Section 7
EVALUATION OF ALTERNATIVES

An evaluation of the identified alternatives to select the preferred alternative is conducted in this section of the report. The evaluation is based on the information developed in the preceding sections. The evaluation was conducted on a set of criteria developed from generally accepted elements of concern. In addition, there are a number of site-specific elements that are also considered that are probably unique to the South Pacific islands and similar remote locations. The selected alternative, described below, will be carried forward through planning level preliminary design in the following sections of the WWFP.

7.1 Summary of Alternatives and Options Considered

A wide range of potential alternatives for wastewater treatment for Aunu'u were considered and most were eliminated during the preliminary assessments described in Section 6. Those that remain for final selection are discussed in more detail below. There are four principal wastewater management components that can be separately considered with distinct alternatives (or options): collection, conveyance, treatment, and disposal. However, the basic collection and conveyance infrastructure is already in place and will be common to all alternatives. No improvements to the existing collection system are required.

The other two components are the treatment and disposal of wastewater. There are three different preferred treatment alternatives and two disposal options for each. Two alternatives involve conventional secondary treatment. The third alternative uses a septic tank for primary treatment and constructed wetlands for additional treatment. The two disposal options are the discharge of treated effluent through an outfall extended to a depth of 100 feet or more with a high-rate diffuser into the ocean and disposal into natural wetlands. Each of these alternatives, as shown in Figure 7-1, is discussed below.

A conservative allowance (larger than expected) for I/I has been provided in sizing the treatment options. However, the space available for a constructed wetlands natural treatment system is limited. Flow reduction would improve the performance of natural treatment by reducing the hydraulic loading to the wetlands system. If flow reduction is required, it could be accomplished by replacing any leaking sewer pipes and reducing I/I in the collection system. A cost allowance is included in this option for an infiltration/inflow reduction program.

7.1.1 Conventional Treatment

Secondary treatment has been selected as the most appropriate conventional treatment method to meet wastewater disposal needs in Aunu'u. One method of conventional secondary treatment employs an SBR and the other an MBR, as discussed in Section 6. These secondary methods are considered to be the only workable secondary conventional options for Aunu'u. An SBR is less technically sophisticated than an MBR but requires more operator attention. While either system should be able to meet the expected effluent limits if properly designed, constructed, operated, and maintained, an MBR is better suited for meeting the 85 percent removal criterion for BOD and TSS for a dilute influent stream. An MBR also has higher capital and O&M costs than an SBR.

Both of these options involve locating a new secondary treatment plant on the island of Aunu'u. The best site, for purposes of this WWFP evaluation, is adjacent to the existing power plant. The close proximity of the power plant and the presence of a back-up generator at the power plant would alleviate the need for a dedicated emergency generator at the treatment plant. ASPA is currently entertaining plans to relocate the existing power plant to a more suitable site. The existing site is located in close proximity to the elementary school and diesel fumes frequently enter the classrooms. Another alternative strategy under consideration would eliminate the need for a diesel generator power plant on Aunu'u Island entirely with construction of a submarine cable from Tutuila Island. Since the new power generation alternatives are still being developed the power plant siting and hence the secondary treatment plant location is also uncertain at this time. Costs for additional electrical generation or transmission capacity were not included as discrete capital cost line items for the alternatives cost comparison.

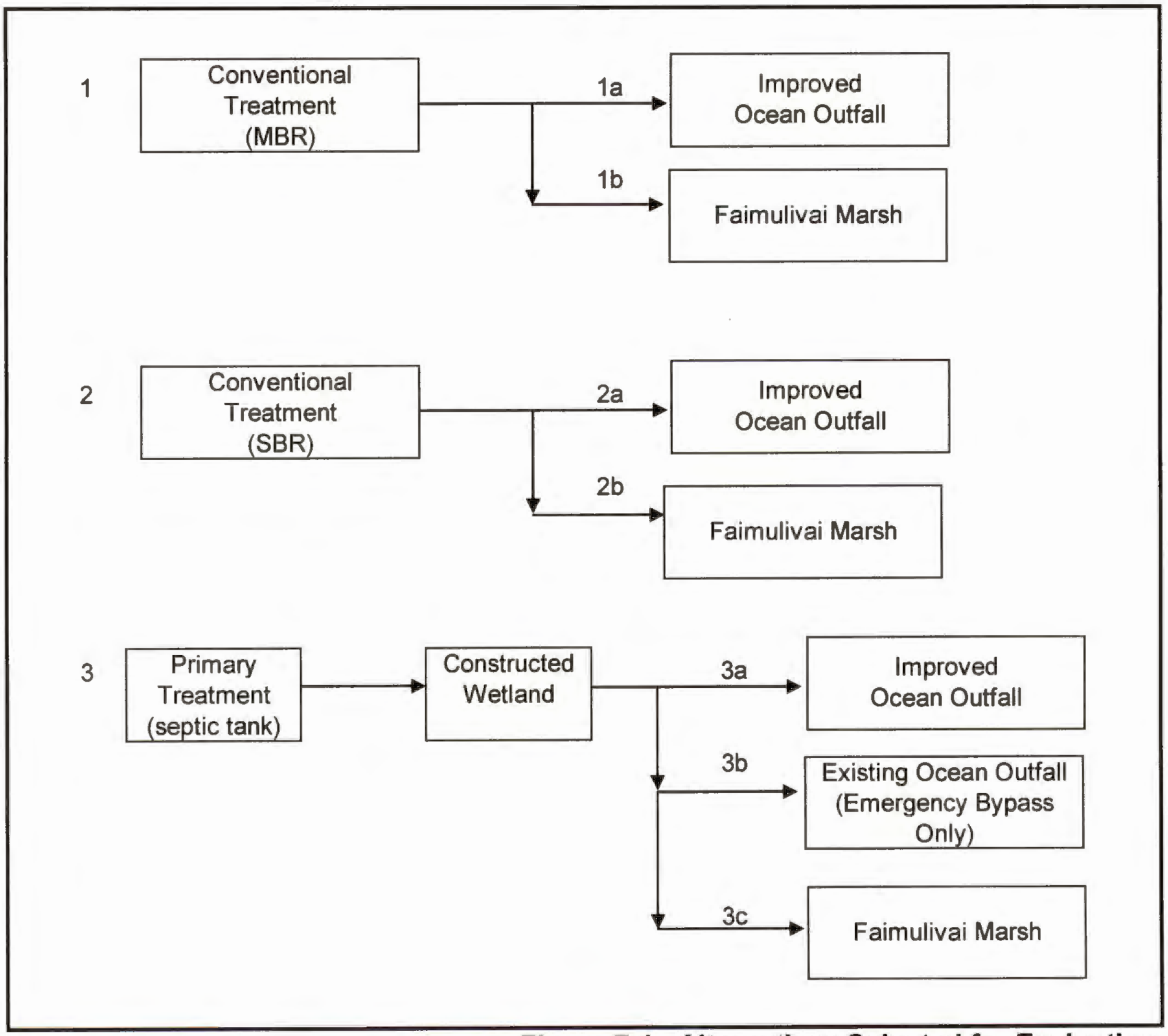

Figure 7-1. Alternatives Selected for Evaluation

Considerations associated with conventional treatment plant options include the acquisition of the land necessary to build the treatment plant. Concerns may be expressed by village members including nearby neighbors regarding noise, light, traffic, odors, or other negative impacts as a result of the location of the treatment works. Each of these concerns can be addressed if a conventional treatment plant approach is selected.

A conventional treatment plant would include not only treatment equipment but also:

- A small building to house spare parts, motor controls, a small laboratory, and employee facilities
- Perimeter fencing and other civil site improvements
- Yard piping and a drainage sump with pumps so that tanks can be drained and cleaned
- Access platforms, ladders, and/or stairs
- Electrical distribution within the plant
- Instrumentation and control
- Aerobic digestion to produce Class B biosolids
- Equipment to allow application of digested biosolids onto forestland of the island
- Allowances for archeological investigations and engineering
- A contingency allowance

New pumps need to be added to the existing pump station to generate the head necessary to send the raw wastewater through approximately 3000 feet of new pipe to the treatment plant site.

Both conventional secondary treatment alternatives involve preliminary treatment using screening. No primary treatment is required for mechanical treatment systems in this size range. A disinfection step can be included after the secondary treatment step to assure that the treated wastewater will meet expected effluent limits for bacteriologic indicators.

7.1.2 Constructed Wetlands Treatment

A constructed free water surface wetland has been selected as the most appropriate natural treatment alternative to meet wastewater disposal needs on Aunu'u. The eastern, volcanic crater portion of the island is the preferred location for a constructed wetland—away from the village and away from the potable water sources. Siting of the constructed wetland requires a relatively flat topography with less than 5% slope. Topography of the proposed constructed wetland location on the southern slopes of the crater marsh allows a maximum footprint of approximately 4.5 acres including berms, or about 3 acres of water surface. A conceptual layout consisting of nine rectangular cells, each approximately one-third acre in area is presented, but actual cell configuration will likely vary to conform to the natural topography.

Constructed wetland treatment is expected to be capable of meeting secondary wastewater treatment standards for most parameters, and exceeding secondary requirements for nutrients. Expected treatment efficiencies are summarized in Table 6.3.

Once established, constructed wetlands require little routine maintenance. The most critical operational requirements are during the initial start-up of the system. It is estimated that initial start-up would take from 1-2 years. Routine maintenance requirements are removal or mowing of vegetation on dry portions of the system (berms, access roads) and periodic inspections for leaks, flow obstructions, and short-circuits.

7.1.3 Disposal through an Ocean Outfall

Following treatment, the effluent will be discharged through the existing ocean outfall. The existing outfall will be extended down the coral reef into deeper water and a diffuser section (possibly with multiple outlet ports) added to allow a high degree of mixing and initial dilution of the effluent with the surrounding ocean water.

Considerations associated with the disposal of treated wastewater using an outfall include the following:

- An improved outfall would result in temporary construction disturbances (noise, traffic), although these are probably minor compared to those associated with the construction of a new treatment plant.

- An improved outfall would result in disturbance to aquatic habitat but would be confined to the region beyond the reef flat.

- The use of high rate diffusers would maintain compliance with water quality standards outside the zone of initial dilution (ZID).

7.1.4 Disposal to Existing Natural Wetlands

The crater wetland, Faimulivai Marsh, is another option considered for discharge from either conventional or natural treatment alternatives. The existing crater wetland would provide significant additional treatment prior to indirect discharge to the ocean. The preferred point of discharge is the southeast edge of the marsh, near the proposed constructed wetland site. Discharge at this point will reduce or eliminate any discharge impacts to the eastern end of the marsh. Impacts of wastewater discharge on the marsh ecology are unclear pending further study. However, it is anticipated that any impacts will be relatively localized near the point of discharge.

Estimated final concentrations of BOD, TSS, TN, TP, fecal coliforms, and Enterococcus at the ocean outfall would be similar to that of the constructed wetland effluent concentrations given previously in Table 6.3. Concentrations of all constituents approach background levels, but exceed ASWQS coastal standards by a significant margin.

7.1.5 Emergency By-pass through the Existing Ocean Outfall

Disposal to the existing natural wetlands is an option that includes some degree of uncertainty with respect to unforeseen operational performance or upsets to the treatment process. The environmental effects of the discharge, although considered benign based on the best available knowledge, may include unexpected responses. Therefore it may be prudent to maintain the existing ocean outfall in place and connected to the wastewater collection system for emergency use. This would be best accomplished by installing a valve at the existing wet well and pumping station on the outfall line.

7.2 Elements of Concern and Evaluation Criteria

There are a variety of disparate elements that should be considered to determine the best overall approach to wastewater treatment for Aunu'u. Because of the location and development of the study area, these elements can be considered in the following broad categories, which account for some site-specific and project type-specific elements that have been introduced:

- Cost: is an obvious and highly weighted criterion. Relatively small differences in cost are not a discriminator unless the other factors discussed below are relatively equal in weight. Therefore planning level rough order of magnitude (ROM) costs are typically sufficient for an initial evaluation. If more than one alternative appears equally favorable, then a more precise cost estimate might be required to finalize the evaluation. Costs to be considered can be further categorized as:

  - Design and design basis costs are usually included in construction or capital costs, but in some cases might be considered separately if circumstances require. For example, a significant geotechnical investigation or substantial technology development cost.

  - Capital (construction) costs are often one of the most important criteria, since the feasibility of a project often depends on the resources available to implement it.

  - Commissioning and initial training costs, as in the case of design costs, are generally included in capital costs. Ongoing training costs are generally considered a part of operations costs described in the following item. In some cases, as is likely in American Samoa, where an extended commissioning period may be required and significant expenditure for continuous training might be necessary, such costs should be considered separately.

  - Operations and maintenance (O&M) costs are considered over the design life of the project as an item separate from the initial capital costs. These costs represent the ongoing periodic cost of normal plant operations (material, supplies, labor, and management) and anticipated repair and preventive maintenance. Low initial construction cost can be more than offset by high ongoing O&M costs.

- Permitting and regulatory costs would are often included with capital and O&M. For the alternatives considered here, there may be significant difference in these costs. Therefore, this factor is considered separately. In addition there may be substantial costs for all alternatives (for example archeological investigations) that should be considered as a separate item.

- Environmental impacts: of the project are an important class of criteria for evaluation. Impacts that occur only during construction, and long-term impacts associated with changes caused by construction or ongoing operations need to be identified and then ranked by relative importance. These criteria are often highly project- and site-specific. There are effects identified directly with the human environment (noise, odor, traffic, visual impacts) and those associated with the natural environment that can directly or indirectly affect people (ecological disturbances). The major categories are identified as follows:
  - Temporary disturbance to human activities during construction
  - Temporary disturbance to wildlife during construction
  - Permanent effects on human activities and environment
  - Permanent effects on terrestrial and aquatic habitats
- Social and economic effects: such as effects on health, income, quality of life, compatibility with social structure
- Technical criteria including:
  - Constructability
  - Availability of materials
  - Availability of local expertise for operation and maintenance
- Regulatory criteria: including the ability to meet regulatory standards and requirements, the likelihood of acquiring appropriate permits, and the ability to maintain compliance with regulatory requirements in the future

7.3 Evaluation of Alternatives

The selected alternatives described above were evaluated based on elements and factors as described in 7.2. Costs are planning level, order of magnitude level. Assumptions are consistent across the various alternatives so that comparisons are considered sufficiently valid to evaluate the relative costs of the alternatives. More detailed cost estimates of the recommended alternative (Section 7.4) are presented in Section 9. The evaluation of the other criteria (Section 7.3.2) is subjective. However, the application was consistent within each category. The various criteria were not weighted relative to each other, although the relative importance of each category is briefly discussed. The overall evaluation is considered unambiguous in the resulting selection of a preferred alternative to carry forward for more detailed examination and planning level design.

7.3.1 Estimated Capital and Operation & Maintenance (O&M) Costs

As described above, there are three distinct alternatives each with two disposal options. The preliminary estimated capital costs of these alternatives and options are shown in Table 7-1. The costs include the cost of an extended outfall as well as allowances for biosolids disposal. Capital costs are very similar among the alternatives. Table 7-1 includes the estimated O&M costs for the three alternatives for a 20-year operation period. The costs are based on a 5% annual increase, based on inflation. Constructed wetlands are expected to have far lower O&M costs than conventional treatment options.

Table 7-1. Summary of 20 year Capital, O&M, and Present Worth Costs for Alternatives (Costs in $1,000)

	SBR with Wetland Discharge	SBR with Ocean Discharge	MBR with Wetland Discharge	MBR with Ocean Discharge	Wetland Treatment with Wetland Discharge	Wetland Treatment with Ocean Discharge	Wetland Treatment with Wetland Disposal with existing Outfall as Emergency Bypass
Capital							
Collection within Service Area	Use Existing Collection System						
Transmission, WWTP, and outfall	$3222	$2888	$3732	$3398	$3147	$4124	$3160
O&M							
O&M of Transmission System and O&M	$394	$385	$434	$425	$287	$317	$288
Present Worth Comparison							
Capital	$3222	$2888	$3732	$3398	$3147	$4124	$3160
Present Value of O&M	$4878	$4812	$5368	$5302	$3533	$3976	$3590
Present value (Capital 20 years of O&M, at 5% interest)	$8100	$7700	$9100	$8700	$6700	$8100	$6750

7.3.2 Other Evaluation Criteria

As described above, cost is not the sole consideration in selecting the most appropriate alternative. Environmental, socio-economic, technical and regulatory criteria are also important and any one of those could provide a critical determinant in selection of an alternative. Table 7-2 lists the general categories that should be considered and provides a semi-quantitative evaluation of each identified criterion. Within each criterion the various alternatives are ranked relative to each other.

The following principal observations are presented in Table 7-2.

- Consideration of environmental criteria results in a preference for conventional secondary treatment with an ocean discharge. Since the project area is in a developed area, the weighting for environmental effects is expected to be fairly low. The exception would be in cases where disruption to the coral reef habitat might occur during extension of the outfall, or the disruption of habitat during wetlands construction.

- Social and economic impacts are generally all positive. However, negative impacts, mostly of perception, are anticipated associated with the siting issues involved. However, it is noted that there is very little usable land for a treatment facilities within the Village of Aunu'u, and land for a WWTP would negatively impact overall land use. Therefore, a new WWTP within the Village is at a slight disadvantage. Health and quality of life should be weighted fairly heavily, but overall this category provides little discrimination between alternatives, except for being heavily against a no action alternative.

- Given the remote location and limitation on, available infrastructure, transportation, and educational and training opportunities in American Samoa, the technical criteria should be heavily weighted. These criteria provide a distinct advantage for wetland treatment and disposal.

- Regulatory criteria are extremely important and should be weighted quite high. The Ocean disposal options are favored, and the conventional treatment is slightly favored. However, for some limitations as given above, regulatory criteron are unavoidably moderated.

Table 7-2. Evaluation Criteria other than Cost (Equal Weighting)

	SBR with Wetland Discharge	SBR with Ocean Discharge	MBR with Wetland Discharge	MBR with Ocean Discharge	Wetland Treatment with Wetland Discharge	Wetland Treatment with Ocean Discharge	Wetland Treatment with Wetland Discharge, Existing Outfall as Emergency Bypass
Environmental Criteria							
Temporary Impacts							
Human Activities	1	1	1	1	0	0	0
Wildlife Disturbance	1	2	1	2	2	2	2
Permanent Impacts							
Human Activities	1	0	1	0	1	1	1
Wildlife Disturbance	1.5	0	1.5	0	1.5	1.5	1.5
Social and Economic Criteria							
Health	0	0	0	0	0	0	0
Quality of Life	0	0	0	0	0	0	0
Economics	0	0	0	0	0	0	0
Social/Cultural	2	2	2	2	1.5	1.5	1.5
Technical Criteria							
Constructability	3	3	3	3	2	2	2
Materials Availability	2	2	2	2	1	1	1
Maintainability	3	3	3	3	1	1	1
Loss damage Potential	3	2	3	2	1	1	1
Local Expertise	3	3	3	3	1	1	1
Regulatory Criteria							
Regulatory Standards	1.5	0.5	1.5	0.5	2	2	2
Operational Compliance	1	0.5	1	0.5	2	2	2
TOTAL	**23**	**19**	**23**	**19**	**16**	**16**	**16**

Key

0 - no adverse impacts, or possible positive effects; no difficulty with technical or regulatory requirements

1 - minimal impacts and little difficulty meeting technical and regulatory criteria

2- noticeable adverse impacts anticipated; some difficulty meeting technical and regulatory criteria

3- major impacts anticipated; considerable difficulty in with technical and regulatory criteria

7.4 Recommended Alternative

Based on all of the considerations discussed above, the wetland treatment alternative appears to be the best approach, with all considerations weighted more-or-less equally. Based on cost the constructed wetland treatment with the wetland disposal option appears to be the most favorable. Along with the wetland disposal the existing outfall should be left in place as an emergency bypass. Some factors support ocean disposal following wetland treatment making it appear to be the best approach for disposal but costs for construction of a new ocean outfall make that alternative prohibitively high. Considering all of the factors involved the recommended approach is as follows:

- Treatment by constructed wetlands on the interior south slope of the tuft cone above Faimulivai Marsh. Wetlands treatment should be preceded by primary treatment by means of a large septic tank located in the vicinity of the existing landfill.

- Wastewater to be collected using the existing collection system and pumped to septic tanks located near the landfill for solids removal.

- Gravity flow of the primary treated wastewater to the constructed wetland for near tertiary treatment.

- Disposal of treated wastewater from the constructed wetland to the natural wetlands of Faimulivai Marsh by overland flow.

- The existing ocean outfall and wet well system should be valved and left in place as an emergency disposal option in case of emergency shutdown of elements in the wastewater treatment system.

Section 8
PRE-DESIGN OF SELECTED ALTERNATIVE

The previous sections of this facilities plan presented information on a variety of potential alternatives for wastewater treatment for the Aunu'u service area. This information was used to select a preferred alternative. ASEPA, USEPA, and ASPA considered the information and selected "...constructed wetlands treatment preceded by primary treatment via septic tank, with final effluent disposal to the Faimulivai Marsh, with emergency bypass option via existing ocean outfall." The pre-design of the selected alternative is based on this selection. A conceptual flow diagram of the selected alternative is shown in Figure 8-1. Figure 8-2 shows an overall conceptual layout of the selected alternative.

8.1 Rationale for the Selection

Selection rationale by the USEPA, ASEPA, and ASPA was discussed in Section 7. The agencies concluded that the selected alternative was appropriate for the following primary reasons:

- Appropriate application of technology,
- Efficiency of operation and maintenance,
- Constructability, and
- Cost.

ASEPA and ASPA are the agencies that ultimately determined the selected alternative in consultation with USEPA. The agencies indicated that the WWFP has demonstrated a need for the selected project, and through a systematic evaluation of feasible alternatives, the selected alternative is the most economical means to meet established water quality goals and eliminate public health concerns, while recognizing environmental, social, and operation/maintenance considerations.

8.2 Key Assumptions

Based on the information described in the preceding sections and on additional discussions with ASEPA and ASPA, the following assumptions were determined to be appropriate for the pre-design:

1. Pre-design consists of the following elements:
   a. A sketch showing a flow diagram of the new wastewater infrastructure.
   b. A layout showing conceptual locations of the new facilities.
   c. A conceptual sketch of submersible pump station.
   d. A sketch showing conceptual septic tank layout.
   e. A sketch showing a conceptual layout of the sludge drying beds.
   f. Sketch(es) showing conceptual design of constructed wetlands (Section 6).
   g. Estimates of capital, operating, and maintenance costs (Section 9).
   h. Implementation plan and schedule (Section 10).

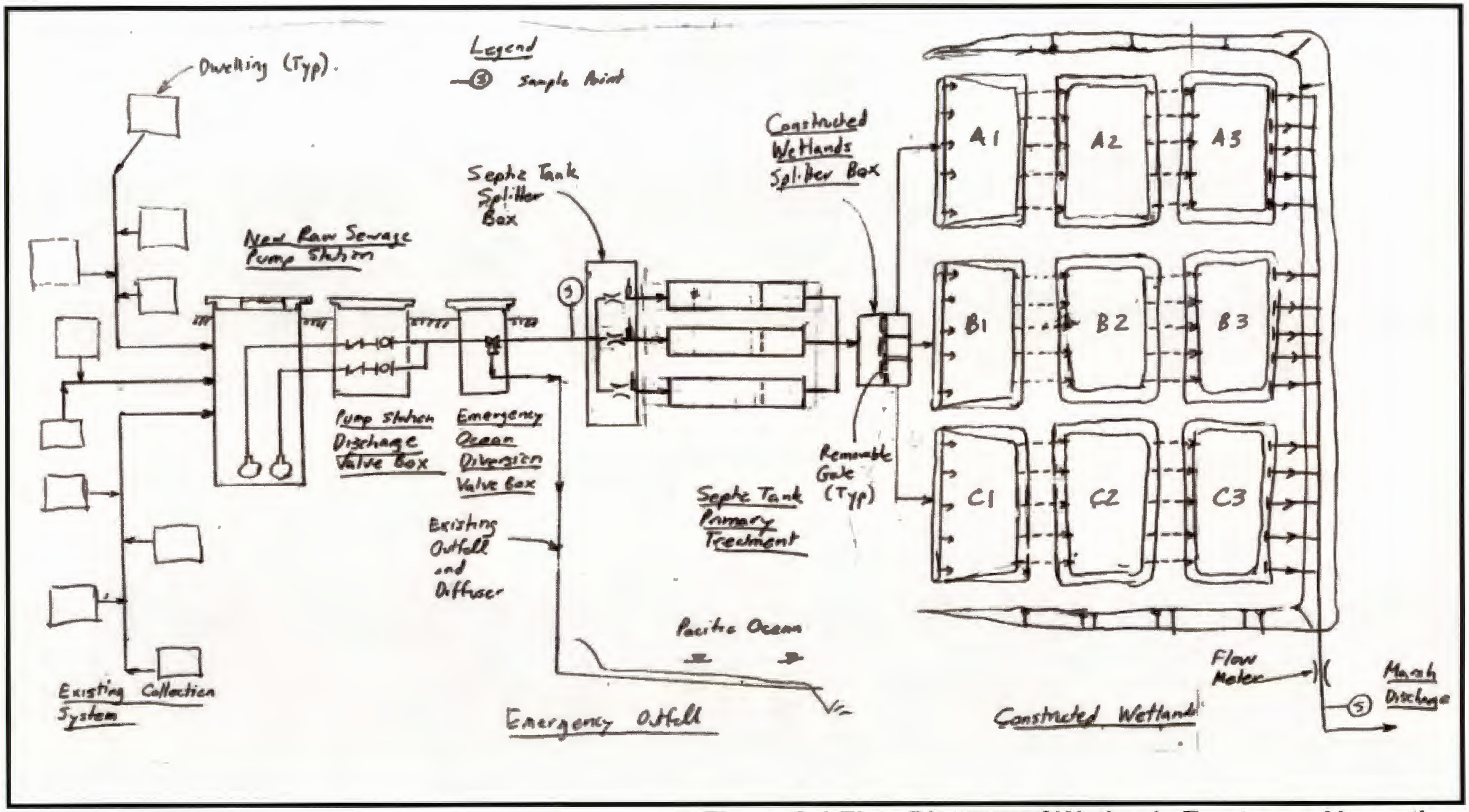

Figure 8-1 Flow Diagram of Wetlands Treatment Alternative

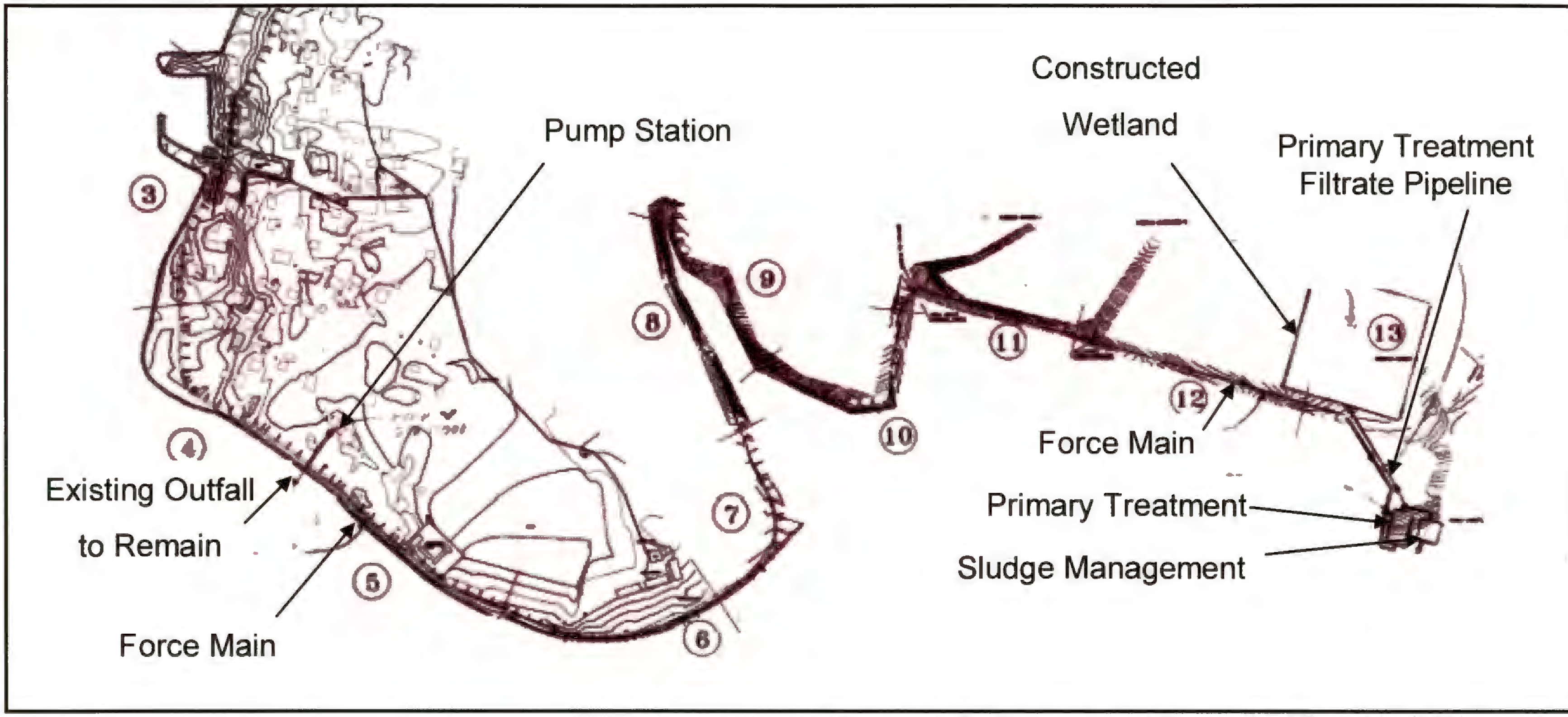

Figure 8-2. Conceptual Layout of Selected Alternative

2. The level of pre-design is at 10-15% as conventionally understood (Planning Level Pre-design). Since there is limited topography, hydrology, and soils data in the area of the new treatment facilities, wetland design and associated cost estimates are based on a conceptual wetland layout.

3. A new pump station will be installed adjacent to the existing pump station. A switchover will be planned over a 12-hour period in which the village will be asked to minimize wastewater generation practices.

4. The new force main will be constructed of high-density polyethylene (HDPE) pipe.

5. There are no utility interferences that will prohibit the construction of the new force main, pump station, and other facilities.

6. Land is available upon which to build the new facilities in appropriate locations. Land acquisition costs are not included in the cost estimates.

7. In areas where the force main will be located in a trench, it will not (in general) need to be buried more than 5 feet deep.

8. Traditional construction techniques will be used for force main construction. It is assumed that no blasting is necessary.

9. Excess excavated material can be disposed of on the island of Aunu'u.

10. The new force main can be constructed using minimal traffic control methods as the access road is only used by ASPA personnel to access the landfill.

11. A minimum of 4.5 acres of land adjacent to the southern edge of Faimulivai Marsh is available for siting of a constructed wetland.

12. Constructed wetland treatment efficiencies will equal or exceed those described in Section 6. Factors that may result in greater efficiencies than those presented in Section 6 are discussed in Section 8.9.

13. The existing roadway will be upgraded to a crushed rock surface once construction is completed.

14. Adequate power is available from ASPA for the new pump station.

15. The system will be adequate for the 20 year planning horizon.

16. This pre-design was prepared with the limited geotechnical information that is available. Some additional geotechnical information is recommended prior to

additional design work. Changes to the preliminary design may be needed once detailed design begins.

17. There are no utilities located past the ASPA water storage tank such that limited utility locations are needed for the project final design. Changes to the preliminary design may be needed once detailed design begins and the utility locations are mapped.

18. There are currently no local standards that apply to the design and construction of sanitary sewer systems in American Samoa. After discussion with ASPA, applicable standards from the current version of the "Design Standards of the Department of Wastewater Management Volume 1 – General Requirements for Wastewater Facilities, Design of Sewers and Pump Stations, City and County of Honolulu, State of Hawaii" (Honolulu Standards) were used where applicable. In some instances, it may not be possible to meet these standards because of project site-specific constraints.

19. The existing outfall will be retained for emergency use. Raw sewage will be pumped to the outfall if the treatment facilities are ever out of service.

20. Given site logistical and technical constraints, natural disinfection will be used rather than disinfection using chemicals or UV light.

21. Several additional investigations are necessary to confirm the viability of the selected approach. A summary of study needs is provided in Section 8.10.

22. All assumptions presented in Sections 1-7 are valid. Possible exceptions are described in Section 8.9 and Section 8.10.

23. The facilities as initially constructed will be able to handle the 2030 design condition.

24. Additional detailed assumptions are discussed in the sections that follow.

8.3 Sewage Collection System

As discussed in Section 4.2, no changes to the existing sewage collection system are needed. One occupied house is currently not connected to the collection system because of repeated waste collection system back-ups and repeated failure to correct the problem, which ultimately caused the owners to disconnect their wastewater connection. There is also one group of abandoned houses that have a break in their waste pipes that are on the ground surface that should be corrected when and if these houses are occupied again. It should be confirmed that the school is connected to the sewer system.

8.4 Pump Station Sewage Collection

New pumps will be needed to lift the wastewater over Fogatia Hill to the treatment facilities which will be located on the east side of the island, as shown on Figure 8-2. Figure 8-3 shows preliminary details of the type of pump station anticipated. However, the existing pump station needs to remain in service to pump sewage to the existing outfall until the new pump station and treatment facilities are installed and are ready to operate. For the purposes of the WWFP, it is assumed that a new pump station will be built immediately adjacent to the existing pump station. The new pump station will be able to handle the estimated design year (year 2030) population without additional upgrades, as discussed in Section 5.

The three existing gravity sewer pipes going to the existing pump station will be connected to the new pump station only after the new pump station and downstream wastewater system components have been fully tested and commissioned. In addition, a connection from the pump station discharge piping to the existing ocean outfall will be made at the same time. Valving to the existing ocean outfall will remain closed except in emergencies.

Table 8-1 shows the estimated details of the pump station. A peaking factor was applied to average flow to allow for diurnal variability. An infiltration and inflow allowance was added to obtain the design flow rate. The pump station size was based on the goal of maintaining pump cycle times of greater than once every 5 minutes and to minimize the amount of sewage sitting in the wet well during low flow periods. A minimum wet-well diameter of 6 feet was assumed. The wet-well depth should be minimized.

Table 8-1. Pump Station Characteristics

Feature	Size/Type	Units
Wet Well Diameter	6	ft
Construction	Pre-cast Concrete	
Depth below Ground	9	ft
Number of Pumps	2	
	1 Prime, 1 Standby	
Type of Pump	Submersible, centrifugal	
Flow (each pump)	242	gpm
Total dynamic head	152	ft
Maximum Cycle Time	7	min
Motor Horsepower	15	hp

A pre-engineered complete pump station system such as that built by Romtec Utilities (www.romtecutilities.com) was assumed for pre-design. This approach, which reportedly is currently being used on a project for ASPA, minimizes construction in the field and would likely be easier to commission. A valve vault will be located adjacent to the wet-well. The piping from each pump will enter the valve vault, where check and isolation valves are installed. The separate discharges from the two pumps are combined in the vault, and a single force main exits the vault. Emergency bypass valving and piping will also be located in the valve vault. Piping will connect the pump station to the existing ocean outfall. When the emergency valve is opened, the pumped wastewater will flow to the ocean instead of to treatment.

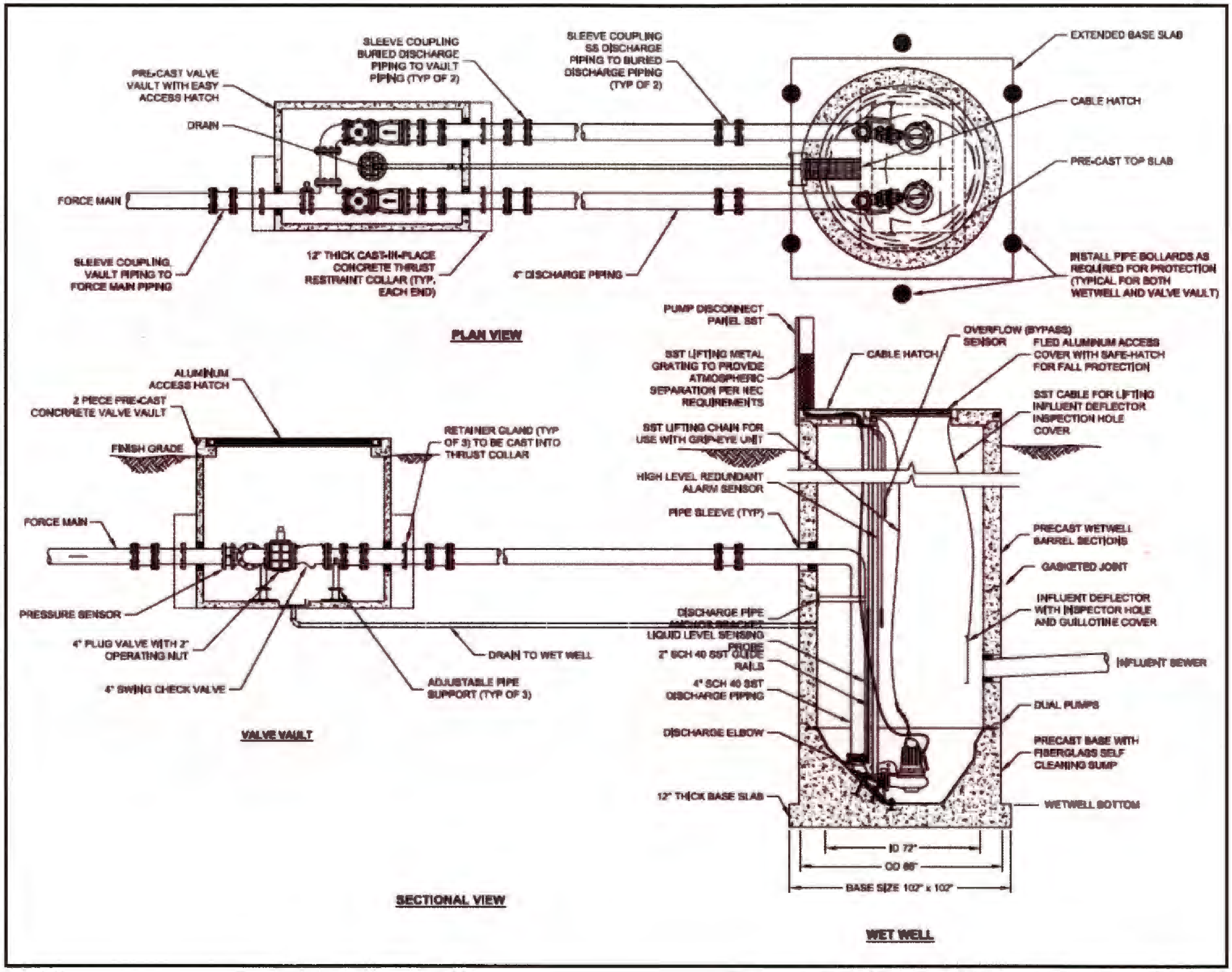

Figure 8-3. Typical Pump Station Detail

The pump station will be equipped with duplex non-clog submersible centrifugal pumps, which are commonly used by ASPA, located in the pump station. An above ground control panel and alarm will be mounted in the fenced area. The pump station will be fenced with a lockable gate large enough for vehicle access. The pump stations will not have a dedicated emergency generator; instead there will be a switchgear and a transfer switch to allow a portable generator to be connected to the station. This is the current practice at ASPA.

8.5 Force Main

As shown in Figure 8-2, the force main leaves the valve vault and goes west to the shore road. The force main will be installed beneath the shore road past the school compound, then continue inland following the road alignment all the way to the crest of the hill. A combination air and vacuum valve assembly will be located at this point. The force main will continue along the existing road alignment into the landfill area where it will empty into a discharge manhole. From that location, sewage will flow to and through the treatment systems by gravity. The force main will be located at least 4-feet deep. To minimize high and low points and still keep below drainage ditches, creeks, and culverts, the force main may be deeper in some locations. If a 4-foot minimum cover cannot be provided, additional protection will be provided by means such as jacketing

Table 8-2 shows characteristics of the force main. By using a flexible HDPE-pipe, the force main alignment and grade can to some extent be adjusted in the field to avoid existing utilities. The force main pipeline need not be installed at a particular slope, although high and low points should be minimized. Where high points cannot be avoided, combination air and vacuum relief valves (designed for sewage service) will be installed. Drain valves will be installed at low points.

Table 8-2. Preliminary Force Main Characteristics

Length of Force Main (ft)	Force Main Size (in)	Velocity (fps)	Head Loss (ft/100 ft)	Friction Loss in Pipe (ft)	Friction Loss for Fittings (ft)	Static Head (ft)	TDH (ft)
8100	6	3	0.52	34[1]	18[1]	118[1]	170

[1] To the crest of the hill. There is adequate elevation head after that point for gravity flow.

To estimate prices in the preliminary design, the force main was assumed as 6-inch diameter HDPE pipe with an SDR of 15.5. The SDR, the ratio of diameter to wall thickness, is commonly used in plastic piping design. This SDR was chosen for the following reasons:

1) It is consistent with the requirement that the SDR for force mains not exceed 17", as specified in the Honolulu Standards.

2) Flow velocity with one pump on is 3 feet per second, consistent with the 3 to 10 feet per second range (Honolulu Standards). Operating at the low end of the range saves energy and reduces the total dynamic head that needs to be met by the pumps.

3) This pipe is strong enough to withstand the water hammer expected during routine and non-routine system operation.

4) Since the sewage is warm, the allowable pipe pressure must be derated from the nameplate pressure at 73 °F. For example, at 85 °F, the correction factor is 0.9. Thus, the pipe pressure rating is actually less than 100 psi. The selected SDR accounts for the required derating.

A cursory water hammer analysis was performed for the force main using the methodology outlined in section 39.10 of the Honolulu Standards. Maximum expected pressures were less than the pressure rating of the pipe. A more complete water hammer analysis should be completed during detailed design.

Sewage residence time in the 6,450-foot force main may result in odor problems. The force main will terminate in a dedicated splitter box structure that will have corrosion protection. The force main discharge will be submerged to minimize turbulence. A vent will be installed in the manhole to add odor control for off-gassing, if needed.

8.6 Septic Tank Primary Treatment

After being pumped to a location at the landfill site sewage will receive primary treatment in septic tanks. There are three septic tank options to choose from:

1. Large cylindrical fiberglass septic tanks with a capacity of as much as 50,000 gallons are available. Shipping this size tank from a U.S. or other manufacturing location and then transporting it along the narrow roads to the east side of the island Aunu'u would be practically impossible.

2. Pre-manufactured polypropylene tanks come shipped as stackable kits and are assembled in the field using a cordless screwdriver. The maximum standard size for this tank is 2,000 gallons. This option would require that the sewage flow must be split to numerous small tanks to receive treatment, which is impractical.

3. Cast-in-place concrete is likely the best choice given the size required. However, transporting concrete, rebar, forms, and tools from Tutuila to Aunu'u could be logistically challenging.

Given the required size of the septic tanks, the alternative using cast-in-place tanks will be assumed. Figure 8-4 shows a conceptual layout of the septic tank system. Sewage discharged from the force main will enter a manhole, where energy will be dissipated. The flow would then enter a splitter box consisting of three flumes, each with a three inch throat. Palmer-Bowlus flumes were chosen because they are resistant to debris build-up. The flumes will be made of corrosion-resistant FRP. Flow will be evenly split through each Parshall flume to three septic tank systems. Removable gates will be installed so that flow to one of the Parshall flumes can be shut off if necessary to maintain the downstream septic tanks. The discharge of each flume will be sent by gravity to a septic tank. The preliminary design criteria for the septic tank system are shown in Table 8-3.

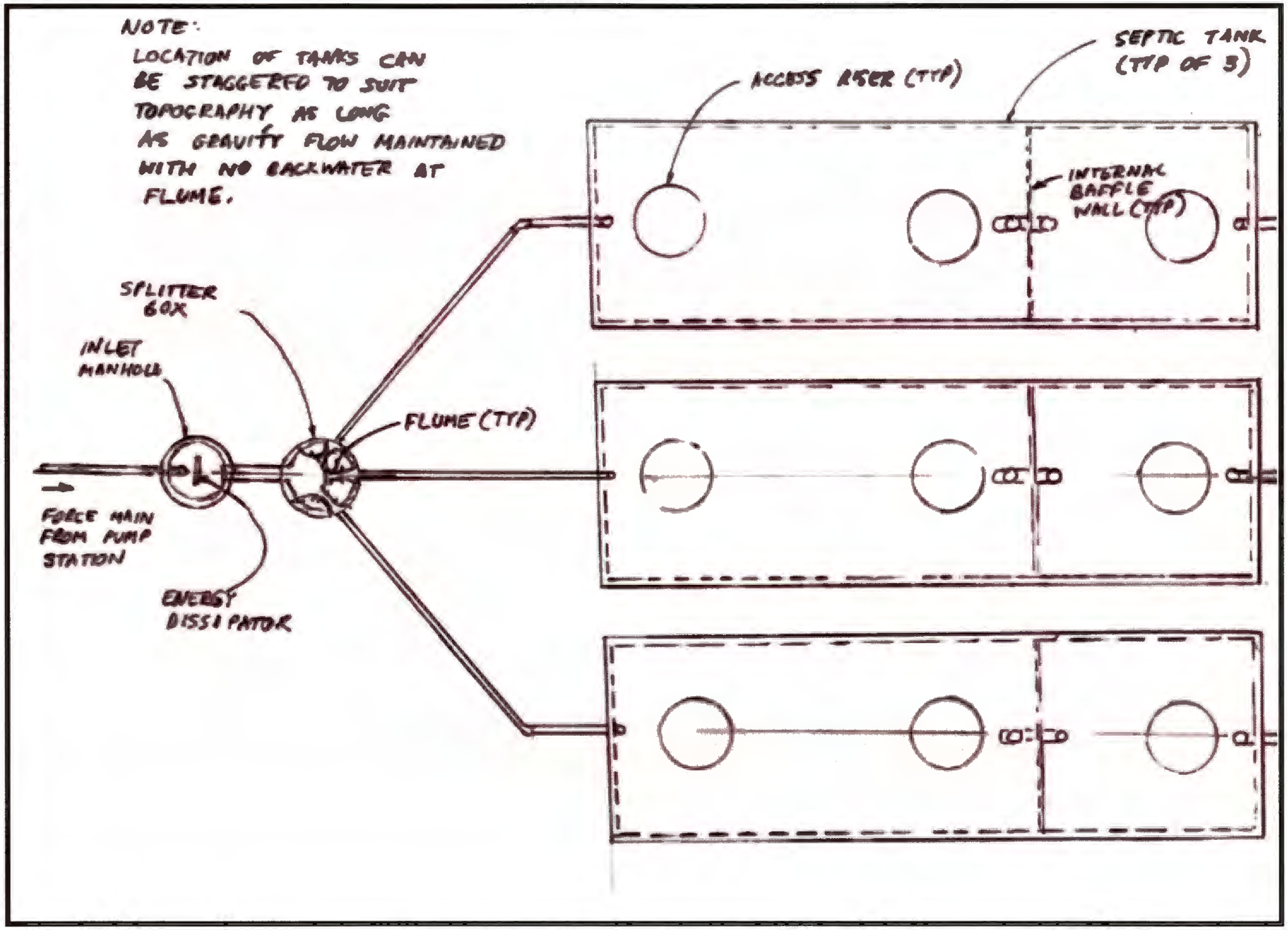

Figure 8-4. Conceptual Septic Tank Layout for Primary Treatment

Table 8-3. Design Criteria - Septic Tank Primary Treatment		
Parameter	**Value**	**Units**
Number of Tanks	3	
Working Volume	57000	gallons per tank
Material of Construction	Reinforced Concrete	
Internal Length	57	ft
Internal Width	19	ft
Liquid Depth	7	ft
Number of Compartments	2	per tank
Hydraulic Retention Time	2	days at avg. annual 2026 flow

Each septic tank will have two compartments and the primary compartment will be approximately twice as large as the secondary compartment. The flow will enter the primary compartment where solids will settle, and if scum is present it will float. A baffled outlet pipe carries the flow through an internal concrete wall from the first compartment to the second compartment where additional solids removal occurs. Most of the settleable and floatable solids will be removed as the sewage passes through the septic tank system. Outlet piping from each of the septic tanks will be recombined and sent by gravity to wetlands treatment.

The septic tank system provides a total hydraulic retention time of two days at average annual 2030 flows and a surface-loading rate of only 26 gallons per day per square foot. With one tank out of service, the total hydraulic retention time is still 24 hours, even at the estimated peak monthly flow rate. This should be adequate to achieve good solids removal.

All three septic tank systems should normally be in service, flow to one septic tank can be halted for a period of time, allowing the solids in that set of tanks to thoroughly digest before being pumped out and sent to the sludge management facility where air drying will further stabilize the sludge solids.

8.7 Sludge Management Facilities

It is impracticable to haul the septage off-island. Drying beds will be located on Aunu'u. Because of the remoteness of the landfill site from the populated areas, the assumed location for the drying beds will be the landfill area. Because it is a simple technology that has been successfully applied by ASPA at the Tafuna WWTP, covered sludge drying beds will be used. It is anticipated that the biosolids will be processed on a once per year basis. To avoid solids carryover and loss of efficiency, septic tanks should be serviced before or when they become half full of solids. It is assumed that septic tanks at Aunu'u will be serviced on a staggered basis; that is, only one septic tank will require servicing at any one time. This allows the sludge to thoroughly dry and stabilize prior to being removed from the drying beds.

A septage haul truck with a capacity of 2,000 gallons will be purchased for use at Aunu'u. This truck would also be used to service the constructed wetlands. When a septic tank requires service, the septage haul truck will remove solids from the tank using a vacuum and carry the solids to the covered sludge drying beds. Approximately 15 loads will be taken to the sludge drying beds during each septic tank cleaning.

Figure 8-5 illustrates the conceptual layout of the drying beds. The sizing of the drying beds is based on assuming that half of the volume of one of the 3 septic tanks will be applied to the drying beds at one time. This volume is conservatively estimated at approximately 30,000 gallons. At the Tafuna WWTP sludge drying facility, the depth of sludge after initial application has been estimated to be roughly 8 to 9 inches (GDC, 2006). If a 9-inch application rate is assumed, a total drying bed area of 5,348 square feet will be required. Six drying beds would supply a total of 5,550 square feet, slightly more than that required. Each drying bed at Tafuna WWTP has dimensions of 25 feet by 37 feet, or 925 square feet per bed. A similar sized bed has been conceptually assumed to be used on Aunu'u.

Decant water and filtrate will be conveyed to the constructed wetlands for treatment. A pipe from the drying beds will convey the filtrate by gravity to a manhole where it will be combined with the primary treated effluent going to the constructed wetlands treatment facility. Based on the experience with extended air-drying of biosolids at Tafuna WWTP, it is predicted that these biosolids will be used for landfill cover on Aunu'u.

8.8 Constructed Wetlands

A constructed free water surface wetland as described in Section 6.4.2 has been selected as the most appropriate natural treatment alternative to meet wastewater disposal needs on Aunu'u. The conceptual design configuration described in Section 6.4.2 will be used for planning level cost analysis in this document. Further studies as described and recommended in Section 8.10 below may result in revisions during the preliminary and final design process, which could affect the cost estimates presented in Section 9.

At the pre-design level of detail, the following design elements are proposed:

- A footprint of about 4.5 acres including berms (about 3 acres of water surface).
- A three-by-three arrangement of rectangular cells, each about one-third acre in area. In order to minimize the change in elevation within each cell (and thereby reduce costs associated with excessive berm heights) cells at the upper end of the treatment train, where natural ground slopes are high, are shorter than those lower in the treatment train. Some grading may be required to further reduce slopes in upper cells.
- The constructed wetland system will be surrounded by earthen berms with membrane liners to ensure berm integrity and eliminate seepage. Interior cells will be separated by similar berms. Exterior berms and berms between treatment trains will be constructed to provide a minimum of two feet of freeboard, while berms within treatment trains will provide one foot of freeboard. All berm will have 3:1 side slopes.

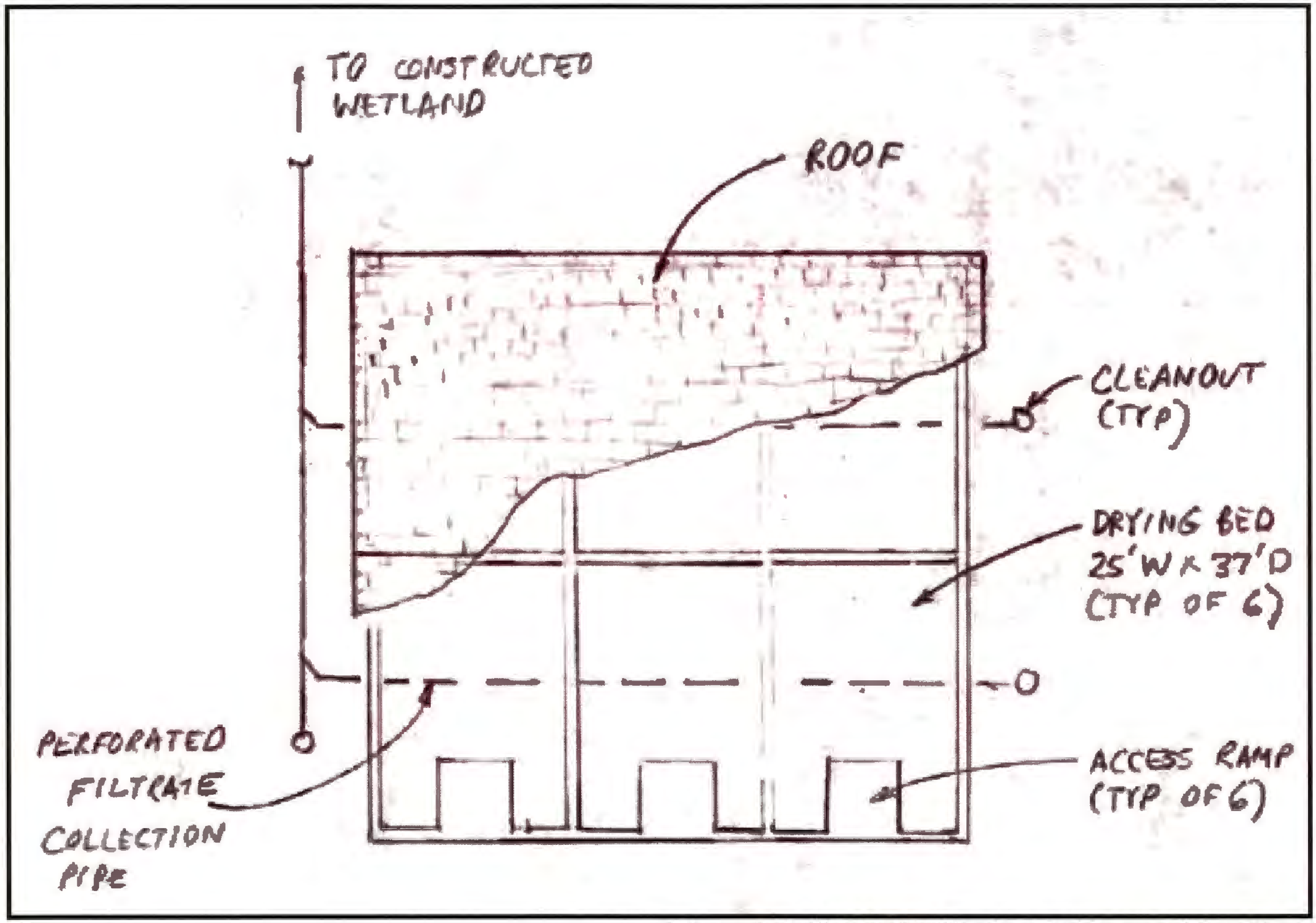

Figure 8-5. Conceptual Drying Bed Layout (Plan View)

- Berms will have three-foot-wide tops, with the exception of berms separating treatment trains, which will have 10-foot-wide tops to allow vehicle access.

- It is not anticipated that the bottom surface of the constructed wetland will need to be lined with impermeable materials as long as infiltration is sufficiently slow to maintain a free water surface under the expected hydraulic loading rates.

- The wetland will be planted in herbaceous species that are already found on the island. An initial planting density of 1,000 plants per acre is anticipated.

- Input to each treatment train is through a distribution manifold from the primary treatment works. The lower berm of each cell will contain between four and six four- to six-foot wide weirs with rocked distribution aprons on the lower side. Rocked aprons will provide aeration and habitat diversity.

- Two or three transverse deep zones will be excavated in each treatment cell. These will provide desirable open water habitat, help distribute wastewater flows across the width of cells, and supply material for construction of berms.

- Discharge will be through a flow distribution structure that allows sheetflow to the portion of the natural wetlands adjacent to the constructed wetland.

- Part or all of the effluent can be diverted via swales to other parts of the natural wetland. Both swales and sheetflow provide modest additional treatment prior to the discharge reaching the natural wetland.

- A perimeter swale will be constructed to divert runoff from upslope of the constructed wetland. Runoff from this perimeter swale can be blended into the constructed wetland discharge to reduce pollutant concentrations.

Section 8.9 below discusses variables that may influence constructed wetland design and treatment efficiency. Once necessary studies are complete, the conceptual wetland configuration can be modified as indicated to maximize treatment efficiencies and minimize construction costs.

8.9 Factors Affecting Expected Constructed Wetland Performance

The estimates of constructed wetland treatment efficiency presented in Section 6.4.2, and on which the pre-design configuration and costs are based, were established on conservative assumptions regarding wetland size and soil infiltration capacity. These assumptions, supported by currently available information, may change after additional information is collected prior to preliminary and final design. Because the initial assumptions are intentionally conservative, any changes are expected to result in increased treatment efficiencies. The potential effects of relaxation of size and infiltration capacity assumptions are described below as guidance as the design process moves forded subsequent to this WWFP. Although the minimum footprint and zero infiltration capacity are expected to meet most discharge criteria, a larger wetland footprint, greater infiltration capacity, or a combination of these would allow more flexibility in the final design, operation, and reliability of the constructed wetland treatment unit.

8.9.1 Constructed wetland size

The primary constraint on constructed wetland size is the availability of reasonably level (< 5 percent slope) land in the proposed location immediately south of Faimulivai Marsh. Based on limited topographical data and field reconnaissance, a constructed wetland footprint of 4.5 acres, with a resulting water surface area of approximately three acres was assumed. Detailed topographic data may reveal a suitable area as large as ten acres, which could result in a constructed wetland water surface of approximately eight acres. This yields a hydraulic loading rate of 1.0 inches per day (0.5 inches per day wastewater plus 0.5 inches per day precipitation) in contrast to the originally assumed 1.8 inches per day (1.3 inches per day wastewater and 0.5 inches per day precipitation).

Expected treatment efficiencies for the potential range of wetland size are presented in Table 8-4. Additional pollutant reduction is provided by increased wetland size to 10 acres (relative to the pre-design footprint of 4.5 acres) and ranges from nearly zero for TSS (due to the fact that both sizes reduce TSS concentrations to near-background levels) to approximately 80 percent for fecal coliform and *Enterococcus sp.* The substantial decrease in expected nitrogen concentrations would significantly reduce impacts on the potentially nitrogen-limited natural marsh. The reduction in bacteria levels would facilitate permitting and reduce the potential for human health impacts.

In addition to increased treatment efficiency, a larger constructed wetland would provide reduced potential for system upsets, greater operational flexibility, and longer system lifespan. It is noted that, because of economies of scale, a ten acre constructed wetland could be built at a cost of approximately 1.5 times that of a 4.5-acre wetland. Overall project cost would only be increased on the order of 10 to 20 percent.

Table 8-4. Effect of Wetland Size on Treatment Efficiency

Constituent	Effluent Concentration (4.5 acre wetland)	Effluent Concentration (10-acre wetland)	Percent Treatment Improvement
Total N (mg/l)	1.7	0.63	62%
Total P (mg/l)	2.0	1.2	40%
BOD (mg/l)	9.7	6.3	34%
TSS (mg/l)	12.6	12.6	0%
Fecal Coliforms (CFU/100ml)	1,470	206	86%
Enterococcus (CFU/100ml)	9,110	819	91%

8.9.2 Soil infiltration capacity

Constructed wetland treatment efficiency estimates for pre-design are based on zero infiltration. This is the most conservative possible assumption. Even a modest infiltration rate would significantly improve expected treatment performance, primarily as a result of removal of pollutants though the bottom of the wetland.

Based on the methods provided by Kadlec and Knight (1996) for calculating the effect of infiltration on treatment kinetics, it is estimated that an infiltration rate as low as 0.5 inches per day can increase pollutant removal rates by as much as 74 percent (Table 8-5). Just as in the case of wetland size discussed above, the benefits of increased infiltration are greatest for bacterial parameters and minimal for TSS. Significant improvements in nutrient and BOD removal are also indicated. If field investigations determine that infiltration potential is equal to or greater than hydraulic loading rate, a no-discharge or wet-weather discharge system may be possible.

If infiltration were to become a factor included in final design for long-term system operation, it would be necessary to take steps to prevent soil clogging. In general, suspended solids of the type found in raw wastewater or in high nutrient pond systems (primarily planktonic algae) tend to reduce long-term infiltration by clogging of soil pores. Solids in natural wetland systems are less prone to clog the soil, because of both the nature of the solids and the effects of wetland plant roots. Thus, clogging would be progressively less problematic as wastewater moved from upper wetland cells to lower cells. In a system designed to rely primarily on the infiltration capacity of the lower cells, it is likely that active measures (such as soil scarification) to restore infiltration capacity would be required very infrequently, if at all.

Table 8-5. Effect of Infiltration on Treatment Efficiency

Constituent	Effluent Concentration (4.5 acres, with no infiltration)	Effluent Concentration (4.5 acres with0.5 inches/day infiltration)	Percent Treatment Improvement
Total N (mg/l)	1.7	0.72	56%
Total P (mg/l)	2.0	1.1	46%
BOD (mg/l)	9.7	6.3	35%
TSS (mg/l)	12.6	12.6	0%
Fecal Coliforms (CFU/100ml)	1,470	284	81%
Enterococcus (CFU/100ml)	9,110	2,520	72%

Infiltration is functionally a discharge to ground water. Percolation though the soil profile will provide a significant, but undetermined at this time, level of wastewater treatment. If required, the uppermost wetland cells could be lined with impermeable material in order to provide pre-treatment prior to infiltration in lower cells.

8.9.3 Increased wetland size combined with infiltration

Treatment performance would be greatly enhanced if both increased wetland size and infiltration are assumed as shown in Table 8-6. All pollutants would be reduced to nearly irreducible background levels. As noted in Section 6 effluent concentrations presented here, while based on conservative assumptions, are subject to significant variability. These estimates represent average removal rates and short-term rates can vary considerably in response to weather and other factors.

Table 8-6. Combined Effect of Wetland Size and Infiltration on Treatment Efficiency

Constituent	Effluent Concentration (4.5 acres, no infiltration)	Effluent Concentration (10 acres, 0.5 in/d infiltration.)	Percent Treatment Improvement
Total N (mg/l)	1.7	0.45	72%
Total P (mg/l)	2.0	0.25	88%
BOD (mg/l)	9.7	5.5	44%
TSS (mg/l)	12.6	12.6	0%
Fecal Coliforms (CFU/100ml)	1,470	192	87%
Enterococcus (CFU/100ml)	9,110	185	98%

Based on current knowledge, there may be potential for modifying wetland area and infiltration capacity assumptions, with resultant increases in treatment efficiencies as described above. Proposed investigations to accurately assess this potential are described in Section 8.10.

8.10 Preliminary and Final Design Basis Data Requirements

Several investigations are recommended to confirm the technical aspects of the selected approach for wastewater treatment on Aunu'u. To acquire or enhance the baseline data needed to develop an appropriate final design, the specific studies described below should be considered prior to initiation of detailed final design work.

8.10.1 Topography

The proposed constructed treatment wetland assumes a minimum of 4.5 acres of reasonably level land along the south edge of Faimulivai Marsh. Preliminary topographic survey work conducted in 2006, as well as reconnaissance conducted by project staff indicate that at least five acres, and possibly more than ten acres, of suitable land lie in the area of interest. A footprint larger than the minimum would provide for additional treatment and system reliability. A detailed topographic survey of approximately 20-25 acres along the south edge of the marsh would assist in establishment of the footprint and internal configuration of the constructed wetland, and facilitate the final design work. Detailed topographic data will assist in siting the most economical configuration that utilizes the natural topography to the greatest extent. The survey area should extend approximately from existing survey station 94+00 to station 109+00 of the 2006 road and village survey conducted by McConnell-Dowell. The survey should extend down slope from the road to the wetland waterline, and upslope until a slope of eight percent is reached. The survey should be conducted at one-foot contour intervals.

8.10.2 Soil Properties

As described in Section 8.9, soil infiltration capacity is a function of saturated hydraulic conductivity and has a major influence on the performance of the constructed wetland system. The proposed constructed wetland site lies on Ofu variant silty clay. The NRCS Soil Survey for American Samoa (1984) indicates a saturated hydraulic conductivity of 2 to 6 inches per hour for surface soils in the Ofu series. The soil survey also suggests a high (but not quantified) infiltration capacity for the subsoils of this series. Project staff collected soil samples from depths up to three feet at four locations in the proposed constructed wetland site in March 2007. While hydraulic conductivity was not measured, dense, clayey soil strata were observed, suggesting low infiltration capacity. NRCS staff has indicated that because of the complex structural properties and high variability of these volcanic soils, infiltration capacity can range from high to extremely low within a small area. Therefore direct on-site measurement would provide valuable information for the basis of final design of the wetlands treatment system.

Infiltration capacity of the surface soil can be measured using cylinder infiltrometers or by the flooded basin technique (Reed et al., 1999). The choice of methods is to a large degree dependent on availability of equipment and related logistic factors:

- Cylinder infiltrometers consist of concentric metal cylinders driven partially into the soil surface and flooded. Infiltration capacity is measured by the rate of water level decline in the inner cylinder after the rings have been flooded for a sufficient time (typically one to several hours) to establish a nearly steady-state infiltration rate. The outer cylinder serves to ensure that water in the inner cylinder percolates in a downward direction rather than laterally. Various standard designs for cylinder infiltrometers have been published, and at least one commercial source exists (http://turf-tec.com). Depending on design, the area inside the infiltrometer can range from about 100 square centimeters to more than a square meter. Larger designs have proportionally greater water requirements, which may require pumping from Faimulivai Marsh as opposed to carrying water to the test site. Depending on site variability and infiltrometer size, between six and twenty infiltrometer measurements should adequately characterize the site.

- The flooded basin technique involves isolating an area of soil with an earthen berm or metal flashing, flooding the area, and measuring steady-state water loss rate. Basin areas are usually on the order of several square meters. Edge effects are relatively smaller with these larger areas, eliminating the need for a concentric outer basin. The flooded basin technique presents greater logistic difficulties (construction, water requirements, and time) than the infiltrometer method, but is regarded to be more representative of actual field performance. Two to four flooded basin tests should adequately characterize the site.

Subsoil infiltration capacity can be tested as described above, but with measurements conducted on the floor of excavated test pits. Alternatively, subsoil hydraulic conductivity can be measured in the laboratory using intact soil cores from the site.

Soils at the proposed constructed wetland site, as well as along the road to the site should be sampled for mechanical properties related to suitability for construction purposes. Sampling and testing should be conducted in accordance with ASTM and/or AASHTO guidelines.

8.10.3 Hydrology and Hydrogeology

The hydrology of the Faimulivai Marsh crater and the hydrogeology of in the area have an influence on the design and subsequent efficiency of the proposed constructed wetland. Crater hydrology also influences the impacts of the constructed wetland on the marsh, as well as expected water quality at the point where the marsh discharges to the ocean. The following interrelated questions should be considered and, if deemed necessary, investigated, prior to final design and permitting:

1. What is the long-term potential for wastewater infiltration in the constructed wetland? Even if the soils work described above reveals that the soils have significant intrinsic infiltration capacity, depth to ground water may limit potential long-term infiltration at the constructed wetland site. If soil investigations show little or no intrinsic infiltration capacity, investigation of ground water levels will shed light on the overall hydrology of the crater and help answer the following, related, question.

2. What is the fate of wastewater in the natural marsh following discharge from the constructed wetland? More specifically, does all flow eventually exit the marsh at the ocean outfall at the east end of the island, or does some portion percolate into the ground water? Some of the water entering the marsh exits via the surface outfall, but it is not known if all, or even a significant portion of water leaves at this point. If the marsh loses a significant portion of its inflow to ground water, mass loss of pollutants from the constructed wetland discharge prior to the ocean discharge point can be expected. It is even possible that a substantial portion of pollutants leaving the constructed wetland never reach the marsh outlet to the ocean. The answer to this question has a significant bearing on potential impact of the wastewater discharge on water quality at the existing marsh outlet.

3. Is there potential for ground water in the eastern half of the island to reach the drinking water aquifer on the western end of the island? Is there a hydrogeologic connection between the two aquifers? This question will need to be addressed if significant percolation potential from the constructed wetland or the natural marsh is identified.

The first question can be answered by installing recording piezometers at the proposed constructed wetland site. A minimum of two piezometers should be installed at different distances from the edge of the natural wetland. Pieziometric ground water levels can be measured using self-contained depth loggers of the type sold by Solinst ™ or Hobo ™. These devices, relatively inexpensive and small enough to be inserted into 2-inch pipes, can record and store up to several thousand water level measurements at user-selectable intervals at accuracies of 0.01 foot. The loggers can be inserted into PVC or metal pipes with slotted wellpoint ends. These pipes will likely need to be installed with the assistance of a mechanized drill rig due to the rockiness of the subsoil. A minimum of one year of data would be required to characterize seasonal ground water trends.

The second question can be addressed by simultaneously measuring changes in marsh storage volume and surface discharge. Given the small, steep watershed, rain events will result in rapid increases in marsh storage because of input from direct precipitation and runoff from the surrounding crater. This will be followed by a decrease in storage caused by surface discharge and loss to ground water, as well as somewhat slower loss to evapotranspiration. Comparison of the change in storage to surface discharge and estimated evapotranspiration will allow loss to ground water to be estimated by subtraction. The approach is essentially the development of a water budget for the Marsh. Changes in marsh storage can be measured by installing a recording depth logger, of the type described above, or other type of stage recording device in the marsh. Flow at the ocean outfall can be quantified by measuring stage in the natural outlet channel between the marsh and the outfall. To estimate discharge, a stage-discharge curve for this channel can be developed, or a weir with known stage-discharge characteristics installed in the channel.

It may be possible to answer the third question by consulting already available geological information—the presence of impermeable rock may divide the island into two discrete ground water basins. If available information fails to conclusively show that there is no potential for commingling of ground water, piezometers can be installed on the western slope of the crater to establish the slope of the piezometric surface in the area. A strong eastward slope (as expected) would indicate eastward movement of ground water away from the potable aquifer on the western coastal plain side of the island.

8.10.4 Other Studies

In addition to the investigations discussed above the following studies or information may be needed for final design, construction, or permitting purposes:

- A water quality characterization in the marsh and at the outfall of the marsh to the ocean should be completed. Water quality analysis should include systematic sampling of dissolved oxygen, nutrients, suspended solids, electrical conductivity, and pathogen indicators (fecal Enterococcus).

- A survey of existing utilities needs to be completed in the pre-design stage or early in the design process to ensure that no interferences will prohibit the construction of the new force main.

- Assessments likely to be required for compliance with federal regulations include: Corps of Engineers' CWA Section 404 jurisdictional delineation, archeological investigations, and biological surveys. Early identification of sensitive cultural and environmental resources will enable a design team to avoid or minimize impacts to these resources during the design process. This up-front investment in studies will ultimately facilitate the permit review process and typically results in cost savings by avoiding or minimizing costly re-designs and compensatory environmental mitigation.

Section 9
PLANNING LEVEL COST ESTIMATE OF SELECTED ALTERNATIVE

Section 7 presented information on a variety of potential wastewater treatment alternatives for Aunu'u, including planning level cost estimates. Those estimates were one of the criteria used to compare the various alternatives in the process of selecting a preferred alternative. Preliminary design considerations for the selected alternative as described in Section 8 provide the information necessary to refine the planning level cost estimates for the selected alterative. It is noted that the cost estimates for the alternatives considered in Section 7 were all based on the same level of detail and are appropriate for comparing the various alternatives. The additional pre-design level of effort for the selected alternative revises the cost estimates for the selected alternative, but does not invalidate the comparative cost estimates presented in Section 7.

9.1 Scope Limitations of the Planning Level Cost Estimates

The costs presented below are refined planning level cost estimates. They are essentially an estimate of the anticipated engineer's estimate that will be based on final detail design of the various elements of the wastewater collection system. Actual bid costs can vary widely from the engineers estimate, and thus can be expected to vary from the planning level estimates. If ASPA crews rather than an outside contractor(s) conduct substantial portions of the work, costs would be expected to be significantly lower.

The planning level costs are divided into major categories corresponding roughly to the various distinct phases of the project described in Section 10. These categories include:

- Construction of a new pump station in the village of Aunu'u, including tie-ins to the existing conveyance system and emergency valving and piping to the existing ocean outfall, including a new force main from the new pump station to the septic tank primary treatment system

- The septic tank primary treatment system, consisting of a splitter box, 3 cast-in-place septic tanks, and related piping and manholes

- A new constructed wetland treatment system, including piping, berms and related earthwork, weirs and flow control structures, liners, and initial wetland plantings, and outfall to Faimulavai Marsh

- The sludge management facilities, including covered sludge drying beds, a filtrate pipeline, and a septage hauling truck.

- Allowances and contingencies

- Operation and maintenance (O&M)

9.2 Estimated Construction Costs of New Pump Station and Force Main

The planning level construction costs for the new pump station and force main are shown in Table 9-1.

Table 9-1. Cost Estimate - New Pump Station and Force Main

Description	Unit	Quantity	Unit Cost	Total
New Pump Station, Fabrication, Assembly, Shipping, and Support	LS	1	$200,000	$200,000
Unloading and Storage	LS	1	$2,000	$2,000
Common Excavation, Including Haul and Disposal	CY	100	$17	$1,700
Installation of Pump Station, including bedding and backfill	LS	1	$30,000	$30,000
Emergency Connection to Existing Outfall and Decommissioning of Old Pump Station	LS	1	$10,000	$10,000
Fencing	LS	1	$4,000	$4,000
Lighting	LS	1	$2,000	$2,000
Utility Water	LS	1	$3,000	$3,000
Combination A&V Station at Crest of Hill	LS	1	$10,000	$10,000
Electrical Power Supply	LS	1	$30,000	$30,000
Force Main HDPE Pipe	LF	8100	$30	$243,000
Force Main Trench Excavation and Backfill	LF	8100	$40	$324,000
Gravel Road Surface	LF	8100	$10	$81,000
Trench Safety	LF	8100	$20	$162,000
Total Estimated New Pump Station and Force Main				$1,102,700

9.3 Estimated Construction Costs of Septic Tank Primary Treatment System

Table 9-2 presents estimated costs of the primary treatment system.

Table 9-2. Cost Estimate - Primary Treatment

Description	Unit	Quantity	Unit Cost	Total
Splitter Box	LS	1	$30,000	$30,000
Inlet Piping	LF	200	$30	$6,000
Manholes	EA	6	$2,000	$12,000
Septic Tank	EA	3	$83,000	$249,000
Outlet Piping to Constructed Wetland	LF	400	$30	$12,000
Trench Excavation and Backfill	LF	400	40	$16,000
Gravel Road Surface	LF	400	10	$4,000
Trench Safety	LF	400	20	$8,000
Total Estimated Primary Treatment Cost				$337,000

9.4 Estimated Construction Costs of Constructed Wetland

Estimated costs for the constructed wetlands treatment system. are shown in Table 9-3.

Table 9-3. Cost Estimate - Constructed Wetlands Treatment System

Description	Unit	Quantity	Unit Cost	Total
Mobilization - General	1	LS	$ 100,000	$ 100,000
Erosion and Sediment control	6	acres	$ 5,000.00	$ 30,000
Clearing and Grubbing	5	acres	$3,225.00	$ 16,125
Selective stump removal (>6 inches)	1000	each	$89.00	$ 89,000
Stripping and stockpiling of topsoil	4000	cubic yards	$7.10	$ 28,400
Mobilization - Heavy Equipment Offloading to Aunu'u	1	lump sum	$20,000.00	$ 20,000
Bulk Excavation with Dozer	1000	cubic yards	$9.05	$ 9,050
Structural Excavation with Backhoe	4500	cubic yards	$4.29	$ 19,305
Backfill with Native Material	4500	cubic yards	$15.84	$ 71,280
Disposal of Excess or Unsuitable Native Material	1000	cubic yards	$5.35	$ 5,350
Liner Bedding Sand	2420	cubic yards	$38.50	$ 93,170
Membrane Liner	43560	square foot	$1.50	$ 65,340
Drainage System around new Site	1700	lineal foot	$30.00	$ 51,000
Wetland Planting	3000	plants	$10.00	$ 30,000
Crushed Rock for Outlet Aprons	400	square yard	$77.00	$ 30,800
Inlet Splitter Box	1	LS	$40,000.00	$ 40,000
Inlet Structures	3	each	$5,000.00	$ 15,000
Perimeter Fence and Gate	1900	lineal feet	$16.85	$ 32,015
Outlet Structures	3	each	$5,000.00	$ 15,000
Sampling Stations	1	each	$10,000.00	$ 10,000
Perimeter Maintenance Road	315	cubic yards	$38.50	$ 12,120
Outfall	500	lf	$50.00	$ 25,000
Total Estimated Constructed Wetlands Treatment Cost				$ 807,955

9.5 Estimated Costs of Sludge Management

Estimated costs associated with sludge management are presented in Table 9-4.

Table 9-4. Cost Estimate - Sludge Management

Description	Unit	Quantity	Unit Cost	Total
Septage Truck	LS	1	$100,000	$100,000
Covered Drying Beds	SF	5550	$100	$555,000
Filtrate Pipeline	EA	200	$30	$6,000
Trench Excavation and Backfill	LF	200	$40	$8,000
Gravel Road Surface	LF	200	$10	$2,000
Trench Safety	LF	200	$20	$4,000
Total Estimated Sludge Management Cost				$675,000

9.6 Allowances, Contingencies, and Associated Costs

In addition to construction costs described in Sections 9.2 to 9.5, there are a number of other costs associated with the project that must be accounted for. These costs are shown in Table 9-5. The basis of most of these costs, at a preliminary planning level, is generally calculated as percentages of construction costs. The costs include indirect construction costs, contingencies for construction, and a variety of administrative costs that can vary substantially depending on how the project is managed.

Costs for permitting and associated environmental and archeological investigations are highly site-specific, and are no costs explicitly stated in Table 9.5. These costs also depend on the role of the owner (ASPA) and external engineering and construction management firms during design and construction (how much is done in-house and how much is contracted). However, the costs can be considered as included in the A/E Design and Construction Administration Fees, except in unique circumstances requiring extraordinary investigations. In this case it is anticipated that archeological, biological, and water quality studies (and possibly hydrological studies) will be required for both construction and discharge permitting. An estimated $375,000 is included in the overall cost estimates in Table 9-5 and Section 9.8 below for these costs. .

Table 9-5. Estimate of Associated Costs

Description	Basis	Estimated Cost
Indirect Construction Costs Based on Direct Construction Costs		
Design Development Allowance	5.00%	$146,133
Escalation over 24 months	3.0%/year	$175,360
Contractors Overhead and Profit	12.50%	$365,333
Construction Contingency Costs Based on Total Construction Cost		
Construction contingencies	10.00%	$292,266
Costs based on Total Construction plus Contingency Cost		
A/E Design and Construction Administration Fees	8.00%	$233,813
Commissioning and Start-up	0.50%	$14,613
ASPA Project Management	2.00%	$58,453
ASPA Administration and Grant Preparation	1.00%	$29,227
ASPA/Third Party Construction Management	3.00%	$87,680
Project Survey and As-built	0.50%	$14,613
Plan Reviews/Construction Permits	0.40%	$11,691
Construction Safety Oversight	0.10%	$2,923
Costs based on Site-specific Conditions		
Pre-Final Design Evaluations	--	$150,000
Environmental Documentation for Funding and Permitting	--	$75,000
Permitting Required for Construction and Operation	--	$50,000
Archeological Investigations and Documentation	--	$100,000

9.7 Operation and Maintenance Costs

The selected alternative will require some annual operation and maintenance. An estimate of these costs is shown in Table 9-6. Note that some activities such as sludge management, special NPDES conditions, and truck maintenance will vary from year to year. For this reason, these estimates of O&M costs should be considered average values. Actual values will be higher or lower the values shown.

Table 9-6. Estimate of Annual Average O&M Costs

Item	Quantity	Unit	Unit Price	Extended
Labor	0.5	person-years	$ 25,000	$ 12,500
Electricity	2	kW	$ 2,278	$ 4,555
Maintenance (including operation costs of sludge truck) and access road repair	1%	of capital	$4,729,767	$ 47,298
NPDES Permit Related Costs – Monitoring	1	Allowance	$ 100,000	$ 100,000
Total Average Annual O&M Costs				$ 164,353

9.8 Overall Capital Cost Summary

Using the component estimates described above the overall capital cost is shown in Table 9-7. These are planning level costs and, as indicated, actual costs may vary substantially.

Table 9-7. Capital Cost Summary

Item	Reference	Corrections/Additions
Direct Construction Costs		
Pump Station and Force Main	Table 9-1	$1,102,700
Primary Treatment	Table 9-2	$337,000
Constructed Wetlands	Table 9-3	$807,955
Sludge Management	Table 9-4	$675,000
Subtotal-Direct Construction		$2,922,655
Indirect Costs		
Design Development	Table 9-5	$146,133
Escalation	Table 9-5	$175,360
Contractors OH&P	Table 9-5	$365,333
Subtotal-Indirects		$686,826
Contingencies and Allowances		
Construction Contingencies	Table 9-5	$292,266
Other Contingencies and Allowances	Table 9-5	$453,013
Site-Specific Evaluations and Environmental Permitting	Table 9-5	$375,000
TOTAL		$4,729,767

Section 10
IMPLEMENTATION PLAN

This section provides a discussion of the governmental responsibilities for construction and maintenance of the selected alternative (constructed wetlands area and additional landfill area). Several departments within the American Samoa Government (ASG) are responsible for specific elements of the project. ASG entities are identified below along with a discussion of the lead agency concept. Potential funding sources are identified and basic requirements for applications are provided. An implementation schedule is provided that takes into account funding for the Aunu'u wastewater system design and construction.

10.1 Institutional Responsibilities

The primary American Samoa entity with responsibility for the design and construction of the Aunu'u wastewater collection system is the American Samoa Power Authority (ASPA). ASPA will be the legal entity entering into contracts for project design and construction. Table 10-1 provides a list of the principal agencies involved in the project. The Aunu'u design will continue from the pre-design completed as part of this WWFP. A preliminary design will first be prepared that will be reviewed by the principal agencies, and agencies listed in Section 11, (Table 11-1). Following review of the preliminary design a final design will be prepared.

The environmental review process can proceed as part of the design process. Environmental review is now considered by most infrastructure managers in the U.S. as an important element of design. The environmental review (Section 11) can be prepared as soon as preliminary design is initiated. The environmental review can be submitted as part of the preliminary design or in advance of it. This WWFP is a pre-design (Section 8) and could readily be used with the pre-design cost estimate (Section 9) and the environmental review (Section 11), as is, in an application for funding. The funding agencies will indicate when environmental and design elements will be reviewed.

ASPA will also be the lead agency for the preparation and submittal of permit applications. The permit applications are generally submitted when the preliminary design is available. Some mitigation measures can be implemented before the construction, such as the archaeological review. Other mitigation measures may be placed in the Construction Bid Documents, and others may be required of the Selected Contractor to budget and implement.

10.2 Funding Sources

The American Samoa Government and ASPA have in the past been successful in obtaining grant funds for many types of government services. The ideal situation is to identify a full range of potential funding sources and then hold discussions to determine the types of funding that each potential grantor has available. Generally for infrastructure, a grant program requires an environmental checklist and a facilities plan that contains details on construction costs, and associated environmental issues such as impacts on the physical, biological, social, economic, and cultural surroundings.

Table 10-1.
American Samoa and U.S. Federal Agencies With Responsibility For Aunu'u Wastewater Design and Construction

American Samoa Agencies	Relationship to Project	Interest in Project
AS Power Authority (ASPA)	Utility provider; Infrastructure and Facility Management (Power, Wastewater, Water)	Lead local agency for final design including permitting, environmental review, mitigation, construction management, and construction
AS Environmental Protection Agency (ASEPA)	Environmental Review	Identification of environmental impacts and mitigation
United States Federal Agencies	**Relationship to Project**	**Interest in Project**
US Department of Agriculture (USDA) – Rural Utility Service (RUS)	Fund Project Design and Construction & Conduct Environmental Review	Possible future lead agency for funding project design and construction
U.S. Environmental Protection Agency (USEPA)	Fund WWFP and Review Environmental Documentation	Future cooperating agency for funding design and construction

This WWFP contains the preferred alternative pre-design (Section 8) and associated costs (Section 9). Initially, this pre-design information can be used to inform potential grantors on the need for the project based on the lack of wastewater treatment on Aunu'u. Discussions can be held with funding agencies to verify the availability and magnitude of funds. Additionally, stakeholders can review the WWFP to verify that the proposed improvements are consistent with their expectations. Clarifications and, if needed, modifications can be made to the preliminary design at that time.

Funding for the next phases of work is required for the Aunu'u wastewater project and a listing of potential federal funding sources is provided below. The publication entitled, *Federal Funding Sources for Small Community Wastewater Systems*, is a product of the Small Underserved Communities team in EPA's Office of Wastewater Management, Municipal Support Division. The team's goal is to administer programs, through which small, under-served, communities can access information, financial resources, and technical assistance, to construct adequate and cost effective wastewater systems. The publication contains 10 fact sheets of possible funding sources. The fact sheets provide information on the types of help each program offers, what projects are funded, who is eligible, and how to apply for the funds. To obtain additional copies of the publication, the reader should contact the National Center for Environmental Publications and Information (NCEPI) at 513-489-8190 or 800-490-9198 and refer to document number EPA 832-F-97-004.

The federal agencies listed below offer financial and technical assistance to help small communities plan, design, and build wastewater systems.

USEPA Clean Water SRF and Drinking Water SRF: USEPA's Office of Water manages two separate but related water programs: the Clean Water State Revolving Loan Fund for wastewater facilities and the Drinking Water State Revolving Loan Fund for drinking water facilities. Each of these programs awards grants to states to "seed" revolving loan funds that provide low-interest loans to eligible communities to build wastewater or water facilities. Community loan repayments return to the state or territory fund to be loaned to other communities.

USEPA Hardship Grant Program for Rural Communities: When disadvantaged rural communities cannot afford the full cost of SRF loans, these communities can seek help through EPA's Hardship Grants program, which helps small, disadvantaged rural communities with fewer than 3,000 people address their wastewater treatment needs.

Department of Housing and Urban Development (HUD) Community Development Block Grant Program: HUD gives block grants to participating states, which allocate the funds to units of local government that carry out development activities principally for people with low or moderate incomes. Funded activities include wastewater, drinking water, and economic development projects.

Department of Agriculture's Rural Utilities Service (RUS) Water and Waste Disposal Program: RUS provides grants and loans to rural communities with fewer than 10,000 people for wastewater, drinking water, Constructed Wetlands Area and Additional Landfill Area solid waste, and storm water drainage projects.

Department of Commerce Economic Development Administration Grants for Public Works and Development Facilities: Fundable projects include water and wastewater facilities that promote economic development in economically depressed areas.

10.3 Implementation Plan

A viable approach to construction of the Aunu'u wastewater treatment system is a phased approach. Phase 1 is the design and construction of the pump station and force main. Phase 1 would also include the rehabilitation of the access road to the landfill area. Concurrent with phase 1, additional field investigations and other confirmational work would occur, including:

- Topography of constructed wetlands area and additional landfill area
- Soils property investigation in constructed wetlands area
- Hydrology and water quality investigation of Faimulivai marsh
- Wetlands delineation of Faimulivai marsh

- Archeological investigation of constructed wetlands area and additional landfill area

Phase 2 would be the design and construction of the septic tank and sludge drying bed system. Phase 3 would be the design and construction of the wetland system. Table 10-2 presents detailed phased approach for the project, developed in consultation with ASPA, with nominal length of time identified for each task. Many of the tasks listed in Table 10-2 can be conducted concurrently, depending on the level of funding available. The durations provided in Table 10-2 are general estimates based on experience and may vary based on site-specific considerations.

Table 10-2. Work Plan for Project Implementation
Design and Construction of the Aunu'u Wastewater Facilities

Activity	Description	Duration
1	**FUNDING and LEASING**	
a	Begin grant applications to fund the design and construction of the project including Phases 1 – 4. Funding will be requested in annual increments. Fund Phase I of the project	6 months
b	Begin land leasing process	6 months
2	**CONSULTANT SELECTION**	
a	Prepare Scope of Work(s) (SOWs)	1 month
b	Transmit SOWs to USEPA and ASPA Board of Directors for review and approval	1 month
c	Advertise Request for Proposal(s) and A/E selection and Environmental Consultant Selection	1 month
d	Review Proposals and Select A/E Consultant and Environmental Consultant	1 month
e	Request for fee proposal, review, and negotiate fee proposal(s) by USEPA and ASPA	1.5 month
3	**A/E CONTRACT and ENVIRONMENTAL CONSULTANT CONTRACT REVIEW AND APPROVAL**	
a	Submit proposed contract(s) to ASPA and USEPA for review and approval of consultant(s)	1 month
b	Issue Notice(s) to Proceed	
4	**Conduct Additional Environmental Evaluations (if Necessary)**	**Concurrent**
a	Topography of Constructed Wetlands and Landfill Areas	2 months
b	Soils Properties Evaluation	10 months
c	Hydrology and Hydrogeology Evaluation	6 months
d	Other Studies; water quality of Marsh, existing utilities, biological assessments, cultural and archaeological resources	12 months
5	**DESIGN PHASE 1 – Pump Station and Force Main**	
a	Design Pump Station, Force Main, and Access Road Rehabilitation including ASPA, ASEPA and USEPA Review and Approval	6 months
b	ASG Public Notification and Review System evaluation and permit approval.	1 month
6	**BID PHASE 1 FOR CONSTRUCTION**	
a	Submit advertisement to ASPA Board of Directors and USEPA for review and approval. Advertise bid, conduct pre-bid conference and bid opening.	1.5 months
b	Submit bidding results to ASPA Board of Directors and USEPA for review and approval.	0.5 months
c	Award Contract, Issue Notice to Proceed	0.25 months

Table 10-2. Work Plan for Project Implementation Design and Construction of the Aunu'u Wastewater Facilities		
Activity	**Description**	**Duration**
7	**CONSTRUCTION PHASE 1 – Pump Station and Force Main**	
a	Conduct Pre-Construction Conference	0.25 months
b	Procure Materials	3 months
c	Construction	4 months
d	Submittal of Operations and Maintenance Manual and Pump Training	0.5 months
e	Final Inspection & Punch list Completion	0.5 months
8	**DESIGN PHASE 2 – Septic Tanks and Sludge Drying Beds**	
a	Design septic tanks and drying beds in landfill area	
b	ASG Public Notification and Review System evaluation and permit approval.	As Required
9	**BID PHASE 2 FOR CONSTRUCTION**	
a	Submit advertisement to ASPA Board of Directors and USEPA for review and approval. Advertise bid, conduct pre-bid conference and bid opening.	1.5 months
b	Submit bidding results to ASPA Board of Directors and USEPA for review and approval.	0.5 months
c	Award Contract, Issue Notice to Proceed and	0.25 months
10	**CONSTRUCTION PHASE 2 – Septic Tanks and Sludge Drying Beds**	
a	Conduct Pre-Construction Conference	0.25 months
b	Procure Materials	4 months
c	Construction	4 months
d	Submittal of Operations and Maintenance Manual, Training and Startup	0.5 months
e	Final Inspection & Punch list Completion	0.5 months
11	**DESIGN PHASE 3 – Constructed Wetland**	
a	Design Constructed Wetland including ASPA, ASEPA and USEPA Review and Approval	6 months
b	ASG Public Notification and Review System evaluation and permit approval.	As Required
12	**BID PHASE 3 FOR CONSTRUCTION**	
a	Submit advertisement to ASPA Board of Directors and USEPA for review and approval. Advertise bid, conduct pre-bid conference and bid opening.	1.5 months
b	Submit bidding results to ASPA Board of Directors and USEPA for review and approval.	0.5 months
c	Award Contract, Issue Notice to Proceed and	0.25 months
13	**CONSTRUCTION PHASE 3 – Constructed Wetland**	
a	Conduct Pre-Construction Conference	0.25 months
b	Procure Materials	4 months
c	Construction	4 months
d	Submittal of Operations and Maintenance Manual, Training and Startup	6 months
e	Final Inspection & Punch list Completion	0.5 months

Section 11
SUMMARY OF ENVIRONMENTAL IMPACTS

An evaluation of the environmental impacts of the selected alternative is conducted in this section of the report. The evaluation is based on the information developed in the preceding sections and identification of general areas of environmental concern for wastewater treatment facilities. In addition, there are a number of site-specific elements also considered that are unique to the South Pacific islands and similar remote locations. The selected alternative, summarized below in Section 11.1, is the subject of the pre-design in Sections 8, 9, and 10.

11.1 Summary of the Selected Alternative

A wide range of potential alternatives for wastewater treatment on Aunu'u was considered and most were eliminated during the preliminary assessments described in Section 6, and the evaluation of alternatives examined in Section 7. The alternative selected to meet wastewater treatment needs includes constructed wetlands treatment preceded by primary treatment by means of a septic tank system, with final effluent disposal to the Faimulivai Marsh. The alternative also includes an emergency bypass option via the existing ocean outfall. Specific elements of the pre-design (described in detail in Section 8) include:

- The existing raw sewage ocean discharge near the Village will cease, but the existing ocean outfall will be retained for emergency use.
- A new pump station will be installed in the village, adjacent to the existing pump station.
- The new force main will, to the maximum extent feasible, follow the existing road alignment.
- The existing roadway will be upgraded to a crushed rock surface once construction is completed. (Some upgrading may be required during construction.)
- Primary treatment will be provided by cast-in-place concrete septic tanks located at or near the existing landfill.
- A constructed freshwater wetland will provide secondary treatment prior to discharge to the Faimulivai Marsh.
- New sludge drying beds will be constructed at the existing landfill. Biosolids will be treated in a manner that is expected to be equivalent to processes that meet Class A criteria for unrestricted reuse.

11.2 Environmental Evaluation Procedures

General environmental impacts from the project were used as one criterion for the comparison of project alternatives in Section 7. Environmental impacts that occur only during construction, and long-term impacts associated with changes caused by construction or ongoing operations, need to be identified and possibly mitigated. These impacts are often highly project- and site-specific. There are impacts identified directly with the human environment (noise, odor, traffic, visual impacts) and those associated with the natural environment (ecological disturbances). For the Aunu'u wastewater project the major environmental evaluation categories are identified below. Not all categories may be applicable to the selected project, but will be discussed for completeness.

- Temporary disturbance to human activities during construction
- Temporary disturbance to wildlife activities during construction
- Permanent effects on terrestrial and aquatic habitats
- Social and economic effects such as effects on health, income, quality of life, and environmental justice
- Cumulative impacts and/or cumulative benefits of the proposed action
- Relationship between local short-term use's of man's environment and the maintenance and enhancement of long-term productivity. (NEPA[1] Required)
- Irreversible and irretrievable commitments of resources, which would be involved in the proposed action. (NEPA Required)
- Mandatory findings of significance. (NEPA Required)

Once the categories of environmental evaluation are described the environmental effects of the selected alternative in each category can be defined. The lead local agency, in the case of the preparation of this WWFP, is the ASEPA. The lead US Federal agency for this WWFP is the USEPA. The lead agency for construction of the Aunu'u project is ASPA. Because this WWFP does not result in any physical activities, no environmental review of the plan is required. However, the subject of the plan will require environmental review and US Federal approval if funding from US Federal agencies is obtained. For example, if the US Department of Agriculture (USDA) Rural Utilities Service (RUS) were to provide major funding for the Aunu'u wastewater project, it would be considered the lead US Federal agency responsible for making the determination whether an EA or EIS is necessary. Where there are multiple US Federal agencies that supply funding for the Aunu'u wastewater treatment system construction, the agencies cooperate as to which agency would take the lead for the NEPA process. Each US Federal agency involved in funding, permitting, or regulating the project makes a finding as to whether environmental review has been made and the results are included in their "findings".

US Federal agencies use the following definitions to describe NEPA policy.

[1] National Environmental Policy Act

- *Major federal action* includes actions with effects that may be major and which are potentially subject to Federal control and responsibility.

- *Environmental impact statement* (EIS) means a detailed written statement as required by section 102(2)(C) of the NEPA, which analyzes the environmental impact of the project.

- *Environmental assessment (EA)* means a concise document that sets forth sufficient information for the US Federal agency to determine whether to prepare an EIS.

- *Finding of no significant impact* (FONSI) means a determination that approval of the filing will not have a significant effect on the quality of the human environment and therefore no further NEPA analysis is required.

- *Categorical exclusion* means a category of filings that does not individually or cumulatively have a significant effect on the human environment, and which require no NEPA analysis.

Typically the lead local agency prepares an environmental checklist and environmental evaluation and the lead funding federal agency prepares the NEPA compliance findings that are outlined in here. Table 11-1 indicates the American Samoa and US Federal agencies that may take part in review of this project. Some agencies may participate in construction permit review and others may make a more substantial review of the environmental effects of the project. As an example, under the USDA/RUS environmental policies and procedures for review of infrastructure projects, the Aunu'u Project falls under one category: Category (4) New facilities (Aunu'u wastewater pumps, force main, septic tanks, constructed wetland secondary treatment and sludge drying beds).

For new facilities the RUS concern is that the project induces only modest growth. The Aunu'u project is designed for modest growth potential. Aunu'u Village is primarily residential and full buildout has almost been achieved. There are a number of abandoned houses in Aunu'u that are in poor disrepair that could be reoccupied. The RUS is concerned that the Aunu'u project is designed for predominantly residential use with users being small-scale, commercial enterprises having limited secondary impacts. In Aunu'u the only types of commercial enterprises are two small grocery/snack shops. The RUS is concerned that the project be confined to areas within the existing service area; and all the construction will occur on the Island of Aunu'u.

Table 11-2 provides a listing of the RUS environmental concerns. If the Aunu'u project negatively affects any of the environmental issues shows in Table 11-2 then RUS may be required to prepare an environmental assessment (EA) with an environmental report. The Aunu'u wastewater project meets the requirements in the first three issues in Table 11-2, but to answer "no" to the fourth category an examination of the number of dwelling units in the Village is necessary. Data from the November 2006 house-to-house survey in located in this report in Section 3.2 indicates that there are 112 housing units in Aunu'u, well under the 500-house limit.

The wastewater engineering required using an estimated percentage increase in wastewater flow given the life expectancy of the infrastructure to the year 2030. The flow predictions used in Section 5 were based on a 33% increase in growth in 20 years, as a conservative engineering design assumption but the increase is assumed to be less based on census data. Given the existing density of the Aunu'u it would impossible to actually get this growth rate without significant changes in three factors, the economy, the preferential single family housing type, difficulty in transporting most household necessities by water taxi or barge.

Table 11-1
American Samoa and US Federal Agencies With an Interest in the Aunu'u Wastewater Treatment System Permitting and Environmental Impact Assessment

American Samoa (AS) Agencies	Relationship to Project	Interest in Project
AS Environmental Protection Agency (ASEPA)	Manage WWFP Contract Environmental Review of Project	Lead local agency for Wastewater Facilities Plan (WWFP) Future interest in environmental impacts identification and mitigation
AS Power Authority (ASPA)	Infrastructure and Facility Management (Power, Wastewater)	Lead local agency for final design and construction
AS Department of Public Works (ASDPW)	Highway Management and Maintenance	Permitting for highway modification and excavation and sealing
AS Department of Commerce, (ASDOC) Planning Division	Planning / Zoning and Land Management System Environmental Review	Coastal consistency determination
AS Marine and Wildlife Resources (ASMWR)	Environmental Review	Review of stream crossing, biological resources impacts
United States (US) Federal Agencies	**Relationship to Project**	**Interest in Project**
US Environmental Protection Agency (USEPA)	Fund WWFP and Environmental Review	Lead federal agency for WWFP funding. Future cooperating agency for funding of design and construction
US Department of Agriculture (USDA) – Rural Utility Service (RUS)	Fund Project Construction and Environmental Review	Possible future lead agency for funding bulk of project construction
US Army Corps of Engineers (USCOE)	Environmental Review	Lead agency for issuance of Clean Water Act Section 404 Permit Applications for work adjoining the Failuvai Marsh
US Fish and Wildlife Service (USFWS)	Environmental Review	Provides comments on Section 404 permit applications, and environmental documents prepared by other Federal agencies involving potential impacts on terrestrial and water related habitats

Table 11-2
USDA Rural Utility Service Environmental Policies and Procedures
Environmental Resources or Issues Questions

Question: Does the project affect or convert to other uses any of the following environmental resources or issues?	Aunu'u Wastewater Project Impacts	
	Construction	Permanent Use
New or relocation of discharge to withdraw from surface or groundwater	No	No
Substantial increases in the volume or the loading of pollutants from an existing discharge to receiving waters	No	No
Substantial increase in the volume of withdrawal from surface or ground waters at an existing site	No	No
Number of EDUs (equivalent dwelling units) more than 500 or does the project provide a capacity to serve a 30% increase in the existing population	No	No/No
Any Formally Classified Lands (Parks, Monuments, Wild and Scenic Rivers, etc)	No	Yes
Important Farmland, Prime Range or Forestland	No	No
Floodplains	No	No
Wetlands	No, with mitigation[1]	Yes
Cultural Resources	No, with mitigation	No
Biological Resources – Threatened and Endangered Species/Critical Habitat	No	No
Water Quality Issues/Sole Source Aquifer areas	No, with mitigation	No
Coastal Resources (Coastal Zone Management Areas/Coastal Barrier Resources)	No, with mitigation	No
Environmental Justice	No	No
Miscellaneous Issues (Air Quality, Noise, Odors)	No	No

[1] Mitigation measures are suggested in Section 11-3, below.

The RUS is concerned with environmental impacts associated with increases in use of natural resources, primarily surface water and groundwater quality and quantity effects. Section 3.4.2 provided a description of the National Landmark Status of the Aunu'u tuff cone containing Faimulivai Marsh. National Landmark Status does not preclude human use of the Aunu'u tuff cone as evidenced by the banana and coconut palm plantations surrounding Faimulivai Marsh. Permanent use of the wetland for discharge of treated wastewater will not degrade the wetland. Water quality tests thus far have indicated that the water quality of Faimulivai Marsh will require a site specific criteria be developed and the constructed wetland treatment could have cleaner water than the existing Marsh. The selected project appears to have no adverse impact on the characteristics that result in National Landmark status.

It can be easily demonstrated that the remaining environmental issues in Table 11-2 can be mitigated as demonstrated in Tables 11-3 through Table 11-6. The Aunu'u project could then qualify for categorical exclusion with very little additional environmental evaluation.

11.3 Environmental Issues and Mitigation Measures

To evaluate the construction impacts of the project Table 11-3, 11-4, 11-5, and 11-6 provide an outline of the predominant temporary and permanent impacts associated with the construction and operation of the Aunu'u wastewater treatment preferred alternative. Even though construction impacts may be temporary they may have associated long-term impacts. Negative impacts occurring during construction can be offset or minimized using mitigation measures. The listed mitigation measures are not exhaustive, but are intended to be representative for the purposes of the WWFP evaluation. Mitigation measures can be suggested by many of the American Samoa and US Federal regulatory and resource agencies including those listed in Table 11-1, particularly because they will all be reviewing the project for environmental concerns. Some mitigation measures are included in Table 11-3 and Table 11-4 that illustrate the types of mitigation measures that can be applied to the Aunu'u Project to minimize temporary construction impacts on human activities (Table 11-3) and biological resources (Table 11-4).

Often some of the best mitigation measures for construction come directly from the contractor selected to construct the various elements of the project. Bid specifications can be prepared requiring the bidder to suggest mitigation measures based on certain environmental requirements. For example, one environmental requirement for water quality impairment might state "discharge of sediment to the Faimulivai Marsh is prohibited during construction". The selected contractor could suggest its own erosion control plan including mitigation measures such as:

- All work near the marsh will have sediment control barriers (e.g., straw rolls, silt curtains) placed before work is commenced.
- No soil from digging of holes and trenches for the force main and the constructed wetland will be stored on the water side of the marsh without covering piles with plastic and surrounding the piles with erosion control measures such as use of straw rolls or some other soil erosion control measure to be determined in consultation with local agencies such as ASPA or ASEPA technical services.

There is no limit as to how many mitigation measures are applied to a given environmental impact. The only time a problem can arise is in the case of conflicting mitigation measures. If this occurs the local and federal lead agencies can rectify the conflicting mitigation measures.

Table 11-3. Temporary Impacts to Human Activities during Construction of the Aunu'u Wastewater System		
Environmental Issues	**Impacts**	**Example Mitigation Measures**
Aesthetics	Temporary interruption of scenic views and vistas	During construction access to the main road to vistas of Faimulivai Marsh and Ma'amaa Cove will be limited. Almost all access is by foot as there are very few vehicles on the Island of Aunu'u.
Air Quality	Construction equipment impairs air quality through emission of diesel and gasoline fumes within in a concentrated area	Impairments to air quality during construction are considered minor. Contractor could be expected to keep equipment in good repair to help minimize emissions.
Cultural Resources (Historical and Archaeological)	Temporary impact to cultural resources primarily to historical and archeological sites.	SHPO and ASPA Archaeological team could review the design plans for elimination of conflict with known archaeological sites prior to construction. During construction measures could be employed that would protect cultural resources if discovered during excavation.
Geology and Soils	Temporary exposure of erodable soils during construction in proximity of Faimulivai Marsh	ASPA could include in Bid Specifications requirements for erosion control during construction; Selected bidder could meet and confer with ASPA, ASEPA environmental staff, and other interested agencies. Selected bidder could prepare an erosion control plan for agency approval. Erosion control can involve replanting if warranted.
Hazards and Hazardous Materials	Construction equipment causes a moving hazard to pedestrians and traffic. Equipment and associated hazardous materials are a nuisance attraction to children.	There is very minimal vehicular travel on the Island as there are very few vehicles. Construction sites could be clearly marked; ASPA construction managers can have contractors comply with all safety regulations regarding hazardous materials.
Hydrology and Water Quality	Temporary diversion or work near to stream, creek, and intermittent waterways.	Bid Specifications could include requirements for Selected Contractor to prepare erosion control plan and include specific items for water quality control of waterway diversions and stream crossings.
Noise	Machinery and equipment will cause noise	Construction equipment will be specified for use between "reasonable" hours of operation. Construction could be controlled with no work conducted in vicinity of churches during Sunday services.
Public Services	Services such as fire, police protection, and ambulance service will have some interruption during construction; schools may have some interruption,	The only service on the Island is trash pick-up conducted by ASPA personnel. As the project entails construction near the landfill access to the landfill will need to be coordinated between ASPA and it's contractor.
Recreation	Swimming near the boat dock	There are no designated recreational sites that will be affected by the construction of the project. The boat dock area is used for swimming by children of all ages. This activity usually occurs after school and on weekends. Access for swimming will be interrupted during offloading of equipment and supplies for the project. Water taxi service to the Island could be interrupted during offloading operations. The water taxi is not scheduled but rather on an as needed basis (about every 30 minutes during peak times).
Transportation/ Traffic	Construction could interfere with traffic and transportation including buses, school buses, passenger and service vehicles	There will be limited interference between construction activities and traffic. There are a limited number of vehicles on the Island. There is one small school bus that picks up children to go to the elementary school on the Island. ASPA has a few trucks for garbage pickup and maintenance activities. Only one resident has a car.
Utilities/Service Systems	Interruption of wastewater collection and electricity during startup is possible.	There should be only one planned interruption of wastewater collection when the existing sewer system is connected to the new force main. Similarly, any interruption in electrical service could be scheduled.

Table 11-4. Temporary Impacts to Physical and Biological Resources during Construction of the Aunu'u Wastewater Treatment Facilities		
Environmental Issues	**Impacts**	**Example Mitigation Measures**
Air Quality	Project construction would generate air pollutants including dust and vehicle emissions that could degrade local air quality.	Air quality impacts would be expected to be short-term and would have minimal impacts on wildlife as most wildlife would be expected to avoid the construction areas when equipment is in operation. Implementation of BMPs such as covering haul trucks and watering active construction sites would control dust and particulate pollution. Likewise, vehicle emissions may be controlled through appropriate BMPs such as requiring proper vehicle maintenance and limiting vehicle idling times.
Hydrology and Water Quality	Project construction could result in the release of construction related sediments from access roads, staging areas, material stockpiles, and other ground-disturbing activities. Additionally, water quality impairment could result from the accidental or uncontrolled release of construction related hazardous materials.	If properly managed through the implementation of appropriate BMPs, construction-related hydrology and water quality impacts should be short-term. Bid specifications could require the contractor to develop and implement a Stormwater Pollution Prevention Plan (SWPPP) consistent with EPA standards. Additionally, bid specification could require minimum management practices such as: • The contractor shall develop and conduct an education program for field personnel involved with construction and construction oversight. • Soil and other materials shall be temporarily stockpiled away from swales and other waters. • Stockpiles shall be covered with plastic, secured in place and surrounded with silt fencing or wattles on the surrounding contour lines, in the event of rain. Bid specifications could require the contractor to develop and implement Spill Prevention and Control Plan. At a minimum, the bid specifications could require that the contractor have emergency clean-up gear and fire equipment available onsite at all times.
Habitat Interference	Construction activities could result in disturbances to or short-term degradation of habitat used for foraging or breeding.	Potential impacts to species and habitats are usually species dependent. Pre-construction surveys could be conducted to identify sensitive species and habitats. Once sensitive species and habitats are identified, appropriate avoidance and minimization measures could be developed. Measures could include construction scheduling to avoid critical seasons for species of concern and exclusionary fencing to isolate sensitive habitats. Work in streams should meet ASEPA guidance on minimizing temporary interferences during construction.
Geology and Soils	Soil disturbance during construction activities could result in increased erosion and sedimentation, particularly in steep areas. Accelerated sedimentation and erosion may result in permanent hydrologic changes and water quality impacts.	Short-term impacts are similar to those addressed above under hydrology and water quality, and could be minimized through implementation of appropriate BMPs as discussed above. While permanent modifications to site hydrology should be addressed during the design phase, several post-construction management practices should be required of the contractor. At the conclusion of construction, the site should be stabilized using appropriate erosion control techniques. Erosion control methods may include installing erosion control fabric and/or re-vegetating all disturbed areas with native vegetation or a sterile seed mix.
Noise	Machinery and equipment may cause sufficient noise levels to be considered a negative impact	Construction equipment could be specified for use between "reasonable" hours of operation, generally daylight hours. This will diminish the evening and night noises that interfere with diurnal wildlife, and eliminate impacts on nocturnal wildlife.

Table 11-5. Impacts to Human Activities during the Permanent Use of Aunu'u Wastewater System

Environmental Issues	Impacts	Possible Mitigation Measures
Agriculture Resources	A small area of planted coconut trees will be permanently removed from production	The area where the constructed treatment wetland will be constructed is in an area that is planted with a limited number of coconut trees. Following completion of the constructed wetland the upland perimeter of the site can be replanted in coconut trees.
Air Quality	There may be some odor problems at the landfill during cleaning of the sludge from the septic tanks.	The odor problem during sludge removal will be temporary but the activity will be permanent in that sludge removal and re-aeration of the drying beds will occur frequently.
Cultural Resources (Historical and Archaeological)	There will be no permanent negative impacts to historical and archaeological resources. More sites documenting cultural resources of American Samoa may be identified because of the project.	The SHPO and the ASPA Archaeological staff requirements for construction will maintain the integrity of any and all portions of the cultural resources negatively impacted by the project. SHPO and the ASPA Archaeological team will be able to document any sites that are in the collection gravity sewer pipe or the force main when they review the main and lateral collection and transmission pipeline routes. Any sites found during construction of the wastewater collection system will be mitigated before additional disturbance takes place.
Hydrology and Water Quality	There will not be any permanent change in hydrology and there should be permanent positive impacts on water quality.	Bid Specification requirements for Contractor prepared erosion control plan will include rehabilitation and restoration. Construction of the Aunu'u wastewater collection system will be a permanent positive effect on water quality. Water quality to ocean waters will improve as a result of the project as the ocean outfall on the reef will end only to be retained in case of an emergency bypass of the constructed marsh treatment system The project will place additional water of good quality into the Marsh and this water may be of higher quality than the existing Marsh water.
Recreation	There will be no permanent impacts to recreation	Swimming access to the Harbor will return to normal following the end of the project and shipping off-island of the construction equipment. Access to scenic viewpoint will be improved as the condition of the access roadway to the Marsh and Cove will be improved.
Public Services	There should be no permanent negative impact from completion of the project to public services	The completion of the project should not have an associated additional need for services with the exception of for ASPA itself. ASPA will need to add the maintenance for the Aunu'u wastewater system into their annual budget.

Table 11-6. Permanent Impacts to Physical and Biological Resources		
Environmental Issues	**Impacts**	**Example Mitigation Measures**
Habitat Interference (non-wetland)	Placement of the sludge drying beds and the constructed wetland treatment unit on the less-disturbed side of the island could result in permanent changes in flora/fauna community structure.	While the natural community structure of the crater side of the island is less disturbed than the village side, the crater has been impacted by ongoing agricultural activities as well as an operating landfill. The location of sludge drying beds at the existing landfill was selected to minimize additional impacts to wildlife. As necessary, facility operation (e.g., limited hours of operation) could be developed to further minimize impacts.
Hydrology and Water Quality	There are several potential long-term impacts effecting hydrology and water quality. As discussed in Table 11.4, soil disturbance during construction activities may result in increased sedimentation and erosion—especially in steep areas. Accelerated sedimentation and erosion could result in permanent hydrologic changes and water quality impacts. Groundwater contamination from the treatment wetland could also be a potential impact. Increased pollutant loading (pathogens, nutrients, BOD) to natural wetland or ocean, potential releases of hazardous materials , and the potential for nuisance conditions associated with mosquito breeding are all typical water quality impacts.	The project design should incorporate construction stormwater controls such as those discussed previously. The project design should also address final grading and incorporate drainage swales or other features that preserve natural site hydrology. Many potential water quality impacts could be avoided or minimized through appropriate design. For example, if necessary, the upper cells of the constructed wetland could be lined to prevent percolation of less highly treated effluent to groundwater. Other potential impacts could be minimized through plant operation and maintenance. For example, scheduled monitoring at wetland outfall and ocean outfall locations could guide implementation of operational changes and/or minor design changes to the constructed wetland. While, because of its small size relative to existing wetlands, the constructed wetland is not expected to contribute significantly to mosquito populations, mosquito-eating fish could be introduced into the constructed wetland.
Wetland Resources	Changes in the type, extent, and integrity of habitat may result from construction and operation of the treatment wetland. These changes could include the introduction of nuisance, exotic, or invasive species from the constructed wetland or changes in community structure due to nutrient inputs from the constructed wetland discharge.	Preliminary design incorporating an appropriately sized constructed treatment wetland preceded by conventional primary treatment is expected to result in minimal impact to the natural wetland. Selection of the point of discharge to the natural wetland at the southeast edge should also minimize disturbance to the wetland. The introduction of invasive and nuisance species can be avoided by using a native plant palette to seed the treatment wetland. Pre-design studies (Section 8) could be conducted to more precisely evaluate appropriate constructed wetland size and potential natural wetland impacts. Measures to reduce hydraulic loading via I/I reduction could further minimize impacts on the natural wetland.
Geology and Soils	No significant geological impacts are expected.	No permanent impacts are expected from construction or operation of the wetland treatment facilities.

11.3.1 Temporary and Permanent Environmental Issues

Temporary impacts during construction are typically a function of the type and duration of construction, and the type and sensitivity of the habitat in affected areas. Permanent impacts associated with the project are related to the design of the overall facility, the respective locations and operations of the various facilities components, and the irreversible allocation of resources to construct and operate the facility,

As part of pre-design development, specific elements were selected to avoid or minimize project-related impacts. Examples include:

- The force main will follow existing road alignment, thereby minimizing new disturbances.
- Upgrading the existing roadway will provide opportunity to regrade and rebank the road to minimize erosion caused by the current sub-standard road conditions.
- Primary and secondary treatment of wastewater prior to discharge to natural wetland will minimize impacts to thewetland.
- The location of primary treatment and sludge drying beds near the existing landfill, away from populated areas, will reduce odor impacts and minimize disturbance to natural areas.

Identification of sensitive environmental resources early in the design phase should enable a design team to avoid or minimize additional impacts to these resources; however, some project-related impacts are unavoidable. These unavoidable temporary and permanent impacts must be addressed through appropriate mitigation measures.

Construction activities are typically considered to have primarily short-term impacts. However, construction can alter natural drainage patterns and affect runoff water quality, resulting in long-term physical and biological impacts. Construction-related impacts can usually be mitigated through implementation of appropriate management practices and construction scheduling. Several manuals are available to assist in the development of construction management plans and to assist in the selection of appropriate construction best management practices (BMPs). Tables 11-4 and 11-5 describe the types of environmental factors related to temporary construction impacts with possible mitigation measures in each category. Many permanent impacts can be avoided or minimized through proper planning and design of the wastewater facilities. Those impacts that cannot be avoided or minimized may be mitigated through specific operation and maintenance measures. Tables 11-6 and 11-7 describe the possible impacts and present possible mitigation measures.

11.3.2 Social and Economic Environmental Effects

Social and economic effects of the Aunu'u wastewater project construction and permanent use are all considered beneficial (Table 11-7). Health and quality of life should be substantially improved as a result of the project. An examination of existing conditions in Section 3 of this report indicates that the exposure to harmful bacteria will reduced or eliminated as a result of the project because the ocean outfall flow will be removed from the coral reef removing the potential transport to the Aunu'u beaches. The water quality of the beaches adjacent to the village will improve and bacteria exceedances should be minimized.

Table 11-7. Social and Economic Effects

Health	Improved by Aunu'u wastewater project
Quality of Life	Improved by Aunu'u wastewater project
Environmental Justice	No negative issues associated with this project
Income	No negative issues associated with this project

The environmental issue of environmental justice should be a positive benefit as a result of this project. During the house-to-house survey the question was asked: "If improved wastewater treatment were provided would you have your house hooked up to it? The overwhelming response was yes, and then the predominant question asked was, "How soon will the sewer be stopped on the beach?"

The project will not have a direct effect on income in Aunu'u as wages are not involved from the standpoint of living in the villages. The project will result in certain number of construction jobs, and may result in a few more permanent ASPA workers. Providing improved wastewater treatment services to Aunu'u will improve the quality of life of people living in the Village but their homes will not increase in market value as a result of the project because ownership in the Samoan system is not explicitly tied to individual assets.

11.3.3 Cumulative Environmental Impacts/ Benefits

There are no cumulative impacts that can be identified that result directly from the project. ASPA will need to add maintenance of the new Aunu'u wastewater system to their annual budget. Many of the dwelling units in Aunu'u do not have the inside pipes and fixtures and some of the houses have no indoor plumbing for kitchens or bathrooms. In some cases outdoor showers have been built. In-home work will probably be the responsibility of the families that occupy the houses, and these costs will be incurred on a household basis. Maintenance of those fixtures and pipes will be necessary. Cumulative benefits that result from the project include improved quality of life for the residents and the removal of raw sewage impacts from the fringing reef biological community.

11.3.4 NEPA Required Environmental Issues

There are three categories of environmental issues that are expressly required for consideration by NEPA. These issues are as follows:

- The relationship between local short-term use's of man's environment and the maintenance and enhancement of long-term productivity,
- Irreversible and irretrievable commitments of resources, which would be involved in the proposed action, and
- Mandatory findings of significance.

This project will not have a negative impact on any of the above categories. The first issue addresses the short-term use of the environment as a tradeoff for the long-term enhancement of the environment. The Aunu'u wastewater project has a short-term disruption during construction as outlined in Tables 11-3 and 11-4, above. The result of this project is in the long-term improvement of the water quality and human health.

There are only a few irreversible and irretrievable commitments of resources associated with this project. The resources involved in the fabrication and use of materials involved in construction of the wastewater infrastructure are lost for use anywhere else. There are no natural or biological resources irreversibly and irretrievably committed by the project.

The mandatory findings of significance are worded slightly differently depending on the lead agency involved in the project. The example of mandatory findings can include the following questions that need to be answered in the environmental documentation:

a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of history or prehistory?

b) Does the project have impacts that are individually limited, but cumulatively considerable? "Cumulatively considerable" means that the project components have minor impacts but the project in the end culminates in negative impacts.

c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?

The selected alternative for the Aunu'u wastewater treatment system will not result in of the impacts listed above. The Aunu'u wastewater treatment system does not degrade the environment and will not cause the degradation or loss of any species. The project is positive towards the environment in that an untreated waste stream will be removed from a coral reef and sand swimming beach.

The Aunu'u wastewater treatment project does not entail cumulative negative effects. The Aunu'u wastewater project culminates in a constructed wetland treatment system that has beneficial impacts on the environment. Plants and animals present in the existing natural environment can use a constructed wetland system. Some constructed wetland treatment systems result in tertiary level of treatment of wastewater. After wetland treatment the water discharged to the Faimulivai Marsh will be generally cleaner than the existing Marsh waters, thereby enhancing water quality. As the water quality of the Marsh may be somewhat impaired at present the project will result in a net benefit. The project will result in environmental effects that will have substantial positive effects on human beings both directly and indirectly. The project will add two additional wastewater treatment levels (primary and secondary) over the present discharge of untreated wastewater to the reef and beach. The potential for disease causing bacteria will be removed from a recreational beach thereby improving the lives of people living in Aunu'u Village.

Section 12
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