

Abstract

The Centro Vacacional y Balneario de Boquerón (CVB) is recognized as a historically high demand publicly owned recreational facility. Throughout the years it has undergone a series of maintenance and compliance issues regarding its existing infrastructure. AVM Engineering considered different alternatives: i) to optimize the wastewater, stormwater, and solid waste management, ii) to refurbish the existing buildings and access roads, iii) to improve the night lightning and the erosion control, and iv) to provide a renewable energy source to its housing units. The selected options were subjected to in-depth analyses based on their environmental impact, viability, and underlying costs. Through these, the CVB may resume its operations providing a safe environment and an efficient functionality of its infrastructure to all visitors and guests.

Introduction

The CVB in Cabo Rojo, Figure 1 and Figure 2, began its services in 1966 with 158 cabins. Due to the demand, 40 villas were built by 1996, and 98 more villas were inaugurated in 2003. Today, the CVB remains closed due to the damages suffered by Hurricane María (2017), the 2020 seismic movements, and the lack of adequate maintenance to the existing infrastructure. The project provided by the Department of Natural and Environmental Resources (DRNA) to AVM Engineering, P.S.C. consisted of proposing improvements to the sewage pumping stations and the wastewater treatment plants (WWTP) of the CVB. Additionally, AVM Engineering has recommended improvements to the buildings, stormwater runoff management, access roads and parking lots, an integrated solid waste management program, turtle friendly night lighting, erosion control, and renewable energy.

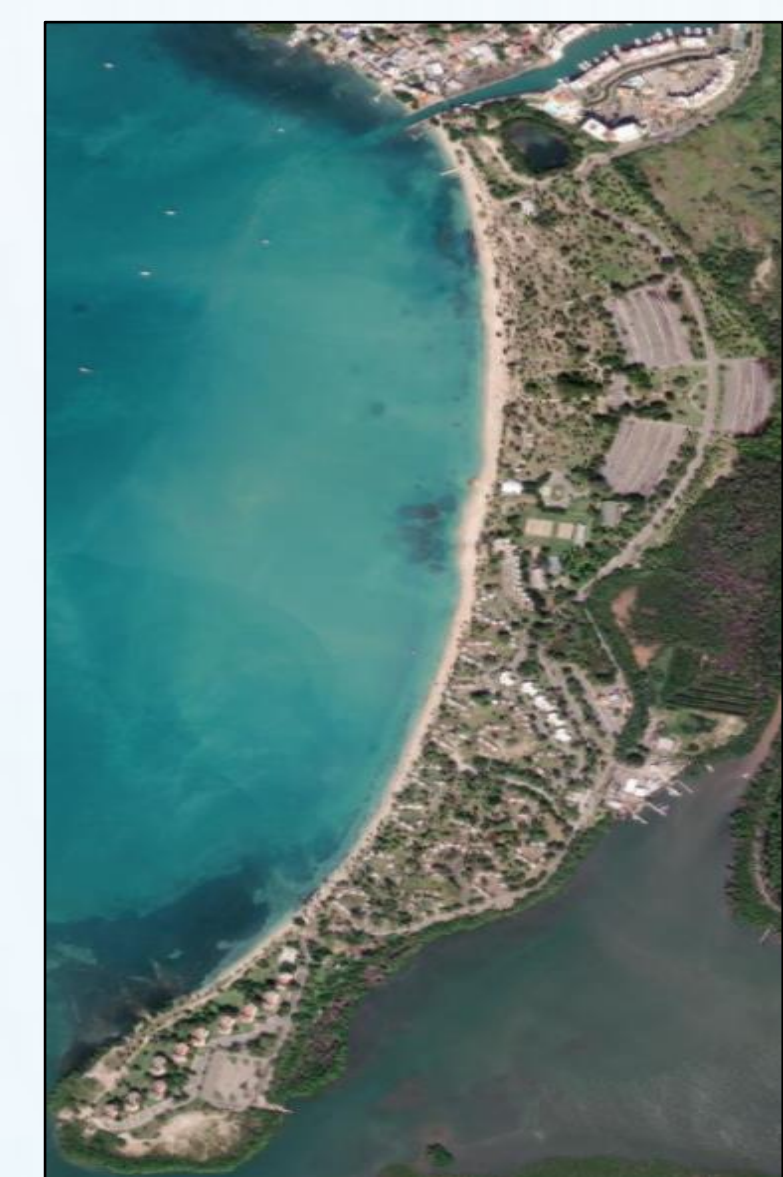


Figure 1: Aerial View of the CVB (1)



Figure 2: Aerial View of the CVB (2)

Objectives

The main objectives of AVM Engineering, P.S.C. for this project are to present possible solutions to a set of problems at the CVB and emphasize its redevelopment based on the alternatives considered. The topics of interest were centered on the following areas:

- Improvements to the wastewater management practices through the elimination or optimization of the two existing WWTP, and possible improvements to the sewage pumping stations.
- Improvement and optimization of different structural aspects of the existing infrastructure that show a lack of maintenance or that were damaged by the natural events of 2017 and 2020.
- Development of adequate stormwater runoff management practices.
- Improvements to the access roads and parking lots.
- Development of an integrated solid waste management program, including recycling and composting.
- Implementation of turtle friendly night lightning.
- Application of erosion control measures.
- Installation of renewable energy equipment.

Wastewater Management

Two secondary WWTP handle the sewage generated at the CVB and discharge their effluents to the Boquerón Lagoon, but their efficiency have been under par for years. Three alternatives were assessed by AVM Engineering to improve the current wastewater management: i) eliminate both WWTP providing a full connection of all sewage to the Puerto Rico Aqueducts and Sewer Authority (PRASA), via a new pressurized sanitary sewer system, ii) eliminate the Northern WWTP and reuse the wastewater effluent from the Southern WWTP for irrigation practices, and iii) refurbishing of both WWTP to continue discharging their effluents to the Boquerón Lagoon. The preferred alternative, due to the long-term economical savings and environmental benefits, is the first one in which all sewage will be conveyed towards PRASA Lajas WWTP. Additionally, improvements to the three existing wastewater pumping stations have been proposed. Figure 3, Figure 4, and Figure 5 show the proposed sanitary force line and the improvements considered for the pumping stations.



Figure 3: Proposed sanitary force line to connect the CVB to PRASA

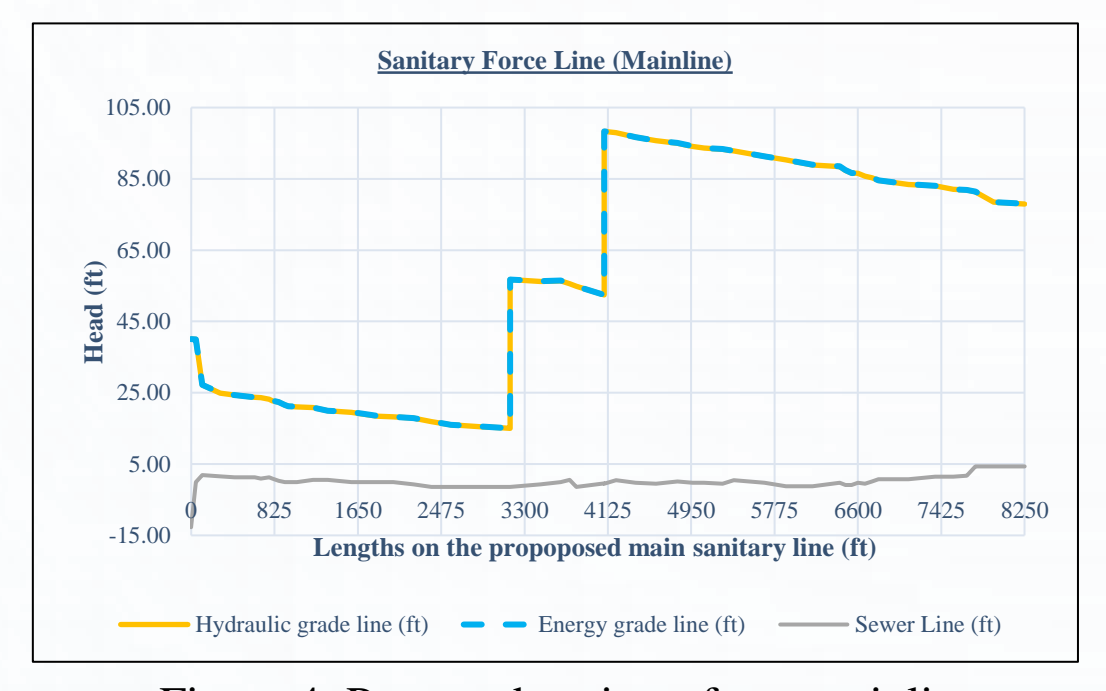


Figure 4: Proposed sanitary force mainline

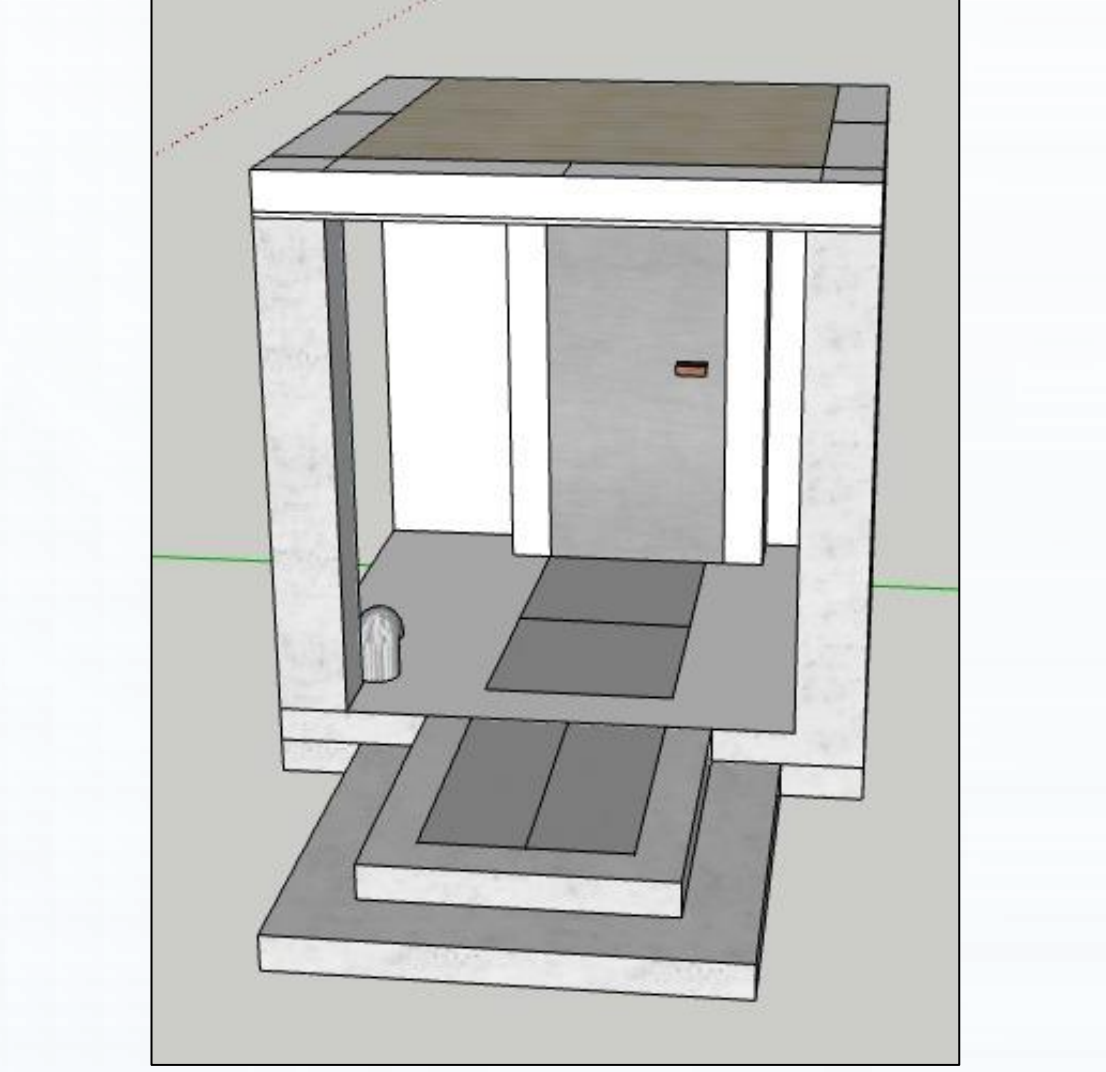


Figure 5: Proposed improvements to the sewage pumping stations

Improvements to the Existing Buildings

The improvements considers the revitalization of all administrative, sports and recreation facilities, short term rental housing units, and other minor structures that were damaged due to the 2017 hurricane. Since then, the CVB has been closed for guests and only operates the administrative buildings, the parking lot facilities, and the boat ramp. Other improvements to the structures contemplate the conditioning of concrete columns failures at the Bathroom Building, Villas II, and other minor improvement details due to the 2020 seismic events. The alternative presented by the AVM Engineering team propose the replacement and reconditioning of roof panels, roofing elastomeric coatings, interior and exterior paint, façade plastering, windows seals, wood and chain link fences, among other maintenance program activities as well, as it is shown in Figure 6.



Figure 6: Existing villas and cabins to be refurbished

Erosion Control

The erosion of the sand dunes at the CVB beach has been affected through the years due to the coastal reduction occurrence by natural events like hurricanes and earthquakes. Some of the CVB cabins are conflicting with the formation of the sand dunes. It is known that the purpose of the erosion sand dunes is to act as a natural barrier to protect the land from floods. Therefore, the implementation of several native species of flora that works as a reinforcement for the existing sand dunes in the area, has been proposed by AVM Engineering. The selected flora will cover an affected area of 4,111 square feet of land with plants like button mangrove (*conocarpus erectus*), guayacán (*guaiacum officinale*), icaco (*chrysobalanus icaco*), borbón (*scaevola plumieri*), and other flora.

Pavements Design

AVM Engineering has designed new pavement structures for the main roads and the beach front access roads, as they are presented in Figure 7. The main asphalt road will comply with Average Annual Daily Traffic (AADT) measures taken from local road PR-101 and will maintain a serviceability index for as long as 25 years. The depth of the new pavement structure will consist of a 10.5-inch asphalt bituminous road thickness overall. For the beach front access roads, a permeable pavement solution will offer safety and serviceability. The technology offered by a local supplier will consist of a concrete brick layering pavement that allows water filtration through the material joint sections. This will let water to infiltrate to the stormwater collection system that will discharge into the stormwater gardens that have been proposed to be placed at different locations of the CVB.

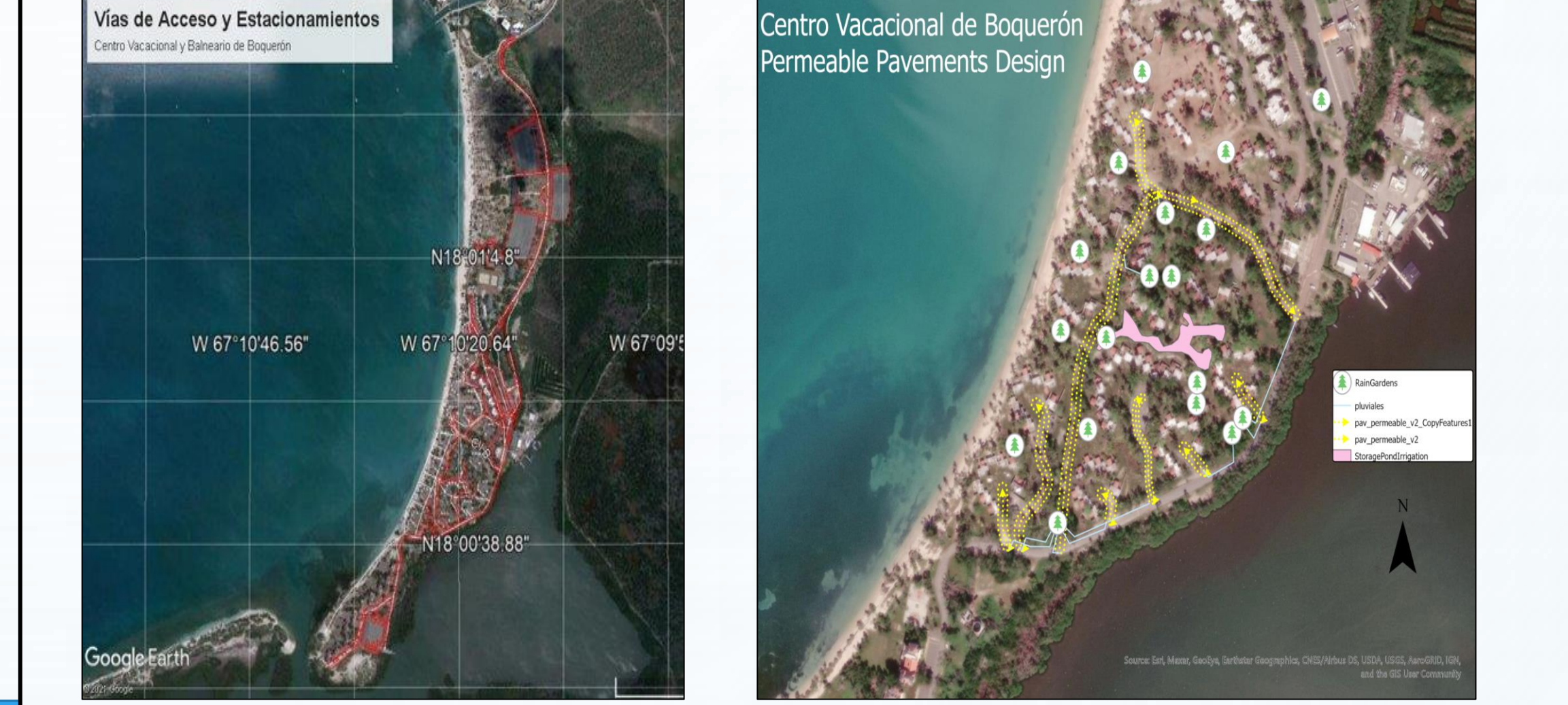


Figure 7: Asphalt roads to be paved and proposed permeable pavement areas

Solid Waste Management

Puerto Rico is known to generate approximately six pounds per day per capita of solid waste. This causes a major problem with the capacity of the existing sanitary landfills. The AVM Engineering team proposed the initiation of a compost program and the reactivation and expansion of the previous recycling program for better management of the solid waste generated at the CVB and to create profits. The compost program will implement either compost greenhouses or outdoor compost containers with an estimated annual generation of 25,800 pounds of compostable material, leading to an annual profit of USD 2,008. The reactivation of the recycling program by creating new recycling stations for all the housing units, cabins, and villas. The CVB will gather around 100,800 pounds per month of recyclable material, that can lead to an annual profit of USD 13,968. Figure 8 shows the proposed designs.

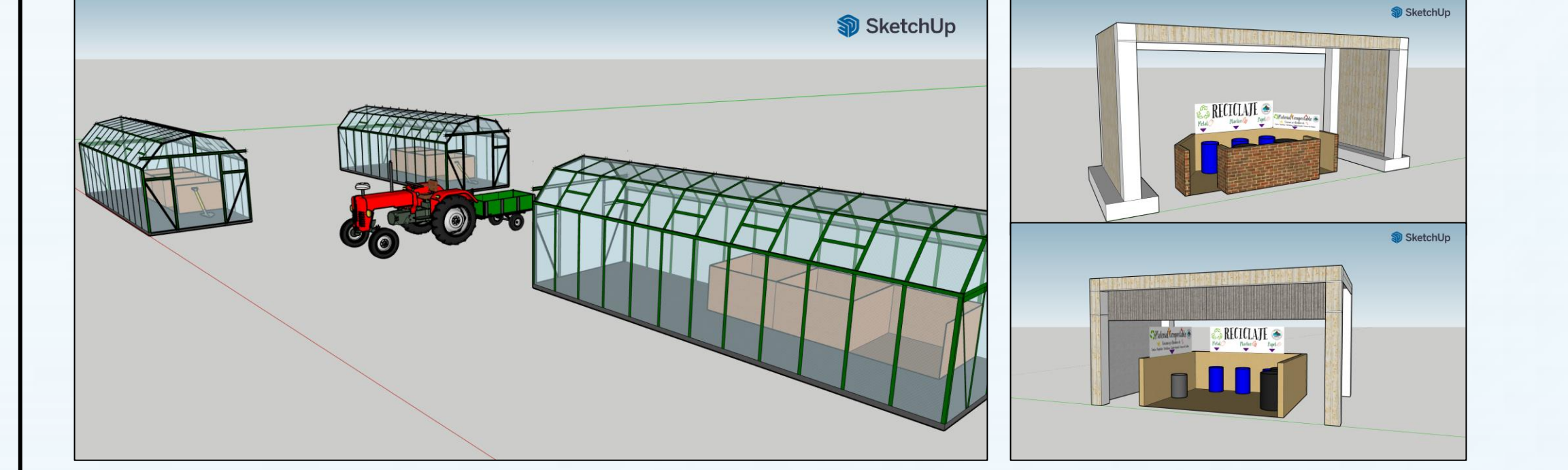


Figure 8: Proposed structures for the compost and recycling programs

Night Lighting

The beach at the CVB has a total of 18 luminaries for the benefit of the public and its security. However, due the aftermath of Hurricane María, the wiring of the luminaries was affected and removed. The beach is known for receiving the visit of endangered species like the leatherback sea turtle for nesting purposes. The AVM Engineering team proposes the replacement of all existing and damaged luminaries with solar energy luminaries with certified turtle friendly amber led lights. By implementing this alternative, the beach will have the corresponding night lighting, for security measures, without affecting the ecosystem of the endangered species.

Stormwater Management

Currently, the CVB uses retention ponds for most of the runoff management in the cabin areas, but these have shown to be ineffective due to their lack of infiltration capacity which in turns causes stormwater to stagnate. Additionally, other areas lack an adequate management of the stormwater runoff. The alternatives evaluated by AVM Engineering for the improvement of the stormwater runoff management were: i) collection of rainwater of the roofs of the cabins and its storage in rain barrels for cleaning and other maintenance uses, and ii) implementation of rain gardens throughout the CVB. The second alternative was selected based on its ecological benefit and its relatively low cost. The proposed rain garden design is shown in Figure 9.



Figure 9: Proposed rain garden design

Renewable Energy

AVM Engineering proposes the installation of photovoltaic panels on the CVB cabins as a renewable energy alternative. Photovoltaic solar energy transforms solar radiation into electricity and uses a system of panels that can vary from small systems to large power plants. The application of the photovoltaic solar panels will be very useful since the study area is located in a region with high photovoltaic power potential. Based on a preliminary load census, each cabin has an electrical consumption of approximately 7 kW.

Conclusion

This project will heighten the quality of the CVB through the development and application of the recommended alternatives for the optimization of wastewater, stormwater, and solid waste management, as well as the refurbishing of the existing buildings and access roads. In addition, other improvements such as night lightning, erosion control, and renewable energy have been suggested. Taking in consideration the selected alternatives, the project has a total estimated cost of USD 18,620,000.

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