



IMPROVEMENTS TO THE WATER SUPPLY, WASTEWATER DISPOSAL, AND SOLID WASTE MANAGEMENT SYSTEMS FOR LA MONTAÑA AND CERROTE COMMUNITIES, YAUCO, P.R.

Environmental Engineering and Civil Engineering Senior Design Project

MEMBERS

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ABSTRACT

Cerrote and La Montaña are two rural communities located in the mountain parts of Puerto Rico; with a total population of 242 inhabitants. Currently, two separate dams provide water that is consumed by the communities. The water does not comply with the Safe Drinking Water Act (SDWA) since it is not filtered. At Cerrote there is an ineffective disinfection system, while there is none at La Montaña. The sewage generated at each housing unit is disposed either in septic tanks/cesspools or directly over the terrain. The solid wastes are handled by the Yauco Municipality and disposed at the town sanitary landfill.

Several alternatives were analyzed in order to improve the water supply, wastewater, and solid waste management systems. The selected options were: a slow sand filter, two-chamber septic tanks with distribution box and percolation trenches, and a recycling program and an aerobic composting system. These are the most feasible options from an environmental, public health, sustainability, and economical perspective.

BACKGROUND

The two communities are composed of a total of 63 homes. A population growth analysis forecasted that the communities will not increase in the next 25 years and their water peak hour demand will remain at 27,225 GPD. The current water sources have the capacity to provide a total of 78,016 GPD. The water source of La Montaña provides 52,373 GPD of the total capacity.

The existing water supply systems do not comply with the SDWA drinking water standards in neither community. 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 communities, each home/commerce disposes its sewage either in septic tanks/cesspools or discharges over the adjacent terrain. These practices represent an environmental and public health risk.

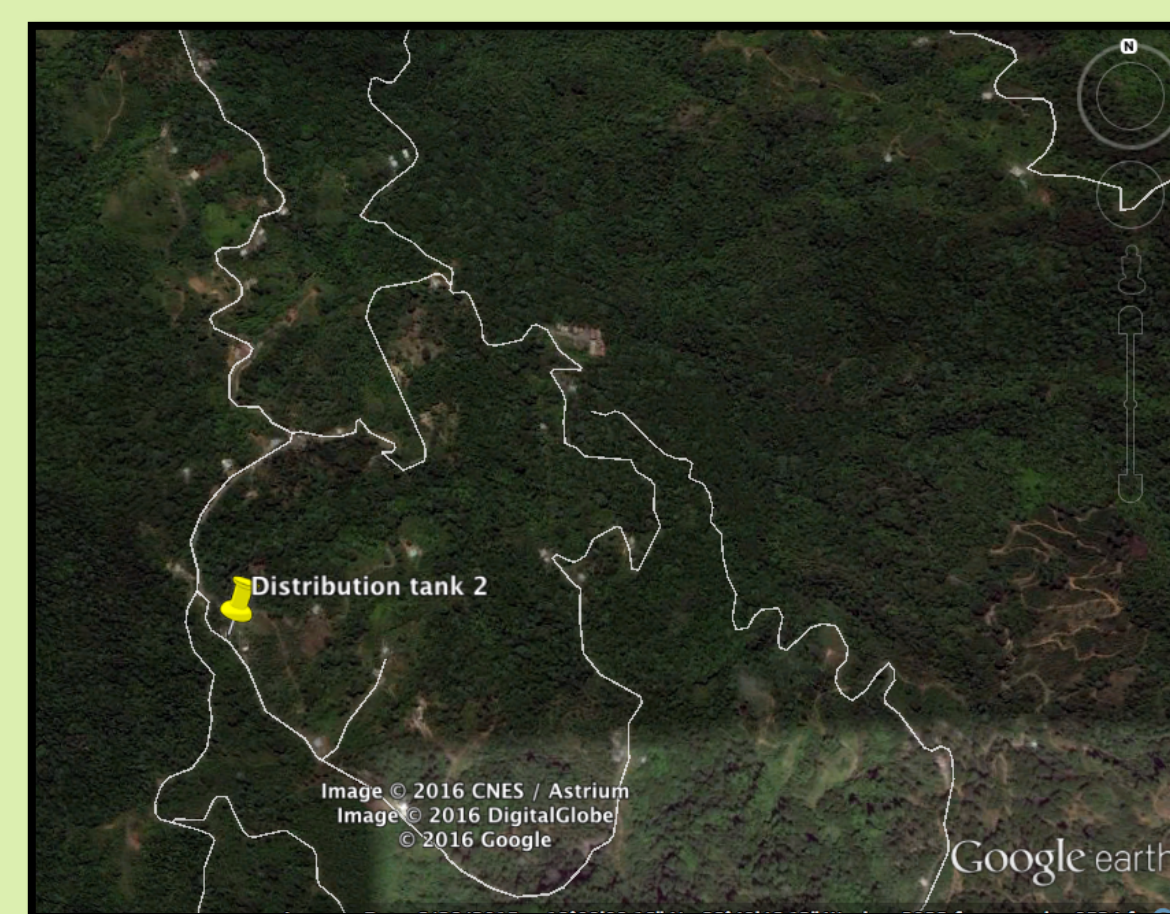
A solid waste production study indicated that in the next 25 years the communities would continue generating approximately 487 lb/day of garbage, which includes 175 lb/day of the organic matter (OM) and 172 lb/day of recyclable material. In order to reduce the amount of garbage that is conveyed to the Yauco sanitary landfill, the diversion (by recycling and composting) of such material from the disposal landfill facility is recommended.

OBJECTIVES

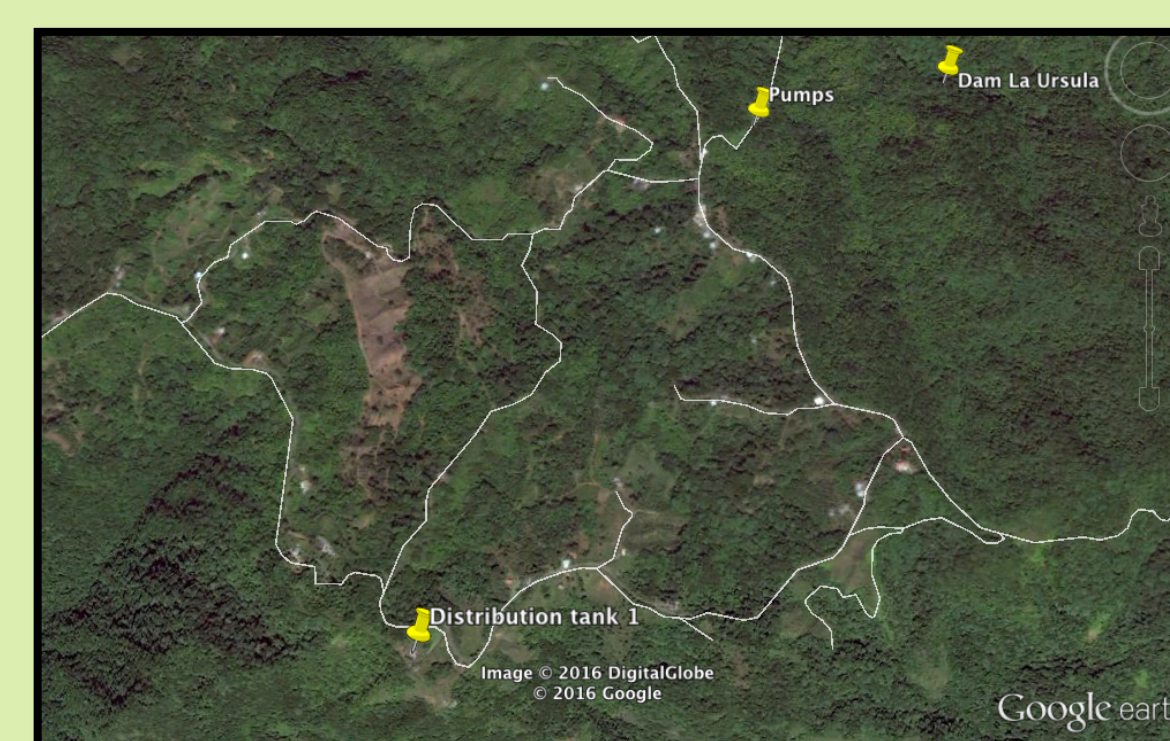
1. Improve the existing water supply system in order to comply with SDWA.
2. Upgrade the wastewater management system.
3. Develop an integrated solid waste management plan.



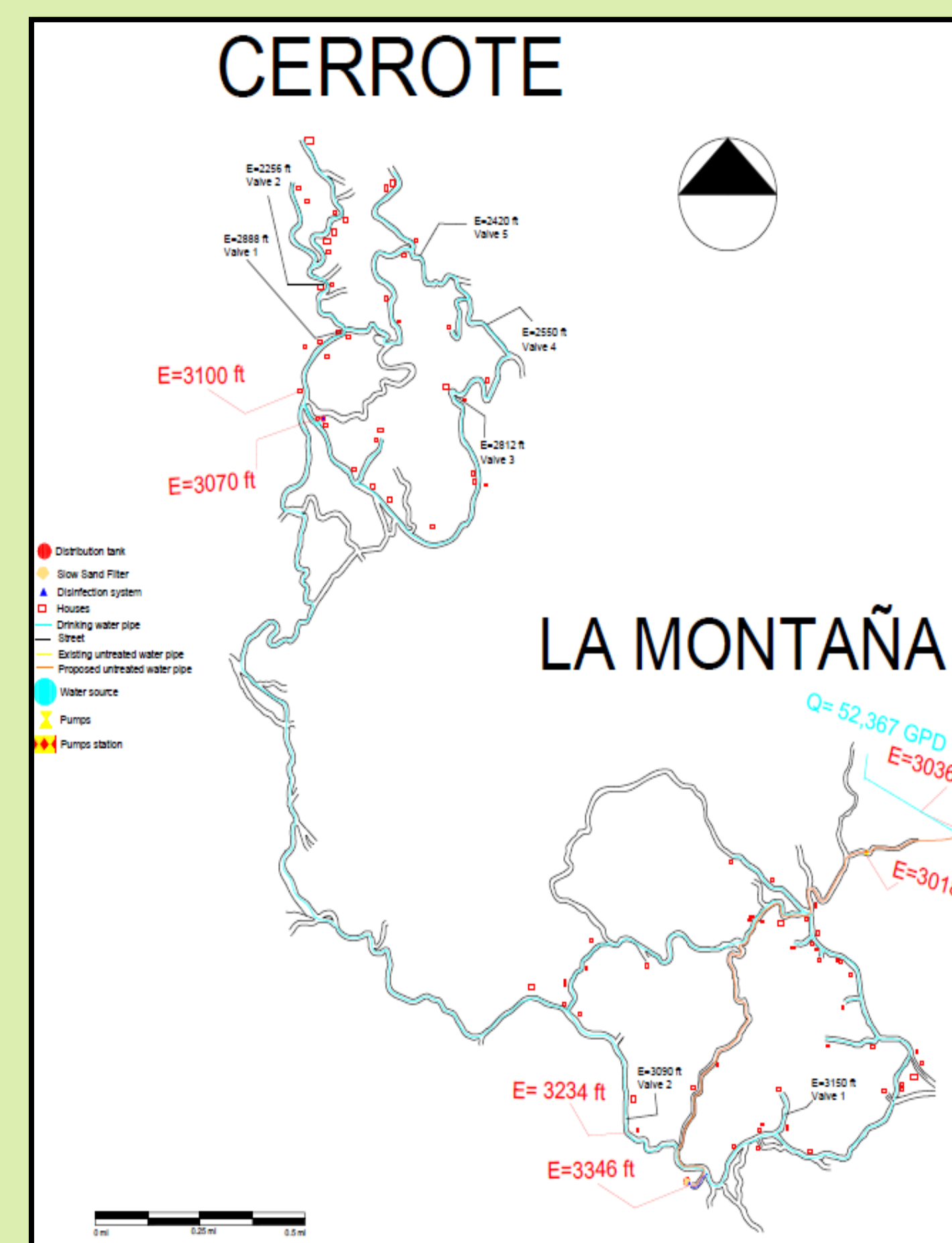
CERROTE



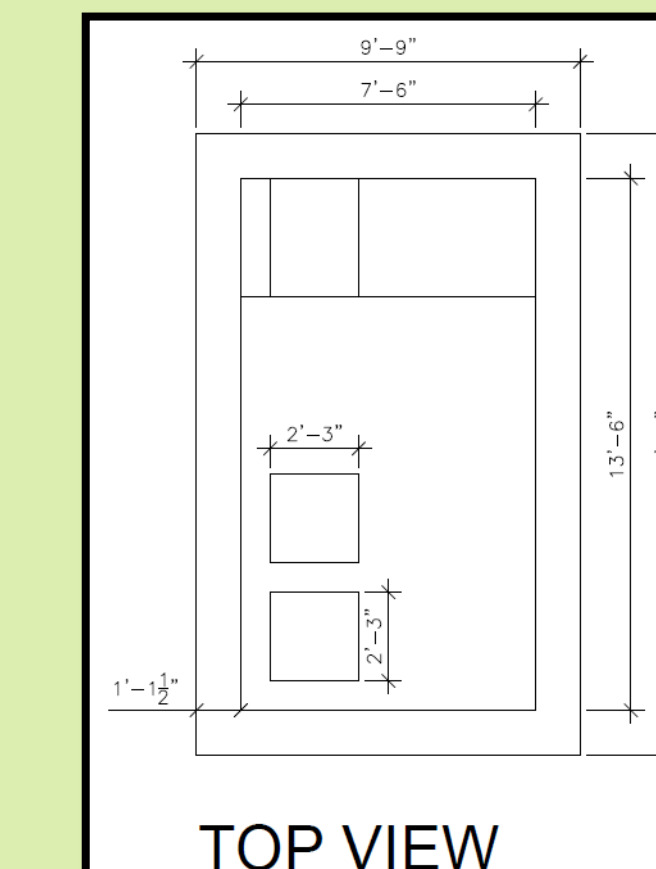
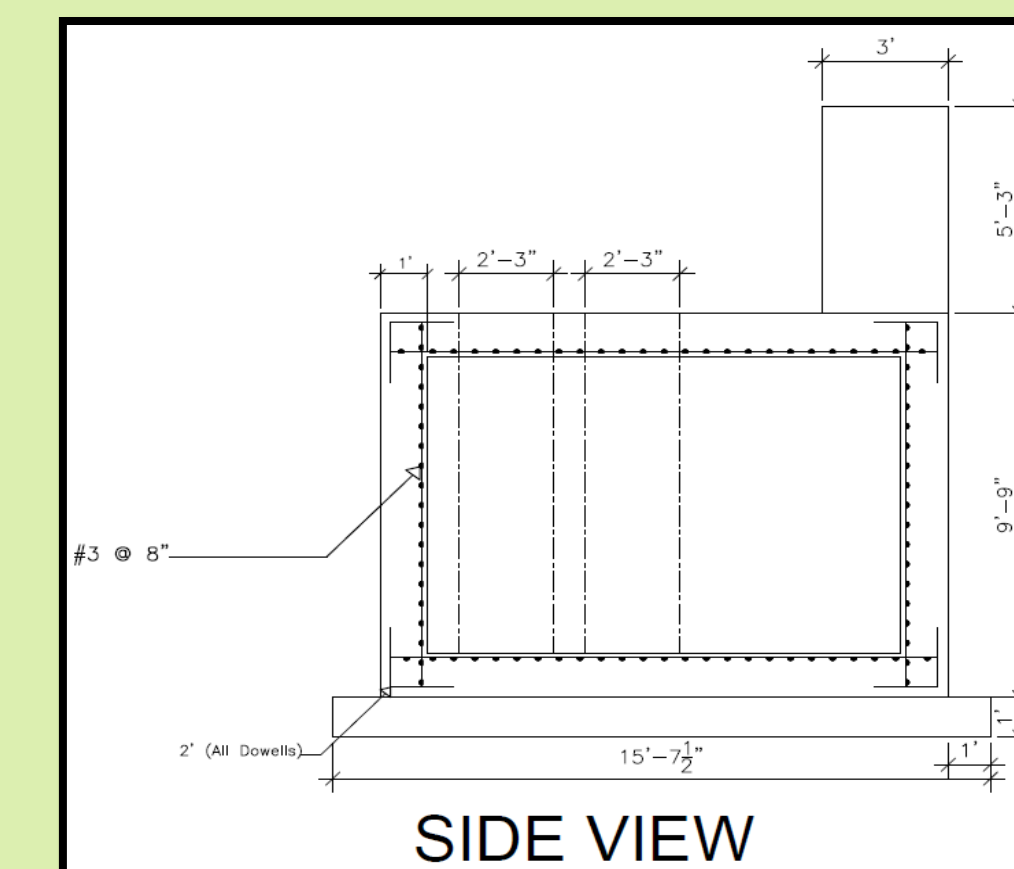
LA MONTAÑA



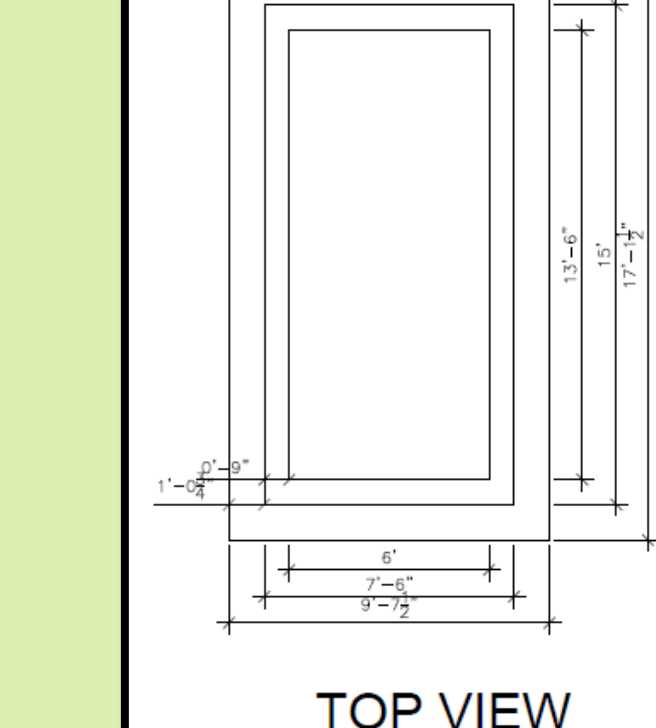
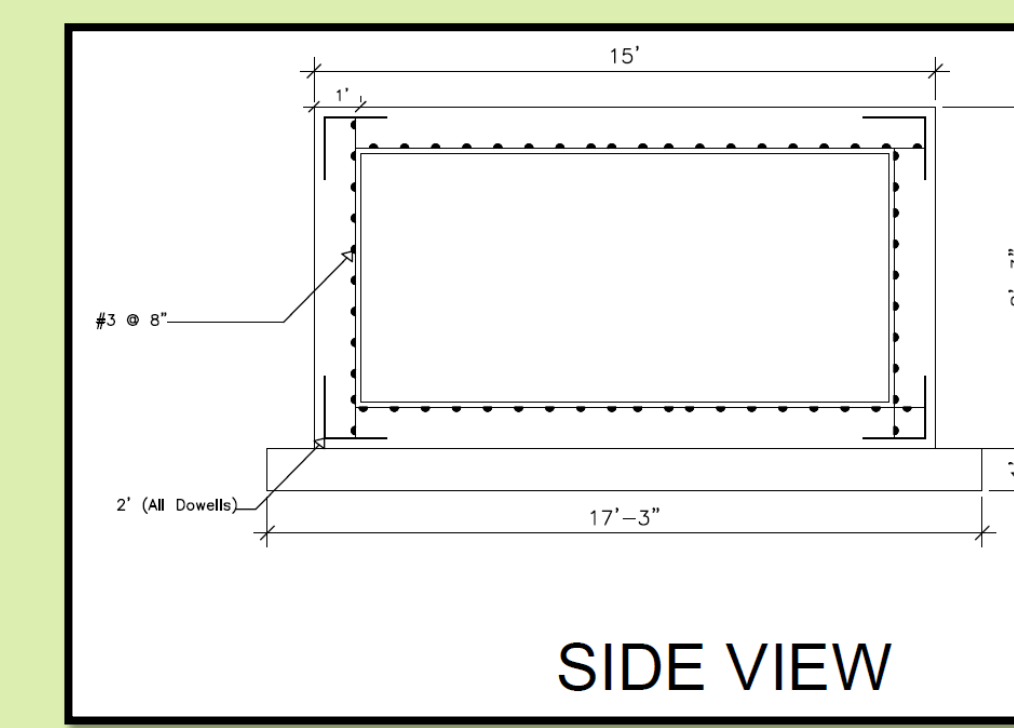
DRINKING WATER SYSTEM



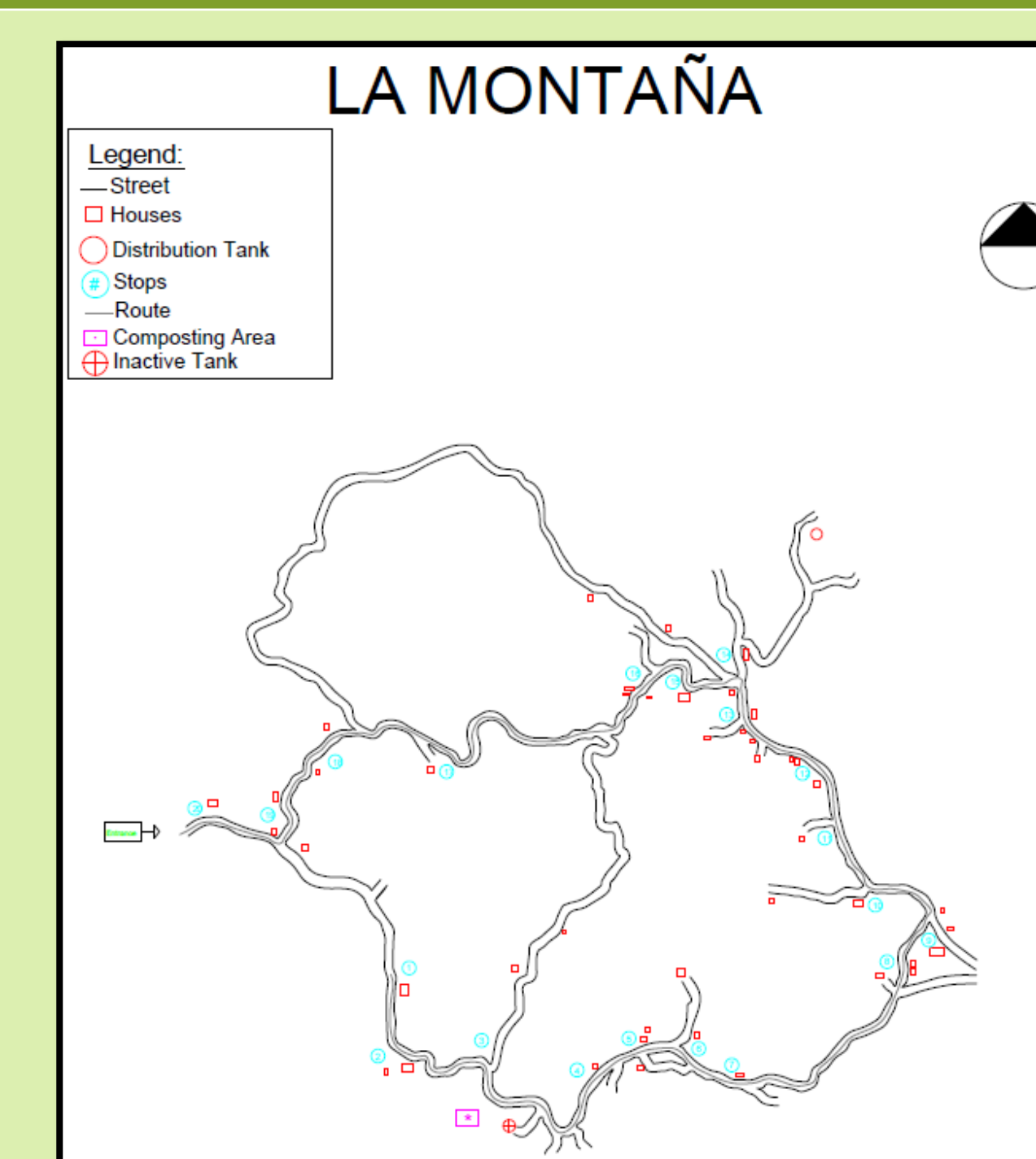
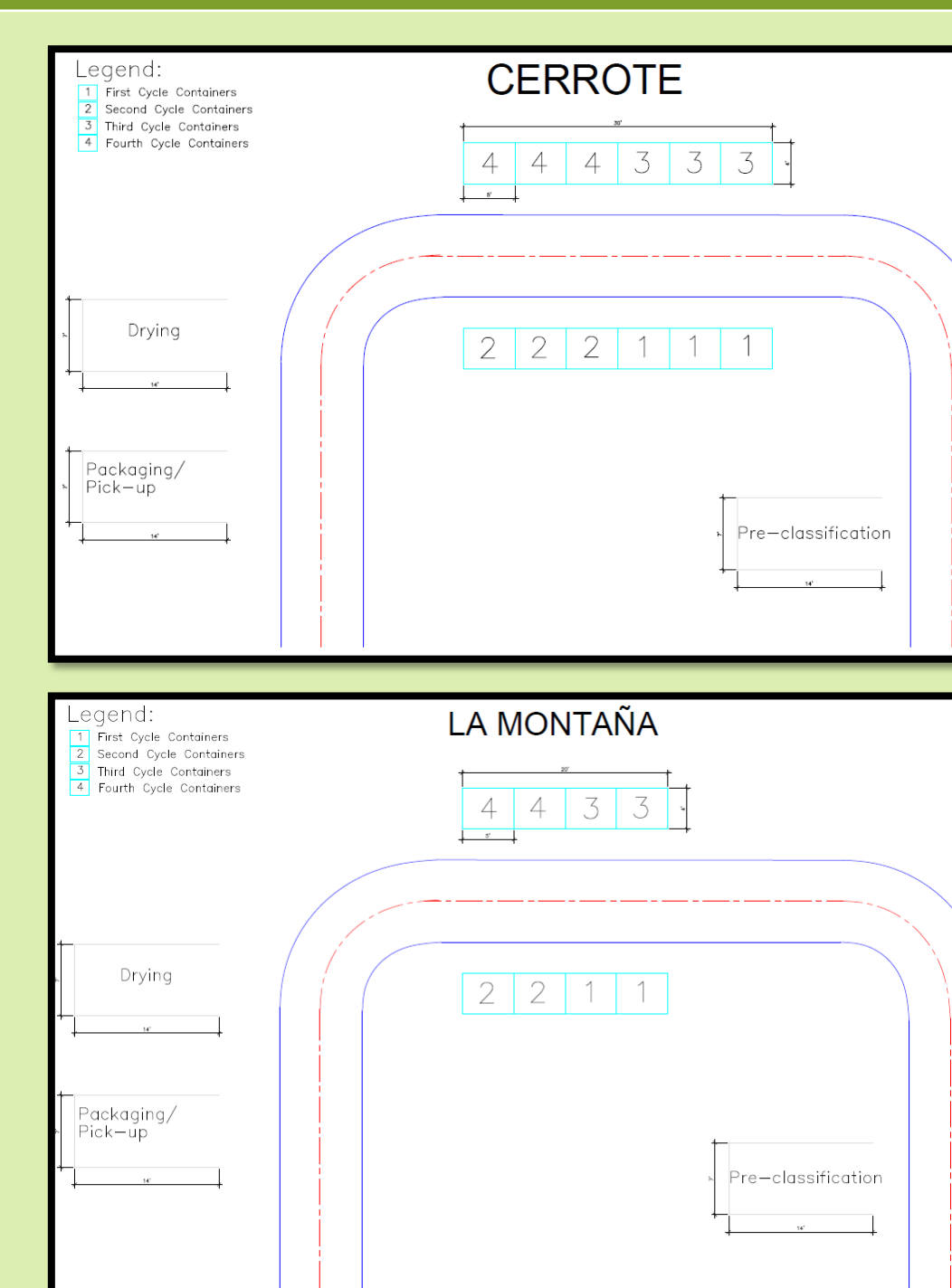
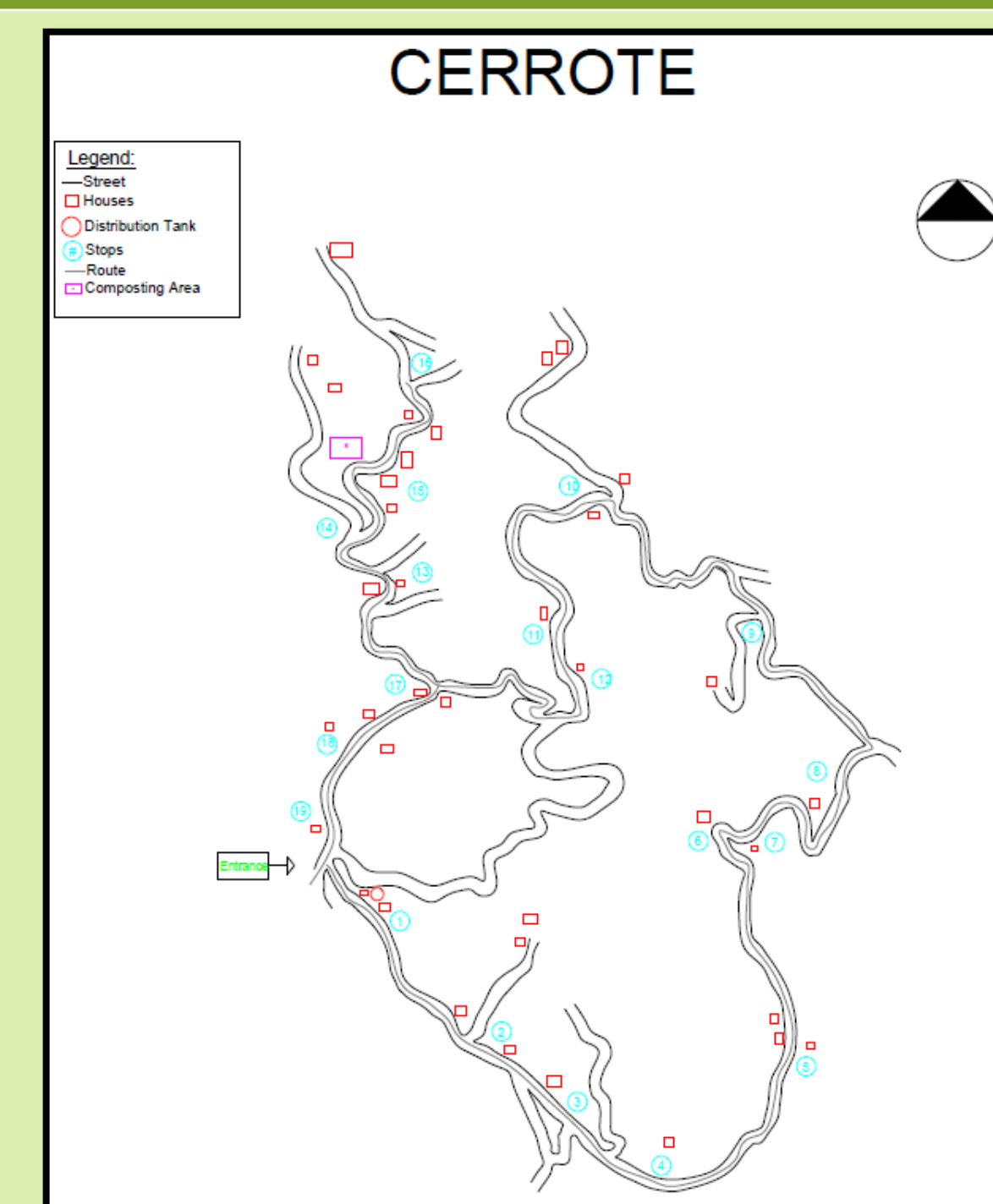
PUMPING STATION LA MONTAÑA



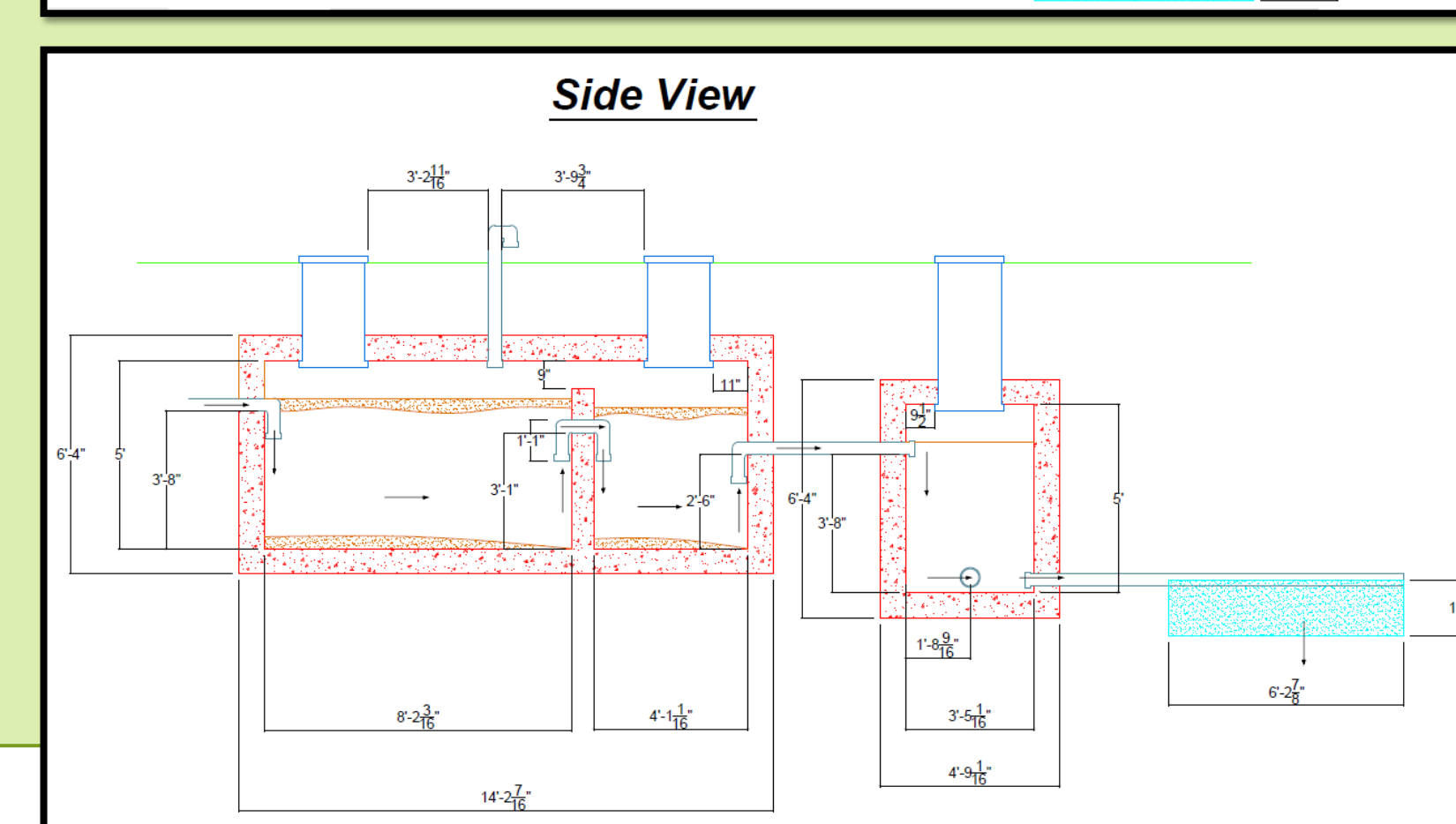
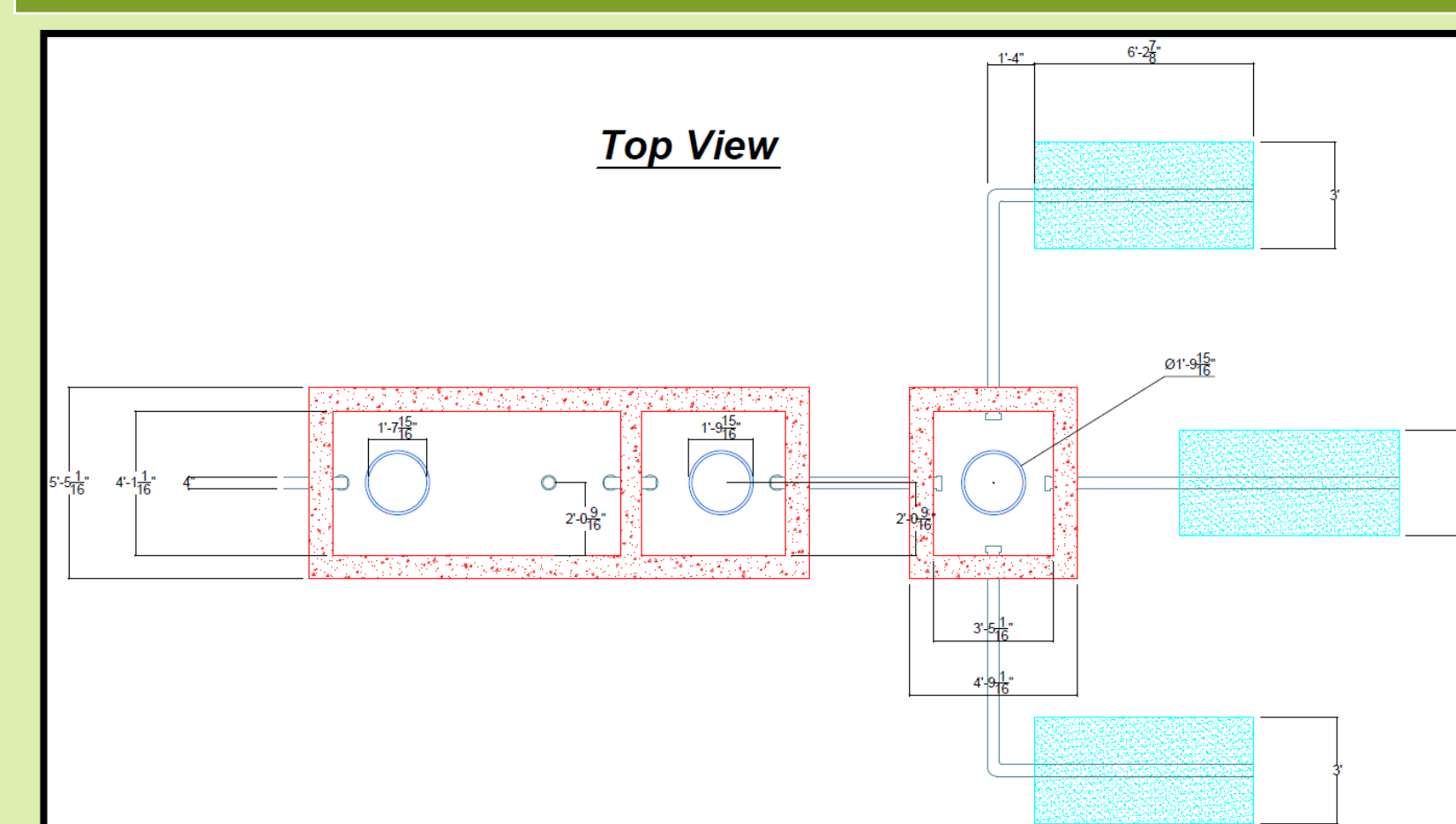
SAND FILTER



SOLID WASTE PROGRAM



SEPTIC TANKS



COST ESTIMATES

Cerrote		
Drinking Water	Wastewater	Solid Waste
\$124,661	\$68,099	\$14,425
Total Project Cost:		\$207,185

La Montaña		
Drinking Water	Wastewater	Solid Waste
\$124,661	\$54,479	\$12,780
Total Project Cost:		\$191,920

DESIGN PROCESS

Several alternatives were evaluated and preliminary designed in order to improve water supply, wastewater, and solid waste management systems. Comparative tables and Leopold matrices were used to select the most feasible options from an environmental, public health, sustainability, and economical perspective.

Final designs of the selected alternatives were done utilizing the:

- Puerto Rico Aqueduct and Sewer Authority Design Rules.
- Environmental Protection Agency Manuals.
- Environmental Quality Board of Puerto Rico 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:

Based on the Peak Hour Demand (PHD), the slow sand filter was designed for the next 25 years. Considering the water filtration rate of 0.15 m³/m²*h, the required surface area of the filter is 136.95 ft². Due to the difference of elevation between the distribution tank (3,356 ft) and the pumping station (3,145 ft), the horsepower needed for both pumps is 1 hp.

Wastewater:

The suggested septic tank was design following the EPA suggested bedroom-based- guidelines. Using both communities' population and the amount of houses, around three to four bed were estimated at each residence. Therefore, and on-site septic tank of at least 200.71 ft³ is required to handle all the domestic wastewater generated at each property.

Solid Waste:

Between both communities an estimated 209 ft³ will be produced during a 4-month composting production cycle. This amount was calculated considering a 2.01 lb/person of solid waste, at 70% compaction rate, generation per day and that density of organic and yard waste are 32.02 lb/ft³ and 14.14 lb/ft³, respectively. An area of 3,784 ft² is required for the aerobic composting system in each community.

Pump Tank at La Montaña		
Length	18.67	[ft]
Height	13.75	[ft]
Width	10.67	[ft]

Slow Sand Filter		
Length	20.33	[ft]
Height	11.00	[ft]
Width	10.33	[ft]

Septic Tank		
Length	14.25	[ft]
Height	6.33	[ft]
Width	5.42	[ft]

CONCLUSIONS

The existing water supply system and quality of the drinking water will be improved with the design. The new septic tanks will provide sufficient volume to treat all wastewater generated at the homes of the communities. The solid waste management program will be improved by the diversion of the OM and recyclable materials to the landfill. These alternatives were designed so that the water used by the communities may comply with the SDWA. The total costs of the project for both communities is approximately \$399,105 and would be divided between both communities.

ACKNOWLEDGMENTS

We wish to express our gratitude to our mentor, José Borrageros, for granting this opportunity and providing us with guidelines throughout the project. Also, we wish to express our gratitude to the communities leaders, Luis Perez and Daniel Malaver, for providing us with the required information of both communities.