AQUEDUCT SYSTEM FOR THE COMMUNITY OF BAJO GAVILAN, PANAMA

Introduction

In August 2014, Team Reasonable Engineering participated in the international senior design program (iDesign) at Michigan Technological University and traveled to Panama. The project site is the village of Bajo Gavilan, a small, rural, and indigenous community in the Bocas del Toro province of Panama.

Figure 1. Map of Panama, with the location of Bajo Gavilan.

The community is geographically split into three sections. Currently, sections 2 and 3 have access to an existing aqueduct while section 1 does not. Section 1 includes 50 residents and the community schoolhouse.

Objectives

This project focused on designing a gravity-fed water distribution for section 1 of the community. The objectives of this project were: (1) evaluate the feasibility of a new spring source and proposed aqueduct route and (2) model and design the proposed aqueduct system.

Methods

Water Supply:

- Flow rate: The flow rate of the spring source was determined by creating a makeshift weir (Figure 2) and using the volume-time method.
- Water quality: The water quality of the spring source and other locations in the community were tested using 3M Petrifilms.

Figure 2. Testing water quality at the spring source.

Aqueduct Route: A topographical survey was performed using a rangefinder, GPS, abney level, and measuring tape (Figure 3).

Water Demand: The water demand for the section 1 of the community was calculated based on the number of residents and average daily use.

Data Analysis: The system was modeled in two water distribution programs: EPANET and Neatwork.

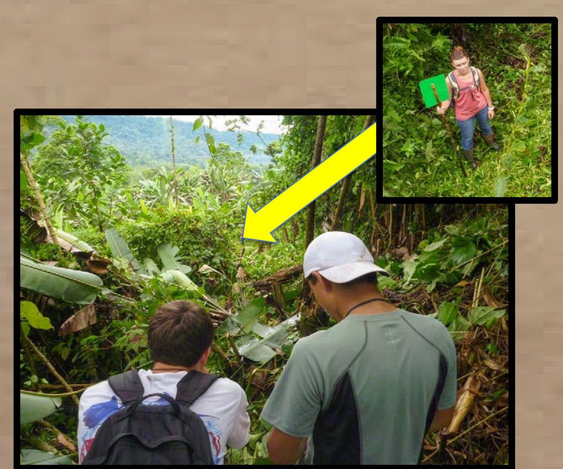

Figure 3. Surveying the route with rangefinder and GPS.

Results

Water Supply and Demand:

- Flow rate: The flow rate of the spring source was determined to be 6.9 gpm, sufficiently above the calculated demand of 2.05 gpm for section 1.
- Water Quality: The water quality of the spring source was found to be acceptable, with very little to no presence of coliforms.

Aqueduct Route: A total of 118 waypoints were recorded to develop a route, about 1.77 miles in length (Figures 4 and 5). The elevation profile is provided in Figure 6.

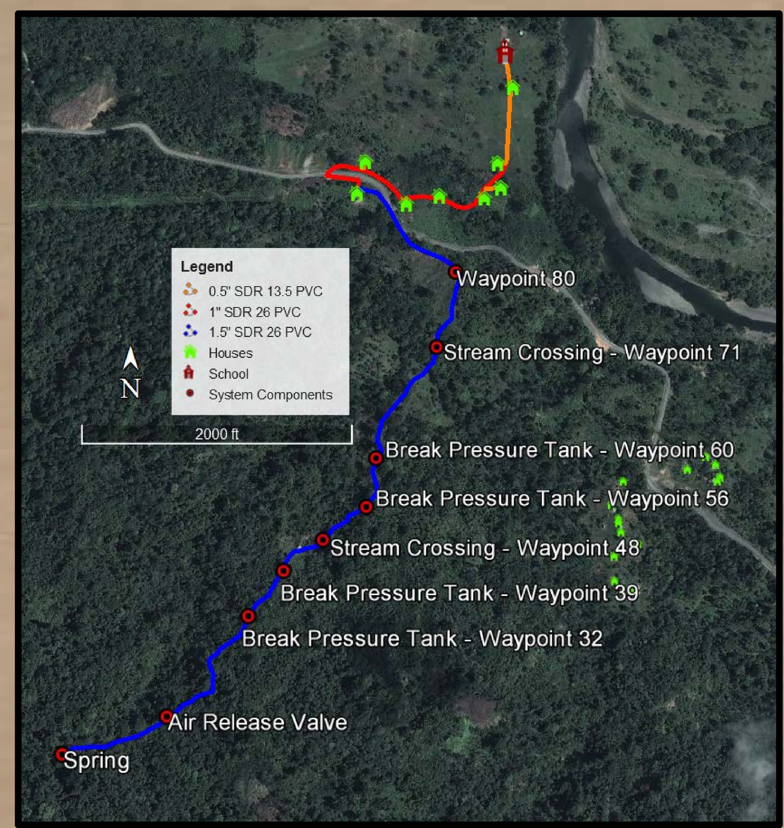

Figure 4. Survey and aqueduct route with Locations of system components.

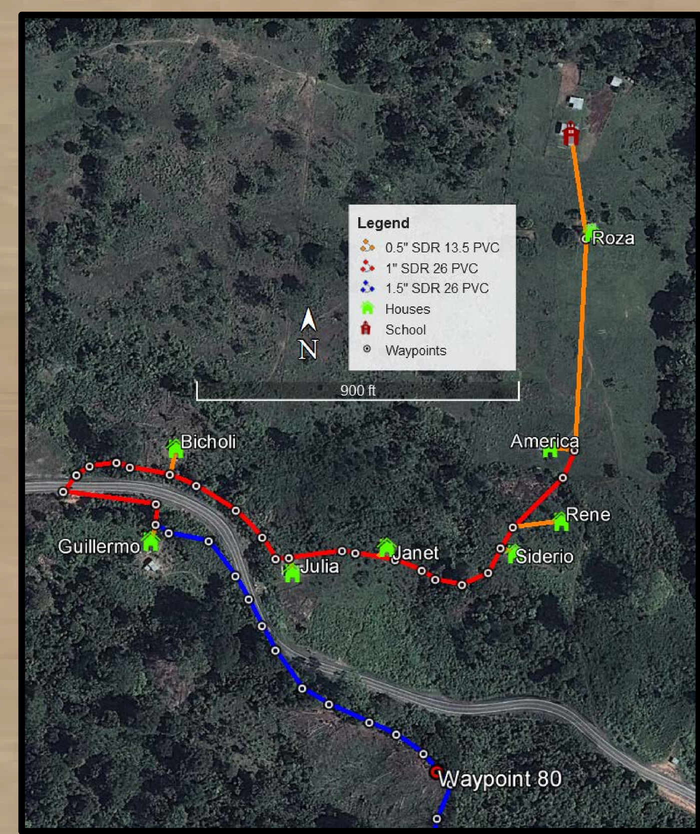

Figure 5. Aqueduct route in section 1 with designed pipe diameters.

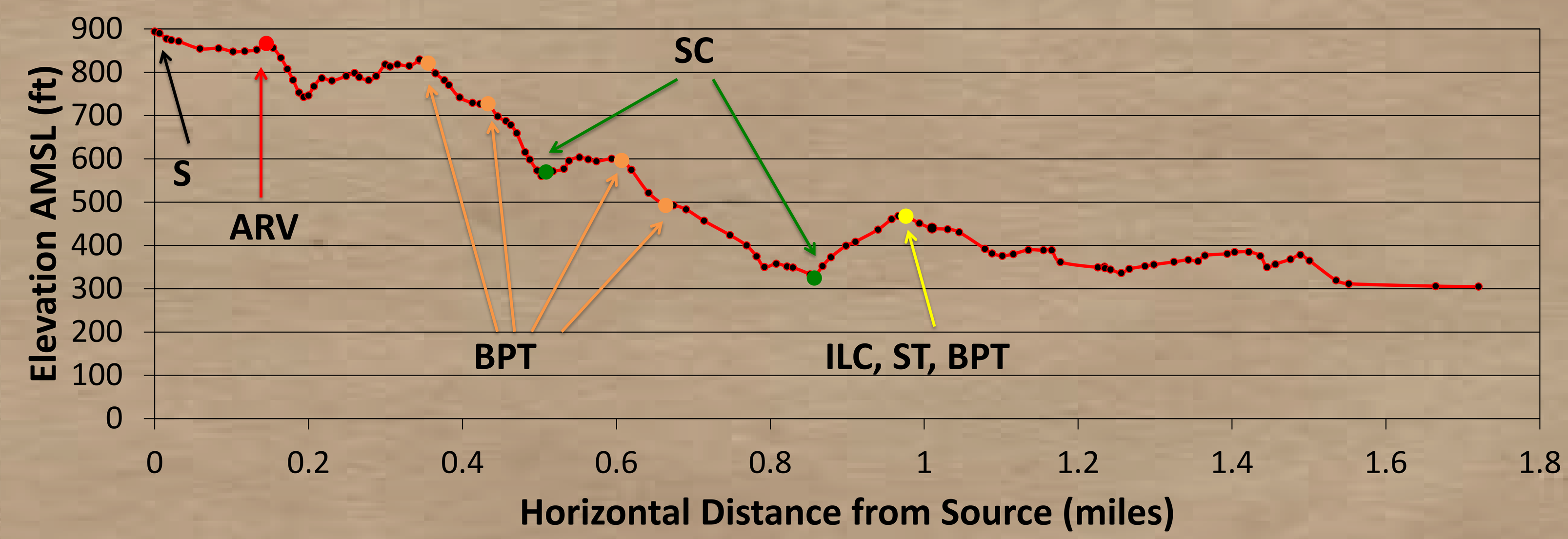

Figure 6. Elevation profile of survey and proposed aqueduct route with system components. S=source, SC=stream crossing, ARV=air release valve, BPT=break pressure tank, ILC=in-line chlorinator, and ST=storage tank.

Proposed Design

Major Components:

- Water Collection: A low-profile spring box should be constructed at the spring source to collect water.
- Water Conveyance: The main aqueduct line will convey water from the spring source to section 1. The aqueduct should be buried about 1.5' underground to protect the pipeline from sunlight and human traffic. Pipe diameter will mainly be 1.5", with exceptions shown in Figure 5.
- Water Access: A tapstand will be provided for each house in section 1 of the community.

Figure 6. Example of trenched aqueduct prior to backfilling.

Proposed Design

System Components: Various components are necessary for the system. The locations for the following components are shown in Figure 4.

- Air Release Valve (Figure 7): One air release valve is required at Waypoint 11, to prevent air blocks which could stop water flow.
- Stream Crossings (Figure 8): The PVC aqueduct will switch to galvanized iron and be buried 2' beneath streams and anchored on each end.
- Break Pressure Tanks (Figures 9 and 10): Break pressure tanks are needed to reduce pipe pressure and prevent pipe failure.

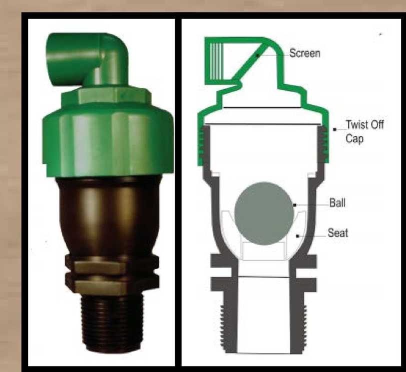

Figure 7. Schematic of air release valve.

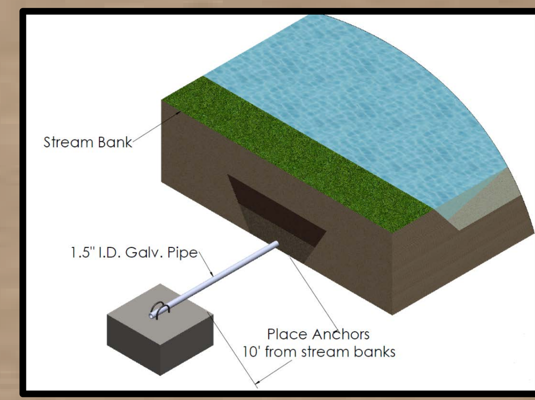

Figure 8. Cross section view of stream crossing.

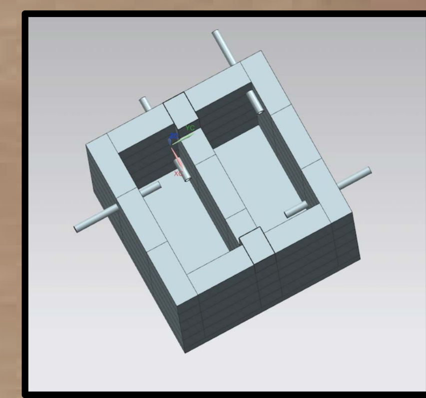

Figure 9. Schematic of break pressure tank.

- In-line chlorinator (Figures 10 and 11): An in-line chlorinator will be installed to ensure the system provides clean water to section 1.
- Storage tank (Figure 10): An unused 4,200L plastic storage tank from the other aqueduct will be relocated on-site to store water.

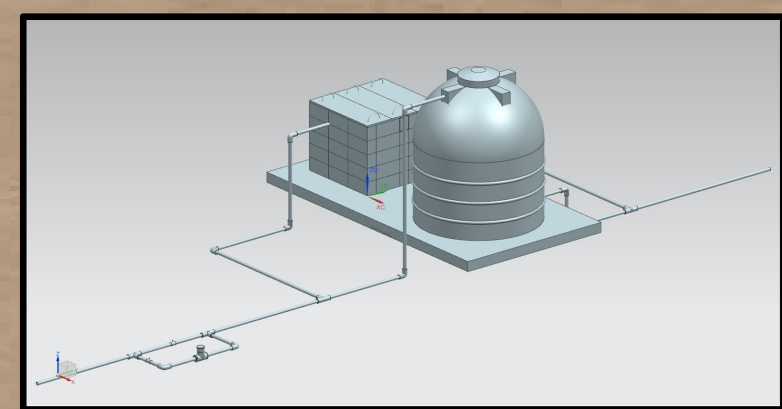

Figure 10. Configuration of in-line chlorinator, storage tank, and break pressure tank located at Waypoint 80.

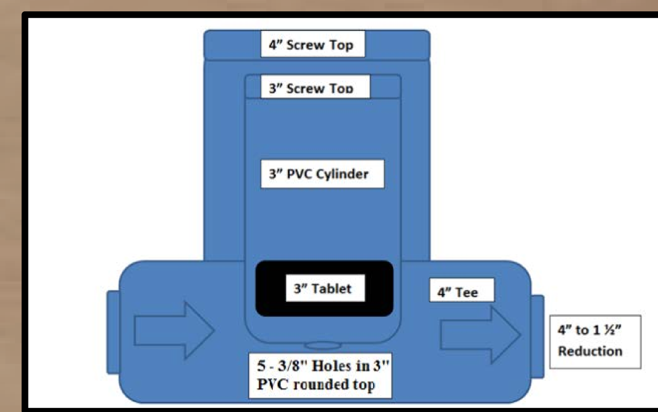

Figure 11. Diagram of in-line chlorinator.

Cost Estimate: A list of materials (and costs from local stores) for the proposed system was created. The cost estimate can be found in Table 1.

- It is assumed that all labor will be donated by the community
- A 10% design and 8% estimate contingency were added to the total

Table 1. Cost Estimate for Aqueduct System

Component	Cost
Main Aqueduct Line Piping	$3,200
Air Release Valve (1)	$70
Low Profile Springbox (1)	$120
Break Pressure Tanks (5)	$1,800
Waypoint 80	$1,200
Tapstands (9)	$170
In-Line Chlorinator (1)	$100
Stream Crossings (2)	$500
Labor	$2,100
Community Contribution	($2,100)
Transportation	$600
Total (+18%)	**$9,300**

Construction Schedule: Construction and installation of the aqueduct is expected to take a total three months.

Conclusions and Recommendations

- ➢ Modeled and designed a feasible, affordable, and sustainable gravity-fed aqueduct system for section 1 of Bajo Gavilan
- ➢ Next steps: provide all information, analysis, recommendations, and cost and construction estimates to local Peace Corps volunteer for review

Reasonable Engineering

Team Members: Megan Farrish, Claira Hart, Kevin Madson, Erika Poli, William Tillmans
Advisors: David Watkins, PhD, PE; and Michael Drewyor, PE

Acknowledgements: Christina Duell, PCV; and Community of Bajo Gavilan

International Senior Design
CE 4916
Fall 2014

Michigan Tech