	581	581	0.041	2.5	0.10	0.020	0.061	0.12	60	0.180	0.30	8	0.52	2.50	0.56	0.54	2.54	4.2
Volcano Makai 5		30	30	99	292	292	0	0	0	0	292	292	0.020	2.5	0.05	0.010	0.031	0.06	30	0.090	0.15	8	0.52	2.50	0.56	0.27	2.11	2.8
Volcano Mauka 9		6	255	22	52	1293	0	0	0	0	52	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22							
Volcano Makai 6		7	517	22	64	2537	0	0	0	0	64	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54	16	0.50	3.89	3.51	0.72	4.24	10.1

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Areas 1, 2, and 3 flow to PS 1. Areas 4 and 5 flow to PS 2.
3. Area 6 is the trunk highway sewer. It receives flows from PS 1, PS 2, and Volcano Mauka (1.22 mgd).
4. Total flow is Volcano Golf Course (0.51 mgd) + Volcano Mauka (0.71 mgd) + Volcano Makai (1.32 mgd) = 2.54 mgd

Computation of Wastewater Flow for Old Volcano Road Sewering

Sewer: Old Volcano Road districts
District: Old Volcano Road
Reference Maps: Hawaii Statewide GIS Program

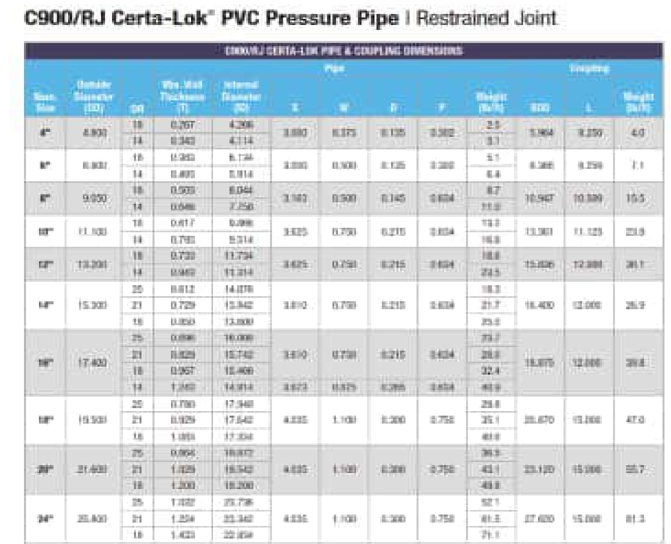
Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 3, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Old Volcano Road																												
Old Volcano Road 1		4	4	17	47	47	0	0	0	0	47	47	0.003	2.5	0.01	0.002	0.005	0.01	4	0.012	0.022	8	0.52	2.50	0.56	0.04	1.21	1.1
Old Volcano Road 2		34	34	142	396	396	0	0	0	0	396	396	0.028	2.5	0.07	0.014	0.042	0.08	34	0.101	0.18	8	0.52	2.50	0.56	0.33	2.22	3.1
Old Volcano Road 3		53	53	225	630	630	0	0	0	0	630	630	0.044	2.5	0.11	0.022	0.066	0.13	53	0.160	0.29	8	0.52	2.50	0.56	0.52	2.52	4.1
Old Volcano Road 4		20	20	84	235	235	0	0	0	0	235	235	0.016	2.5	0.04	0.008	0.025	0.05	20	0.060	0.11	8	0.52	2.50	0.56	0.19	1.94	2.4
Old Volcano Road 5		14	87	59	164	1029	0	0	0	0	164	1029	0.072	2.5	0.18	0.036	0.108	0.22	87	0.262	0.48	12	0.31	2.53	1.28	0.37	2.34	5.1
Volcano Makai		7	517	22	64	2537	0	0	0	0	64	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54							
Old Volcano Road 6		4	646	19	53	4062	0	0	0	0	53	6221	0.435	2.5	1.09	0.218	0.653	1.31	646	1.939	3.25	16	1.00	5.50	4.96	0.65	5.86	9.4

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Areas 1 and 2 flow to highway. Areas 3 and 4 flow to area 5. Area 5 flows to highway.
3. Area 6 is the trunk highway sewer. It receives flows from areas 1, 2, and 5.
4. Total flow is Volcano Golf Course (0.51 mgd) + Volcano Mauka (0.71 mgd) + Volcano Makai (1.32 mgd) + Old Volcano Road (0.71) = 3.25 mgd

A-4: Pump Station and Force Main Hydraulic Calculations

Note: There are no pump station and force main calculations for Volcano Mauka because this area does not have any proposed Regional WWPSs.



Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

<u>Assumption:</u>
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

<u>Quick notes to check FM calculation:</u>
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Volcano GC 1-29-2023																						
PS1																						
6.134	0.51	0.205	0.74	3900	3995	20	3975	4028	10	4018	43	0.45	313	0.70	3.39	140	0.0067	26.3	15	2.6	86.9	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Volcano 2-1-2023																						
PS1																						
8.044	0.67	0.353	0.53	2800	3530	20	3510	3565	10	3555	45	0.84	583	1.30	3.68	140	0.0057	16.0	15	1.6	77.6	ok
PS2																						
6.134	0.51	0.205	0.53	2800	3430	20	3410	3480	10	3470	60	0.45	313	0.70	3.39	140	0.0067	18.9	15	1.9	95.8	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

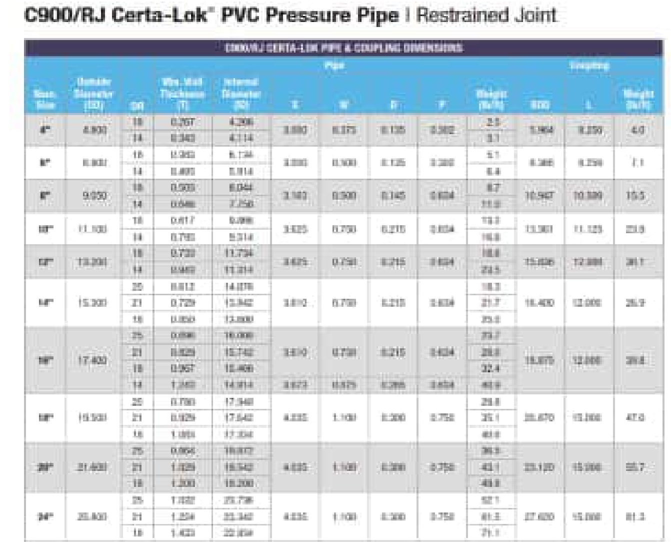
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



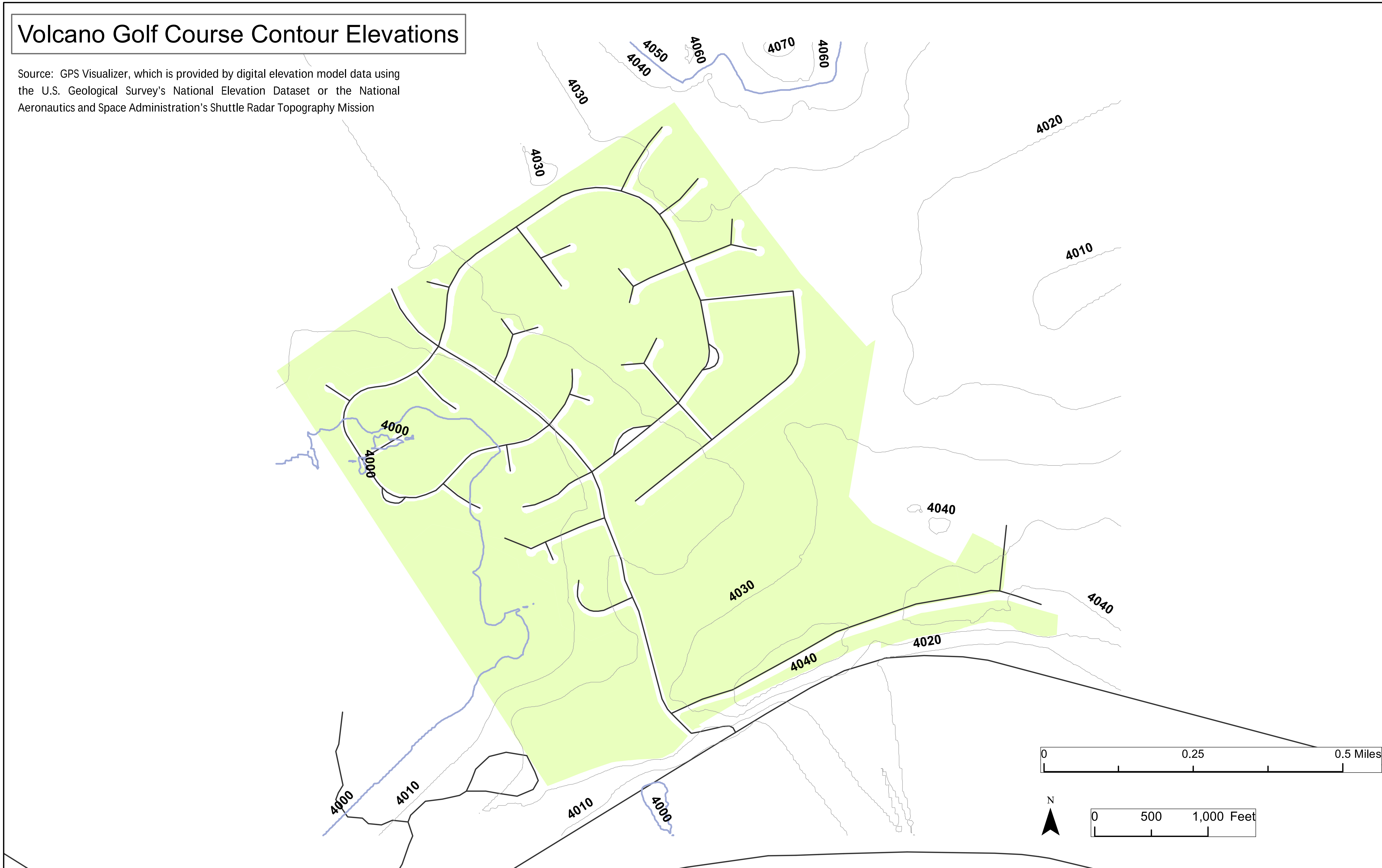
Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Old Volcano Road 2-2-2023																						
PS1																						
6	0.50	0.196	0.23	1200	2825	20	2805	2880	10	2870	65	0.25	174	0.39	1.97	140	0.0025	3.0	15	0.3	83.3	ok
PS2																						
6	0.50	0.196	0.15	800	2880	20	2860	2940	10	2930	70	0.25	174	0.39	1.97	140	0.0025	2.0	15	0.2	87.2	ok

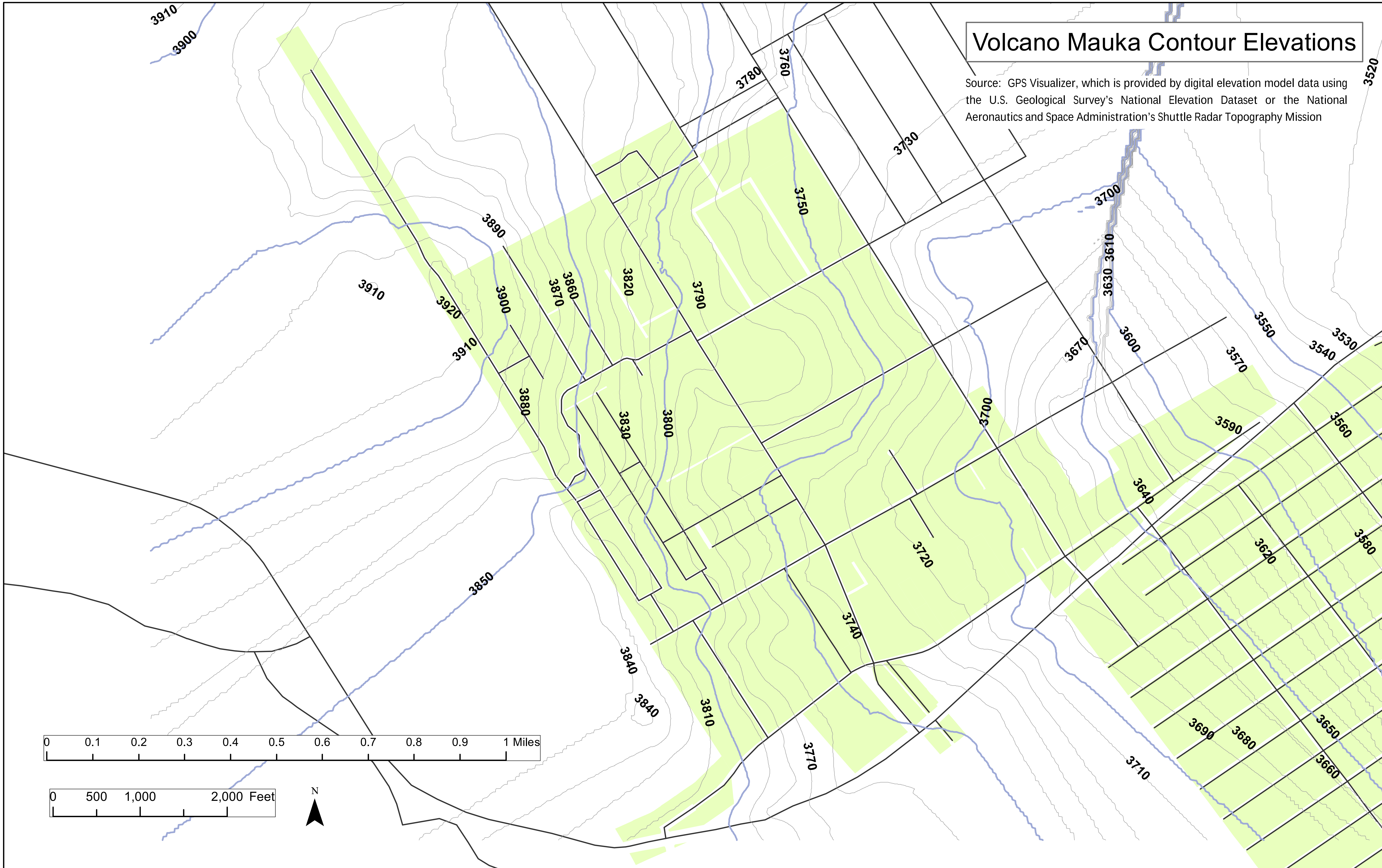
Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

A-5: Contour Maps (Basis for Collection System Layout and calculation)

Volcano Golf Course Contour Elevations

Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission

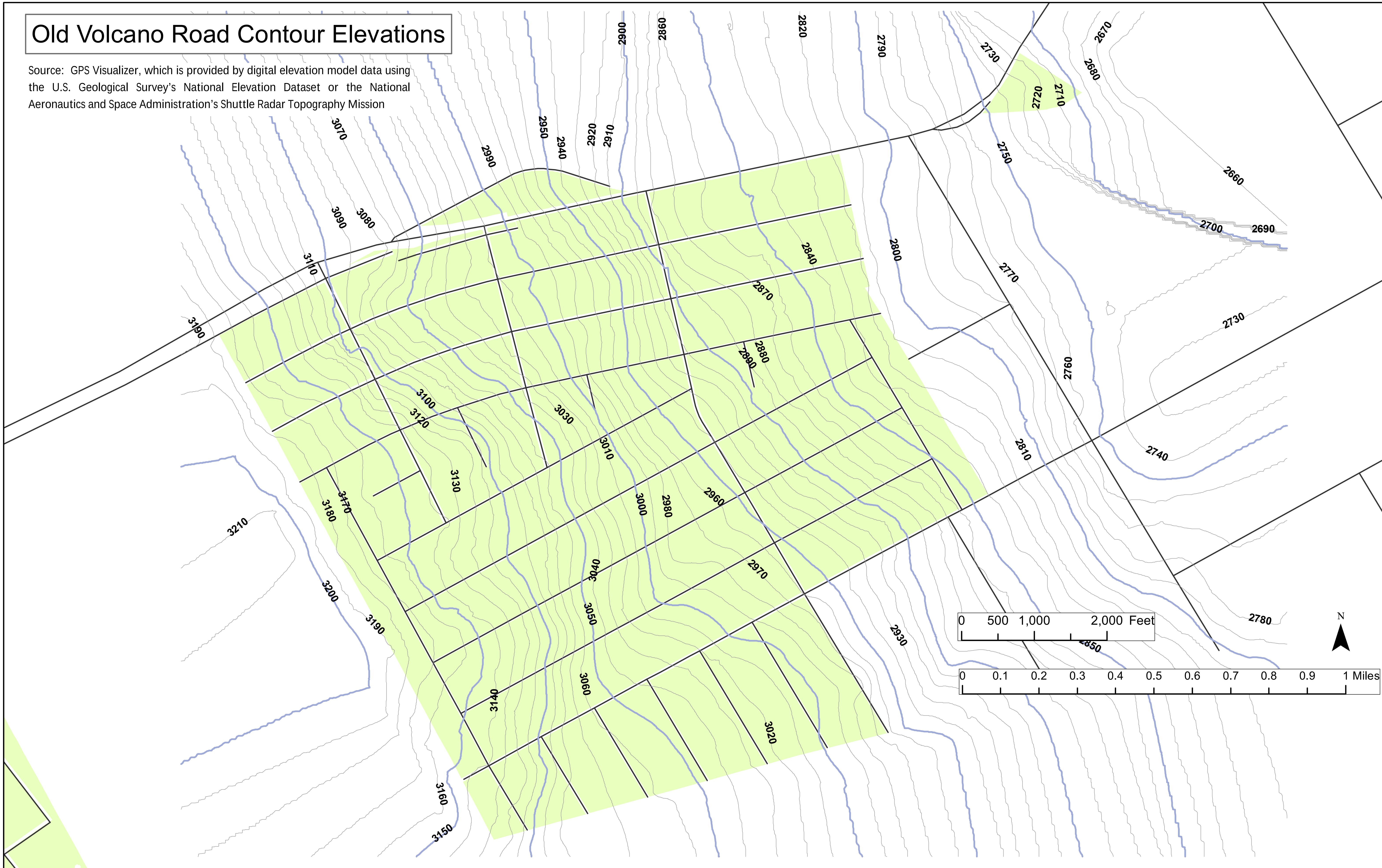




Volcano Mauka Contour Elevations
Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Miles
0 500 1,000 2,000 Feet
N

Volcano Makai Contour Elevations

Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission



Old Volcano Road Contour Elevations

Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission

Appendix B Collection System Layout Maps and Hydraulic Calculations

Kea‘au Subregion

B-1: Overall Collection System Layout Map

B-2: Community Collection System Layout Maps

B-3: Sewer Hydraulic Calculations

B-4: Pump Station and Force Main Hydraulic Calculations

B-5: Contour Maps (Basis for Collection System Layout and calculation)

B-1: Overall Collection System Layout Map

Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A). The trunk/interceptor is based on Alternative 2A as an example.
West Kea‘au
Kurtistown
Pa‘ahana and Kea‘au
Highway 11
Eden Roc
Kea‘au Subregional Tributary
Hawaiian Paradise Park (HPP) Subregional Tributary (see HPP figures)
N
0
0.5
1
Miles
Sources: Esri, 2022; Hawai‘i Statewide GIS, 2022; County of Hawai‘i, 2022
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-6_4-Plant_Keaau Region_Sewer.mxd
Overall Collection System Layout
Kea‘au Subregion
Gravity Sewer in Existing Roadway
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
12" Gravity Trunk
Force Main
Neighborhood PS FM
Gravity Trunk/Interceptor
12"
16"
18"
24"
Neighborhood PS
Regional PS
Subregional WWTP

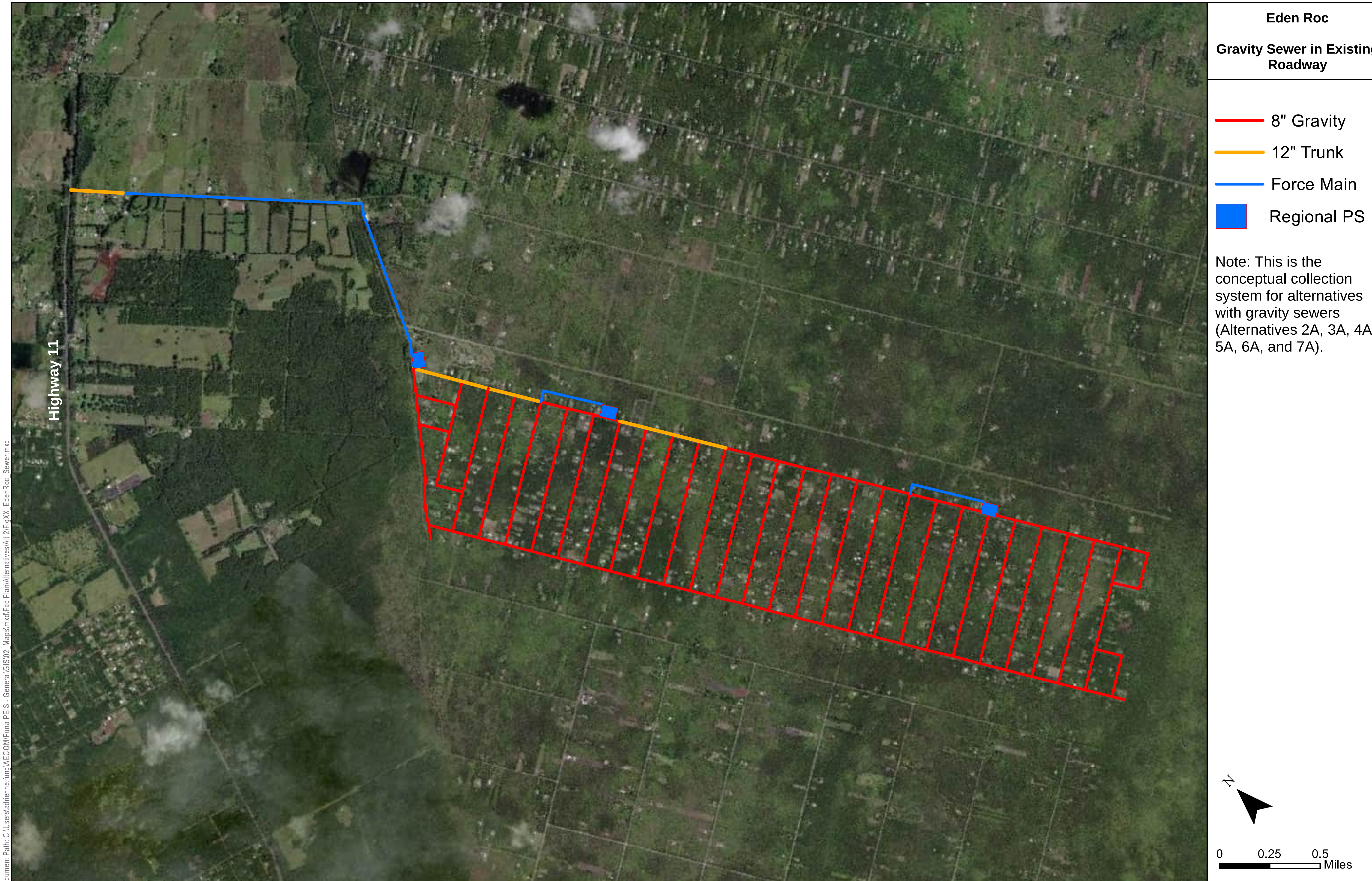

Notes:
This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B). The trunk/interceptor is based on Alternative 2B as an example.
Eden Roc does not have a proposed collection system using low pressure sewers because neighborhood pump stations are not anticipated for this area.
West Keaʻau
Kurtistown
Paʻahana and Keaʻau
Highway 11
Eden Roc
Keaʻau Subregional Tributary
Hawaiian Paradise Park (HPP) Subregional Tributary (see HPP figures)
N
0 0.5 1 Miles
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022
Overall Collection System Layout
Keaʻau Subregion
Gravity Sewer and LPS
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
12" Gravity Trunk
Force Main
Low Pressure Sewer
Gravity Trunk/Interceptor
12"
16"
18"
24"
Regional PS
Subregional WWTP

Overall Collection System Layout
Kea‘au Subregion
Cross-Country Sewers
Notes:
This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7 C). The trunk/interceptor is based on Alternative 2C as an example.
Eden Roc and Kurtistown areas do not have a proposed collection system using easement options. Eden Roc is not anticipated to have proposed neighborhood pump stations. Kurtistown does not have potential easement routes due to the land elevation.
West Kea‘au
Kurtistown
Pa‘ahana and Kea‘au
Highway 11
Eden Roc
Kea‘au Subregional Tributary
Hawaiian Paradise Park (HPP) Subregional Tributary (see HPP figures)
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
8" Gravity in Easement
12" Gravity Trunk
12" Gravity in Easement
Force Main
Neighborhood PS FM
Gravity Trunk/Interceptor
12"
16"
18"
24"
Neighborhood PS
Regional PS
Subregional WWTP
N
0 0.5 1 Miles
Sources: Esri, 2022; Hawai‘i Statewide GIS, 2022; County of Hawai‘i, 2022

B-2: Community Collection System Layout Maps

Gravity Sewer in Existing Roadways


West Kea‘au
Gravity Sewer in Existing Roadway
8" Gravity
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
Highway 11
N
0 0.25 0.5 Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022



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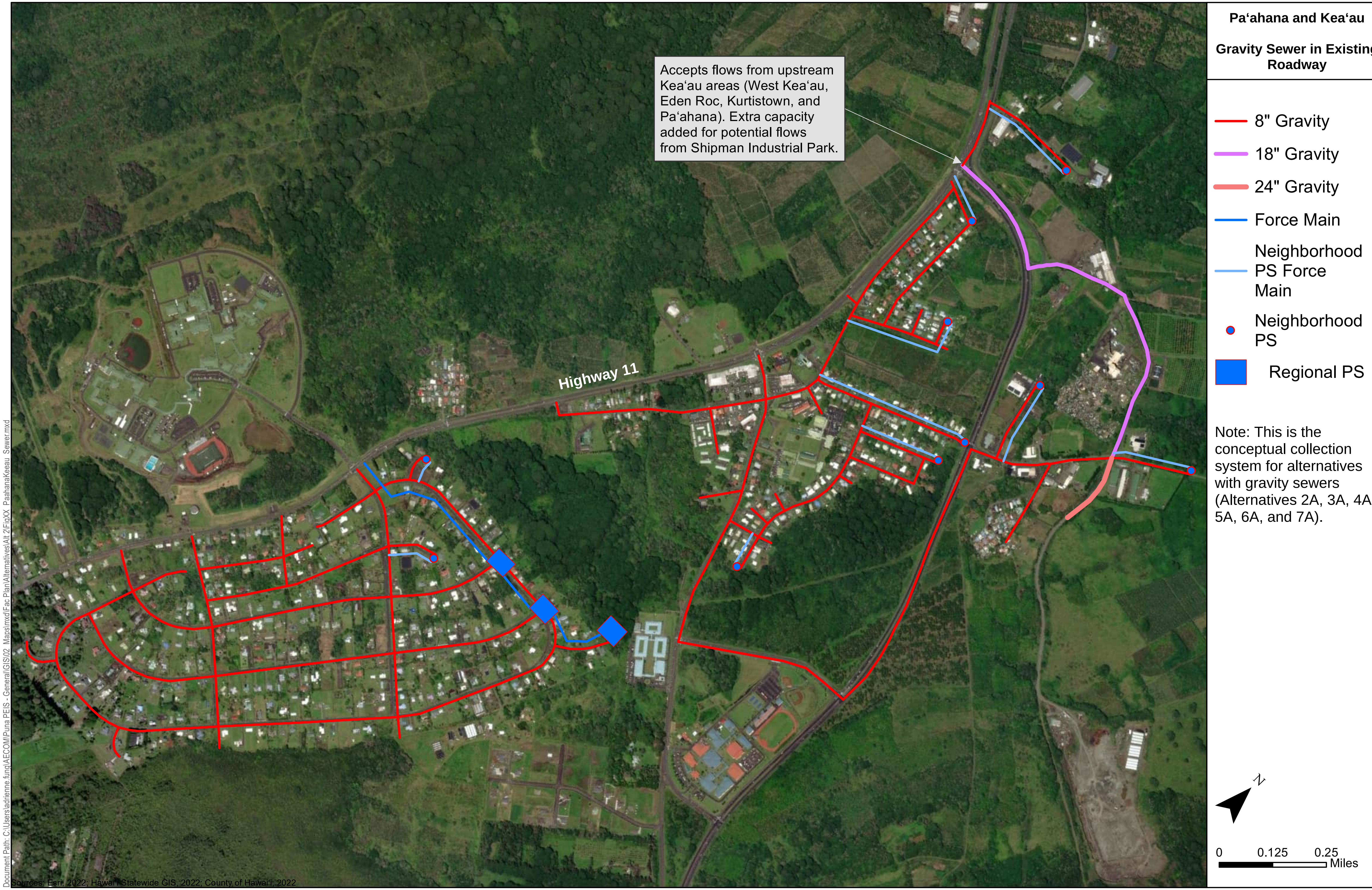
Kurtistown
Gravity Sewer in Existing Roadway
8" Gravity
Neighborhood PS Force Main
Neighborhood PS
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
Highway 11
Highway 11
N
0
0.15
0.3
Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

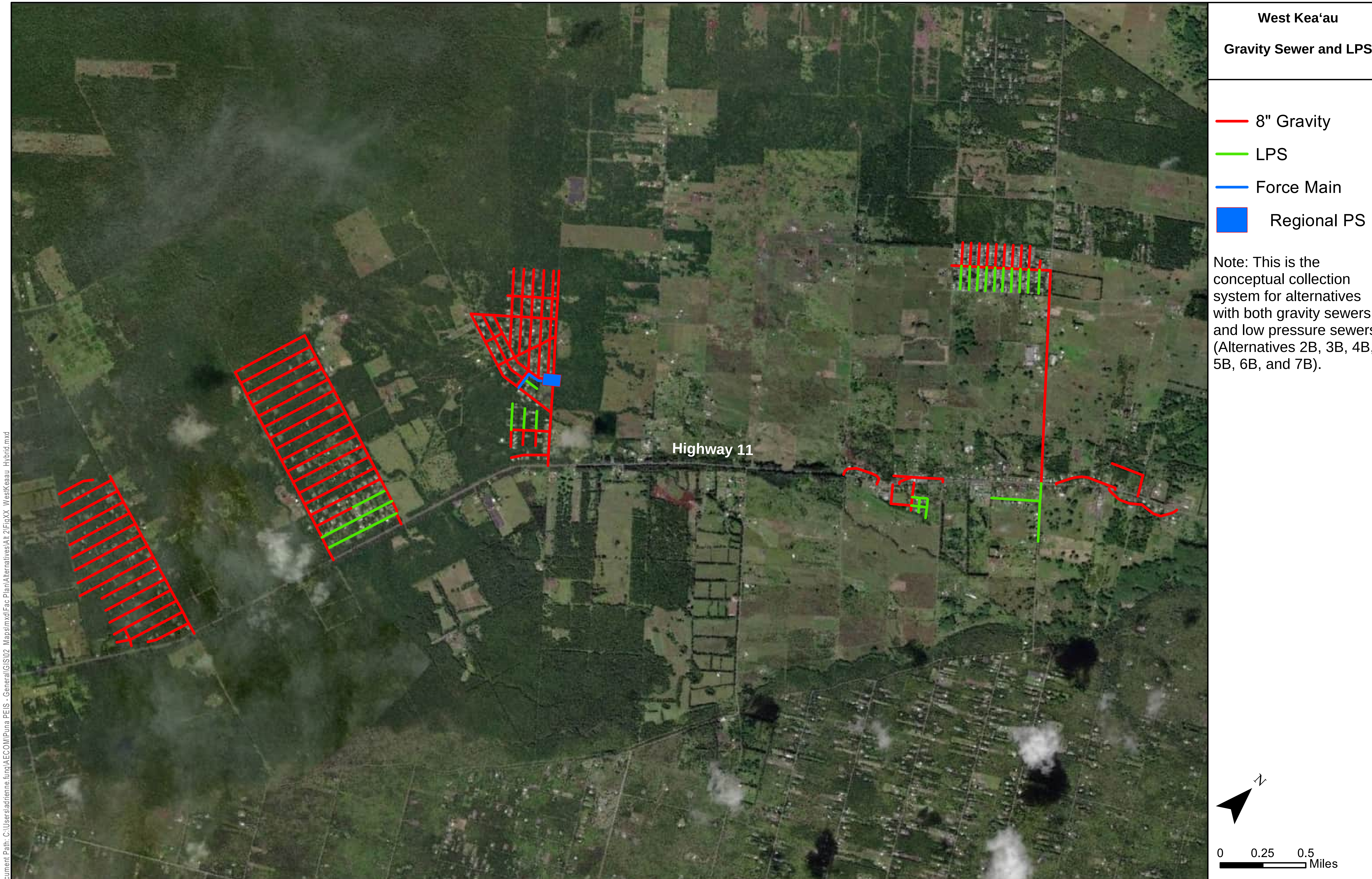


Pa'ahana and Kea'au
Gravity Sewer in Existing Roadway
8" Gravity
18" Gravity
24" Gravity
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
N
0 0.125 0.25 Miles
Accepts flows from upstream Kea'au areas (West Kea'au, Eden Roc, Kurtistown, and Pa'ahana). Extra capacity added for potential flows from Shipman Industrial Park.
Highway 11
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

B-2: Community Collection System Layout Maps

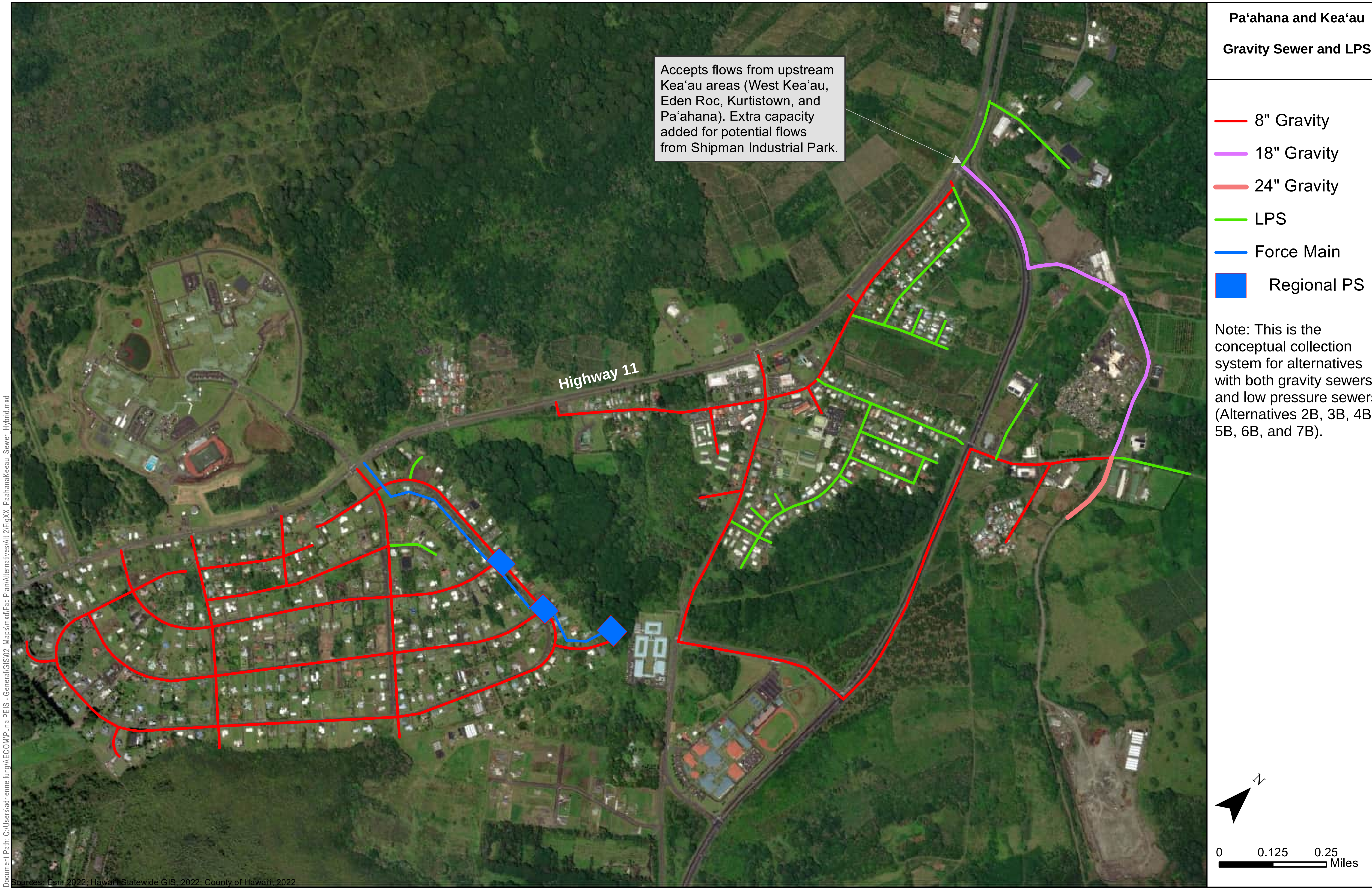
Gravity Sewer and LPS

Note: Eden Roc does not have an LPS option because this area does not have proposed WWPSs.



Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_WestKeaau_Hybrid.mxd


Kurtistown
Gravity Sewer and LPS
8" Gravity
LPS
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).
Highway 11
Highway 11
N
0 0.15 0.3 Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022



Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_PaahanaKeeau_Sewer_Hybrid.mxd

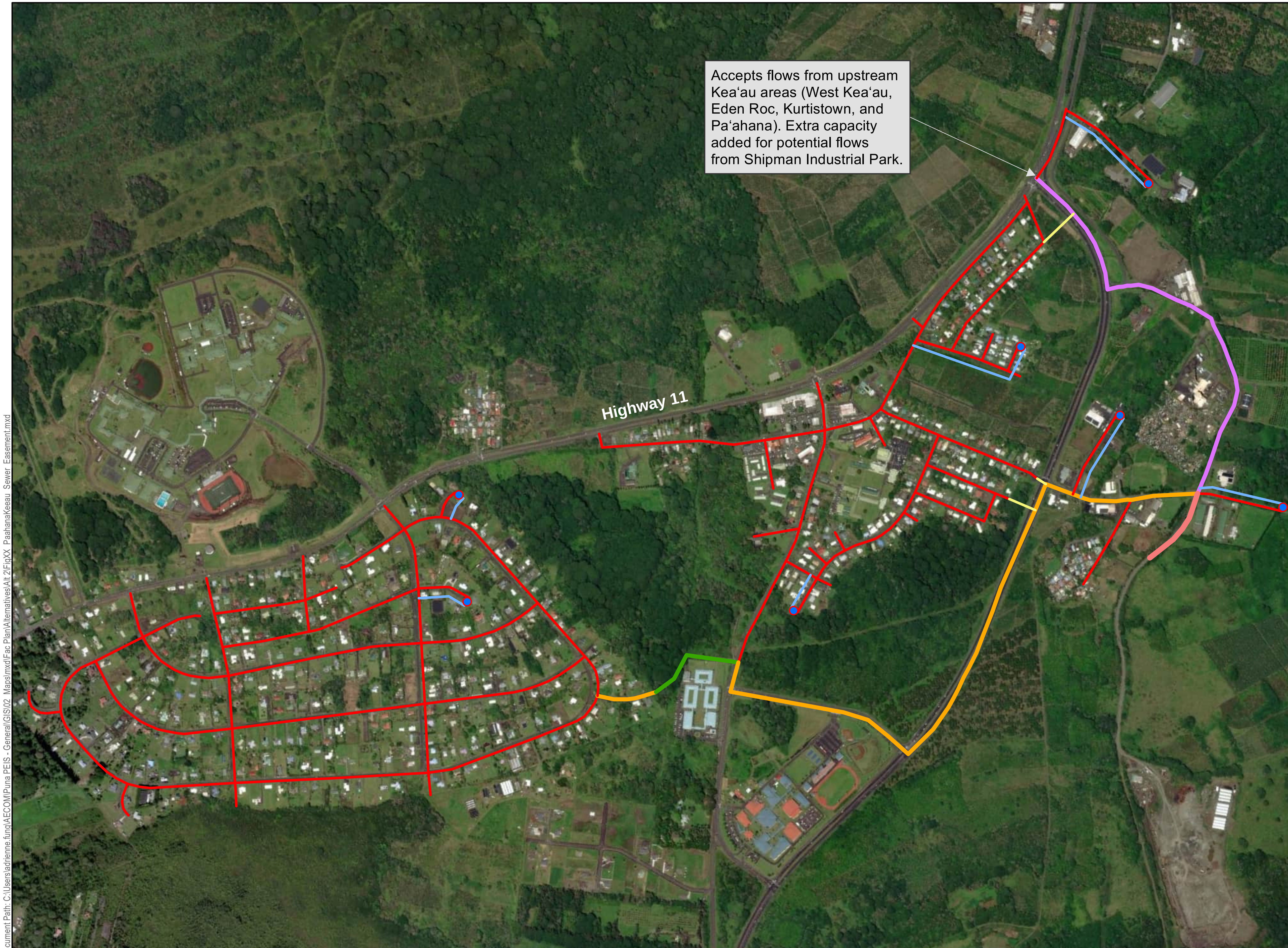
B-2: Community Collection System Layout Maps

Cross-Country Sewers in New Easements

Note: Eden Roc does not have a cross-country sewer option because this area does not have proposed WWPSs. Kurtistown does not have a cross-country sewer option due to land slope.

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_WestKeaau_Easement.mxd

Pa‘ahana and Kea‘au Cross-Country Sewer



B-3: Sewer Hydraulic Calculations

Computation of Wastewater Flow for West Keaʻau Sewering

Sewer: West Keaʻau districts
District: West Keaʻau
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 6, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation										( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
West Keaʻau																												
West Keaʻau 1		59	59	268	584	584	0	0	0	0	584	584	0.041	2.5	0.10	0.020	0.061	0.12	59	0.177	0.30	8	0.52	2.50	0.56	0.53	2.54	4.2
West Keaʻau 2		41	41	185	403	403	0	0	0	0	403	403	0.028	2.5	0.07	0.014	0.042	0.08	41	0.122	0.21	8	0.52	2.50	0.56	0.37	2.31	3.4
West Keaʻau 3		48	48	215	469	469	0	0	0	0	469	469	0.033	2.5	0.08	0.016	0.049	0.10	48	0.143	0.24	8	0.52	2.50	0.56	0.43	2.40	3.6
West Keaʻau 4		71	71	322	701	701	0	0	0	0	701	701	0.049	2.5	0.12	0.025	0.074	0.15	71	0.213	0.36	8	0.52	2.50	0.56	0.64	2.65	4.6
West Keaʻau 5		50	50	227	495	495	0	0	0	0	495	495	0.035	2.5	0.09	0.017	0.052	0.10	50	0.150	0.25	8	0.52	2.50	0.56	0.45	2.42	3.7
West Keaʻau 6		28	28	125	272	272	0	0	0	0	272	272	0.019	2.5	0.05	0.010	0.029	0.06	28	0.083	0.14	8	0.52	2.50	0.56	0.25	2.07	2.7

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Each area flows separately to the highway. Areas 2 and 3 are in the same neighborhood. Area 6 consists of many smaller neighborhoods.

Computation of Wastewater Flow for Eden Roc Sewering

Sewer: Eden Roc districts
District: Eden Roc
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 6, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Eden Roc																												
Eden Roc 1		60	60	150	399	399	0	0	0	0	399	399	0.028	2.5	0.07	0.014	0.042	0.08	60	0.180	0.26	8	0.52	2.50	0.56	0.47	2.45	3.8
Eden Roc 2		53	113	133	355	754	0	0	0	0	355	754	0.053	2.5	0.13	0.026	0.079	0.16	113	0.340	0.50	8	0.63	2.75	0.62	0.80	3.06	5.4
Eden Roc 3		27	140	67	178	932	0	0	0	0	178	932	0.065	2.5	0.16	0.033	0.098	0.20	140	0.421	0.62	12	0.31	2.53	1.28	0.48	2.51	5.9
Eden Roc 4		13	13	33	89	89	0	0	0	0	89	89	0.006	2.5	0.02	0.003	0.009	0.02	13	0.040	0.06	8	0.52	2.50	0.56	0.10	1.63	1.8
Eden Roc 5		34	188	85	226	1247	0	0	0	0	226	1247	0.087	2.5	0.22	0.044	0.131	0.26	188	0.563	0.82	12	0.31	2.53	1.28	0.64	2.68	7.0
Eden Roc 6		2	189	4	11	1258	0	0	0	0	11	1258	0.088	2.5	0.22	0.044	0.132	0.26	189	0.568	0.83	12	0.31	2.53	1.28	0.65	2.69	7.0

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Area 1 flows to trunk and PS 1. Area 2 flows to trunk sewer. Area 3 flows to trunk sewer. Area 4 flows to PS 2. Area 5 flows to trunk and then PS 3, which pumps to area 6.

Computation of Wastewater Flow for Kurtistown Sewering

Sewer: Kurtistown districts
District: Kurtistown
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 6, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation										( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Kurtistown																												
Kurtistown 1		17	17	85	253	253	0	0	0	0	253	253	0.018	2.5	0.04	0.009	0.027	0.05	17	0.051	0.10	8	0.52	2.50	0.56	0.19	1.89	2.3
Kurtistown 2		5	5	23	68	68	0	0	0	0	68	68	0.005	2.5	0.01	0.002	0.007	0.01	5	0.014	0.03	8	0.52	2.50	0.56	0.05	1.33	1.3
Kurtistown 3		7	7	37	111	111	0	0	0	0	111	111	0.008	2.5	0.02	0.004	0.012	0.02	7	0.022	0.05	8	0.52	2.50	0.56	0.08	1.54	1.6
Kurtistown 4		2	2	8	23	23	0	0	0	0	23	23	0.002	2.5	0.00	0.001	0.002	0.00	2	0.005	0.01	8	0.52	2.50	0.56	0.02	0.95	0.7
Kurtistown 5		8	8	42	126	126	0	0	0	0	126	126	0.009	2.5	0.02	0.004	0.013	0.03	8	0.025	0.05	8	0.52	2.50	0.56	0.09	1.54	1.6
Kurtistown 6		21	21	103	308	308	0	0	0	0	308	308	0.022	2.5	0.05	0.011	0.032	0.06	21	0.062	0.13	8	0.52	2.50	0.56	0.23	2.03	2.6
Kurtistown 7		3	3	14	43	43	0	0	0	0	43	43	0.003	2.5	0.01	0.002	0.005	0.01	3	0.009	0.02	8	0.52	2.50	0.56	0.03	1.18	1.0
Kurtistown 8		20	20	101	300	300	0	0	0	0	300	300	0.021	2.5	0.05	0.011	0.032	0.06	20	0.061	0.12	8	0.52	2.50	0.56	0.22	1.98	2.5
Kurtistown 9		19	19	95	283	283	0	0	0	0	283	283	0.020	2.5	0.05	0.010	0.030	0.06	19	0.057	0.12	8	0.52	2.50	0.56	0.21	1.98	2.5
Kurtistown 10		20	20	98	292	292	0	0	0	0	292	292	0.020	2.5	0.05	0.010	0.031	0.06	20	0.059	0.12	8	0.52	2.50	0.56	0.21	1.98	2.5

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Each area flows separately to the highway.

Computation of Wastewater Flow for Pa‘ahana-Kea‘au Sewering

Sewer: Pa‘ahana-Kea‘au districts
District: Pa‘ahana-Kea‘au
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 7, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Pa‘ahana-Kea‘au																												
Pa‘ahana 1		40	40	145	431	431	0	0	0	0	431	431	0.030	2.5	0.08	0.015	0.045	0.09	40	0.121	0.21	8	0.52	2.50	0.56	0.38	2.31	3.4
Pa‘ahana 2		29	29	103	306	306	0	0	0	0	306	306	0.021	2.5	0.05	0.011	0.032	0.06	29	0.086	0.15	8	0.52	2.50	0.56	0.27	2.11	2.8
Pa‘ahana 3		62	62	224	666	666	0	0	0	0	666	666	0.047	2.5	0.12	0.023	0.070	0.14	62	0.187	0.33	8	0.52	2.50	0.56	0.58	2.59	4.4
Kea‘au 4		40	40	149	457	457	0	0	0	0	457	457	0.032	2.5	0.08	0.016	0.048	0.10	40	0.119	0.22	8	0.52	2.50	0.56	0.38	2.34	3.5
Kea‘au 5		27	27	103	317	317	0	0	0	0	317	317	0.022	2.5	0.06	0.011	0.033	0.07	27	0.082	0.15	8	0.52	2.50	0.56	0.26	2.11	2.8
Kea‘au 6		21	49	81	247	564	0	0	0	0	247	564	0.039	2.5	0.10	0.020	0.059	0.12	49	0.147	0.27	8	0.52	2.50	0.56	0.47	2.47	3.9
Kea‘au 7		12	51	44	135	593	0	0	0	0	135	593	0.041	2.5	0.10	0.021	0.062	0.12	51	0.154	0.28	8	0.52	2.50	0.56	0.49	2.49	4.0
Kea‘au 8		4	4	14	44	44	0	0	0	0	44	44	0.003	2.5	0.01	0.002	0.005	0.01	4	0.011	0.02	8	0.52	2.50	0.56	0.04	1.18	1.0
West Kea‘au, Eden Roc, Kurtistown, Pa‘ahana																					3.77							
Kea‘au 9		15	68	56	172	780	0	0	0	0	172	780	0.055	2.5	0.14	0.027	0.082	0.16	68	0.203	4.13	18	0.80	5.32	6.07	0.68	5.72	10.9
Kea‘au 10		3	3	11	34	34	0	0	0	0	34	34	0.002	2.5	0.01	0.001	0.004	0.01	3	0.009	0.02	8	0.52	2.50	0.56	0.03	1.18	1.0
Kea‘au 11		3	125	11	33	1439	0	0	0	0	33	1439	0.101	2.5	0.25	0.050	0.151	0.30	125	0.375	4.44	24	0.20	3.22	6.54	0.68	3.46	14.5

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Areas 1-3 are in Pa‘alana. Areas 4-11 are in Kea‘au.
3. Areas 1-3 each flow to separate PS. Area 4 flows to area 7. Area 5 flows to area 6. Areas 6 and 8 flow to area 9. Areas 7, 9, and 10 flow to area 11 before the WWTP.
4. Area 9 will also receive flow from the rest of Kea‘au (West Kea‘au, Eden Roc, Kurtistown, and Pa‘ahana).

B-4: Pump Station and Force Main Hydraulic Calculations

Note: Kurtistown does not have any Regional WWPSs.

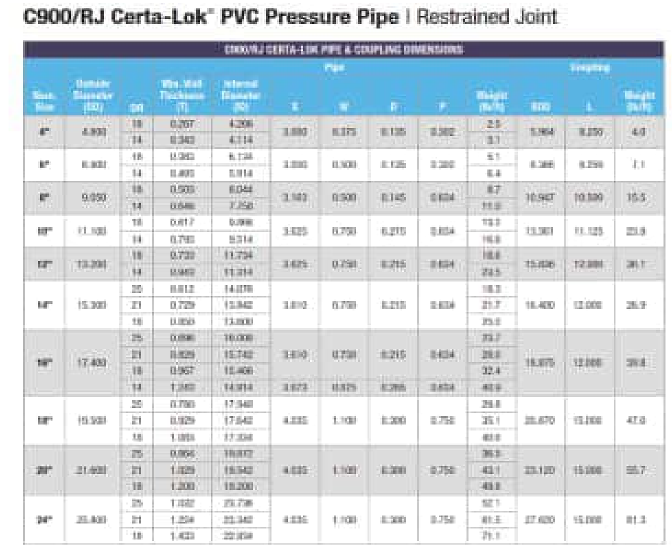
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
West Kea‘au 2-3-2023																						
PS1																						
6.134	0.51	0.205	0.27	1400	1980	20	1960	2025	10	2015	55	0.30	208	0.46	2.26	140	0.0032	4.5	15	0.4	74.9	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
EdenRoc 2-3-2023																						
PS1																						
6.134	0.51	0.205	0.42	2200	1775	20	1755	1785	10	1775	20	0.26	181	0.40	1.96	140	0.0024	5.4	15	0.5	40.9	ok
PS2																						
6.134	0.51	0.205	0.34	1800	1645	20	1625	1680	10	1670	45	0.68	472	1.05	5.13	140	0.0145	26.1	15	2.6	88.7	ok
PS3																						
9.866	0.82	0.531	2.03	10700	1640	20	1620	1670	5	1665	45	0.82	569	1.27	2.39	140	0.0020	21.6	15	2.2	83.8	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

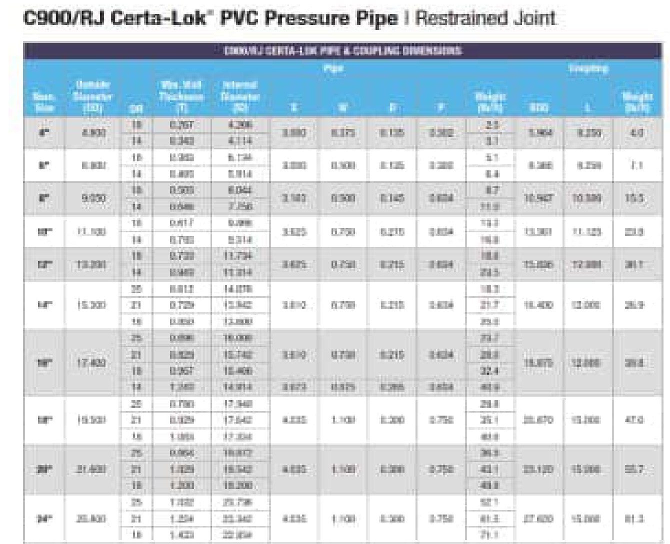
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

<u>Assumption:</u>
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

<u>Quick notes to check FM calculation:</u>
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Paʻahana-Keʻeau 2-5-2023																						
PS1																						
6.134	0.51	0.205	0.20	1056	375	20	355	428	10	418	63	0.21	146	0.32	1.58	140	0.0016	1.7	15	0.2	79.9	ok
PS2																						
6.134	0.51	0.205	0.17	898	428	20	408	478	10	468	60	0.36	250	0.56	2.71	140	0.0045	4.0	15	0.4	79.4	ok
PS2																						
8.044	0.67	0.353	0.50	2640	478	20	458	528	10	518	60	0.69	479	1.07	3.03	140	0.0040	10.5	15	1.0	86.5	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

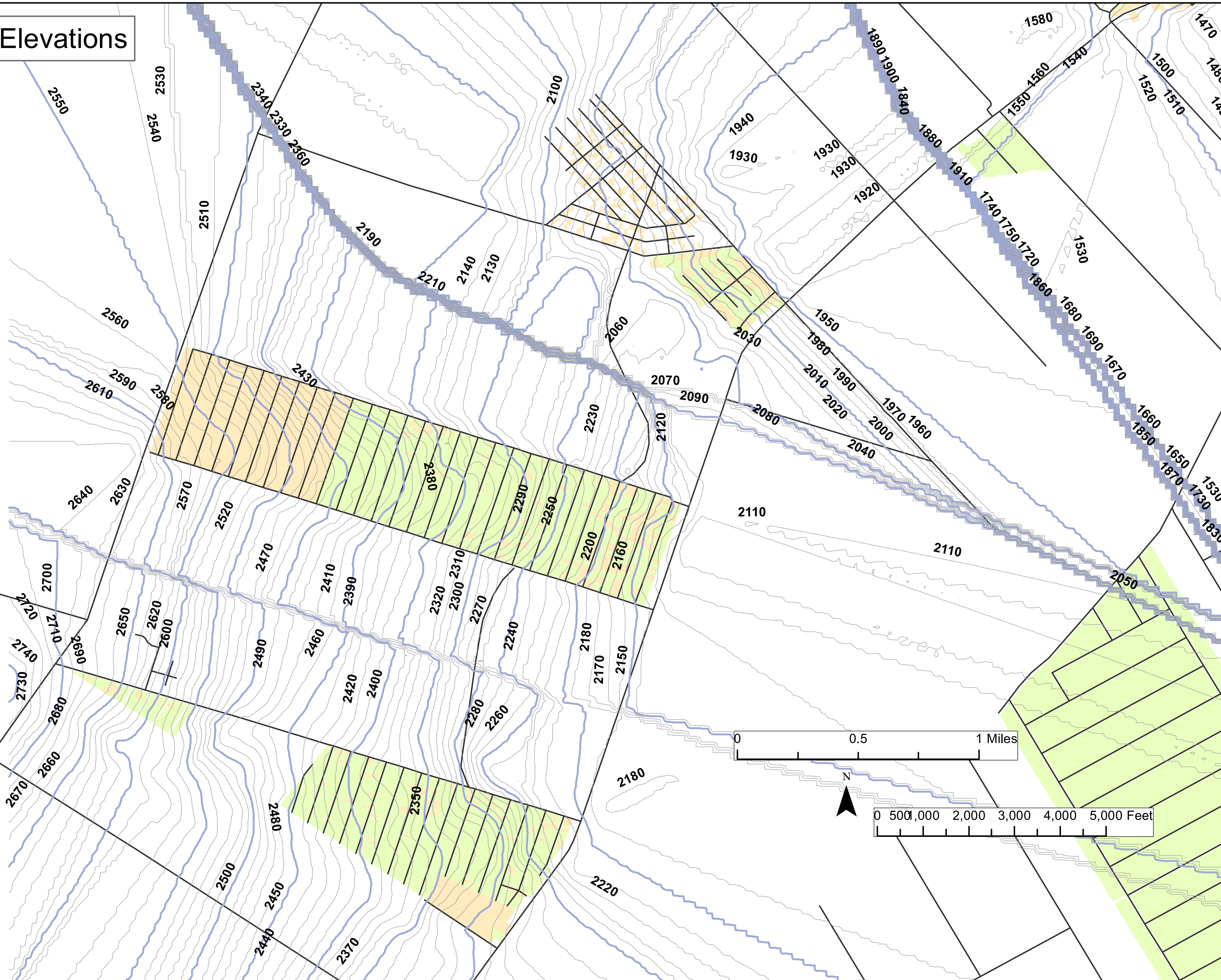
B-5: Contour Maps (Basis for Collection System Layout and calculation)

West Keaau Contour Elevations

Orange denotes TMKs part of urbane sewering.
Green indicates urban sewering based on zoning from PDR.

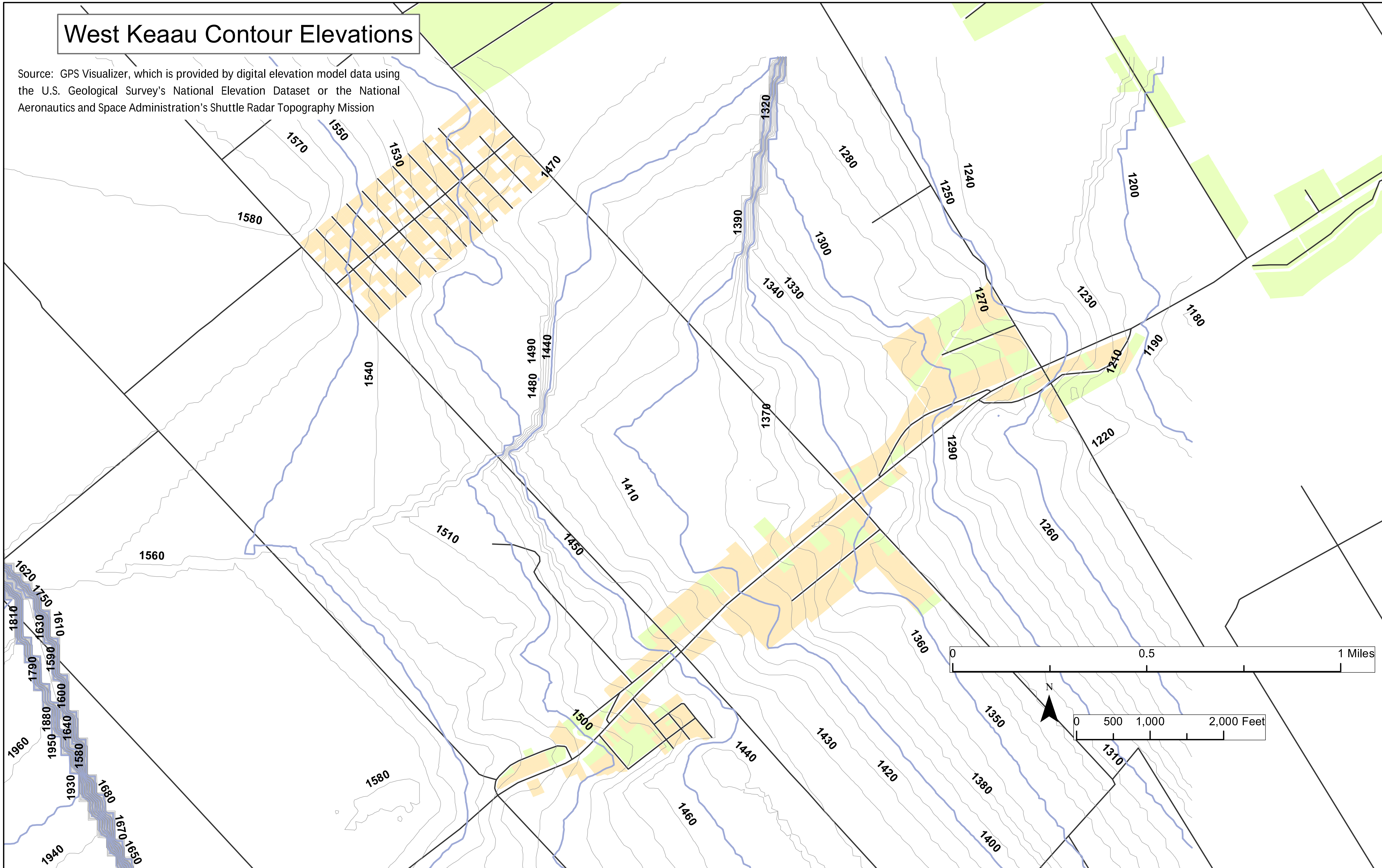
Some orange TMKs aren't in the green areas. These were added to urban sewering because of other non-zoning related criteria: small, populated, near highway or other urban sewering area.

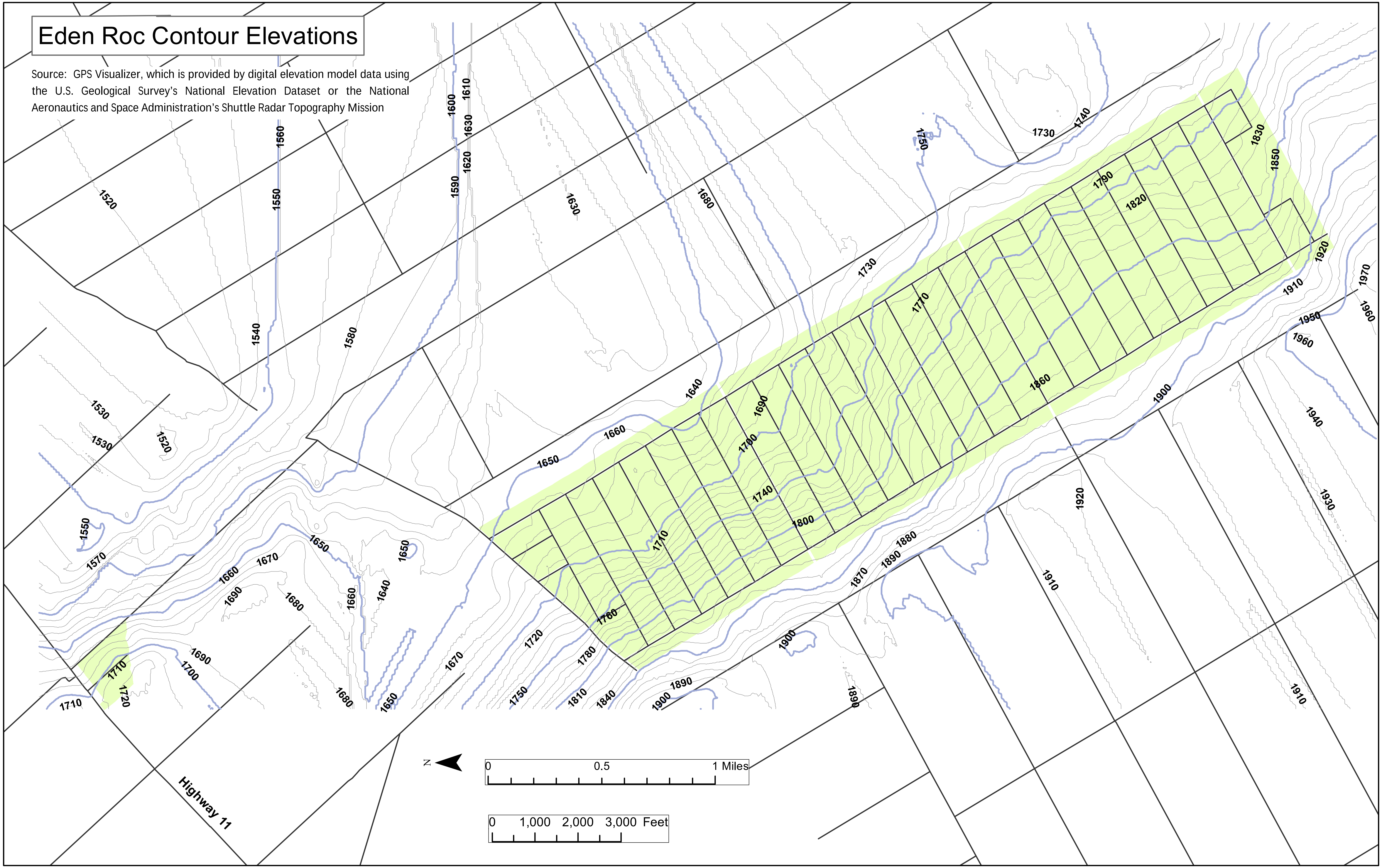
Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission



West Keaau Contour Elevations

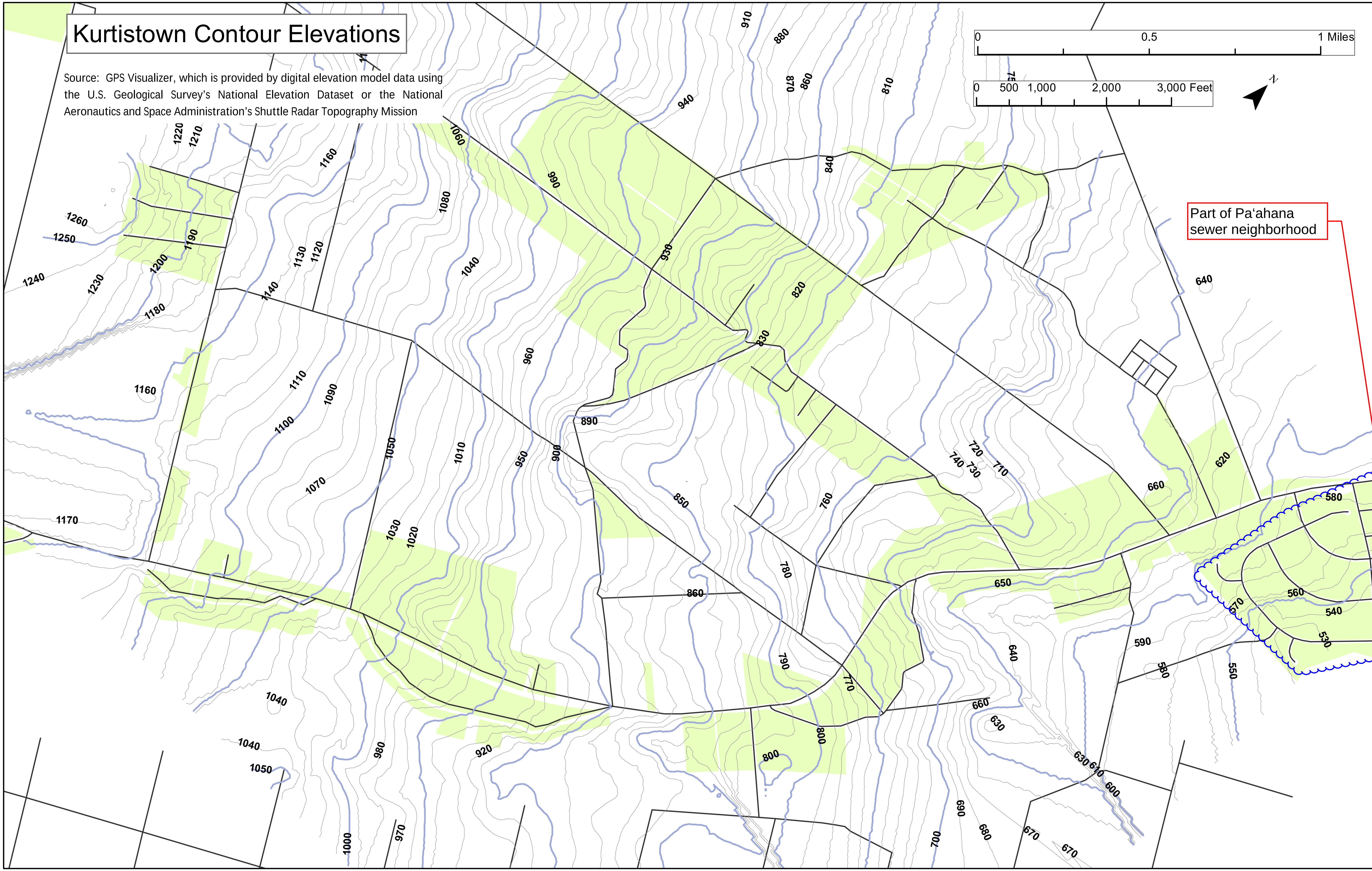
Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission

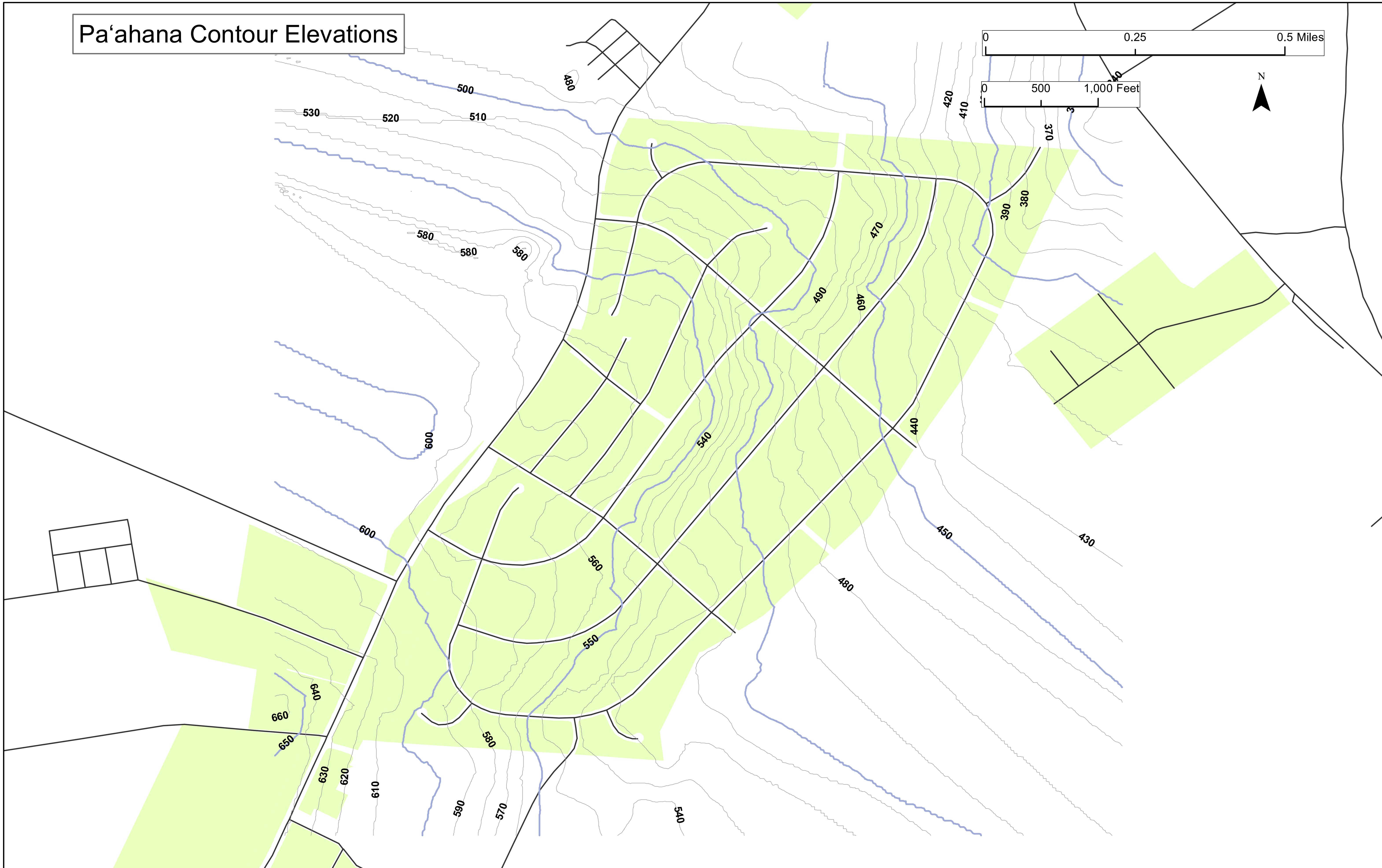



Eden Roc Contour Elevations
Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission
Highway 11
N
0
0.5
1 Miles
0
1,000
2,000
3,000
Feet

Kurtistown Contour Elevations

Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission




Pa'ahana Contour Elevations
0
0.25
0.5 Miles
0
500
1,000 Feet
N
500
480
530
520
510
580
580
580
420
410
370
390
380
470
490
460
600
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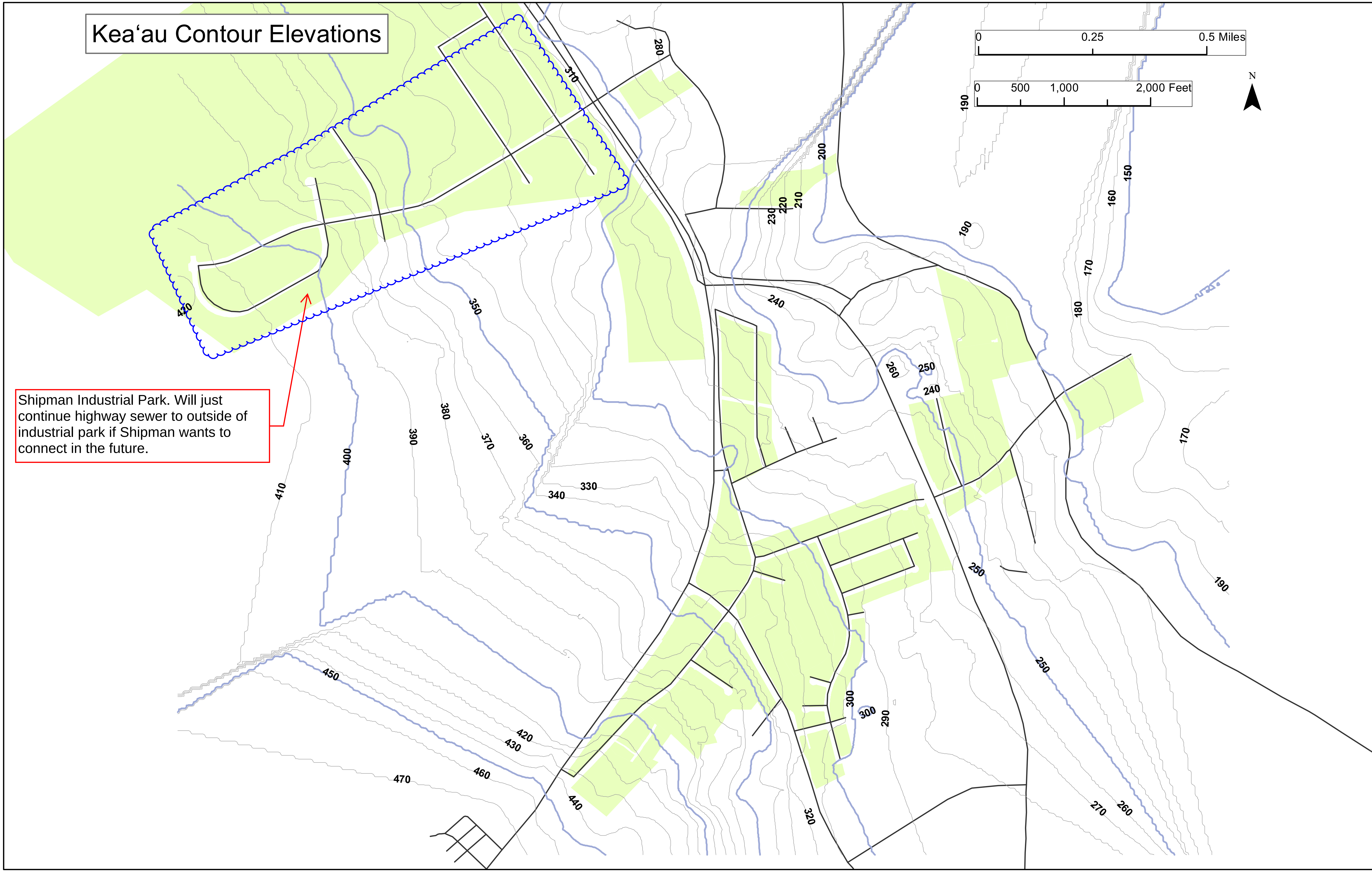
650
580
630
620
610
590
570
540



Kea'au Contour Elevations
0
0.25
0.5 Miles
0
500
1,000
2,000 Feet
N
Shipman Industrial Park. Will just continue highway sewer to outside of industrial park if Shipman wants to connect in the future.

Appendix C Collection System Layout Maps and Hydraulic Calculations

Hawaiian Paradise Park Subregion

C-1: Overall Collection System Layout Map

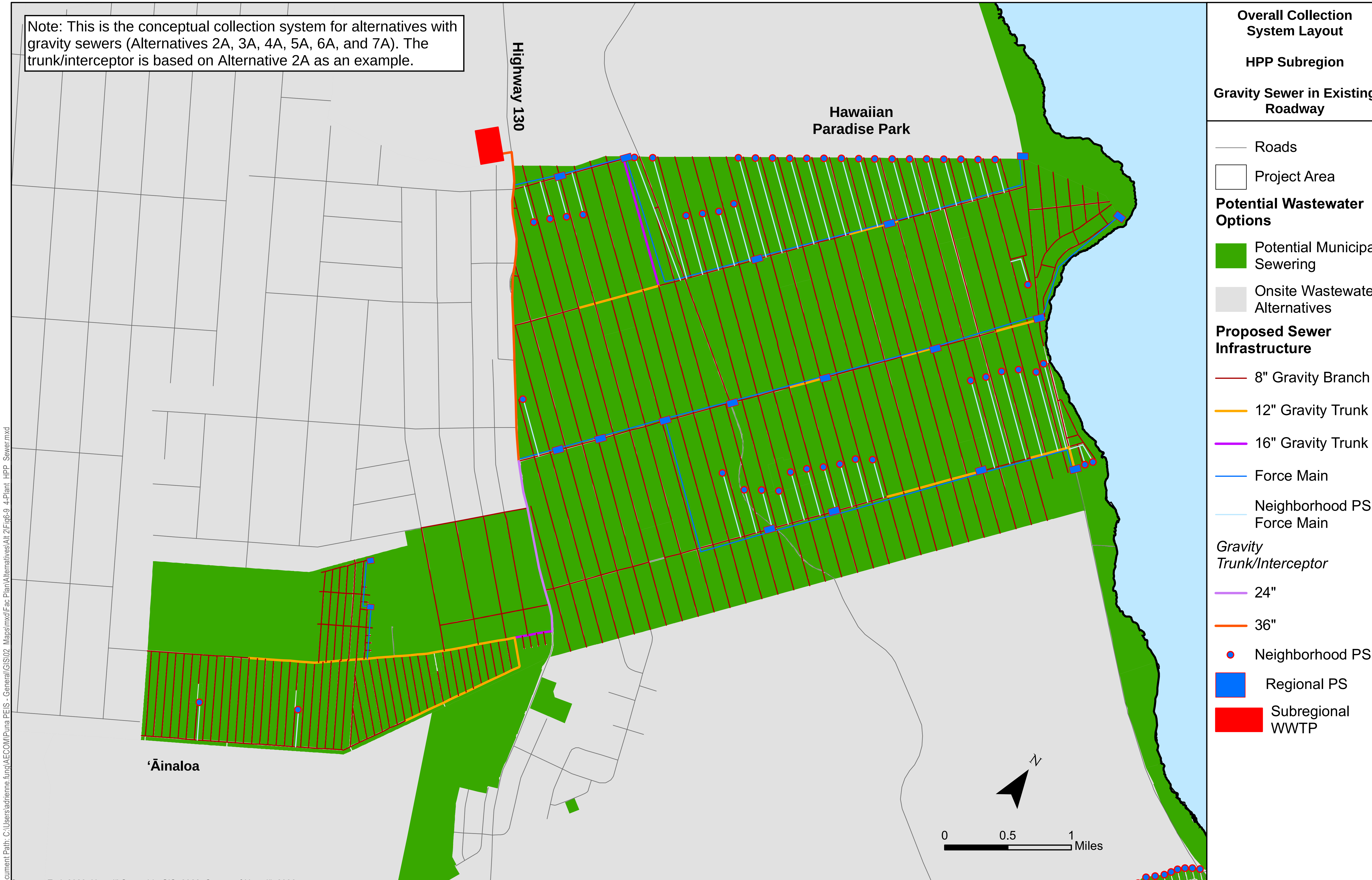
C-2: Community Collection System Layout Maps

C-3: Sewer Hydraulic Calculations

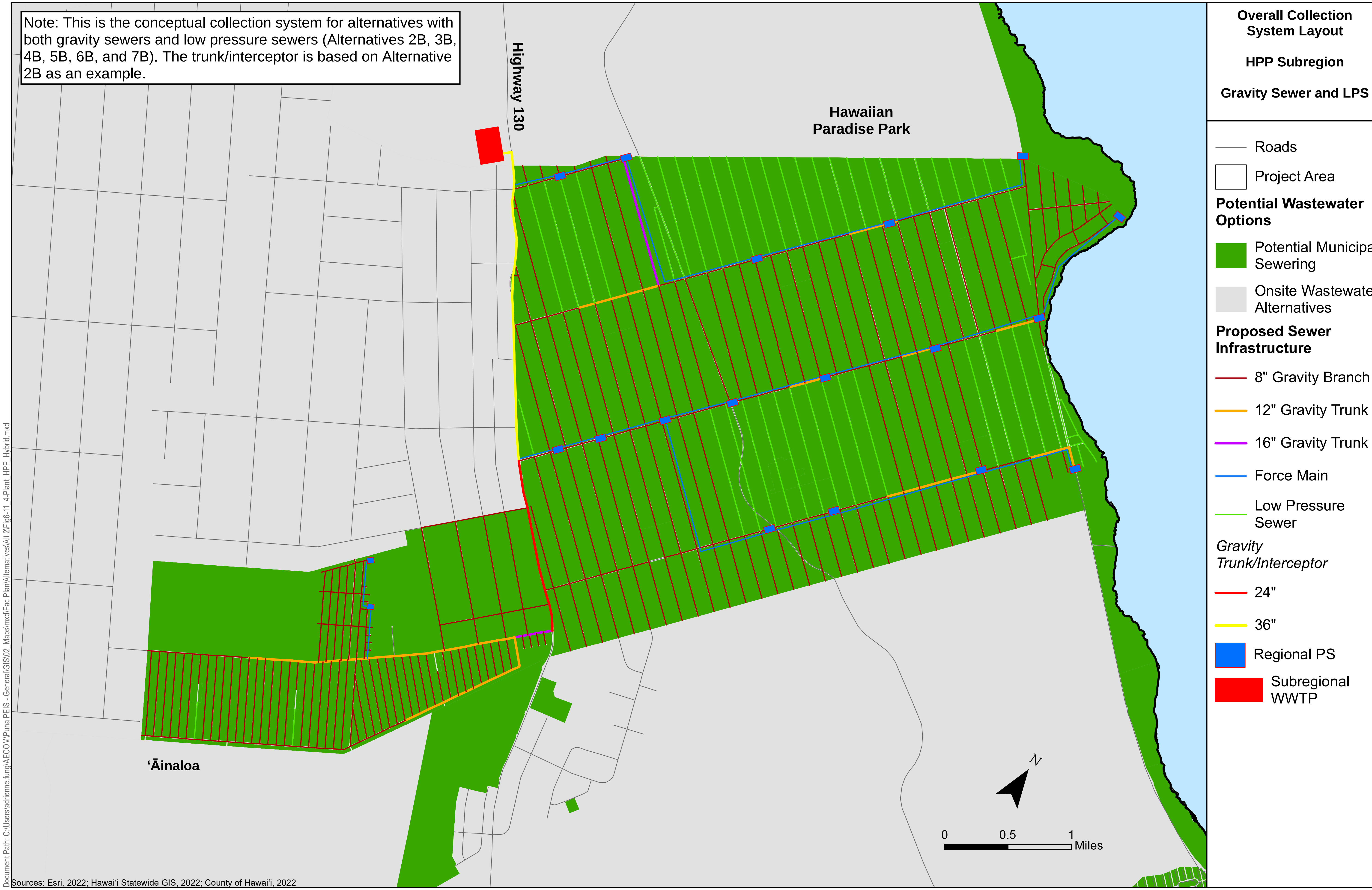
C-4: Pump Station and Force Main Hydraulic Calculations

C-5: Contour Maps (Basis for Collection System Layout and calculation)

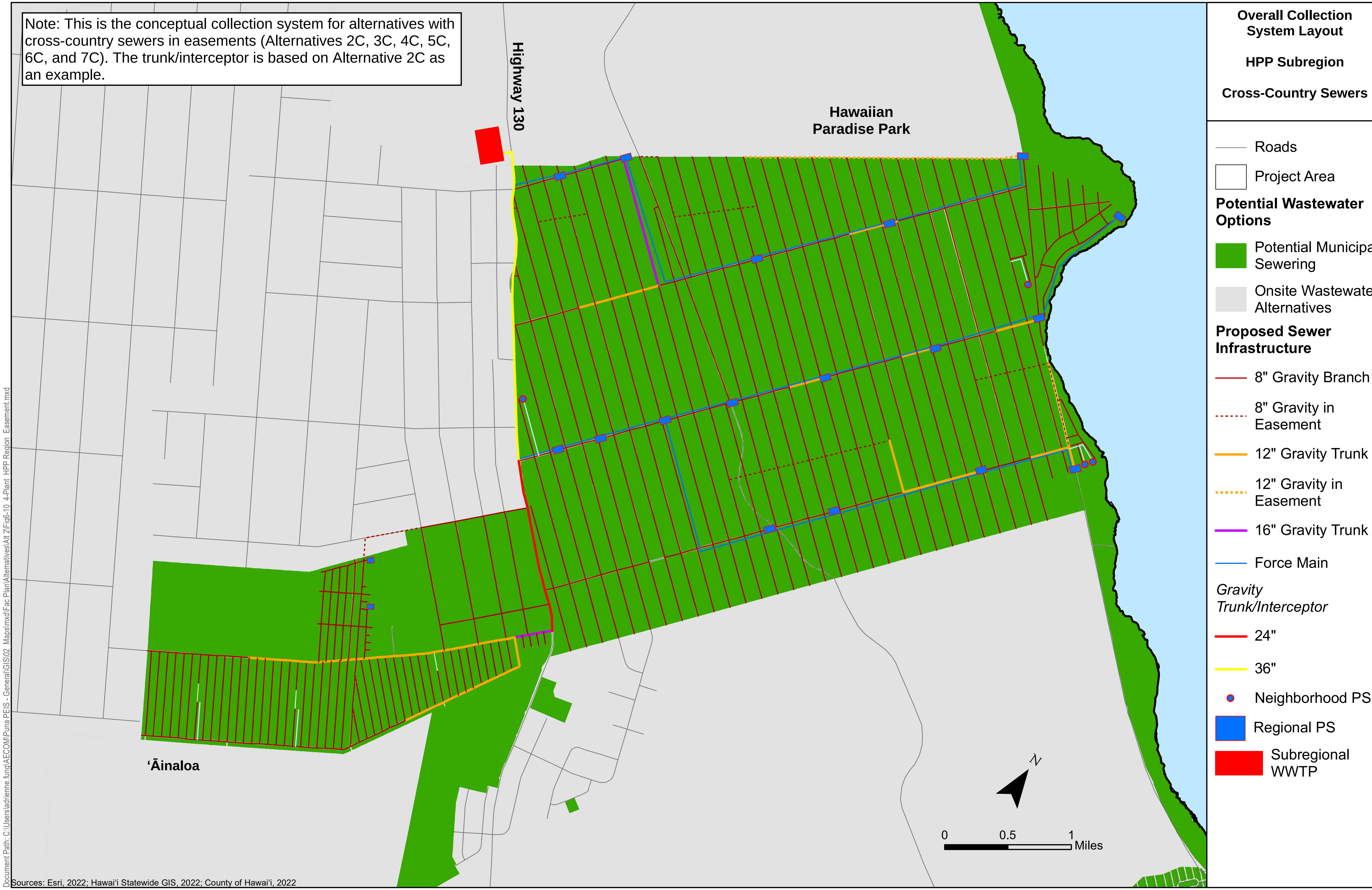
C-1: Overall Collection System Layout Map



Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A). The trunk/interceptor is based on Alternative 2A as an example.
Highway 130
Hawaiian Paradise Park
ʻĀinaloa
N
0
0.5
1
Miles
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022
Overall Collection System Layout
HPP Subregion
Gravity Sewer in Existing Roadway
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
12" Gravity Trunk
16" Gravity Trunk
Force Main
Neighborhood PS Force Main
Gravity Trunk/Interceptor
24"
36"
Neighborhood PS
Regional PS
Subregional WWTP



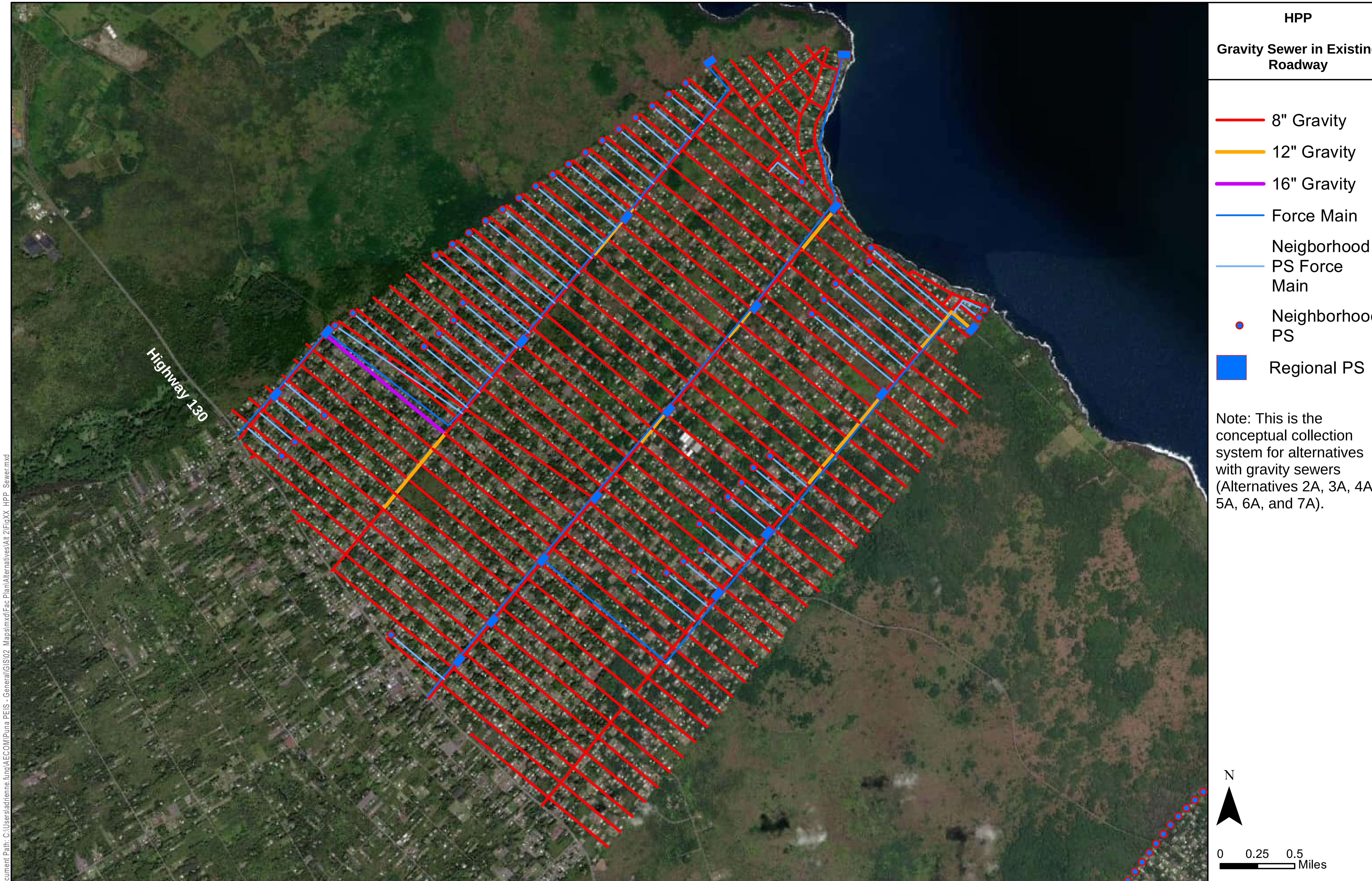
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-11_4-Plant_HPP_Hybrid.mxd



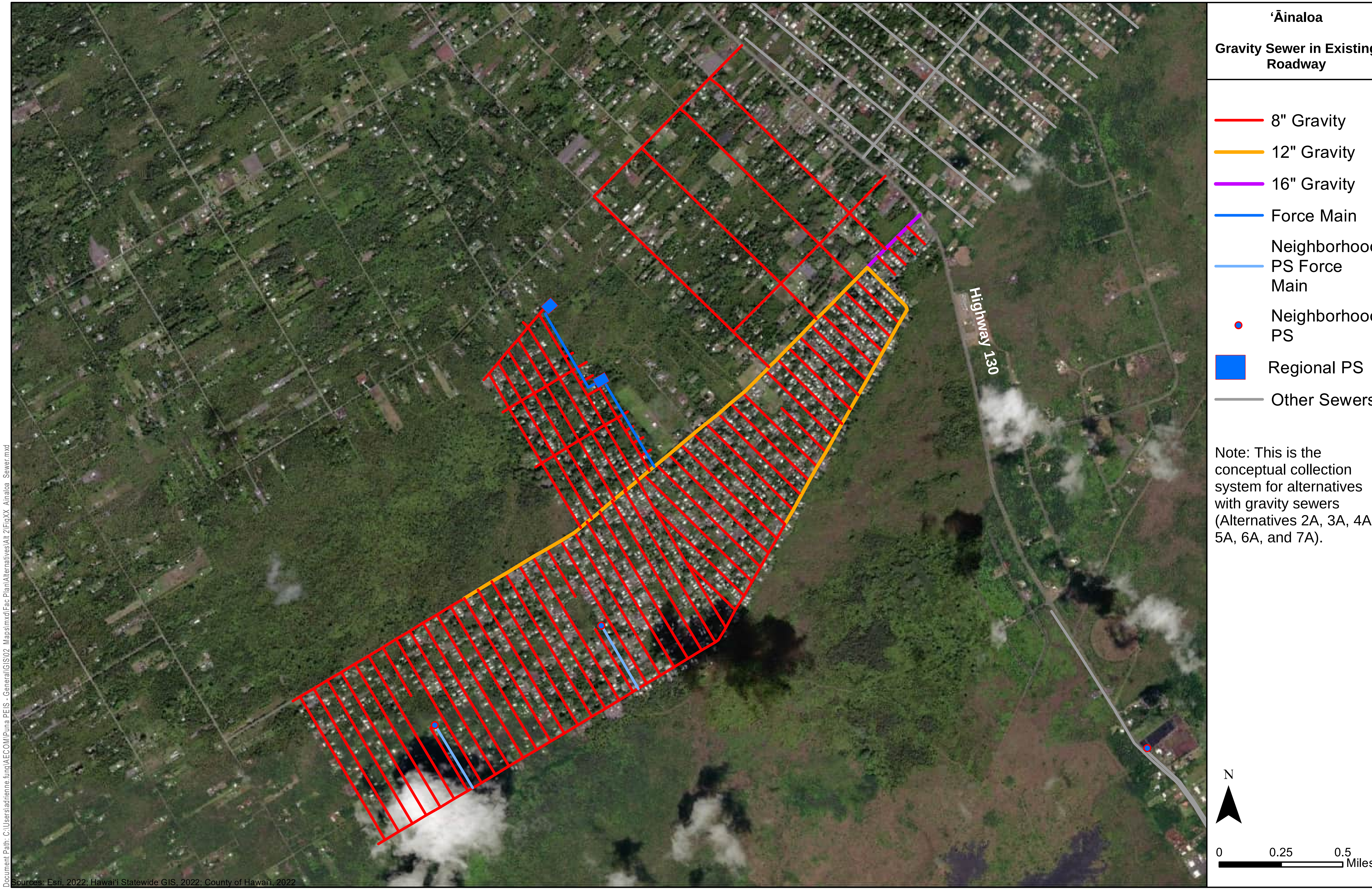
Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C). The trunk/interceptor is based on Alternative 2C as an example.
Highway 130
Hawaiian Paradise Park
ʻĀinaloa
Overall Collection System Layout
HPP Subregion
Cross-Country Sewers
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
8" Gravity in Easement
12" Gravity Trunk
12" Gravity in Easement
16" Gravity Trunk
Force Main
Gravity Trunk/Interceptor
24"
36"
Neighborhood PS
Regional PS
Subregional WWTP
N
0
0.5
1
Miles
Sources: Esri, 2022; Hawaiʻi Statewide GIS, 2022; County of Hawaiʻi, 2022
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-10_4-Plant_HPP Region_Easement.mxd

C-2: Community Collection System Layout Maps

Gravity Sewer in Existing Roadways



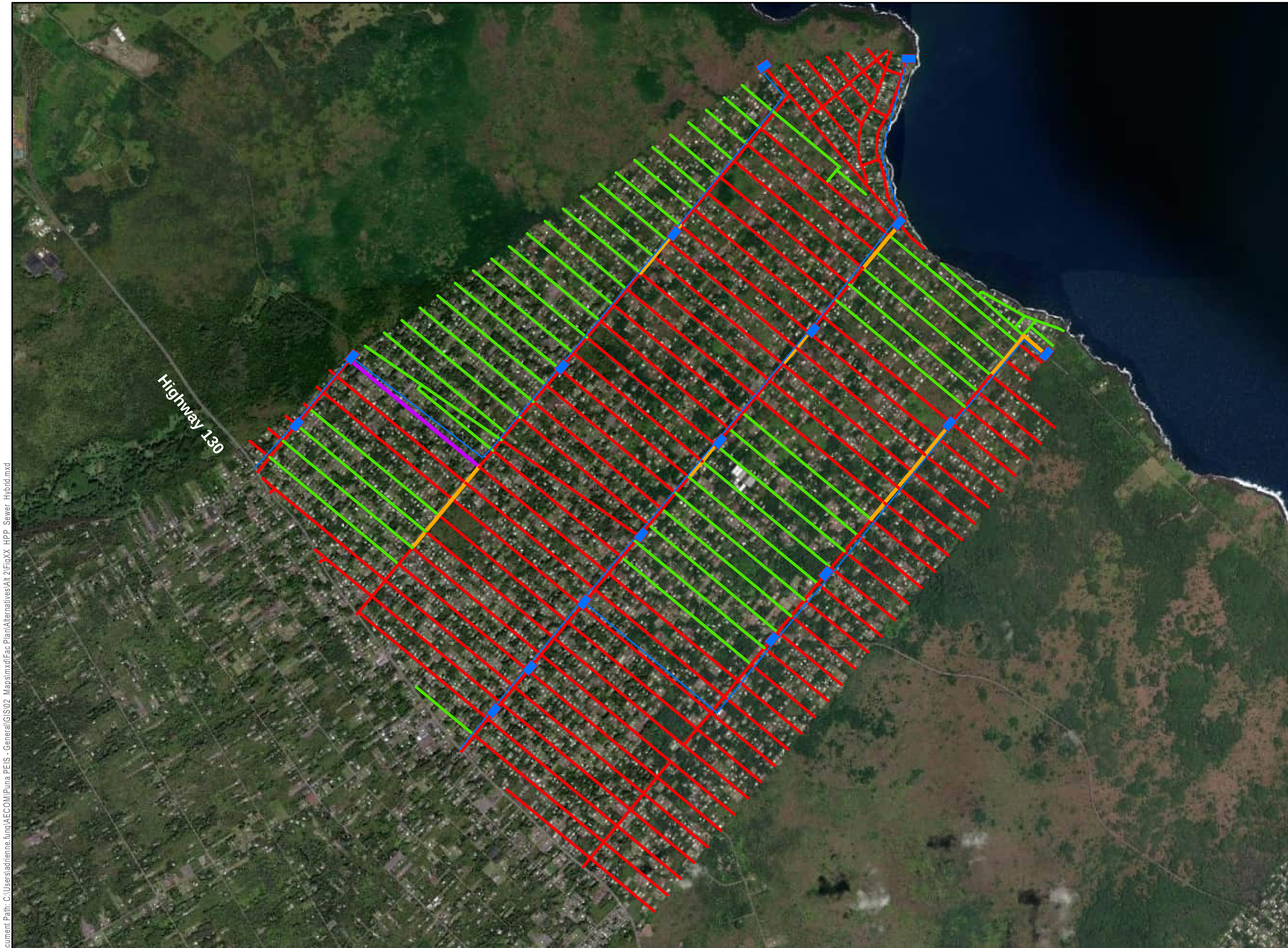
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_HPP_Sewer.mxd



‘Āinaloa
Gravity Sewer in Existing Roadway
8" Gravity
12" Gravity
16" Gravity
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Other Sewers
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
Highway 130
N
0
0.25
0.5
Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

C-2: Community Collection System Layout Maps

Gravity Sewer and LPS



HPP

Gravity Sewer and LPS

8" Gravity
12" Gravity
16" Gravity
LPS
Force Main
Regional PS

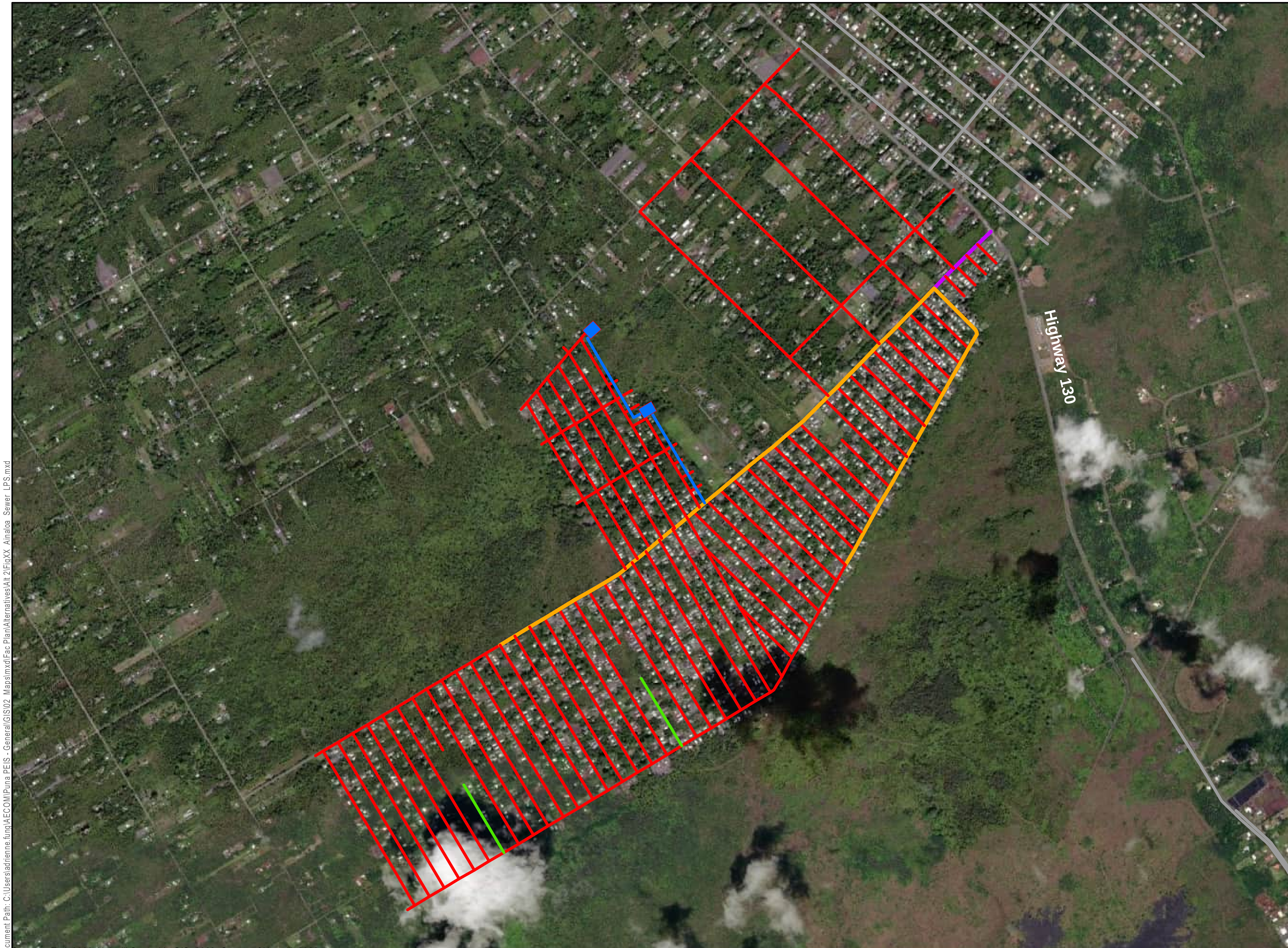
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).

N

0 0.25 0.5 Miles

ʻĀinaloa

Gravity Sewer and LPS



8" Gravity

12" Gravity

16" Gravity

LPS

Force Main

Regional PS

Other Sewers

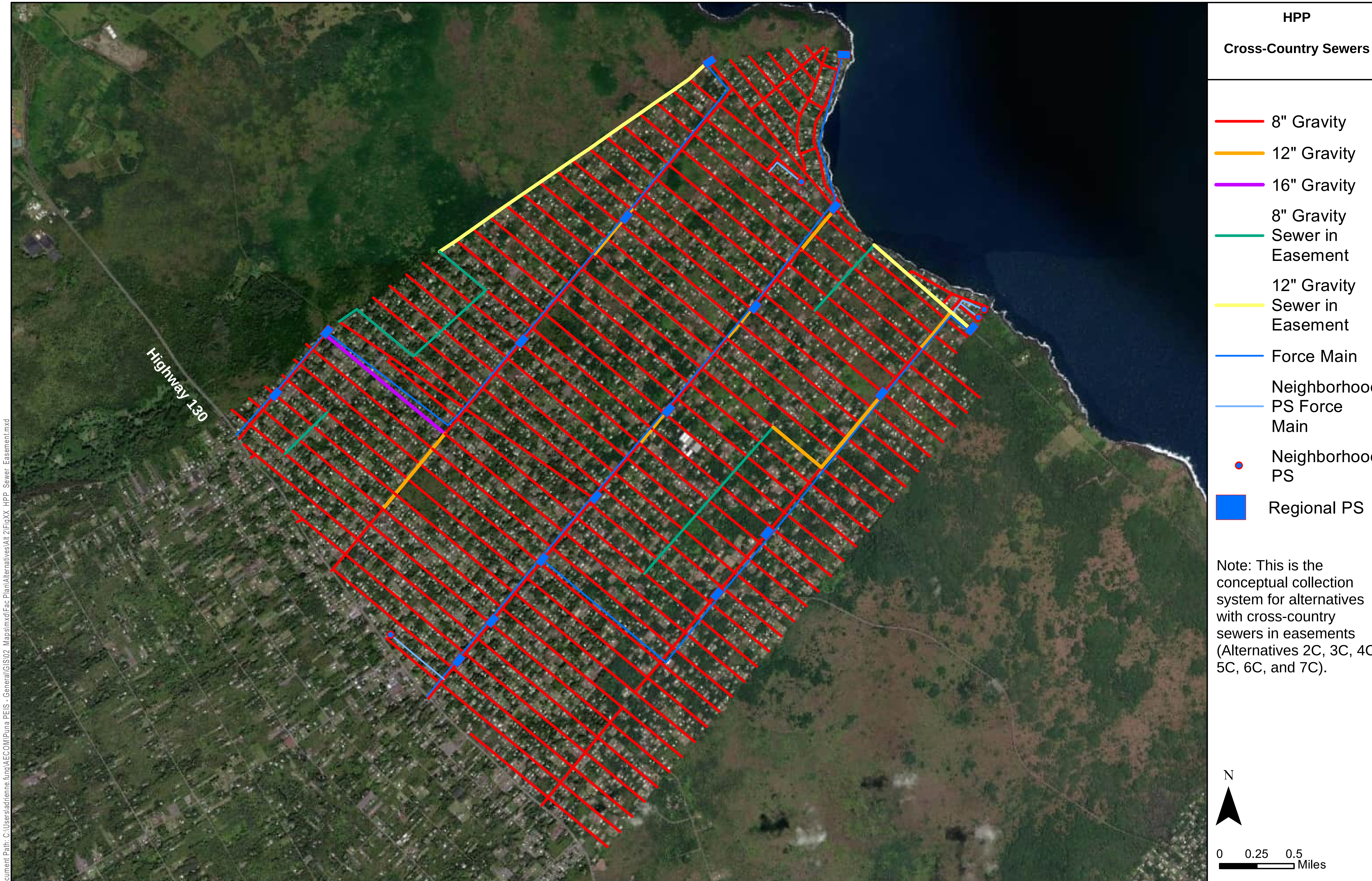
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).

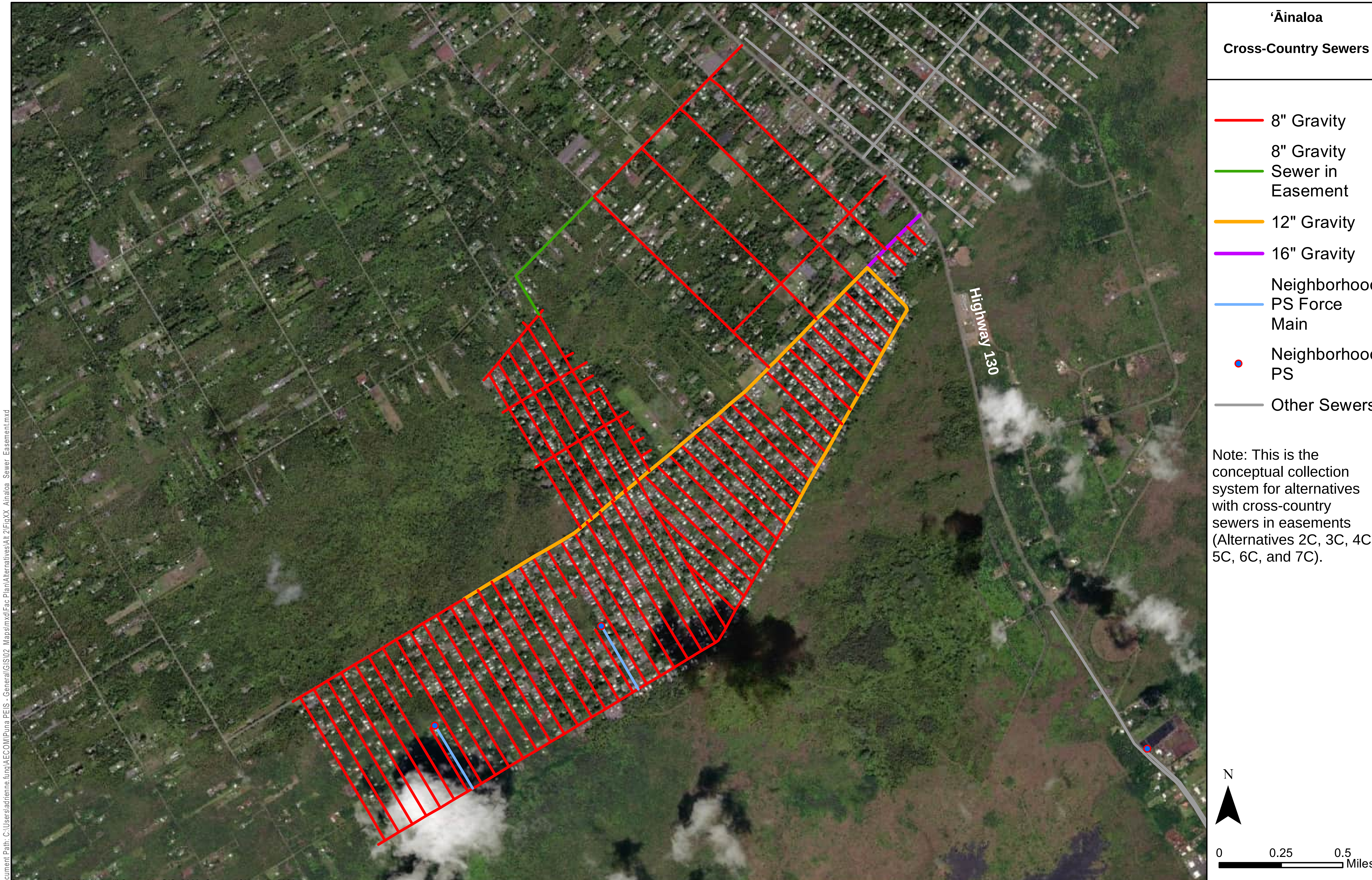
N

0 0.25 0.5 Miles

C-2: Community Collection System Layout Maps

Cross-Country Sewers in New Easements


HPP
Cross-Country Sewers
8" Gravity
12" Gravity
16" Gravity
8" Gravity Sewer in Easement
12" Gravity Sewer in Easement
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C).
Highway 130
N
0 0.25 0.5
Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022



Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_Ainaloa_Sewer_Easement.mxd

C-3: Sewer Hydraulic Calculations

Computation of Wastewater Flow for HPP Sewering

Sewer: HPP 1-17 segments
District: HPP
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: January 30, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
HPP																												
HPP 1		67	67	224	769	769	0	0	0	0	769	769	0.054	2.5	0.13	0.027	0.081	0.16	67	0.200	0.36	8	0.52	2.50	0.56	0.64	2.65	4.6
HPP 2	A	69	69	233	800	800	0	0	0	0	800	800	0.056	2.5	0.14	0.028	0.084	0.17	69	0.208	0.38	8	0.52	2.50	0.56	0.67	2.68	4.8
HPP 2	B	31	100	104	355	1154	0	0	0	0	355	1154	0.081	2.5	0.20	0.040	0.121	0.24	100	0.300	0.54	12	0.31	2.53	1.28	0.42	2.42	5.4
HPP 3		104	104	352	1207	1207	0	0	0	0	1207	1207	0.084	2.5	0.21	0.042	0.127	0.25	104	0.313	0.57	8	0.80	3.10	0.70	0.81	3.45	5.5
HPP 42 (4B)		19	546	63	216	6307	0	0	0	0	216	6307	0.442	2.5	1.10	0.221	0.662	1.32	546	1.638	2.96	16	0.60	4.26	3.84	0.77	4.70	10.5
HPP 43 (4C)		58	58	194	665	665	0	0	0	0	665	665	0.047	2.5	0.12	0.023	0.070	0.14	58	0.173	0.31	8	0.52	2.50	0.56	0.55	2.56	4.2
HPP 41 (4A)	A	94	94	318	1090	1090	0	0	0	0	1090	1090	0.076	2.5	0.19	0.038	0.114	0.23	94	0.283	0.51	8	0.65	2.79	0.63	0.81	3.11	5.5
HPP 41 (4A)	B	104	199	352	1207	2296	0	0	0	0	1207	2296	0.161	2.5	0.40	0.080	0.241	0.48	199	0.596	1.08	12	0.35	2.68	1.36	0.79	2.98	8.1
HPP 5		59	59	198	677	677	0	0	0	0	677	677	0.047	2.5	0.12	0.024	0.071	0.14	59	0.176	0.32	8	0.52	2.50	0.56	0.56	2.58	4.3
DISCHARGE TO HIGHWAY																												

Computation of Wastewater Flow for HPP Sewering

Sewer: HPP 1-17 segments
District: HPP
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: January 30, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential																								
				Homes			Apartment		Other		Total																	
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
HPP																												
HPP 6		95	95	321	1099	1099	0	0	0	0	1099	1099	0.077	2.5	0.19	0.038	0.115	0.23	95	0.285	0.52	8	0.65	2.79	0.63	0.82	3.12	5.5
HPP 7	A	55	55	186	638	638	0	0	0	0	638	638	0.045	2.5	0.11	0.022	0.067	0.13	55	0.166	0.30	8	0.52	2.50	0.56	0.53	2.54	4.2
HPP 7	B	66	121	223	765	1403	0	0	0	0	765	1403	0.098	2.5	0.25	0.049	0.147	0.29	121	0.364	0.66	12	0.31	2.53	1.28	0.51	2.54	6.1
HPP 8	A	73	73	247	844	844	0	0	0	0	844	844	0.059	2.5	0.15	0.030	0.089	0.18	73	0.219	0.40	8	0.52	2.50	0.56	0.70	2.71	5.0
HPP 8	B	51	124	173	591	1436	0	0	0	0	591	1436	0.100	2.5	0.25	0.050	0.151	0.30	124	0.373	0.67	12	0.31	2.53	1.28	0.53	2.55	6.2
HPP 9	A	55	55	184	631	631	0	0	0	0	631	631	0.044	2.5	0.11	0.022	0.066	0.13	55	0.164	0.30	8	0.52	2.50	0.56	0.53	2.54	4.2
HPP 9	B	51	106	173	593	1224	0	0	0	0	593	1224	0.086	2.5	0.21	0.043	0.129	0.26	106	0.318	0.57	12	0.31	2.53	1.28	0.45	2.45	5.6
HPP 10		72	72	242	828	828	0	0	0	0	828	828	0.058	2.5	0.14	0.029	0.087	0.17	72	0.215	0.39	8	0.52	2.50	0.56	0.69	2.69	4.9
HPP 11	A	81	81	272	933	933	0	0	0	0	933	933	0.065	2.5	0.16	0.033	0.098	0.20	81	0.242	0.44	8	0.52	2.50	0.56	0.78	2.76	5.3
HPP 11	B	66	146	222	759	1692	0	0	0	0	759	1692	0.118	2.5	0.30	0.059	0.178	0.36	146	0.439	0.79	12	0.31	2.53	1.28	0.62	2.66	6.8
HPP 12	A	100	100	337	1153	1153	0	0	0	0	1153	1153	0.081	2.5	0.20	0.040	0.121	0.24	100	0.299	0.54	8	0.70	2.90	0.65	0.83	3.23	5.5
HPP 12	B	153	252	515	1762	2915	0	0	0	0	1762	2915	0.204	2.5	0.51	0.102	0.306	0.61	252	0.757	1.37	12	0.55	3.36	1.71	0.80	3.74	8.1
HPP 13		102	102	345	1182	1182	0	0	0	0	1182	1182	0.083	2.5	0.21	0.041	0.124	0.25	102	0.307	0.56	8	0.75	3.00	0.68	0.82	3.35	5.6
HPP 14		70	70	237	813	813	0	0	0	0	813	813	0.057	2.5	0.14	0.028	0.085	0.17	70	0.211	0.38	8	0.52	2.50	0.56	0.68	2.68	4.8
HPP 15		108	108	365	1251	1251	0	0	0	0	1251	1251	0.088	2.5	0.22	0.044	0.131	0.26	108	0.325	0.59	8	0.85	3.19	0.72	0.82	3.56	5.5
HPP 16		85	85	285	977	977	0	0	0	0	977	977	0.068	2.5	0.17	0.034	0.103	0.21	85	0.254	0.46	8	0.52	2.50	0.56	0.81	2.78	5.5
HPP 17		81	81	274	937	937	0	0	0	0	937	937	0.066	2.5	0.16	0.033	0.098	0.20	81	0.243	0.44	8	0.52	2.50	0.56	0.78	2.76	5.3
DISCHARGE TO HIGHWAY																	2.39				10.68							

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Area 42 (4B) receives flow from areas 1, 2, 3, 41 (4a), 42 (4b), and 43 (4c).

Computation of Wastewater Flow for **ʻĀ**inaloa Sewering

Sewer: ʻĀinaloa districts
District: ʻĀinaloa
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: January 31, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
ʻĀinaloa																												
ʻĀinaloa 1		32	32	123	384	384	0	0	0	0	384	384	0.027	2.5	0.07	0.013	0.040	0.08	32	0.097	0.18	8	1.00	3.46	0.78	0.23	2.81	2.6
ʻĀinaloa 2		52	84	197	611	994	0	0	0	0	611	994	0.070	2.5	0.17	0.035	0.104	0.21	84	0.252	0.46	8	1.00	3.46	0.78	0.59	3.60	4.4
ʻĀinaloa 3		43	127	165	512	1507	0	0	0	0	512	1507	0.105	2.5	0.26	0.053	0.158	0.32	127	0.382	0.70	12	1.00	4.54	2.30	0.30	3.98	4.5
ʻĀinaloa 4		12	139	46	142	1648	0	0	0	0	142	1648	0.115	2.5	0.29	0.058	0.173	0.35	139	0.418	0.76	12	1.00	4.54	2.30	0.33	4.07	4.7
ʻĀinaloa 5		131	131	500	1554	1554	0	0	0	0	1554	1554	0.109	2.5	0.27	0.054	0.163	0.33	131	0.394	0.72	8	1.50	4.24	0.96	0.75	4.66	5.2
ʻĀinaloa 6		79	211	302	937	2491	0	0	0	0	937	2491	0.174	2.5	0.44	0.087	0.262	0.52	211	0.632	1.16	12	1.00	4.54	2.30	0.50	4.55	6.0
ʻĀinaloa 7		55	266	209	650	3141	0	0	0	0	650	3141	0.220	2.5	0.55	0.110	0.330	0.66	266	0.797	1.46	12	0.70	3.80	1.93	0.76	4.17	7.8
ʻĀinaloa 8		92	358	351	1091	4232	0	0	0	0	1091	4232	0.296	2.5	0.74	0.148	0.444	0.89	358	1.074	1.96	12	1.50	5.56	2.82	0.70	6.00	7.4
ʻĀinaloa 9		52	410	196	609	4842	0	0	0	0	609	4842	0.339	2.5	0.85	0.169	0.508	1.02	410	1.229	2.25	12	1.50	5.56	2.82	0.80	6.17	8.1
ʻĀinaloa 10		10	559	39	120	6610	0	0	0	0	120	6610	0.463	2.5	1.16	0.231	0.694	1.39	559	1.678	3.07	16	0.70	4.60	4.15	0.74	5.03	10.2
ʻĀinaloa 11		82	82	312	970	970	0	0	0	0	970	970	0.068	2.5	0.17	0.034	0.102	0.20	82	0.246	0.45	8	0.52	2.50	0.56	0.80	2.77	5.4

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Areas 1, 2, 3, 4 and areas 5, 6, 7, 8, 9 join before area 10.
3. Area 11 flows directly to highway.

C-4: Pump Station and Force Main Hydraulic Calculations

HPP

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

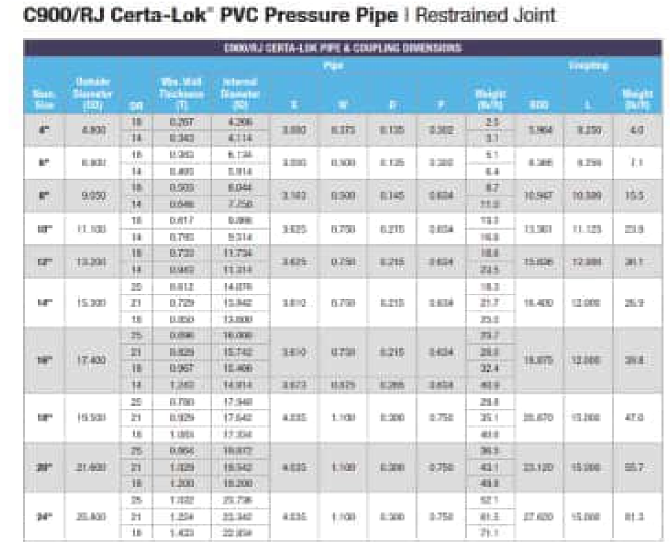
DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
HPP 1-26-2023																						
PS1																						
6.134	0.51	0.205	1.20	6336	55	20	35	101	12	89	54	0.36	250	0.56	2.71	140	0.0045	28.2	15	2.8	100.1	ok
PS2																						
9.866	0.82	0.531	1.10	5808	101	20	81	163	12	151	70	0.9	625	1.39	2.62	140	0.0024	14.0	15	1.4	100.4	ok
PS3																						
11.734	0.98	0.751	0.90	4752	163	20	143	225	10	215	72	1.5	1,021	2.27	3.03	140	0.0026	12.2	15	1.2	100.4	ok
PS 4																						
15.466	1.29	1.305	0.50	2640	183	20	163	247	10	237	74	2.96	2,056	4.58	3.51	140	0.0024	6.4	15	0.6	96.1	ok
PS 5																						
17.334	1.44	1.639	0.45	2376	247	20	227	315	10	305	78	3.28	2,278	5.08	3.10	140	0.0017	4.0	15	0.4	97.4	ok
PS 6																						
6.134	0.51	0.205	1.10	5808	20	20	0	36	10	26	26	0.52	361	0.80	3.92	140	0.0088	51.2	15	5.1	97.3	ok
PS 7																						
9.866	0.82	0.531	0.90	4752	36	20	16	90	10	80	64	1.18	819	1.83	3.44	140	0.0040	18.9	15	1.9	99.7	ok
PS8																						
11.734	0.98	0.751	1.00	5280	90	20	70	140	10	130	60	1.85	1,285	2.86	3.81	140	0.0039	20.7	15	2.1	97.8	ok
PS 9																						
13.6	1.13	1.009	0.60	3168	140	20	120	200	10	190	70	2.42	1,681	3.74	3.71	140	0.0031	10.0	15	1.0	96.0	ok
PS 10																						
15.466	1.29	1.305	0.70	3696	200	20	180	260	10	250	70	2.8	1,951	4.35	3.33	140	0.0022	8.2	15	0.8	94.0	ok

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280



Assumption:

1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:

1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
PS 11																						
9.866	0.82	0.531	1.10	5808	30	20	10	90	10	80	70	0.79	549	1.22	2.30	140	0.0019	11.0	15	1.1	97.1	ok
PS12																						
13.6	1.13	1.009	1.20	6336	90	20	70	147	10	137	67	2.16	1,500	3.34	3.31	140	0.0025	16.1	15	1.6	99.7	ok
PS 13																						
15.466	1.29	1.305	0.55	2904	147	20	127	215	10	205	78	2.72	1,889	4.21	3.23	140	0.0021	6.1	15	0.6	99.7	ok
PS 14																						
17.334	1.44	1.639	1.60	8448	215	20	195	275	12	263	68	3.10	2,153	4.80	2.93	140	0.0015	12.9	15	1.3	97.2	ok
PS 15																						
17.334	1.44	1.639	0.50	2640	260	20	240	310	10	300	60	6.5	4,514	10.06	6.14	140	0.0060	15.9	15	1.6	92.5	ok
PS 16																						
17.334	1.44	1.639	0.30	1584	310	20	290	370	10	360	70	7.0	4,833	10.77	6.57	140	0.0068	10.8	15	1.1	96.9	ok
PS 17																						
17.334	1.44	1.639	0.30	1584	370	20	350	420	10	410	60	7.4	5,139	11.45	6.99	140	0.0076	12.1	15	1.2	88.3	ok

Note:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

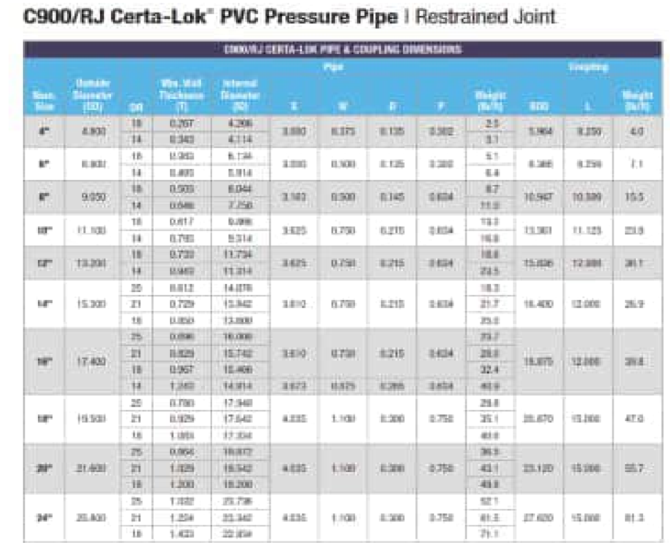
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

<u>Assumption:</u>
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

<u>Quick notes to check FM calculation:</u>
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

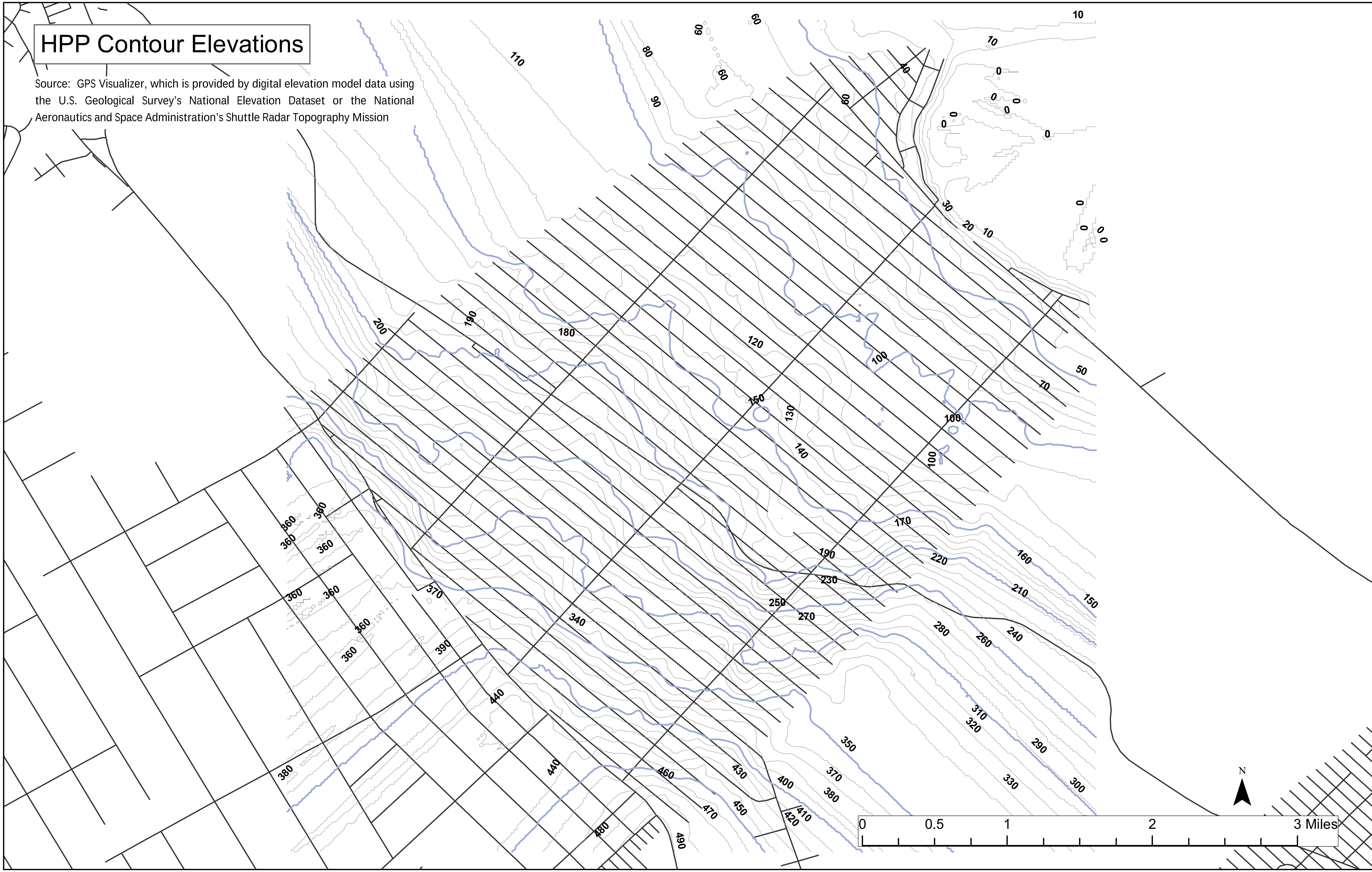
DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
ʻĀinaloa 1-29-2023																						
PS1																						
6.134	0.51	0.205	0.47	2500	585	20	565	630	10	620	55	0.45	313	0.70	3.39	140	0.0067	16.8	15	1.7	88.5	ok
PS2																						
6.134	0.51	0.205	0.38	2000	630	20	610	690	13	677	67	0.5	347	0.77	3.77	140	0.0082	16.4	15	1.6	100.0	ok

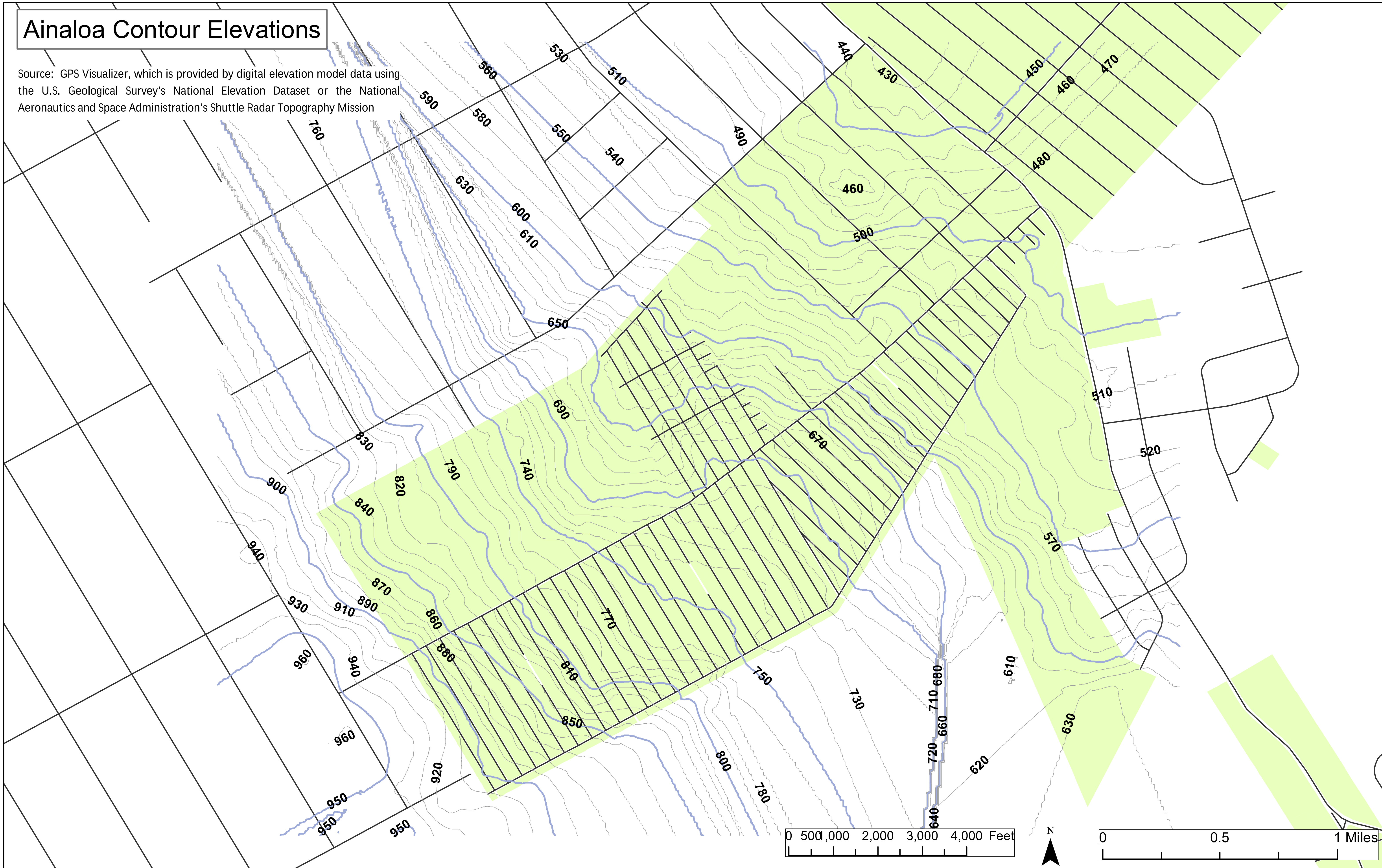
Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

C-5: Contour Maps (Basis for Collection System Layout and calculation)


HPP Contour Elevations
Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission
0
0.5
1
2
3 Miles
N

Ainaloa Contour Elevations

Source: GPS Visualizer, which is provided by digital elevation model data using the U.S. Geological Survey's National Elevation Dataset or the National Aeronautics and Space Administration's Shuttle Radar Topography Mission

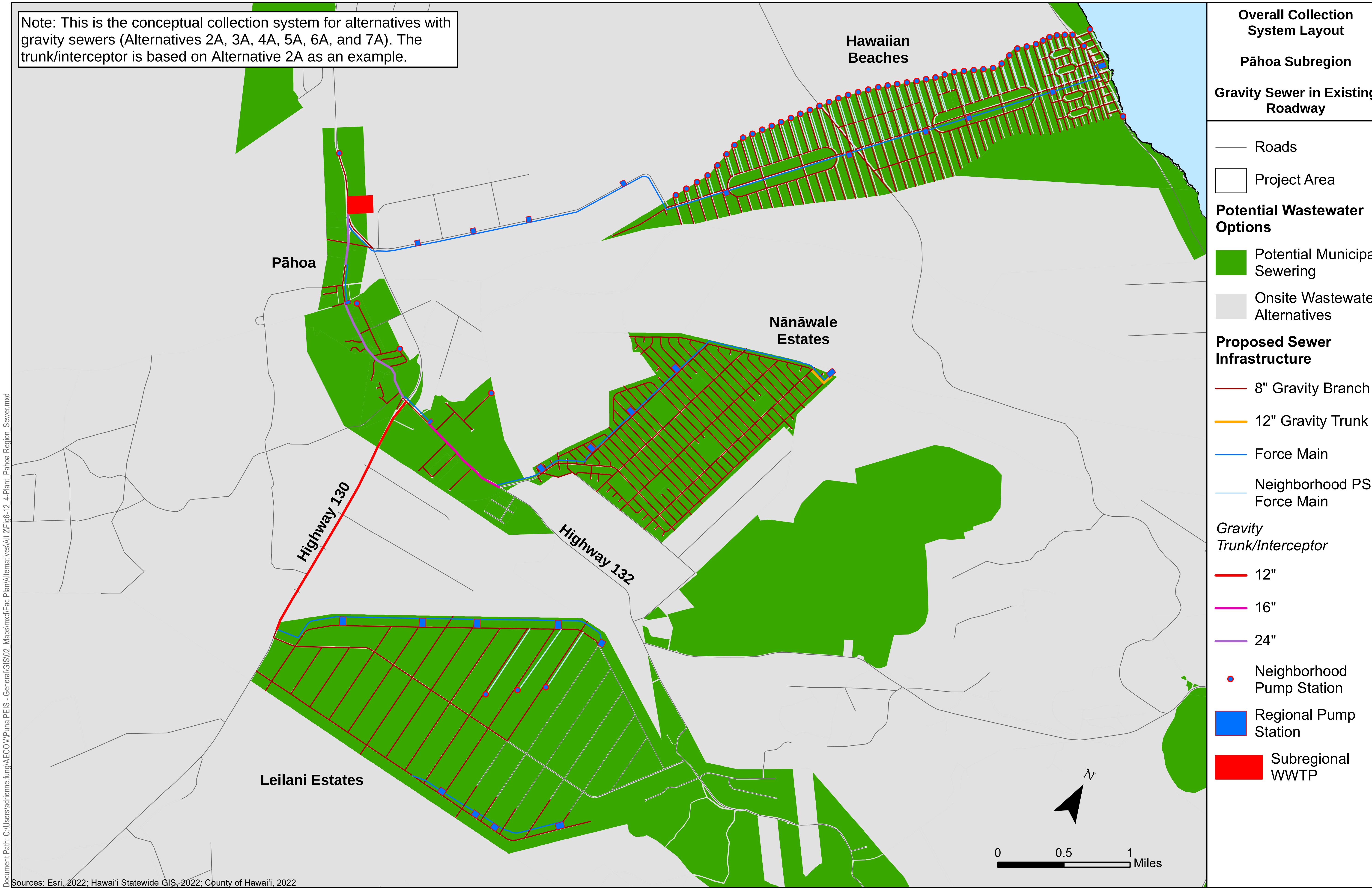


Appendix D Collection System Layout Maps and Hydraulic Calculations

Pāhoa Subregion

D-1: Overall Collection System Layout Map
D-2: Community Collection System Layout Maps
D-3: Sewer Hydraulic Calculations
D-4: Pump Station and Force Main Hydraulic Calculations
D-5: Contour Maps (Basis for Collection System Layout and calculation)

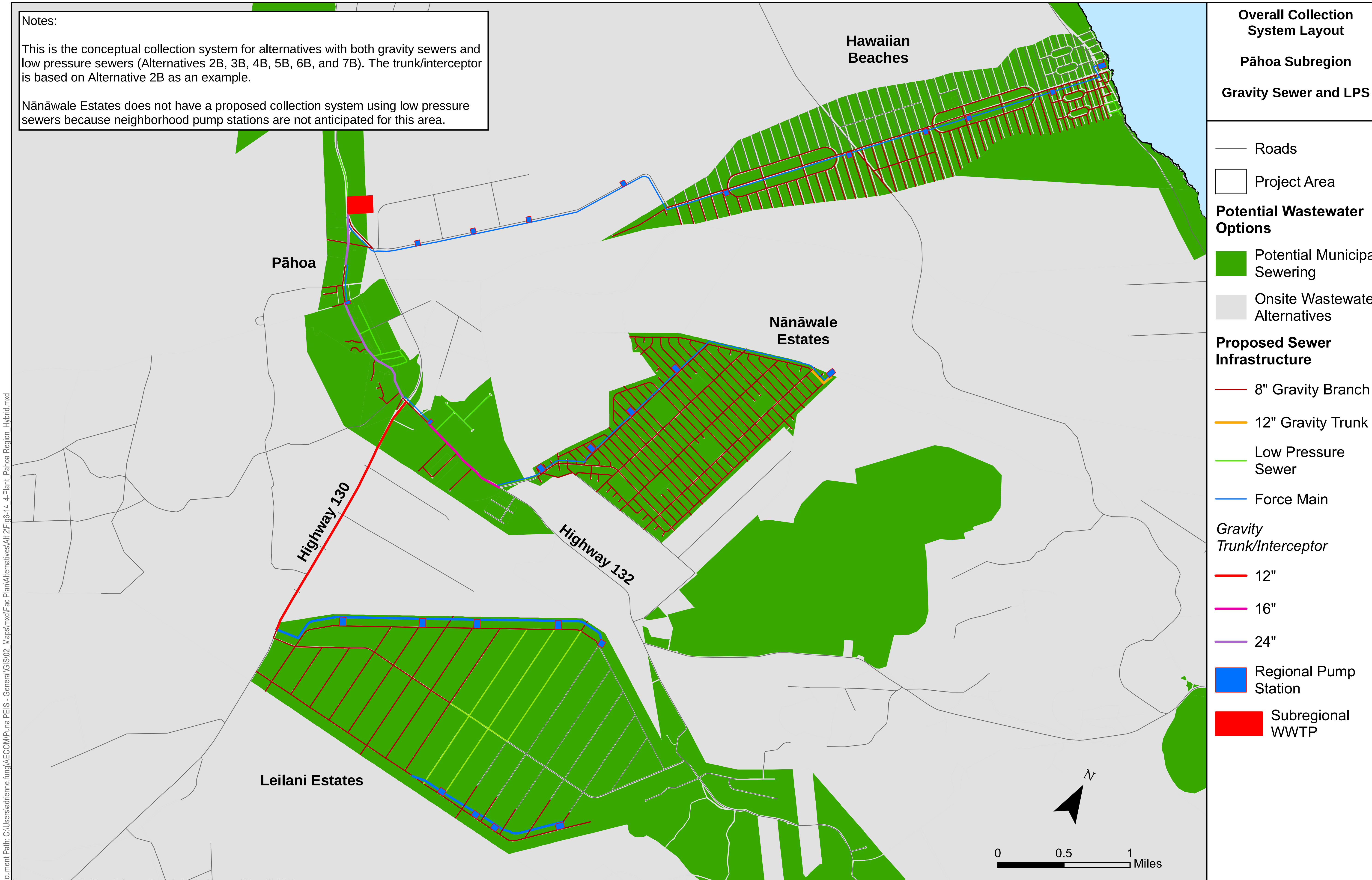
D-1: Overall Collection System Layout Map


Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A). The trunk/interceptor is based on Alternative 2A as an example.
Hawaiian Beaches
Pāhoa
Nānāwale Estates
Highway 130
Highway 132
Leilani Estates
0
0.5
1
Miles
N
Overall Collection System Layout
Pāhoa Subregion
Gravity Sewer in Existing Roadway
Roads
Project Area
Potential Wastewater Options
Potential Municipal Sewering
Onsite Wastewater Alternatives
Proposed Sewer Infrastructure
8" Gravity Branch
12" Gravity Trunk
Force Main
Neighborhood PS Force Main
Gravity Trunk/Interceptor
12"
16"
24"
Neighborhood Pump Station
Regional Pump Station
Subregional WWTP
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-12_4-Plant_Pahoa Region_Sewer.mxd

Notes:

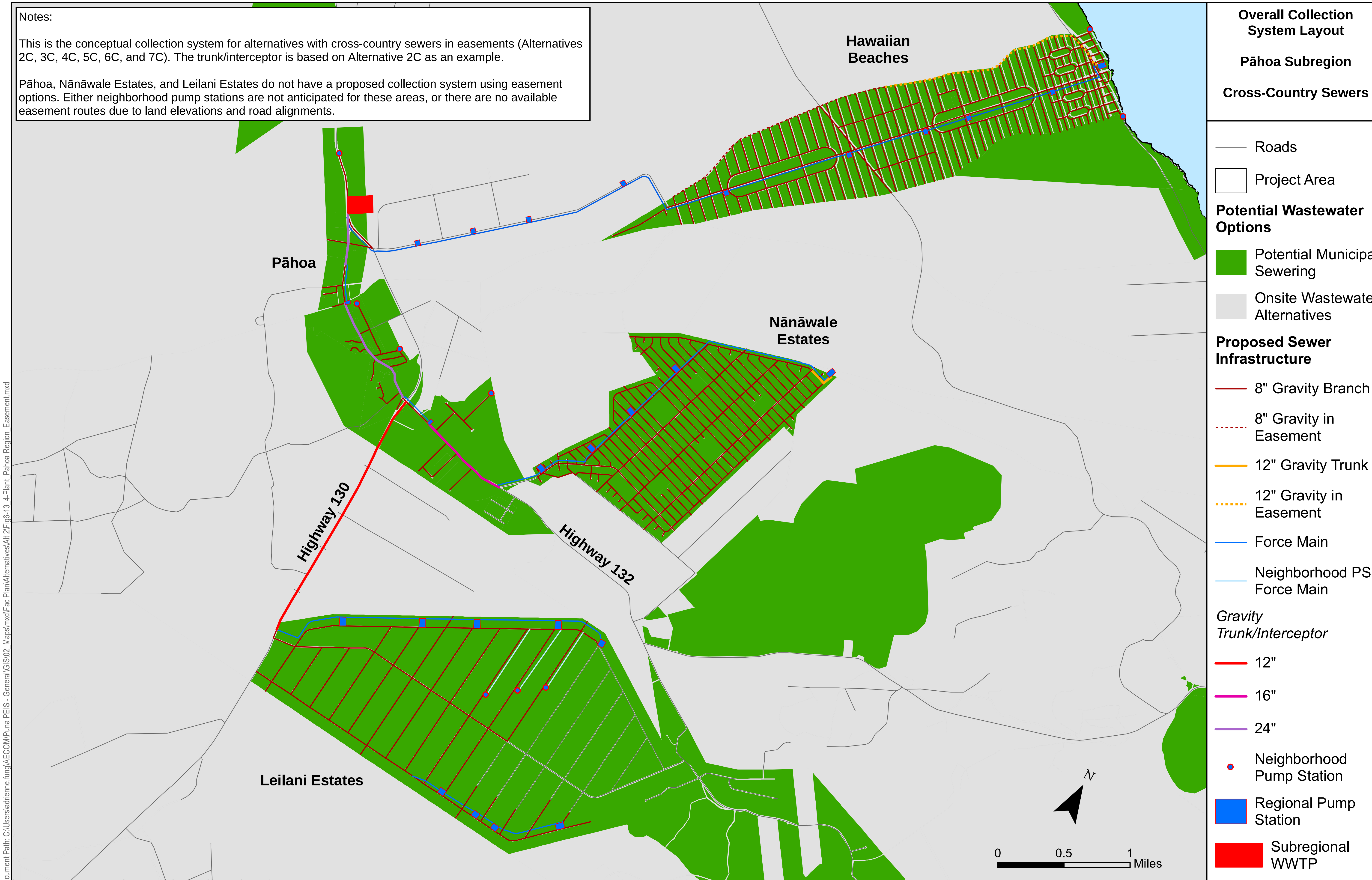
This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B). The trunk/interceptor is based on Alternative 2B as an example.

Nānāwale Estates does not have a proposed collection system using low pressure sewers because neighborhood pump stations are not anticipated for this area.



Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

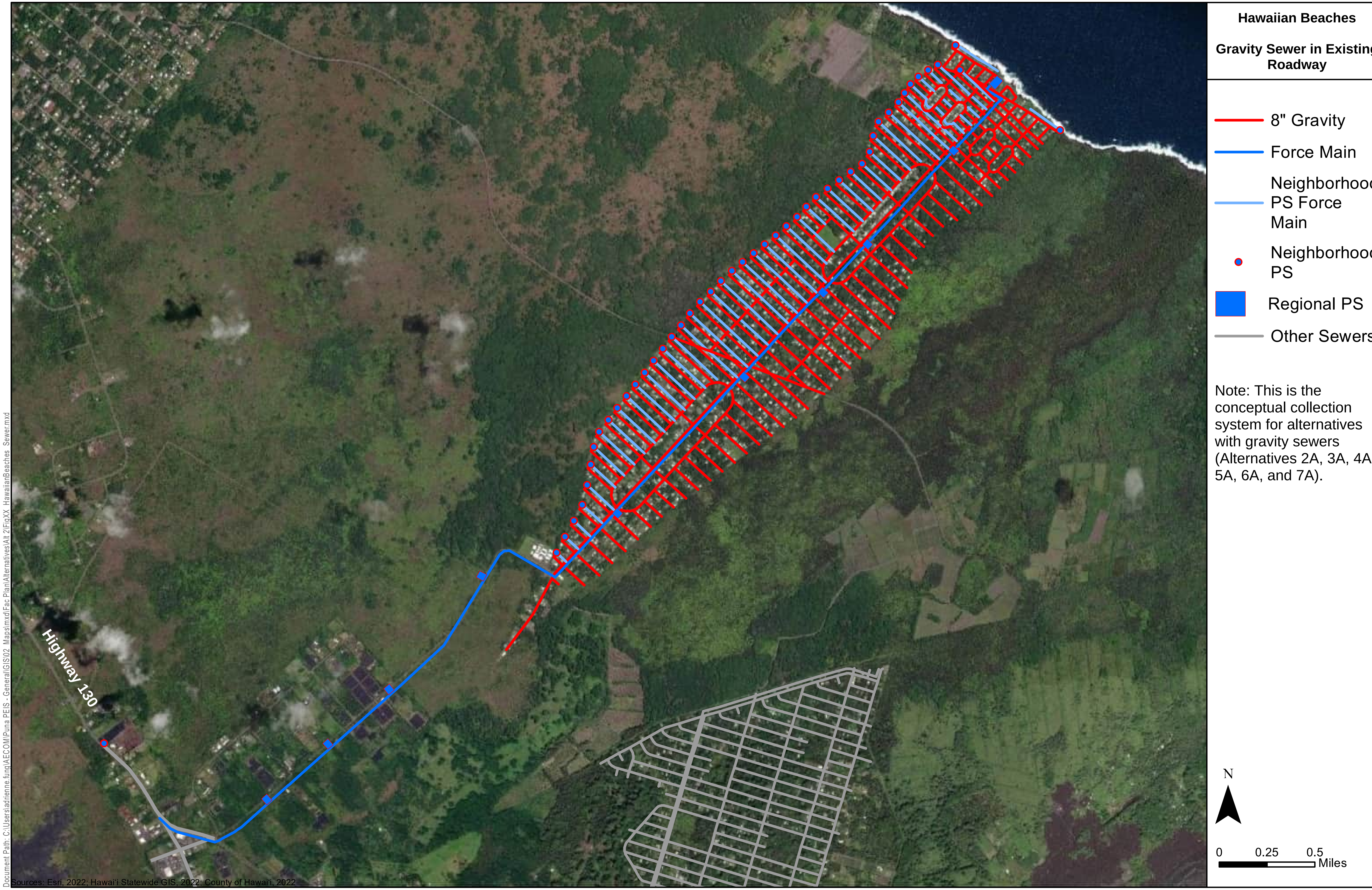
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-14_4-Plant_Pahoa Region_Hybrid.mxd



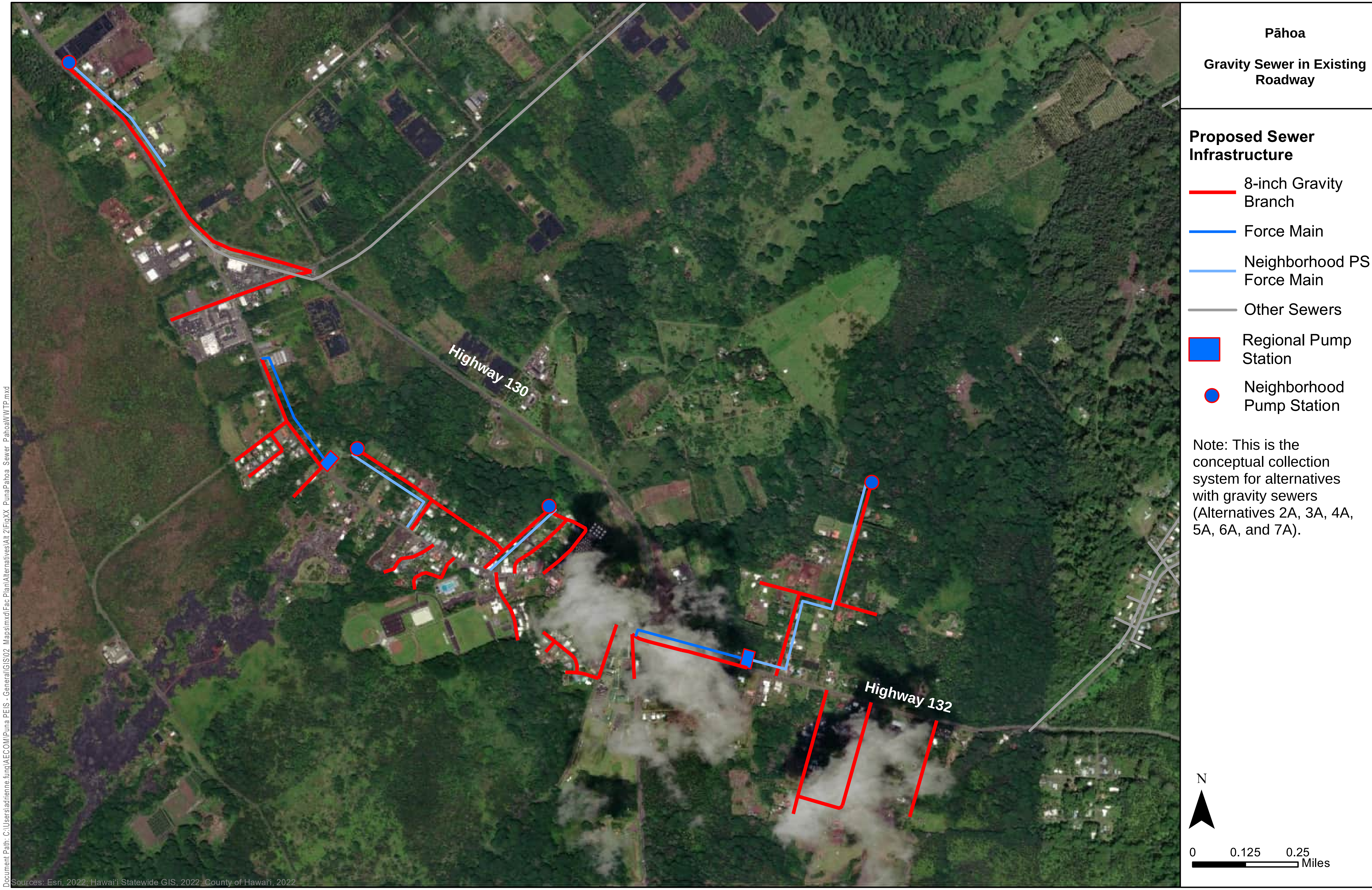
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\Fig6-13_4-Plant_Pahoa Region_Easement.mxd

D-2: Community Collection System Layout Maps

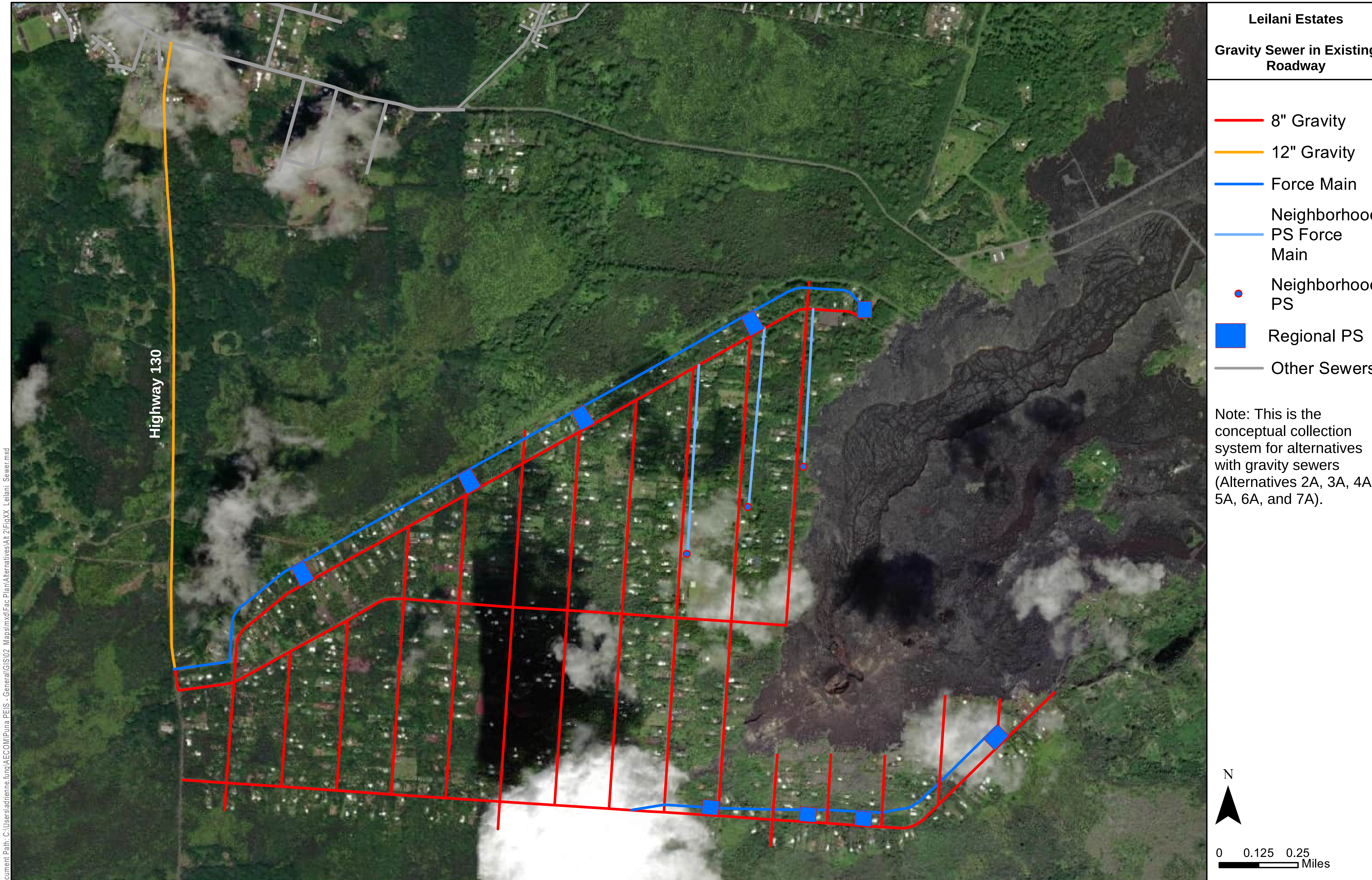
Gravity Sewer in Existing Roadways



Hawaiian Beaches
Gravity Sewer in Existing Roadway
8" Gravity
Force Main
Neighborhood PS Force Main
Neighborhood PS
Regional PS
Other Sewers
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).
Highway 130
N
0 0.25 0.5 Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022



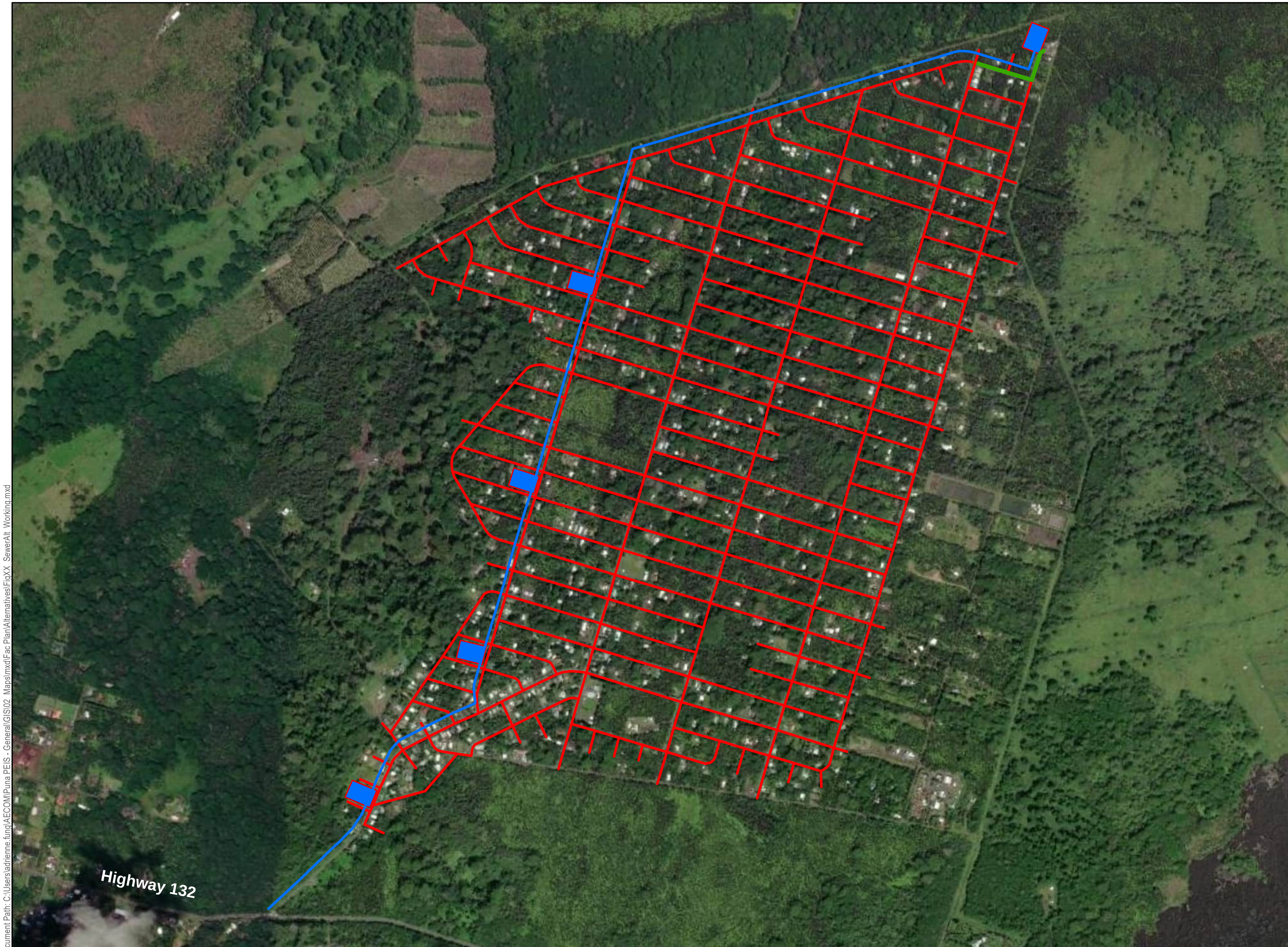
Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_PunaPahoa_Sewer_PahoaWWTP.mxd



Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_Leilani_Sewer.mxd

Nānāwale Estates

Gravity Sewer in Existing Roadway



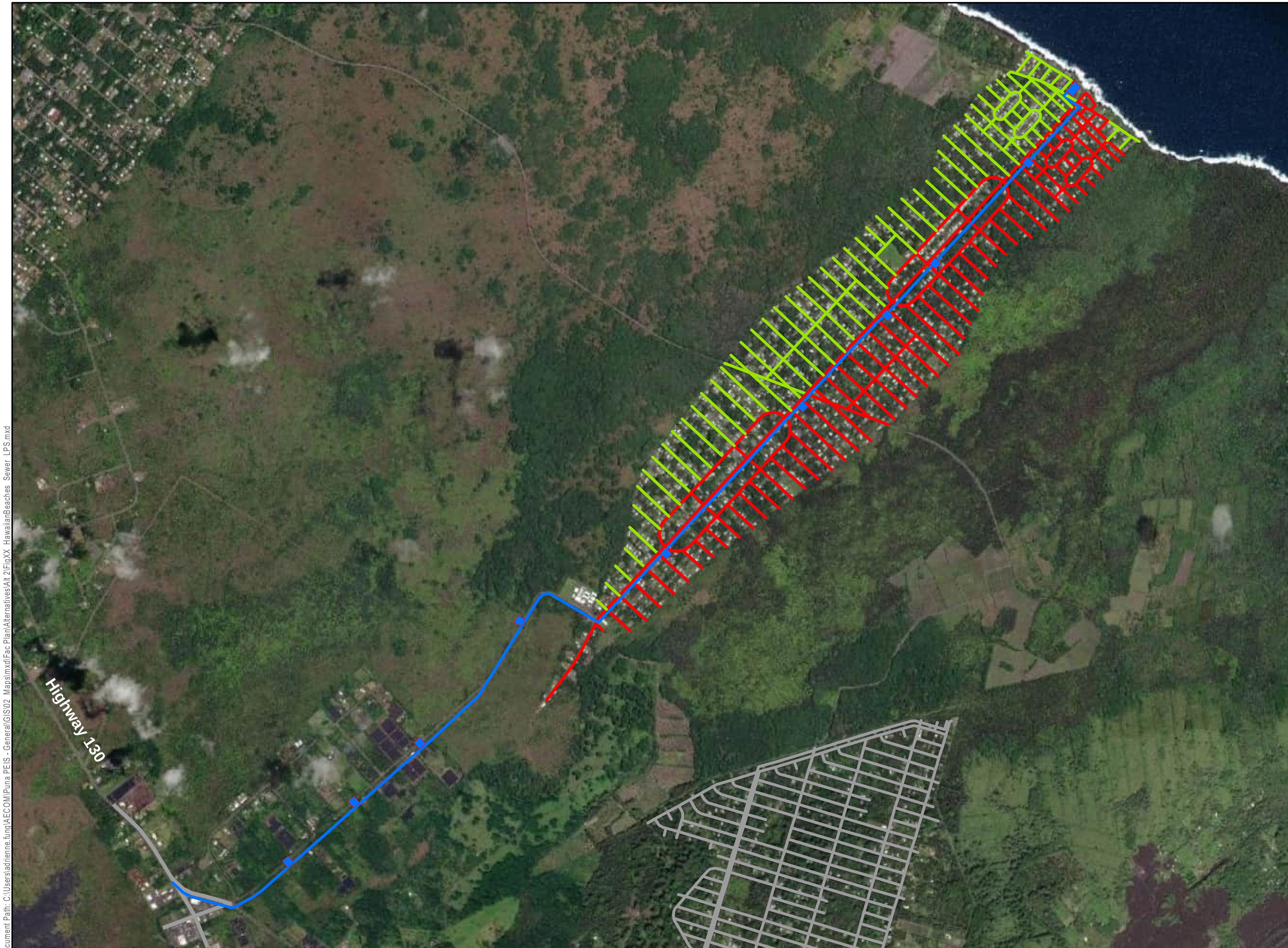
Note: This is the conceptual collection system for alternatives with gravity sewers (Alternatives 2A, 3A, 4A, 5A, 6A, and 7A).

Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\FigXX_SewerAlt_Working.mxd

D-2: Community Collection System Layout Maps

Gravity Sewer and LPS

Note: Nānāwale Estates does not have a LPS option because there are no proposed neighborhood WWPSs.



Hawaiian Beaches

Gravity Sewer and LPS

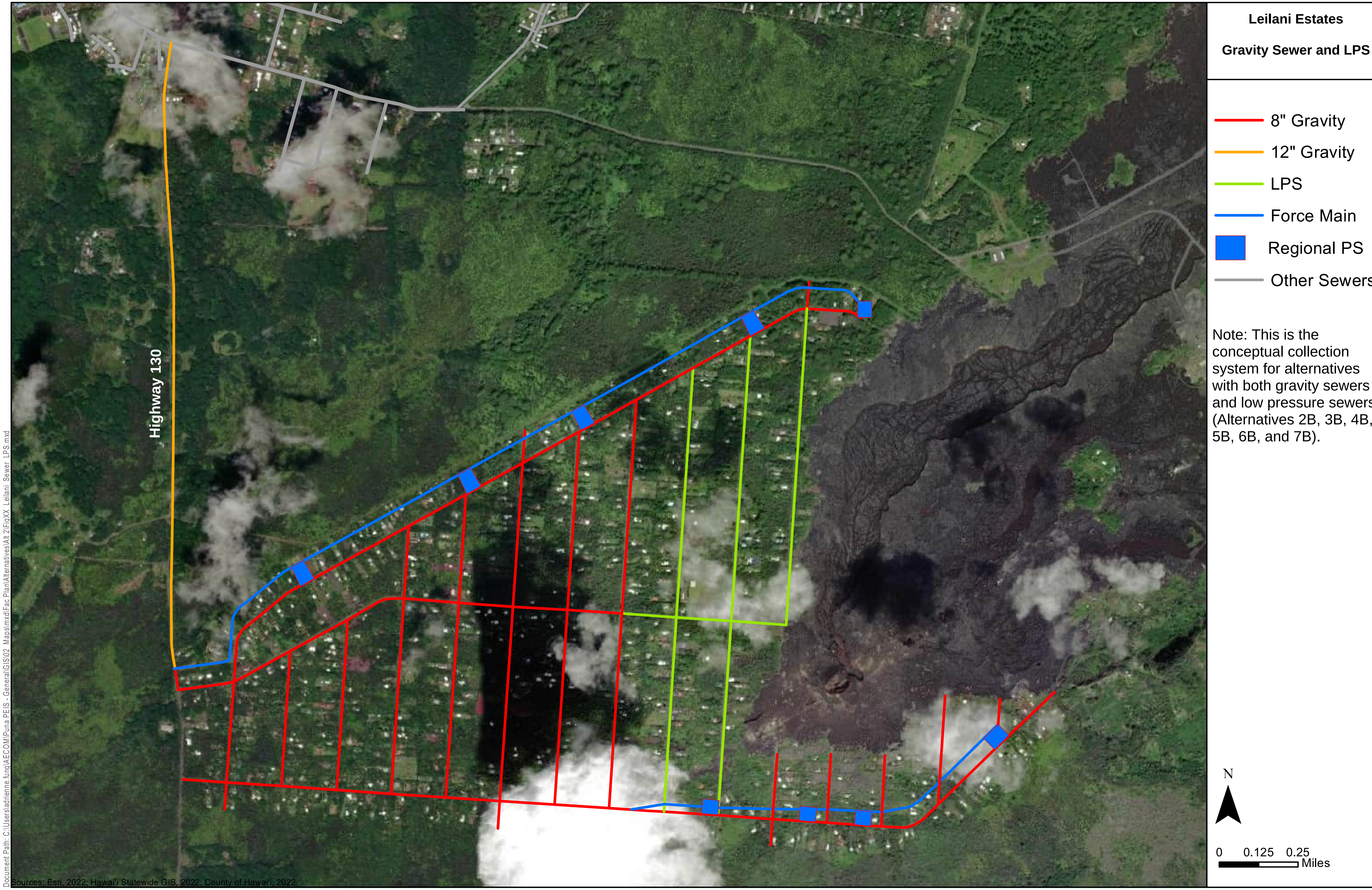
8" Gravity
LPS
FM
Regional PS
Other Sewers

Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).

N

0 0.25 0.5 Miles


Pāhoa
Gravity Sewer and LPS
Proposed Sewer Infrastructure
8" Gravity
LPS
Force Main
Regional Pump Station
Other Sewers
Note: This is the conceptual collection system for alternatives with both gravity sewers and low pressure sewers (Alternatives 2B, 3B, 4B, 5B, 6B, and 7B).
Highway 130
Highway 132
N
0
0.125
0.25
Miles
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

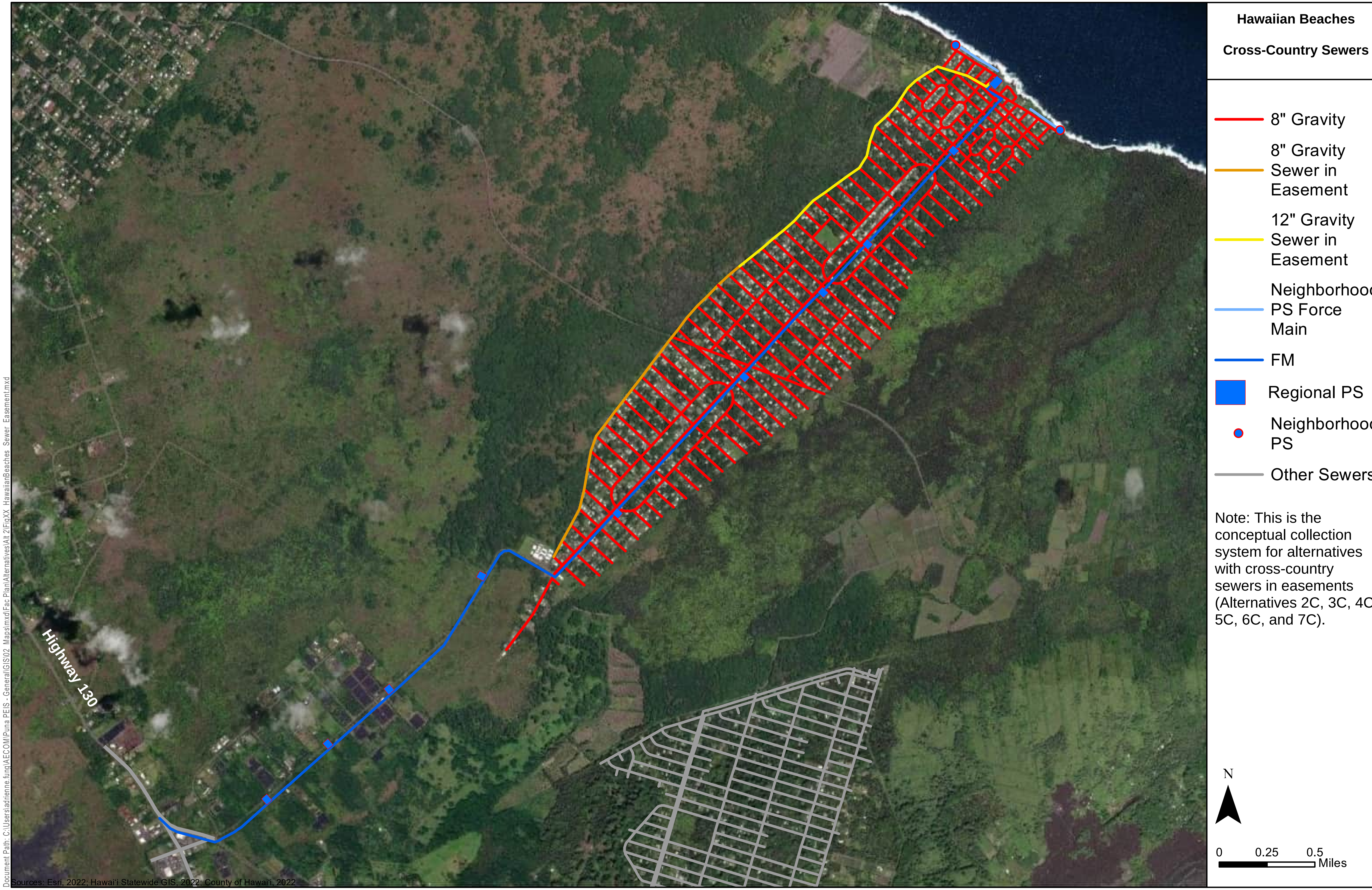


Document Path: C:\Users\adrienne.fung\AECOM\Puna PEIS - General\GIS\02_Maps\mxd\Fac Plan\Alternatives\Alt 2\FigXX_Leilani_Sewer_LPS.mxd

D-2: Community Collection System Layout Maps

Cross-Country Sewers in New Easements

Note: Pāhoa, Nānāwale Estates, and Leilani Estates do not have a cross-country sewer option due to land slope.



Hawaiian Beaches
Cross-Country Sewers
8" Gravity
8" Gravity Sewer in Easement
12" Gravity Sewer in Easement
Neighborhood PS Force Main
FM
Regional PS
Neighborhood PS
Other Sewers
Note: This is the conceptual collection system for alternatives with cross-country sewers in easements (Alternatives 2C, 3C, 4C, 5C, 6C, and 7C).
N
0 0.25 0.5 Miles
Highway 130
Sources: Esri, 2022; Hawai'i Statewide GIS, 2022; County of Hawai'i, 2022

D-3: Sewer Hydraulic Calculations

Computation of Wastewater Flow for Hawaiian Beaches Sewering

Sewer: Hawaiian Beaches segments 1-10
District: Hawaiian Beaches
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: January 23, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population: Residential: Homes			Residential: Apartment		Other		Total		Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) (a)	Depth at Design Flow - D_{DES} (in) (a)
Hawaiian Beaches																													
Hawaiian Beaches 1			141	141	473	1309	1309	0	0	0	0	1309	1309	0.092	2.5	0.23	0.046	0.137	0.27	141	0.423	0.70	8	1.10	3.63	0.82	0.85	4.08	5.7
Hawaiian Beaches 2			113	113	379	1049	1049	0	0	0	0	1049	1049	0.073	2.5	0.18	0.037	0.110	0.22	113	0.339	0.56	8	0.72	2.94	0.66	0.84	3.29	5.6
Hawaiian Beaches 3			78	78	263	728	728	0	0	0	0	728	728	0.051	2.5	0.13	0.025	0.076	0.15	78	0.235	0.39	8	0.52	2.50	0.56	0.69	2.69	4.9
Hawaiian Beaches 4			142	142	476	1319	1319	0	0	0	0	1319	1319	0.092	2.5	0.23	0.046	0.138	0.28	142	0.426	0.70	8	1.20	3.79	0.86	0.82	4.23	5.5
Hawaiian Beaches 5			162	162	545	1509	1509	0	0	0	0	1509	1509	0.106	2.5	0.26	0.053	0.158	0.32	162	0.487	0.80	8	1.50	4.24	0.96	0.84	4.75	5.6
Hawaiian Beaches 6			48	48	162	449	449	0	0	0	0	449	449	0.031	2.5	0.08	0.016	0.047	0.09	48	0.145	0.24	8	0.52	2.50	0.56	0.43	2.40	3.6
Hawaiian Beaches 7 to 10			N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	0.52	2.50	0.56	N/A	N/A	N/A

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Roadway elevation profile appears to be approximately 1% to 1.5%. Therefore, can increase slope of trunk sewer up to 1.5%.

Computation of Wastewater Flow for Pāhoa Sewering

Sewer: Pāhoa 1, Pāhoa 2, Pāhoa 3 segments; Nanawale, Leilani Estates, and Hawaiian Beaches
District: Pāhoa
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: December 15, 2022

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population: Residential: Homes			Residential: Apartment		Other		Total		Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Pāhoa																													
Nanawale		Kapoho Rd./Nanawale Blvd. (Nanawale dis.)	214	214	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	214	0.643	1.17							
Pāhoa 1	1	Kapoho Rd./Nanawale Blvd. (Kaululaau NH dis.)	11	225	40	108	2628	0	0	0	0	108	2628	0.184	2.5	0.46	0.092	0.276	0.55	225	0.675	1.23	16	0.21	2.52	2.27	0.54	2.57	8.4
Pāhoa 1	2	Kapoho Rd./Lehualani Pl.	4	229	16	43	2671	0	0	0	0	43	2671	0.187	2.5	0.47	0.093	0.280	0.56	229	0.688	1.25	16	0.21	2.52	2.27	0.55	2.58	8.5
Pāhoa 1	3	Kapoho Rd./Ho Opili St.	10	239	36	96	2767	0	0	0	0	96	2767	0.194	2.5	0.48	0.097	0.291	0.58	239	0.716	1.30	16	0.21	2.52	2.27	0.57	2.60	8.7
Pāhoa 1	4	Kapoho Rd./Tangerine Rd.	7	246	28	75	2842	0	0	0	0	75	2842	0.199	2.5	0.50	0.099	0.298	0.60	246	0.739	1.34	16	0.21	2.52	2.27	0.59	2.62	8.8
Pāhoa 1	5*	Kapoho Rd./Naele Rd. (Naele NH dis.)	16	263	61	165	3007	0	0	0	0	165	3007	0.211	2.5	0.53	0.105	0.316	0.63	263	0.788	1.42	16	0.21	2.52	2.27	0.62	2.66	9.2
Leilani		Keeau-Pahoa Rd./Pahoa Kalapana Rd. (Leilani dis.)	402	665	1006	1381	4388	0	0	0	0	1381	4388	0.307	2.5	0.77	0.154	0.461	0.92	665	1.995	2.92							
Pāhoa 2	1	Keeau-Pahoa Rd./Kaohe Homestead Rd.	12	677	43	117	4505	0	0	0	0	117	4505	0.315	2.5	0.79	0.158	0.473	0.95	677	2.030	2.98	24	0.16	2.88	5.85	0.51	2.89	12.1
Pāhoa 2	2	Keeau-Pahoa Rd./Kauhale St.	8	684	28	77	4581	0	0	0	0	77	4581	0.321	2.5	0.80	0.160	0.481	0.96	684	2.052	3.01	24	0.16	2.88	5.85	0.52	2.90	12.2
Pāhoa 2	3	Keeau-Pahoa Rd./Akeakamai Loop (Akeakamai NH dis.)	18	702	67	182	4763	0	0	0	0	182	4763	0.333	2.5	0.83	0.167	0.500	1.00	702	2.106	3.11	24	0.16	2.88	5.85	0.53	2.92	12.4
Pāhoa 2	4	Keeau-Pahoa Rd./Pahoa Village Center Mall	4	706	15	42	4805	0	0	0	0	42	4805	0.336	2.5	0.84	0.168	0.504	1.01	706	2.119	3.13	24	0.16	2.88	5.85	0.53	2.93	12.5
Pāhoa 2	5	Keeau-Pahoa Rd./Pahoa village Rd.	4	710	13	36	4841	0	0	0	0	36	4841	0.339	2.5	0.85	0.169	0.508	1.02	710	2.129	3.15	24	0.16	2.88	5.85	0.54	2.93	12.5
Pāhoa 2	6	Keeau-Pahoa Rd./Post Office Rd. (Post Office NH dis.)	10	720	38	102	4943	0	0	0	0	102	4943	0.346	2.5	0.87	0.173	0.519	1.04	720	2.160	3.20	24	0.16	2.88	5.85	0.55	2.95	12.7
Pāhoa 2	7*	Keeau-Pahoa Rd./Apaa St.	17	737	65	175	5118	0	0	0	0	175	5118	0.358	2.5	0.90	0.179	0.537	1.07	737	2.212	3.29	24	0.16	2.88	5.85	0.56	2.97	12.9
Hawaiian Beaches		Keeau-Pahoa Rd./Pahoa Bypass Rd. (Hawaiian Beaches dis.)	685	1422	2299	6363	11481	0	0	0	0	6363	11481	0.804	2.5	2.01	0.402	1.205	2.41	1422	4.266	6.68							
Pāhoa 3	1	3.1b Flow along Keeau Pahoa Rd./Kahakai Blvd.	18	1440	67	182	11663	0	0	0	0	182	11663	0.816	2.5	2.04	0.408	1.225	2.45	1440	4.320	6.77	24	0.50	5.09	10.34	0.65	5.43	14.2
Pāhoa 3	2*	Flow along Keeau-Pahoa Rd. south of WWTP	6	1446	24	64	11727	0	0	0	0	64	11727	0.821	2.5	2.05	0.410	1.231	2.46	1446	4.339	6.80	24	0.50	5.09	10.34	0.66	5.43	14.2

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Branch sewer (along trunk from one direction) and other trunk (from other direction) combine at MH, then get pumped to PS. Branch sewer will be 8". Sewer with combined flow is disregarded in this project; will be part of PS project.
3. The sewer length ratio was used to calculate the residential home increment. This is based on the following proportion:
4. The OSDS ratio was used to calculate population in the sewer neighborhood. This is based on the following proportion:
5. For the tributary area, the acre/TMK is based on the average area for TMKs less than 0.4 acres, which is equivalent to
6. The population/TMK is calculated by 2020 population/No. TMKs with OSDSs.
* Includes branch flow to PS or TS site. These are the connection sewer from trunk to PS.

Computation of Wastewater Flow for Leilani Estates Sewering

Sewer: Leilani Estates Segments 1-9
District: Leilani Estates
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: January 25, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population										Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
					Residential					Other		Total																		
					Homes			Apartment																						
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Leilani Estates																														
Leilani Estates 1			30	30	76	104	104	0	0	0	0	104	104	0.007	2.5	0.02	0.004	0.011	0.02	30	0.091	0.11	8	0.52	2.50	0.56	0.20	1.94	2.4
Leilani Estates 2			8	8	20	28	28	0	0	0	0	28	28	0.002	2.5	0.00	0.001	0.003	0.01	8	0.024	0.03	8	0.52	2.50	0.56	0.05	1.33	1.3
Leilani Estates 3			12	12	31	42	42	0	0	0	0	42	42	0.003	2.5	0.01	0.001	0.004	0.01	12	0.037	0.05	8	0.52	2.50	0.56	0.08	1.54	1.6
Leilani Estates 4			7	7	18	24	24	0	0	0	0	24	24	0.002	2.5	0.00	0.001	0.003	0.01	7	0.021	0.03	8	0.52	2.50	0.56	0.05	1.33	1.3
Leilani Estates 5			46	46	116	159	159	0	0	0	0	159	159	0.011	2.5	0.03	0.006	0.017	0.03	46	0.139	0.17	8	0.52	2.50	0.56	0.31	2.19	3.0
Leilani Estates 6			101	101	253	347	347	0	0	0	0	347	347	0.024	2.5	0.06	0.012	0.036	0.07	101	0.303	0.38	8	0.52	2.50	0.56	0.67	2.68	4.8
Leilani Estates 7			73	131	182	250	449	0	0	0	0	250	449	0.031	2.5	0.08	0.016	0.047	0.09	131	0.392	0.49	8	0.68	2.85	0.64	0.76	3.14	5.2
Leilani Estates 8			111	111	277	381	381	0	0	0	0	381	381	0.027	2.5	0.07	0.013	0.040	0.08	111	0.333	0.41	8	0.52	2.50	0.56	0.73	2.72	5.1
Leilani Estates 9			13	13	33	45	45	0	0	0	0	45	45	0.003	2.5	0.01	0.002	0.005	0.01	13	0.040	0.05	8	0.52	2.50	0.56	0.09	1.54	1.6
Leilani Estates 10			0	402	0	0	1381	0	0	0	0	0	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	12	1.00	4.54	2.30	0.65	4.83	7.1

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.
2. Leilani Estates 7 has flow from segments 1-4.
3. Leilani Estates 10 is the highway gravity sewer with flow from segments 1-9.

Computation of Wastewater Flow for Nānāwale Sewering

Sewer: Nānāwale 1, 2, 3, 4 segments
District: Nānāwale
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: January 4, 2023

Sewer Location		Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
				Residential					Other		Total																	
				Homes			Apartment																					
District Zone or Street	Segment Name	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Nānāwale																												
Nānāwale 1	A	61	61	301	713	713	0	0	0	0	713	713	0.050	2.5	0.12	0.025	0.075	0.15	61	0.182	0.33	8	0.52	2.50	0.56	0.59	2.59	4.4
Nānāwale 1	B	22	83	109	258	971	0	0	0	0	258	971	0.068	2.5	0.17	0.034	0.102	0.20	83	0.248	0.45	12	0.31	2.53	1.28	0.35	2.30	4.9
Nānāwale 2		60	60	298	707	707	0	0	0	0	707	707	0.049	2.5	0.12	0.025	0.074	0.15	60	0.180	0.33	8	0.52	2.50	0.56	0.58	2.59	4.4
Nānāwale 3		59	59	295	699	699	0	0	0	0	699	699	0.049	2.5	0.12	0.024	0.073	0.15	59	0.178	0.33	8	0.52	2.50	0.56	0.58	2.59	4.4
Nānāwale 4		12	12	60	142	142	0	0	0	0	142	142	0.010	2.5	0.02	0.005	0.015	0.03	12	0.036	0.07	8	0.52	2.50	0.56	0.12	1.70	1.9

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).
1. Minimum slope is used for undulating roadway segments in which sewers are planned to mimimize sewer depth.

D-4: Pump Station and Force Main Hydraulic Calculations

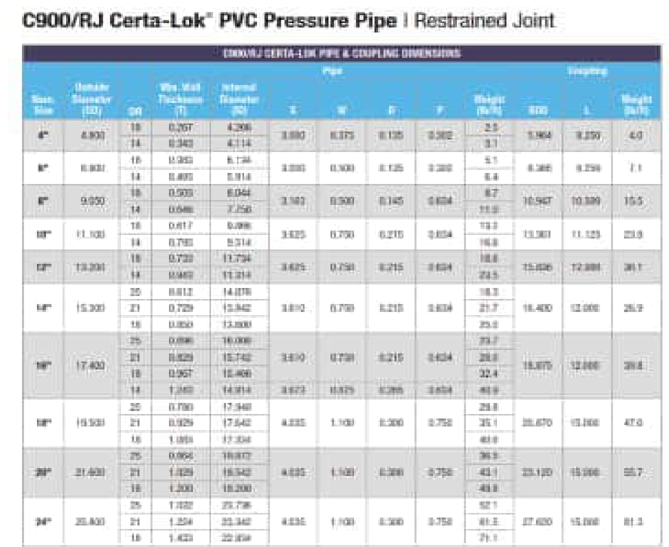
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in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Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Hawaiian Beaches PS1																						
8.044	0.67	0.353	0.37	1954	51	20	31	109	10	99	68	0.70	486	1.08	3.07	140	0.0041	8.0	15	0.8	91.8	ok
Hawaiian Beaches PS2																						
9.866	0.82	0.531	0.72	3802	109	20	89	164	10	154	65	1.26	875	1.95	3.67	140	0.0045	17.0	15	1.7	98.7	ok
Hawaiian Beaches PS3																						
9.866	0.82	0.531	0.36	1901	164	20	144	222	10	212	68	1.65	1,146	2.55	4.81	140	0.0074	14.0	15	1.4	98.4	ok
Hawaiian Beaches PS4																						
13.6	1.13	1.009	0.54	2851	222	20	202	281	10	271	69	2.35	1,632	3.64	3.60	140	0.0030	8.5	15	0.8	93.3	ok
Hawaiian Beaches PS5																						
15.466	1.29	1.305	0.99	5227	281	20	261	332	10	322	61	3.15	2,188	4.87	3.74	140	0.0027	14.3	15	1.4	91.7	ok
Hawaiian Beaches PS6																						
15.466	1.29	1.305	1.00	5280	332	20	312	379	10	369	57	3.39	2,354	5.25	4.02	140	0.0031	16.6	15	1.7	90.2	ok
Hawaiian Beaches PS7																						
15.466	1.29	1.305	0.53	2798	379	20	359	439	10	429	70	3.39	2,354	5.25	4.02	140	0.0031	8.8	15	0.9	94.7	ok
Hawaiian Beaches PS8																						
15.466	1.29	1.305	0.68	3590	439	20	419	500	10	490	71	3.39	2,354	5.25	4.02	140	0.0031	11.3	15	1.1	98.4	ok
Hawaiian Beaches PS9																						
15.466	1.29	1.305	0.42	2218	500	20	480	560	10	550	70	3.39	2,354	5.25	4.02	140	0.0031	7.0	15	0.7	92.7	ok
Hawaiian Beaches PS10																						
15.466	1.29	1.305	0.32	1690	560	20	540	612	10	602	62	3.39	2,354	5.25	4.02	140	0.0031	5.3	15	0.5	82.8	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

C900/RJ CERTA-LOK PIPE & COUPLING DIMENSIONS

Nom. Size	Outside Diameter (OD)	DR	Pipe: Min. Wall Thickness (T)	Pipe: Internal Diameter (ID)	Pipe: X	Pipe: W	Pipe: D	Pipe: P	Pipe: Weight (lb/ft)	Coupling: BOD	Coupling: L	Coupling: Weight (lb/ft)
4"	4.800	18	0.267	4.266	3.000	0.375	0.135	0.302	2.5	5.964	8.250	4.0
		14	0.343	4.114					3.1			
6"	6.900	18	0.383	6.134	3.000	0.500	0.135	0.302	5.1	8.366	8.250	7.1
		14	0.493	5.914					6.4			
8"	9.050	18	0.503	8.044	3.163	0.500	0.145	0.634	8.7	10.947	10.500	15.5
		14	0.646	7.758					11.0			
10"	11.100	18	0.617	9.866	3.625	0.750	0.215	0.634	13.2	13.361	11.125	23.9
		14	0.793	9.514					16.6			
12"	13.200	18	0.733	11.734	3.625	0.750	0.215	0.634	18.6	15.836	12.000	36.1
		14	0.943	11.314					23.5			
14"	15.300	25	0.612	14.076	3.610	0.750	0.215	0.634	18.3	16.400	12.000	26.9
		21	0.729	13.842					21.7			
		18	0.850	13.600					25.0			
16"	17.400	25	0.696	16.008	3.610	0.750	0.215	0.634	23.7	18.875	12.000	39.8
		21	0.829	15.742					28.0			
		18	0.967	15.466					32.4			
		14	1.243	14.914	3.673	0.875	0.265	0.634	40.9			
18"	19.500	25	0.780	17.940	4.035	1.100	0.300	0.750	29.8	20.870	15.000	47.0
		21	0.929	17.642					35.1			
		18	1.083	17.334					40.6			
20"	21.600	25	0.864	19.872	4.035	1.100	0.300	0.750	36.5	23.120	15.000	55.7
		21	1.029	19.542					43.1			
		18	1.200	19.200					49.8			
24"	25.800	25	1.032	23.736	4.035	1.100	0.300	0.750	52.1	27.620	15.000	81.3
		21	1.224	23.342					61.5			
		18	1.433	22.934					71.1			

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Pāhoa PS1 Pahoa only																						
4.266	0.36	0.099	0.33	1742	641	20	621	674	10	664	43	0.25	174	0.39	3.90	140	0.0133	23.2	15	2.3	83.5	ok
Pāhoa PS2 Pahoa only																						
6.134	0.51	0.205	0.24	1267	623	20	603	639	10	629	26	0.62	431	0.96	4.67	140	0.0122	15.5	15	1.5	58.0	ok
Pāhoa PS1 Puna Flow																						
9.866	0.82	0.531	0.33	1742	641	20	621	674	10	664	43	1.42	986	2.20	4.14	140	0.0056	9.7	15	1.0	68.7	ok
Pāhoa PS2 Puna Flow																						
13.6	1.13	1.009	0.24	1267	623	20	603	639	10	629	26	3.29	2,285	5.09	5.05	140	0.0056	7.0	15	0.7	48.7	ok
Pāhoa NH PS1																						
2	0.17	0.022	0.25	1320	655	10	645	656	10	646	1	0.05	35	0.08	3.55	140	0.0270	35.7	15	3.6	55.3	ok
Pāhoa NH PS1																						
3.5	0.29	0.067	0.56	2957	589	10	579	643	10	633	54	0.09	63	0.14	2.08	140	0.0053	15.6	15	1.6	86.1	ok
Pāhoa NH PS3																						
2.5	0.21	0.034	0.21	1109	626	10	616	649	10	639	23	0.09	63	0.14	4.09	140	0.0271	30.0	15	3.0	71.0	ok
Pāhoa NH PS4																						
2	0.17	0.022	0.18	950	620	10	610	649	10	639	29	0.05	35	0.08	3.55	140	0.0270	25.7	15	2.6	72.3	ok
Pāhoa NH PS5																						
2	0.17	0.022	0.37	1954	594	10	584	614	10	604	20	0.05	35	0.08	3.55	140	0.0270	52.8	15	5.3	93.1	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:

1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:

1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
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16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Lelani 1-23-2023																						
PS1																						
6.134	0.51	0.205	0.47	2482	672	20	652	728	10	718	66	0.25	174	0.39	1.88	140	0.0023	5.6	15	0.6	87.2	ok
PS2																						
6.134	0.51	0.205	0.22	1162	728	20	708	784	10	774	66	0.28	194	0.43	2.11	140	0.0028	3.3	15	0.3	84.6	ok
PS3																						
6.134	0.51	0.205	0.25	1320	784	20	764	842	10	832	68	0.33	229	0.51	2.49	140	0.0038	5.0	15	0.5	88.5	ok
PS 4																						
6.134	0.51	0.205	0.24	1267	842	20	822	897	10	887	65	0.36	250	0.56	2.71	140	0.0045	5.6	15	0.6	86.2	ok
PS 5																						
6.134	0.51	0.205	0.40	2112	670	20	650	728	10	718	68	0.25	174	0.39	1.88	140	0.0023	4.8	15	0.5	88.3	ok
PS 6																						
8.044	0.67	0.353	0.64	3379	728	20	708	778	10	768	60	0.63	438	0.97	2.76	140	0.0034	11.3	15	1.1	87.5	ok
PS 7																						
9.866	0.82	0.531	0.40	2112	778	20	758	836	10	826	68	1.45	1,007	2.24	4.23	140	0.0058	12.3	15	1.2	96.5	ok
PS 8																						
11.734	0.98	0.751	0.60	3168	836	20	816	900	10	890	74	1.5	1,042	2.32	3.09	140	0.0027	8.4	15	0.8	98.3	ok
PS 9																						
11.734	0.98	0.751	0.40	2112	900	20	880	967	10	957	77	1.5	1,042	2.32	3.09	140	0.0027	5.6	15	0.6	98.2	ok

Note:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

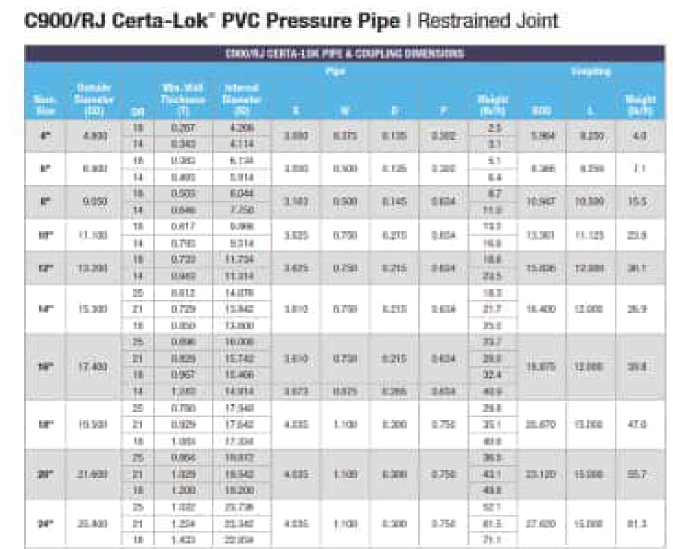
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

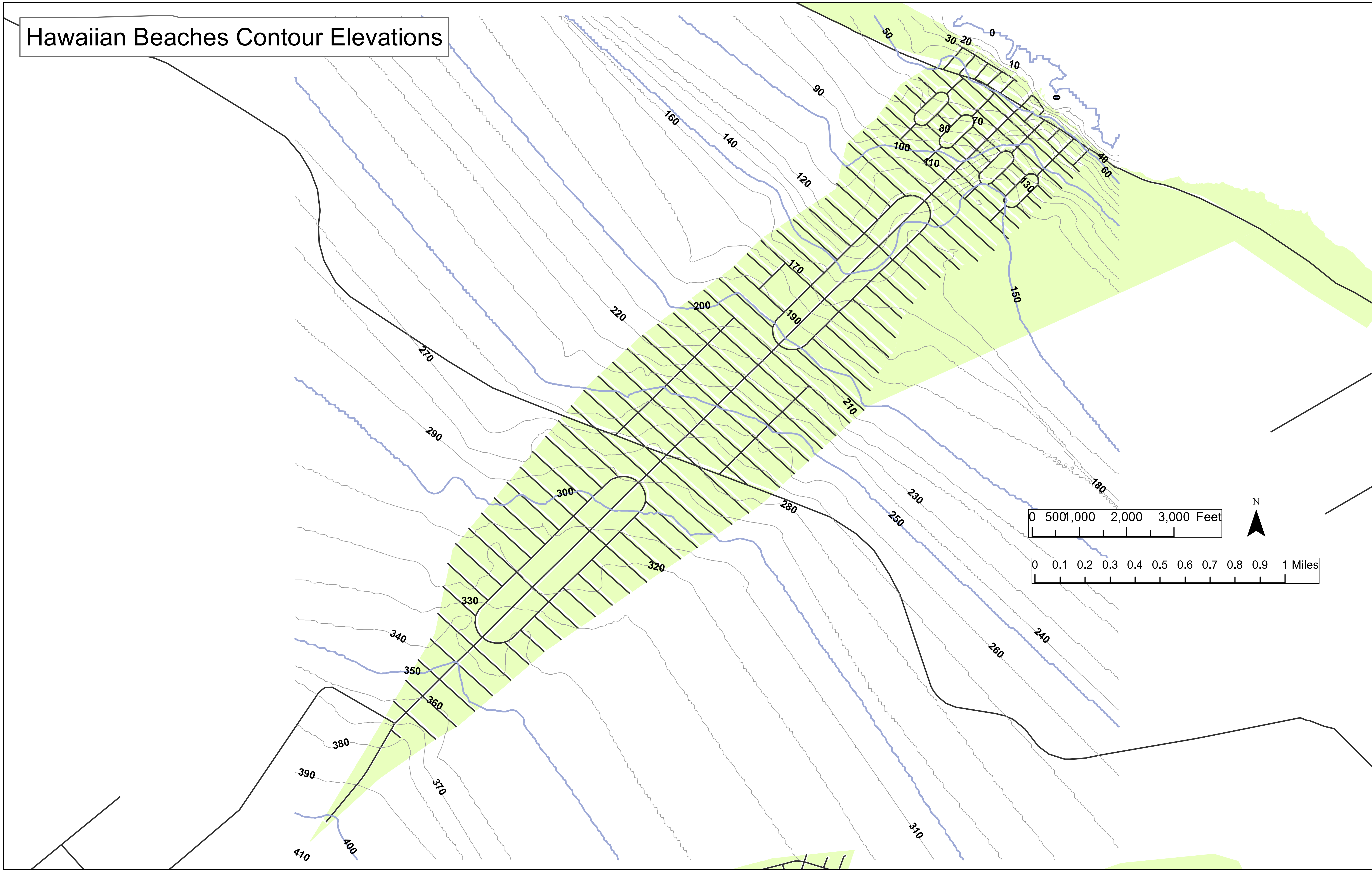
DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



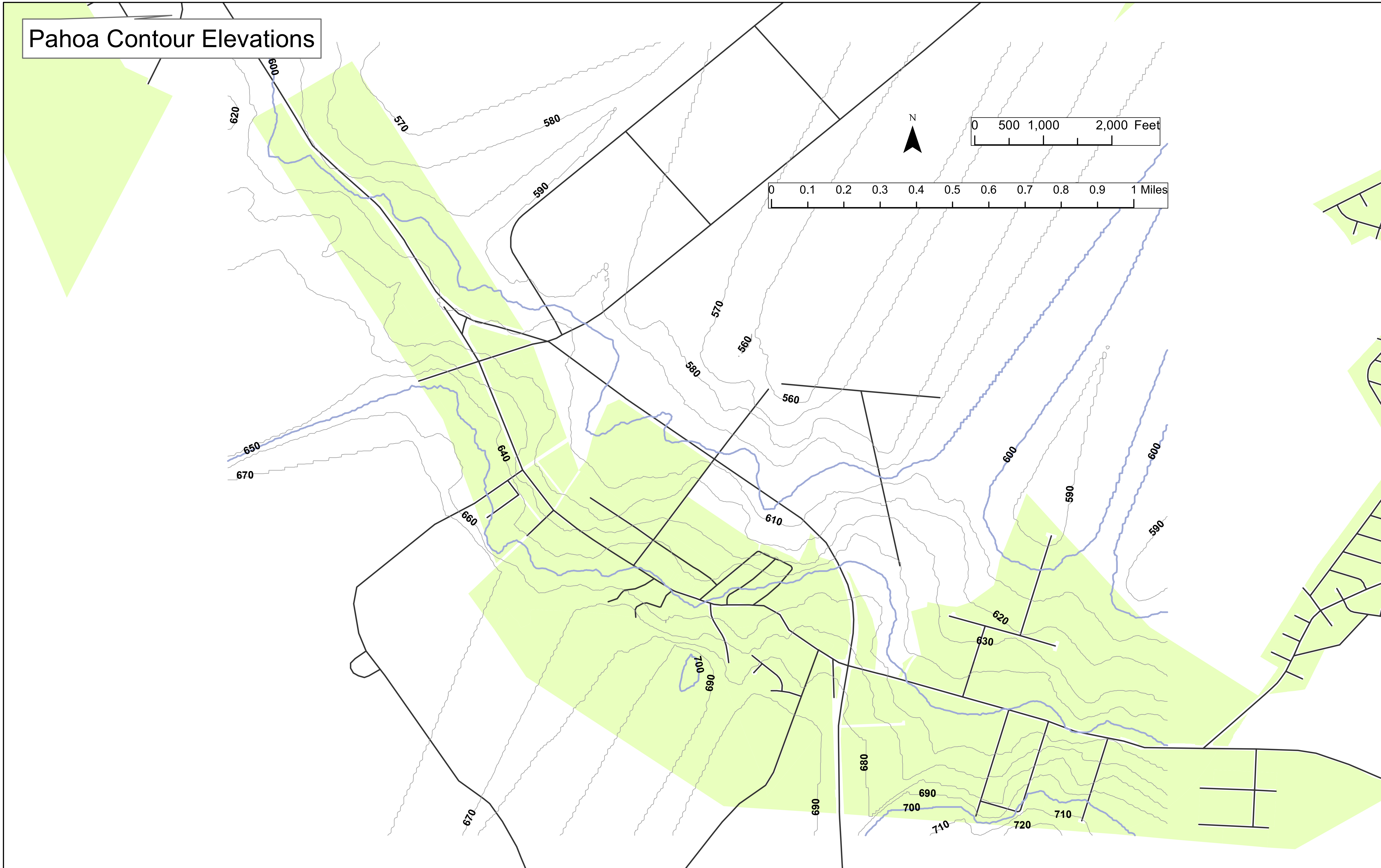
Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Nānāwale PS1																						
8.044	0.67	0.353	1.34	7075	357	15	342	410	10	400	58	0.45	313	0.70	1.97	140	0.0018	12.7	15	1.3	87.0	ok
Nānāwale PS2																						
8.044	0.67	0.353	0.45	2376	410	20	390	475	13	462	72	0.78	542	1.21	3.42	140	0.0050	11.8	15	1.2	100.0	ok
Nānāwale PS3																						
9.866	0.82	0.531	0.42	2218	475	20	455	540	10	530	75	1.11	771	1.72	3.24	140	0.0035	7.9	15	0.8	98.6	ok
Nānāwale PS4																						
9.866	0.82	0.531	0.46	2429	540	20	520	600	10	590	70	1.18	819	1.83	3.44	140	0.0040	9.6	15	1.0	95.6	ok
Nānāwale PS5																						
9.866	0.82	0.531	0.32	1690	600	20	580	656	10	646	66	1.18	819	1.83	3.44	140	0.0040	6.7	15	0.7	88.4	ok

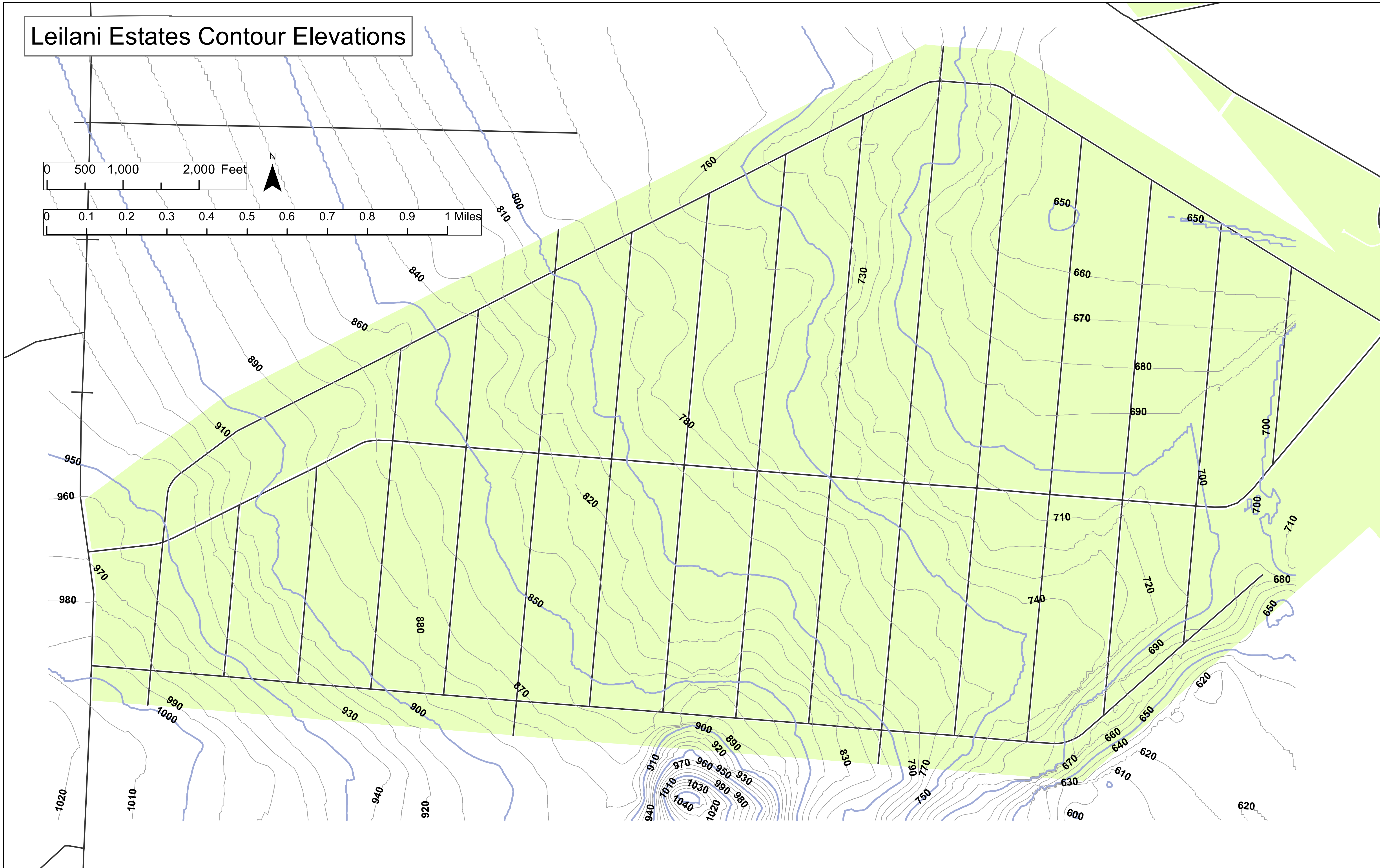
Note:
1) 8" FM is assumed for PS1 at this planning level to maintain TDH not exceeding 100 ft.
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

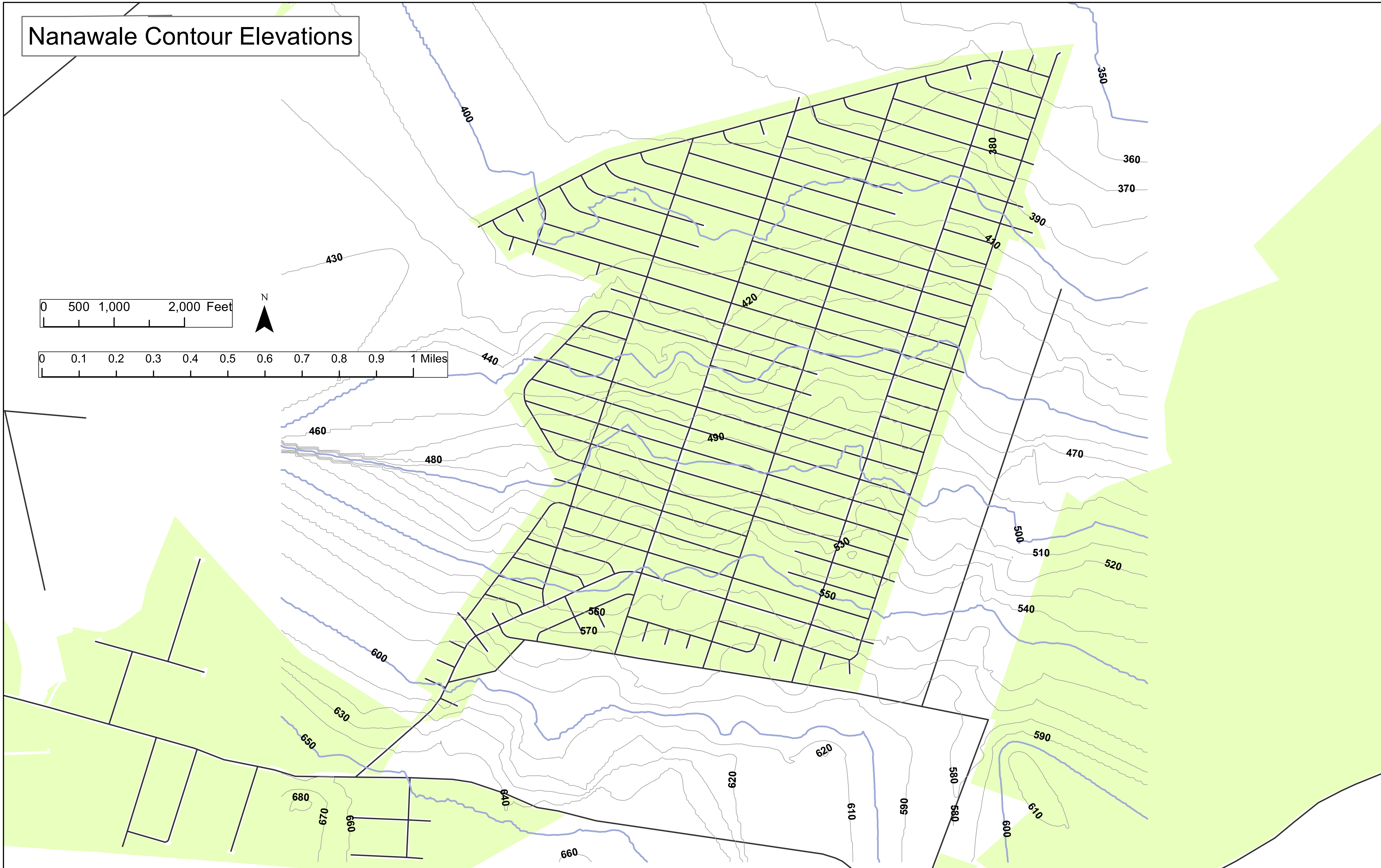
D-5: Contour Maps (Basis for Collection System Layout and calculation)



Hawaiian Beaches Contour Elevations
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
0 500 1,000 2,000 3,000 Feet
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Miles
N


Pahoa Contour Elevations
N
0 500 1,000 2,000 Feet
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Miles
600
620
570
580
590
570
560
580
560
650
670
640
660
610
600
590
600
590
620
630
700
690
680
690
670
690
700
710
720
710


Leilani Estates Contour Elevations
0 500 1,000 2,000 Feet
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Miles
N
760
800
810
840
860
890
910
950
960
970
980
990
1000
1020
1010
930
900
940
920
870
850
880
820
780
730
650
660
670
680
690
700
710
720
740
830
790
770
750
900
890
920
910
970
960
950
930
1010
1030
990
980
1040
1020
940
690
680
650
620
660
640
670
630
620
610
600
620



Nanawale Contour Elevations
0 500 1,000 2,000 Feet
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Miles
N
350
360
370
380
390
400
410
420
430
440
460
470
480
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
690

Appendix E Interceptor Sewer System Hydraulic Calculations

Alternatives with 1, 3, or 4 New Puna WWTPs

E-1: Sewer Hydraulic Calculations

E-2: Pump Station and Force Main Hydraulic Calculations

Note: The collection system maps and calculations for subregions (Volcano, Keaʻau, HPP, and Pāhoa) are presented in Appendices A through D. Appendix E contains the calculations for sizing the interceptor sewer along the highway. Maps of the interceptor sewers are shown in the main report in Section 6.5.

E-1: Sewer Hydraulic Calculations

Computation of Wastewater Flow for Puna Sewering - 1 Regional Plant - Full Flow Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
					Residential					Other		Total																	
					Homes			Apartment																					
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Keaau Regional Plant-1																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	-	-	-	-	-	-	-
Volcano Mauka added flow	2a	Volcano Mauka to Volcano Makai	160	415	400	933	3091	0	0	0	0	933	3091	0.216	2.5	0.54	0.108	0.325	0.65	415	1.245	1.89	12	1.00	4.54	2.30	0.82	5.06	8.3
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	677	857	2537	5629	0	0	0	0	2537	5629	0.394	2.5	0.99	0.197	0.591	1.18	677	2.031	3.21	18	0.50	4.20	4.80	0.67	4.50	10.8
Old Volcano Road	4	Old Volcano Road to Plant	129	806	545	1525	7154	0	0	0	0	1525	7154	0.501	2.5	1.25	0.250	0.751	1.50	806	2.419	3.92	18	1.00	5.94	6.79	0.58	6.16	9.8
West Kea'au	5	West Kea'au to Eden Rock	296	1102	1341	2923	10077	0	0	0	0	2923	10077	0.705	2.5	1.76	0.353	1.058	2.12	1102	3.306	5.42	-	-	-	-	-	-	-
West Kea'au added flow	5a	West Kea'au to Eden Rock	880	1982	2200	4796	14873	0	0	0	0	4796	14873	1.041	2.5	2.60	0.521	1.562	3.12	1982	5.946	9.07	24	1.00	7.20	14.62	0.62	7.58	13.7
Eden Rock	6	Eden Rock to Kurtistown	189	2172	473	1258	16131	0	0	0	0	1258	16131	1.129	2.5	2.82	0.565	1.694	3.39	2172	6.515	9.90	24	1.50	8.82	17.91	0.55	9.04	12.7
Kurtistown	7	Kurtistown to Pa'ahana St.	122	2293	606	1808	17939	0	0	0	0	1808	17939	1.256	2.5	3.14	0.628	1.884	3.77	2293	6.880	10.65	-	-	-	-	-	-	-
Kurtistown added flow	7a	Kurtistown to Pa'ahana St.	880	3173	2200	6566	24505	0	0	0	0	6566	24505	1.715	2.5	4.29	0.858	2.573	5.15	3173	9.520	14.67	24	1.60	9.11	18.50	0.79	10.10	16.1
Pa'ahana St.	8	Pa'ahana St. to Kea'au Shipman Road	131	3304	472	1402	25907	0	0	0	0	1402	25907	1.814	2.5	4.53	0.907	2.720	5.44	3304	9.913	15.35	24	1.80	9.66	19.62	0.78	10.69	16.0
Kea'au	9	Kea'au to Plant (Shipman Road)	125	3429	469	1439	27346	0	0	0	0	1439	27346	1.914	2.5	4.79	0.957	2.871	5.74	3429	10.288	16.03	30	0.70	6.99	22.18	0.72	7.61	18.9
Keaau Regional Plant-2																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	-	-	-	-	-	-	-
Leilani Estates added flow	1a	Leilani Estates to Pahoa2	1040	1442	2600	3567	4948	0	0	0	0	3567	4948	0.346	2.5	0.87	0.173	0.520	1.04	1442	4.327	5.37	18	1.00	5.94	6.79	0.79	6.59	12.1
Nanawale Estates	2	Nanawale Estates to Pahoa1	215	215	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	215	0.645	1.17	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa1 added flow	3a	Pahoa1 to Pahoa2	160	375	400	1084	3603	0	0	0	0	1084	3603	0.252	2.5	0.63	0.126	0.378	0.76	375	1.125	1.88	16	0.50	3.89	3.51	0.54	3.95	8.3
Pahoa1	3	Pahoa1 to Pahoa2	134	1952	503	1362	9913	0	0	0	0	1362	9913	0.694	2.5	1.73	0.347	1.041	2.08	1952	5.855	7.94	24	1.00	7.20	14.62	0.54	7.35	12.6
Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	2636	2299	6363	16276	0	0	0	0	6363	16276	1.139	2.5	2.85	0.570	1.709	3.42	2636	7.909	11.33	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	2647	38	102	16378	0	0	0	0	102	16378	1.146	2.5	2.87	0.573	1.720	3.44	2647	7.940	11.38	30	0.32	4.73	15.00	0.76	5.20	19.5
Ainaloa	6	Ainaloa to HPP	641	3288	2441	7580	23958	0	0	0	0	7580	23958	1.677	2.5	4.19	0.839	2.516	5.03	3288	9.864	14.89	36	0.22	4.43	20.22	0.74	4.84	23.0
HPP1	7	HPP to HPP Pump Station	1968	5256	6641	22743	46700	0	0	0	0	22743	46700	3.269	2.5	8.17	1.635	4.904	9.81	5256	15.768	25.58	-	-	-	-	-	-	-
HPP added flow	7a	HPP to HPP Pump Station	920	6176	2300	7876	54577	0	0	0	0	7876	54577	3.820	2.5	9.55	1.910	5.731	11.46	6176	18.528	29.99	48	0.20	5.11	41.52	0.72	5.57	30.2
Keeau	8	HPP PS FM discharge to Keeau		6176			54577	0	0	0	0		54577	3.820	2.5	9.55	1.910	5.731	11.46	6176	18.528	29.99	48	0.20	5.11	41.52	0.72	5.57	30.2
Keaau Regional Plant																													
Keeau	1	Kea'au to Plant (Railroad Avenue)		9605			81923						81923	5.735	2.5	14.34	2.867	8.602	17.20	9605	28.816	46.02	54	0.20	5.53	56.84	0.81	6.16	36.9

[a] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

1. N/A = not applicable
2. This calculation spreadsheet is based on the table "Computation of Wastewater Flow (Sample)" from the July 2017 Wastewater System Design Standards City and County of Honolulu.
3. Sewer design and sizing based on the July 2017 Wastewater System Design Standards City and County of Honolulu.
4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
6. See map of Pahoa Regional Plant. There are two starting trunks (Leilani Estates and Nanawale Estates). These flow to Pahoa1. There are also two trunks (Hawaiian Beaches and Pahoa1) flowing to Pahoa2.
7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

Computation of Wastewater Flow for Puna Sewering - 1 Regional Plant - Urban Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population: Residential: Homes			Residential: Apartment		Other		Total		Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Keaau Regional Plant-1																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	12	1.00	4.54	2.30	0.53	4.60	6.2
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	517	857	2537	4696	0	0	0	0	2537	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54	16	0.50	3.89	3.51	0.72	4.24	10.1
Old Volcano Road	4	Old Volcano Road to Plant	129	646	545	1525	6221	0	0	0	0	1525	6221	0.435	2.5	1.09	0.218	0.653	1.31	646	1.939	3.25	16	1.00	5.50	4.96	0.65	5.86	9.4
West Keaʻau	5	West Keaʻau to Eden Rock	296	942	1341	2923	9145	0	0	0	0	2923	9145	0.640	2.5	1.60	0.320	0.960	1.92	942	2.826	4.75	18	1.00	5.94	6.79	0.70	6.43	11.1
Eden Rock	6	Eden Rock to Kurtistown	189	1132	473	1258	10403	0	0	0	0	1258	10403	0.728	2.5	1.82	0.364	1.092	2.18	1132	3.395	5.58	18	1.50	7.28	8.32	0.67	7.80	10.8
Kurtistown	7	Kurtistown to Paʻahana St.	122	1253	606	1808	12211	0	0	0	0	1808	12211	0.855	2.5	2.14	0.427	1.282	2.56	1253	3.760	6.32	18	1.50	7.28	8.32	0.76	8.01	11.7
Paʻahana St.	8	Paʻahana St. to Keaʻau Shipman Road	131	1384	472	1402	13613	0	0	0	0	1402	13613	0.953	2.5	2.38	0.476	1.429	2.86	1384	4.153	7.01	18	1.50	7.28	8.32	0.84	8.16	12.7
Keaʻau	9	Keaʻau to Plant (Shipman Road)	125	1509	469	1439	15052	0	0	0	0	1439	15052	1.054	2.5	2.63	0.527	1.580	3.16	1509	4.528	7.69	24	0.70	6.02	12.23	0.63	6.36	13.8
Keaau Regional Plant-2																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	12	0.80	4.06	2.06	0.73	4.42	7.6
Nanawale Estates	2	Nanawale Estates to Pahoa1	215	215	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	215	0.645	1.17	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa1	3	Pahoa1 to Pahoa2	134	752	503	1362	5262	0	0	0	0	1362	5262	0.368	2.5	0.92	0.184	0.552	1.10	752	2.255	3.36	16	1.00	5.50	4.96	0.68	5.90	9.7
Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	1436	2299	6363	11624	0	0	0	0	6363	11624	0.814	2.5	2.03	0.407	1.221	2.44	1436	4.309	6.75	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	1447	38	102	11727	0	0	0	0	102	11727	0.821	2.5	2.05	0.410	1.231	2.46	1447	4.340	6.80	24	0.32	4.07	8.27	0.82	4.55	16.6
Ainaloa	6	Ainaloa to HPP	641	2088	2441	7580	19306	0	0	0	0	7580	19306	1.351	2.5	3.38	0.676	2.027	4.05	2088	6.264	10.32	30	0.22	3.92	12.44	0.83	4.38	20.9
HPP1	7	HPP to HPP Pump Station	1968	4056	6641	22743	42049	0	0	0	0	22743	42049	2.943	2.5	7.36	1.472	4.415	8.83	4056	12.168	21.00	42	0.20	4.68	29.08	0.72	5.09	26.4
Keaau	8	HPP PS FM discharge to Keeau		4056			42049	0	0	0	0		42049	2.943	2.5	7.36	1.472	4.415	8.83	4056	12.168	21.00	42	0.20	4.68	29.08	0.72	5.09	26.4
Keaau Regional Plant																													
Keeau	1	Keaʻau to Plant (Railroad Avenue)		5565			57101						57101	3.997	2.5	9.99	1.999	5.996	11.99	5565	16.696	28.69	48	0.20	5.11	41.52	0.69	5.52	29.3
																total average flow:		6.00	mgd										

[a] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

1. N/A = not applicable
2. This calculation spreadsheet is based on the table "Computation of Wastewater Flow (Sample)" from the July 2017 Wastewater System Design Standards City and County of Honolulu.
3. Sewer design and sizing based on the July 2017 Wastewater System Design Standards City and County of Honolulu.
4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
6. See map of Pahoa Regional Plant. There are two starting trunks (Leilani Estates and Nanawale Estates). These flow to Pahoa1. There are also two trunks (Hawaiian Beaches and Pahoa1) flowing to Pahoa2.
7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

Computation of Wastewater Flow for Puna Sewering - 3 Subregional Plants - Urban Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population									Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
					Residential					Other		Total																	
					Homes			Apartment																					
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Volcano Subregional Plant																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	12	1.00	4.54	2.30	0.53	4.60	6.2
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	517	857	2537	4696	0	0	0	0	2537	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54	16	0.50	3.89	3.51	0.72	4.24	10.1
Old Volcano Road	4	Old Volcano Road to Plant	129	646	545	1525	6221	0	0	0	0	1525	6221	0.435	2.5	1.09	0.218	0.653	1.31	646	1.939	3.25	16	1.00	5.50	4.96	0.65	5.86	9.4
Keaʻau Subregional Plant																													
West Keaʻau	1	West Keaʻau to Eden Rock	296	296	1341	2923	2923	0	0	0	0	2923	2923	0.205	2.5	0.51	0.102	0.307	0.61	296	0.888	1.50	12	1.00	4.54	2.30	0.65	4.83	7.1
Eden Rock	2	Eden Rock to Kurtistown	189	485	473	1258	4181	0	0	0	0	1258	4181	0.293	2.5	0.73	0.146	0.439	0.88	485	1.456	2.33	12	2.00	6.42	3.26	0.72	6.97	7.5
Kurtistown	3	Kurtistown to Paʻahana St.	122	607	606	1808	5990	0	0	0	0	1808	5990	0.419	2.5	1.05	0.210	0.629	1.26	607	1.821	3.08	16	1.00	5.50	4.96	0.62	5.79	9.1
Paʻahana St.	4	Paʻahana St. to Keaʻau Shipman Road	131	738	472	1402	7392	0	0	0	0	1402	7392	0.517	2.5	1.29	0.259	0.776	1.55	738	2.214	3.77	16	1.00	5.50	4.96	0.76	6.05	10.4
Keaʻau	5	Keaʻau to Plant (Shipman Road)	125	863	469	1439	8831	0	0	0	0	1439	8831	0.618	2.5	1.55	0.309	0.927	1.85	863	2.589	4.44	18	0.70	4.97	5.68	0.78	5.50	12.0
Keaʻau	6	Keaʻau to Plant (Railroad Avenue)		863			8831	0	0	0	0		8831	0.618	2.5	1.55	0.309	0.927	1.85	863	2.589	4.44	24	0.20	3.22	6.54	0.68	3.46	14.5
HPP Subregional Plant																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	12	0.80	4.06	2.06	0.73	4.42	7.6
Nanawale Estates	2	Nanawale Estates to Pahoa1	215	215	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	215	0.645	1.17	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa1	3	Pahoa1 to Pahoa2	134	752	503	1362	5262	0	0	0	0	1362	5262	0.368	2.5	0.92	0.184	0.552	1.10	752	2.255	3.36	16	1.00	5.50	4.96	0.68	5.90	9.7
Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	1436	2299	6363	11624	0	0	0	0	6363	11624	0.814	2.5	2.03	0.407	1.221	2.44	1436	4.309	6.75	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	1447	38	102	11727	0	0	0	0	102	11727	0.821	2.5	2.05	0.410	1.231	2.46	1447	4.340	6.80	24	0.32	4.07	8.27	0.82	4.55	16.6
Ainaloa	6	Ainaloa to HPP	641	2088	2441	7580	19306	0	0	0	0	7580	19306	1.351	2.5	3.38	0.676	2.027	4.05	2088	6.264	10.32	30	0.22	3.92	12.44	0.83	4.38	20.9
HPP	7	HPP to Plant	1968	4056	6641	22743	42049	0	0	0	0	22743	42049	2.943	2.5	7.36	1.472	4.415	8.83	4056	12.168	21.00	42	0.20	4.68	29.08	0.72	5.09	26.4

[(a)] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

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4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
6. See map of Pahoa Regional Plant. There are two starting trunks (Leilani Estates and Nanawale Estates). These flow to Pahoa1. There are also two trunks (Hawaiian Beaches and Pahoa1) flowing to Pahoa2.
7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

Computation of Wastewater Flow for Puna Sewering - 4 Subregional Plants - Urban Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Page: 1 of 1
Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location: District Zone or Street	Sewer Location: Segment Name	Sewer Location: Point (Start to End)	Tributary Area (Acres): Increment	Tributary Area (Acres): Total	Tributary Equivalent Population: Residential: Homes: Lots	Residential: Homes: Increment	Residential: Homes: Total	Residential: Apartment: Increment	Residential: Apartment: Total	Other: Increment	Other: Total	Total: Increment	Total: Total	Wastewater Flow Computation: Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	( ) Exisiting Sewer Study (X) Ultimate Sewer Study: Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [a]	Depth at Design Flow - D_{DES} (in) [a]
Volcano Subregional Plant																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	12	1.00	4.54	2.30	0.53	4.60	6.2
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	517	857	2537	4696	0	0	0	0	2537	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54	16	0.50	3.89	3.51	0.72	4.24	10.1
Old Volcano Road	4	Old Volcano Road to Plant	129	646	545	1525	6221	0	0	0	0	1525	6221	0.435	2.5	1.09	0.218	0.653	1.31	646	1.939	3.25	16	1.00	5.50	4.96	0.65	5.86	9.4
Kea'au Subregional Plant																													
West Kea'au	1	West Kea'au to Eden Rock	296	296	1341	2923	2923	0	0	0	0	2923	2923	0.205	2.5	0.51	0.102	0.307	0.61	296	0.888	1.50	12	1.00	4.54	2.30	0.65	4.83	7.1
Eden Rock	2	Eden Rock to Kurtistown	189	485	473	1258	4181	0	0	0	0	1258	4181	0.293	2.5	0.73	0.146	0.439	0.88	485	1.456	2.33	12	2.00	6.42	3.26	0.72	6.97	7.5
Kurtistown	3	Kurtistown to Pa'ahana St.	122	607	606	1808	5990	0	0	0	0	1808	5990	0.419	2.5	1.05	0.210	0.629	1.26	607	1.821	3.08	16	1.00	5.50	4.96	0.62	5.79	9.1
Pa'ahana St.	4	Pa'ahana St. to Kea'au Shipman Road	131	738	472	1402	7392	0	0	0	0	1402	7392	0.517	2.5	1.29	0.259	0.776	1.55	738	2.214	3.77	16	1.00	5.50	4.96	0.76	6.05	10.4
Kea'au	5	Kea'au to Plant (Shipman Road)	125	863	469	1439	8831	0	0	0	0	1439	8831	0.618	2.5	1.55	0.309	0.927	1.85	863	2.589	4.44	18	1.00	5.94	6.79	0.65	6.34	10.6
Kea'au	6	Kea'au to Plant (Railroad Avenue)		863			8831	0	0	0	0		8831	0.618	2.5	1.55	0.309	0.927	1.85	863	2.589	4.44	24	0.20	3.22	6.54	0.68	3.46	14.5
HPP Subregional Plant																													
Ainaloa	1	Ainaloa to HPP	641	641	2441	7580	7580	0	0	0	0	7580	7580	0.531	2.5	1.33	0.265	0.796	1.59	641	1.924	3.52	24	0.22	3.38	6.86	0.51	3.40	12.2
HPP	2	HPP to Plant	1968	2610	6641	22743	30322	0	0	0	0	22743	30322	2.123	2.5	5.31	1.061	3.184	6.37	2610	7.829	14.20	36	0.20	4.22	19.28	0.74	4.61	23.0
Pahoa Subregional Plant																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	12	0.80	4.06	2.06	0.73	4.42	7.6
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Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	1436	2299	6363	11624	0	0	0	0	6363	11624	0.814	2.5	2.03	0.407	1.221	2.44	1436	4.309	6.75	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	1447	38	102	11727	0	0	0	0	102	11727	0.821	2.5	2.05	0.410	1.231	2.46	1447	4.340	6.80	24	0.45	4.83	9.81	0.69	5.22	14.7

[a] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

1. N/A = not applicable
2. This calculation spreadsheet is based on the table "Computation of Wastewater Flow (Sample)" from the July 2017 Wastewater System Design Standards City and County of Honolulu.
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4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
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7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

E-2: Pump Station and Force Main Hydraulic Calculations

Note: Alternatives with 3 or 4 WWTPs do not have proposed pump stations along the interceptor sewer.

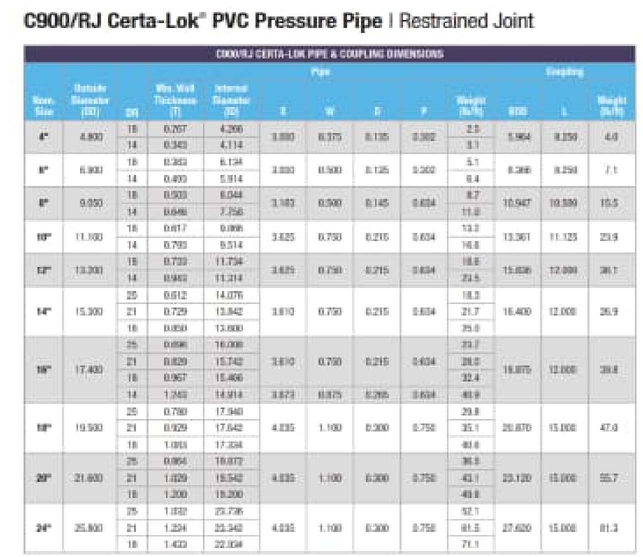
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in



C900/RJ Certa-Lok® PVC Pressure Pipe I Restrained Joint

C900/RJ CERTA-LOK PIPE & COUPLING DIMENSIONS

Nom. Size	Outside Diameter (OD)	DR	Min. Wall Thickness (T)	Internal Diameter (ID)	X	W	D	P	Weight (lb/ft)	BOD	L	Weight (lb/ft)
4"	4.800	18	0.267	4.266	3.000	0.375	0.135	0.302	2.5	5.964	8.250	4.0
		14	0.343	4.114					3.1			
6"	6.900	18	0.383	6.134	3.000	0.500	0.135	0.302	5.1	8.366	8.250	7.1
		14	0.493	5.914					6.4			
8"	9.050	18	0.503	8.044	3.183	0.500	0.145	0.634	8.7	10.947	10.500	15.5
		14	0.646	7.758					11.0			
10"	11.100	18	0.617	9.866	3.625	0.750	0.215	0.634	13.2	13.361	11.125	23.9
		14	0.793	9.514					16.8			
12"	13.200	18	0.733	11.734	3.625	0.750	0.215	0.634	18.8	15.836	12.000	38.1
		14	0.943	11.314					23.5			
14"	15.300	25	0.612	14.076	3.810	0.750	0.215	0.634	18.3	16.400	12.000	26.9
		21	0.729	13.842					21.7			
		18	0.850	13.600					25.0			
16"	17.400	25	0.696	16.008	3.810	0.750	0.215	0.634	23.7	18.875	12.000	39.8
		21	0.829	15.742					28.0			
		18	0.967	15.466					32.4			
		14	1.243	14.914	3.873	0.875	0.265	0.634	40.9			
18"	19.500	25	0.780	17.940	4.035	1.100	0.300	0.750	29.8	20.870	15.000	47.0
		21	0.929	17.642					35.1			
		18	1.083	17.334					40.6			
20"	21.600	25	0.864	19.872	4.035	1.100	0.300	0.750	36.5	23.120	15.000	55.7
		21	1.029	19.542					43.1			
		18	1.200	19.200					49.8			
24"	25.800	25	1.032	23.736	4.035	1.100	0.300	0.750	52.1	27.620	15.000	81.3
		21	1.229	23.342					61.5			
		18	1.433	22.934					71.1			

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Full flow Regional 2-12-2023																						
Pāhoa PS1																						
9.866	0.82	0.531	0.33	1742	641	20	621	674	10	664	43	2.13	1,479	3.30	6.21	140	0.0118	20.6	15	2.1	80.7	ok
Pāhoa PS2																						
17.334	1.44	1.639	0.24	1267	623	20	603	639	10	629	26	7.94	5,514	12.29	7.50	140	0.0087	11.0	15	1.1	53.1	ok
HPP PS1																						
42	3.50	9.621	2.37	12514	300	20	280	347	10	337	57	29.99	20,826	46.40	4.82	140	0.0014	17.1	15	1.7	90.9	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

C900/RJ Certa-Lok® PVC Pressure Pipe | Restrained Joint

C900/RJ CERTA-LOK PIPE & COUPLING DIMENSIONS

			Pipe							Coupling		
Nom. Size	Outside Diameter (OD)	DR	Min. Wall Thickness (T)	Internal Diameter (ID)	E	W	D	F	Weight (lb/ft)	BOD	L	Weight (lb/ft)
4"	4.800	18	0.267	4.266	3.000	0.375	0.135	0.302	2.5	5.964	8.250	4.0
		14	0.343	4.114					3.1			
6"	6.900	18	0.383	6.134	3.000	0.500	0.135	0.302	5.1	8.366	8.250	7.1
		14	0.493	5.914					6.4			
8"	9.050	18	0.503	8.044	3.163	0.500	0.145	0.634	8.7	10.947	10.500	15.5
		14	0.646	7.758					11.0			
10"	11.100	18	0.617	9.866	3.625	0.750	0.215	0.634	13.2	13.361	11.125	23.9
		14	0.793	9.514					16.8			
12"	13.200	18	0.733	11.734	3.625	0.750	0.215	0.634	18.8	15.636	12.000	38.1
		14	0.943	11.314					23.5			
14"	15.300	25	0.612	14.076	3.610	0.750	0.215	0.634	18.3	16.400	12.000	26.9
		21	0.729	13.842					21.7			
		18	0.850	13.600					25.0			
16"	17.400	25	0.696	16.008	3.610	0.750	0.215	0.634	23.7	18.675	12.000	39.8
		21	0.829	15.742					28.0			
		18	0.967	15.466					32.4			
		14	1.243	14.914	3.873	0.875	0.265	0.634	40.9			
18"	19.500	25	0.780	17.940	4.035	1.100	0.300	0.750	29.8	20.870	15.000	47.0
		21	0.929	17.642					35.1			
		18	1.083	17.334					40.6			
20"	21.600	25	0.864	19.872	4.035	1.100	0.300	0.750	36.6	23.120	15.000	55.7
		21	1.029	19.542					43.1			
		18	1.200	19.200					49.8			
24"	25.800	25	1.032	23.736	4.035	1.100	0.300	0.750	52.1	27.620	15.000	81.3
		21	1.229	23.342					61.5			
		18	1.433	22.934					71.1			

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Regional 2-10-2023																						
PS1																						
36	3.00	7.069	2.37	12514	300	20	280	347	10	337	57	21	14,583	32.49	4.60	140	0.0015	18.8	15	1.9	92.6	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Appendix F Interceptor Sewer System Hydraulic Calculations

Alternatives with Puna Flows to Hilo WWTP

F-1: Sewer Hydraulic Calculations

F-2: Pump Station and Force Main Hydraulic Calculations

Note: The collection system maps and calculations for subregions (Volcano, Kea‘au, HPP, and Pāhoa) are presented in Appendices A through D. Appendix F contains the calculations for sizing the interceptor sewer along the highway. Maps of the interceptor sewers are shown in the main report in Section 6.5.

F-1: Sewer Hydraulic Calculations

Computation of Wastewater Flow for Puna Sewering - Flow to Hilo - Full Flow Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location: District Zone or Street	Sewer Location: Segment Name	Sewer Location: Point (Start to End)	Tributary Area (Acres): Increment	Tributary Area (Acres): Total	Tributary Equivalent Population: Residential: Homes: Lots	Residential: Homes: Increment	Residential: Homes: Total	Residential: Apartment: Increment	Residential: Apartment: Total	Other: Increment	Other: Total	Total: Increment	Total: Total	Wastewater Flow Computation: Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	( ) Exisiting Sewer Study (X) Ultimate Sewer Study: Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Keaau Regional Plant-1																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22							
Volcano Mauka added flow	2a	Volcano Mauka to Volcano Makai	160	415	400	933	3091	0	0	0	0	933	3091	0.216	2.5	0.54	0.108	0.325	0.65	415	1.245	1.89	12	1.00	4.54	2.30	0.82	5.06	8.3
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	677	857	2537	5629	0	0	0	0	2537	5629	0.394	2.5	0.99	0.197	0.591	1.18	677	2.031	3.21	18	0.50	4.20	4.80	0.67	4.50	10.8
Old Volcano Road	4	Old Volcano Road to Plant	129	806	545	1525	7154	0	0	0	0	1525	7154	0.501	2.5	1.25	0.250	0.751	1.50	806	2.419	3.92	18	1.00	5.94	6.79	0.58	6.16	9.8
West Kea'au	5	West Kea'au to Eden Rock	296	1102	1341	2923	10077	0	0	0	0	2923	10077	0.705	2.5	1.76	0.353	1.058	2.12	1102	3.306	5.42							
West Kea'au added flow	5a	West Kea'au to Eden Rock	880	1982	2200	4796	14873	0	0	0	0	4796	14873	1.041	2.5	2.60	0.521	1.562	3.12	1982	5.946	9.07	24	1.00	7.20	14.62	0.62	7.58	13.7
Eden Rock	6	Eden Rock to Kurtistown	189	2172	473	1258	16131	0	0	0	0	1258	16131	1.129	2.5	2.82	0.565	1.694	3.39	2172	6.515	9.90	24	1.50	8.82	17.91	0.55	9.04	12.7
Kurtistown	7	Kurtistown to Pa'ahana St.	122	2293	606	1808	17939	0	0	0	0	1808	17939	1.256	2.5	3.14	0.628	1.884	3.77	2293	6.880	10.65							
Kurtistown added flow	7a	Kurtistown to Pa'ahana St.	880	3173	2200	6566	24505	0	0	0	0	6566	24505	1.715	2.5	4.29	0.858	2.573	5.15	3173	9.520	14.67	24	1.60	9.11	18.50	0.79	10.10	16.1
Pa'ahana St.	8	Pa'ahana St. to Kea'au Shipman Road	131	3304	472	1402	25907	0	0	0	0	1402	25907	1.814	2.5	4.53	0.907	2.720	5.44	3304	9.913	15.35	24	1.80	9.66	19.62	0.78	10.69	16.0
Kea'au	9	Kea'au to Plant (Shipman Road)	125	3429	469	1439	27346	0	0	0	0	1439	27346	1.914	2.5	4.79	0.957	2.871	5.74	3429	10.288	16.03	30	0.70	6.99	22.18	0.72	7.61	18.9
Keaau Regional Plant-2																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50							
Leilani Estates added flow	1a	Leilani Estates to Pahoa2	1040	1442	2600	3567	4948	0	0	0	0	3567	4948	0.346	2.5	0.87	0.173	0.520	1.04	1442	4.327	5.37	18	1.00	5.94	6.79	0.79	6.59	12.1
Nanawale Estates	2	Nanawale Estates to Pahoa1	215	215	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	215	0.645	1.17	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa1 added flow	3a	Pahoa1 to Pahoa2	160	375	400	1084	3603	0	0	0	0	1084	3603	0.252	2.5	0.63	0.126	0.378	0.76	375	1.125	1.88	16	0.50	3.89	3.51	0.54	3.95	8.3
Pahoa1	3	Pahoa1 to Pahoa2	134	1952	503	1362	9913	0	0	0	0	1362	9913	0.694	2.5	1.73	0.347	1.041	2.08	1952	5.855	7.94	24	1.00	7.20	14.62	0.54	7.35	12.6
Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	2636	2299	6363	16276	0	0	0	0	6363	16276	1.139	2.5	2.85	0.570	1.709	3.42	2636	7.909	11.33	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	2647	38	102	16378	0	0	0	0	102	16378	1.146	2.5	2.87	0.573	1.720	3.44	2647	7.940	11.38	30	0.32	4.73	15.00	0.76	5.20	19.5
Ainaloa	6	Ainaloa to HPP	641	3288	2441	7580	23958	0	0	0	0	7580	23958	1.677	2.5	4.19	0.839	2.516	5.03	3288	9.864	14.89	36	0.22	4.43	20.22	0.74	4.84	23.0
HPP1	7	HPP to HPP Pump Station	1968	5256	6641	22743	46700	0	0	0	0	22743	46700	3.269	2.5	8.17	1.635	4.904	9.81	5256	15.768	25.58							
HPP added flow	7a	HPP to HPP Pump Station	920	6176	2300	7876	54577	0	0	0	0	7876	54577	3.820	2.5	9.55	1.910	5.731	11.46	6176	18.528	29.99	48	0.20	5.11	41.52	0.72	5.57	30.2
Keaau	8	HPP PS FM discharge to Keeau		6176			54577	0	0	0	0		54577	3.820	2.5	9.55	1.910	5.731	11.46	6176	18.528	29.99	48	0.20	5.11	41.52	0.72	5.57	30.2
Keaau Regional Plant																													
Keeau	1	Kea'au to Hilo WWTP		9605			81923						81923	5.735	2.5	14.34	2.867	8.602	17.20	9605	28.816	46.02	54	0.20	5.53	56.84	0.81	6.16	36.9

[(a)] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

1. N/A = not applicable
2. This calculation spreadsheet is based on the table "Computation of Wastewater Flow (Sample)" from the July 2017 Wastewater System Design Standards City and County of Honolulu.
3. Sewer design and sizing based on the July 2017 Wastewater System Design Standards City and County of Honolulu.
4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
6. See map of Pahoa Regional Plant. There are two starting trunks (Leilani Estates and Nanawale Estates). These flow to Pahoa1. There are also two trunks (Hawaiian Beaches and Pahoa1) flowing to Pahoa2.
7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

Computation of Wastewater Flow for Puna Sewering - Flow to Hilo - Urban Sewering

Sewer: Collection system with subregional plants
District: Puna
Reference Maps: Hawaii Statewide GIS Program

Computed by: Adrienne Fung, Tieshi Huang
Date: February 10, 2023

Sewer Location			Tributary Area (Acres)		Tributary Equivalent Population: Residential: Homes			Residential: Apartment		Other		Total		Wastewater Flow Computation									( ) Exisiting Sewer Study (X) Ultimate Sewer Study						
District Zone or Street	Segment Name	Point (Start to End)	Increment	Total	Lots	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Base Sanitary Flow - BSF @ 70 gpcd (MGD)	Flow Factor	Peak Base Sanitary Flow - PBSF (MGD)	Ground Water Infiltration - GWI @ 35 gpcd (MGD)	Average Dry Weather Flow - ADWF (MGD)	Peak Dry Weather Flow - PDWF (MGD)	Area Used for Wet Weather I/I Calculation (acres)	Wet Weather I/I @ 3000 gpad (MGD)	Design Peak Flow - Q_{DES} (MGD)	Pipe Diameter (in)	Slope (%)	Velocity at Full Pipe - V_{FULL} (fps)	Full Pipe Flow - Q_{FULL} (MGD)	Design Flow - Q_{DES} (MGD) / Full Pipe Flow - Q_{FULL} (MGD)	Velocity at Design Flow - V_{DES} (fps) [(a)]	Depth at Design Flow - D_{DES} (in) [(a)]
Keaau Regional Plant-1																													
Volcano Golf Course	1	VGC to Volcano Mauka	109	109	400	866	866	0	0	0	0	866	866	0.061	2.5	0.15	0.030	0.091	0.18	109	0.328	0.51	12	0.31	2.53	1.28	0.40	2.38	5.3
Volcano Mauka	2	Volcano Mauka to Volcano Makai	146	255	554	1293	2159	0	0	0	0	1293	2159	0.151	2.5	0.38	0.076	0.227	0.45	255	0.765	1.22	12	1.00	4.54	2.30	0.53	4.60	6.2
Volcano Makai	3	Volcano Makai to Old Volcano Road	262	517	857	2537	4696	0	0	0	0	2537	4696	0.329	2.5	0.82	0.164	0.493	0.99	517	1.551	2.54	16	0.50	3.89	3.51	0.72	4.24	10.1
Old Volcano Road	4	Old Volcano Road to Plant	129	646	545	1525	6221	0	0	0	0	1525	6221	0.435	2.5	1.09	0.218	0.653	1.31	646	1.939	3.25	16	1.00	5.50	4.96	0.65	5.86	9.4
West Kea‘au	5	West Kea‘au to Eden Rock	296	942	1341	2923	9145	0	0	0	0	2923	9145	0.640	2.5	1.60	0.320	0.960	1.92	942	2.826	4.75	18	1.00	5.94	6.79	0.70	6.43	11.1
Eden Rock	6	Eden Rock to Kurtistown	189	1132	473	1258	10403	0	0	0	0	1258	10403	0.728	2.5	1.82	0.364	1.092	2.18	1132	3.395	5.58	18	1.50	7.28	8.32	0.67	7.80	10.8
Kurtistown	7	Kurtistown to Pa‘ahana St.	122	1253	606	1808	12211	0	0	0	0	1808	12211	0.855	2.5	2.14	0.427	1.282	2.56	1253	3.760	6.32	18	1.50	7.28	8.32	0.76	8.01	11.7
Pa‘ahana St.	8	Pa‘ahana St. to Kea‘au Shipman Road	131	1384	472	1402	13613	0	0	0	0	1402	13613	0.953	2.5	2.38	0.476	1.429	2.86	1384	4.153	7.01	18	1.50	7.28	8.32	0.84	8.16	12.7
Kea‘au	9	Kea‘au to Plant (Shipman Road)	125	1509	469	1439	15052	0	0	0	0	1439	15052	1.054	2.5	2.63	0.527	1.580	3.16	1509	4.528	7.69	24	0.70	6.02	12.23	0.63	6.36	13.8
Keaau Regional Plant-2																													
Leilani Estates	1	Leilani Estates to Pahoa1	402	402	1006	1381	1381	0	0	0	0	1381	1381	0.097	2.5	0.24	0.048	0.145	0.29	402	1.207	1.50	12	0.80	4.06	2.06	0.73	4.42	7.6
Nanawale Estates	2	Nanawale Estates to Pahoa1	215	215	1062	2519	2519	0	0	0	0	2519	2519	0.176	2.5	0.44	0.088	0.265	0.53	215	0.645	1.17	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa1	3	Pahoa1 to Pahoa2	134	752	503	1362	5262	0	0	0	0	1362	5262	0.368	2.5	0.92	0.184	0.552	1.10	752	2.255	3.36	16	1.00	5.50	4.96	0.68	5.90	9.7
Hawaiian Beaches	4	Hawaiian Beaches to Pahoa2	685	1436	2299	6363	11624	0	0	0	0	6363	11624	0.814	2.5	2.03	0.407	1.221	2.44	1436	4.309	6.75	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM	NH FM
Pahoa2	5	Pahoa2 to Plant	10	1447	38	102	11727	0	0	0	0	102	11727	0.821	2.5	2.05	0.410	1.231	2.46	1447	4.340	6.80	24	0.32	4.07	8.27	0.82	4.55	16.6
Ainaloa	6	Ainaloa to HPP	641	2088	2441	7580	19306	0	0	0	0	7580	19306	1.351	2.5	3.38	0.676	2.027	4.05	2088	6.264	10.32	30	0.22	3.92	12.44	0.83	4.38	20.9
HPP1	7	HPP to HPP Pump Station	1968	4056	6641	22743	42049	0	0	0	0	22743	42049	2.943	2.5	7.36	1.472	4.415	8.83	4056	12.168	21.00	42	0.20	4.68	29.08	0.72	5.09	26.4
Keaau	8	HPP PS FM discharge to Keeau		4056			42049	0	0	0	0		42049	2.943	2.5	7.36	1.472	4.415	8.83	4056	12.168	21.00	42	0.20	4.68	29.08	0.72	5.09	26.4
Keaau Regional Plant																													
Keeau	1	Kea‘au to Hilo WWTP		5565			57101						57101	3.997	2.5	9.99	1.999	5.996	11.99	5565	16.696	28.69	48	0.20	5.11	41.52	0.69	5.52	29.3

[(a)] Calculated using Bentley FlowMaster.

Notes:

Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

1. N/A = not applicable
2. This calculation spreadsheet is based on the table "Computation of Wastewater Flow (Sample)" from the July 2017 Wastewater System Design Standards City and County of Honolulu.
3. Sewer design and sizing based on the July 2017 Wastewater System Design Standards City and County of Honolulu.
4. Lateral sewers are not shown in calculation. Lateral sewers are designed with 6-inch diameter at minimum 2% slope.
5. Starting slope most upstream was initially set at the minimum per CCH standards for 12". Connecting downstream segments are set at 2-3% slope to roughly match the roads.
6. See map of Pahoa Regional Plant. There are two starting trunks (Leilani Estates and Nanawale Estates). These flow to Pahoa1. There are also two trunks (Hawaiian Beaches and Pahoa1) flowing to Pahoa2.
7. Leilani Estates peaking factor around 12 due to higher lot sizes and larger tributary areas.
8. Hawaiian Beaches and Nanawale Estates flow to Pahoa through PS FM.
9. Small segment upstream of Pahoa plant is 8" gravity. See map.

F-2: Pump Station and Force Main Hydraulic Calculations

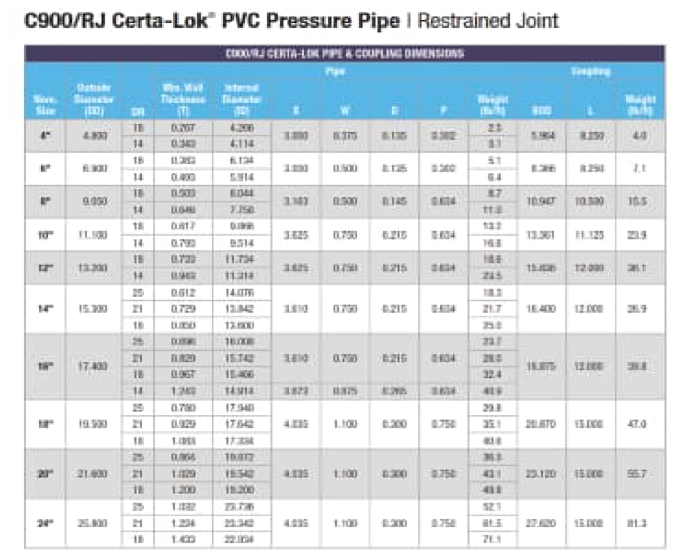
Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D(ft)$^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

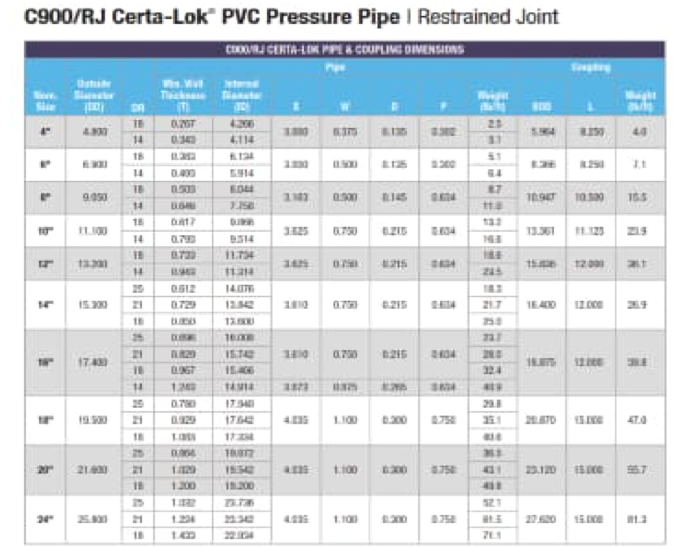

C900/RJ Certa-Lok® PVC Pressure Pipe I Restrained Joint

C900/RJ CERTA-LOK PIPE & COUPLING DIMENSIONS

Nom. Size	Outside Diameter (OD)	DR	Min. Wall Thickness (T)	Internal Diameter (ID)	E	W	D	F	Weight (lb/ft)	BOD	L	Weight (lb/ft)
4"	4.800	18	0.267	4.266	3.000	0.375	0.135	0.302	2.5	5.964	8.250	4.0
		14	0.343	4.114					3.1			
6"	6.900	18	0.383	6.134	3.000	0.500	0.135	0.302	5.1	8.366	8.250	7.1
		14	0.493	5.914					6.4			
8"	9.050	18	0.503	8.044	3.163	0.500	0.145	0.634	8.7	10.947	10.500	15.5
		14	0.646	7.758					11.0			
10"	11.100	18	0.617	9.866	3.625	0.750	0.215	0.634	13.2	13.361	11.125	23.9
		14	0.793	9.514					16.8			
12"	13.200	18	0.733	11.734	3.625	0.750	0.215	0.634	18.6	15.636	12.000	38.1
		14	0.943	11.314					23.5			
14"	15.300	25	0.612	14.076	3.610	0.750	0.215	0.634	18.3	16.400	12.000	26.9
		21	0.729	13.842					21.7			
		18	0.850	13.600					25.0			
16"	17.400	25	0.696	16.008	3.610	0.750	0.215	0.634	23.7	18.675	12.000	39.8
		21	0.829	15.742					28.0			
		18	0.967	15.466					32.4			
		14	1.243	14.914	3.873	0.875	0.265	0.634	40.9			
18"	19.500	25	0.780	17.940	4.035	1.100	0.300	0.750	29.8	20.870	15.000	47.0
		21	0.929	17.642					35.1			
		18	1.083	17.334					40.8			
20"	21.600	25	0.864	19.872	4.035	1.100	0.300	0.750	36.6	23.120	15.000	55.7
		21	1.029	19.542					43.1			
		18	1.200	19.200					49.8			
24"	25.800	25	1.032	23.736	4.035	1.100	0.300	0.750	52.1	27.620	15.000	81.3
		21	1.229	23.342					61.5			
		18	1.433	22.934					71.1			

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Full flow Regional 2-12-2023																						
Pāhoa PS1																						
9.866	0.82	0.531	0.33	1742	641	20	621	674	10	664	43	2.13	1,479	3.30	6.21	140	0.0118	20.6	15	2.1	80.7	ok
Pāhoa PS2																						
17.334	1.44	1.639	0.24	1267	623	20	603	639	10	629	26	7.94	5,514	12.29	7.50	140	0.0087	11.0	15	1.1	53.1	ok
HPP PS1																						
42	3.50	9.621	2.37	12514	300	20	280	347	10	337	57	29.99	20,826	46.40	4.82	140	0.0014	17.1	15	1.7	90.9	ok
Kea'au PS1																						
36	3.00	7.069	0.35	1848	223	20	203	268	10	258	55	29.99	20,826	46.40	6.56	140	0.0029	5.4	15	0.5	75.9	ok
Kea'au PS2																						
42	3.50	9.621	0.44	2323	268	20	248	309	10	299	51	46.02	31,958	71.21	7.40	140	0.0030	7.0	15	0.7	73.7	ok
Kea'au PS3																						
48	4.00	12.566	3.20	16896	28	20	8	52	10	42	34	46.02	31,958	71.21	5.67	140	0.0016	26.7	15	2.7	78.4	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).



Pipe Friction Loss Hazen-Williams =>	h_L=L(ft)*((2.314 Q(ft^3/s))/(C*D$(ft)^{2.63}$))$^{1.852}$ (ft)
Pipe & Valve Minor Loss Equation =>	h_M=K*V^2/2g (ft)

Mile to ft 5280

Assumption:
1. pipe length and surface elevation were based on Google Earth profile
2. C value of 140 for PVC pipe
3. station loss of 15 ft at this planning level
4. 10% of FM friction loss to account for minor loss along FM routeat this planing level
5. Pipe inside diameter, C900 DR18 (235 psi)

Quick notes to check FM calculation:
1. maintain FM velocity between 3-5 ft to minimize friction loss
2. TDH shold be less than 100 ft per CCH Design Standard at this planning level.

DR18 PVC inside diameter		
4"	4.266	in
6"	6.134	in
8"	8.044	in
10"	9.866	in
12"	11.734	in
14"	13.6	in
16"	15.466	in
18"	17.334	in
20"	19.2	in
24"	22.934	in

Pipe D (in)	Pipe D (ft)	Pipe A (ft2)	Pipe L (mi)	Pipe L (ft)	PS Surface Ele. (ft)	Incoming Sewer Depth (ft)	Wet Well Ele. (ft)	Discharge Surface Ele. (ft)	Minimum Cover (ft)	Discharge Ele. (ft)	Static H (ft)	Q (mgd)	Q (gpm)	Q (ft^3/s)	V (ft/s)	C	Friction Slope (ft/ft)	Friction H_L (ft)	Station H_L (ft)	Minor H_L (ft)	TDH (ft)	check
Urban Sewering, Flow to Hilo 2-12-2023																						
Pāhoa PS1																						
9.866	0.82	0.531	0.33	1742	641	20	621	674	10	664	43	1.42	986	2.20	4.14	140	0.0056	9.7	15	1.0	68.7	ok
Pāhoa PS2																						
13.6	1.13	1.009	0.24	1267	623	20	603	639	10	629	26	3.29	2,285	5.09	5.05	140	0.0056	7.0	15	0.7	48.7	ok
HPP PS1																						
36	3.00	7.069	2.37	12514	300	20	280	347	10	337	57	21	14,583	32.49	4.60	140	0.0015	18.8	15	1.9	92.6	ok
Kea'au PS1																						
30	2.50	4.909	0.35	1848	223	20	203	268	10	258	55	21	14,583	32.49	6.62	140	0.0036	6.7	15	0.7	77.4	ok
Kea'au PS2																						
36	3.00	7.069	0.44	2323	268	20	248	309	10	299	51	28.69	19,924	44.39	6.28	140	0.0027	6.2	15	0.6	72.8	ok
Kea'au PS3																						
36	3.00	7.069	3.20	16896	28	20	8	52	10	42	34	28.69	19,924	44.39	6.28	140	0.0027	45.2	15	4.5	98.7	ok

Note:
Cells in gray are based on user-input values for population, pipe diameter, pipe slope, or FlowMaster (for velocity and depth at design flow).

Appendix G Construction Cost Estimation and Life Cycle Cost (LCC) Analysis

G-1: LCC Analysis Summary and Assumptions

G-2: Pipe, IWS, and WWTP Unit Costs

G-3: Alternative 1A Construction Cost and LCC Analysis

G-4: Alternative 1B Construction Cost and LCC Analysis

G5: Alternative 2A Construction Cost and LCC Analysis

G-6: Alternative 2B Construction Cost and LCC Analysis

G-7: Alternative 2C Construction Cost and LCC Analysis

G-8: Alternative 3A Construction Cost and LCC Analysis

G-9: Alternative 3B Construction Cost and LCC Analysis

G-10: Alternative 3C Construction Cost and LCC Analysis

G-11: Alternative 4A Construction Cost and LCC Analysis

G-12: Alternative 4B Construction Cost and LCC Analysis

G-13: Alternative 4C Construction Cost and LCC Analysis

G-14: Alternative 5A Construction Cost and LCC Analysis

G-15: Alternative5B Construction Cost and LCC Analysis

G-16: Alternative 5C Construction Cost and LCC Analysis

G-17: Alternative 6A Construction Cost and LCC Analysis

G-18: Alternative 6B Construction Cost and LCC Analysis

G-19: Alternative 6C Construction Cost and LCC Analysis

G-20: Alternative 7A Construction Cost and LCC Analysis

G-21: Alternative 7B Construction Cost and LCC Analysis

G-22: Alternative 7C Construction Cost and LCC Analysis

G-1: LCC Analysis Summary and Assumptions

JOB #:	Puna Wastewater Facility Plan	**AECOM**	
DATE:	October 8, 2023	**Construction Cost Estimate**	
LOCATION:	Puna Wastewater Facility Plan	**Conceptual Level**	
PREPARED BY:	T. Huang	**Wastewater Facility Plan Estimates**	
REVIEWED BY:	B. Stallings/A. Symonds	********************************	
		G R A N D S U M M A R Y	

Alternative No.	DESCRIPTION	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
1A	IWS for All Residential + Decentralized Treatment for Commercial/Institutions	$2,779,056,000	$865,650,000	$793,673,000	$2,808,130,000
1B	Decentralized On-Site Treament_Low Pressure Sewer	$4,051,988,000	$1,017,514,000	$1,521,153,000	$3,548,349,000
2A	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity Sewer				
	Keeau	$1,850,484,000	$42,131,000	$806,248,000	$1,086,367,000
	HPP	$3,531,484,000	$141,632,000	$1,531,293,000	$2,141,823,000
	Pahoa	$2,264,666,000	$113,668,000	$960,677,000	$1,417,657,000
	Volcano	$1,087,967,000	$31,824,000	$470,187,000	$649,604,000
	2A Total	$8,734,601,000	$329,255,000	$3,768,405,000	$5,295,451,000
2B	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity & LP Sewer				
	Keeau	$1,716,177,000	$39,044,000	$751,506,000	$1,003,715,000
	HPP	$3,083,466,000	$172,684,000	$1,332,069,000	$1,924,081,000
	Pahoa	$1,929,383,000	$122,441,000	$816,886,000	$1,234,938,000
	Volcano	$968,288,000	$27,942,000	$421,598,000	$574,632,000
	2B Total	$7,697,314,000	$362,111,000	$3,322,059,000	$4,737,366,000
2C	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Cross Country Sewer				
	Keeau	$1,819,279,000	$24,741,000	$801,981,000	$1,042,039,000
	HPP	$3,526,988,000	$121,471,000	$1,541,727,000	$2,106,732,000
	Pahoa	$2,180,037,000	$95,506,000	$933,389,000	$1,342,154,000
	Volcano	$1,033,930,000	$20,201,000	$452,683,000	$601,448,000
	2C Total	$8,560,234,000	$261,919,000	$3,729,780,000	$5,092,373,000

3A	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity Sewer				
	Keeau	$1,850,484,000	$42,131,000	$806,248,000	$1,086,367,000
	HPP (w/ Pahoa)	$6,044,418,000	$254,119,000	$2,604,111,000	$3,694,426,000
	Volcano	$1,087,967,000	$31,824,000	$470,187,000	$649,604,000
	3A Total	$8,982,869,000	$328,074,000	$3,880,546,000	$5,430,397,000
3B	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity & LP Sewer				
	Keeau	$1,716,177,000	$39,044,000	$751,506,000	$1,003,715,000
	HPP (w/ Pahoa)	$5,261,116,000	$295,484,000	$2,261,094,000	$3,295,506,000
	Volcano	$968,288,000	$27,942,000	$421,598,000	$574,632,000
	3B Total	$7,945,581,000	$362,470,000	$3,434,198,000	$4,873,853,000
3C	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Cross Country Sewer				
	Keeau	$1,819,279,000	$24,694,000	$801,981,000	$1,041,992,000
	HPP (w/ Pahoa)	$5,955,293,000	$215,569,000	$2,587,255,000	$3,583,607,000
	Volcano	$1,033,930,000	$19,980,000	$452,683,000	$601,227,000
	3C Total	$8,808,502,000	$260,243,000	$3,841,919,000	$5,226,826,000
4A	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity Sewer	$9,697,522,000	$334,922,000	$4,204,271,000	$5,828,173,000
4B	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity & LP Sewer	$8,660,234,000	$369,318,000	$3,757,922,000	$5,271,630,000
4C	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Cross Country Sewer	$9,479,359,000	$268,825,000	$4,146,001,000	$5,602,183,000
5A	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity Sewer	$10,206,042,000	$361,107,000	$4,429,763,000	$6,137,386,000
5B	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity & LP Sewer	$9,168,754,000	$395,503,000	$3,983,415,000	$5,580,842,000
5C	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Cross Country Sewer	$9,987,880,000	$291,935,000	$4,371,494,000	$5,908,321,000
6A	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity Sewer	$10,847,017,000	$409,251,000	$4,712,150,000	$6,544,118,000
6B	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity & LP Sewer	$9,810,925,000	$443,690,000	$4,266,319,000	$5,988,296,000
6C	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Cross Country Sewer	$10,628,855,000	$364,773,000	$4,653,880,000	$6,339,748,000
7A	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity Sewer	$11,546,694,000	$392,339,000	$5,023,283,000	$6,915,750,000
7B	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity & LP Sewer	$10,510,602,000	$426,778,000	$4,577,451,000	$6,359,929,000
7C	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Cross Country Sewer	$11,328,532,000	$326,241,000	$4,965,014,000	$6,689,759,000

JOB #:	Puna Wastewater Facility Plan		**AECOM**
DATE:	October 9, 2023		**Construction Cost Estimate (Excluding Lava Zones 1 and 2)**
LOCATION:	Puna Wastewater Facility Plan		**Conceptual Level**
PREPARED BY:	T. Huang		**Wastewater Facility Plan Estimates**
REVIEWED BY:	B. Stallings/A. Symonds		*********************************
			GRAND SUMMARY

Alternative No.	DESCRIPTION	Capital Cost	NPV of O&M Cost	Residual Value	Total LCC
2A	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity Sewer				
	Keeau	$1,850,484,000	$42,131,000	$806,248,000	$1,086,367,000
	HPP	$3,531,484,000	$141,632,000	$1,531,293,000	$2,141,823,000
	Volcano	$1,087,967,000	$31,824,000	$470,187,000	$649,604,000
	2A Total	$6,469,935,000	$215,587,000	$2,807,728,000	$3,877,794,000
2B	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity & LP Sewer				
	Keeau	$1,716,177,000	$39,044,000	$751,506,000	$1,003,715,000
	HPP	$3,083,466,000	$172,684,000	$1,332,069,000	$1,924,081,000
	Volcano	$968,288,000	$27,942,000	$421,598,000	$574,632,000
	2B Total	$5,767,931,000	$239,670,000	$2,505,173,000	$3,502,428,000
2C	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Cross Country Sewer				
	Keeau	$1,819,279,000	$24,741,000	$801,981,000	$1,042,039,000
	HPP	$3,526,988,000	$121,471,000	$1,541,727,000	$2,106,732,000
	Volcano	$1,033,930,000	$20,201,000	$452,683,000	$601,448,000
	2C Total	$6,380,197,000	$166,413,000	$2,796,391,000	$3,750,219,000

3A	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity Sewer				
	Keeau	$1,850,484,000	$42,131,000	$806,248,000	$1,086,367,000
	HPP	$3,531,484,000	$141,632,000	$1,531,293,000	$2,141,823,000
	Volcano	$1,087,967,000	$31,824,000	$470,187,000	$649,604,000
	3A Total	$6,469,935,000	$215,587,000	$2,807,728,000	$3,877,794,000
3B	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity & LP Sewer				
	Keeau	$1,716,177,000	$39,044,000	$751,506,000	$1,003,715,000
	HPP	$3,083,466,000	$172,684,000	$1,332,069,000	$1,924,081,000
	Volcano	$968,288,000	$27,942,000	$421,598,000	$574,632,000
	3B Total	$5,767,931,000	$239,670,000	$2,505,173,000	$3,502,428,000
3C	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Cross Country Sewer				
	Keeau	$1,819,279,000	$24,694,000	$801,981,000	$1,041,992,000
	HPP	$3,526,988,000	$121,471,000	$1,541,727,000	$2,106,732,000
	Volcano	$1,033,930,000	$19,980,000	$452,683,000	$601,227,000
	3C Total	$6,380,197,000	$166,145,000	$2,796,391,000	$3,749,951,000
4A	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity Sewer	$7,333,958,000	$228,317,000	$3,195,359,000	$4,366,916,000
4B	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity & LP Sewer	$6,631,954,000	$252,400,000	$2,892,803,000	$3,991,551,000
4C	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Cross Country Sewer	$7,244,221,000	$180,478,000	$3,184,020,000	$4,240,679,000
5A	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity Sewer	$7,818,980,000	$247,554,000	$3,410,281,000	$4,656,253,000
5B	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity & LP Sewer	$7,379,442,000	$375,622,000	$3,192,230,000	$4,562,834,000
5C	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Cross Country Sewer	$7,729,243,000	$200,532,000	$3,398,942,000	$4,530,833,000
6A	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity Sewer	$8,378,535,000	$256,830,000	$3,656,033,000	$4,979,332,000
6B	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity & LP Sewer	$7,677,726,000	$280,957,000	$3,353,994,000	$4,604,689,000
6C	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Cross Country Sewer	$8,288,798,000	$208,991,000	$3,644,695,000	$4,853,094,000
7A	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity Sewer	$9,005,485,000	$286,631,000	$3,934,444,000	$5,357,672,000
7B	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity & LP Sewer	$8,304,675,000	$310,757,000	$3,632,404,000	$4,983,028,000
7C	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Cross Country Sewer	$8,915,747,000	$238,791,000	$3,923,105,000	$5,231,433,000

Capital Cost Percentage for Different Type of WW Infrastructures

Alternative No.	DESCRIPTION	Capital Cost	Capital Cost %		
			Piping	PS	WWTP
1A	IWS for All Residential + Decentralized Treatment for Commercial/Institutions	$2,779,056,000	**0%**	**0%**	**100%**
1B	Decentralized On-Site Treament_Low Pressure Sewer	$4,051,988,000	**77.5%**	**0.0%**	**22.5%**
2A	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity Sewer	$8,734,601,000	**88.6%**	**9.8%**	**1.6%**
2B	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Gravity & LP Sewer	$7,697,314,000	**90.7%**	**7.5%**	**1.8%**
2C	Subregional Plants (6 mgd) - 4 plants - Urban Sewering_Cross Country Sewer	$8,560,234,000	**91.8%**	**6.6%**	**1.6%**
3A	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity Sewer	$8,982,869,000	**88.9%**	**9.6%**	**1.5%**
3B	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Gravity & LP Sewer	$7,945,581,000	**91.0%**	**7.3%**	**1.7%**
3C	Subregional Plants (6 mgd) - 3 plants - Urban Sewering_Cross Country Sewer	$8,808,502,000	**92.1%**	**6.4%**	**1.5%**
4A	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity Sewer	$9,697,522,000	**90.0%**	**9.0%**	**1.1%**
4B	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Gravity & LP Sewer	$8,660,234,000	**92.0%**	**6.8%**	**1.2%**
4C	Regional Plants (6 mgd) - 1 plant - Urban Sewering_Cross Country Sewer	$9,479,359,000	**92.9%**	**6.0%**	**1.1%**
5A	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity Sewer	$10,206,042,000	**90.2%**	**8.5%**	**1.3%**
5B	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Gravity & LP Sewer	$9,168,754,000	**92.1%**	**6.4%**	**1.4%**
5C	Regional Plants (8.5 mgd) - 1 plant - Full Flow_Cross Country Sewer	$9,987,880,000	**93.0%**	**5.7%**	**1.3%**
6A	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity Sewer	$10,847,017,000	**90.4%**	**8.3%**	**1.3%**
6B	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Gravity & LP Sewer	$9,810,925,000	**92.2%**	**6.3%**	**1.5%**
6C	Flow to Hilo WWTP (11 mgd) - Urban Sewering_Cross Country Sewer	$10,628,855,000	**93.0%**	**5.7%**	**1.4%**
7A	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity Sewer	$11,546,694,000	**90.7%**	**7.8%**	**1.5%**
7B	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Gravity & LP Sewer	$10,510,602,000	**92.5%**	**5.9%**	**1.7%**
7C	Flow to Hilo WWTP (13.5 mgd) - Full Flow_Cross Country Sewer	$11,328,532,000	**93.1%**	**5.3%**	**1.5%**

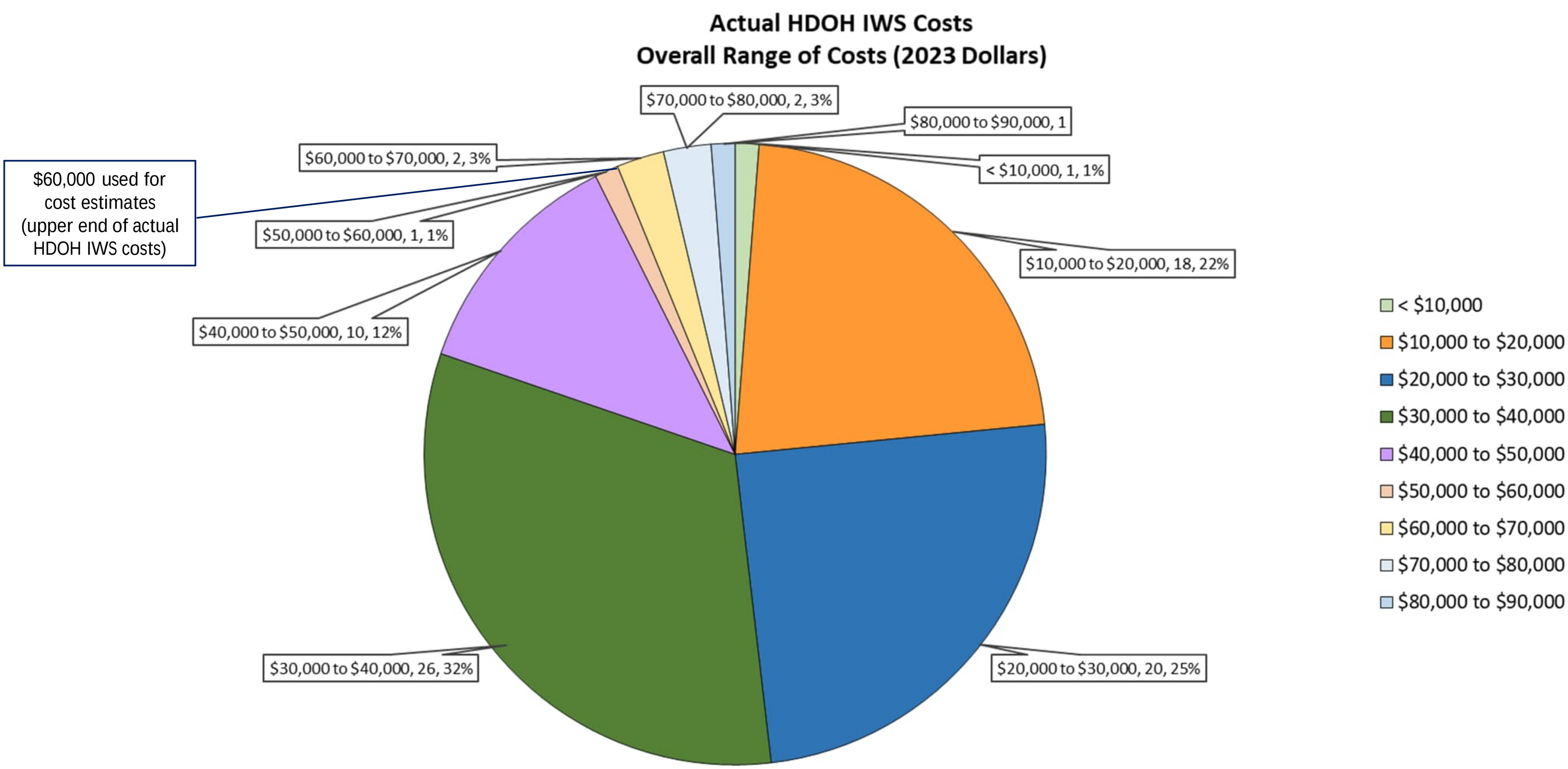
Life-Cycle Cost Assumptions

Item	*Criteria*	*Notes*	
Cash Flow Assumptions			
Economic Base Year	2022		
Analysis Period	30	years	
Discount Interest Rate (Nominal)	3.11%	10 year average of Nominal Treasury Interest Rates for Different Maturities (30 years)	
Escalation rate (Nominal)	3.37%	10 year average of ENR construciton cost index	
Effective Interest Rate (Real)	-0.26%	Calculated from discount interest rate (nominal) and escalation rate (nominal)	
Planning cycle	30	years	
Residual Value			
Residual Value at End of Design Life	0		
Percentage of Capital Cost			
Piping, Valves, etc	20%	Percentage of capital cost	
Electrical and Motorized Equipment	30%	Percentage of capital cost	
Hydraulic Structures and Buildings	50%	Percentage of capital cost	
Design Life			
Gravity Sewers/New Force Mains	75	years	
Electrical and Motorized Equipment	20	years	
Hydraulic Structures and Buildings & Piping, valves	50	years	
Septic Tank/Leach Field	50	years	

O&M Cost Assumptions

Item	*Unit Cost*	*Unit*	*Notes*
Sewer Inspection - CCTV	$ 14.00	per FT	every 10 years
Sewer Cleaning	$ 7.00	per FT	every 20 years
Force Main Assessment	$ 70.00	per LF	every 20 years
Linear asset labor	$ 0.70	Hr/ Day	
Average Electrical rate	$ 0.44	per kWh	
GST inspection	$ 70.00	per LF	2 years after construction and every 10 years thereafter
GST cleaning	$ 70.00	per LF	every 20 years

G-2: Pipe, IWS, and WWTP Unit Costs


Actual HDOH IWS Costs
Overall Range of Costs (2023 Dollars)
$70,000 to $80,000, 2, 3%
$80,000 to $90,000, 1
$60,000 to $70,000, 2, 3%
< $10,000, 1, 1%
$60,000 used for cost estimates (upper end of actual HDOH IWS costs)
$50,000 to $60,000, 1, 1%
$10,000 to $20,000, 18, 22%
$40,000 to $50,000, 10, 12%
$30,000 to $40,000, 26, 32%
$20,000 to $30,000, 20, 25%
< $10,000
$10,000 to $20,000
$20,000 to $30,000
$30,000 to $40,000
$40,000 to $50,000
$50,000 to $60,000
$60,000 to $70,000
$70,000 to $80,000
$80,000 to $90,000

Basis of Pipe Unit Cost

Project	Bid Date	Size, in	Length, ft	Low Bid	High Bid	Average Bid	Cost Per Foot	Ratio of Avg. bid to Low Bid	Escalation Factor	Escalated Cost/ft	Cost/ft used, rounded	Average Size, inch
CCH Aala Drive WWPS Force Main	September 30 2019	8	612	$2,170,000	$7,300,000	$4,500,000	$7,353	2.07	1.12	$8,235		
CCH Ahuimanu Pre-Treatment FM	April 6 2017	16 to 24	3657	$7,700,000	$9,570,000	$8,800,000	$2,406	1.14	1.22	$2,936		
CCH Dowsett - Nuuanu	**February 28 2018**	**8 to 24**	**6575**	**$21,260,000**	**$44,300,000**	**$32,600,000**	**$4,958**	**1.53**	**1.17**	$5,801	**$5,800**	**16**
CCH Dowsett - Pali Hwy	March 2 2018	12 to 18	9763	$41,560,000	$52,850,000	$48,200,000	$4,937	1.16	1.17	$5,776		
CCH Kahanahou WWPS FM	April 13 2017	12 to 24	4733	$14,700,000	$21,800,000	$18,400,000	$3,888	1.25	1.22	$4,743		
COH DWS Paukaa	**January 12 2017**	**6**	**680**	**$318,350**	**$653,500**	**$492,390**	**$724**	**1.55**	**1.25**	$905	**$900**	**6**
COH DWS Paukaa	June 16 2016	6	2956	$648,555	$1,168,560	$926,706	$314	1.43	1.28	$401		
COH Lono Kona	**January 29 2018**	**8**	**6744**	**$7,728,427**	**$10,726,943**	**$9,009,168**	**$1,336**	**1.17**	**1.21**	**$1,617**	**$1,600**	**8**
COH Lanihau FM	April 9 2020	8	677	$990,700	$2,403,424	$1,611,473	$2,380	1.63	1.08	$2,571		
COH Kaloko Heights	2021	8 to 12	12115	$8,753,520	Unknown	$10,204,137	$842	1.17	1.09	$918		
COH Lono Kona Rebid	March 29 2018	8	6386	$8,522,630	Unknown	$9,934,984	$1,556	1.17	1.20	$1,867		

Summary of Estimated Construction Cost Per Foot*

Gravity Sewer		Force Main		LPS	
Size, inch	Unit Cost	Size, inch	Unit Cost	Size, inch	Unit Cost
8	$1,600	4	$600	2	$300
12	$3,700	6	$900	3	$450
16	$5,800	8	$1,600	4	$600
18	$6,525	10	$2,650		
24	$8,700	12	$3,700		
30	$10,875	14	$4,750		
36	$13,050	16	$5,800		
42	$15,200	18	$6,525		
48	$17,400	24	$8,700		
54	$19,500	30	$10,875		
		36	$13,050		
		42	$15,200		
		48	$17,400		

Notes:
* for the project.
Cost estimates for pipes with 2-inch to 14-inch diameter are based on COH projects and already account for an Island of Hawai'i factor.

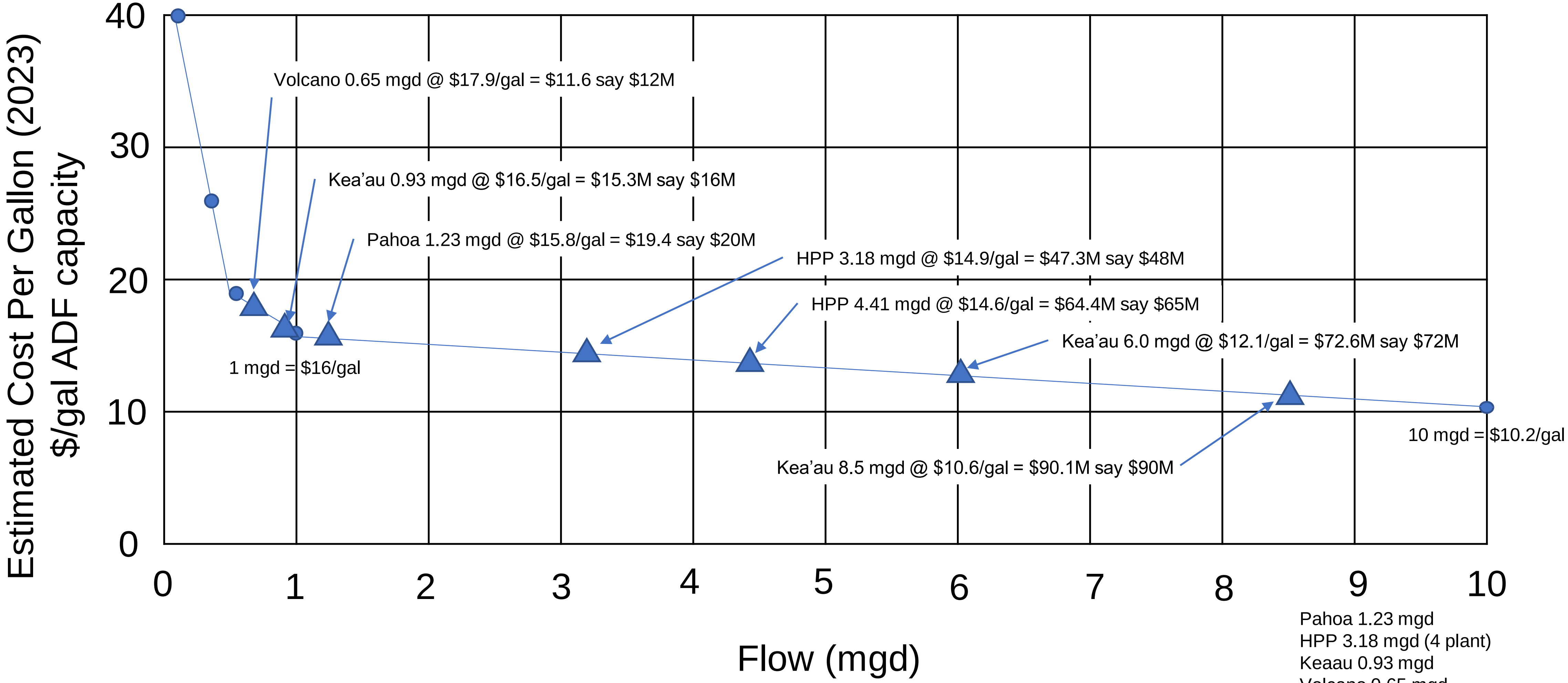
Pahoa 1.23 mgd
HPP 3.18 mgd (4 plant)
Keaau 0.93 mgd
Volcano 0.65 mgd
HPP 4.41 mgd (3 plant).
Keaau 6.0 mgd (1 plant)
Keaau 8.5 mgd (1 plant full flow)

4 plant	
Pahoa	$20M
HPP	$48M
Keaau	$16M
Volcano	$12M
Total	**$96M**

3 plant	
HPP	$65M
Keaau	$16M
Volcano	$12M
Total	**$93M**

1 plant (6 mgd)	
Keaau	$72M
Total	**$72M**

1 plant (8.5 mgd)	
Keaau	$90M
Total	**$90M**



Pahoa 1.23 mgd
HPP 3.18 mgd (4 plant)
Keaau 0.93 mgd
Volcano 0.65 mgd
HPP 4.41 mgd (3 plant).
Keaau 6.0 mgd (1 plant)
Keaau 8.5 mgd (1 plant full flow)

5 Alternatives Analysis

5.1 Estimated Capital Cost

A summary of the opinion of probable construction cost (cost estimate) for the Waimea WWTP Upgrade and Expansion is outlined in this report. The cost estimates are based on unit pricing from recent local Hawaii wastewater pumping and treatment projects, and local vendor quotes for major process equipment. The cost estimate is in current September 2016 dollars. ($ENR_{20\ Cities}$ Index = 10,132). The following allowances are included in the estimate to cover the contractor's general office expenses:

- Mobilization at 5 percent of the raw construction cost.
- General Contractor's home office overhead and profit at 10 percent of the total estimated construction cost.
- Sales tax at 4.166 percent of the estimated materials cost.
- Vehicle/auto insurance at 0.5 percent of the raw construction cost, builder's risk insurance at 1.0 percent of the raw construction cost and general liability insurance at 1.5 percent of the raw construction cost (3.0 percent total allowance).
- Bond costs for the payment and performance bonds at 2.0 percent of the raw construction cost.
- Miscellaneous home office expenses at approximately 1 percent of the raw construction cost.

The preliminary construction cost estimate for the Waimea WWTP Upgrade and Expansion for the three biological treatment alternatives is shown **Table 5-1**.

Table 5-1: Waimea WWTP Upgrade and Expansion Estimated Construction Cost

Description	Estimated Cost PHASE 1 and 2			Estimated Cost PHASE 3		
	Extended Air AS	SBR	Aerated Lagoon	Extended Air AS	SBR	Aerated Lagoon
Division 0 - General Conditions	1,323,443	1,167,269	1,588,277	602,921	484,354	1,105,507
Division 1 - Contractor Field Office	322,640	322,640	322,640	244,480	244,480	244,480
Division 2 - Sitework	508,350	157,100	1,438,500	384,500	78,000	1,156,300
Division 3 - Concrete	1,505,500	1,670,500	198,000	532,000	603,400	60,000
Division 4 - Masonry	50,400	50,400	50,400	0	0	0
Division 5 - Metals	30,300	75,600	12,000	6,300	28,800	0
Division 6 - Wood and Plastics	64,200	1,200	476,000	157,500	94,500	476,000
Division 7 - Roofing & Insulation	23,100	23,100	23,100	0	0	0
Division 8 - Doors &Windows	7,800	7,800	7,800	0	0	0
Division 9 - Finishes	117,000	126,000	6,000	34,500	81,000	6,000
Division 10 - Specialties	1,200	1,200	300	300	300	300
Division 11 - Equipment	2,033,750	1,627,500	2,090,000	857,500	537,500	1,582,000
Division 12 - Furnishings	1,650	1,650	1,650	0	0	0
Division 13 - Special Construction	0	0	0	0	0	0
Division 14 - Conveying Systems	18,000	27,000	9,000	0	9,000	0
Division 15 - Mechanical	391,000	340,040	571,000	215,000	215,000	371,450
Division 16 - Electrical	510,000	485,000	1,466,000	125,000	120,000	833,630
Division 17 - Instrumentation	175,000	166,000	156,000	90,000	87,000	81,000

Description	Estimated Cost PHASE 1 and 2			Estimated Cost PHASE 3		
	Extended Air AS	SBR	Aerated Lagoon	Extended Air AS	SBR	Aerated Lagoon
Subtotal of Divisions 1 to 17	$5,759,890	$5,082,731	$ 6,828,390	$2,647,079	$2,098,980	$4,811,160
Division 0	$1,323,443	$1,167,269	$1,588,277	$602,921	$484,354	$1,105,507
Subtotal of Divisions 0 to 17	$7,083,333	$6,250,000	$8,416,667	$3,250,000	$2,583,334	$5,916,667
20 percent Contingency	$1,416,667	$1,250,000	$1,683,333	$650,000	$516,667	$1,183,333
Total Estimated Construction Cost	**$8,500,000**	**$7,500,000**	**$10,100,000**	**$3,900,000**	**$3,100,000**	**$7,100,000**

5.2 Estimated O&M Costs

This section reviews projected operation and maintenance costs for various biological treatment and solids handling system improvements. Annual Operation and Maintenance (O&M) Cost Estimates are costs associated with the annual operation and maintenance of the asset and do not include costs associated with replacement of equipment or structures that are at the end of their service life. Annual O&M Cost Estimates are derived from estimated electrical usage, labor, chemical usage, and allowances for miscellaneous utility usage such as water, gas, fuel, and oil. Allowances for the cost of sampling and analysis are also included. The general assumptions used in this report for local Hawaii annual O&M cost estimates include:

- Energy rates of $0.28/kilowatt-hour using estimated motor horsepower sizes provided by the manufacturer, and the operating times of the “duty” equipment. The “redundant” or standby equipment is not included in the estimated energy costs.
- Labor rates of $40/hour including fringe benefits using person-hour requirements based on other similar size operating systems (or facilities).
- Concentrated polymer cost of $7.00 per gallon, and approximately 4 lbs of active polymer per gallon of concentrated polymer solution.
- Combined biosolids processing, transport and tipping fee of $90 per wet ton.
- An average interest rate of approximately 3 percent over a twenty year period is used to amortize the value of the estimated construction cost of each alternative.
- Residual or salvage value is not included in these comparative cost evaluations since most items have a typical service life of twenty years or more which is the time period used for the life cycle cost comparisons.

The following are the typical service life for each major component of well-maintained wastewater systems:

- Reinforced concrete or masonry structures: 50 or more years.
- Concrete or iron piping: 50 or more years
- Iron valves: 20 or more years
- Mechanical and electrical equipment inside buildings: 20 or more years
- Immersed equipment: 15 or more years
- Exposed plastics (piping, valves, liners etc.): Less than 15 years

The annual O&M cost estimates for each alternative are based on current 2016 dollars using the 1 mgd Phase 3 design flow as the basis of the estimate for the purpose of comparing alternatives. Actual operating costs should be lower during initial operation at lower influent flows and loads.

The preliminary annual cost evaluation for the solids handling improvement alternatives related to the Waimea WWTP Upgrade and Expansion is shown **Table 5-2**.

$12.4M + $10.6M + $17.2M / 3 = $13.4M Avg
$13.4 x 13200 /10,132 ENR Index 2016 to 2023 = $17.46M
$17.46M / 1.2 contingency = $14.6M x 1.1 area adjustment = $16/gal for 1 mgd w/o contingency

Table 5-2: Waimea WWTP Upgrade and Expansion Solids Handling Annual Cost Evaluation

Description	Solids Handling Alternative				
	Solar Drying	Screw Press	Rotary Press	Belt Press	Centrifuge
Estimated Construction Cost					
Sitework	$175,000	$15,000	$15,000	$15,000	$15,000
Reinforced Concrete	$725,000	$30,000	$30,000	$60,000	$30,000
Dewatering System	$0	$300,000	$320,000	$225,000	$360,000
Polymer Feed System	$0	$22,000	$22,000	$22,000	$22,000
Electrical	$0	$36,000	$38,000	$27,000	$43,000
Instrumentation	$0	$24,000	$26,000	$18,000	$29,000
Total Estimated Construction Cost	**$900,000**	**$427,000**	**$451,000**	**$367,000**	**$499,000**
Estimated Annual O&M Cost – Phase 3 Flows					
Labor	$10,400	$50,000	$50,000	$50,000	$50,000
Rental Equipment	$11,600	$0	$0	$0	$0
Power	$0	$500	$1,400	$1,300	$6,500
Chemicals	$0	$9,500	$9,600	$7,700	$11,500
Solids Disposal	$124,000	$109,000	$109,000	$116,000	$98,000
Total Estimated Annual O&M Cost	**$146,000**	**$169,000**	**$170,000**	**$175,000**	**$166,000**
Total Annual Cost					
Amortized Construction Cost (3% Interest, 20 years)	$60,000	$29,000	$30,000	$25,000	$34,000
Estimated Annual O&M Cost	$146,000	$169,000	$170,000	$175,000	$166,000
Total Estimated Annual Cost	**$206,000**	**$198,000**	**$200,000**	**$200,000**	**$200,000**

Based on the review of solids handling alternatives the screw press dewatering system has the lowest estimated annual cost and would be used as the basis of the capital cost estimates and comparison of biological treatment alternatives.

The preliminary annual cost evaluation for the biological treatment alternatives related to the Waimea WWTP Upgrade and Expansion is shown **Table 5-3**.

Table 5-3: Waimea WWTP Upgrade and Expansion Biological Treatment Annual Cost Evaluation

Description	Biological Treatment Alternative		
	Extended Air AS	SBR	Aerated Lagoon
Estimated Construction Cost			
Estimated Construction Cost Phase 1	$8,500,000	$7,500,000	$10,100,000
Estimated Construction Cost Phase 2	$3,900,000	$3,100,000	$7,100,000
Total Estimated Construction Cost	**$12,400,000**	**$10,600,000**	**$17,200,000**
Estimated Annual O&M Cost – Phase 3 Flows			
Labor	$208,000	$208,000	$166,000
Rental Equipment	$0	$0	$18,000
Power	$171,000	$167,000	$274,000
Chemicals	$0	$0	$0
Replacement Parts	$23,000	$18,000	$29,000
Solids Disposal	$169,000	$169,000	$57,000
Total Estimated Annual O&M Cost	**$571,000**	**$562,000**	**$544,000**
Total Annual Cost			

Amortized Construction Cost (3% Interest, 20 years)	$834,000	$713,000	$1,156,000
Estimated Annual O&M Cost	$571,000	$562,000	$544,000
Total Estimated Annual Cost	**$1,405,000**	**$1,275,000**	**$1,700,000**

Based on the review of biological treatment alternatives the SBR biological treatment system has the lowest estimated annual cost.

5.3 Other Technical Considerations

The following "other technical considerations" were identified. These other technical considerations would be reviewed to compare the various biological treatment alternatives for the Waimea WWTP upgrade and expansion. The comparison helps to differentiate between the three treatment alternatives. The following considerations and technical criteria are considered in the ranking of each biological treatment alternative:

- Site utilization and layout efficiency
- Constructability
- Energy efficiency
- Operability
- Maintainability
- Security
- Biosolids treatment and disposal
- Odor and vector control
- Hawaii HB 2030 adaptability
- Future ability to produce R2 or R1 effluent
- Implementation schedule

A relatively simple multi-criteria rating system has been prepared to evaluate the alternatives and assist with the selection of a preferred treatment alternative. The rating system allows the comparison of each alternative. The following rating scale is used:

- A plus "+" sign means the alternative is better than the others.
- A minus "-" sign means the Alternative is worse than the others.
- A zero "0" sign means the Alternatives are all equal.

It is possible to add additional numerical ratings to weight the importance of each evaluation criteria. **Table 5-4** shows a summary of the multi-criteria ratings for the three alternatives.

Table 5-4: Evaluation of Biological Treatment Alternatives

Criteria	Treatment Alternative			Discussion
	Extended Aeration AS	SBR	Aerated Lagoon	
Site utilization & layout efficiency	-	+	-	SBR has smallest footprint
Constructability	-	+	-	SBR requires minimal excavation
Energy efficiency	+	+	-	SBR and AS have the lowest equipment horsepower
Operability	-	-	+	Lagoon requires minimal operator intervention
Maintainability	-	+	-	SBR has least amount of equipment
Security	-	+	-	SBR has most compact layout to secure
Biosolids treatment and disposal	-	-	+	Lagoon aerobically digests solids
Odor and vector control	-	+	-	SBR footprint is small and easy to cover
Hawaii HB 2030 adaptability	+	+	-	Waste solids could be used to produce biogas

G-3: Alternative 1A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 1A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
IWS + Decentralized Treatment							
	Homeowner: IWS, incl. septic tank & leach field with new soil	30,625	EA			60,000	$1,837,500,000
	Cluster treatment plant (15,000 - 50,000 gpd) for commercial and schools, assuming avg. 25,000 gpd.	22	EA			4,200,000	$92,400,000
	Subtotal of Estimated Construction Cost						**$1,929,900,000**
	Contingency	20%					$385,980,000
	Total Estimated Project Cost						**$2,315,880,000**
	Project services	20%					$463,176,000
	TOTAL CAPITAL COST						**2,779,056,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	151211	kWH	$ 0.44	$66,533
	Labor and Materials	$ 27,584,500	LS	-	$27,584,500
Annual O&M					**$27,651,033**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 28,584,063		$28,584,063	
2		$ 29,548,576		$29,548,576	
3		$ 30,545,634		$30,545,634	
4		$ 31,576,336		$31,576,336	
5		$ 32,641,818		$32,641,818	
6		$ 33,743,252		$33,743,252	
7		$ 34,881,851		$34,881,851	
8		$ 36,058,870		$36,058,870	
9		$ 37,275,606		$37,275,606	
10		$ 38,533,398		$38,533,398	
11		$ 39,833,632		$39,833,632	
12		$ 41,177,739		$41,177,739	
13		$ 42,567,201		$42,567,201	
14		$ 44,003,547		$44,003,547	
15		$ 45,488,360		$45,488,360	
16		$ 47,023,275		$47,023,275	
17		$ 48,609,983		$48,609,983	
18		$ 50,250,231		$50,250,231	
19		$ 51,945,826		$51,945,826	
20		$ 53,698,636		$53,698,636	
21		$ 55,510,591	$ 55,649,045	$111,159,636	replace elec./ motorized equipment
22		$ 57,383,686		$57,383,686	
23		$ 59,319,986		$59,319,986	
24		$ 61,321,622		$61,321,622	
25		$ 63,390,799		$63,390,799	
26		$ 65,529,797		$65,529,797	
27		$ 67,740,971		$67,740,971	
28		$ 70,026,757		$70,026,757	
29		$ 72,389,672		$72,389,672	
30		$ 74,832,319		$74,832,319	
		Present value of O&M		**$865,650,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Septic Tank and Leach Field	
Present Cost	$ 27,720,000	$ 64,680,000	$ 1,837,500,000	
Design Life (Years)	20	50	50	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	20	
Present Value of Residual Value	**$14,966,000**	**$27,937,000**	**$793,673,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **2,808,130,000**

IWS Unit Cost Estimation - Alternative 1A

Kapoho	2009 cost	2023 cost
Septic Tank/Leach Field	$ 16,000.00	$ 25,000
Septic Tank/Mound System	$ 32,000.00	$ 50,000
Carollo	2020 cost	2023 cost
IWS Low	$ 9,000.00	$ 11,000
IWS High	$ 60,000.00	$ 70,000
IWS Average	$ 23,000.00	$ 27,000
Puna		**2023 cost**
IWS		**$ 60,000**

Note: Puna IWS will be in the range of $50,000 (Kapoho) and $69,000 (High DOH IWS Cost).
Take average, roughly $60,000

Puna IWS Quantity - Alternative 1A

Year		Quantity
Total Current Cesspool (2022)		16000
Total Current OSDS (2022)		19620
Growth Factor (2052 pop/2020 pop)		1.56
Total Future OSDS (2052)		30607
Use total future TMK for cost estimate		**30625**

Cluster Package Plant Unit Cost - Alternative 1A

Ref. 1: Kapoho	2009 cost	2023 cost
Cluster plant (0.33 mgd)	$ 1,000,000	$ 1,551,000
SBR+injection well, included 15% contingency and 15 project service		
Ref. 2: Puna Kai Shopping Center WWTP	2020 cost	2023 cost
design 0.02 mgd	$ 1,600,000	$ 1,854,000
Trickling filter/constured wetland, including. site collection and disposal		
Ref. 3: Ulu Wini package plant proposal	2022 cost	2023 cost
Design flow 320,000 gpd	$ 5,247,000	$ 5,360,000
Ref. 4: 250,000 gpd package plant, Alt. 1B		2023 cost
Design flow 250,000 gpd		$ 12,000,000
Puna (based on Ref 3 to be conservative & ref 4)		**2023 cost**
Cluster package plant (0.015 mgd)		**$ 2,500,000**
Cluster package plant (0.025 mgd)		**$ 4,200,000**
Cluster package plant (0.050 mgd)		**$ 5,900,000**
Cluster Package Plant quantity		
current	14	
growth factor	1.56	
future	**22**	

Cluster Package Plant O&M - Alternative 1A

O&M Cost				
Kapoho	Labor	Electricity	Maintenance	Total
Septic/Mound System (2009)	310	30	200	$ 540
Septic/Mound System (2023)	490	50	320	$ 860
Septic/Leach Field (2009)	240		130	$ 370
Septic/Leach Field (2023)	380		210	$ 590
O&M Cost				
Puna				
IWS, including septic/Leach field with new soil or mound system, use				$ 900
Number of IWS units				$ 30,625
Total				**$ 27,562,500**

Note: drain field last 20 to 50 years, when well designed and maintained, can last 50 years.
Added some Maintenance cost and assume 50 years life.

Annual Power Estimation - Alternative 1A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS (NA)		Regional PS (NA)		WWTP	
				0.025	mgd, wwtp
				17	gpm
				60	ft
				0.75	efficiency
				0.35	hp
				0.26	kw
				22	ea
				5.75	kw,
				50,404	pumping kwh annual
				100,808	other kwh annual, approx 2x pumping
total power	151211	kwh annual			

Labor and Material Estimation - Alternative 1A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,250	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 10,990	0.55	mgd, total flow
Puna Use	**$ 22,000**		Assume 2x due to extra cost for small plant

G-4: Alternative 1B Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
Alternative 1B Full Flow Decentralized Treatment Low Pressure Sewer							
	In-Street Low Pressure (2")	1,270,000	LF			$ 300	$381,000,000
	In-Street Low Pressure (3")	1,270,000	LF			$ 450	$571,500,000
	In-Street Low Pressure (4")	635,000	LF			$ 600	$381,000,000
	Low pressure sewer (On-Lot)	30,625	EA			$ 26,000	$796,250,000
	Neighborhood On-Site treatment plant, 15,000 gpd	8	EA			$ 2,500,000	$20,000,000
	Neighborhood On-Site treatment plant, 25,000 gpd	7	EA			$ 4,200,000	$29,400,000
	Neighborhood On-Site treatment plant, 50,000 gpd	11	EA			$ 5,900,000	$64,900,000
	Neighborhood On-Site treatment plant, 75,000 gpd	18	EA			$ 6,700,000	$120,600,000
	Neighborhood On-Site treatment plant, 100,000 gpd	11	EA			$ 7,400,000	$81,400,000
	Neighborhood On-Site treatment plant, 120,000 gpd	1	EA			$ 8,000,000	$8,000,000
	Neighborhood On-Site treatment plant, 130,000 gpd	1	EA			$ 8,300,000	$8,300,000
	Neighborhood On-Site treatment plant, 150,000 gpd	8	EA			$ 9,000,000	$72,000,000
	Neighborhood On-Site treatment plant, 200,000 gpd	9	EA			$ 10,500,000	$94,500,000
	Neighborhood On-Site treatment plant, 250,000 gpd	10	EA			$ 12,000,000	$120,000,000
	Subtotal of Estimated Construction Cost						**$2,748,850,000**
	Right of Way	3,252	Ac			$ 20,000	$65,030,376
	Contingency	20%					$562,776,075
	Total Estimated Project Cost						**$3,376,656,452**
	Project services	20%					$675,331,290
	TOTAL CAPITAL COST						**4,051,988,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	2336903	kWH	$ 0.44	$1,028,237
	Labor and Materials	$ 18,224,250	LS	-	$18,224,250

Annual O&M **$19,252,487**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 19,902,125		$19,902,125	
2		$ 20,573,683		$20,573,683	
3		$ 21,267,901		$21,267,901	
4		$ 21,985,545		$21,985,545	
5		$ 22,727,403		$22,727,403	
6		$ 23,494,295		$23,494,295	
7		$ 24,287,064		$24,287,064	
8		$ 25,106,583		$25,106,583	
9		$ 25,953,755		$25,953,755	
10		$ 26,829,513		$26,829,513	
11		$ 27,734,822		$27,734,822	
12		$ 28,670,679		$28,670,679	
13		$ 29,638,115		$29,638,115	
14		$ 30,638,195		$30,638,195	
15		$ 31,672,020		$31,672,020	
16		$ 32,740,730		$32,740,730	
17		$ 33,845,502		$33,845,502	
18		$ 34,987,552		$34,987,552	
19		$ 36,168,138		$36,168,138	
20		$ 37,388,560		$37,388,560	
21		$ 38,650,164	$ 852,412,074	$891,062,238	replace elec./ motorized equipment
22		$ 39,954,337		$39,954,337	
23		$ 41,302,518		$41,302,518	
24		$ 42,696,190		$42,696,190	
25		$ 44,136,889		$44,136,889	
26		$ 45,626,201		$45,626,201	
27		$ 47,165,767		$47,165,767	
28		$ 48,757,283		$48,757,283	
29		$ 50,402,502		$50,402,502	
30		$ 52,103,235		$52,103,235	
		Present value of O&M		**$1,017,514,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 424,605,000	$ 990,745,000	$ 1,333,500,000	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$229,250,000**	**$427,933,000**	**$863,970,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **3,548,349,000**

Easement Area Estimation - Alternative 1B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	3175000	40	127000000	2916
Regional PS				
Neighborhood PS				
WWTP				336
Total				3252

Quantity and Unit Cost for Puna Cluster Package Plant - Alternative 1B

	# of plant	Flow, mgd	total flow, gpd	unit Cost
	8	15,000	120,000	$ 2,500,000
	7	25,000	175,000	$ 4,200,000
MBR package plant (Ulu Wini), see Alt. 1A		32,000		$ 5,360,000
	11	50,000	550,000	$ 5,900,000
	18	75,000	1,350,000	$ 6,700,000
	11	100,000	1,100,000	$ 7,400,000
	1	120,000	120,000	$ 8,000,000
	1	130,000	130,000	$ 8,300,000
	8	150,000	1,200,000	$ 9,000,000
	9	200,000	1,800,000	$ 10,500,000
	10	250,000	2,500,000	$ 12,000,000
Total	**84**		**9,045,000**	

Note:

1. A total of 84 package plants with capacities ranging between 15,000 gpd and 250,000 gpd.
2. 0.25 mgd is commonly the highest flow for a package plant
   (EPA Fact Sheet - Package Plants, 2020, and Metcalf and Eddy, 1991).
3. Total flow of the 84 package plants is 9.0 mgd, which can handle the total flow of 8.5 mgd.

Length of LPS - Alternative 1B

Urban Sewering Total LPS, ft	2,241,463	percentage
LPS, 2"	897,000	40%
LPS, 3"	897,000	40%
LPS, 4"	448,000	20%
Full Flow Total LPS (ratio 8.5/6), ft	3,175,000	percentage
LPS, 2"	1,270,000	40%
LPS, 3"	1,270,000	40%
LPS, 4"	635,000	20%

Puna IWS Quantity - Alternative 1A

Year		Quantity
Total Current Cesspool (2022)		16000
Total Current OSDS (2022)		19620
Growth Factor (2052 pop/2020 pop)		1.56
Total Future OSDS (2052)		30607
Use total future TMK for cost estimate		**30625**

Annual Power Estimation - Alternative 1B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS (NA)		Regional PS (NA)		WWTP	
				8.5	mgd, wwtp
				5,903	gpm
				60	ft
				0.75	efficiency
				119.25	hp
				88.92	kw
				1	LS
				88.92	kw,
				778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
total power	2,336,903	kwh annual			

Labor and Material Estimation - Alternative 1B

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ 169,869	8.5	mgd, total flow
Puna Use		**$ 340,000**		Assume 2x due to extra cost for multiple small plants

G-5: Alternative 2A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Gravity Sewer							
	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	111,912	LF			$ 3,700	$ 414,073,873
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	14,973	LF			$ 8,700	$ 130,261,902
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	57	EA			$ 7,000,000	$ 399,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP (6 mgd total)	4	LS			NA	$ 96,000,000
	Subtotal of Estimated Construction Cost						**$ 6,011,023,266**
	Right of Way	2,734	Ac			$ 20,000	$ 54,671,931
	Contingency	20%					$ 1,213,139,039
	Total Estimated Project Cost						**$ 7,278,834,236**
	Project services	20%					$ 1,455,766,847
	TOTAL CAPITAL COST						**8,734,601,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5331748	kWH	$ 0.44	$2,345,969
	Labor and Materials	$ 1,034,488	LS	-	$1,034,488
Annual O&M					**$3,380,457**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,494,523		$3,494,523	
2		$ 3,612,439		$3,612,439	
3		$ 3,734,334		$3,734,334	
4		$ 3,860,342		$3,860,342	
5		$ 3,990,601		$3,990,601	
6		$ 4,125,256		$4,125,256	
7		$ 4,264,455		$4,264,455	
8		$ 4,408,351		$4,408,351	
9		$ 4,557,102		$4,557,102	
10		$ 4,710,872		$4,710,872	
11		$ 4,869,831		$4,869,831	
12		$ 5,034,154		$5,034,154	
13		$ 5,204,022		$5,204,022	
14		$ 5,379,621		$5,379,621	
15		$ 5,561,146		$5,561,146	
16		$ 5,748,796		$5,748,796	
17		$ 5,942,778		$5,942,778	
18		$ 6,143,305		$6,143,305	
19		$ 6,350,599		$6,350,599	
20		$ 6,564,887		$6,564,887	
21		$ 6,786,406	$ 413,754,262	$420,540,668	replace elec./ motorized equipment
22		$ 7,015,400		$7,015,400	
23		$ 7,252,121	$ 33,308,070	$40,560,191	sewer inspection at yr 10 of service
24		$ 7,496,830		$7,496,830	
25		$ 7,749,795		$7,749,795	
26		$ 8,011,297		$8,011,297	
27		$ 8,281,622		$8,281,622	
28		$ 8,561,069		$8,561,069	
29		$ 8,849,946		$8,849,946	
30		$ 9,148,570		$9,148,570	
		Present value of O&M		**$329,256,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 206,100,000	$ 480,900,000	$ 5,324,023,266	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$111,276,000**	**$207,716,000**	**$3,449,415,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,295,450,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity Sewer							
Keeau WWTP	Gravity Sewer 8 inch	464,427	LF			$ 1,600	$ 743,082,519
Service Area Only	Gravity Sewer 12 inch	41,181	LF			$ 3,700	$ 152,369,275
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	27,892	LF			$ 600	$ 16,735,419
	Force main 6 inch	7,354	LF			$ 900	$ 6,618,240
	Force main 8 inch	2,640	LF			$ 1,600	$ 4,224,000
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	7	EA			$ 7,000,000	$ 49,000,000
	Neighborhood PS	32	EA			$ 1,200,000	$ 38,400,000
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,273,706,506**
	Right of Way	568	Ac			$ 20,000	$ 11,351,904
	Contingency	20%					$ 257,011,682
	Total Estimated Project Cost						**$ 1,542,070,093**
	Project services	20%					$ 308,414,019
	TOTAL CAPITAL COST						**1,850,484,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	419273	kWH	$ 0.44	$184,480
	Labor and Materials	$ 38,303	LS	-	$38,303
Annual O&M					**$222,783**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 230,301		$230,301	
2		$ 238,072		$238,072	
3		$ 246,105		$246,105	
4		$ 254,409		$254,409	
5		$ 262,994		$262,994	
6		$ 271,868		$271,868	
7		$ 281,042		$281,042	
8		$ 290,525		$290,525	
9		$ 300,328		$300,328	
10		$ 310,462		$310,462	
11		$ 320,938		$320,938	
12		$ 331,768		$331,768	
13		$ 342,962		$342,962	
14		$ 354,535		$354,535	
15		$ 366,498		$366,498	
16		$ 378,865		$378,865	
17		$ 391,649		$391,649	
18		$ 404,864		$404,864	
19		$ 418,526		$418,526	
20		$ 432,648		$432,648	
21		$ 447,247	$ 62,273,931	$62,721,178	replace elec./ motorized equipment
22		$ 462,338		$462,338	
23		$ 477,939	$ 7,589,998	$8,067,937	sewer inspection at yr 10 of service
24		$ 494,066		$494,066	
25		$ 510,737		$510,737	
26		$ 527,971		$527,971	
27		$ 545,787		$545,787	
28		$ 564,203		$564,203	
29		$ 583,241		$583,241	
30		$ 602,921		$602,921	
		Present value of O&M		**$42,131,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 31,020,000	$ 72,380,000	$ 1,170,306,506	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$16,748,000**	**$31,263,000**	**$758,237,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,086,367,000**

Easement Area Estimation - Alternative 2A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	590729	40	23629148	542
Regional PS	150	150	157500	4
Neighborhood PS	150	150	720000	17
WWTP				5
Total				568

Annual Power Estimation - Alternative 2A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	61	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0.4	hp	2	hp	13	hp
0.3	kw	1.2	kw	9.7	kw
32	ea	7	ea	1	ea
10.04	kw	8.63	kw	9.73	kw
87,978	kwh annual	75,611	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**419,273**	**kwh annual**			

Labor and Material Estimation - Alternative 2A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,319	0.47	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 16,233		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 3,485		total
Total for WWTP, Regional PS, and NH PS	**$ 38,303**		

Pump Station Weighted Average and Peak Flows - Alternative 2A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau						
to Hilo						
Weighted Average	7	0.47	3.30		0.09	0.62

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
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Alternative 2A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity Sewer							
HPP WWTP	Gravity Sewer 8 inch	882,604	LF			$ 1,600	$ 1,412,165,736
Service Area Only	Gravity Sewer 12 inch	34,554	LF			$ 3,700	$ 127,850,866
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	7,239	LF			$ 8,700	$ 62,976,299
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	122,299	LF			$ 600	$ 73,379,226
	Force main 6 inch	16,644	LF			$ 900	$ 14,979,600
	Force main 8 inch		LF			$ 1,600	$ -
	Force main 10 inch	16,368	LF			$ 2,650	$ 43,375,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	19	EA			$ 7,000,000	$ 133,000,000
	Neighborhood PS	46	EA			$ 1,200,000	$ 55,200,000
	HPP WWTP (3.18 mgd)	1	LS			NA	$ 48,000,000
	Subtotal of Estimated Construction Cost						**$ 2,430,409,323**
	Right of Way	1,100	Ac			$ 20,000	$ 22,009,907
	Contingency	20%					$ 490,483,846
	Total Estimated Project Cost						**$ 2,942,903,076**
	Project services	20%					$ 588,580,615
	TOTAL CAPITAL COST						**3,531,484,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	3081019	kWH	$ 0.44	$1,355,648
	Labor and Materials	$ 717,356	LS	-	$717,356
Annual O&M					**$2,073,004**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 2,142,954		$2,142,954	
2		$ 2,215,263		$2,215,263	
3		$ 2,290,013		$2,290,013	
4		$ 2,367,285		$2,367,285	
5		$ 2,447,164		$2,447,164	
6		$ 2,529,739		$2,529,739	
7		$ 2,615,100		$2,615,100	
8		$ 2,703,342		$2,703,342	
9		$ 2,794,561		$2,794,561	
10		$ 2,888,858		$2,888,858	
11		$ 2,986,336		$2,986,336	
12		$ 3,087,104		$3,087,104	
13		$ 3,191,273		$3,191,273	
14		$ 3,298,956		$3,298,956	
15		$ 3,410,273		$3,410,273	
16		$ 3,525,346		$3,525,346	
17		$ 3,644,301		$3,644,301	
18		$ 3,767,271		$3,767,271	
19		$ 3,894,390		$3,894,390	
20		$ 4,025,799		$4,025,799	
21		$ 4,161,641	$ 142,254,377	$146,416,018	replace elec./ motorized equipment
22		$ 4,302,068		$4,302,068	
23		$ 4,447,233	$ 13,227,525	$17,674,758	sewer inspection at yr 10 of service
24		$ 4,597,296		$4,597,296	
25		$ 4,752,422		$4,752,422	
26		$ 4,912,784		$4,912,784	
27		$ 5,078,556		$5,078,556	
28		$ 5,249,922		$5,249,922	
29		$ 5,427,070		$5,427,070	
30		$ 5,610,196		$5,610,196	
		Present value of O&M		**$141,632,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 70,860,000	$ 165,340,000	$ 2,194,209,323	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$38,258,000**	**$71,415,000**	**$1,421,620,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **2,141,823,000**

Easement Area Estimation - Alternative 2A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1145542	40	45821678	1052
Regional PS	150	150	427500	10
Neighborhood PS	150	150	1035000	24
WWTP				15
Total				1100

Annual Power Estimation - Alternative 2A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.90	mgd, Avg.	3.18	mgd, avg.
21	gpm	622	gpm	2,208	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	17	hp	45	hp
0.3	kw	12.5	kw	33.3	kw
46	ea	19	ea	1	ea
14.44	kw	237.47	kw	33.27	kw
126,468	kwh annual	2,080,275	kwh annual	291,426	pumping kwh annual
				582,851	other kwh annual, approx 2x pumping
Total Power	**3,081,019**	**kwh annual**			

Labor and Material Estimation - Alternative 2A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 63,551	3.18	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 34,147	4.00	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 648,795		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 5,009		total
Total for WWTP, Regional PS, and NH PS	**$ 717,356**		

Pump Station Weighted Average and Peak Flows - Alternative 2A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau						
to Hilo						
Weighted Average	19	4.00	76.09		0.90	17.02

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Gravity Sewer							
Pahoa WWTP	Gravity Sewer 8 inch	553,702	LF			$ 1,600	$ 885,923,384
Service Area Only	Gravity Sewer 12 inch	11,505	LF			$ 3,700	$ 42,566,672
	Gravity Sewer 16 inch	3,797	LF			$ 5,800	$ 22,020,693
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	6,560	LF			$ 8,700	$ 57,070,192
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	84,902	LF			$ 600	$ 50,940,973
	Force main 6 inch	8,342	LF			$ 900	$ 7,508,160
	Force main 8 inch	14,784	LF			$ 1,600	$ 23,654,400
	Force main 10 inch	15,893	LF			$ 2,650	$ 42,115,920
	Force main 12 inch	5,280	LF			$ 3,700	$ 19,536,000
	Force main 14 inch	4,118	LF			$ 4,750	$ 19,562,400
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	26	EA			$ 7,000,000	$ 182,000,000
	Neighborhood PS	54	EA			$ 1,200,000	$ 64,800,000
	Pahoa WWTP (1.23 mgd)	1	LS			NA	$ 20,000,000
	Subtotal of Estimated Construction Cost						**$ 1,558,357,353**
	Right of Way	716	Ac			$ 20,000	$ 14,327,466
	Contingency	20%					$ 314,536,964
	Total Estimated Project Cost						**$ 1,887,221,783**
	Project services	20%					$ 377,444,357
	TOTAL CAPITAL COST						**2,264,666,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	1521303	kWH	$ 0.44	$669,373
	Labor and Materials	$ 251,721	LS	-	$251,721

Annual O&M **$921,095**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 952,175		$952,175	
2		$ 984,304		$984,304	
3		$ 1,017,518		$1,017,518	
4		$ 1,051,852		$1,051,852	
5		$ 1,087,345		$1,087,345	
6		$ 1,124,035		$1,124,035	
7		$ 1,161,963		$1,161,963	
8		$ 1,201,172		$1,201,172	
9		$ 1,241,703		$1,241,703	
10		$ 1,283,601		$1,283,601	
11		$ 1,326,914		$1,326,914	
12		$ 1,371,688		$1,371,688	
13		$ 1,417,973		$1,417,973	
14		$ 1,465,820		$1,465,820	
15		$ 1,515,281		$1,515,281	
16		$ 1,566,411		$1,566,411	
17		$ 1,619,267		$1,619,267	
18		$ 1,673,906		$1,673,906	
19		$ 1,730,388		$1,730,388	
20		$ 1,788,777		$1,788,777	
21		$ 1,849,136	$ 160,683,606	$162,532,741	replace elec./ motorized equipment
22		$ 1,911,531		$1,911,531	
23		$ 1,976,032	$ 8,057,883	$10,033,915	sewer inspection at yr 10 of service
24		$ 2,042,709		$2,042,709	
25		$ 2,111,636		$2,111,636	
26		$ 2,182,889		$2,182,889	
27		$ 2,256,547		$2,256,547	
28		$ 2,332,689		$2,332,689	
29		$ 2,411,401		$2,411,401	
30		$ 2,492,769		$2,492,769	
		Present value of O&M		**$113,668,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 80,040,000	$ 186,760,000	$ 1,291,557,353	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$43,215,000**	**$80,667,000**	**$836,795,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,417,657,000**

Easement Area Estimation - Alternative 2A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	729686	40	29187420	670
Regional PS	150	150	585000	13
Neighborhood PS	150	150	1215000	28
WWTP				5
Total				716

Annual Power Estimation - Alternative 2A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.33	mgd, Avg.	1.23	mgd, avg.
21	gpm	226	gpm	854	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	6	hp	17	hp
0.3	kw	4.5	kw	12.9	kw
54	ea	26	ea	1	ea
16.95	kw	118.11	kw	12.87	kw
148,462	kwh annual	1,034,677	kwh annual	112,721	pumping kwh annual
				225,442	other kwh annual, approx 2x pumping
Total Power	**1,521,303**	**kwh annual**			

Labor and Material Estimation - Alternative 2A

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	24,581	1.23	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	8,510	1.73	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	221,260		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	5,881		total
Total for WWTP, Regional PS, and NH PS	**$**	**251,721**		

Pump Station Weighted Average and Peak Flows - Alternative 2A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau						
to Hilo						
Weighted Average	26	1.73	44.98		0.33	8.47

JOB #:	Puna Wastewater Facility Plan		**AECOM**
DATE:	October 16, 2023		Construction Cost Estimate
LOCATION:	Puna Wastewater Facility Plan		Conceptual Level
PREPARED BY:	T. Huang		Wastewater Facility Plan Estimates

Alternative 2A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Gravity Sewer							
Volcano WWTP Service Area Only	Gravity Sewer 8 inch	272,806	LF			$ 1,600	$ 436,489,437
	Gravity Sewer 12 inch	24,672	LF			$ 3,700	$ 91,287,059
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	28,079	LF			$ 600	$ 16,847,531
	Force main 6 inch	8,700	LF			$ 900	$ 7,830,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch		LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	5	EA			$ 7,000,000	$ 35,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 748,550,084**
	Right of Way	349	Ac			$ 20,000	$ 6,982,654
	Contingency	20%					$ 151,106,547
	Total Estimated Project Cost						**$ 906,639,285**
	Project services	20%					$ 181,327,857
	TOTAL CAPITAL COST						**1,087,967,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	310153	kWH	$ 0.44	$136,467
	Labor and Materials	$ 27,107	LS	-	$27,107
Annual O&M					**$163,574**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 169,094		$169,094	
2		$ 174,800		$174,800	
3		$ 180,698		$180,698	
4		$ 186,795		$186,795	
5		$ 193,098		$193,098	
6		$ 199,614		$199,614	
7		$ 206,350		$206,350	
8		$ 213,312		$213,312	
9		$ 220,510		$220,510	
10		$ 227,951		$227,951	
11		$ 235,643		$235,643	
12		$ 243,594		$243,594	
13		$ 251,813		$251,813	
14		$ 260,310		$260,310	
15		$ 269,094		$269,094	
16		$ 278,174		$278,174	
17		$ 287,561		$287,561	
18		$ 297,264		$297,264	
19		$ 307,294		$307,294	
20		$ 317,663		$317,663	
21		$ 328,382	$ 48,542,349	$48,870,731	replace elec./ motorized equipment
22		$ 339,463		$339,463	
23		$ 350,917	$ 4,432,663	$4,783,580	sewer inspection at yr 10 of service
24		$ 362,758		$362,758	
25		$ 374,999		$374,999	
26		$ 387,653		$387,653	
27		$ 400,733		$400,733	
28		$ 414,255		$414,255	
29		$ 428,233		$428,233	
30		$ 442,683		$442,683	
		Present value of O&M		**$31,824,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 24,180,000	$ 56,420,000	$ 667,950,084	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$13,055,000**	**$24,370,000**	**$432,762,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **649,604,000**

Easement Area Estimation - Alternative 2A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	356198	40	14247920	327
Regional PS	150	150	112500	3
Neighborhood PS	150	150	630000	14
WWTP				5
Total				349

Annual Power Estimation - Alternative 2A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.65	mgd, avg.
21	gpm	62	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.2	kw	6.8	kw
28	ea	5	ea	1	ea
8.79	kw	6.22	kw	6.80	kw
76,980	kwh annual	54,468	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**310,153**	**kwh annual**			

Labor and Material Estimation - Alternative 2A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,214	0.45	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 11,068		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 3,049		total
Total for WWTP, Regional PS, and NH PS	**$ 27,107**		

Pump Station Weighted Average and Peak Flows - Alternative 2A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau						
to Hilo						
Weighted Average	5	0.45	2.25		0.09	0.45

G-6: Alternative 2B Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity and LP Sewer							
	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	111,912	LF			$ 3,700	$ 414,073,873
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	14,973	LF			$ 8,700	$ 130,261,902
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	406,495	LF			$ 450	$ 182,922,677
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	57	EA			$ 7,000,000	$ 399,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (6 mgd total)	4	LS			NA	$ 96,000,000
	Subtotal of Estimated Construction Cost						**$ 5,297,170,573**
	Right of Way	2,409	Ac			$ 20,000	$ 48,185,762
	Contingency	20%					$ 1,069,071,267
	Total Estimated Project Cost						**$ 6,414,427,602**
	Project services	20%					$ 1,282,885,520
	TOTAL CAPITAL COST						**7,697,313,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4815636	kWH	$ 0.44	$2,118,880
	Labor and Materials	$ 3,328,992	LS	-	$3,328,992
Annual O&M					**$5,447,872**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 5,631,700		$5,631,700	
2		$ 5,821,730		$5,821,730	
3		$ 6,018,173		$6,018,173	
4		$ 6,221,245		$6,221,245	
5		$ 6,431,168		$6,431,168	
6		$ 6,648,175		$6,648,175	
7		$ 6,872,505		$6,872,505	
8		$ 7,104,404		$7,104,404	
9		$ 7,344,128		$7,344,128	
10		$ 7,591,941		$7,591,941	
11		$ 7,848,116		$7,848,116	
12		$ 8,112,936		$8,112,936	
13		$ 8,386,691		$8,386,691	
14		$ 8,669,683		$8,669,683	
15		$ 8,962,224		$8,962,224	
16		$ 9,264,637		$9,264,637	
17		$ 9,577,254		$9,577,254	
18		$ 9,900,420		$9,900,420	
19		$ 10,234,490		$10,234,490	
20		$ 10,579,832		$10,579,832	
21		$ 10,936,828	$ 360,755,172	$371,692,000	replace elec./ motorized equipment
22		$ 11,305,870		$11,305,870	
23		$ 11,687,364	$ 27,617,142	$39,304,506	sewer inspection at yr 10 of service
24		$ 12,081,731		$12,081,731	
25		$ 12,489,405		$12,489,405	
26		$ 12,910,836		$12,910,836	
27		$ 13,346,487		$13,346,487	
28		$ 13,796,837		$13,796,837	
29		$ 14,262,385		$14,262,385	
30		$ 14,743,641		$14,743,641	
		Present value of O&M		**$362,111,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 179,700,000	$ 419,300,000	$ 4,698,170,573	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$97,022,000**	**$181,109,000**	**$3,043,927,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,737,366,000**

JOB #:	Puna Wastewater Facility Plan	AECOM
DATE:	October 16, 2023	Construction Cost Estimate
LOCATION:	Puna Wastewater Facility Plan	Conceptual Level
PREPARED BY:	T. Huang	Wastewater Facility Plan Estimates

Alternative 2B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity and LP Sewer							
Keeau WWTP	Gravity Sewer 8 inch	423,374	LF			$ 1,600	$ 677,398,705
Service Area Only	Gravity Sewer 12 inch	41,181	LF			$ 3,700	$ 152,369,275
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	8,040	LF			$ 900	$ 7,236,000
	Force main 8 inch	1,954	LF			$ 1,600	$ 3,125,760
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	41,052	LF			$ 450	$ 18,473,573
	Low pressure sewer (On-Lot)	400	EA			$ 26,000	$ 10,400,000
	Regional PS	7	EA			$ 7,000,000	$ 49,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,181,280,365**
	Right of Way	525	Ac			$ 20,000	$ 10,509,069
	Contingency	20%					$ 238,357,887
	Total Estimated Project Cost						**$ 1,430,147,321**
	Project services	20%					$ 286,029,464
	TOTAL CAPITAL COST						**1,716,177,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	331295	kWH	$ 0.44	$145,770
	Labor and Materials	$ 268,071	LS	-	$268,071
Annual O&M					**$413,841**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 427,805		$427,805	
2		$ 442,241		$442,241	
3		$ 457,163		$457,163	
4		$ 472,589		$472,589	
5		$ 488,536		$488,536	
6		$ 505,021		$505,021	
7		$ 522,061		$522,061	
8		$ 539,677		$539,677	
9		$ 557,888		$557,888	
10		$ 576,713		$576,713	
11		$ 596,173		$596,173	
12		$ 616,289		$616,289	
13		$ 637,085		$637,085	
14		$ 658,582		$658,582	
15		$ 680,804		$680,804	
16		$ 703,777		$703,777	
17		$ 727,524		$727,524	
18		$ 752,073		$752,073	
19		$ 777,450		$777,450	
20		$ 803,684		$803,684	
21		$ 830,803	$ 45,410,584	$46,241,387	replace elec./ motorized equipment
22		$ 858,837		$858,837	
23		$ 887,816	$ 7,015,265	$7,903,081	sewer inspection at yr 10 of service
24		$ 917,774		$917,774	
25		$ 948,742		$948,742	
26		$ 980,756		$980,756	
27		$ 1,013,850		$1,013,850	
28		$ 1,048,060		$1,048,060	
29		$ 1,083,425		$1,083,425	
30		$ 1,119,983		$1,119,983	
		Present value of O&M		**$39,044,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 22,620,000	$ 52,780,000	$ 1,105,880,365	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$12,213,000**	**$22,797,000**	**$716,496,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,003,715,000**

Easement Area Estimation - Alternative 2B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	562836	40	22513453	517
Regional PS	150	150	157500	4
Neighborhood PS	150	150	0	0
WWTP				5
Total				525

Annual Power Estimation - Alternative 2B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	61	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	13	hp
0.3	kw	1.2	kw	9.7	kw
0	ea	7	ea	1	ea
0.00	kw	8.63	kw	9.73	kw
-	kwh annual	75,611	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**331,295**	**kwh annual**			

Labor and Material Estimation - Alternative 2B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,319	0.47	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 16,233		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 34,819**		

Pump Station Weighted Average and Peak Flows - Alternative 2B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	0					
to Hilo	0					
Weighted Average	7	0.47	3.30		0.09	0.62

O&M Estimation for Puna LPS - Alternative 2B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	41052	$ 450	$ 18,473,573	0.81	**$ 33,252**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	400	$ 26,000	$ 10,400,000	500	**$ 200,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity and LP Sewer							
HPP WWTP Service Area Only	Gravity Sewer 8 inch	681,018	LF			$ 1,600	$ 1,089,629,199
	Gravity Sewer 12 inch	34,554	LF			$ 3,700	$ 127,850,866
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	7,239	LF			$ 8,700	$ 62,976,299
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	16,644	LF			$ 900	$ 14,979,600
	Force main 8 inch		LF			$ 1,600	$ -
	Force main 10 inch	16,368	LF			$ 2,650	$ 43,375,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	201,585	LF			$ 450	$ 90,713,401
	Low pressure sewer (On-Lot)	2,000	EA			$ 26,000	$ 52,000,000
	Regional PS	19	EA			$ 7,000,000	$ 133,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	HPP WWTP (3.18 mgd)	1	LS			NA	$ 48,000,000
	Subtotal of Estimated Construction Cost						**$ 2,122,006,960**
	Right of Way	964	Ac			$ 20,000	$ 19,288,627
	Contingency	20%					$ 428,259,117
	Total Estimated Project Cost						**$ 2,569,554,704**
	Project services	20%					$ 513,910,941
	TOTAL CAPITAL COST						**3,083,466,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	2954551	kWH	$ 0.44	$1,300,003
	Labor and Materials	$ 1,875,630	LS	-	$1,875,630
Annual O&M					**$3,175,633**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,282,789		$3,282,789	
2		$ 3,393,560		$3,393,560	
3		$ 3,508,069		$3,508,069	
4		$ 3,626,442		$3,626,442	
5		$ 3,748,809		$3,748,809	
6		$ 3,875,305		$3,875,305	
7		$ 4,006,070		$4,006,070	
8		$ 4,141,246		$4,141,246	
9		$ 4,280,985		$4,280,985	
10		$ 4,425,438		$4,425,438	
11		$ 4,574,766		$4,574,766	
12		$ 4,729,132		$4,729,132	
13		$ 4,888,707		$4,888,707	
14		$ 5,053,667		$5,053,667	
15		$ 5,224,193		$5,224,193	
16		$ 5,400,473		$5,400,473	
17		$ 5,582,702		$5,582,702	
18		$ 5,771,079		$5,771,079	
19		$ 5,965,813		$5,965,813	
20		$ 6,167,117		$6,167,117	
21		$ 6,375,215	$ 140,327,137	$146,702,352	replace elec./ motorized equipment
22		$ 6,590,334		$6,590,334	
23		$ 6,812,711	$ 10,405,331	$17,218,042	sewer inspection at yr 10 of service
24		$ 7,042,593		$7,042,593	
25		$ 7,280,231		$7,280,231	
26		$ 7,525,889		$7,525,889	
27		$ 7,779,835		$7,779,835	
28		$ 8,042,350		$8,042,350	
29		$ 8,313,723		$8,313,723	
30		$ 8,594,253		$8,594,253	
		Present value of O&M		**$172,684,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 69,900,000	$ 163,100,000	$ 1,889,006,960	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$37,740,000**	**$70,448,000**	**$1,223,881,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,924,081,000**

Easement Area Estimation - Alternative 2B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1023243	40	40929729	940
Regional PS	150	150	427500	10
Neighborhood PS	150	150	0	0
WWTP				15
Total				964

Annual Power Estimation - Alternative 2B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.90	mgd, Avg.	3.18	mgd, avg.
21	gpm	622	gpm	2,208	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	17	hp	45	hp
0.3	kw	12.5	kw	33.3	kw
0	ea	19	ea	1	ea
0.00	kw	237.47	kw	33.27	kw
-	kwh annual	2,080,275	kwh annual	291,426	pumping kwh annual
				582,851	other kwh annual, approx 2x pumping
Total Power	**2,954,551**	**kwh annual**			

Labor and Material Estimation - Alternative 2B

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	63,551	3.18	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	34,147	4.00	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	648,795		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total				
Flow prorated for Puna H WWPSs, total	$	-		total
Total for WWTP, Regional PS, and NH PS	**$**	**712,346**		

Pump Station Weighted Average and Peak Flows - Alternative 2B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	19	4.00	76.09		0.90	17.02

O&M Estimation for Puna LPS - Alternative 2B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	201585	$ 450	$ 90,713,401	0.81	**$ 163,284**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	2000	$ 26,000	$ 52,000,000	500	**$ 1,000,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

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Alternative 2B	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Gravity and LP Sewer							
Pahoa WWTP	Gravity Sewer 8 inch	424,330	LF			$ 1,600	$ 678,928,274
Service Area Only	Gravity Sewer 12 inch	11,505	LF			$ 3,700	$ 42,566,672
	Gravity Sewer 16 inch	3,797	LF			$ 5,800	$ 22,020,693
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	6,560	LF			$ 8,700	$ 57,070,192
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	8,342	LF			$ 900	$ 7,508,160
	Force main 8 inch	14,784	LF			$ 1,600	$ 23,654,400
	Force main 10 inch	15,893	LF			$ 2,650	$ 42,115,920
	Force main 12 inch	5,280	LF			$ 3,700	$ 19,536,000
	Force main 14 inch	4,118	LF			$ 4,750	$ 19,562,400
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	129,372	LF			$ 450	$ 58,217,375
	Low pressure sewer (On-Lot)	1,300	EA			$ 26,000	$ 33,800,000
	Regional PS	26	EA			$ 7,000,000	$ 182,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	Pahoa WWTP (1.23 mgd)	1	LS			NA	$ 20,000,000
	Subtotal of Estimated Construction Cost						**$ 1,327,638,646**
	Right of Way	611	Ac			$ 20,000	$ 12,210,356
	Contingency	20%					$ 267,969,800
	Total Estimated Project Cost						**$ 1,607,818,802**
	Project services	20%					$ 321,563,760
	TOTAL CAPITAL COST						**1,929,383,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	1296616	kWH	$ 0.44	$570,511
	Labor and Materials	$ 983,300	LS	-	$983,300
Annual O&M					**$1,553,811**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 1,606,241		$1,606,241	
2		$ 1,660,441		$1,660,441	
3		$ 1,716,469		$1,716,469	
4		$ 1,774,388		$1,774,388	
5		$ 1,834,261		$1,834,261	
6		$ 1,896,155		$1,896,155	
7		$ 1,960,137		$1,960,137	
8		$ 2,026,278		$2,026,278	
9		$ 2,094,651		$2,094,651	
10		$ 2,165,330		$2,165,330	
11		$ 2,238,395		$2,238,395	
12		$ 2,313,926		$2,313,926	
13		$ 2,392,004		$2,392,004	
14		$ 2,472,718		$2,472,718	
15		$ 2,556,155		$2,556,155	
16		$ 2,642,407		$2,642,407	
17		$ 2,731,570		$2,731,570	
18		$ 2,823,742		$2,823,742	
19		$ 2,919,023		$2,919,023	
20		$ 3,017,520		$3,017,520	
21		$ 3,119,340	$ 142,013,472	$145,132,812	replace elec./ motorized equipment
22		$ 3,224,596		$3,224,596	
23		$ 3,333,404	$ 6,246,676	$9,580,080	sewer inspection at yr 10 of service
24		$ 3,445,883		$3,445,883	
25		$ 3,562,157		$3,562,157	
26		$ 3,682,355		$3,682,355	
27		$ 3,806,609		$3,806,609	
28		$ 3,935,056		$3,935,056	
29		$ 4,067,836		$4,067,836	
30		$ 4,205,098		$4,205,098	
		Present value of O&M		**$122,441,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 70,740,000	$ 165,060,000	$ 1,091,838,646	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$38,193,000**	**$71,295,000**	**$707,398,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,234,938,000**

Easement Area Estimation - Alternative 2B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	644784	40	25791355	592
Regional PS	150	150	585000	13
Neighborhood PS	150	150	0	0
WWTP				5
Total				611

Annual Power Estimation - Alternative 2B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.30	mgd, Avg.	1.23	mgd, avg.
21	gpm	210	gpm	854	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	6	hp	17	hp
0.3	kw	4.2	kw	12.9	kw
0	ea	26	ea	1	ea
0.00	kw	109.41	kw	12.87	kw
-	kwh annual	958,453	kwh annual	112,721	pumping kwh annual
				225,442	other kwh annual, approx 2x pumping
Total Power	**1,296,616**	**kwh annual**			

Labor and Material Estimation - Alternative 2B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 24,581	1.23	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 7,843	1.59	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 203,928		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 228,509**		

Pump Station Weighted Average and Peak Flows - Alternative 2B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	0					
to Hilo	0					
Weighted Average	29	1.59	46.24		0.30	8.75

O&M Estimation for Puna LPS - Alternative 2B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	129372	$ 450	$ 58,217,375	0.81	**$ 104,791**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	1300	$ 26,000	$ 33,800,000	500	**$ 650,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
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PREPARED BY: T. Huang

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Alternative 2B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Gravity and LP Sewer							
Volcano WWTP Service Area Only	Gravity Sewer 8 inch	238,321	LF			$ 1,600	$ 381,313,159
	Gravity Sewer 12 inch	24,672	LF			$ 3,700	$ 91,287,059
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	8,700	LF			$ 900	$ 7,830,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch		LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	34,485	LF			$ 450	$ 15,518,328
	Low pressure sewer (On-Lot)	300	EA			$ 26,000	$ 7,800,000
	Regional PS	5	EA			$ 7,000,000	$ 35,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 666,244,602**
	Right of Way	309	Ac			$ 20,000	$ 6,177,709
	Contingency	20%					$ 134,484,462
	Total Estimated Project Cost						**$ 806,906,774**
	Project services	20%					$ 161,381,355
	TOTAL CAPITAL COST						**968,288,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	233173	kWH	$ 0.44	$102,596
	Labor and Materials	$ 201,991	LS	-	$201,991
Annual O&M					**$304,587**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 314,864		$314,864	
2		$ 325,489		$325,489	
3		$ 336,472		$336,472	
4		$ 347,826		$347,826	
5		$ 359,562		$359,562	
6		$ 371,695		$371,695	
7		$ 384,237		$384,237	
8		$ 397,202		$397,202	
9		$ 410,605		$410,605	
10		$ 424,460		$424,460	
11		$ 438,783		$438,783	
12		$ 453,589		$453,589	
13		$ 468,894		$468,894	
14		$ 484,716		$484,716	
15		$ 501,072		$501,072	
16		$ 517,980		$517,980	
17		$ 535,458		$535,458	
18		$ 553,526		$553,526	
19		$ 572,203		$572,203	
20		$ 591,511		$591,511	
21		$ 611,471	$ 33,003,979	$33,615,450	replace elec./ motorized equipment
22		$ 632,103		$632,103	
23		$ 653,433	$ 3,949,870	$4,603,303	sewer inspection at yr 10 of service
24		$ 675,481		$675,481	
25		$ 698,274		$698,274	
26		$ 721,836		$721,836	
27		$ 746,193		$746,193	
28		$ 771,372		$771,372	
29		$ 797,400		$797,400	
30		$ 824,307		$824,307	
		Present value of O&M		**$27,942,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 16,440,000	$ 38,360,000	$ 611,444,602	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$8,876,000**	**$16,569,000**	**$396,153,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **574,632,000**

Easement Area Estimation - Alternative 2B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	328119	40	13124751	301
Regional PS	150	150	112500	3
Neighborhood PS	150	150	0	0
WWTP				5
Total				309

Annual Power Estimation - Alternative 2B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.65	mgd, avg.
21	gpm	62	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.2	kw	6.8	kw
0	ea	5	ea	1	ea
0.00	kw	6.22	kw	6.80	kw
-	kwh annual	54,468	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**233,173**	**kwh annual**			

Labor and Material Estimation - Alternative 2B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,214	0.45	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 11,068		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 24,058**		

Pump Station Weighted Average and Peak Flows - Alternative 2B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	5	0.45	2.25		0.09	0.45

O&M Estimation for Puna LPS - Alternative 2B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	34485	$ 450	$ 15,518,328	0.81	**$ 27,933**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	300	$ 26,000	$ 7,800,000	500	**$ 150,000**					

G-7: Alternative 2C Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
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Alternative 2C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Cross-Country Sewer							
	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	119,374	LF			$ 3,700	$ 441,684,298
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	14,973	LF			$ 8,700	$ 130,261,902
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	7,286	LF			$ 4,750	$ 34,610,400
	Force main 16 inch	41,606	LF			$ 5,800	$ 241,317,120
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	49	EA			$ 7,000,000	$ 343,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP (6 mgd total)	4	LS			NA	$ 96,000,000
	Subtotal of Estimated Construction Cost						**$ 5,893,718,176**
	Right of Way	2,544	Ac			$ 20,000	$ 50,889,077
	Contingency	20%					$ 1,188,921,451
	Total Estimated Project Cost						**$ 7,133,528,704**
	Project services	20%					$ 1,426,705,741
	TOTAL CAPITAL COST						**8,560,234,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4911636	kWH	$ 0.44	$2,161,120
	Labor and Materials	$ 1,040,000	LS	-	$1,040,000
Annual O&M					**$3,201,120**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,309,135		$3,309,135	
2		$ 3,420,796		$3,420,796	
3		$ 3,536,224		$3,536,224	
4		$ 3,655,547		$3,655,547	
5		$ 3,778,896		$3,778,896	
6		$ 3,906,407		$3,906,407	
7		$ 4,038,221		$4,038,221	
8		$ 4,174,483		$4,174,483	
9		$ 4,315,343		$4,315,343	
10		$ 4,460,956		$4,460,956	
11		$ 4,611,482		$4,611,482	
12		$ 4,767,087		$4,767,087	
13		$ 4,927,943		$4,927,943	
14		$ 5,094,227		$5,094,227	
15		$ 5,266,121		$5,266,121	
16		$ 5,443,816		$5,443,816	
17		$ 5,627,507		$5,627,507	
18		$ 5,817,396		$5,817,396	
19		$ 6,013,693		$6,013,693	
20		$ 6,216,613		$6,216,613	
21		$ 6,426,380	$ 291,133,639	$297,560,020	replace elec./ motorized equipment
22		$ 6,643,226		$6,643,226	
23		$ 6,867,389	$ 34,566,408	$41,433,797	sewer inspection at yr 10 of service
24		$ 7,099,115		$7,099,115	
25		$ 7,338,661		$7,338,661	
26		$ 7,586,289		$7,586,289	
27		$ 7,842,274		$7,842,274	
28		$ 8,106,896		$8,106,896	
29		$ 8,380,447		$8,380,447	
30		$ 8,663,229		$8,663,229	
		Present value of O&M		**$261,919,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 145,020,000	$ 338,380,000	$ 5,410,318,176	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$78,298,000**	**$146,157,000**	**$3,505,325,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,092,373,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
4 plants urban sewering Cross-Country Sewer							
Keeau WWTP Service Area Only	Gravity Sewer 8 inch	472,118	LF			$ 1,600	$ 755,389,530
	Gravity Sewer 12 inch	50,847	LF			$ 3,700	$ 188,135,674
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	10,974	LF			$ 600	$ 6,584,148
	Force main 6 inch	4,000	LF			$ 900	$ 3,600,000
	Force main 8 inch	-	LF			$ 1,600	$ -
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	3	EA			$ 7,000,000	$ 21,000,000
	Neighborhood PS	12	EA			$ 1,200,000	$ 14,400,000
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,252,386,403**
	Right of Way	550	Ac			$ 20,000	$ 11,001,970
	Contingency	20%					$ 252,677,675
	Total Estimated Project Cost						**$ 1,516,066,048**
	Project services	20%					$ 303,213,210
	TOTAL CAPITAL COST						**1,819,279,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	322424	kWH	$ 0.44	$141,867
	Labor and Materials	$ 30,000	LS	-	$30,000
Annual O&M					**$171,867**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 177,666		$177,666	
2		$ 183,661		$183,661	
3		$ 189,858		$189,858	
4		$ 196,265		$196,265	
5		$ 202,887		$202,887	
6		$ 209,733		$209,733	
7		$ 216,810		$216,810	
8		$ 224,126		$224,126	
9		$ 231,689		$231,689	
10		$ 239,507		$239,507	
11		$ 247,588		$247,588	
12		$ 255,943		$255,943	
13		$ 264,579		$264,579	
14		$ 273,507		$273,507	
15		$ 282,736		$282,736	
16		$ 292,276		$292,276	
17		$ 302,138		$302,138	
18		$ 312,333		$312,333	
19		$ 322,872		$322,872	
20		$ 333,767		$333,767	
21		$ 345,029	$ 30,956,287	$31,301,316	replace elec./ motorized equipment
22		$ 356,672		$356,672	
23		$ 368,707	$ 7,833,017	$8,201,724	sewer inspection at yr 10 of service
24		$ 381,148		$381,148	
25		$ 394,009		$394,009	
26		$ 407,304		$407,304	
27		$ 421,048		$421,048	
28		$ 435,256		$435,256	
29		$ 449,942		$449,942	
30		$ 465,125		$465,125	
		Present value of O&M		**$24,741,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 15,420,000	$ 35,980,000	$ 1,200,986,403	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$8,325,000**	**$15,541,000**	**$778,115,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,042,039,000**

Easement Area Estimation - Alternative 2C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	585175	40	23406992	537
Regional PS	150	150	67500	2
Neighborhood PS	150	150	270000	6
WWTP				5
Total				550

Annual Power Estimation - Alternative 2C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	64	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	13	hp
0.3	kw	1.3	kw	9.7	kw
12	ea	3	ea	1	ea
3.77	kw	3.85	kw	9.73	kw
32,992	kwh annual	33,748	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**322,424**	**kwh annual**			

Labor and Material Estimation - Alternative 2C

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	2,853	0.58	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	8,559		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	1,307		total
Total for WWTP, Regional PS, and NH PS	**$**	**28,452**		
Use	**$**	**30,000**	rounded up	

Pump Station Weighted Average and Peak Flows - Alternative 2C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	3	0.58	1.74		0.09	0.28

JOB #: Puna Wastewater Facility Plan
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PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Cross-Country Sewer							
HPP WWTP	Gravity Sewer 8 inch	928,916	LF			$ 1,600	$ 1,486,265,126
Service Area Only	Gravity Sewer 12 inch	33,864	LF			$ 3,700	$ 125,297,448
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	7,239	LF			$ 8,700	$ 62,976,299
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch	13,328	LF			$ 13,050	$ 173,932,708
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	9,348	LF			$ 600	$ 5,608,846
	Force main 6 inch	5,808	LF			$ 900	$ 5,227,200
	Force main 8 inch		LF			$ 1,600	$ -
	Force main 10 inch	10,560	LF			$ 2,650	$ 27,984,000
	Force main 12 inch	22,176	LF			$ 3,700	$ 82,051,200
	Force main 14 inch	3,168	LF			$ 4,750	$ 15,048,000
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	17	EA			$ 7,000,000	$ 119,000,000
	Neighborhood PS	6	EA			$ 1,200,000	$ 7,200,000
	HPP WWTP (3.18 mgd)	1	LS			NA	$ 48,000,000
	Subtotal of Estimated Construction Cost						**$ 2,428,944,674**
	Right of Way	1,018	Ac			$ 20,000	$ 20,352,856
	Contingency	20%					$ 489,859,506
	Total Estimated Project Cost						**$ 2,939,157,036**
	Project services	20%					$ 587,831,407
	TOTAL CAPITAL COST						**3,526,988,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	2944784	kWH	$ 0.44	$1,295,705
	Labor and Materials	$ 730,000	LS	-	$730,000
Annual O&M					**$2,025,705**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 2,094,059		$2,094,059	
2		$ 2,164,718		$2,164,718	
3		$ 2,237,763		$2,237,763	
4		$ 2,313,272		$2,313,272	
5		$ 2,391,328		$2,391,328	
6		$ 2,472,019		$2,472,019	
7		$ 2,555,432		$2,555,432	
8		$ 2,641,660		$2,641,660	
9		$ 2,730,798		$2,730,798	
10		$ 2,822,943		$2,822,943	
11		$ 2,918,198		$2,918,198	
12		$ 3,016,667		$3,016,667	
13		$ 3,118,458		$3,118,458	
14		$ 3,223,685		$3,223,685	
15		$ 3,332,462		$3,332,462	
16		$ 3,444,909		$3,444,909	
17		$ 3,561,151		$3,561,151	
18		$ 3,681,315		$3,681,315	
19		$ 3,805,533		$3,805,533	
20		$ 3,933,944		$3,933,944	
21		$ 4,066,687	$ 104,914,108	$108,980,795	replace elec./ motorized equipment
22		$ 4,203,909		$4,203,909	
23		$ 4,345,762	$ 13,866,233	$18,211,995	sewer inspection at yr 10 of service
24		$ 4,492,401		$4,492,401	
25		$ 4,643,988		$4,643,988	
26		$ 4,800,690		$4,800,690	
27		$ 4,962,680		$4,962,680	
28		$ 5,130,136		$5,130,136	
29		$ 5,303,242		$5,303,242	
30		$ 5,482,190		$5,482,190	
		Present value of O&M		**$121,471,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 52,260,000	$ 121,940,000	$ 2,254,744,674	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$28,216,000**	**$52,670,000**	**$1,460,841,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) 2,106,732,000

Easement Area Estimation - Alternative 2C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1078941	40	43157621	991
Regional PS	150	150	382500	9
Neighborhood PS	150	150	135000	3
WWTP				15
Total				1018

Annual Power Estimation - Alternative 2C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.99	mgd, Avg.	3.18	mgd, avg.
21	gpm	687	gpm	2,208	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	18	hp	45	hp
0.3	kw	13.8	kw	33.3	kw
6	ea	17	ea	1	ea
1.88	kw	234.48	kw	33.27	kw
16,496	kwh annual	2,054,012	kwh annual	291,426	pumping kwh annual
				582,851	other kwh annual, approx 2x pumping
Total Power	**2,944,784**	**kwh annual**			

Labor and Material Estimation - Alternative 2C

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	63,551	3.18	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	38,911	4.42	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	661,488		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	653		total
Total for WWTP, Regional PS, and NH PS	**$**	**725,692**		
Use	**$**	**730,000**	rounded up	

Pump Station Weighted Average and Peak Flows - Alternative 2C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	17	4.42	75.14		0.99	16.81

JOB #: Puna Wastewater Facility Plan
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LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
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Wastewater Facility Plan Estimates

Alternative 2C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Cross-Country Sewer							
Pahoa WWTP Service Area Only	Gravity Sewer 8 inch	571,280	LF			$ 1,600	$ 914,048,047
	Gravity Sewer 12 inch	11,505	LF			$ 3,700	$ 42,566,672
	Gravity Sewer 16 inch	3,797	LF			$ 5,800	$ 22,020,693
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	6,560	LF			$ 8,700	$ 57,070,192
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	18,934	LF			$ 600	$ 11,360,522
	Force main 6 inch	8,342	LF			$ 900	$ 7,508,160
	Force main 8 inch	12,830	LF			$ 1,600	$ 20,528,640
	Force main 10 inch	12,144	LF			$ 2,650	$ 32,181,600
	Force main 12 inch	10,982	LF			$ 3,700	$ 40,634,880
	Force main 14 inch	4,118	LF			$ 4,750	$ 19,562,400
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	26	EA			$ 7,000,000	$ 182,000,000
	Neighborhood PS	9	EA			$ 1,200,000	$ 10,800,000
	Pahoa WWTP (1.23 mgd)	1	LS			NA	$ 20,000,000
	Subtotal of Estimated Construction Cost						**$ 1,500,940,367**
	Right of Way	649	Ac			$ 20,000	$ 12,973,894
	Contingency	20%					$ 302,782,852
	Total Estimated Project Cost						**$ 1,816,697,112**
	Project services	20%					$ 363,339,422
	TOTAL CAPITAL COST						**2,180,037,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	1397584	kWH	$ 0.44	$614,937
	Labor and Materials	$ 250,000	LS	-	$250,000
Annual O&M					**$864,937**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 894,123		$894,123	
2		$ 924,293		$924,293	
3		$ 955,482		$955,482	
4		$ 987,722		$987,722	
5		$ 1,021,051		$1,021,051	
6		$ 1,055,505		$1,055,505	
7		$ 1,091,120		$1,091,120	
8		$ 1,127,938		$1,127,938	
9		$ 1,165,998		$1,165,998	
10		$ 1,205,343		$1,205,343	
11		$ 1,246,014		$1,246,014	
12		$ 1,288,059		$1,288,059	
13		$ 1,331,522		$1,331,522	
14		$ 1,376,451		$1,376,451	
15		$ 1,422,897		$1,422,897	
16		$ 1,470,910		$1,470,910	
17		$ 1,520,543		$1,520,543	
18		$ 1,571,851		$1,571,851	
19		$ 1,624,890		$1,624,890	
20		$ 1,679,718		$1,679,718	
21		$ 1,736,397	$ 128,161,437	$129,897,834	replace elec./ motorized equipment
22		$ 1,794,988		$1,794,988	
23		$ 1,855,557	$ 8,303,974	$10,159,531	sewer inspection at yr 10 of service
24		$ 1,918,169		$1,918,169	
25		$ 1,982,894		$1,982,894	
26		$ 2,049,802		$2,049,802	
27		$ 2,118,969		$2,118,969	
28		$ 2,190,469		$2,190,469	
29		$ 2,264,382		$2,264,382	
30		$ 2,340,790		$2,340,790	
		Present value of O&M		**$95,506,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 63,840,000	$ 148,960,000	$ 1,288,140,367	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$34,468,000**	**$64,340,000**	**$834,581,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,342,154,000**

Easement Area Estimation - Alternative 2C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	681296	40	27251840	626
Regional PS	150	150	585000	13
Neighborhood PS	150	150	202500	5
WWTP				5
Total				649

Annual Power Estimation - Alternative 2C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.33	mgd, Avg.	1.23	mgd, avg.
21	gpm	226	gpm	854	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	6	hp	17	hp
0.3	kw	4.5	kw	12.9	kw
9	ea	26	ea	1	ea
2.82	kw	118.11	kw	12.87	kw
24,744	kwh annual	1,034,677	kwh annual	112,721	pumping kwh annual
				225,442	other kwh annual, approx 2x pumping
Total Power	**1,397,584**	**kwh annual**			

Labor and Material Estimation - Alternative 2C

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	24,581	1.23	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	8,510	1.73	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	221,260		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	980		total
Total for WWTP, Regional PS, and NH PS	**$**	**246,821**		
Use	**$**	**250,000**	rounded up	

Pump Station Weighted Average and Peak Flows - Alternative 2C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	26	1.73	44.98		0.33	8.47

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 2C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
4 plants urban sewering Cross-Country Sewer							
Volcano WWTP Service Area Only	Gravity Sewer 8 inch	283,643	LF			$ 1,600	$ 453,828,835
	Gravity Sewer 12 inch	23,158	LF			$ 3,700	$ 85,684,504
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	9,012	LF			$ 600	$ 5,407,337
	Force main 6 inch	6,700	LF			$ 900	$ 6,030,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch		LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	3	EA			$ 7,000,000	$ 21,000,000
	Neighborhood PS	10	EA			$ 1,200,000	$ 12,000,000
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 711,446,733**
	Right of Way	328	Ac			$ 20,000	$ 6,560,357
	Contingency	20%					$ 143,601,418
	Total Estimated Project Cost						**$ 861,608,507**
	Project services	20%					$ 172,321,701
	TOTAL CAPITAL COST						**1,033,930,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	246843	kWH	$ 0.44	$108,611
	Labor and Materials	$ 30,000	LS	-	$30,000

Annual O&M **$138,611**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 143,288		$143,288	
2		$ 148,123		$148,123	
3		$ 153,121		$153,121	
4		$ 158,288		$158,288	
5		$ 163,629		$163,629	
6		$ 169,150		$169,150	
7		$ 174,858		$174,858	
8		$ 180,758		$180,758	
9		$ 186,858		$186,858	
10		$ 193,163		$193,163	
11		$ 199,681		$199,681	
12		$ 206,419		$206,419	
13		$ 213,384		$213,384	
14		$ 220,584		$220,584	
15		$ 228,027		$228,027	
16		$ 235,721		$235,721	
17		$ 243,675		$243,675	
18		$ 251,898		$251,898	
19		$ 260,398		$260,398	
20		$ 269,184		$269,184	
21		$ 278,267	$ 27,101,808	$27,380,075	replace elec./ motorized equipment
22		$ 287,657		$287,657	
23		$ 297,363	$ 4,563,184	$4,860,547	sewer inspection at yr 10 of service
24		$ 307,397		$307,397	
25		$ 317,770		$317,770	
26		$ 328,492		$328,492	
27		$ 339,577		$339,577	
28		$ 351,035		$351,035	
29		$ 362,880		$362,880	
30		$ 375,124		$375,124	
		Present value of O&M		**$20,201,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 13,500,000	$ 31,500,000	$ 666,446,733	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$7,289,000**	**$13,606,000**	**$431,788,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **601,448,000**

Easement Area Estimation - Alternative 2C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	344454	40	13778157	316
Regional PS	150	150	67500	2
Neighborhood PS	150	150	225000	5
WWTP				5
Total				328

Annual Power Estimation - Alternative 2C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.11	mgd, Avg.	0.65	mgd, avg.
21	gpm	77	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.5	kw	6.8	kw
10	ea	3	ea	1	ea
3.14	kw	4.64	kw	6.80	kw
27,493	kwh annual	40,646	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**246,843**	**kwh annual**			

Labor and Material Estimation - Alternative 2C

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	2,869	0.58	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	8,608		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	1,089		total
Total for WWTP, Regional PS, and NH PS	**$**	**22,687**		
Use	**$**	**30,000**	rounded up	

Pump Station Weighted Average and Peak Flows - Alternative 2C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	3	0.58	1.75		0.11	0.33

G-8: Alternative 3A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering Gravity Sewer							
	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	111,912	LF			$ 3,700	$ 414,073,873
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	22,772	LF			$ 8,700	$ 198,118,137
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	57	EA			$ 7,000,000	$ 399,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP (6 mgd total)	3	LS			NA	$ 93,000,000
	Subtotal of Estimated Construction Cost						**$ 6,183,255,455**
	Right of Way	2,742	Ac			$ 20,000	$ 54,848,115
	Contingency	20%					$ 1,247,620,714
	Total Estimated Project Cost						**$ 7,485,724,284**
	Project services	20%					$ 1,497,144,857
	TOTAL CAPITAL COST						**8,982,869,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5331748	kWH	$ 0.44	$2,345,969
	Labor and Materials	$ 1,022,561	LS	-	$1,022,561
Annual O&M					**$3,368,530**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,482,195		$3,482,195	
2		$ 3,599,694		$3,599,694	
3		$ 3,721,159		$3,721,159	
4		$ 3,846,722		$3,846,722	
5		$ 3,976,522		$3,976,522	
6		$ 4,110,702		$4,110,702	
7		$ 4,249,410		$4,249,410	
8		$ 4,392,798		$4,392,798	
9		$ 4,541,024		$4,541,024	
10		$ 4,694,252		$4,694,252	
11		$ 4,852,650		$4,852,650	
12		$ 5,016,393		$5,016,393	
13		$ 5,185,662		$5,185,662	
14		$ 5,360,642		$5,360,642	
15		$ 5,541,526		$5,541,526	
16		$ 5,728,514		$5,728,514	
17		$ 5,921,811		$5,921,811	
18		$ 6,121,631		$6,121,631	
19		$ 6,328,193		$6,328,193	
20		$ 6,541,726		$6,541,726	
21		$ 6,762,464	$ 411,947,475	$418,709,939	replace elec./ motorized equipment
22		$ 6,990,650		$6,990,650	
23		$ 7,226,535	$ 33,518,605	$40,745,140	sewer inspection at yr 10 of service
24		$ 7,470,380		$7,470,380	
25		$ 7,722,454		$7,722,454	
26		$ 7,983,033		$7,983,033	
27		$ 8,252,404		$8,252,404	
28		$ 8,530,866		$8,530,866	
29		$ 8,818,723		$8,818,723	
30		$ 9,116,293		$9,116,293	
		Present value of O&M		**$328,075,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 205,200,000	$ 478,800,000	$ 5,499,255,455	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$110,790,000**	**$206,808,000**	**$3,562,947,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,430,399,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering Gravity Sewer							
Keeau WWTP Service Area Only	Gravity Sewer 8 inch	464,427	LF			$ 1,600	$ 743,082,519
	Gravity Sewer 12 inch	41,181	LF			$ 3,700	$ 152,369,275
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	27,892	LF			$ 600	$ 16,735,419
	Force main 6 inch	7,354	LF			$ 900	$ 6,618,240
	Force main 8 inch	2,640	LF			$ 1,600	$ 4,224,000
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	7	EA			$ 7,000,000	$ 49,000,000
	Neighborhood PS	32	EA			$ 1,200,000	$ 38,400,000
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,273,706,506**
	Right of Way	568	Ac			$ 20,000	$ 11,351,904
	Contingency	20%					$ 257,011,682
	Total Estimated Project Cost						**$ 1,542,070,093**
	Project services	20%					$ 308,414,019
	TOTAL CAPITAL COST						**1,850,484,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	419273	kWH	$ 0.44	$184,480
	Labor and Materials	$ 38,303	LS	-	$38,303
Annual O&M					**$222,783**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 230,301		$230,301	
2		$ 238,072		$238,072	
3		$ 246,105		$246,105	
4		$ 254,409		$254,409	
5		$ 262,994		$262,994	
6		$ 271,868		$271,868	
7		$ 281,042		$281,042	
8		$ 290,525		$290,525	
9		$ 300,328		$300,328	
10		$ 310,462		$310,462	
11		$ 320,938		$320,938	
12		$ 331,768		$331,768	
13		$ 342,962		$342,962	
14		$ 354,535		$354,535	
15		$ 366,498		$366,498	
16		$ 378,865		$378,865	
17		$ 391,649		$391,649	
18		$ 404,864		$404,864	
19		$ 418,526		$418,526	
20		$ 432,648		$432,648	
21		$ 447,247	$ 62,273,931	$62,721,178	replace elec./ motorized equipment
22		$ 462,338		$462,338	
23		$ 477,939	$ 7,589,998	$8,067,937	sewer inspection at yr 10 of service
24		$ 494,066		$494,066	
25		$ 510,737		$510,737	
26		$ 527,971		$527,971	
27		$ 545,787		$545,787	
28		$ 564,203		$564,203	
29		$ 583,241		$583,241	
30		$ 602,921		$602,921	
		Present value of O&M		**$42,131,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 31,020,000	$ 72,380,000	$ 1,170,306,506	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$16,748,000**	**$31,263,000**	**$758,237,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,086,367,000**

Easement Area Estimation - Alternative 3A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	590729	40	23629148	542
Regional PS	150	150	157500	4
Neighborhood PS	150	150	720000	17
WWTP				5
Total				568

Annual Power Estimation - Alternative 3A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	61	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	13	hp
0.3	kw	1.2	kw	9.7	kw
32	ea	7	ea	1	ea
10.04	kw	8.63	kw	9.73	kw
87,978	kwh annual	75,611	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**419,273**	**kwh annual**			

Labor and Material Estimation - Alternative 3A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,319	0.47	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 16,233		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 3,485		total
Total for WWTP, Regional PS, and NH PS	**$ 38,303**		

Pump Station Weighted Average and Peak Flows - Alternative 3A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	0					
to Hilo	0					
Weighted Average	7	0.47	3.30		0.09	0.62

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering Gravity Sewer							
HPP (w/ Pahoa) WWTP	Gravity Sewer 8 inch	1,436,306	LF			$ 1,600	$ 2,298,089,120
Service Area Only	Gravity Sewer 12 inch	46,059	LF			$ 3,700	$ 170,417,538
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	21,598	LF			$ 8,700	$ 187,902,726
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	207,200	LF			$ 600	$ 124,320,199
	Force main 6 inch	24,986	LF			$ 900	$ 22,487,760
	Force main 8 inch	14,784	LF			$ 1,600	$ 23,654,400
	Force main 10 inch	32,261	LF			$ 2,650	$ 85,491,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	45	EA			$ 7,000,000	$ 315,000,000
	Neighborhood PS	100	EA			$ 1,200,000	$ 120,000,000
	HPP w/ Pahoa WWTP (4.41 mgd)	1	LS			NA	$ 65,000,000
	Subtotal of Estimated Construction Cost						**$ 4,160,998,865**
	Right of Way	1,826	Ac			$ 20,000	$ 36,513,557
	Contingency	20%					$ 839,502,484
	Total Estimated Project Cost						**$ 5,037,014,907**
	Project services	20%					$ 1,007,402,981
	TOTAL CAPITAL COST						**6,044,418,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4602322	kWH	$ 0.44	$2,025,022
	Labor and Materials	$ 957,151	LS	-	$957,151
Annual O&M					**$2,982,172**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,082,800		$3,082,800	
2		$ 3,186,823		$3,186,823	
3		$ 3,294,356		$3,294,356	
4		$ 3,405,518		$3,405,518	
5		$ 3,520,430		$3,520,430	
6		$ 3,639,220		$3,639,220	
7		$ 3,762,018		$3,762,018	
8		$ 3,888,960		$3,888,960	
9		$ 4,020,186		$4,020,186	
10		$ 4,155,839		$4,155,839	
11		$ 4,296,069		$4,296,069	
12		$ 4,441,032		$4,441,032	
13		$ 4,590,886		$4,590,886	
14		$ 4,745,796		$4,745,796	
15		$ 4,905,934		$4,905,934	
16		$ 5,071,475		$5,071,475	
17		$ 5,242,602		$5,242,602	
18		$ 5,419,503		$5,419,503	
19		$ 5,602,373		$5,602,373	
20		$ 5,791,414		$5,791,414	
21		$ 5,986,834	$ 301,131,195	$307,118,029	replace elec./ motorized equipment
22		$ 6,188,848		$6,188,848	
23		$ 6,397,679	$ 21,495,944	$27,893,622	sewer inspection at yr 10 of service
24		$ 6,613,556		$6,613,556	
25		$ 6,836,717		$6,836,717	
26		$ 7,067,409		$7,067,409	
27		$ 7,305,885		$7,305,885	
28		$ 7,552,407		$7,552,407	
29		$ 7,807,248		$7,807,248	
30		$ 8,070,689		$8,070,689	
		Present value of O&M		**$254,119,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 150,000,000	$ 350,000,000	$ 3,660,998,865	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$80,987,000**	**$151,176,000**	**$2,371,948,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **3,694,426,000**

Easement Area Estimation - Alternative 3A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1890266	40	75610627	1736
Regional PS	150	150	1012500	23
Neighborhood PS	150	150	2250000	52
WWTP				15
Total				1826

Annual Power Estimation - Alternative 3A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.57	mgd, Avg.	4.41	mgd, avg.
21	gpm	393	gpm	3,063	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	62	hp
0.3	kw	7.9	kw	46.1	kw
100	ea	45	ea	1	ea
31.38	kw	355.59	kw	46.14	kw
274,930	kwh annual	3,114,952	kwh annual	404,147	pumping kwh annual
				808,294	other kwh annual, approx 2x pumping
Total Power	**4,602,322**	**kwh annual**			

Labor and Material Estimation - Alternative 3A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 88,132	4.41	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 19,070	2.69	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 858,129		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 10,890		total
Total for WWTP, Regional PS, and NH PS	**$ 957,151**		

Pump Station Weighted Average and Peak Flows - Alternative 3A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	45	2.69	121.07		0.57	25.49

JOB #: Puna Wastewater Facility Plan
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PREPARED BY: T. Huang

AECOM
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Wastewater Facility Plan Estimates

Alternative 3A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
3 plants urban sewering							
Gravity Sewer							
Volcano WWTP	Gravity Sewer 8 inch	272,806	LF			$ 1,600	$ 436,489,437
Service Area Only	Gravity Sewer 12 inch	24,672	LF			$ 3,700	$ 91,287,059
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	28,079	LF			$ 600	$ 16,847,531
	Force main 6 inch	8,700	LF			$ 900	$ 7,830,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch	-	LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch		LF			$ 15,200	$ -
	Force main 48 inch		LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch		LF			$ 450	$ -
	Regional PS	5	EA			$ 7,000,000	$ 35,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 748,550,084**
	Right of Way	349	Ac			$ 20,000	$ 6,982,654
	Contingency	20%					$ 151,106,547
	Total Estimated Project Cost						**$ 906,639,285**
	Project services	20%					$ 181,327,857
	TOTAL CAPITAL COST						**1,087,967,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	310153	kWH	$ 0.44	$136,467
	Labor and Materials	$ 27,107	LS	-	$27,107
Annual O&M					**$163,574**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 169,094		$169,094	
2		$ 174,800		$174,800	
3		$ 180,698		$180,698	
4		$ 186,795		$186,795	
5		$ 193,098		$193,098	
6		$ 199,614		$199,614	
7		$ 206,350		$206,350	
8		$ 213,312		$213,312	
9		$ 220,510		$220,510	
10		$ 227,951		$227,951	
11		$ 235,643		$235,643	
12		$ 243,594		$243,594	
13		$ 251,813		$251,813	
14		$ 260,310		$260,310	
15		$ 269,094		$269,094	
16		$ 278,174		$278,174	
17		$ 287,561		$287,561	
18		$ 297,264		$297,264	
19		$ 307,294		$307,294	
20		$ 317,663		$317,663	
21		$ 328,382	$ 48,542,349	$48,870,731	replace elec./ motorized equipment
22		$ 339,463		$339,463	
23		$ 350,917	$ 4,432,663	$4,783,580	sewer inspection at yr 10 of service
24		$ 362,758		$362,758	
25		$ 374,999		$374,999	
26		$ 387,653		$387,653	
27		$ 400,733		$400,733	
28		$ 414,255		$414,255	
29		$ 428,233		$428,233	
30		$ 442,683		$442,683	
		Present value of O&M		**$31,824,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 24,180,000	$ 56,420,000	$ 667,950,084	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$13,055,000**	**$24,370,000**	**$432,762,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) 649,604,000

Easement Area Estimation - Alternative 3A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	356198	40	14247920	327
Regional PS	150	150	112500	3
Neighborhood PS	150	150	630000	14
WWTP				5
Total				349

Annual Power Estimation - Alternative 3A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.65	mgd, avg.
21	gpm	62	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.2	kw	6.8	kw
28	ea	5	ea	1	ea
8.79	kw	6.22	kw	6.80	kw
76,980	kwh annual	54,468	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**310,153**	**kwh annual**			

Labor and Material Estimation - Alternative 3A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,214	0.45	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 11,068		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 3,049		total
Total for WWTP, Regional PS, and NH PS	**$ 27,107**		

Pump Station Weighted Average and Peak Flows - Alternative 3A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	5	0.45	2.25		0.09	0.45

G-9: Alternative 3B Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering 'Gravity and LP Sewer							
	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	111,912	LF			$ 3,700	$ 414,073,873
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	22,772	LF			$ 8,700	$ 198,118,137
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	406,495	LF			$ 450	$ 182,922,677
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	57	EA			$ 7,000,000	$ 399,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (6 mgd total)	3	LS			NA	$ 93,000,000
	Subtotal of Estimated Construction Cost						**$ 5,469,402,762**
	Right of Way	2,418	Ac			$ 20,000	$ 48,361,946
	Contingency	20%					$ 1,103,552,942
	Total Estimated Project Cost						**$ 6,621,317,650**
	Project services	20%					$ 1,324,263,530
	TOTAL CAPITAL COST						**7,945,581,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4891860	kWH	$ 0.44	$2,152,418
	Labor and Materials	$ 3,334,398	LS	-	$3,334,398
Annual O&M					**$5,486,816**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 5,671,958		$5,671,958	
2		$ 5,863,347		$5,863,347	
3		$ 6,061,194		$6,061,194	
4		$ 6,265,718		$6,265,718	
5		$ 6,477,142		$6,477,142	
6		$ 6,695,700		$6,695,700	
7		$ 6,921,633		$6,921,633	
8		$ 7,155,190		$7,155,190	
9		$ 7,396,628		$7,396,628	
10		$ 7,646,213		$7,646,213	
11		$ 7,904,219		$7,904,219	
12		$ 8,170,932		$8,170,932	
13		$ 8,446,644		$8,446,644	
14		$ 8,731,659		$8,731,659	
15		$ 9,026,291		$9,026,291	
16		$ 9,330,866		$9,330,866	
17		$ 9,645,718		$9,645,718	
18		$ 9,971,193		$9,971,193	
19		$ 10,307,652		$10,307,652	
20		$ 10,655,463		$10,655,463	
21		$ 11,015,011	$ 358,948,385	$369,963,395	replace elec./ motorized equipment
22		$ 11,386,691		$11,386,691	
23		$ 11,770,912	$ 27,827,677	$39,598,589	sewer inspection at yr 10 of service
24		$ 12,168,098		$12,168,098	
25		$ 12,578,687		$12,578,687	
26		$ 13,003,130		$13,003,130	
27		$ 13,441,895		$13,441,895	
28		$ 13,895,465		$13,895,465	
29		$ 14,364,340		$14,364,340	
30		$ 14,849,037		$14,849,037	
		Present value of O&M		**$362,470,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 178,800,000	$ 417,200,000	$ 4,873,402,762	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$96,537,000**	**$180,202,000**	**$3,157,460,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,873,852,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering 'Gravity and LP Sewer							
Keeau WWTP	Gravity Sewer 8 inch	423,374	LF			$ 1,600	$ 677,398,705
Service Area Only	Gravity Sewer 12 inch	41,181	LF			$ 3,700	$ 152,369,275
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	8,040	LF			$ 900	$ 7,236,000
	Force main 8 inch	1,954	LF			$ 1,600	$ 3,125,760
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch		LF			$ 10,875	$ -
	Force main 36 inch		LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	41,052	LF			$ 450	$ 18,473,573
	Low pressure sewer (On-Lot)	400	EA			$ 26,000	$ 10,400,000
	Regional PS	7	EA			$ 7,000,000	$ 49,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,181,280,365**
	Right of Way	525	Ac			$ 20,000	$ 10,509,069
	Contingency	20%					$ 238,357,887
	Total Estimated Project Cost						**$ 1,430,147,321**
	Project services	20%					$ 286,029,464
	TOTAL CAPITAL COST						**1,716,177,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	331295	kWH	$ 0.44	$145,770
	Labor and Materials	$ 268,071	LS	-	$268,071
Annual O&M					**$413,841**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 427,805		$427,805	
2		$ 442,241		$442,241	
3		$ 457,163		$457,163	
4		$ 472,589		$472,589	
5		$ 488,536		$488,536	
6		$ 505,021		$505,021	
7		$ 522,061		$522,061	
8		$ 539,677		$539,677	
9		$ 557,888		$557,888	
10		$ 576,713		$576,713	
11		$ 596,173		$596,173	
12		$ 616,289		$616,289	
13		$ 637,085		$637,085	
14		$ 658,582		$658,582	
15		$ 680,804		$680,804	
16		$ 703,777		$703,777	
17		$ 727,524		$727,524	
18		$ 752,073		$752,073	
19		$ 777,450		$777,450	
20		$ 803,684		$803,684	
21		$ 830,803	$ 45,410,584	$46,241,387	replace elec./ motorized equipment
22		$ 858,837		$858,837	
23		$ 887,816	$ 7,015,265	$7,903,081	sewer inspection at yr 10 of service
24		$ 917,774		$917,774	
25		$ 948,742		$948,742	
26		$ 980,756		$980,756	
27		$ 1,013,850		$1,013,850	
28		$ 1,048,060		$1,048,060	
29		$ 1,083,425		$1,083,425	
30		$ 1,119,983		$1,119,983	
		Present value of O&M		**$39,044,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 22,620,000	$ 52,780,000	$ 1,105,880,365	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$12,213,000**	**$22,797,000**	**$716,496,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,003,715,000**

Easement Area Estimation - Alternative 3B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	562836	40	22513453	517
Regional PS	150	150	157500	4
Neighborhood PS	150	150	0	0
WWTP				5
Total				525

Annual Power Estimation - Alternative 3B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	61	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	13	hp
0.3	kw	1.2	kw	9.7	kw
0	ea	7	ea	1	ea
0.00	kw	8.63	kw	9.73	kw
-	kwh annual	75,611	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**331,295**	**kwh annual**			

Labor and Material Estimation - Alternative 3B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,319	0.47	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 16,233		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 34,819**		

Pump Station Weighted Average and Peak Flows - Alternative 3B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	0					
to Hilo	0					
Weighted Average	7	0.47	3.30		0.09	0.62

O&M Estimation for Puna LPS - Alternative 3B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00

Puna LPS OM Cost					
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM
LP pipe, valves, etc.	41052	$ 450	$ 18,473,573	0.81	**$ 33,252**
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM
lat Kits, etc.	400	$ 26,000	$ 10,400,000	500	**$ 200,000**

JOB #: Puna Wastewater Facility Plan
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PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering 'Gravity and LP Sewer HPP (w/ Pahoa) WWTP Service Area Only							
	Gravity Sewer 8 inch	1,105,348	LF			$ 1,600	$ 1,768,557,473
	Gravity Sewer 12 inch	46,059	LF			$ 3,700	$ 170,417,538
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	21,598	LF			$ 8,700	$ 187,902,726
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	24,986	LF			$ 900	$ 22,487,760
	Force main 8 inch	14,784	LF			$ 1,600	$ 23,654,400
	Force main 10 inch	32,261	LF			$ 2,650	$ 85,491,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	330,957	LF			$ 450	$ 148,930,776
	Low pressure sewer (On-Lot)	3,300	EA			$ 26,000	$ 85,800,000
	Regional PS	45	EA			$ 7,000,000	$ 315,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	HPP w/ Pahoa WWTP (4.41 mgd)	1	LS			NA	$ 65,000,000
	Subtotal of Estimated Construction Cost						**$ 3,621,877,795**
	Right of Way	1,584	Ac			$ 20,000	$ 31,675,167
	Contingency	20%					$ 730,710,592
	Total Estimated Project Cost						**$ 4,384,263,555**
	Project services	20%					$ 876,852,711
	TOTAL CAPITAL COST						**5,261,116,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4327392	kWH	$ 0.44	$1,904,053
	Labor and Materials	$ 2,864,336	LS	-	$2,864,336
Annual O&M					**$4,768,389**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,929,289		$4,929,289	
2		$ 5,095,618		$5,095,618	
3		$ 5,267,559		$5,267,559	
4		$ 5,445,303		$5,445,303	
5		$ 5,629,044		$5,629,044	
6		$ 5,818,985		$5,818,985	
7		$ 6,015,335		$6,015,335	
8		$ 6,218,311		$6,218,311	
9		$ 6,428,135		$6,428,135	
10		$ 6,645,040		$6,645,040	
11		$ 6,869,264		$6,869,264	
12		$ 7,101,054		$7,101,054	
13		$ 7,340,665		$7,340,665	
14		$ 7,588,361		$7,588,361	
15		$ 7,844,415		$7,844,415	
16		$ 8,109,110		$8,109,110	
17		$ 8,382,735		$8,382,735	
18		$ 8,665,594		$8,665,594	
19		$ 8,957,998		$8,957,998	
20		$ 9,260,268		$9,260,268	
21		$ 9,572,737	$ 280,533,821	$290,106,559	replace elec./ motorized equipment
22		$ 9,895,750		$9,895,750	
23		$ 10,229,663	$ 16,862,542	$27,092,205	sewer inspection at yr 10 of service
24		$ 10,574,843		$10,574,843	
25		$ 10,931,670		$10,931,670	
26		$ 11,300,538		$11,300,538	
27		$ 11,681,852		$11,681,852	
28		$ 12,076,033		$12,076,033	
29		$ 12,483,515		$12,483,515	
30		$ 12,904,747		$12,904,747	
		Present value of O&M		**$295,484,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 139,740,000	$ 326,060,000	$ 3,156,077,795	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$75,448,000**	**$140,835,000**	**$2,044,811,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **3,295,506,000**

Easement Area Estimation - Alternative 3B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1683065	40	67322614	1546
Regional PS	150	150	1012500	23
Neighborhood PS	150	150	0	0
WWTP				15
Total				1584

Annual Power Estimation - Alternative 3B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.57	mgd, Avg.	4.41	mgd, avg.
21	gpm	393	gpm	3,063	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	62	hp
0.3	kw	7.9	kw	46.1	kw
0	ea	45	ea	1	ea
0.00	kw	355.59	kw	46.14	kw
-	kwh annual	3,114,952	kwh annual	404,147	pumping kwh annual
				808,294	other kwh annual, approx 2x pumping
Total Power	**4,327,392**	**kwh annual**			

Labor and Material Estimation - Alternative 3B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 88,132	4.41	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 19,070	2.69	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 858,129		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 946,261**		

Pump Station Weighted Average and Peak Flows - Alternative 3B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	45	2.69	121.07		0.57	25.49

O&M Estimation for Puna LPS - Alternative 3B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	330957	$ 450	$ 148,930,776	0.81	**$ 268,075**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	3300	$ 26,000	$ 85,800,000	500	**$ 1,650,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3B	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
3 plants urban sewering 'Gravity and LP Sewer							
Volcano WWTP	Gravity Sewer 8 inch	238,321	LF			$ 1,600	$ 381,313,159
Service Area Only	Gravity Sewer 12 inch	24,672	LF			$ 3,700	$ 91,287,059
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch		LF			$ 600	$ -
	Force main 6 inch	8,700	LF			$ 900	$ 7,830,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch		LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	34,485	LF			$ 450	$ 15,518,328
	Low pressure sewer (On-Lot)	300	EA			$ 26,000	$ 7,800,000
	Regional PS	5	EA			$ 7,000,000	$ 35,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 666,244,602**
	Right of Way	309	Ac			$ 20,000	$ 6,177,709
	Contingency	20%					$ 134,484,462
	Total Estimated Project Cost						**$ 806,906,774**
	Project services	20%					$ 161,381,355
	TOTAL CAPITAL COST						**968,288,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	233173	kWH	$ 0.44	$102,596
	Labor and Materials	$ 201,991	LS	-	$201,991

Annual O&M **$304,587**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 314,864		$314,864	
2		$ 325,489		$325,489	
3		$ 336,472		$336,472	
4		$ 347,826		$347,826	
5		$ 359,562		$359,562	
6		$ 371,695		$371,695	
7		$ 384,237		$384,237	
8		$ 397,202		$397,202	
9		$ 410,605		$410,605	
10		$ 424,460		$424,460	
11		$ 438,783		$438,783	
12		$ 453,589		$453,589	
13		$ 468,894		$468,894	
14		$ 484,716		$484,716	
15		$ 501,072		$501,072	
16		$ 517,980		$517,980	
17		$ 535,458		$535,458	
18		$ 553,526		$553,526	
19		$ 572,203		$572,203	
20		$ 591,511		$591,511	
21		$ 611,471	$ 33,003,979	$33,615,450	replace elec./ motorized equipment
22		$ 632,103		$632,103	
23		$ 653,433	$ 3,949,870	$4,603,303	sewer inspection at yr 10 of service
24		$ 675,481		$675,481	
25		$ 698,274		$698,274	
26		$ 721,836		$721,836	
27		$ 746,193		$746,193	
28		$ 771,372		$771,372	
29		$ 797,400		$797,400	
30		$ 824,307		$824,307	
		Present value of O&M		**$27,942,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 16,440,000	$ 38,360,000	$ 611,444,602	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$8,876,000**	**$16,569,000**	**$396,153,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **574,632,000**

Easement Area Estimation - Alternative 3B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	328119	40	13124751	301
Regional PS	150	150	112500	3
Neighborhood PS	150	150	0	0
WWTP				5
Total				309

Annual Power Estimation - Alternative 3B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.65	mgd, avg.
21	gpm	62	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.2	kw	6.8	kw
0	ea	5	ea	1	ea
0.00	kw	6.22	kw	6.80	kw
-	kwh annual	54,468	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**233,173**	**kwh annual**			

Labor and Material Estimation - Alternative 3B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,214	0.45	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 11,068		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 24,058**		

Pump Station Weighted Average and Peak Flows - Alternative 3B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	5	0.45	2.25		0.09	0.45

O&M Estimation for Puna LPS - Alternative 3B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00

Puna LPS OM Cost					
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM
LP pipe, valves, etc.	34485	$ 450	$ 15,518,328	0.81	**$ 27,933**
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM
lat Kits, etc.	300	$ 26,000	$ 7,800,000	500	**$ 150,000**

G-10: Alternative 3C Construction Cost and LCC Analysis

	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
Alternative 3C							
3 plants urban sewering Cross-Country Sewer							
	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	119,374	LF			$ 3,700	$ 441,684,298
	Gravity Sewer 16 inch	60,414	LF			$ 5,800	$ 350,403,958
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	22,772	LF			$ 8,700	$ 198,118,137
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	7,286	LF			$ 4,750	$ 34,610,400
	Force main 16 inch	41,606	LF			$ 5,800	$ 241,317,120
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	49	EA			$ 7,000,000	$ 343,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP (6 mgd total)	3	LS			NA	$ 93,000,000
	Subtotal of Estimated Construction Cost						**$ 6,065,950,366**
	Right of Way	2,553	Ac			$ 20,000	$ 51,065,261
	Contingency	20%					$ 1,223,403,125
	Total Estimated Project Cost						**$ 7,340,418,752**
	Project services	20%					$ 1,468,083,750
	TOTAL CAPITAL COST						**8,808,503,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4911636	kWH	$ 0.44	$2,161,120
	Labor and Materials	$ 1,011,725	LS	-	$1,011,725

Annual O&M **$3,172,845**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,279,907		$3,279,907	
2		$ 3,390,581		$3,390,581	
3		$ 3,504,989		$3,504,989	
4		$ 3,623,258		$3,623,258	
5		$ 3,745,518		$3,745,518	
6		$ 3,871,903		$3,871,903	
7		$ 4,002,553		$4,002,553	
8		$ 4,137,611		$4,137,611	
9		$ 4,277,227		$4,277,227	
10		$ 4,421,553		$4,421,553	
11		$ 4,570,750		$4,570,750	
12		$ 4,724,981		$4,724,981	
13		$ 4,884,416		$4,884,416	
14		$ 5,049,231		$5,049,231	
15		$ 5,219,607		$5,219,607	
16		$ 5,395,733		$5,395,733	
17		$ 5,577,801		$5,577,801	
18		$ 5,766,013		$5,766,013	
19		$ 5,960,576		$5,960,576	
20		$ 6,161,704		$6,161,704	
21		$ 6,369,618	$ 289,326,852	$295,696,470	replace elec./ motorized equipment
22		$ 6,584,548		$6,584,548	
23		$ 6,806,731	$ 34,776,943	$41,583,674	sewer inspection at yr 10 of service
24		$ 7,036,411		$7,036,411	
25		$ 7,273,841		$7,273,841	
26		$ 7,519,282		$7,519,282	
27		$ 7,773,005		$7,773,005	
28		$ 8,035,290		$8,035,290	
29		$ 8,306,425		$8,306,425	
30		$ 8,586,709		$8,586,709	
		Present value of O&M		**$260,243,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 144,120,000	$ 336,280,000	$ 5,585,550,366	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$77,812,000**	**$145,250,000**	**$3,618,857,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,226,827,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering							
Cross-Country Sewer							
Keeau WWTP	Gravity Sewer 8 inch	472,118	LF			$ 1,600	$ 755,389,530
Service Area Only	Gravity Sewer 12 inch	50,847	LF			$ 3,700	$ 188,135,674
	Gravity Sewer 16 inch	30,379	LF			$ 5,800	$ 176,195,723
	Gravity Sewer 18 inch	4,983	LF			$ 6,525	$ 32,510,919
	Gravity Sewer 24 inch	1,174	LF			$ 8,700	$ 10,215,411
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	10,974	LF			$ 600	$ 6,584,148
	Force main 6 inch	4,000	LF			$ 900	$ 3,600,000
	Force main 8 inch	-	LF			$ 1,600	$ -
	Force main 10 inch	10,700	LF			$ 2,650	$ 28,355,000
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	3	EA			$ 7,000,000	$ 21,000,000
	Neighborhood PS	12	EA			$ 1,200,000	$ 14,400,000
	Keeau WWTP (0.93 mgd)	1	LS			NA	$ 16,000,000
	Subtotal of Estimated Construction Cost						**$ 1,252,386,403**
	Right of Way	550	Ac			$ 20,000	$ 11,001,970
	Contingency	20%					$ 252,677,675
	Total Estimated Project Cost						**$ 1,516,066,048**
	Project services	20%					$ 303,213,210
	TOTAL CAPITAL COST						**1,819,279,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	322424	kWH	$ 0.44	$141,867
	Labor and Materials	$ 28,452	LS	-	$28,452
Annual O&M					**$170,318**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 176,065		$176,065	
2		$ 182,006		$182,006	
3		$ 188,148		$188,148	
4		$ 194,496		$194,496	
5		$ 201,059		$201,059	
6		$ 207,844		$207,844	
7		$ 214,857		$214,857	
8		$ 222,107		$222,107	
9		$ 229,601		$229,601	
10		$ 237,349		$237,349	
11		$ 245,358		$245,358	
12		$ 253,637		$253,637	
13		$ 262,195		$262,195	
14		$ 271,043		$271,043	
15		$ 280,188		$280,188	
16		$ 289,643		$289,643	
17		$ 299,416		$299,416	
18		$ 309,519		$309,519	
19		$ 319,964		$319,964	
20		$ 330,760		$330,760	
21		$ 341,921	$ 30,956,287	$31,298,208	replace elec./ motorized equipment
22		$ 353,458		$353,458	
23		$ 365,385	$ 7,833,017	$8,198,402	sewer inspection at yr 10 of service
24		$ 377,714		$377,714	
25		$ 390,460		$390,460	
26		$ 403,635		$403,635	
27		$ 417,255		$417,255	
28		$ 431,334		$431,334	
29		$ 445,889		$445,889	
30		$ 460,934		$460,934	
		Present value of O&M		**$24,694,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 15,420,000	$ 35,980,000	$ 1,200,986,403	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$8,325,000**	**$15,541,000**	**$778,115,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **1,041,992,000**

Easement Area Estimation - Alternative 3C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	585175	40	23406992	537
Regional PS	150	150	67500	2
Neighborhood PS	150	150	270000	6
WWTP				5
Total				550

Annual Power Estimation - Alternative 3C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.09	mgd, Avg.	0.93	mgd, avg.
21	gpm	64	gpm	646	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	13	hp
0.3	kw	1.3	kw	9.7	kw
12	ea	3	ea	1	ea
3.77	kw	3.85	kw	9.73	kw
32,992	kwh annual	33,748	kwh annual	85,228	pumping kwh annual
				170,456	other kwh annual, approx 2x pumping
Total Power	**322,424**	**kwh annual**			

Labor and Material Estimation - Alternative 3C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 18,586	0.93	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,853	0.58	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 8,559		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 1,307		total
Total for WWTP, Regional PS, and NH PS	**$ 28,452**		

Pump Station Weighted Average and Peak Flows - Alternative 3C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	3	0.58	1.74		0.09	0.28

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
3 plants urban sewering Cross-Country Sewer							
HPP (w/ Pahoa) WWTP Service Area Only	Gravity Sewer 8 inch	1,500,196	LF			$ 1,600	$ 2,400,313,173
	Gravity Sewer 12 inch	45,369	LF			$ 3,700	$ 167,864,120
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch	21,598	LF			$ 8,700	$ 187,902,726
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch	13,328	LF			$ 15,200	$ 202,588,289
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	28,282	LF			$ 600	$ 16,969,368
	Force main 6 inch	14,150	LF			$ 900	$ 12,735,360
	Force main 8 inch	12,830	LF			$ 1,600	$ 20,528,640
	Force main 10 inch	22,704	LF			$ 2,650	$ 60,165,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	7,286	LF			$ 4,750	$ 34,610,400
	Force main 16 inch	41,606	LF			$ 5,800	$ 241,317,120
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	43	EA			$ 7,000,000	$ 301,000,000
	Neighborhood PS	15	EA			$ 1,200,000	$ 18,000,000
	HPP w/ Pahoa WWTP (4.41 mgd)	1	LS			NA	$ 65,000,000
	Subtotal of Estimated Construction Cost						**$ 4,102,117,230**
	Right of Way	1,675	Ac			$ 20,000	$ 33,502,934
	Contingency	20%					$ 827,124,033
	Total Estimated Project Cost						**$ 4,962,744,196**
	Project services	20%					$ 992,548,839
	TOTAL CAPITAL COST						**5,955,293,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4342369	kWH	$ 0.44	$1,910,642
	Labor and Materials	$ 960,587	LS	-	$960,587
Annual O&M					**$2,871,229**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 2,968,113		$2,968,113	
2		$ 3,068,266		$3,068,266	
3		$ 3,171,798		$3,171,798	
4		$ 3,278,825		$3,278,825	
5		$ 3,389,462		$3,389,462	
6		$ 3,503,833		$3,503,833	
7		$ 3,622,063		$3,622,063	
8		$ 3,744,282		$3,744,282	
9		$ 3,870,625		$3,870,625	
10		$ 4,001,232		$4,001,232	
11		$ 4,136,246		$4,136,246	
12		$ 4,275,815		$4,275,815	
13		$ 4,420,094		$4,420,094	
14		$ 4,569,242		$4,569,242	
15		$ 4,723,422		$4,723,422	
16		$ 4,882,804		$4,882,804	
17		$ 5,047,565		$5,047,565	
18		$ 5,217,885		$5,217,885	
19		$ 5,393,952		$5,393,952	
20		$ 5,575,961		$5,575,961	
21		$ 5,764,110	$ 231,268,758	$237,032,868	replace elec./ motorized equipment
22		$ 5,958,609		$5,958,609	
23		$ 6,159,670	$ 22,380,743	$28,540,413	sewer inspection at yr 10 of service
24		$ 6,367,516		$6,367,516	
25		$ 6,582,376		$6,582,376	
26		$ 6,804,485		$6,804,485	
27		$ 7,034,089		$7,034,089	
28		$ 7,271,440		$7,271,440	
29		$ 7,516,801		$7,516,801	
30		$ 7,770,441		$7,770,441	
		Present value of O&M		**$215,569,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 115,200,000	$ 268,800,000	$ 3,718,117,230	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$62,198,000**	**$116,103,000**	**$2,408,954,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **3,583,607,000**

Easement Area Estimation - Alternative 3C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1775275	40	71010990	1630
Regional PS	150	150	967500	22
Neighborhood PS	150	150	337500	8
WWTP				15
Total				1675

Annual Power Estimation - Alternative 3C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.59	mgd, Avg.	4.41	mgd, avg.
21	gpm	408	gpm	3,063	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	62	hp
0.3	kw	8.2	kw	46.1	kw
15	ea	43	ea	1	ea
4.71	kw	352.59	kw	46.14	kw
41,239	kwh annual	3,088,689	kwh annual	404,147	pumping kwh annual
				808,294	other kwh annual, approx 2x pumping
Total Power	**4,342,369**	**kwh annual**			

Labor and Material Estimation - Alternative 3C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 88,132	4.41	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 20,252	2.79	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 870,821		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 1,634		total
Total for WWTP, Regional PS, and NH PS	**$ 960,587**		

Pump Station Weighted Average and Peak Flows - Alternative 3C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC		0.45	0	5.61	0.08	0.00
Volcano Makai		0.65	0	5.15	0.13	0.00
Old Volcano Rd.		0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	43	2.79	120.12		0.59	25.28

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 3C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering Cross-Country Sewer							
Volcano WWTP Service Area Only	Gravity Sewer 8 inch	283,643	LF			$ 1,600	$ 453,828,835
	Gravity Sewer 12 inch	23,158	LF			$ 3,700	$ 85,684,504
	Gravity Sewer 16 inch	19,141	LF			$ 5,800	$ 111,016,056
	Gravity Sewer 18 inch		LF			$ 6,525	$ -
	Gravity Sewer 24 inch		LF			$ 8,700	$ -
	Gravity Sewer 30 inch		LF			$ 10,875	$ -
	Gravity Sewer 36 inch		LF			$ 13,050	$ -
	Gravity Sewer 42 inch		LF			$ 15,200	$ -
	Gravity Sewer 48 inch		LF			$ 17,400	$ -
	Gravity Sewer 54 inch		LF			$ 19,500	$ -
	Force main 4 inch	9,012	LF			$ 600	$ 5,407,337
	Force main 6 inch	6,700	LF			$ 900	$ 6,030,000
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch		LF			$ 2,650	$ -
	Force main 12 inch		LF			$ 3,700	$ -
	Force main 14 inch		LF			$ 4,750	$ -
	Force main 16 inch		LF			$ 5,800	$ -
	Force main 18 inch		LF			$ 6,525	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	3	EA			$ 7,000,000	$ 21,000,000
	Neighborhood PS	10	EA			$ 1,200,000	$ 12,000,000
	Volcano WWTP (0.65 mgd)	1	LS			NA	$ 12,000,000
	Subtotal of Estimated Construction Cost						**$ 711,446,733**
	Right of Way	328	Ac			$ 20,000	$ 6,560,357
	Contingency	20%					$ 143,601,418
	Total Estimated Project Cost						**$ 861,608,507**
	Project services	20%					$ 172,321,701
	TOTAL CAPITAL COST						**1,033,930,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	246843	kWH	$ 0.44	$108,611
	Labor and Materials	$ 22,687	LS	-	$22,687
Annual O&M					**$131,298**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 135,729		$135,729	
2		$ 140,309		$140,309	
3		$ 145,043		$145,043	
4		$ 149,937		$149,937	
5		$ 154,997		$154,997	
6		$ 160,227		$160,227	
7		$ 165,633		$165,633	
8		$ 171,222		$171,222	
9		$ 177,000		$177,000	
10		$ 182,972		$182,972	
11		$ 189,146		$189,146	
12		$ 195,529		$195,529	
13		$ 202,126		$202,126	
14		$ 208,947		$208,947	
15		$ 215,997		$215,997	
16		$ 223,286		$223,286	
17		$ 230,820		$230,820	
18		$ 238,608		$238,608	
19		$ 246,660		$246,660	
20		$ 254,983		$254,983	
21		$ 263,587	$ 27,101,808	$27,365,394	replace elec./ motorized equipment
22		$ 272,481		$272,481	
23		$ 281,675	$ 4,563,184	$4,844,859	sewer inspection at yr 10 of service
24		$ 291,180		$291,180	
25		$ 301,005		$301,005	
26		$ 311,162		$311,162	
27		$ 321,662		$321,662	
28		$ 332,515		$332,515	
29		$ 343,735		$343,735	
30		$ 355,334		$355,334	
		Present value of O&M		**$19,980,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 13,500,000	$ 31,500,000	$ 666,446,733	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$7,289,000**	**$13,606,000**	**$431,788,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **601,227,000**

Easement Area Estimation - Alternative 3C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	344454	40	13778157	316
Regional PS	150	150	67500	2
Neighborhood PS	150	150	225000	5
WWTP				5
Total				328

Annual Power Estimation - Alternative 3C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.11	mgd, Avg.	0.65	mgd, avg.
21	gpm	77	gpm	451	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	2	hp	9	hp
0.3	kw	1.5	kw	6.8	kw
10	ea	3	ea	1	ea
3.14	kw	4.64	kw	6.80	kw
27,493	kwh annual	40,646	kwh annual	59,568	pumping kwh annual
				119,136	other kwh annual, approx 2x pumping
Total Power	**246,843**	**kwh annual**			

Labor and Material Estimation - Alternative 3C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 12,990	0.65	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 2,869	0.58	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 8,608		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 1,089		total
Total for WWTP, Regional PS, and NH PS	**$ 22,687**		

Pump Station Weighted Average and Peak Flows - Alternative 3C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa		2.36	0	4.49	0.53	0.00
Lelani		0.73	0	10.3	0.07	0.00
Nanawale		0.938	0	4.43	0.21	0.00
Hawaiian Beaches		2.9	0	5.07	0.57	0.00
HPP		4.42	0	4.47	0.99	0.00
Ainaloa		0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc		0.58	0	6.3	0.09	0.00
West Keaau		0.3	0	4.89	0.06	0.00
Paahana-Keaau		0.42	0	4.48	0.09	0.00
HPP to Keaau	0					
to Hilo	0					
Weighted Average	3	0.58	1.75		0.11	0.33

G-11: Alternative 4A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 4A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
1 plants urban sewering							
Gravity Sewer							
	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	78,405	LF			$ 3,700	$ 290,100,132
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	26,581	LF			$ 8,700	$ 231,250,618
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	58	EA			$ 7,000,000	$ 406,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 6,678,942,804**
	Right of Way	2,772	Ac			$ 20,000	$ 55,447,128
	Contingency	20%					$ 1,346,877,986
	Total Estimated Project Cost						**$ 8,081,267,919**
	Project services	20%					$ 1,616,253,584
	TOTAL CAPITAL COST						**9,697,522,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5873575	kWH	$ 0.44	$2,584,373
	Labor and Materials	$ 1,146,703	LS	-	$1,146,703
Annual O&M					**$3,731,076**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,856,974		$3,856,974	
2		$ 3,987,120		$3,987,120	
3		$ 4,121,658		$4,121,658	
4		$ 4,260,735		$4,260,735	
5		$ 4,404,505		$4,404,505	
6		$ 4,553,126		$4,553,126	
7		$ 4,706,763		$4,706,763	
8		$ 4,865,583		$4,865,583	
9		$ 5,029,763		$5,029,763	
10		$ 5,199,482		$5,199,482	
11		$ 5,374,928		$5,374,928	
12		$ 5,556,295		$5,556,295	
13		$ 5,743,781		$5,743,781	
14		$ 5,937,594		$5,937,594	
15		$ 6,137,946		$6,137,946	
16		$ 6,345,059		$6,345,059	
17		$ 6,559,160		$6,559,160	
18		$ 6,780,486		$6,780,486	
19		$ 7,009,281		$7,009,281	
20		$ 7,245,795		$7,245,795	
21		$ 7,490,290	$ 403,515,802	$411,006,092	replace elec./ motorized equipment
22		$ 7,743,035		$7,743,035	
23		$ 8,004,309	$ 33,868,397	$41,872,706	sewer inspection at yr 10 of service
24		$ 8,274,398		$8,274,398	
25		$ 8,553,601		$8,553,601	
26		$ 8,842,226		$8,842,226	
27		$ 9,140,589		$9,140,589	
28		$ 9,449,021		$9,449,021	
29		$ 9,767,859		$9,767,859	
30		$ 10,097,456		$10,097,456	
		Present value of O&M		**$334,922,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 201,000,000	$ 469,000,000	$ 6,008,942,804	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$108,523,000**	**$202,576,000**	**$3,893,172,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,828,173,000**

Easement Area Estimation - Alternative 4A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2874691	40	114987646	2640
Regional PS	150	150	1305000	30
Neighborhood PS	150	150	3600000	83
WWTP				20
Total				2772

Annual Power Estimation - Alternative 4A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.53	mgd, Avg.	6	mgd, avg.
21	gpm	371	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	10	hp	84	hp
0.3	kw	7.4	kw	62.8	kw
160	ea	58	ea	1	ea
50.22	kw	431.98	kw	62.77	kw
439,888	kwh annual	3,784,109	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**5,873,575**	**kwh annual**			

Labor and Material Estimation - Alternative 4A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 17,403	2.55	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,009,372		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 17,424		total
Total for WWTP, Regional PS, and NH PS	**$ 1,146,703**		

Pump Station Weighted Average and Peak Flows - Alternative 4A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	21	21	4.76	4.41	4.41
to Hilo	0					
Weighted Average	58	2.55	147.62		0.53	30.97

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 4A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants urban sewering							
Gravity Sewer							
Excluding Lava	Gravity Sewer 8 inch	1,619,836	LF			$ 1,600	$ 2,591,737,693
Zones 1 & 2	Gravity Sewer 12 inch	66,901	LF			$ 3,700	$ 247,533,460
	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	27,259	LF			$ 8,700	$ 237,156,725
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	20,109	LF			$ 13,050	$ 262,420,592
	Gravity Sewer 42 inch	1,174	LF			$ 15,200	$ 17,847,614
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	178,270	LF			$ 600	$ 106,962,177
	Force main 6 inch	32,698	LF			$ 900	$ 29,427,840
	Force main 8 inch	5,440	LF			$ 1,600	$ 8,704,000
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	12,514	LF			$ 10,875	$ 136,085,400
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	32	EA			$ 7,000,000	$ 224,000,000
	Neighborhood PS	106	EA			$ 1,200,000	$ 127,200,000
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 5,051,807,044**
	Right of Way	2,061	Ac			$ 20,000	$ 41,219,663
	Contingency	20%					$ 1,018,605,341
	Total Estimated Project Cost						**$ 6,111,632,048**
	Project services	20%					$ 1,222,326,410
	TOTAL CAPITAL COST						**7,333,958,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4515877	kWH	$ 0.44	$1,986,986
	Labor and Materials	$ 853,480	LS	-	$853,480
Annual O&M					**$2,840,466**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 2,936,311		$2,936,311	
2		$ 3,035,392		$3,035,392	
3		$ 3,137,815		$3,137,815	
4		$ 3,243,694		$3,243,694	
5		$ 3,353,146		$3,353,146	
6		$ 3,466,292		$3,466,292	
7		$ 3,583,255		$3,583,255	
8		$ 3,704,165		$3,704,165	
9		$ 3,829,154		$3,829,154	
10		$ 3,958,362		$3,958,362	
11		$ 4,091,929		$4,091,929	
12		$ 4,230,003		$4,230,003	
13		$ 4,372,736		$4,372,736	
14		$ 4,520,285		$4,520,285	
15		$ 4,672,814		$4,672,814	
16		$ 4,830,488		$4,830,488	
17		$ 4,993,484		$4,993,484	
18		$ 5,161,979		$5,161,979	
19		$ 5,336,160		$5,336,160	
20		$ 5,516,218		$5,516,218	
21		$ 5,702,352	$ 254,877,444	$260,579,796	replace elec./ motorized equipment
22		$ 5,894,767		$5,894,767	
23		$ 6,093,674	$ 25,810,514	$31,904,188	sewer inspection at yr 10 of service
24		$ 6,299,293		$6,299,293	
25		$ 6,511,850		$6,511,850	
26		$ 6,731,580		$6,731,580	
27		$ 6,958,724		$6,958,724	
28		$ 7,193,532		$7,193,532	
29		$ 7,436,264		$7,436,264	
30		$ 7,687,186		$7,687,186	
		Present value of O&M		**$228,317,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 126,960,000	$ 296,240,000	$ 4,628,607,044	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$68,547,000**	**$127,955,000**	**$2,998,857,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,366,916,000**

Easement Area Estimation - Alternative 4A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2145006	40	85800225	1970
Regional PS	150	150	720000	17
Neighborhood PS	150	150	2385000	55
WWTP				20
Total				2061

Annual Power Estimation - Alternative 4A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.66	mgd, Avg.	6	mgd, avg.
21	gpm	457	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	12	hp	84	hp
0.3	kw	9.2	kw	62.8	kw
106	ea	32	ea	1	ea
33.27	kw	293.94	kw	62.77	kw
291,426	kwh annual	2,574,873	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**4,515,877**	**kwh annual**			

Labor and Material Estimation - Alternative 4A

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 22,563	3.00	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 722,029		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 11,543		total
Total for WWTP, Regional PS, and NH PS		**$ 853,480**		

Pump Station Weighted Average and Peak Flows - Alternative 4A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	0					
Weighted Average	32	3.00	95.84		0.66	21.07

G-12: Alternative 4B Construction Cost and LCC Analysis

JOB #:	Puna Wastewater Facility Plan	AECOM
DATE:	October 16, 2023	Construction Cost Estimate
LOCATION:	Puna Wastewater Facility Plan	Conceptual Level
PREPARED BY:	T. Huang	Wastewater Facility Plan Estimates

Alternative 4B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering 'Gravity and LP Sewer							
	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	78,405	LF			$ 3,700	$ 290,100,132
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	26,581	LF			$ 8,700	$ 231,250,618
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	406,495	LF			$ 450	$ 182,922,677
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	58	EA			$ 7,000,000	$ 406,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 5,965,090,111**
	Right of Way	2,448	Ac			$ 20,000	$ 48,960,959
	Contingency	20%					$ 1,202,810,214
	Total Estimated Project Cost						**$ 7,216,861,284**
	Project services	20%					$ 1,443,372,257
	TOTAL CAPITAL COST						**8,660,234,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5433687	kWH	$ 0.44	$2,390,822
	Labor and Materials	$ 3,458,540	LS	-	$3,458,540

Annual O&M **$5,849,363**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 6,046,738		$6,046,738	
2		$ 6,250,773		$6,250,773	
3		$ 6,461,693		$6,461,693	
4		$ 6,679,730		$6,679,730	
5		$ 6,905,125		$6,905,125	
6		$ 7,138,124		$7,138,124	
7		$ 7,378,986		$7,378,986	
8		$ 7,627,976		$7,627,976	
9		$ 7,885,367		$7,885,367	
10		$ 8,151,443		$8,151,443	
11		$ 8,426,497		$8,426,497	
12		$ 8,710,833		$8,710,833	
13		$ 9,004,763		$9,004,763	
14		$ 9,308,611		$9,308,611	
15		$ 9,622,712		$9,622,712	
16		$ 9,947,411		$9,947,411	
17		$ 10,283,067		$10,283,067	
18		$ 10,630,049		$10,630,049	
19		$ 10,988,739		$10,988,739	
20		$ 11,359,532		$11,359,532	
21		$ 11,742,837	$ 350,516,711	$362,259,548	replace elec./ motorized equipment
22		$ 12,139,076		$12,139,076	
23		$ 12,548,685	$ 28,177,469	$40,726,155	sewer inspection at yr 10 of service
24		$ 12,972,116		$12,972,116	
25		$ 13,409,834		$13,409,834	
26		$ 13,862,323		$13,862,323	
27		$ 14,330,080		$14,330,080	
28		$ 14,813,620		$14,813,620	
29		$ 15,313,476		$15,313,476	
30		$ 15,830,200		$15,830,200	
		Present value of O&M		**$369,318,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 174,600,000	$ 407,400,000	$ 5,383,090,111	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$94,269,000**	**$175,969,000**	**$3,487,684,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,271,630,000**

Easement Area Estimation - Alternative 4B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2611519	40	104460769	2398
Regional PS	150	150	1305000	30
Neighborhood PS	150	150	0	0
WWTP				20
Total				2448

Annual Power Estimation - Alternative 4B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.53	mgd, Avg.	6	mgd, avg.
21	gpm	371	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	10	hp	84	hp
0.3	kw	7.4	kw	62.8	kw
0	ea	58	ea	1	ea
0.00	kw	431.98	kw	62.77	kw
-	kwh annual	3,784,109	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**5,433,687**	**kwh annual**			

Labor and Material Estimation - Alternative 4B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 17,403	2.55	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,009,372		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 1,129,279**		

Pump Station Weighted Average and Peak Flows - Alternative 4B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	21	21	4.76	4.41	4.41
to Hilo	0		0			0.00
Weighted Average	58	2.55	147.62		0.53	30.97

O&M Estimation for Puna LPS - Alternative 4B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	406495	$ 450	$ 182,922,677	0.81	**$ 329,261**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	4000	$ 26,000	$ 104,000,000	500	**$ 2,000,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 4B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
3 plants urban sewering 'Gravity and LP Sewer Excluding Lava Zones 1 & 2							
	Gravity Sewer 8 inch	1,342,713	LF			$ 1,600	$ 2,148,341,062
	Gravity Sewer 12 inch	66,901	LF			$ 3,700	$ 247,533,460
	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	27,259	LF			$ 8,700	$ 237,156,725
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	20,109	LF			$ 13,050	$ 262,420,592
	Gravity Sewer 42 inch	1,174	LF			$ 15,200	$ 17,847,614
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	33,384	LF			$ 900	$ 30,045,600
	Force main 8 inch	4,754	LF			$ 1,600	$ 7,605,760
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	12,514	LF			$ 10,875	$ 136,085,400
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	277,123	LF			$ 450	$ 124,705,302
	Low pressure sewer (On-Lot)	2,700	EA			$ 26,000	$ 70,200,000
	Regional PS	32	EA			$ 7,000,000	$ 224,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 4,568,673,059**
	Right of Way	1,843	Ac			$ 20,000	$ 36,850,603
	Contingency	20%					$ 921,104,732
	Total Estimated Project Cost						**$ 5,526,628,395**
	Project services	20%					$ 1,105,325,679
	TOTAL CAPITAL COST						**6,631,954,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4224452	kWH	$ 0.44	$1,858,759
	Labor and Materials	$ 2,416,406	LS	-	$2,416,406
Annual O&M					**$4,275,164**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,419,421		$4,419,421	
2		$ 4,568,546		$4,568,546	
3		$ 4,722,703		$4,722,703	
4		$ 4,882,061		$4,882,061	
5		$ 5,046,797		$5,046,797	
6		$ 5,217,091		$5,217,091	
7		$ 5,393,131		$5,393,131	
8		$ 5,575,112		$5,575,112	
9		$ 5,763,233		$5,763,233	
10		$ 5,957,702		$5,957,702	
11		$ 6,158,733		$6,158,733	
12		$ 6,366,547		$6,366,547	
13		$ 6,581,374		$6,581,374	
14		$ 6,803,449		$6,803,449	
15		$ 7,033,018		$7,033,018	
16		$ 7,270,334		$7,270,334	
17		$ 7,515,657		$7,515,657	
18		$ 7,769,258		$7,769,258	
19		$ 8,031,416		$8,031,416	
20		$ 8,302,420		$8,302,420	
21		$ 8,582,569	$ 220,548,487	$229,131,057	replace elec./ motorized equipment
22		$ 8,872,171		$8,872,171	
23		$ 9,171,545	$ 21,930,793	$31,102,339	sewer inspection at yr 10 of service
24		$ 9,481,021		$9,481,021	
25		$ 9,800,939		$9,800,939	
26		$ 10,131,653		$10,131,653	
27		$ 10,473,525		$10,473,525	
28		$ 10,826,934		$10,826,934	
29		$ 11,192,267		$11,192,267	
30		$ 11,569,928		$11,569,928	
		Present value of O&M		**$252,400,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 109,860,000	$ 256,340,000	$ 4,202,473,059	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$59,315,000**	**$110,721,000**	**$2,722,767,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **3,991,551,000**

Easement Area Estimation - Alternative 4B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1966735	40	78669414	1806
Regional PS	150	150	720000	17
Neighborhood PS	150	150	0	0
WWTP				20
Total				1843

Annual Power Estimation - Alternative 4B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.66	mgd, Avg.	6	mgd, avg.
21	gpm	457	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	12	hp	84	hp
0.3	kw	9.2	kw	62.8	kw
0	ea	32	ea	1	ea
0.00	kw	293.94	kw	62.77	kw
-	kwh annual	2,574,873	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**4,224,452**	**kwh annual**			

Labor and Material Estimation - Alternative 4B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 22,563	3.00	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 722,029		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 841,936**		

Pump Station Weighted Average and Peak Flows - Alternative 4B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	0		0			0.00
Weighted Average	32	3.00	95.84		0.66	21.07

O&M Estimation for Puna LPS - Alternative 4B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00

Puna LPS OM Cost					
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM
LP pipe, valves, etc.	277123	$ 450	$ 124,705,302	0.81	**$ 224,470**
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM
lat Kits, etc.	2700	$ 26,000	$ 70,200,000	500	**$ 1,350,000**

G-13: Alternative 4C Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 4C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
1 plants urban sewering Cross-Country Sewer						C	
	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	85,868	LF			$ 3,700	$ 317,710,558
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	26,581	LF			$ 8,700	$ 231,250,618
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	7,286	LF			$ 4,750	$ 34,610,400
	Force main 16 inch	36,379	LF			$ 5,800	$ 210,999,360
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	50	EA			$ 7,000,000	$ 350,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 6,531,319,954**
	Right of Way	2,578	Ac			$ 20,000	$ 51,568,274
	Contingency	20%					$ 1,316,577,646
	Total Estimated Project Cost						**$ 7,899,465,874**
	Project services	20%					$ 1,579,893,175
	TOTAL CAPITAL COST						**9,479,359,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5453464	kWH	$ 0.44	$2,399,524
	Labor and Materials	$ 1,193,140	LS	-	$1,193,140
Annual O&M					**$3,592,664**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,713,892		$3,713,892	
2		$ 3,839,210		$3,839,210	
3		$ 3,968,756		$3,968,756	
4		$ 4,102,674		$4,102,674	
5		$ 4,241,111		$4,241,111	
6		$ 4,384,219		$4,384,219	
7		$ 4,532,156		$4,532,156	
8		$ 4,685,084		$4,685,084	
9		$ 4,843,173		$4,843,173	
10		$ 5,006,597		$5,006,597	
11		$ 5,175,534		$5,175,534	
12		$ 5,350,173		$5,350,173	
13		$ 5,530,704		$5,530,704	
14		$ 5,717,326		$5,717,326	
15		$ 5,910,246		$5,910,246	
16		$ 6,109,676		$6,109,676	
17		$ 6,315,835		$6,315,835	
18		$ 6,528,950		$6,528,950	
19		$ 6,749,257		$6,749,257	
20		$ 6,976,997		$6,976,997	
21		$ 7,212,422	$ 280,895,179	$288,107,601	replace elec./ motorized equipment
22		$ 7,455,791		$7,455,791	
23		$ 7,707,372	$ 35,126,736	$42,834,108	sewer inspection at yr 10 of service
24		$ 7,967,442		$7,967,442	
25		$ 8,236,288		$8,236,288	
26		$ 8,514,205		$8,514,205	
27		$ 8,801,500		$8,801,500	
28		$ 9,098,490		$9,098,490	
29		$ 9,405,500		$9,405,500	
30		$ 9,722,870		$9,722,870	
		Present value of O&M		**$268,825,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 139,920,000	$ 326,480,000	$ 6,064,919,954	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$75,545,000**	**$141,017,000**	**$3,929,439,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,602,183,000**

Easement Area Estimation - Alternative 4C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2737175	40	109487001	2513
Regional PS	150	150	1125000	26
Neighborhood PS	150	150	832500	19
WWTP				20
Total				2578

Annual Power Estimation - Alternative 4C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.61	mgd, Avg.	6	mgd, avg.
21	gpm	421	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	84	hp
0.3	kw	8.5	kw	62.8	kw
37	ea	50	ea	1	ea
11.61	kw	422.62	kw	62.77	kw
101,724	kwh annual	3,702,161	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**5,453,464**	**kwh annual**			

Labor and Material Estimation - Alternative 4C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 21,384	2.89	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,069,204		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 4,029		total
Total for WWTP, Regional PS, and NH PS	**$ 1,193,140**		

Pump Station Weighted Average and Peak Flows - Alternative 4C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	2.36	4.72	4.49	0.53	1.05
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	21	21	4.76	4.41	4.41
to Hilo	0		0			0.00
Weighted Average	50	2.89	144.61		0.61	30.30

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 4C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants urban sewering							
Cross-Country Sewer						C	
Excluding Lava	Gravity Sewer 8 inch	1,684,677	LF			$ 1,600	$ 2,695,483,491
Zones 1 & 2	Gravity Sewer 12 inch	74,363	LF			$ 3,700	$ 275,143,886
	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	27,259	LF			$ 8,700	$ 237,156,725
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	20,109	LF			$ 13,050	$ 262,420,592
	Gravity Sewer 42 inch	1,174	LF			$ 15,200	$ 17,847,614
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	29,334	LF			$ 600	$ 17,600,330
	Force main 6 inch	16,508	LF			$ 900	$ 14,857,200
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch	21,260	LF			$ 2,650	$ 56,339,000
	Force main 12 inch	22,176	LF			$ 3,700	$ 82,051,200
	Force main 14 inch	3,168	LF			$ 4,750	$ 15,048,000
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	12,514	LF			$ 10,875	$ 136,085,400
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	24	EA			$ 7,000,000	$ 168,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	WWTP (6 mgd total)	1	LS			NA	$ 72,000,000
	Subtotal of Estimated Construction Cost						**$ 4,991,918,942**
	Right of Way	1,940	Ac			$ 20,000	$ 38,790,381
	Contingency	20%					$ 1,006,141,865
	Total Estimated Project Cost						**$ 6,036,851,187**
	Project services	20%					$ 1,207,370,237
	TOTAL CAPITAL COST						**7,244,221,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4219484	kWH	$ 0.44	$1,856,573
	Labor and Materials	$ 904,817	LS	-	$904,817

Annual O&M **$2,761,390**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 2,854,568		$2,854,568	
2		$ 2,950,890		$2,950,890	
3		$ 3,050,462		$3,050,462	
4		$ 3,153,393		$3,153,393	
5		$ 3,259,798		$3,259,798	
6		$ 3,369,794		$3,369,794	
7		$ 3,483,501		$3,483,501	
8		$ 3,601,045		$3,601,045	
9		$ 3,722,555		$3,722,555	
10		$ 3,848,165		$3,848,165	
11		$ 3,978,014		$3,978,014	
12		$ 4,112,244		$4,112,244	
13		$ 4,251,004		$4,251,004	
14		$ 4,394,446		$4,394,446	
15		$ 4,542,728		$4,542,728	
16		$ 4,696,013		$4,696,013	
17		$ 4,854,471		$4,854,471	
18		$ 5,018,275		$5,018,275	
19		$ 5,187,607		$5,187,607	
20		$ 5,362,653		$5,362,653	
21		$ 5,543,605	$ 164,778,990	$170,322,595	replace elec./ motorized equipment
22		$ 5,730,663		$5,730,663	
23		$ 5,924,033	$ 26,822,762	$32,746,794	sewer inspection at yr 10 of service
24		$ 6,123,928		$6,123,928	
25		$ 6,330,567		$6,330,567	
26		$ 6,544,180		$6,544,180	
27		$ 6,765,000		$6,765,000	
28		$ 6,993,272		$6,993,272	
29		$ 7,229,246		$7,229,246	
30		$ 7,473,183		$7,473,183	
		Present value of O&M		**$180,478,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 82,080,000	$ 191,520,000	$ 4,718,318,942	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$44,316,000**	**$82,723,000**	**$3,056,981,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,240,679,000**

Easement Area Estimation - Alternative 4C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2061106	40	82444249	1893
Regional PS	150	150	540000	12
Neighborhood PS	150	150	630000	14
WWTP				20
Total				1940

Annual Power Estimation - Alternative 4C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.85	mgd, Avg.	6	mgd, avg.
21	gpm	590	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	16	hp	84	hp
0.3	kw	11.9	kw	62.8	kw
28	ea	24	ea	1	ea
8.79	kw	284.58	kw	62.77	kw
76,980	kwh annual	2,492,925	kwh annual	549,860	pumping kwh annual
				1,099,719	other kwh annual, approx 2x pumping
Total Power	**4,219,484**	**kwh annual**			

Labor and Material Estimation - Alternative 4C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 119,907	6	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 32,578	3.87	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 781,861		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 3,049		total
Total for WWTP, Regional PS, and NH PS	**$ 904,817**		

Pump Station Weighted Average and Peak Flows - Alternative 4C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	0		0			0.00
Weighted Average	24	3.87	92.83		0.85	20.40

G-14: Alternative 5A Construction Cost and LCC Analysis

JOB #:	Puna Wastewater Facility Plan
DATE:	October 16, 2023
LOCATION:	Puna Wastewater Facility Plan
PREPARED BY:	T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 5A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants full flow 8.5 mgd Gravity Sewer							
	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	67,925	LF			$ 3,700	$ 251,320,775
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,109	LF			$ 17,400	$ 349,894,123
	Gravity Sewer 54 inch	1,174	LF			$ 19,500	$ 22,896,610
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	12,355	LF			$ 4,750	$ 58,687,200
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	12,514	LF			$ 15,200	$ 190,206,720
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	58	EA			$ 7,000,000	$ 406,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 7,032,082,285**
	Right of Way	2,772	Ac			$ 20,000	$ 55,447,128
	Contingency	20%					$ 1,417,505,883
	Total Estimated Project Cost						**$ 8,505,035,296**
	Project services	20%					$ 1,701,007,059
	TOTAL CAPITAL COST						**10,206,042,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6936999	kWH	$ 0.44	$3,052,280
	Labor and Materials	$ 1,361,059	LS	-	$1,361,059
Annual O&M					**$4,413,339**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,562,258		$4,562,258	
2		$ 4,716,202		$4,716,202	
3		$ 4,875,341		$4,875,341	
4		$ 5,039,850		$5,039,850	
5		$ 5,209,910		$5,209,910	
6		$ 5,385,708		$5,385,708	
7		$ 5,567,438		$5,567,438	
8		$ 5,755,300		$5,755,300	
9		$ 5,949,502		$5,949,502	
10		$ 6,150,256		$6,150,256	
11		$ 6,357,784		$6,357,784	
12		$ 6,572,315		$6,572,315	
13		$ 6,794,085		$6,794,085	
14		$ 7,023,338		$7,023,338	
15		$ 7,260,327		$7,260,327	
16		$ 7,505,312		$7,505,312	
17		$ 7,758,564		$7,758,564	
18		$ 8,020,362		$8,020,362	
19		$ 8,290,993		$8,290,993	
20		$ 8,570,756		$8,570,756	
21		$ 8,859,959	$ 414,356,525	$423,216,484	replace elec./ motorized equipment
22		$ 9,158,921		$9,158,921	
23		$ 9,467,971	$ 33,868,397	$43,336,368	sewer inspection at yr 10 of service
24		$ 9,787,449		$9,787,449	
25		$ 10,117,707		$10,117,707	
26		$ 10,459,109		$10,459,109	
27		$ 10,812,032		$10,812,032	
28		$ 11,176,862		$11,176,862	
29		$ 11,554,003		$11,554,003	
30		$ 11,943,871		$11,943,871	
		Present value of O&M		**$361,107,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 206,400,000	$ 481,600,000	$ 6,344,082,285	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$111,438,000**	**$208,018,000**	**$4,110,307,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **6,137,386,000**

Easement Area Estimation - Alternative 5A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2874691	40	114987646	2640
Regional PS	150	150	1305000	30
Neighborhood PS	150	150	3600000	83
WWTP				20
Total				2772

Annual Power Estimation - Alternative 5A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.59	mgd, Avg.	8.5	mgd, avg.
21	gpm	408	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	119	hp
0.3	kw	8.2	kw	88.9	kw
160	ea	58	ea	1	ea
50.22	kw	474.91	kw	88.92	kw
439,888	kwh annual	4,160,208	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**6,936,999**	**kwh annual**			

Labor and Material Estimation - Alternative 5A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 169,869	8.5	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 20,237	2.79	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,173,766		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 17,424		total
Total for WWTP, Regional PS, and NH PS	**$ 1,361,059**		

Pump Station Weighted Average and Peak Flows - Alternative 5A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	29.99	29.99	4.76	6.30	6.30
to Hilo	0		0			0.00
Weighted Average	58	2.79	161.95		0.59	34.05

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 5A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants full flow 8.5 mgd Gravity Sewer Excluding Lava Zones 1 & 2							
	Gravity Sewer 8 inch	1,619,836	LF			$ 1,600	$ 2,591,737,693
	Gravity Sewer 12 inch	56,420	LF			$ 3,700	$ 208,754,103
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	178,270	LF			$ 600	$ 106,962,177
	Force main 6 inch	32,698	LF			$ 900	$ 29,427,840
	Force main 8 inch	5,440	LF			$ 1,600	$ 8,704,000
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	8,237	LF			$ 4,750	$ 39,124,800
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	32	EA			$ 7,000,000	$ 224,000,000
	Neighborhood PS	106	EA			$ 1,200,000	$ 127,200,000
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 5,388,627,266**
	Right of Way	2,061	Ac			$ 20,000	$ 41,219,663
	Contingency	20%					$ 1,085,969,386
	Total Estimated Project Cost						**$ 6,515,816,315**
	Project services	20%					$ 1,303,163,263
	TOTAL CAPITAL COST						**7,818,980,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5316408	kWH	$ 0.44	$2,339,220
	Labor and Materials	$ 954,033	LS	-	$954,033
Annual O&M					**$3,293,252**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,404,376		$3,404,376	
2		$ 3,519,250		$3,519,250	
3		$ 3,638,001		$3,638,001	
4		$ 3,760,758		$3,760,758	
5		$ 3,887,657		$3,887,657	
6		$ 4,018,838		$4,018,838	
7		$ 4,154,446		$4,154,446	
8		$ 4,294,630		$4,294,630	
9		$ 4,439,544		$4,439,544	
10		$ 4,589,347		$4,589,347	
11		$ 4,744,206		$4,744,206	
12		$ 4,904,290		$4,904,290	
13		$ 5,069,775		$5,069,775	
14		$ 5,240,845		$5,240,845	
15		$ 5,417,687		$5,417,687	
16		$ 5,600,496		$5,600,496	
17		$ 5,789,474		$5,789,474	
18		$ 5,984,828		$5,984,828	
19		$ 6,186,774		$6,186,774	
20		$ 6,395,535		$6,395,535	
21		$ 6,611,340	$ 265,718,167	$272,329,506	replace elec./ motorized equipment
22		$ 6,834,426		$6,834,426	
23		$ 7,065,041	$ 25,810,514	$32,875,555	sewer inspection at yr 10 of service
24		$ 7,303,436		$7,303,436	
25		$ 7,549,877		$7,549,877	
26		$ 7,804,632		$7,804,632	
27		$ 8,067,984		$8,067,984	
28		$ 8,340,222		$8,340,222	
29		$ 8,621,647		$8,621,647	
30		$ 8,912,567		$8,912,567	
		Present value of O&M		**$247,554,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 132,360,000	$ 308,840,000	$ 4,947,427,266	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$71,463,000**	**$133,398,000**	**$3,205,420,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,656,253,000**

Easement Area Estimation - Alternative 5A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2145006	40	85800225	1970
Regional PS	150	150	720000	17
Neighborhood PS	150	150	2385000	55
WWTP				20
Total				2061

Annual Power Estimation - Alternative 5A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.69	mgd, Avg.	8.5	mgd, avg.
21	gpm	477	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	13	hp	119	hp
0.3	kw	9.6	kw	88.9	kw
106	ea	32	ea	1	ea
33.27	kw	306.86	kw	88.92	kw
291,426	kwh annual	2,688,079	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**5,316,408**	**kwh annual**			

Labor and Material Estimation - Alternative 5A

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ 169,869	8.5	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 24,144	3.13	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 772,621		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 11,543		total
Total for WWTP, Regional PS, and NH PS		**$ 954,033**		

Pump Station Weighted Average and Peak Flows - Alternative 5A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.61	18.61	4.76	3.91	3.91
to Hilo	0		0			0.00
Weighted Average	32	3.13	100.25		0.69	22.00

G-15: Alternative 5B Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 5B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants full flow 8.5 mgd 'Gravity and LP Sewer							
	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	67,925	LF			$ 3,700	$ 251,320,775
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,109	LF			$ 17,400	$ 349,894,123
	Gravity Sewer 54 inch	1,174	LF			$ 19,500	$ 22,896,610
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	12,355	LF			$ 4,750	$ 58,687,200
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	12,514	LF			$ 15,200	$ 190,206,720
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	406,495	LF			$ 450	$ 182,922,677
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	58	EA			$ 7,000,000	$ 406,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 6,318,229,592**
	Right of Way	2,448	Ac			$ 20,000	$ 48,960,959
	Contingency	20%					$ 1,273,438,110
	Total Estimated Project Cost						**$ 7,640,628,661**
	Project services	20%					$ 1,528,125,732
	TOTAL CAPITAL COST						**9,168,754,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6497112	kWH	$ 0.44	$2,858,729
	Labor and Materials	$ 3,672,896	LS	-	$3,672,896
Annual O&M					**$6,531,625**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 6,752,022		$6,752,022	
2		$ 6,979,855		$6,979,855	
3		$ 7,215,377		$7,215,377	
4		$ 7,458,845		$7,458,845	
5		$ 7,710,530		$7,710,530	
6		$ 7,970,706		$7,970,706	
7		$ 8,239,662		$8,239,662	
8		$ 8,517,693		$8,517,693	
9		$ 8,805,106		$8,805,106	
10		$ 9,102,217		$9,102,217	
11		$ 9,409,353		$9,409,353	
12		$ 9,726,853		$9,726,853	
13		$ 10,055,067		$10,055,067	
14		$ 10,394,355		$10,394,355	
15		$ 10,745,092		$10,745,092	
16		$ 11,107,664		$11,107,664	
17		$ 11,482,471		$11,482,471	
18		$ 11,869,924		$11,869,924	
19		$ 12,270,451		$12,270,451	
20		$ 12,684,493		$12,684,493	
21		$ 13,112,507	$ 361,357,434	$374,469,941	replace elec./ motorized equipment
22		$ 13,554,962		$13,554,962	
23		$ 14,012,348	$ 28,177,469	$42,189,817	sewer inspection at yr 10 of service
24		$ 14,485,167		$14,485,167	
25		$ 14,973,940		$14,973,940	
26		$ 15,479,206		$15,479,206	
27		$ 16,001,522		$16,001,522	
28		$ 16,541,462		$16,541,462	
29		$ 17,099,621		$17,099,621	
30		$ 17,676,614		$17,676,614	
		Present value of O&M		**$395,503,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 180,000,000	$ 420,000,000	$ 5,718,229,592	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$97,184,000**	**$181,411,000**	**$3,704,820,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,580,842,000**

Easement Area Estimation - Alternative 5B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2611519	40	104460769	2398
Regional PS	150	150	1305000	30
Neighborhood PS	150	150	0	0
WWTP				20
Total				2448

Annual Power Estimation - Alternative 5B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.59	mgd, Avg.	8.5	mgd, avg.
21	gpm	408	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	11	hp	119	hp
0.3	kw	8.2	kw	88.9	kw
0	ea	58	ea	1	ea
0.00	kw	474.91	kw	88.92	kw
-	kwh annual	4,160,208	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**6,497,112**	**kwh annual**			

Labor and Material Estimation - Alternative 5B

Honouliuli WWTP 2014 total		$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$	169,869	8.5	mgd, total flow
Halawa WWPS 2014 total		$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$	20,237	2.79	mgd, each
Flow prorated for Puna Regional WWPSs, total		$	1,173,766		total
Flow prorated for Puna neighborhood WWPSs		$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total					
Flow prorated for Puna H WWPSs, total		$	-		total
Total for WWTP, Regional PS, and NH PS		**$**	**1,343,635**		

Pump Station Weighted Average and Peak Flows - Alternative 5B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	29.99	29.99	4.76	6.30	6.30
to Hilo	0		0			0.00
Weighted Average	58	2.79	161.95		0.59	34.05

O&M Estimation for Puna LPS - Alternative 5B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	406495	$ 450	$ 182,922,677	0.81	**$ 329,261**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	4000	$ 26,000	$ 104,000,000	500	**$ 2,000,000**					

JOB #:	Puna Wastewater Facility Plan	**AECOM**	
DATE:	October 16, 2023	Construction Cost Estimate	
LOCATION:	Puna Wastewater Facility Plan	Conceptual Level	
PREPARED BY:	T. Huang	Wastewater Facility Plan Estimates	

Alternative 5B	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
1 plants full flow 8.5 mgd 'Gravity and LP Sewer							
Excluding Lava Zones 1 & 2	Gravity Sewer 8 inch	1,342,713	LF			$ 1,600	$ 2,148,341,062
	Gravity Sewer 12 inch	56,420	LF			$ 3,700	$ 208,754,103
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	33,384	LF			$ 900	$ 30,045,600
	Force main 8 inch	4,754	LF			$ 1,600	$ 7,605,760
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	8,237	LF			$ 4,750	$ 39,124,800
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	277,123	LF			$ 450	$ 124,705,302
	Low pressure sewer (On-Lot)	2,700	EA			$ 26,000	$ 70,200,000
	Regional PS	58	EA			$ 7,000,000	$ 406,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 5,087,493,281**
	Right of Way	1,856	Ac			$ 20,000	$ 37,119,198
	Contingency	20%					$ 1,024,922,496
	Total Estimated Project Cost						**$ 6,149,534,975**
	Project services	20%					$ 1,229,906,995
	TOTAL CAPITAL COST						**7,379,442,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	7209047	kWH	$ 0.44	$3,171,981
	Labor and Materials	$ 3,144,713	LS	-	$3,144,713
Annual O&M					**$6,316,694**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 6,529,838		$6,529,838	
2		$ 6,750,174		$6,750,174	
3		$ 6,977,946		$6,977,946	
4		$ 7,213,403		$7,213,403	
5		$ 7,456,805		$7,456,805	
6		$ 7,708,420		$7,708,420	
7		$ 7,968,526		$7,968,526	
8		$ 8,237,408		$8,237,408	
9		$ 8,515,363		$8,515,363	
10		$ 8,802,697		$8,802,697	
11		$ 9,099,727		$9,099,727	
12		$ 9,406,779		$9,406,779	
13		$ 9,724,192		$9,724,192	
14		$ 10,052,316		$10,052,316	
15		$ 10,391,512		$10,391,512	
16		$ 10,742,153		$10,742,153	
17		$ 11,104,626		$11,104,626	
18		$ 11,479,329		$11,479,329	
19		$ 11,866,677		$11,866,677	
20		$ 12,267,094		$12,267,094	
21		$ 12,681,023	$ 341,000,965	$353,681,989	replace elec./ motorized equipment
22		$ 13,108,919		$13,108,919	
23		$ 13,551,254	$ 21,930,793	$35,482,048	sewer inspection at yr 10 of service
24		$ 14,008,514		$14,008,514	
25		$ 14,481,204		$14,481,204	
26		$ 14,969,844		$14,969,844	
27		$ 15,474,972		$15,474,972	
28		$ 15,997,144		$15,997,144	
29		$ 16,536,936		$16,536,936	
30		$ 17,094,943		$17,094,943	
		Present value of O&M		**$375,622,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 169,860,000	$ 396,340,000	$ 4,521,293,281	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$91,710,000**	**$171,191,000**	**$2,929,329,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,562,834,000**

Easement Area Estimation - Alternative 5B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	1966735	40	78669414	1806
Regional PS	150	150	1305000	30
Neighborhood PS	150	150	0	0
WWTP				20
Total				1856

Annual Power Estimation - Alternative 5B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.69	mgd, Avg.	8.5	mgd, avg.
21	gpm	477	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	13	hp	119	hp
0.3	kw	9.6	kw	88.9	kw
0	ea	58	ea	1	ea
0.00	kw	556.18	kw	88.92	kw
-	kwh annual	4,872,144	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**7,209,047**	**kwh annual**			

Labor and Material Estimation - Alternative 5B

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	169,869	8.5	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	24,144	3.13	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	1,400,375		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total				
Flow prorated for Puna H WWPSs, total	$	-		total
Total for WWTP, Regional PS, and NH PS	**$**	**1,570,243**		

Pump Station Weighted Average and Peak Flows - Alternative 5B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.61	18.61	4.76	3.91	3.91
to Hilo	0		0			0.00
Weighted Average	32	3.13	100.25		0.69	22.00

O&M Estimation for Puna LPS - Alternative 5B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	277123	$ 450	$ 124,705,302	0.81	**$ 224,470**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	2700	$ 26,000	$ 70,200,000	500	**$ 1,350,000**					

G-16: Alternative 5C Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 5C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
1 plants full flow 8.5 mgd Cross-Country Sewer							
	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	75,387	LF			$ 3,700	$ 278,931,200
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,109	LF			$ 17,400	$ 349,894,123
	Gravity Sewer 54 inch	1,174	LF			$ 19,500	$ 22,896,610
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	6,019	LF			$ 4,750	$ 28,591,200
	Force main 16 inch	36,379	LF			$ 5,800	$ 210,999,360
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	-	LF			$ 13,050	$ -
	Force main 42 inch	12,514	LF			$ 15,200	$ 190,206,720
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	50	EA			$ 7,000,000	$ 350,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 6,884,459,435**
	Right of Way	2,578	Ac			$ 20,000	$ 51,568,274
	Contingency	20%					$ 1,387,205,542
	Total Estimated Project Cost						**$ 8,323,233,251**
	Project services	20%					$ 1,664,646,650
	TOTAL CAPITAL COST						**9,987,880,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6286111	kWH	$ 0.44	$2,765,889
	Labor and Materials	$ 1,407,496	LS	-	$1,407,496
Annual O&M					**$4,173,385**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,314,207		$4,314,207	
2		$ 4,459,782		$4,459,782	
3		$ 4,610,268		$4,610,268	
4		$ 4,765,833		$4,765,833	
5		$ 4,926,646		$4,926,646	
6		$ 5,092,886		$5,092,886	
7		$ 5,264,736		$5,264,736	
8		$ 5,442,384		$5,442,384	
9		$ 5,626,027		$5,626,027	
10		$ 5,815,866		$5,815,866	
11		$ 6,012,111		$6,012,111	
12		$ 6,214,978		$6,214,978	
13		$ 6,424,690		$6,424,690	
14		$ 6,641,478		$6,641,478	
15		$ 6,865,582		$6,865,582	
16		$ 7,097,247		$7,097,247	
17		$ 7,336,730		$7,336,730	
18		$ 7,584,294		$7,584,294	
19		$ 7,840,211		$7,840,211	
20		$ 8,104,763		$8,104,763	
21		$ 8,378,242	$ 291,735,902	$300,114,144	replace elec./ motorized equipment
22		$ 8,660,950		$8,660,950	
23		$ 8,953,196	$ 35,126,736	$44,079,932	sewer inspection at yr 10 of service
24		$ 9,255,304		$9,255,304	
25		$ 9,567,606		$9,567,606	
26		$ 9,890,446		$9,890,446	
27		$ 10,224,180		$10,224,180	
28		$ 10,569,175		$10,569,175	
29		$ 10,925,811		$10,925,811	
30		$ 11,294,481		$11,294,481	
		Present value of O&M		**$291,935,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 145,320,000	$ 339,080,000	$ 6,400,059,435	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$78,460,000**	**$146,459,000**	**$4,146,575,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,908,321,000**

Easement Area Estimation - Alternative 5C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2737175	40	109487001	2513
Regional PS	150	150	1125000	26
Neighborhood PS	150	150	832500	19
WWTP				20
Total				2578

Annual Power Estimation - Alternative 5C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.63	mgd, Avg.	8.5	mgd, avg.
21	gpm	437	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	12	hp	119	hp
0.3	kw	8.8	kw	88.9	kw
37	ea	50	ea	1	ea
11.61	kw	439.21	kw	88.92	kw
101,724	kwh annual	3,847,484	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**6,286,111**	**kwh annual**			

Labor and Material Estimation - Alternative 5C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ 169,869	8.5	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 24,672	3.18	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,233,598		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 4,029		total
Total for WWTP, Regional PS, and NH PS	**$ 1,407,496**		

Pump Station Weighted Average and Peak Flows - Alternative 5C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	29.99	29.99	4.76	4.41	4.41
to Hilo	0		0			0.00
Weighted Average	50	3.18	158.94		0.63	31.49

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 5C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
1 plants full flow 8.5 mgd Cross-Country Sewer Excluding Lava Zones 1 & 2							
	Gravity Sewer 8 inch	1,684,677	LF			$ 1,600	$ 2,695,483,491
	Gravity Sewer 12 inch	63,882	LF			$ 3,700	$ 236,364,528
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	22,024	LF			$ 10,875	$ 239,514,664
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,109	LF			$ 15,200	$ 305,654,636
	Gravity Sewer 48 inch	1,174	LF			$ 17,400	$ 20,430,821
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	29,334	LF			$ 600	$ 17,600,330
	Force main 6 inch	16,508	LF			$ 900	$ 14,857,200
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch	21,260	LF			$ 2,650	$ 56,339,000
	Force main 12 inch	22,176	LF			$ 3,700	$ 82,051,200
	Force main 14 inch	1,901	LF			$ 4,750	$ 9,028,800
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch					$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	12,514	LF			$ 13,050	$ 163,302,480
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	24	EA			$ 7,000,000	$ 168,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	WWTP (8.5 mgd total)	1	LS			NA	$ 90,000,000
	Subtotal of Estimated Construction Cost						**$ 5,328,739,164**
	Right of Way	1,940	Ac			$ 20,000	$ 38,790,381
	Contingency	20%					$ 1,073,505,909
	Total Estimated Project Cost						**$ 6,441,035,453**
	Project services	20%					$ 1,288,207,091
	TOTAL CAPITAL COST						**7,729,243,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5081367	kWH	$ 0.44	$2,235,802
	Labor and Materials	$ 1,005,370	LS	-	$1,005,370
Annual O&M					**$3,241,172**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,350,539		$3,350,539	
2		$ 3,463,596		$3,463,596	
3		$ 3,580,468		$3,580,468	
4		$ 3,701,284		$3,701,284	
5		$ 3,826,177		$3,826,177	
6		$ 3,955,283		$3,955,283	
7		$ 4,088,747		$4,088,747	
8		$ 4,226,713		$4,226,713	
9		$ 4,369,335		$4,369,335	
10		$ 4,516,770		$4,516,770	
11		$ 4,669,180		$4,669,180	
12		$ 4,826,732		$4,826,732	
13		$ 4,989,600		$4,989,600	
14		$ 5,157,965		$5,157,965	
15		$ 5,332,010		$5,332,010	
16		$ 5,511,928		$5,511,928	
17		$ 5,697,917		$5,697,917	
18		$ 5,890,182		$5,890,182	
19		$ 6,088,935		$6,088,935	
20		$ 6,294,394		$6,294,394	
21		$ 6,506,786	$ 175,619,713	$182,126,499	replace elec./ motorized equipment
22		$ 6,726,345		$6,726,345	
23		$ 6,953,312	$ 26,822,762	$33,776,074	sewer inspection at yr 10 of service
24		$ 7,187,938		$7,187,938	
25		$ 7,430,481		$7,430,481	
26		$ 7,681,208		$7,681,208	
27		$ 7,940,395		$7,940,395	
28		$ 8,208,328		$8,208,328	
29		$ 8,485,302		$8,485,302	
30		$ 8,771,621		$8,771,621	
		Present value of O&M		**$200,532,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 87,480,000	$ 204,120,000	$ 5,037,139,164	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$47,232,000**	**$88,166,000**	**$3,263,544,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,530,833,000**

Easement Area Estimation - Alternative 5C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2061106	40	82444249	1893
Regional PS	150	150	540000	12
Neighborhood PS	150	150	630000	14
WWTP				20
Total				1940

Annual Power Estimation - Alternative 5C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.91	mgd, Avg.	8.5	mgd, avg.
21	gpm	632	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	17	hp	119	hp
0.3	kw	12.7	kw	88.9	kw
28	ea	24	ea	1	ea
8.79	kw	304.51	kw	88.92	kw
76,980	kwh annual	2,667,484	kwh annual	778,968	pumping kwh annual
				1,557,936	other kwh annual, approx 2x pumping
Total Power	**5,081,367**	**kwh annual**			

Labor and Material Estimation - Alternative 5C

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ 169,869	8.5	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 34,686	4.05	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 832,452		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 3,049		total
Total for WWTP, Regional PS, and NH PS		**$ 1,005,370**		

Pump Station Weighted Average and Peak Flows - Alternative 5C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	18.61	18.61	4.76	4.41	4.41
to Hilo	0		0			0.00
Weighted Average	24	4.05	97.24		0.91	21.83

G-17: Alternative 6A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 6A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (11 mgd) urban sewering Gravity Sewer							
	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	78,405	LF			$ 3,700	$ 290,100,132
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,151	LF			$ 8,700	$ 201,415,356
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	18,337	LF			$ 15,200	$ 278,720,010
	Gravity Sewer 48 inch	31,900	LF			$ 17,400	$ 555,064,888
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	31,733	LF			$ 13,050	$ 414,115,650
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	61	EA			$ 7,000,000	$ 427,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 7,476,717,152**
	Right of Way	2,797	Ac			$ 20,000	$ 55,933,807
	Contingency	20%					$ 1,506,530,192
	Total Estimated Project Cost						**$ 9,039,181,150**
	Project services	20%					$ 1,807,836,230
	TOTAL CAPITAL COST						**10,847,017,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	7521985	kWH	$ 0.44	$3,309,673
	Labor and Materials	$ 2,373,603	LS	-	$2,373,603
Annual O&M					**$5,683,276**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 5,875,047		$5,875,047	
2		$ 6,073,289		$6,073,289	
3		$ 6,278,220		$6,278,220	
4		$ 6,490,066		$6,490,066	
5		$ 6,709,061		$6,709,061	
6		$ 6,935,445		$6,935,445	
7		$ 7,169,468		$7,169,468	
8		$ 7,411,387		$7,411,387	
9		$ 7,661,470		$7,661,470	
10		$ 7,919,991		$7,919,991	
11		$ 8,187,236		$8,187,236	
12		$ 8,463,498		$8,463,498	
13		$ 8,749,082		$8,749,082	
14		$ 9,044,302		$9,044,302	
15		$ 9,349,485		$9,349,485	
16		$ 9,664,965		$9,664,965	
17		$ 9,991,090		$9,991,090	
18		$ 10,328,219		$10,328,219	
19		$ 10,676,725		$10,676,725	
20		$ 11,036,990		$11,036,990	
21		$ 11,409,411	$ 433,026,659	$444,436,070	replace elec./ motorized equipment
22		$ 11,794,399		$11,794,399	
23		$ 12,192,378	$ 34,225,744	$46,418,122	sewer inspection at yr 10 of service
24		$ 12,603,786		$12,603,786	
25		$ 13,029,076		$13,029,076	
26		$ 13,468,717		$13,468,717	
27		$ 13,923,192		$13,923,192	
28		$ 14,393,003		$14,393,003	
29		$ 14,878,666		$14,878,666	
30		$ 15,380,717		$15,380,717	
		Present value of O&M		**$409,251,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 215,700,000	$ 503,300,000	$ 6,757,717,152	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$116,459,000**	**$217,391,000**	**$4,378,300,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **6,544,118,000**

Easement Area Estimation - Alternative 6A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2921283	40	116851331	2683
Regional PS	150	150	1372500	32
Neighborhood PS	150	150	3600000	83
WWTP				0
Total				2797

Annual Power Estimation - Alternative 6A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.95	mgd, Avg.	6	mgd, avg.
21	gpm	660	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	18	hp	84	hp
0.3	kw	13.3	kw	62.8	kw
160	ea	61	ea	0	ea
50.22	kw	808.46	kw	0.00	kw
439,888	kwh annual	7,082,097	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**7,521,985**	**kwh annual**			

Labor and Material Estimation - Alternative 6A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 38,626	4.40	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 2,356,179		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 17,424		total
Total for WWTP, Regional PS, and NH PS	**$ 2,373,603**		

Pump Station Weighted Average and Peak Flows - Alternative 6A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	35	4.40	153.83		0.95	33.26

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

							TOTAL
	DESCRIPTION	**QUAN**	**UN**			**UNIT**	**DIRECT**
Alternative 6A						**COST**	**COST**
to Hilo wwtp (11 mgd)							
urban sewering							
Gravity Sewer	Gravity Sewer 8 inch	1,619,836	LF			$ 1,600	$ 2,591,737,693
Excluding Lava	Gravity Sewer 12 inch	66,901	LF			$ 3,700	$ 247,533,460
Zones 1 & 2	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,830	LF			$ 8,700	$ 207,321,463
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	18,337	LF			$ 13,050	$ 239,295,798
	Gravity Sewer 42 inch	31,900	LF			$ 15,200	$ 484,884,270
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	178,270	LF			$ 600	$ 106,962,177
	Force main 6 inch	32,698	LF			$ 900	$ 29,427,840
	Force main 8 inch	5,440	LF			$ 1,600	$ 8,704,000
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch	1,848	LF			$ 8,700	$ 16,077,600
	Force main 30 inch	14,837	LF			$ 10,875	$ 161,352,375
	Force main 36 inch	16,896	LF			$ 13,050	$ 220,492,800
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	35	EA			$ 7,000,000	$ 245,000,000
	Neighborhood PS	106	EA			$ 1,200,000	$ 127,200,000
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 5,776,721,019**
	Right of Way	2,085	Ac			$ 20,000	$ 41,706,341
	Contingency	20%					$ 1,163,685,472
	Total Estimated Project Cost						**$ 6,982,112,832**
	Project services	20%					$ 1,396,422,566
	TOTAL CAPITAL COST						**8,378,535,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4354924	kWH	$ 0.44	$1,916,167
	Labor and Materials	$ 1,363,449	LS	-	$1,363,449
Annual O&M					**$3,279,616**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,390,280		$3,390,280	
2		$ 3,504,678		$3,504,678	
3		$ 3,622,937		$3,622,937	
4		$ 3,745,186		$3,745,186	
5		$ 3,871,559		$3,871,559	
6		$ 4,002,198		$4,002,198	
7		$ 4,137,244		$4,137,244	
8		$ 4,276,847		$4,276,847	
9		$ 4,421,161		$4,421,161	
10		$ 4,570,344		$4,570,344	
11		$ 4,724,561		$4,724,561	
12		$ 4,883,983		$4,883,983	
13		$ 5,048,783		$5,048,783	
14		$ 5,219,144		$5,219,144	
15		$ 5,395,254		$5,395,254	
16		$ 5,577,306		$5,577,306	
17		$ 5,765,501		$5,765,501	
18		$ 5,960,047		$5,960,047	
19		$ 6,161,157		$6,161,157	
20		$ 6,369,053		$6,369,053	
21		$ 6,583,964	$ 284,388,301	$290,972,265	replace elec./ motorized equipment
22		$ 6,806,127		$6,806,127	
23		$ 7,035,786	$ 26,167,860	$33,203,647	sewer inspection at yr 10 of service
24		$ 7,273,195		$7,273,195	
25		$ 7,518,615		$7,518,615	
26		$ 7,772,316		$7,772,316	
27		$ 8,034,577		$8,034,577	
28		$ 8,305,688		$8,305,688	
29		$ 8,585,947		$8,585,947	
30		$ 8,875,663		$8,875,663	
		Present value of O&M		**$256,830,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 141,660,000	$ 330,540,000	$ 5,304,521,019	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$76,484,000**	**$142,770,000**	**$3,436,779,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,979,332,000**

Easement Area Estimation - Alternative 6A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2191598	40	87663911	2012
Regional PS	150	150	787500	18
Neighborhood PS	150	150	2385000	55
WWTP				0
Total				2085

Annual Power Estimation - Alternative 6A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.95	mgd, Avg.	6	mgd, avg.
21	gpm	660	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	18	hp	84	hp
0.3	kw	13.3	kw	62.8	kw
106	ea	35	ea	0	ea
33.27	kw	463.87	kw	0.00	kw
291,426	kwh annual	4,063,499	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**4,354,924**	**kwh annual**			

Labor and Material Estimation - Alternative 6A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 38,626	4.40	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,351,906		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 11,543		total
Total for WWTP, Regional PS, and NH PS	**$ 1,363,449**		

Pump Station Weighted Average and Peak Flows - Alternative 6A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	35	4.40	153.83		0.95	33.26

G-18: Alternative 6B Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 6B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (11 mgd) urban sewering 'Gravity and LP Sewer	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	78,405	LF			$ 3,700	$ 290,100,132
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,151	LF			$ 8,700	$ 201,415,356
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	18,337	LF			$ 15,200	$ 278,720,010
	Gravity Sewer 48 inch	31,900	LF			$ 17,400	$ 555,064,888
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	13,622	LF			$ 4,750	$ 64,706,400
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	31,733	LF			$ 13,050	$ 414,115,650
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	408,267	LF			$ 450	$ 183,720,183
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	61	EA			$ 7,000,000	$ 427,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 6,763,661,965**
	Right of Way	2,474	Ac			$ 20,000	$ 49,480,186
	Contingency	20%					$ 1,362,628,430
	Total Estimated Project Cost						**$ 8,175,770,581**
	Project services	20%					$ 1,635,154,116
	TOTAL CAPITAL COST						**9,810,925,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	7082097	kWH	$ 0.44	$3,116,123
	Labor and Materials	$ 4,686,875	LS	-	$4,686,875
Annual O&M					**$7,802,998**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 8,066,295		$8,066,295	
2		$ 8,338,476		$8,338,476	
3		$ 8,619,841		$8,619,841	
4		$ 8,910,701		$8,910,701	
5		$ 9,211,375		$9,211,375	
6		$ 9,522,195		$9,522,195	
7		$ 9,843,502		$9,843,502	
8		$ 10,175,652		$10,175,652	
9		$ 10,519,009		$10,519,009	
10		$ 10,873,952		$10,873,952	
11		$ 11,240,873		$11,240,873	
12		$ 11,620,174		$11,620,174	
13		$ 12,012,274		$12,012,274	
14		$ 12,417,604		$12,417,604	
15		$ 12,836,612		$12,836,612	
16		$ 13,269,758		$13,269,758	
17		$ 13,717,520		$13,717,520	
18		$ 14,180,390		$14,180,390	
19		$ 14,658,880		$14,658,880	
20		$ 15,153,515		$15,153,515	
21		$ 15,664,840	$ 380,027,568	$395,692,409	replace elec./ motorized equipment
22		$ 16,193,420		$16,193,420	
23		$ 16,739,835	$ 28,534,816	$45,274,650	sewer inspection at yr 10 of service
24		$ 17,304,687		$17,304,687	
25		$ 17,888,600		$17,888,600	
26		$ 18,492,215		$18,492,215	
27		$ 19,116,199		$19,116,199	
28		$ 19,761,237		$19,761,237	
29		$ 20,428,041		$20,428,041	
30		$ 21,117,345		$21,117,345	
		Present value of O&M		**$443,690,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 189,300,000	$ 441,700,000	$ 6,132,661,965	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$102,206,000**	**$190,784,000**	**$3,973,329,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,988,296,000**

Easement Area Estimation - Alternative 6B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2659884	40	106395344	2443
Regional PS	150	150	1372500	32
Neighborhood PS	150	150	0	0
WWTP				0
Total				2474

Annual Power Estimation - Alternative 6B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.95	mgd, Avg.	6	mgd, avg.
21	gpm	660	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	18	hp	84	hp
0.3	kw	13.3	kw	62.8	kw
0	ea	61	ea	0	ea
0.00	kw	808.46	kw	0.00	kw
-	kwh annual	7,082,097	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**7,082,097**	**kwh annual**			

Labor and Material Estimation - Alternative 6B

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ -	0	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 38,626	4.40	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 2,356,179		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total				
Flow prorated for Puna H WWPSs, total		$ -		total
Total for WWTP, Regional PS, and NH PS		**$ 2,356,179**		

Pump Station Weighted Average and Peak Flows - Alternative 6B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	35	4.40	153.83		0.95	33.26

O&M Estimation for Puna LPS - Alternative 6B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	408267	$ 450	$ 183,720,183	0.81	**$ 330,696**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	4000	$ 26,000	$ 104,000,000	500	**$ 2,000,000**					

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
Alternative 6B							
to Hilo wwtp (11 mgd) urban sewering							
'Gravity and LP Sewer	Gravity Sewer 8 inch	1,342,713	LF			$ 1,600	$ 2,148,341,062
Excluding Lava	Gravity Sewer 12 inch	66,901	LF			$ 3,700	$ 247,533,460
Zones 1 & 2	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,830	LF			$ 8,700	$ 207,321,463
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	18,337	LF			$ 13,050	$ 239,295,798
	Gravity Sewer 42 inch	31,900	LF			$ 15,200	$ 484,884,270
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	33,384	LF			$ 900	$ 30,045,600
	Force main 8 inch	4,754	LF			$ 1,600	$ 7,605,760
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	9,504	LF			$ 4,750	$ 45,144,000
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch	1,848	LF			$ 8,700	$ 16,077,600
	Force main 30 inch	14,837	LF			$ 10,875	$ 161,352,375
	Force main 36 inch	16,896	LF			$ 13,050	$ 220,492,800
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	278,895	LF			$ 450	$ 125,502,808
	Low pressure sewer (On-Lot)	2,700	EA			$ 26,000	$ 70,200,000
	Regional PS	35	EA			$ 7,000,000	$ 245,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 5,294,384,540**
	Right of Way	1,868	Ac			$ 20,000	$ 37,369,830
	Contingency	20%					$ 1,066,350,874
	Total Estimated Project Cost						**$ 6,398,105,243**
	Project services	20%					$ 1,279,621,049
	TOTAL CAPITAL COST						**7,677,726,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4063499	kWH	$ 0.44	$1,787,939
	Labor and Materials	$ 2,927,811	LS	-	$2,927,811
Annual O&M					**$4,715,750**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,874,874		$4,874,874	
2		$ 5,039,367		$5,039,367	
3		$ 5,209,410		$5,209,410	
4		$ 5,385,192		$5,385,192	
5		$ 5,566,904		$5,566,904	
6		$ 5,754,749		$5,754,749	
7		$ 5,948,931		$5,948,931	
8		$ 6,149,666		$6,149,666	
9		$ 6,357,175		$6,357,175	
10		$ 6,571,685		$6,571,685	
11		$ 6,793,434		$6,793,434	
12		$ 7,022,665		$7,022,665	
13		$ 7,259,631		$7,259,631	
14		$ 7,504,592		$7,504,592	
15		$ 7,757,820		$7,757,820	
16		$ 8,019,593		$8,019,593	
17		$ 8,290,198		$8,290,198	
18		$ 8,569,934		$8,569,934	
19		$ 8,859,110		$8,859,110	
20		$ 9,158,043		$9,158,043	
21		$ 9,467,063	$ 250,059,344	$259,526,408	replace elec./ motorized equipment
22		$ 9,786,511		$9,786,511	
23		$ 10,116,737	$ 22,288,140	$32,404,877	sewer inspection at yr 10 of service
24		$ 10,458,106		$10,458,106	
25		$ 10,810,995		$10,810,995	
26		$ 11,175,790		$11,175,790	
27		$ 11,552,895		$11,552,895	
28		$ 11,942,725		$11,942,725	
29		$ 12,345,709		$12,345,709	
30		$ 12,762,291		$12,762,291	
		Present value of O&M		**$280,957,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 124,560,000	$ 290,640,000	$ 4,879,184,540	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$67,252,000**	**$125,536,000**	**$3,161,206,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,604,689,000**

Easement Area Estimation - Alternative 6B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2015100	40	80603989	1850
Regional PS	150	150	787500	18
Neighborhood PS	150	150	0	0
WWTP				0
Total				1868

Annual Power Estimation - Alternative 6B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.95	mgd, Avg.	6	mgd, avg.
21	gpm	660	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	18	hp	84	hp
0.3	kw	13.3	kw	62.8	kw
0	ea	35	ea	0	ea
0.00	kw	463.87	kw	0.00	kw
-	kwh annual	4,063,499	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**4,063,499**	**kwh annual**			

Labor and Material Estimation - Alternative 6B

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ -	0	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 38,626	4.40	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 1,351,906		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total				
Flow prorated for Puna H WWPSs, total		$ -		total
Total for WWTP, Regional PS, and NH PS		**$ 1,351,906**		

Pump Station Weighted Average and Peak Flows - Alternative 6B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	35	4.40	153.83		0.95	33.26

O&M Estimation for Puna LPS - Alternative 6B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00
Puna LPS OM Cost										
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM					
LP pipe, valves, etc.	278895	$ 450	$ 125,502,808	0.81	**$ 225,905**					
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM					
lat Kits, etc.	2700	$ 26,000	$ 70,200,000	500	**$ 1,350,000**					

G-19: Alternative 6C Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 6C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
to Hilo wwtp (11 mgd) urban sewering							
Cross-Country Sewer	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	85,868	LF			$ 3,700	$ 317,710,558
	Gravity Sewer 16 inch	48,240	LF			$ 5,800	$ 279,794,282
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,151	LF			$ 8,700	$ 201,415,356
	Gravity Sewer 30 inch	7,239	LF			$ 10,875	$ 78,720,374
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	18,337	LF			$ 15,200	$ 278,720,010
	Gravity Sewer 48 inch	31,900	LF			$ 17,400	$ 555,064,888
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	7,286	LF			$ 4,750	$ 34,610,400
	Force main 16 inch	36,379	LF			$ 5,800	$ 210,999,360
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	31,733	LF			$ 13,050	$ 414,115,650
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	53	EA			$ 7,000,000	$ 371,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 7,329,094,302**
	Right of Way	2,603	Ac			$ 20,000	$ 52,054,953
	Contingency	20%					$ 1,476,229,851
	Total Estimated Project Cost						**$ 8,857,379,106**
	Project services	20%					$ 1,771,475,821
	TOTAL CAPITAL COST						**10,628,855,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	7917360	kWH	$ 0.44	$3,483,639
	Labor and Materials	$ 2,775,218	LS	-	$2,775,218
Annual O&M					**$6,258,856**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 6,470,049		$6,470,049	
2		$ 6,688,368		$6,688,368	
3		$ 6,914,054		$6,914,054	
4		$ 7,147,355		$7,147,355	
5		$ 7,388,529		$7,388,529	
6		$ 7,637,840		$7,637,840	
7		$ 7,895,564		$7,895,564	
8		$ 8,161,984		$8,161,984	
9		$ 8,437,394		$8,437,394	
10		$ 8,722,097		$8,722,097	
11		$ 9,016,407		$9,016,407	
12		$ 9,320,648		$9,320,648	
13		$ 9,635,155		$9,635,155	
14		$ 9,960,274		$9,960,274	
15		$ 10,296,364		$10,296,364	
16		$ 10,643,795		$10,643,795	
17		$ 11,002,949		$11,002,949	
18		$ 11,374,222		$11,374,222	
19		$ 11,758,022		$11,758,022	
20		$ 12,154,774		$12,154,774	
21		$ 12,564,913	$ 310,406,036	$322,970,949	replace elec./ motorized equipment
22		$ 12,988,891		$12,988,891	
23		$ 13,427,175	$ 35,484,082	$48,911,257	sewer inspection at yr 10 of service
24		$ 13,880,249		$13,880,249	
25		$ 14,348,611		$14,348,611	
26		$ 14,832,776		$14,832,776	
27		$ 15,333,279		$15,333,279	
28		$ 15,850,670		$15,850,670	
29		$ 16,385,520		$16,385,520	
30		$ 16,938,417		$16,938,417	
		Present value of O&M		**$364,773,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 154,620,000	$ 360,780,000	$ 6,813,694,302	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$83,481,000**	**$155,832,000**	**$4,414,567,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) 6,339,748,000

Easement Area Estimation - Alternative 6C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2783767	40	111350687	2556
Regional PS	150	150	1192500	27
Neighborhood PS	150	150	832500	19
WWTP				0
Total				2603

Annual Power Estimation - Alternative 6C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	1.21	mgd, Avg.	6	mgd, avg.
21	gpm	838	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	23	hp	84	hp
0.3	kw	16.8	kw	62.8	kw
37	ea	53	ea	0	ea
11.61	kw	892.20	kw	0.00	kw
101,724	kwh annual	7,815,636	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**7,917,360**	**kwh annual**			

Labor and Material Estimation - Alternative 6C

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ -	0	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 52,287	5.59	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 2,771,188		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 4,029		total
Total for WWTP, Regional PS, and NH PS		**$ 2,775,218**		

Pump Station Weighted Average and Peak Flows - Alternative 6C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	27	5.59	150.82		1.21	32.58

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 6C	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
to Hilo wwtp (11 mgd) urban sewering							
Cross-Country Sewer	Gravity Sewer 8 inch	1,684,677	LF			$ 1,600	$ 2,695,483,491
Excluding Lava Zones 1 & 2	Gravity Sewer 12 inch	74,363	LF			$ 3,700	$ 275,143,886
	Gravity Sewer 16 inch	44,444	LF			$ 5,800	$ 257,773,588
	Gravity Sewer 18 inch	63,885	LF			$ 6,525	$ 416,849,555
	Gravity Sewer 24 inch	23,830	LF			$ 8,700	$ 207,321,463
	Gravity Sewer 30 inch	-	LF			$ 10,875	$ -
	Gravity Sewer 36 inch	18,337	LF			$ 13,050	$ 239,295,798
	Gravity Sewer 42 inch	31,900	LF			$ 15,200	$ 484,884,270
	Gravity Sewer 48 inch	-	LF			$ 17,400	$ -
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	29,334	LF			$ 600	$ 17,600,330
	Force main 6 inch	16,508	LF			$ 900	$ 14,857,200
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch	21,260	LF			$ 2,650	$ 56,339,000
	Force main 12 inch	22,176	LF			$ 3,700	$ 82,051,200
	Force main 14 inch	3,168	LF			$ 4,750	$ 15,048,000
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch	16,632	LF			$ 6,525	$ 108,523,800
	Force main 24 inch	1,848	LF			$ 8,700	$ 16,077,600
	Force main 30 inch	14,837	LF			$ 10,875	$ 161,352,375
	Force main 36 inch	16,896	LF			$ 13,050	$ 220,492,800
	Force main 42 inch	-	LF			$ 15,200	$ -
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	27	EA			$ 7,000,000	$ 189,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	WWTP	-	LS			NA	$ 100,000,000
	Subtotal of Estimated Construction Cost						**$ 5,716,832,916**
	Right of Way	1,964	Ac			$ 20,000	$ 39,277,059
	Contingency	20%					$ 1,151,221,995
	Total Estimated Project Cost						**$ 6,907,331,970**
	Project services	20%					$ 1,381,466,394
	TOTAL CAPITAL COST						**8,288,798,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4058531	kWH	$ 0.44	$1,785,754
	Labor and Materials	$ 1,414,787	LS	-	$1,414,787
Annual O&M					**$3,200,540**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 3,308,536		$3,308,536	
2		$ 3,420,176		$3,420,176	
3		$ 3,535,583		$3,535,583	
4		$ 3,654,885		$3,654,885	
5		$ 3,778,212		$3,778,212	
6		$ 3,905,700		$3,905,700	
7		$ 4,037,490		$4,037,490	
8		$ 4,173,727		$4,173,727	
9		$ 4,314,561		$4,314,561	
10		$ 4,460,148		$4,460,148	
11		$ 4,610,647		$4,610,647	
12		$ 4,766,224		$4,766,224	
13		$ 4,927,051		$4,927,051	
14		$ 5,093,304		$5,093,304	
15		$ 5,265,168		$5,265,168	
16		$ 5,442,831		$5,442,831	
17		$ 5,626,488		$5,626,488	
18		$ 5,816,343		$5,816,343	
19		$ 6,012,604		$6,012,604	
20		$ 6,215,487		$6,215,487	
21		$ 6,425,217	$ 194,289,847	$200,715,064	replace elec./ motorized equipment
22		$ 6,642,023		$6,642,023	
23		$ 6,866,145	$ 27,180,108	$34,046,253	sewer inspection at yr 10 of service
24		$ 7,097,830		$7,097,830	
25		$ 7,337,332		$7,337,332	
26		$ 7,584,916		$7,584,916	
27		$ 7,840,854		$7,840,854	
28		$ 8,105,428		$8,105,428	
29		$ 8,378,930		$8,378,930	
30		$ 8,661,660		$8,661,660	
		Present value of O&M		**$208,991,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 96,780,000	$ 225,820,000	$ 5,394,232,916	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$52,253,000**	**$97,539,000**	**$3,494,903,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,853,094,000**

Easement Area Estimation - Alternative 6C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2107698	40	84307935	1935
Regional PS	150	150	607500	14
Neighborhood PS	150	150	630000	14
WWTP				0
Total				1964

Annual Power Estimation - Alternative 6C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	1.21	mgd, Avg.	6	mgd, avg.
21	gpm	838	gpm	4,167	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	23	hp	84	hp
0.3	kw	16.8	kw	62.8	kw
28	ea	27	ea	0	ea
8.79	kw	454.51	kw	0.00	kw
76,980	kwh annual	3,981,551	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**4,058,531**	**kwh annual**			

Labor and Material Estimation - Alternative 6C

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ -	0	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 52,287	5.59	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 1,411,738		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 3,049		total
Total for WWTP, Regional PS, and NH PS		**$ 1,414,787**		

Pump Station Weighted Average and Peak Flows - Alternative 6C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	14.2	14.2	4.76	2.98	2.98
to Hilo	3	19.33	57.99	4.76	4.06	12.18
Weighted Average	27	5.59	150.82		1.21	32.58

G-20: Alternative 7A Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7A	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (13.5 mgd) Full Flow Gravity Sewer	Gravity Sewer 8 inch	2,173,538	LF			$ 1,600	$ 3,477,661,076
	Gravity Sewer 12 inch	67,925	LF			$ 3,700	$ 251,320,775
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,684	LF			$ 17,400	$ 359,905,516
	Gravity Sewer 54 inch	29,553	LF			$ 19,500	$ 576,281,523
	Force main 4 inch	263,172	LF			$ 600	$ 157,903,149
	Force main 6 inch	41,040	LF			$ 900	$ 36,936,000
	Force main 8 inch	20,224	LF			$ 1,600	$ 32,358,400
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	12,355	LF			$ 4,750	$ 58,687,200
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	1,848	LF			$ 13,050	$ 24,116,400
	Force main 42 inch	14,837	LF			$ 15,200	$ 225,519,360
	Force main 48 inch	16,896	LF			$ 17,400	$ 293,990,400
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	61	EA			$ 7,000,000	$ 427,000,000
	Neighborhood PS	160	EA			$ 1,200,000	$ 192,000,000
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 7,962,603,953**
	Right of Way	2,797	Ac			$ 20,000	$ 55,933,803
	Contingency	20%					$ 1,603,707,551
	Total Estimated Project Cost						**$ 9,622,245,307**
	Project services	20%					$ 1,924,449,061
	TOTAL CAPITAL COST						**11,546,694,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6564394	kWH	$ 0.44	$2,888,333
	Labor and Materials	$ 2,033,644	LS	-	$2,033,644
Annual O&M					**$4,921,977**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 5,088,059		$5,088,059	
2		$ 5,259,746		$5,259,746	
3		$ 5,437,226		$5,437,226	
4		$ 5,620,694		$5,620,694	
5		$ 5,810,354		$5,810,354	
6		$ 6,006,412		$6,006,412	
7		$ 6,209,087		$6,209,087	
8		$ 6,418,600		$6,418,600	
9		$ 6,635,183		$6,635,183	
10		$ 6,859,075		$6,859,075	
11		$ 7,090,521		$7,090,521	
12		$ 7,329,776		$7,329,776	
13		$ 7,577,105		$7,577,105	
14		$ 7,832,780		$7,832,780	
15		$ 8,097,081		$8,097,081	
16		$ 8,370,301		$8,370,301	
17		$ 8,652,741		$8,652,741	
18		$ 8,944,710		$8,944,710	
19		$ 9,246,532		$9,246,532	
20		$ 9,558,538		$9,558,538	
21		$ 9,881,072	$ 445,071,906	$454,952,979	replace elec./ motorized equipment
22		$ 10,214,490		$10,214,490	
23		$ 10,559,157	$ 34,225,744	$44,784,901	sewer inspection at yr 10 of service
24		$ 10,915,455		$10,915,455	
25		$ 11,283,776		$11,283,776	
26		$ 11,664,525		$11,664,525	
27		$ 12,058,121		$12,058,121	
28		$ 12,464,999		$12,464,999	
29		$ 12,885,605		$12,885,605	
30		$ 13,320,405		$13,320,405	
		Present value of O&M		**$392,339,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 221,700,000	$ 517,300,000	$ 7,223,603,953	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$119,699,000**	**$223,438,000**	**$4,680,146,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **6,915,750,000**

Easement Area Estimation - Alternative 7A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2921283	40	116851323	2683
Regional PS	150	150	1372500	32
Neighborhood PS	150	150	3600000	83
WWTP				0
Total				2797

Annual Power Estimation - Alternative 7A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.82	mgd, Avg.	8.5	mgd, avg.
21	gpm	571	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	15	hp	119	hp
0.3	kw	11.5	kw	88.9	kw
160	ea	61	ea	0	ea
50.22	kw	699.14	kw	0.00	kw
439,888	kwh annual	6,124,506	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**6,564,394**	**kwh annual**			

Labor and Material Estimation - Alternative 7A

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 33,053	3.91	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 2,016,220		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 17,424		total
Total for WWTP, Regional PS, and NH PS	**$ 2,033,644**		

Pump Station Weighted Average and Peak Flows - Alternative 7A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	61	3.91	238.47		0.82	50.12

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7A	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
to Hilo wwtp (13.5 mgd)							
Full Flow							
Gravity Sewer	Gravity Sewer 8 inch	1,619,836	LF			$ 1,600	$ 2,591,737,693
Excluding Lava	Gravity Sewer 12 inch	56,420	LF			$ 3,700	$ 208,754,103
Zones 1 & 2	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,684	LF			$ 15,200	$ 314,400,221
	Gravity Sewer 48 inch	29,553	LF			$ 17,400	$ 514,220,436
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	178,270	LF			$ 600	$ 106,962,177
	Force main 6 inch	32,698	LF			$ 900	$ 29,427,840
	Force main 8 inch	5,440	LF			$ 1,600	$ 8,704,000
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	8,237	LF			$ 4,750	$ 39,124,800
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch	-	LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	14,837	LF			$ 13,050	$ 193,620,240
	Force main 42 inch	16,896	LF			$ 15,200	$ 256,819,200
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	35	EA			$ 7,000,000	$ 245,000,000
	Neighborhood PS	106	EA			$ 1,200,000	$ 127,200,000
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 6,212,102,347**
	Right of Way	2,085	Ac			$ 20,000	$ 41,706,337
	Contingency	20%					$ 1,250,761,737
	Total Estimated Project Cost						**$ 7,504,570,422**
	Project services	20%					$ 1,500,914,084
	TOTAL CAPITAL COST						**9,005,485,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	5235932	kWH	$ 0.44	$2,303,810
	Labor and Materials	$ 1,757,169	LS	-	$1,757,169
Annual O&M					**$4,060,979**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,198,009		$4,198,009	
2		$ 4,339,662		$4,339,662	
3		$ 4,486,096		$4,486,096	
4		$ 4,637,470		$4,637,470	
5		$ 4,793,952		$4,793,952	
6		$ 4,955,715		$4,955,715	
7		$ 5,122,936		$5,122,936	
8		$ 5,295,799		$5,295,799	
9		$ 5,474,495		$5,474,495	
10		$ 5,659,222		$5,659,222	
11		$ 5,850,181		$5,850,181	
12		$ 6,047,584		$6,047,584	
13		$ 6,251,647		$6,251,647	
14		$ 6,462,597		$6,462,597	
15		$ 6,680,665		$6,680,665	
16		$ 6,906,090		$6,906,090	
17		$ 7,139,123		$7,139,123	
18		$ 7,380,019		$7,380,019	
19		$ 7,629,043		$7,629,043	
20		$ 7,886,470		$7,886,470	
21		$ 8,152,583	$ 296,433,549	$304,586,132	replace elec./ motorized equipment
22		$ 8,427,676		$8,427,676	
23		$ 8,712,051	$ 26,167,860	$34,879,912	sewer inspection at yr 10 of service
24		$ 9,006,022		$9,006,022	
25		$ 9,309,913		$9,309,913	
26		$ 9,624,058		$9,624,058	
27		$ 9,948,802		$9,948,802	
28		$ 10,284,505		$10,284,505	
29		$ 10,631,535		$10,631,535	
30		$ 10,990,276		$10,990,276	
		Present value of O&M		**$286,631,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 147,660,000	$ 344,540,000	$ 5,719,902,347	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$79,724,000**	**$148,817,000**	**$3,705,903,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,357,672,000**

Easement Area Estimation - Alternative 7A

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2191598	40	87663903	2012
Regional PS	150	150	787500	18
Neighborhood PS	150	150	2385000	55
WWTP				0
Total				2085

Annual Power Estimation - Alternative 7A

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	1.16	mgd, Avg.	8.5	mgd, avg.
21	gpm	803	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	22	hp	119	hp
0.3	kw	16.1	kw	88.9	kw
106	ea	35	ea	0	ea
33.27	kw	564.44	kw	0.00	kw
291,426	kwh annual	4,944,506	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**5,235,932**	**kwh annual**			

Labor and Material Estimation - Alternative 7A

Honouliuli WWTP 2014 total	$	584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$	791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$	-	0	mgd, total flow
Halawa WWPS 2014 total	$	6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$	8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$	36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$	49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$	49,875	5.38	mgd, each
Flow prorated for Puna Regional WWPSs, total	$	1,745,626		total
Flow prorated for Puna neighborhood WWPSs	$	109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$	11,543		total
Total for WWTP, Regional PS, and NH PS	**$**	**1,757,169**		

Pump Station Weighted Average and Peak Flows - Alternative 7A

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	35	5.38	188.15		1.16	40.47

G-21: Alternative 7B Construction Cost and LCC Analysis

JOB #:	Puna Wastewater Facility Plan
DATE:	October 16, 2023
LOCATION:	Puna Wastewater Facility Plan
PREPARED BY:	T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7B	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (13.5 mgd) Full Flow							
'Gravity and LP Sewer	Gravity Sewer 8 inch	1,767,043	LF			$ 1,600	$ 2,827,269,336
	Gravity Sewer 12 inch	67,925	LF			$ 3,700	$ 251,320,775
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,684	LF			$ 17,400	$ 359,905,516
	Gravity Sewer 54 inch	29,553	LF			$ 19,500	$ 576,281,523
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	41,726	LF			$ 900	$ 37,553,760
	Force main 8 inch	19,538	LF			$ 1,600	$ 31,260,160
	Force main 10 inch	42,961	LF			$ 2,650	$ 113,846,120
	Force main 12 inch	15,312	LF			$ 3,700	$ 56,654,400
	Force main 14 inch	12,355	LF			$ 4,750	$ 58,687,200
	Force main 16 inch	30,043	LF			$ 5,800	$ 174,250,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	1,848	LF			$ 13,050	$ 24,116,400
	Force main 42 inch	14,837	LF			$ 15,200	$ 225,519,360
	Force main 48 inch	16,896	LF			$ 17,400	$ 293,990,400
	Low Pressure Sewer In-Street (3 inch)	408,267	LF			$ 450	$ 183,720,183
	Low pressure sewer (On-Lot)	4,000	EA			$ 26,000	$ 104,000,000
	Regional PS	61	EA			$ 7,000,000	$ 427,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 7,249,548,766**
	Right of Way	2,474	Ac			$ 20,000	$ 49,480,182
	Contingency	20%					$ 1,459,805,790
	Total Estimated Project Cost						**$ 8,758,834,737**
	Project services	20%					$ 1,751,766,947
	TOTAL CAPITAL COST						**10,510,602,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6124506	kWH	$ 0.44	$2,694,783
	Labor and Materials	$ 4,346,916	LS	-	$4,346,916

Annual O&M **$7,041,699**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 7,279,307		$7,279,307	
2		$ 7,524,933		$7,524,933	
3		$ 7,778,847		$7,778,847	
4		$ 8,041,329		$8,041,329	
5		$ 8,312,668		$8,312,668	
6		$ 8,593,162		$8,593,162	
7		$ 8,883,122		$8,883,122	
8		$ 9,182,865		$9,182,865	
9		$ 9,492,723		$9,492,723	
10		$ 9,813,036		$9,813,036	
11		$ 10,144,158		$10,144,158	
12		$ 10,486,452		$10,486,452	
13		$ 10,840,297		$10,840,297	
14		$ 11,206,081		$11,206,081	
15		$ 11,584,208		$11,584,208	
16		$ 11,975,095		$11,975,095	
17		$ 12,379,171		$12,379,171	
18		$ 12,796,882		$12,796,882	
19		$ 13,228,687		$13,228,687	
20		$ 13,675,063		$13,675,063	
21		$ 14,136,501	$ 392,072,816	$406,209,317	replace elec./ motorized equipment
22		$ 14,613,510		$14,613,510	
23		$ 15,106,614	$ 28,534,816	$43,641,429	sewer inspection at yr 10 of service
24		$ 15,616,357		$15,616,357	
25		$ 16,143,300		$16,143,300	
26		$ 16,688,024		$16,688,024	
27		$ 17,251,128		$17,251,128	
28		$ 17,833,234		$17,833,234	
29		$ 18,434,981		$18,434,981	
30		$ 19,057,033		$19,057,033	
		Present value of O&M		**$426,778,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 195,300,000	$ 455,700,000	$ 6,598,548,766	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$105,445,000**	**$196,831,000**	**$4,275,175,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **6,359,929,000**

Easement Area Estimation - Alternative 7B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2659883	40	106395336	2443
Regional PS	150	150	1372500	32
Neighborhood PS	150	150	0	0
WWTP				0
Total				2474

Annual Power Estimation - Alternative 7B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.82	mgd, Avg.	8.5	mgd, avg.
21	gpm	571	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	15	hp	119	hp
0.3	kw	11.5	kw	88.9	kw
0	ea	61	ea	0	ea
0.00	kw	699.14	kw	0.00	kw
-	kwh annual	6,124,506	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**6,124,506**	**kwh annual**			

Labor and Material Estimation - Alternative 7B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 33,053	3.91	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 2,016,220		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 2,016,220**		

Pump Station Weighted Average and Peak Flows - Alternative 7B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	61	3.91	238.47		0.82	50.12

O&M Estimation for Puna LPS - Alternative 7B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00

Puna LPS OM Cost					
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM
LP pipe, valves, etc.	408267	$ 450	$ 183,720,183	0.81	**$ 330,696**
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM
lat Kits, etc.	4000	$ 26,000	$ 104,000,000	500	**$ 2,000,000**

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7B	**DESCRIPTION**	**QUAN**	**UN**			**UNIT COST**	**TOTAL DIRECT COST**
to Hilo wwtp (13.5 mgd) Full Flow							
'Gravity and LP Sewer	Gravity Sewer 8 inch	1,342,713	LF			$ 1,600	$ 2,148,341,062
Excluding Lava Zones 1 & 2	Gravity Sewer 12 inch	56,420	LF			$ 3,700	$ 208,754,103
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,684	LF			$ 15,200	$ 314,400,221
	Gravity Sewer 48 inch	29,553	LF			$ 17,400	$ 514,220,436
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	-	LF			$ 600	$ -
	Force main 6 inch	33,384	LF			$ 900	$ 30,045,600
	Force main 8 inch	4,754	LF			$ 1,600	$ 7,605,760
	Force main 10 inch	27,068	LF			$ 2,650	$ 71,730,200
	Force main 12 inch	10,032	LF			$ 3,700	$ 37,118,400
	Force main 14 inch	8,237	LF			$ 4,750	$ 39,124,800
	Force main 16 inch	9,240	LF			$ 5,800	$ 53,592,000
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch	-	LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	14,837	LF			$ 13,050	$ 193,620,240
	Force main 42 inch	16,896	LF			$ 15,200	$ 256,819,200
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer In-Street (3 inch)	278,895	LF			$ 450	$ 125,502,808
	Low pressure sewer (On-Lot)	2,700	EA			$ 26,000	$ 70,200,000
	Regional PS	35	EA			$ 7,000,000	$ 245,000,000
	Neighborhood PS	-	EA			$ 1,200,000	$ -
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 5,729,765,868**
	Right of Way	1,868	Ac			$ 20,000	$ 37,369,826
	Contingency	20%					$ 1,153,427,139
	Total Estimated Project Cost						**$ 6,920,562,833**
	Project services	20%					$ 1,384,112,567
	TOTAL CAPITAL COST						**8,304,675,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4944506	kWH	$ 0.44	$2,175,583
	Labor and Materials	$ 3,321,531	LS	-	$3,321,531
Annual O&M					**$5,497,113**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 5,682,603		$5,682,603	
2		$ 5,874,351		$5,874,351	
3		$ 6,072,569		$6,072,569	
4		$ 6,277,476		$6,277,476	
5		$ 6,489,297		$6,489,297	
6		$ 6,708,266		$6,708,266	
7		$ 6,934,623		$6,934,623	
8		$ 7,168,618		$7,168,618	
9		$ 7,410,509		$7,410,509	
10		$ 7,660,562		$7,660,562	
11		$ 7,919,053		$7,919,053	
12		$ 8,186,266		$8,186,266	
13		$ 8,462,495		$8,462,495	
14		$ 8,748,045		$8,748,045	
15		$ 9,043,231		$9,043,231	
16		$ 9,348,377		$9,348,377	
17		$ 9,663,819		$9,663,819	
18		$ 9,989,906		$9,989,906	
19		$ 10,326,996		$10,326,996	
20		$ 10,675,460		$10,675,460	
21		$ 11,035,682	$ 262,104,592	$273,140,275	replace elec./ motorized equipment
22		$ 11,408,060		$11,408,060	
23		$ 11,793,002	$ 22,288,140	$34,081,142	sewer inspection at yr 10 of service
24		$ 12,190,934		$12,190,934	
25		$ 12,602,293		$12,602,293	
26		$ 13,027,532		$13,027,532	
27		$ 13,467,121		$13,467,121	
28		$ 13,921,542		$13,921,542	
29		$ 14,391,297		$14,391,297	
30		$ 14,876,903		$14,876,903	
		Present value of O&M		**$310,757,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 130,560,000	$ 304,640,000	$ 5,294,565,868	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$70,491,000**	**$131,583,000**	**$3,430,330,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **4,983,028,000**

Easement Area Estimation - Alternative 7B

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2015100	40	80603981	1850
Regional PS	150	150	787500	18
Neighborhood PS	150	150	0	0
WWTP				0
Total				1868

Annual Power Estimation - Alternative 7B

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	1.16	mgd, Avg.	8.5	mgd, avg.
21	gpm	803	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	22	hp	119	hp
0.3	kw	16.1	kw	88.9	kw
0	ea	35	ea	0	ea
0.00	kw	564.44	kw	0.00	kw
-	kwh annual	4,944,506	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**4,944,506**	**kwh annual**			

Labor and Material Estimation - Alternative 7B

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 49,875	5.38	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 1,745,626		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total			
Flow prorated for Puna H WWPSs, total	$ -		total
Total for WWTP, Regional PS, and NH PS	**$ 1,745,626**		

Pump Station Weighted Average and Peak Flows - Alternative 7B

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	2	0.475	0.95	4.42	0.11	0.21
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	2	0.25	0.5	4.42	0.06	0.11
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	1	0.3	0.3	4.89	0.06	0.06
Paahana-Keaau	3	0.42	1.26	4.48	0.09	0.28
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	35	5.38	188.15		1.16	40.47

O&M Estimation for Puna LPS - Alternative 7B

Basis of LPS Unit Cost (Kapoho)										
In-Street	LF	2009 total cost	2023 total cost	2023 cost/LF	2009 Op cost	2009 Main cost		2009 total OM	2023 total OM	2023 OM/LF
LP pipe, valves, etc.	3400			Use $450/LF	$ 1,700	$ 70		$ 1,770	$ 2,744	$ 0.81
On-Lot	# of lots	2009 total cost	2023 total cost	2023 cost/lot	2009 Op cost	2009 Main cost	2009 Elec. Cost	2009 total OM	2023 total OM	2023 OM/Lot
lat Kits, etc.	36	$ 592,000	$ 917,930	$ 26,000	$ 3,600	$ 5,800	$ 2,200	$ 11,600	$ 17,986	$ 500.00

Puna LPS OM Cost					
In-Street	LF	2023 cost/LF	2023 cost	2023 OM/LF	2023 total OM
LP pipe, valves, etc.	278895	$ 450	$ 125,502,808	0.81	**$ 225,905**
On-Lot	# of lots	2023 cost/lot	2023 cost	2023 OM/Lot	2023 total OM
lat Kits, etc.	2700	$ 26,000	$ 70,200,000	500	**$ 1,350,000**

G-22: Alternative 7C Construction Cost and LCC Analysis

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (13.5 mgd) Full Flow Cross-Country Sewer							
	Gravity Sewer 8 inch	2,255,957	LF			$ 1,600	$ 3,609,531,538
	Gravity Sewer 12 inch	75,387	LF			$ 3,700	$ 278,931,200
	Gravity Sewer 16 inch	10,895	LF			$ 5,800	$ 63,192,179
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	68,441	LF			$ 8,700	$ 595,438,293
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	7,239	LF			$ 13,050	$ 94,464,449
	Gravity Sewer 42 inch	-	LF			$ 15,200	$ -
	Gravity Sewer 48 inch	20,684	LF			$ 17,400	$ 359,905,516
	Gravity Sewer 54 inch	29,553	LF			$ 19,500	$ 576,281,523
	Force main 4 inch	48,268	LF			$ 600	$ 28,960,852
	Force main 6 inch	24,850	LF			$ 900	$ 22,365,360
	Force main 8 inch	15,630	LF			$ 1,600	$ 25,008,640
	Force main 10 inch	33,404	LF			$ 2,650	$ 88,520,600
	Force main 12 inch	33,158	LF			$ 3,700	$ 122,686,080
	Force main 14 inch	6,019	LF			$ 4,750	$ 28,591,200
	Force main 16 inch	36,379	LF			$ 5,800	$ 210,999,360
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch		LF			$ 8,700	$ -
	Force main 30 inch	-	LF			$ 10,875	$ -
	Force main 36 inch	1,848	LF			$ 13,050	$ 24,116,400
	Force main 42 inch	14,837	LF			$ 15,200	$ 225,519,360
	Force main 48 inch	16,896	LF			$ 17,400	$ 293,990,400
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	53	EA			$ 7,000,000	$ 371,000,000
	Neighborhood PS	37	EA			$ 1,200,000	$ 44,400,000
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 7,814,981,103**
	Right of Way	2,603	Ac			$ 20,000	$ 52,054,949
	Contingency	20%					$ 1,573,407,210
	Total Estimated Project Cost						**$ 9,440,443,263**
	Project services	20%					$ 1,888,088,653
	TOTAL CAPITAL COST						**11,328,532,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	6144282	kWH	$ 0.44	$2,703,484
	Labor and Materials	$ 2,080,081	LS	-	$2,080,081
Annual O&M					**$4,783,565**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,944,977		$4,944,977	
2		$ 5,111,836		$5,111,836	
3		$ 5,284,324		$5,284,324	
4		$ 5,462,633		$5,462,633	
5		$ 5,646,959		$5,646,959	
6		$ 5,837,505		$5,837,505	
7		$ 6,034,480		$6,034,480	
8		$ 6,238,102		$6,238,102	
9		$ 6,448,594		$6,448,594	
10		$ 6,666,189		$6,666,189	
11		$ 6,891,127		$6,891,127	
12		$ 7,123,654		$7,123,654	
13		$ 7,364,028		$7,364,028	
14		$ 7,612,512		$7,612,512	
15		$ 7,869,382		$7,869,382	
16		$ 8,134,918		$8,134,918	
17		$ 8,409,415		$8,409,415	
18		$ 8,693,174		$8,693,174	
19		$ 8,986,508		$8,986,508	
20		$ 9,289,740		$9,289,740	
21		$ 9,603,204	$ 322,451,284	$332,054,488	replace elec./ motorized equipment
22		$ 9,927,246		$9,927,246	
23		$ 10,262,221	$ 35,484,082	$45,746,303	sewer inspection at yr 10 of service
24		$ 10,608,499		$10,608,499	
25		$ 10,966,462		$10,966,462	
26		$ 11,336,504		$11,336,504	
27		$ 11,719,032		$11,719,032	
28		$ 12,114,468		$12,114,468	
29		$ 12,523,246		$12,523,246	
30		$ 12,945,819		$12,945,819	
		Present value of O&M		**$326,241,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 160,620,000	$ 374,780,000	$ 7,279,581,103	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$86,721,000**	**$161,879,000**	**$4,716,414,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **6,689,759,000**

Easement Area Estimation - Alternative 7C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2783767	40	111350679	2556
Regional PS	150	150	1192500	27
Neighborhood PS	150	150	832500	19
WWTP				0
Total				2603

Annual Power Estimation - Alternative 7C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	0.93	mgd, Avg.	8.5	mgd, avg.
21	gpm	648	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	17	hp	119	hp
0.3	kw	13.0	kw	88.9	kw
37	ea	53	ea	0	ea
11.61	kw	689.79	kw	0.00	kw
101,724	kwh annual	6,042,558	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**6,144,282**	**kwh annual**			

Labor and Material Estimation - Alternative 7C

Honouliuli WWTP 2014 total	$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated	$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total	$ -	0	mgd, total flow
Halawa WWPS 2014 total	$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated	$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total	$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated	$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs	$ 39,171	4.44	mgd, each
Flow prorated for Puna Regional WWPSs, total	$ 2,076,052		total
Flow prorated for Puna neighborhood WWPSs	$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total	$ 4,029		total
Total for WWTP, Regional PS, and NH PS	**$ 2,080,081**		

Pump Station Weighted Average and Peak Flows - Alternative 7C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa	2	5.03	10.06	4.49	1.12	2.24
Lelani	9	0.73	6.57	10.3	0.07	0.64
Nanawale	5	0.938	4.69	4.43	0.21	1.06
Hawaiian Beaches	10	2.9	29	5.07	0.57	5.72
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	53	4.44	235.46		0.93	49.45

JOB #: Puna Wastewater Facility Plan
DATE: October 16, 2023
LOCATION: Puna Wastewater Facility Plan
PREPARED BY: T. Huang

AECOM
Construction Cost Estimate
Conceptual Level
Wastewater Facility Plan Estimates

Alternative 7C	DESCRIPTION	QUAN	UN			UNIT COST	TOTAL DIRECT COST
to Hilo wwtp (13.5 mgd) Full Flow							
Cross-Country Sewer	Gravity Sewer 8 inch	1,684,677	LF			$ 1,600	$ 2,695,483,491
Excluding Lava Zones 1 & 2	Gravity Sewer 12 inch	63,882	LF			$ 3,700	$ 236,364,528
	Gravity Sewer 16 inch	7,099	LF			$ 5,800	$ 41,171,486
	Gravity Sewer 18 inch	47,826	LF			$ 6,525	$ 312,065,285
	Gravity Sewer 24 inch	69,120	LF			$ 8,700	$ 601,344,400
	Gravity Sewer 30 inch	18,595	LF			$ 10,875	$ 202,220,586
	Gravity Sewer 36 inch	-	LF			$ 13,050	$ -
	Gravity Sewer 42 inch	20,684	LF			$ 15,200	$ 314,400,221
	Gravity Sewer 48 inch	29,553	LF			$ 17,400	$ 514,220,436
	Gravity Sewer 54 inch	-	LF			$ 19,500	$ -
	Force main 4 inch	29,334	LF			$ 600	$ 17,600,330
	Force main 6 inch	16,508	LF			$ 900	$ 14,857,200
	Force main 8 inch	2,800	LF			$ 1,600	$ 4,480,000
	Force main 10 inch	21,260	LF			$ 2,650	$ 56,339,000
	Force main 12 inch	22,176	LF			$ 3,700	$ 82,051,200
	Force main 14 inch	1,901	LF			$ 4,750	$ 9,028,800
	Force main 16 inch	20,803	LF			$ 5,800	$ 120,658,560
	Force main 18 inch	17,899	LF			$ 6,525	$ 116,792,280
	Force main 24 inch	-	LF			$ 8,700	$ -
	Force main 30 inch	1,848	LF			$ 10,875	$ 20,097,000
	Force main 36 inch	14,837	LF			$ 13,050	$ 193,620,240
	Force main 42 inch	16,896	LF			$ 15,200	$ 256,819,200
	Force main 48 inch	-	LF			$ 17,400	$ -
	Low Pressure Sewer 3 inch	-	LF			$ 450	$ -
	Regional PS	27	EA			$ 7,000,000	$ 189,000,000
	Neighborhood PS	28	EA			$ 1,200,000	$ 33,600,000
	WWTP	-	LS			NA	$ 120,000,000
	Subtotal of Estimated Construction Cost						**$ 6,152,214,245**
	Right of Way	1,964	Ac			$ 20,000	$ 39,277,055
	Contingency	20%					$ 1,238,298,260
	Total Estimated Project Cost						**$ 7,429,789,560**
	Project services	20%					$ 1,485,957,912
	TOTAL CAPITAL COST						**8,915,747,000**

O&M

	Item	QUAN	UN	Unit cost	Total Annual
	Electricity	4939538	kWH	$ 0.44	$2,173,397
	Labor and Materials	$ 1,808,507	LS	-	$1,808,507
Annual O&M					**$3,981,904**

Year	Year	Annual $	Additional Cost	Total	
0		$ -		$ -	
1		$ 4,116,265		$4,116,265	
2		$ 4,255,160		$4,255,160	
3		$ 4,398,742		$4,398,742	
4		$ 4,547,169		$4,547,169	
5		$ 4,700,605		$4,700,605	
6		$ 4,859,217		$4,859,217	
7		$ 5,023,182		$5,023,182	
8		$ 5,192,679		$5,192,679	
9		$ 5,367,896		$5,367,896	
10		$ 5,549,025		$5,549,025	
11		$ 5,736,266		$5,736,266	
12		$ 5,929,825		$5,929,825	
13		$ 6,129,915		$6,129,915	
14		$ 6,336,757		$6,336,757	
15		$ 6,550,579		$6,550,579	
16		$ 6,771,615		$6,771,615	
17		$ 7,000,110		$7,000,110	
18		$ 7,236,315		$7,236,315	
19		$ 7,480,490		$7,480,490	
20		$ 7,732,904		$7,732,904	
21		$ 7,993,836	$ 206,335,095	$214,328,931	replace elec./ motorized equipment
22		$ 8,263,572		$8,263,572	
23		$ 8,542,410	$ 27,180,108	$35,722,518	sewer inspection at yr 10 of service
24		$ 8,830,657		$8,830,657	
25		$ 9,128,630		$9,128,630	
26		$ 9,436,658		$9,436,658	
27		$ 9,755,079		$9,755,079	
28		$ 10,084,245		$10,084,245	
29		$ 10,424,518		$10,424,518	
30		$ 10,776,273		$10,776,273	
		Present value of O&M		**$238,791,000**	

Residual Value

Item Description	Electrical/ Motorized Equipment	Pipes, valves, hydraulic structure, etc	Gravity Sewer/New Force Main	
Present Cost	$ 102,780,000	$ 239,820,000	$ 5,809,614,245	
Design Life (Years)	20	50	75	
Residual Value at End of Design Life	$0	$0	$0	
Effective Interest Rate	-0.26%	-0.26%	-0.26%	
Planning Cycle (Years)	30	30	30	
Remaining Life	10	20	45	
Present Value of Residual Value	**$55,492,000**	**$103,586,000**	**$3,764,027,000**	

NET PRESENT Value (Total Capital Cost + Net Present Value of O&M - Residual Value) **5,231,433,000**

Easement Area Estimation - Alternative 7C

WW Infrastructure	Length, ft	Width, ft	Area, ft2	Area, Ac
Sewer	2107698	40	84307927	1935
Regional PS	150	150	607500	14
Neighborhood PS	150	150	630000	14
WWTP				0
Total				1964

Annual Power Estimation - Alternative 7C

Hp = (Q x H) ÷ (3,960 gallons per minute per foot x eff)					
1 HP to KW	0.7457				
Neighborhood PS		Regional PS		WWTP	
0.03	mgd, Avg.	1.47	mgd, Avg.	8.5	mgd, avg.
21	gpm	1,024	gpm	5,903	gpm
60	ft	80	ft	60	ft
0.75	efficiency	0.75	efficiency	0.75	efficiency
0	hp	28	hp	119	hp
0.3	kw	20.6	kw	88.9	kw
28	ea	27	ea	0	ea
8.79	kw	555.09	kw	0.00	kw
76,980	kwh annual	4,862,558	kwh annual	-	pumping kwh annual
				-	other kwh annual, approx 2x pumping
Total Power	**4,939,538**	**kwh annual**			

Labor and Material Estimation - Alternative 7C

Honouliuli WWTP 2014 total		$ 584,000	39.6	mgd, flow
Honouliuli WWTP 2023 estimated		$ 791,388	39.6	mgd, flow
Flow prorated for Puna WWTPs, total		$ -	0	mgd, total flow
Halawa WWPS 2014 total		$ 6,534	1.8	mgd, flow
Halawa WWPS 2023 estimated		$ 8,854	1.8	mgd, flow
Waimalu WWPS 2014 total		$ 36,164	5.3	mgd, flow
Waimalu WWPS 2023 estimated		$ 49,006	5.3	mgd, flow
Flow prorated for Puna Regional WWPSs		$ 66,869	6.86	mgd, each
Flow prorated for Puna Regional WWPSs, total		$ 1,805,457		total
Flow prorated for Puna neighborhood WWPSs		$ 109	0.03	mgd, each
Flow prorated for Puna neighborhood WWPSs, total		$ 3,049		total
Total for WWTP, Regional PS, and NH PS		**$ 1,808,507**		

Pump Station Weighted Average and Peak Flows - Alternative 7C

Area	# of Re PS	Avg of Pk Flow, mgd	#*Peak Flow	Peak to Avg ratio	Avg. Flow, mgd	#*Avg. Flow
Pahoa						
Lelani						
Nanawale						
Hawaiian Beaches						
HPP	17	4.42	75.14	4.47	0.99	16.81
Ainaloa	0	0.475	0	4.42	0.11	0.00
Volcano GC	1	0.45	0.45	5.61	0.08	0.08
Volcano Makai	2	0.65	1.3	5.15	0.13	0.25
Old Volcano Rd.	0	0.25	0	4.42	0.06	0.00
Edon Roc	3	0.58	1.74	6.3	0.09	0.28
West Keaau	0	0.3	0	4.89	0.06	0.00
Paahana-Keaau	0	0.42	0	4.48	0.09	0.00
HPP to Keaau	1	18.6	18.61	4.76	3.91	3.91
to Hilo	3	29.3	87.9	4.76	6.16	18.47
Weighted Average	27	6.86	185.14		1.47	39.79

Appendix H

Overview of State of Hawaii Department of Health Cesspool Pilot Grant Program

Overview: HDOH Cesspool Pilot Grant Program

- Up to $20,000 in reimbursements per applicant
- First-come, first-served basis
- Note: 9 months requirement to complete conversion or connection (based on expiration of funds that HDOH receives)
- For more information: https://health.hawaii.gov/wastewater/home/ccpgp/

Starting March 15, 2023

- Determine Eligibility[1]

→

- Complete & Submit Grant Application by mail or submit in person

→

Est. 1-2 Weeks

- HDOH review
- HDOH issues Grant Qualification Letter (starts 9-month clock)

→

9 Months

- Convert to IWS
  - Obtain construction plans, submit to HDOH for plan approval, receive HDOH Approval-to-Construct (HDOH review est. 3-4 weeks)
  - Install IWS, submit final inspection report, receive HDOH Approval-To-Use letter (HDOH review est. 1-2 weeks)
- If connecting to sewer, apply to County sewer agency
- Submit grant documents[2] to HDOH

→

Est. 1-2 Weeks

- Issue of grant reimbursement

[1] Eligibility Requirements

a) Applicant must be owner of real property or DHHL lessee.

b) Cesspool must be in Priority Level 1 or 2 (see Slide 2).

c) Household income for most recent closed taxable year must be less than 140% of the area median income (see Slide 3).

d) Cesspools upgraded/converted with Approval-To-Use date or connected to sewer before 7/1/2022 are *not* eligible.

[2] Grant Documents

a) Design plans prepared by HI-licensed engineer (must comply with HAR 11-62 or utility standards for sewer connection) and approved by HDOH

b) Engineer's final construction inspection report w/photos, as-builts, certifications

c) Copy of Approval-To-Use letter from HDOH

d) Receipts of payment made to engineer and contractor

Step B of Eligibility Criteria:
Determine Cesspool Priority

- Areas shaded in red are Priority 1 or 2
- https://histategis.maps.arcgis.com/apps/webappviewer/index.html?id=8708c5c6d0404d299de2139348442a3a

- Can also look up by TMK
- https://health.hawaii.gov/wastewater/files/2023/02/EligibleTMKList_Hawaii.pdf

Step C of Eligibility Criteria: Determine Area Median Income

1. Create list of number of adults and children (all HM) that occupy home.
2. Collect 1040 Federal Tax Returns for most recent year for all HM generating income.
3. Determine each HM's income by using the Adjusted Gross Income on the 1040 Federal Tax Return.
4. Add up the adjusted gross income for all HMs to determine Total Household Income.
5. Review chart and determine if Total Household Income is equal or less than the 140% AMI.

HM: household member

2021 – 140% Area Median Income (AMI)

	Family Size (# of Persons)							
	1	2	3	4	5	6	7	8
Hawaii County	$84,000	$95,900	$107,940	$119,840	$129,500	$139,020	$148,680	$158,200
Maui County	$101,360	$115,780	$130,200	$144,620	$156,240	$167,860	$179,340	$190,960
Kauai County	$99,960	$106,080	$119,340	$132,470	$143,130	$153,790	$164,320	$174,980
City & County of Honolulu	$118,440	$135,380	$152,320	$169,120	$182,700	$196,280	$209,720	$223,300

2022 – 140% Area Median Income (AMI)

	Family Size (# of Persons)							
	1	2	3	4	5	6	7	8
Hawaii County	$93,380	$106,680	$119,980	$133,280	$144,060	$154,700	$165,340	$175,980
Maui County	$111,860	$127,820	$143,780	$159,740	$172,620	$185,360	$198,100	$210,980
Kauai County	$111,720	$127,680	$143,340	$159,600	$172,480	$185,220	$197,960	$210,700
City & County of Honolulu	$128,100	$146,300	$164,640	$182,840	$197,540	$212,000	$226,800	$241,360