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Project Background

In August 2012, Team Hard Body traveled to the Republic of Panama to participate in an International Senior Design Project. The indigenous communities of Hato Pilón asked that the team, in cooperation with local Peace Corps volunteers, design a sustainable water distribution system. The design goals were to provide clean water system at a low cost, with low maintenance and a sufficient supply for all community members in the dry and rainy seasons and a low environmental impact.

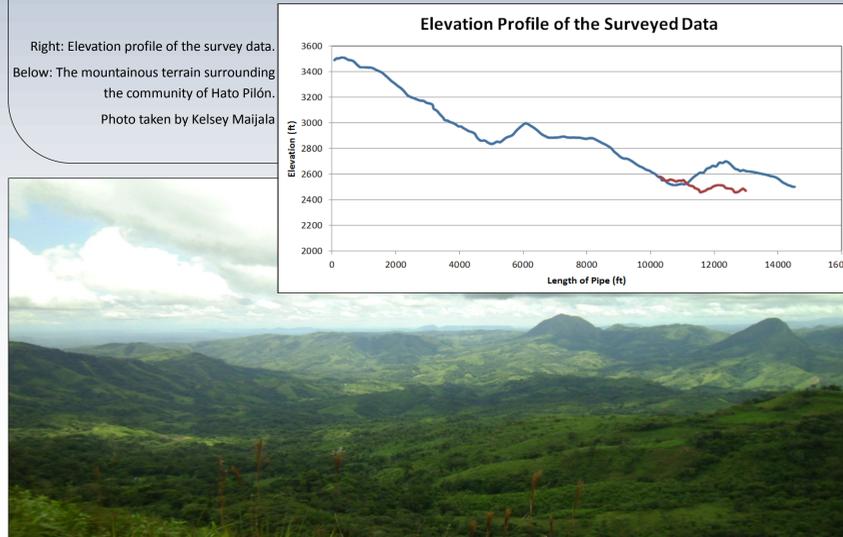


The region of Hato Pilón, located in the Chiriquí Region of the Republic of Panama.

Accessed at http://en.wikipedia.org/wiki/File:Panam%C3%A1_Ngobe-Bugle_comarca.svg

Engineering Design Challenge

Team Hard Body was tasked to design a gravity fed water distribution system that is sustainable and feasible for three communities in this mountainous region. Elevations changes are as high as 1,000 feet in some locations, and pressure in the pipeline must be sufficient to overcome the peaks in the route, but not so great in the valleys that it will burst the pipe. Cost efficiency and simplicity are prioritized due to limited financial and technical resources in the region.

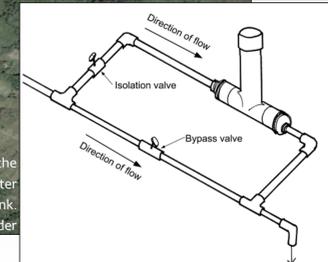


Proposed Design

Water Collection: A spring box was designed with two wing walls to collect and direct the seepage to the distribution line.

Pressure Relief Basins: Two pressure relief basins will be necessary for the system beneficial locations are before the storage tank and on the branch towards Cerro Peña.

Water Storage Tank: The masonry storage tank, with dimensions of 10' x 10' x 10', holds 6,400 gallons, more than one day's supply of water for the three communities.



Above: Image of assembled in-line chlorinator
Photo accessed from Fred Jacob and Charles Tafin, Compatible Technology International.

Below: Air release valve that can be constructed by hand with available resources.
Photo Accessed from Peace Corps International.

Water Treatment: An in-line chlorinator, to be installed directly before the storage tank, includes the use chlorine tablets to ensure proper treatment.

Pipeline: The pipe should be buried 2-3 feet underground to protect it from damage. Most pipeline should be able to withstand pressures up to 160 PSI, while the branch of Cerro Peña will need to withstand pressures up to 250 PSI. Branches off the main pipeline to the homes will be 1/2" in diameter.

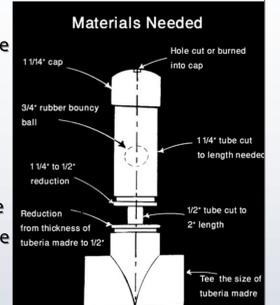
Air Release Valves: These are to be built on-site and installed on any at specified high points in the system; where a buildup of air could cause blockages.

Cable Bridge: A cable bridge must be installed in Cerro Peña where it is necessary for the pipe to cross a small creek. This will support the pipe over a distance of eighty feet.

Cost Estimate: From the materials and prices available to Hato Pilón, a complete cost estimation was developed. It is assumed that unskilled labor will be a donated service, and that one technical supervisor will be present during the project. The largest cost is the pipeline and the concrete materials.

Proposed Cost Estimate	
Materials	\$7,645
Professional Labor	\$2,251
Total Cost	\$9,896

Construction Schedule: A recommended schedule of construction was created with the most efficient task sequencing. The project is expected to take four months.



Community Background

The community of Hato Pilón is located in a northwestern comarca of Panama, similar to an Indian reservation in the United States. The people of the community are part of the Ngöbe Bugle group. Hato Pilón consists of four different communities: Cerro Mesa, Cerro Peña, Hato Pilón Arriba, and Hato Pilón Abajo. Of these, Hato Pilón Abajo is considered to be the community center, with a municipal building, health clinic, and primary school. Hato Pilón Abajo is the only community with a functional water supply system, and the remaining residents must walk up to 30 minutes to obtain water. Their current drinking water sources are creeks and streams, which are also used for bathing, cleaning, and livestock use.



Far Left: Typical dress for residents. Most youth attend the local school until age 16.

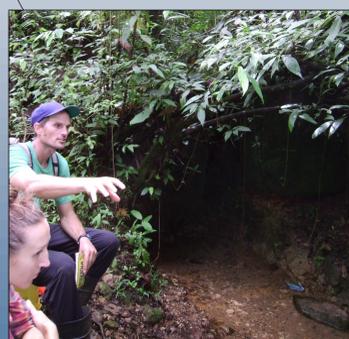


Left: A usual home for a typical family of 6-9 people.
Photos taken by Kelsey Maijala

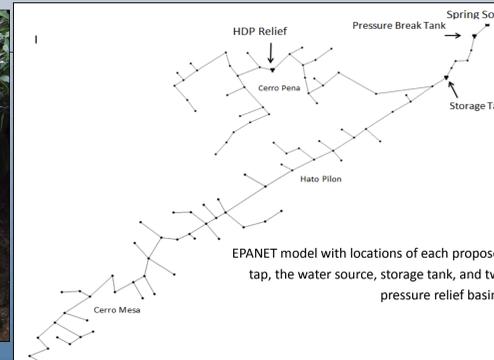
Data Analysis

Team Hard Body utilized data collected in the communities and engineering resources to develop a number of design recommendations. The GPS data was plotted in Google Earth Pro to analyze the route of the pipeline. EPANET was used to simulate the flow of water through the piping network. Nodes were created for each proposed spigot, and parameters varied for the length of pipe between each node, the size of pipe used, and the capacity of the storage tank. Scenarios were run when all nodes were closed, testing the highest pressures that might occur, as well as when there was a water demand in the system.

This analysis was used to determine the locations of pressure relief basins and the storage tank that will maintain the desired pressures in the system. Pressure calculations were confirmed in Microsoft Excel® that elevation changes will not cause the pressures at low points to exceed the maximum allowable pressure of the pipe available, 160 PSI. Even with the installation of pressure relief basins, there is one location where piping with an increased pressure allowance should be used.



Above: Collecting survey data in the community with an Abney Level.
Photo taken by Angella Mickowski
Right: Location of water source.
Photo taken by Rebecca Bender



Acknowledgements: Hato Pilón community members
Peace Corps volunteers: Pete and Kelly Brands, Erica Jones and Jordan VanSickle
Michigan Tech Faculty: Dr. David Watkins, Mike Drewyor, P.E., Dr. Brian Barkdoll, P.E.

Data Collection

- Surveying:** Using Abney levels and a tape measure, almost 4 miles of land was surveyed to obtain topographical data for the proposed pipeline.
- Water Quality:** From the proposed water source, a spring on a nearby mountain top, water was tested to determine the water quality. The water proved to have low turbidity, zero E-coli present, low natural bacteria counts, making it an ideal water source.
- Water Supply:** Property owner, Emilio Quintero, confirms a consistent annual flow from the proposed source. The volumetric flowrate was estimated of the to be 24 gal/min, which is sufficient supply for the needs of the communities
- Estimated Usage:** Population census and water use estimates were collected while taking the survey data. The system incorporates nearly 50 homes and just over 250 people, and the design goal is to provide 20 gallons per person per day.

Conclusions

Team Hard Body has compiled the above engineering design recommendations for a water distribution system that is both economically feasible and sustainable for the future use of the communities of Hato Pilón.

The operation and maintenance of the system, funded by monthly fees for each tap, is to be overseen by the standing water committee. This engineering design was developed with extensive research, and is intended to best meet the project goals.



Pictured Above: Team Hard Body observing the Panama terrain from a mountain peak.
Photo taken by Peter Brands

