Water Supply and Watershed Protection
Quebrada Caracol, Panama

Project Overview
In August of 2015, Clean Water Consulting travelled to the country of Panamá to collect field data for an International Senior Design (iDesign) project at Michigan Technological University. The project site was located in the village of Quebrada Caracol, an indigenous community in the Ngöbe -Buglé Comarca (Figure 1).

Data Collection & Analysis
Surveying included the following:
• Current system from natural spring source to outlet
• Delineation of micro-watershed containing spring
• Elevation profiles through the community

Water quality tests were performed on the following:
• Water from spring supplying the distribution system
• Runoff near spring box
• Taps throughout community

Water in spring was found contaminated with disease causing bacteria such as Salmonella and Shigella.

Recommendations

Recommended System Design Improvements
Pipeline: Update the current system by replacing old pipes that are worn or broken. Extend the current system that serves one house to serve four houses. Add ball valves throughout system to provide convenient shutdown for future repairs (Figure 4).
Pressure Reducing Discs: Install pressure reducing discs to system so that the pressure at each faucet is suitable for water collection. The target pressure at each of the faucets was 40-60 psi.
Tap Stands: Install tap stands to provide clean and easy access to drinking water. Utilizing a control valve will enable the faucet to be turned off when not in use, allowing water to collect in the storage tank.
Runoff Diversions: Reroute the runoff water from the upper spring by digging a trench that directs the water away from the spring box. Create a berm on the downhill side of the channel using the excavated clay and line the new trench with rip rap (Figure 5).

Project Schedule
A total of 35 work days will be required to construct the system with 8 people working full time (30 hours/week). The community does not work on Saturday or Sunday, so it will take about 2 months to complete the project.

Current System Updates
• Replace Broken Pipes: 3 days
• Extend Pipeline: 11 days

New System Construction
• Buy/Transport Materials: 4 days
• Install Test Chlorinator: 3 days
• Relocate Spring Box: 8 days
• Install Tap Stands: 6 days

Cost Estimate
The total cost estimate for the aqueduct system is about $5,700. This account for all materials of the design and necessary equipment. Community members will be volunteering their time to construct the system, which has a monetary value of $1,600.

Component Cost Breakdown

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Replace &amp; Extend Piping</td>
<td>$4,400</td>
</tr>
<tr>
<td>Spring Box &amp; Storage Tank Lids</td>
<td>$300</td>
</tr>
<tr>
<td>Chlorinator</td>
<td>$300</td>
</tr>
<tr>
<td>Tap Stand Supplies</td>
<td>$200</td>
</tr>
<tr>
<td>Tools &amp; Equipment</td>
<td>$700</td>
</tr>
<tr>
<td>Total Project Costs</td>
<td>$5,700</td>
</tr>
</tbody>
</table>

Recommendations
CWC has designed an updated water distribution system that services three additional homes. Diverting runoff from the upper spring will prevent contamination from entering the spring box. Relocating the chlorination system upstream of the water storage tank will allow adequate contact time to disinfect the water. Installing tap stands will provide access to clean water. Performing routine maintenance is crucial in protecting the water.

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Acknowledgements: Leigh Miller, Peace Corps Volunteer & Quebrada Caracol Community Members

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CE 4916 International Senior Design
Fall 2015