

Civil and Environmental Engineering Senior Design Project

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ABSTRACT

Zamas is a rural community of 1,815 inhabitants located in the mountain area of Jayuya, Puerto Rico. Currently, the Zamas River provides the water that is consumed by the community. Since the water is not filtered and the disinfection is not adequate, it does not comply with the Safe Drinking Water Act (SDWA). The sewage generated at each housing unit is disposed either in septic tanks/cesspools or directly over the terrain. The solid wastes are handled biweekly by the Jayuya Municipality and disposed at the Jayuya sanitary landfill. The recycling materials are recovered weekly by the Recycling Center La Pica located in Jayuya, Puerto Rico. Several alternatives were analyzed to improve the water supply, wastewater and solid waste management systems. The selected options were: construction of a distribution tank (with chlorination system) and multi-media filter, septic tanks with double compartment and infiltrator chambers, an aerobic composting, a collection route, and designated containers for recyclable and compostable solid wastes. These are the most feasible options from an environmental, public health, sustainability, and economical perspective.

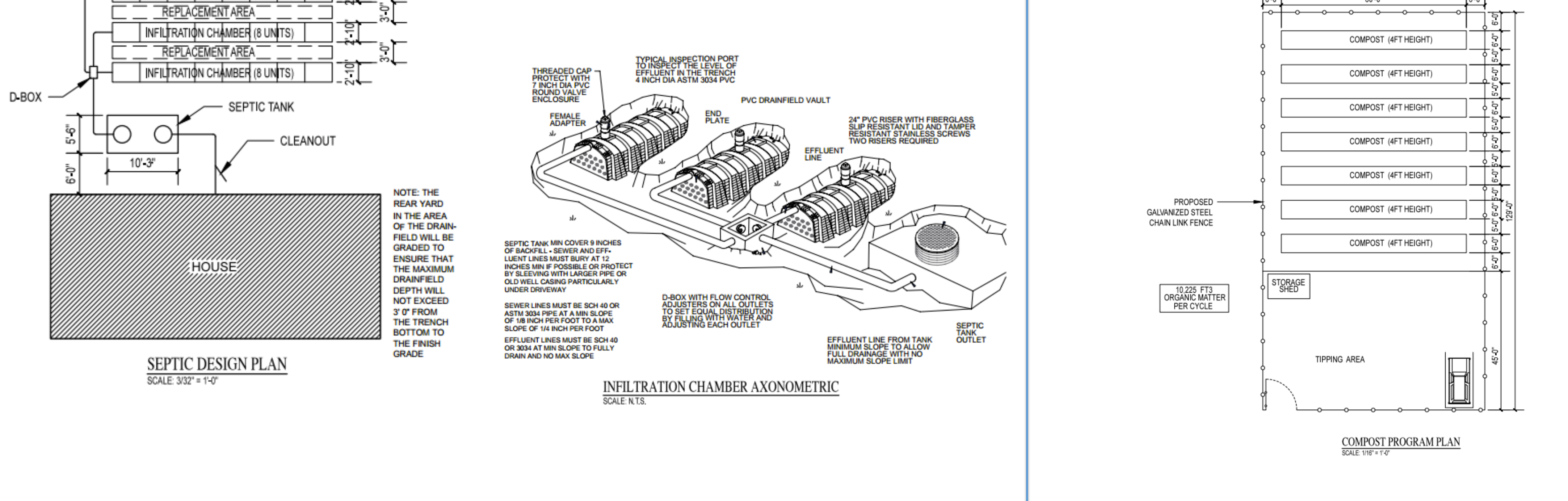
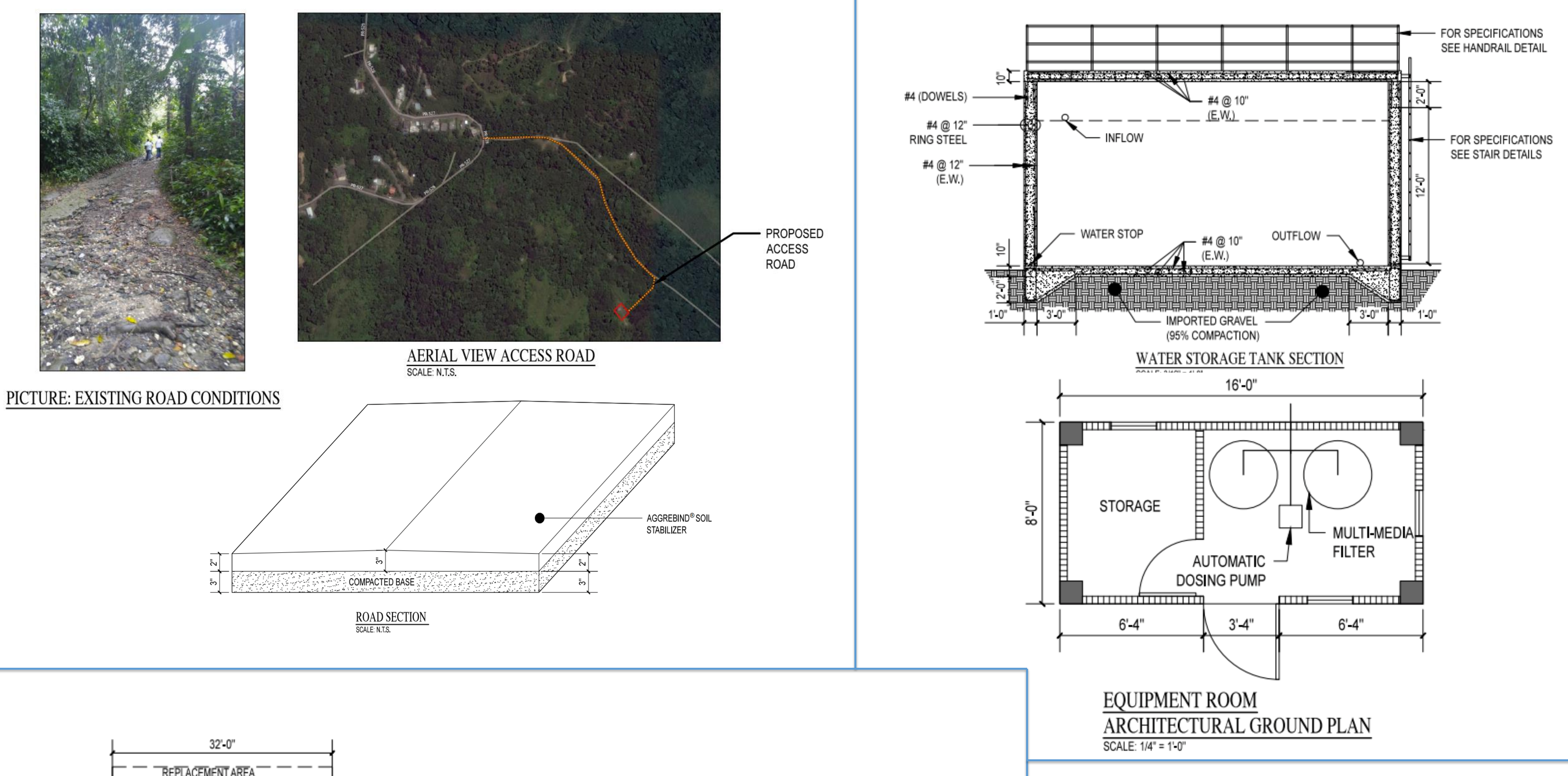
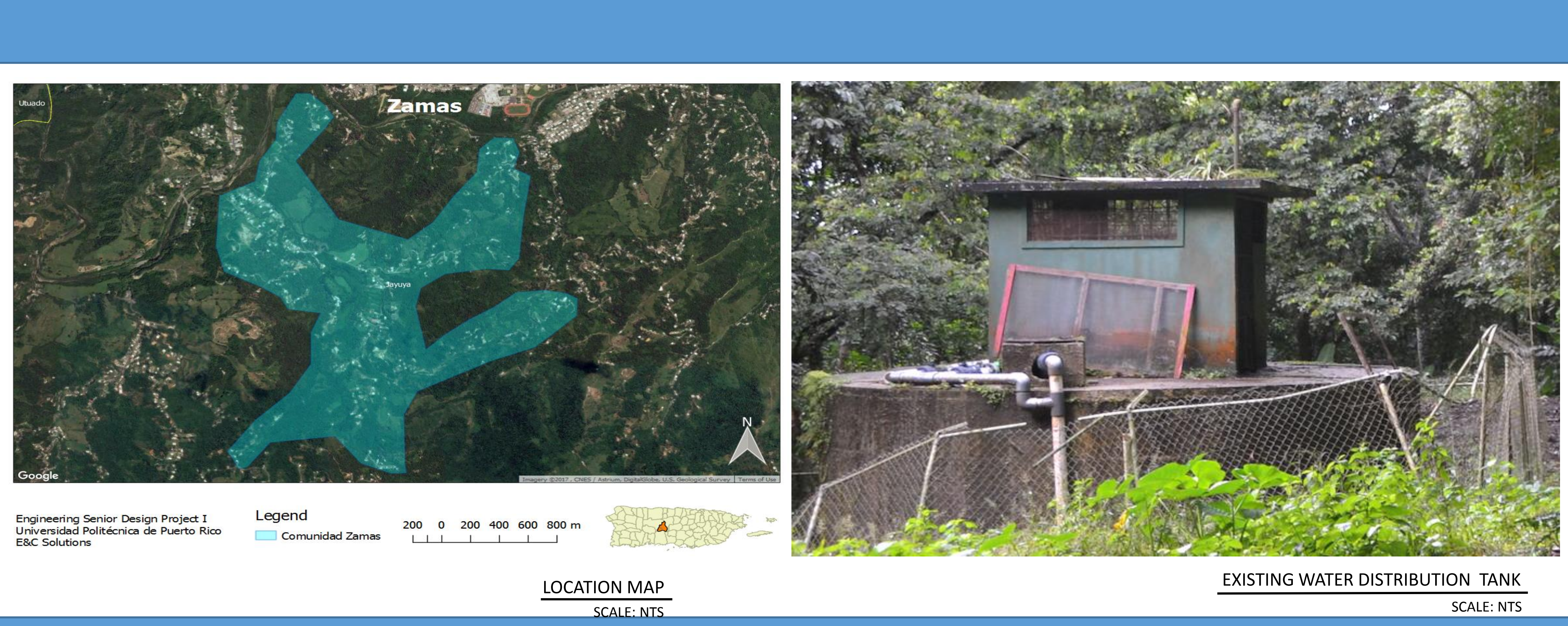
BACKGROUND

Zamas is a community composed of 363 rural housing units. A population growth analysis forecasted that the community will not increase in the next 25 years and its water peak hour demand will remain at 206,658 GPD. The current water source provides 589,091GPD. The existing water supply system does not comply with the SDWA drinking water standards. This was confirmed by the water quality data provided by the Puerto Rico Department of Health and by the sampling and analysis done during the study period. Therefore, a water quality improvement is needed in order to satisfy the regulatory parameters established by the Environmental Protection Agency (EPA).

According to a survey conducted at the community, each unit disposes its sewage either in septic tanks/cesspools or discharges over the adjacent terrain. These practices represent an environmental and public health risk. A solid waste production study indicated that in the next 25 years the community will continue to generate approximately 9,402 lb/day of garbage, which includes 3,290 lb/day of organic matter and 3,666 lb/day of recyclable materials. In order to reduce the amount of garbage that is conveyed to the Jayuya sanitary landfill, the diversion (by recycling and composting) of such material from the disposal landfill facility is recommended.

OBJECTIVES

- Improve the existing water supply system in order to comply with the SDWA,
 - upgrade the wastewater management system, and
 - develop an integrated solid waste management plan.
- To achieve these objectives the alternatives were evaluated taking into consideration the following factors: sustainability, feasibility of implementation / construction, health and safety, economical, social, and environmental aspects.



DESIGN PROCESS

Several alternatives were evaluated designed in order to improve the water supply, wastewater and solid waste management systems. Comparative tables and Leopold matrices were used to select the most feasible options. Final designs of the selected alternatives were done utilizing the:

- Puerto Rico Aqueduct and Sewer Authority Design Rules
- Environmental Protection Agency Manuals
- Puerto Rico environmental Quality Board Design Rules
- Puerto Rico Authority of Solid Wastes Guidelines
- American Concrete Institute Codes
- Portland Cement Association Design Manual
- American Society for Testing and Materials International Standards

FINAL DESIGN

Drinking Water: Due to the health risk of the existing water supply and distribution tank, a new distribution tank (with chlorination system) was designed for the community. Based on the Peak Hour Demand (PHD), a multi-media filter system was designed for the next 25 years. Considering the filtration rate of 35 gpm/ft³ the required surface area of the filter is 14 ft². The proposed distribution tank will be 14.8 ft. height with 27 ft. of diameter.

Wastewater: The suggested septic tank with double compartment and infiltrator chambers was designed following the EPA Underground Injection Control. The proposed septic tanks have a capacity of 1,212 GPD, with three infiltration chambers that includes eight infiltrators of 4 ft. each for a total length of 32 ft.

Solid Waste: The community will produce 10,255 ft³ of organic matter during a five-month composting production cycle. This amount was calculated considering a 5.18 lb/person of solid waste generation per day, and that 35% of the garbage is of organic origin. An area of 11,400 ft² is required for the aerobic composting.

CONCLUSION

The water quality of the existing system should be improved with the design. The septic tanks will provide sufficient volume to treat all wastewater generated at the houses of this community. The solid waste management program will be improved by the diversion of organic matter and recyclable materials to the landfill. These designs ensure that the drinking water will comply with the SDWA, and a reduction of the environmental impact caused by wastewater and solid wastes. The total cost of the alternatives is \$238,622.

ACKNOWLEDGEMENTS

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