Quebrada Pastor Water Distribution System

International Senior Design – Summer 2015

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AquaVenture Engineering Inc.
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Outline

- iDesign Program
- Quebrada Pastor Background
- Cultural Understanding
- Design Projects
- Conclusion
- Questions

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International Senior Design

- 2 Semester, 6 credits
- 2 Weeks in Panama
  - 7 days in villages
- Design solutions to problems in the village
  - Analyzed water distribution system
- Work with Peace Corps Volunteers
- Have community support

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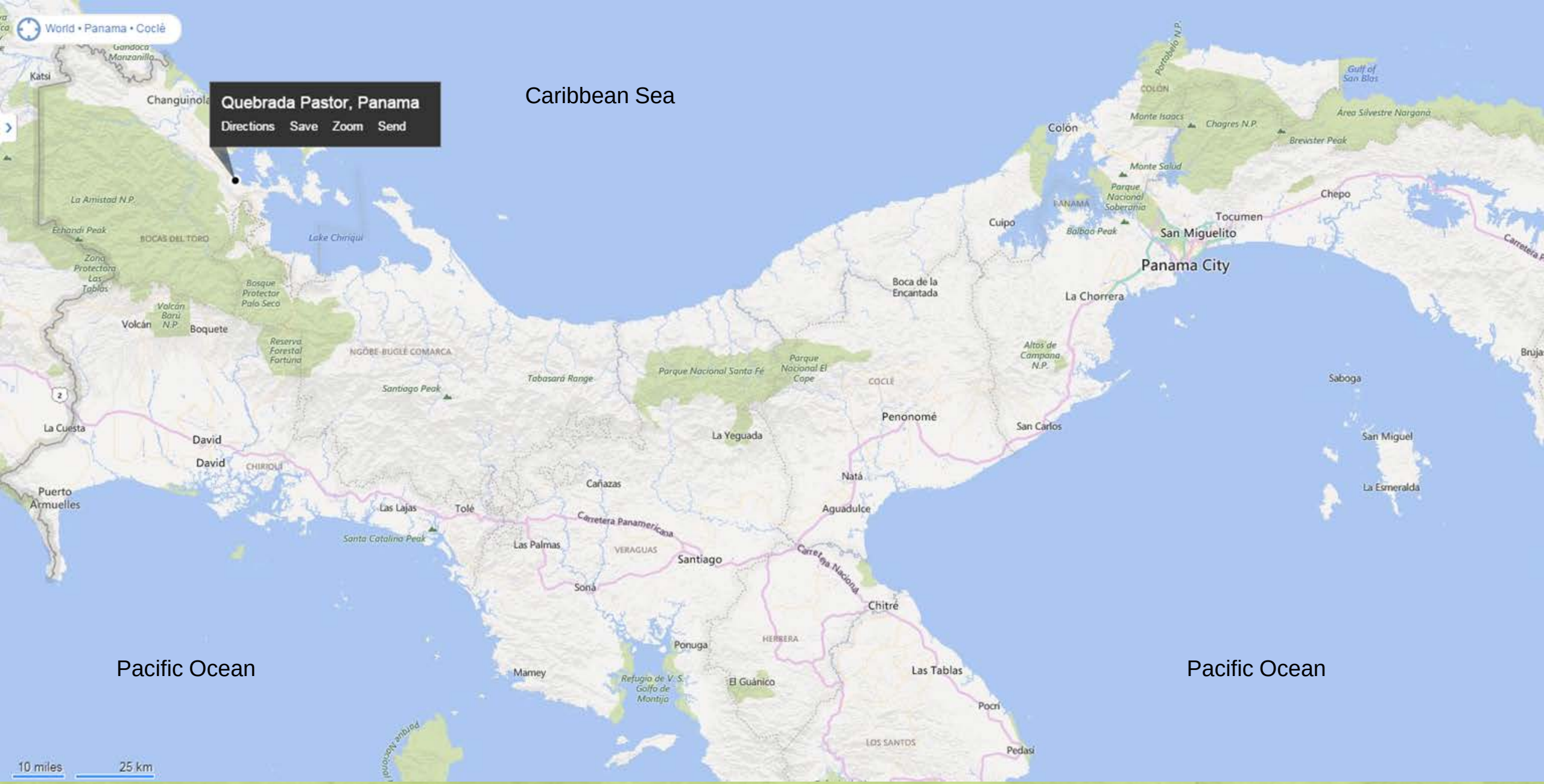

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Quebrada Pastor

- Approximately 800 people & 100 homes
- 2 Churches
- K-10 School
- Small Businesses
- Community Income
  - Fincas
  - Cash crops- yucca, cacao, bananas, etc
  - Tourism outside the community
  - Bocas Island
  - Domestic Services

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Host Family

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PCV: Alex

- Very Supportive
- Thinks like an Engineer
  - Senior Design: Analyze the Aqueduct
- Sustainable Development = Empowerment
- Did leave halfway through
- Continued to communicate with during fall semester

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Background of Aqueduct

- Senior Design: Analyze the Aqueduct
- Originally built in 2002 by parents of school students and residential users
  - Funded by the government
  - Two Tomas (Spring Box)
  - Three 1,000-gallon storage tanks
- Built to service 8-10 connections including the school
- Currently serves 30 homes, as well as school, church, and Heidy Organic Chocolates
- Directiva controls it

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Directiva: Water Committee

- High functioning committee
  - 6 Executive Board positions
- All users pay $3/month
  - School does not pay
  - Line will be cut after 2 months of delinquent payments
- Operator maintains the line
  - $20/month salary

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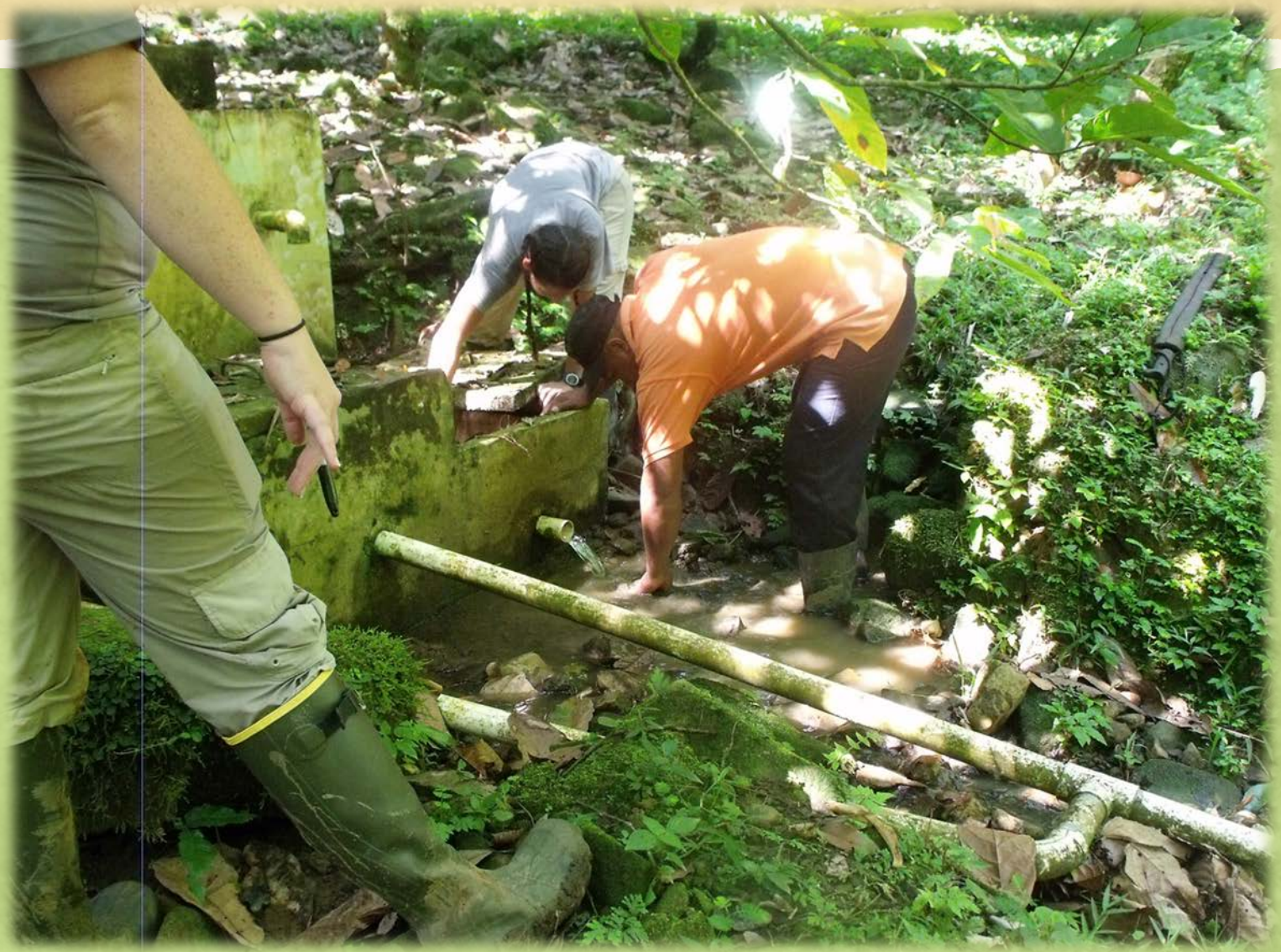
Community Support

- Very hands on
- Villagers with us every day
- Showed the line location
- Cleared the brush as needed
- Helped with surveying
- Very hospitable
- Receptive to our questions



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Interviewing the Villagers

- Tried to talk to as many people as possible
  - Users from each branch of system
  - Each member of the directiva
  - System Operator
  - Principal of the school
  - Women who cook & work at the school
- Questions:
  - Demand
  - Uses
- Cultural understanding

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Gathering Data Wasn't Easy

- Were not fluent in Spanish
- Unfamiliar equipment
- Field Survey
- Flow Measurements
- Water Quality
- Interviews

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Environmental and Societal Constraints

- Villagers would be doing work
  - Not particularly skilled
  - Very proud of their previous improvements to system
- Terrain is hilly and muddy
- Have to carry all the supplies a mile up to reach improvement areas
- Will need to shut off the line during construction

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Tomas: Spring Sources

- Two Tomas feed entire aqueduct system
- First was built by the Panamanian government
- Second was constructed by the community

Toma 2

Toma 1

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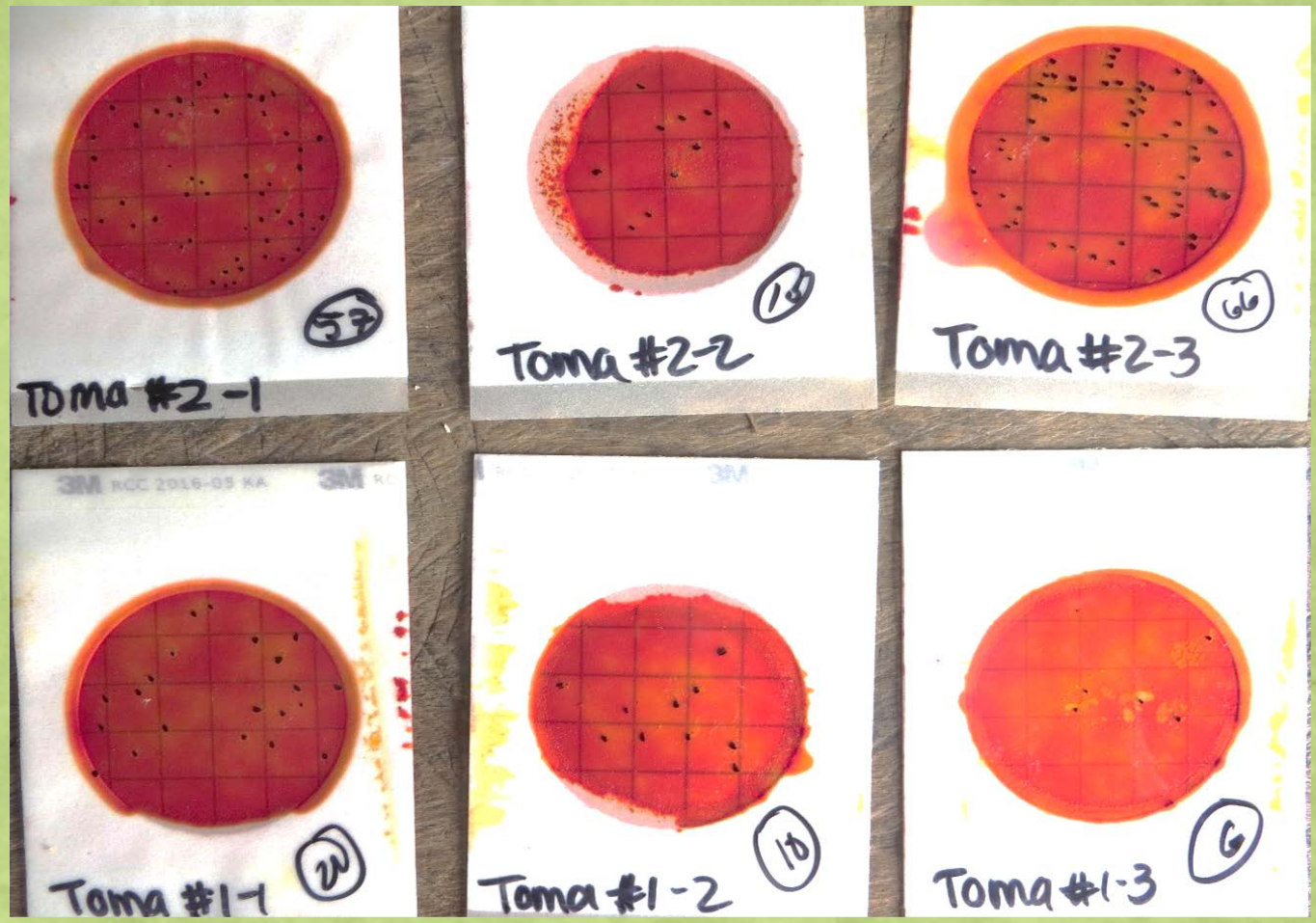
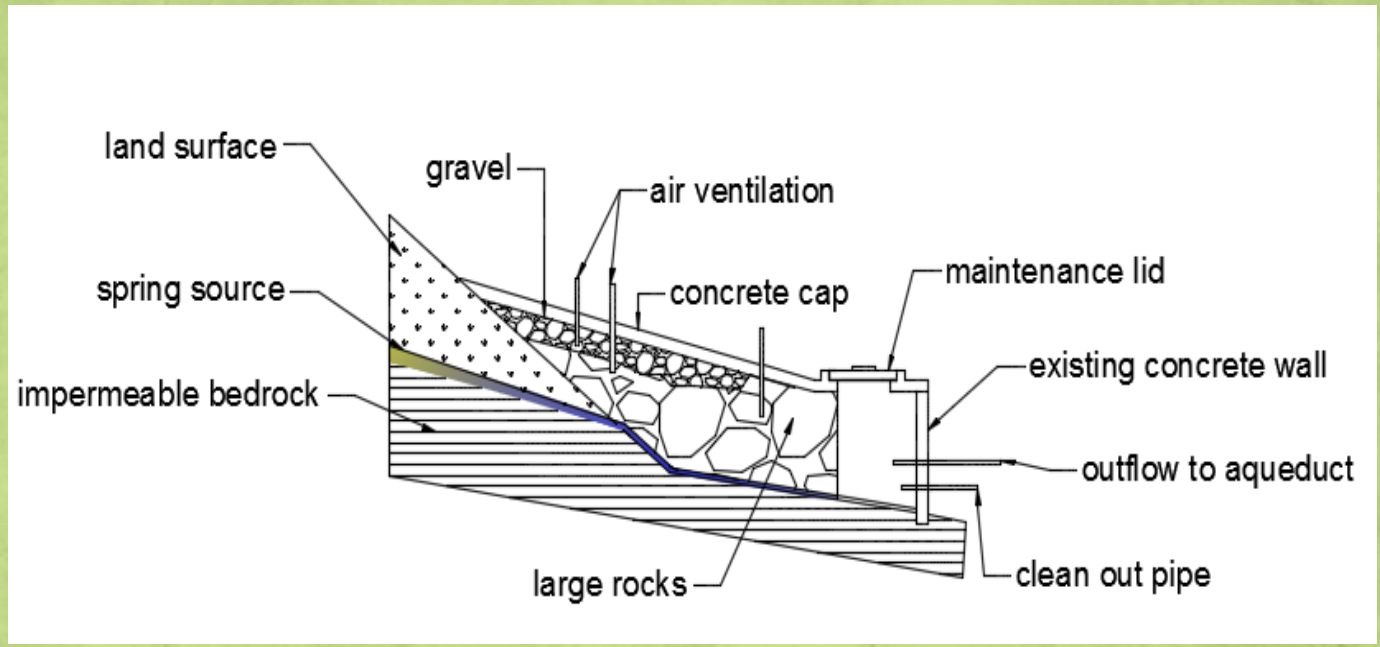
Toma 2

- Lacks proper sealing
- Sediment build up = turbid water
- Rapid coliform counts
  - Toma 1 Average: 12
  - Toma 2 Average: 44
- Design improvements will enhance quality and increase flow



Toma 2 Design Improvement

- Low-profile toma design
- Remove original lid
- Use existing concrete walls
- Rock and gravel fill
- Seal off with concrete cap
- Concrete lid for maintenance



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Stream Crossing Supports

- 2 Crossings
- 1st in worst shape
- New support design

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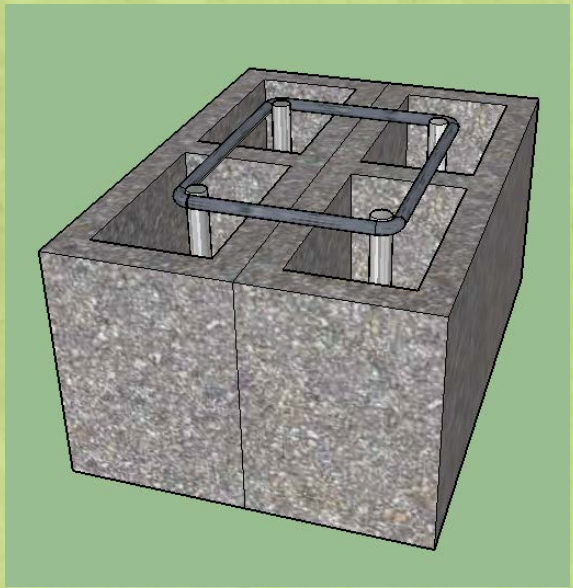
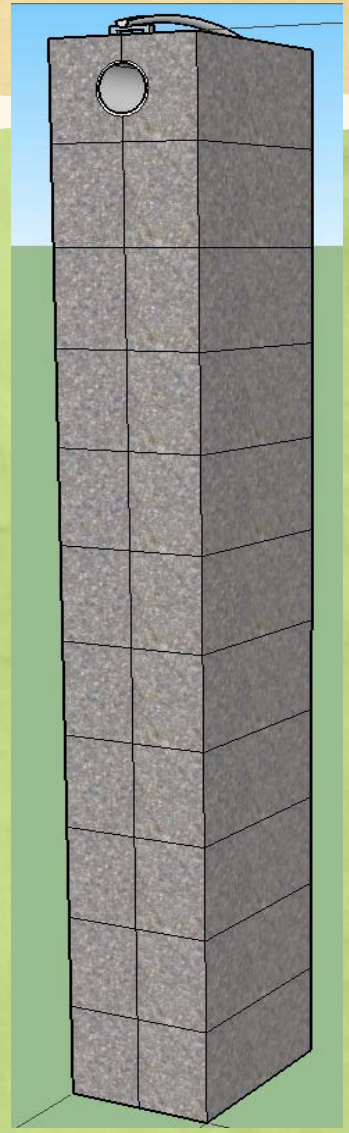
Stream Crossing Design Improvement



- 6" Masonry Blocks
- #5 rebar running vertically
- #3 rebar stirrups
- 2 blocks wide
- 11 blocks tall
- Placed in a 30"x16"x12" concrete footing
- Allowable Axial Load: 6,800 lbs



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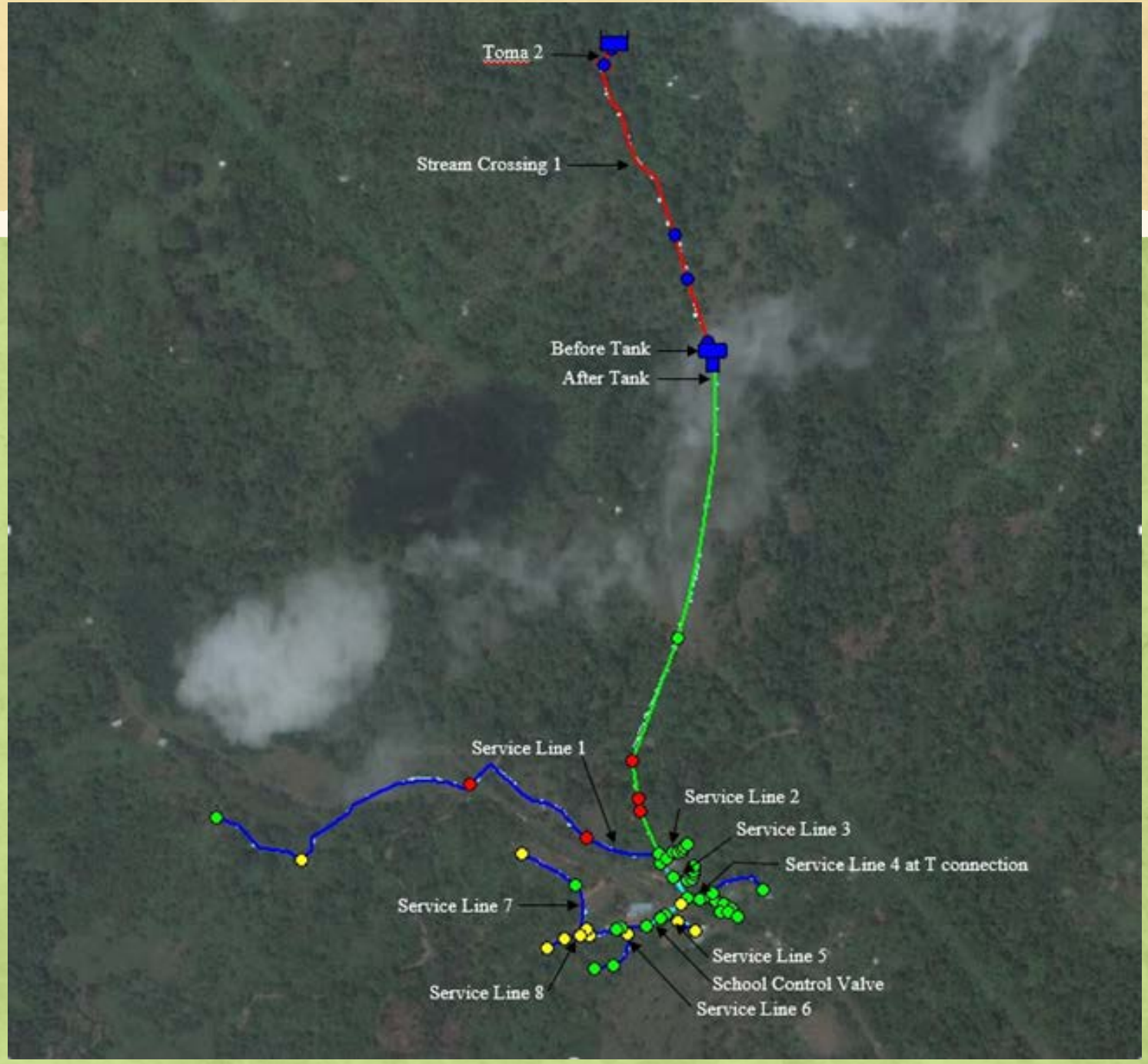
Control Valves

- 5 currently
- Add more valves
  - Before and after storage tanks
  - Service Lines shutoffs



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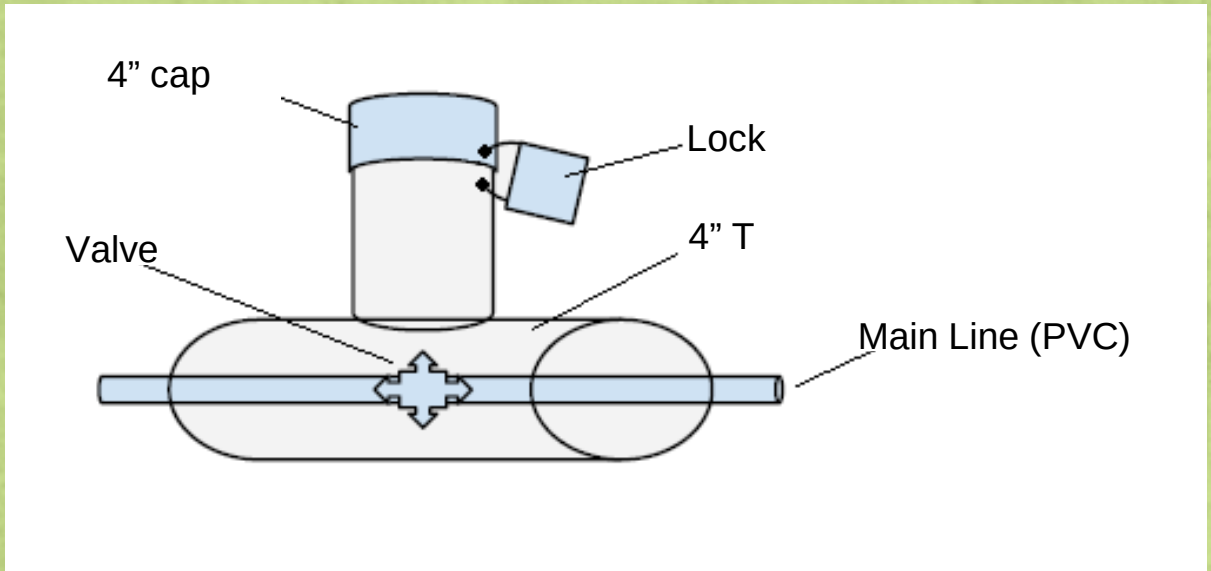
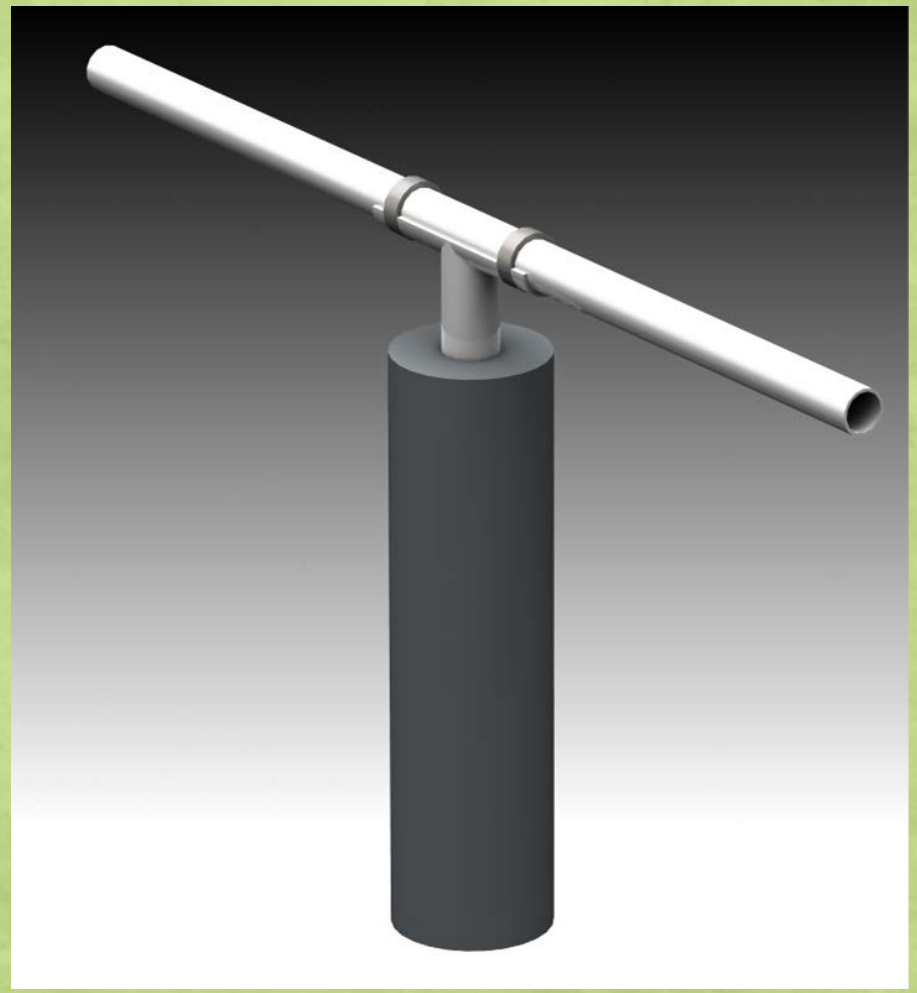
Control Valve Design Improvement



- 13 new valves
- One on each service line
- Valve protection

Elevation Changes

Ascent Improvements



- 200m ascent
- 30 degree incline
- 4 equally spaced
- 2 inch T-connection
- Pipe clamps
- Paint for UV protection

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Rainwater Catchment Supplements

- School owns two 1,500-gallon rain catchment tanks
  - Not in service due to misuse
  - Demand: 1,000 gallons water/day
  - Average monthly rainfall: 209mm
- 46-year Rainfall Data used to determine potential supply and reliability of rain catchment system
- Analysis suggests that an average of 48% of water demands could be met each month

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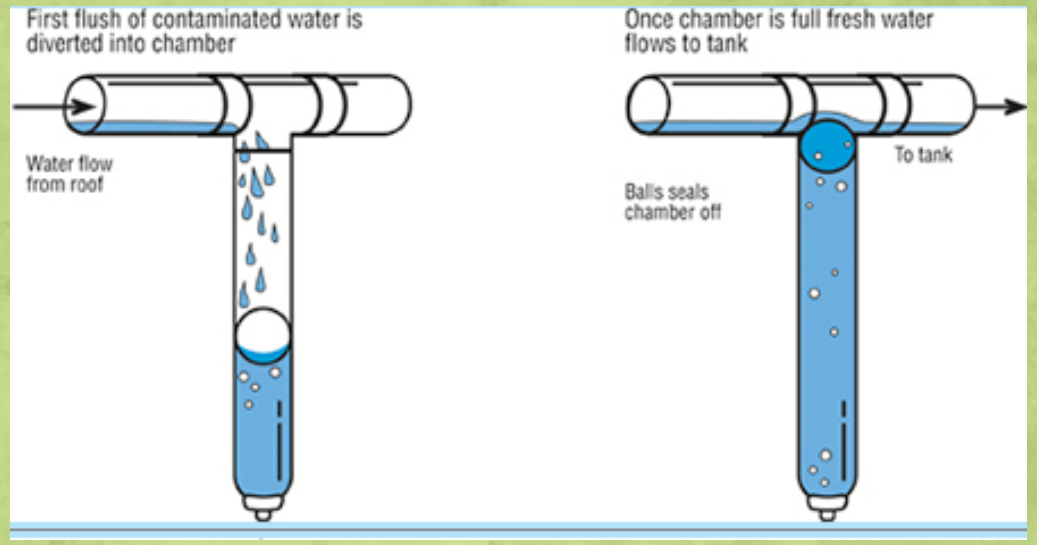
Rainwater Catchment Recommendations

- Fencing with a lock to protect tanks
- Additional gutter to increase supply
- Screen to prevent debris from entering gutters
- First-flush system to increase water quality
- Recommend that school rely more on rain catchment than on the aqueduct



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EPANET Modeling

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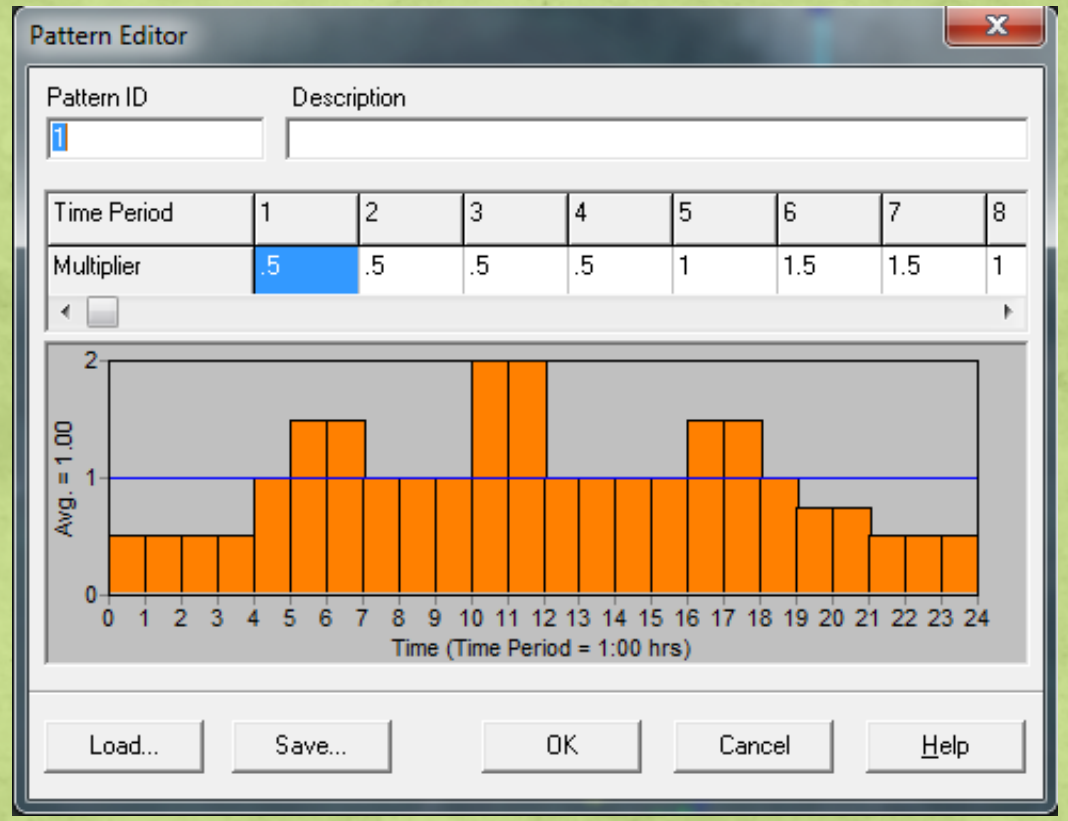
EPANET Graphs



Node ID	Elevation (m)	Demand (LPM)	Head (m)	Pressure (m)
Junc 14	38.17	0.19	128.9	90.73
Junc 15	58.1	0.19	128.88	70.78
Junc 16	71.79	0.19	128.77	56.98
Junc 17	68.72	0.19	128.71	59.99

Nodes at 6:00 hours

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Construction Cost

Improvement	Cost
Rainwater Catchment	$193
Low Profile Spring Box	$71
Pipe Crossings	$653
System Control	$243
Total (rounded)	$1,300

Potential Sources of Funding:

- All families with children attending school
- Aqueduct users
- Fundraisers
- Government

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Construction Schedule

Improvement	Duration (Days)
Water Supply and Quality	**18**
Toma 2	16
Rainwater Catchment System	2
System Control	**11**
Installing Ball Valves	11
Lifespan Improvements	**30**
Stream Crossing 1	13
Quebrada Pastor Crossing	6
Quebrada Pastor Ascent	11

- 59 days total
- 2 Person Crew
- 5 Hours a day
- January and February

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Conclusion

- Surveyed 14,000 ft of pipe servicing 30 houses, a school, church and small business
- Focused on improving
  - Water Supply and Quality
  - System Control
  - Lifespan Improvements
- PCV had meeting with village on Dec 15th
- Loved experiencing Quebrada Pastor

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¿Preguntas?