Community Background

The Quebrada Arena Community lies within the Ngobe Bugle region and is surrounded by large mountains which isolate several nearby communities. For nearly 200 years, the community has resided in the Ngobe Bugle region and today is comprised of nearly 300 households. Approximately 240 members are 30 households living in 7-8 month dry season. 50% under age of 15. Subsistence Farming. Primary Education. Walking is primary form of transportation.

Current Water Situation

- Location of Source
- Women of children hike long distances to get water for bathing, laundry, and consumption (Figure 2).
- Water Quality
- Uninhabited agricultural runoff and bacteria contamination are leading to health issues in children and elders.
- Low pressure in annual water availability.
- During the dry season, several springs provide water to community members. During the dry season, only one spring provides water but at a very minimal rate.

Design

Based on conclusions made from the data analysis, a water distribution system was determined to be the most appropriate improvement for the Quebrada Arena Community and will provide easily accessible, disinfected water to all community members (Figure 6).

Pipeline: The largest and most cost effective component of the system is the polyvinyl chloride pipe (PVC). Each service line leading to a tap stand will be ⅝”. Implementation of higher rated pipe such as SCH 40 PVC would not hinder the system if chosen but was avoided due to high costs.
- SDR 26
- ⅝” PVC
- Low Cost
- High Pressure Rating
- ⅝” in Green
- ⅛” in Blue
- ⅜” in Red
- Pipeline (3.6 miles)
- Top Cost
- In accordance to Figure 6

Pressure Release Tanks: Due to the 300 meter drop in elevation between the source and the lowest house, the water pressure throughout the system may cause harm to pipes and faucets. To alleviate the high pressures encountered in the pipeline, six pressure break tanks are recommended.
- Storage Tank: To allow time for disinfection and storage during the night, a 9 m³ storage tank will be constructed after the spring box.
- Concrete Block walls
- Styrofoam insulation
- Res. Time of 2.8 hrs.

Spring Box: To provide the initial capture of the system’s water, a standard spring box will be constructed:
- Provides Penetration and Initial Capture of Water
- Constructed of Concrete Walls
- Offers primary treatment through gravel and sand filter
- Excess Water will return to original path of travel

Gully Crossing: Due to the extreme changes in elevation surrounding the community, all crossing will need to be constructed (Figure 7).
- 2 Suspension Bridges
- Easy Constructability
- Low Cost
- ⅛” Steel Cable
- 0.5” concrete anchors at each end

In-Line Chlorinator: Currently not implemented.
- Size: 4” PVC tee
- 0.5” PVC
- 1.0” PVC
- 1.5” PVC

Cost Estimate

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Cost Estimate</th>
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<tbody>
<tr>
<td>Spring Box (1)</td>
<td>$750</td>
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<tr>
<td>Storage Tank (1)</td>
<td>$1,230</td>
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<tr>
<td>Top Stand (32)</td>
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<tr>
<td>Pressure Break Tanks (6)</td>
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<td>Bridge Structures (2)</td>
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<td>Pipeline (3.6 miles)</td>
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<td>Air Release Valves (5)</td>
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<tr>
<td>Transportation of Material</td>
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<td>Total Cost (+10% Contingency Cover)</td>
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Construction

The construction schedule for the design has been estimated at 6 months and assumes a crew of 5 laborers and 1 Peace Corp Volunteer. With dry seasons lasting only 4 months per year, construction will need to be divided into two dry seasons to avoid wet season work.

Acknowledgments: Christopher Kingdry, PCV: Jacob Mlakoff, PCV: Zoe Miller, Graduate Student Trip Mentor

Advisors: Michael Drewyor, P.E.
Dr. David Watkins

Figure 1: Ngobe Bugle Comarca of Western Panama. Cerro Piedra is shown by the star.

Figure 2: A map of the Quebrada Arena Community. The yellow roads indicate the main transportation routes. The green fields indicate the agricultural fields.

Figure 3: Yucca Engineering performing flow analysis.

Figure 4: A map of the proposed pipeline route with labeled components.

Figure 5: A map of the proposed water distribution system with labelled components.

Figure 6: A diagram of the proposed water distribution system with labelled components.

Figure 7: A diagram of the proposed gully crossing suspension bridge.