Quian Designs

iDesign 2015: Water Supply in Quebrada Pinzón

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Michigan Technological University

Meet the Team

Team Members

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Presentation Outline

- Project Site Background
- Team Experiences
- Community Layout
- Existing Water Infrastructure
- Project Site: Las Delicias
- Data Collection
- Design Alternatives 1 & 2
- Alternative Analysis
- QD's Recommendation
- Conclusion
- Q & A

Background: Quebrada Pinzón

Province: Bocas del Toro

- Census Information:
  - 37 houses
  - 220 inhabitants
  - Monthly income average: 144 balboas
  - 36% is illiterate
  - 6th grade education on average
- 1 hour dirt road hike
- Main income source: Cacao and Banana farming

Historical and Cultural Dynamics

- Selected as a BioComunidad Project Site
  - Many recent improvements to community facilities and infrastructure
- Current Peace Corps Volunteer
  - Briana Arnold
- Family units are stronger than organized committees

Team Experiences

Project Site: Las Delicias

Objective

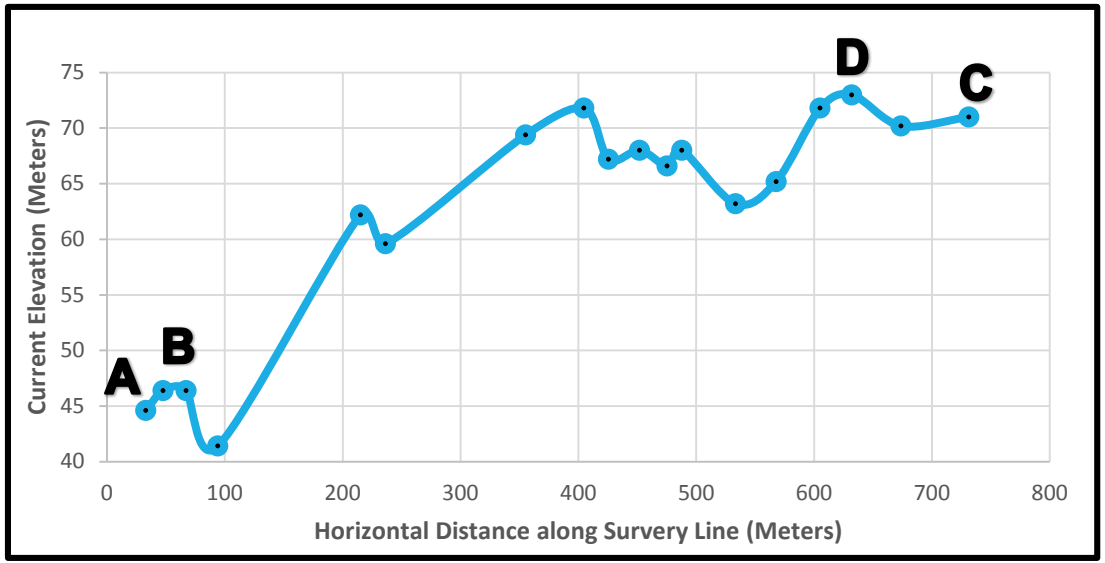
To provide Las Delicias with basic water infrastructure and an uninterrupted water supply for storage, drinking, and sanitation purposes.

Community Layout

Las Delicias: Data Collection

- Rain catchment area measurements
- Two sets of water quality tests
- Assessment of existing systems
- River slope and velocity measurements
- Surveyed elevations within Las Delicias

Las Delicias: Survey Line



A. Structure A (Church)
B. Structure B (Family Home)
C. Structure C (Family Home)
D. Proposed Tank Location

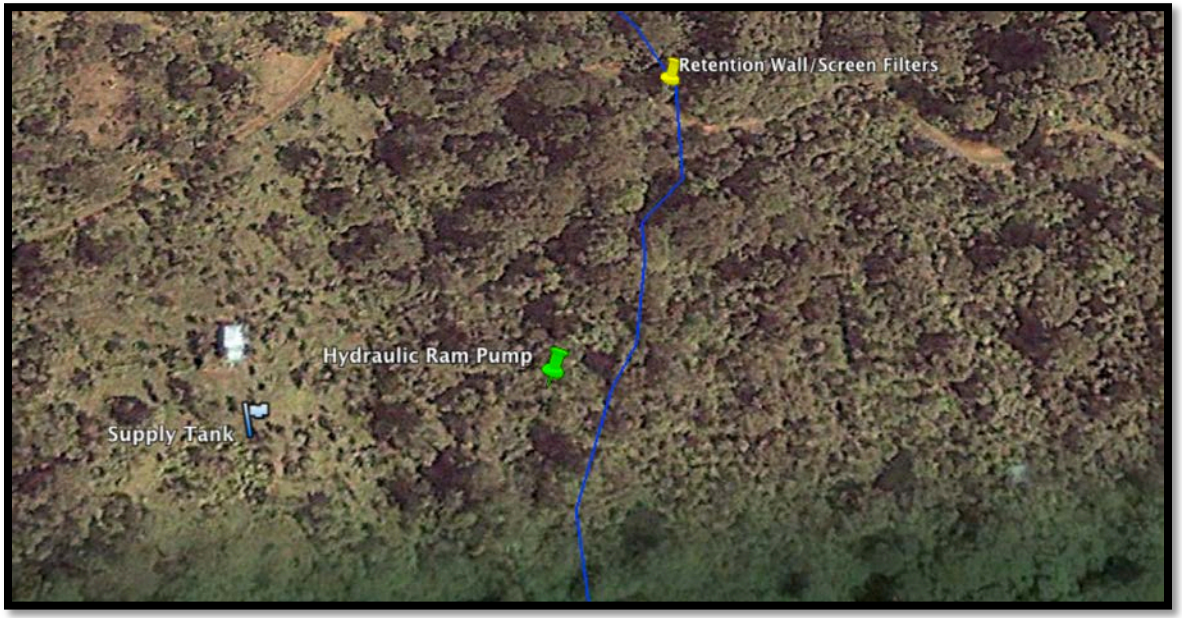
Design Alternatives

1. River Pump System
2. Individual Rainwater Harvesting Systems

Alternative One

River Pump System

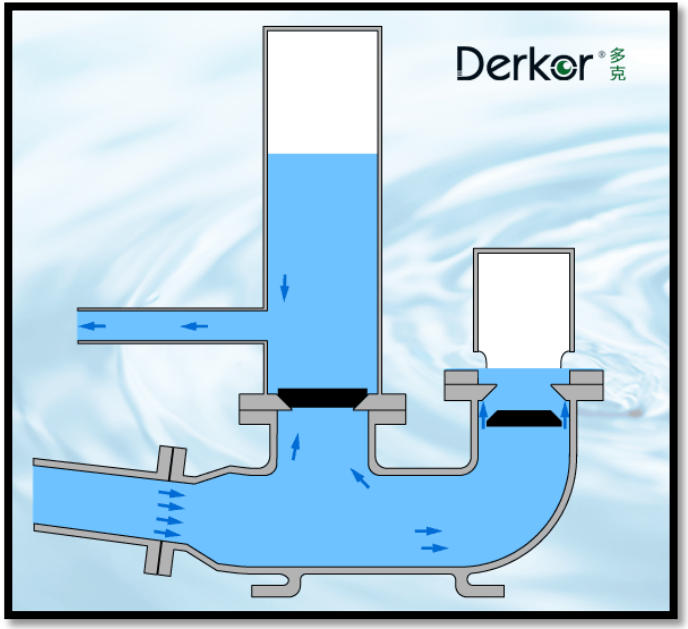
Layout of River Pump System



Alternative One: River Pump System

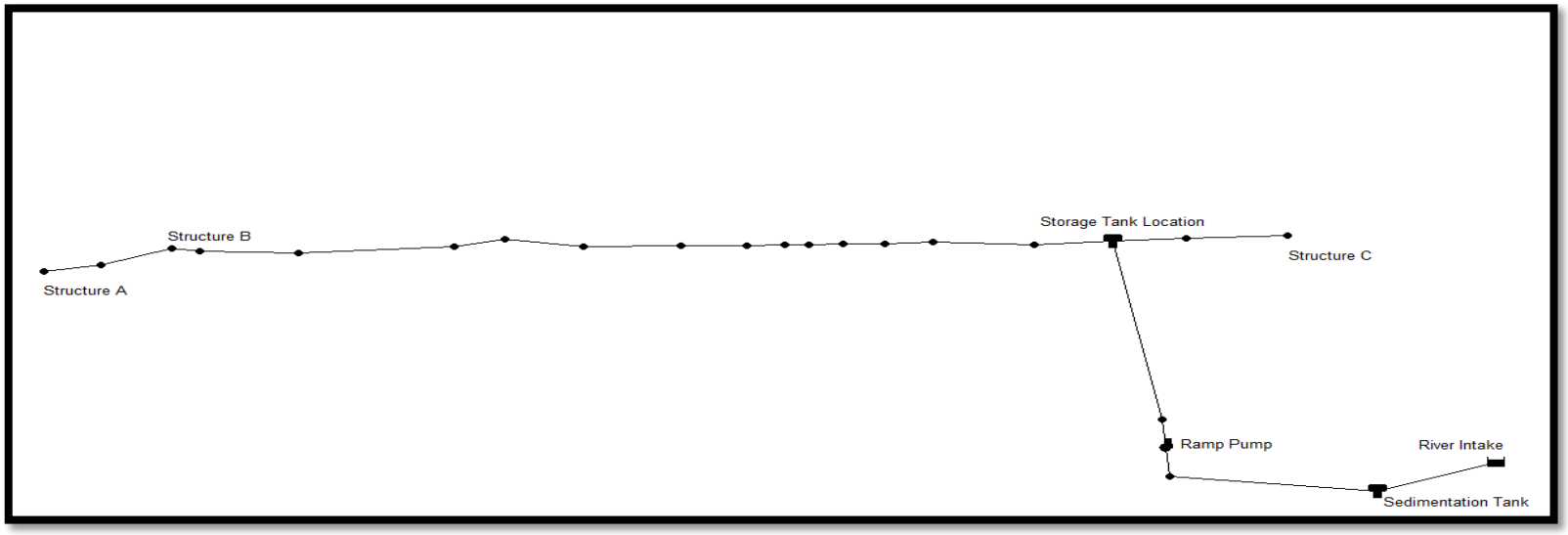
Hydraulic Ram Pump system

- Harvesting the power and size of the rivers energy and general typography
- No external power necessary
- Environmentally friendly



System Modeling

- EPANET 2.0 was used to analyze pressures and flow rates within the system
- Two different water demand patterns were modeled for weekdays and weekends

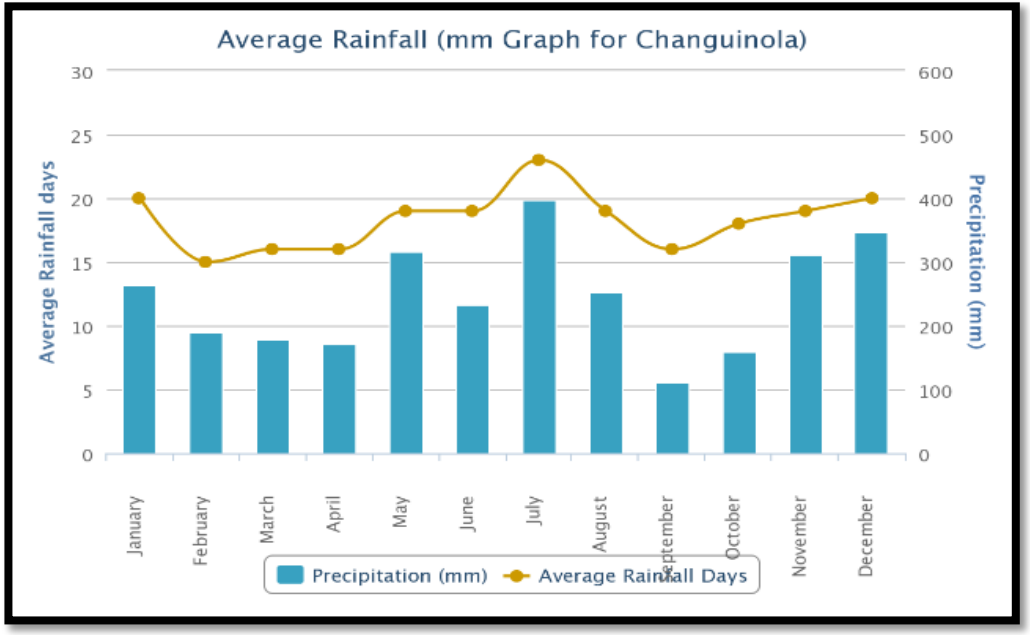


Alternative Two

Rainwater Harvesting Systems

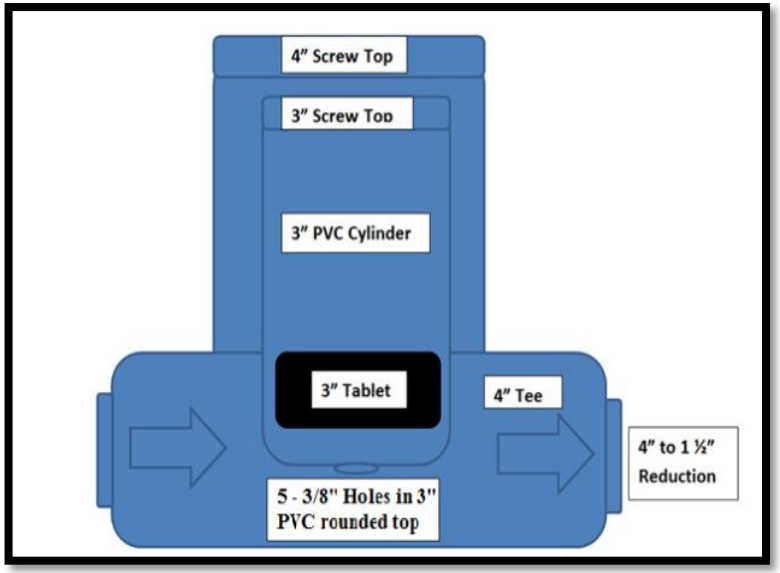
Alternative Two: Rainwater Harvesting Systems

- Rainfall Data for the nearby city of Changuinola (2000-2012)
- Long term variability analysis with historical data (1960-1972)
- Reliability and Storage analysis



Alternative Two: System Components

- Catchment area: Rooftops of Structures A, B, and C
- PVC (Polyvinyl Chloride) gutters
- Filtration: Mesh filters and first flush system
- Disinfection: In-line chlorinators
- Plastic storage tanks

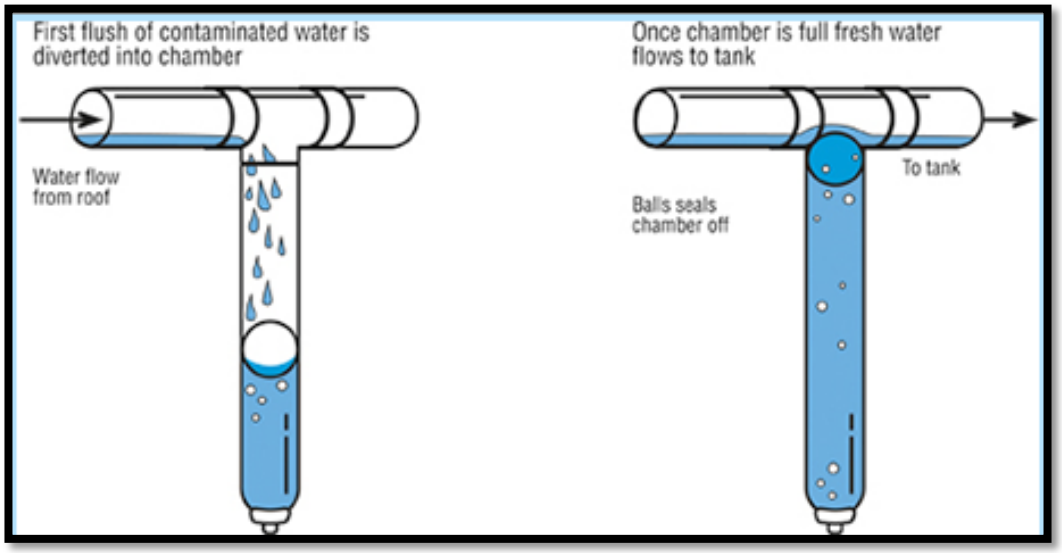


MINSA's In Line Chlorinator [1]

Mesh Filter

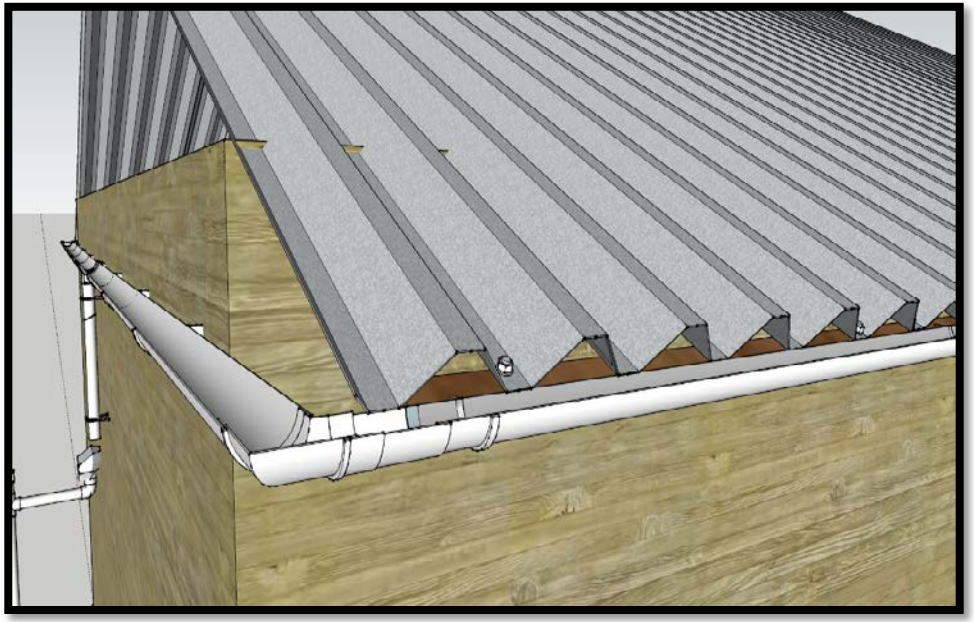
[2]

First Flush System

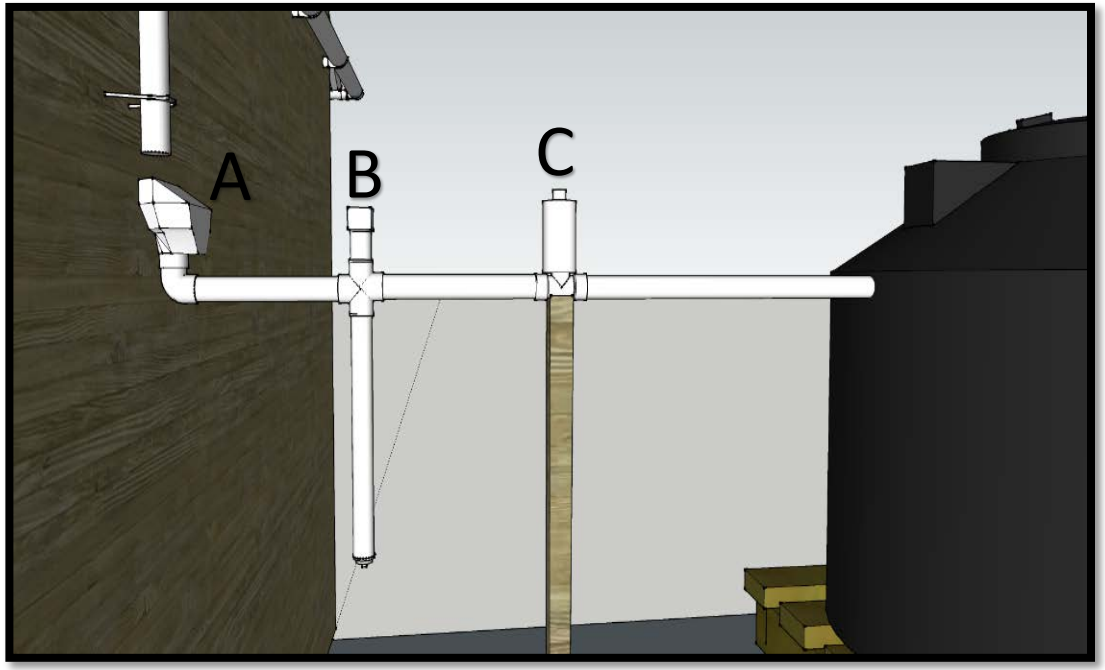


[3]

3D Model: Catchment System



3D Model: Filtration and Disinfection

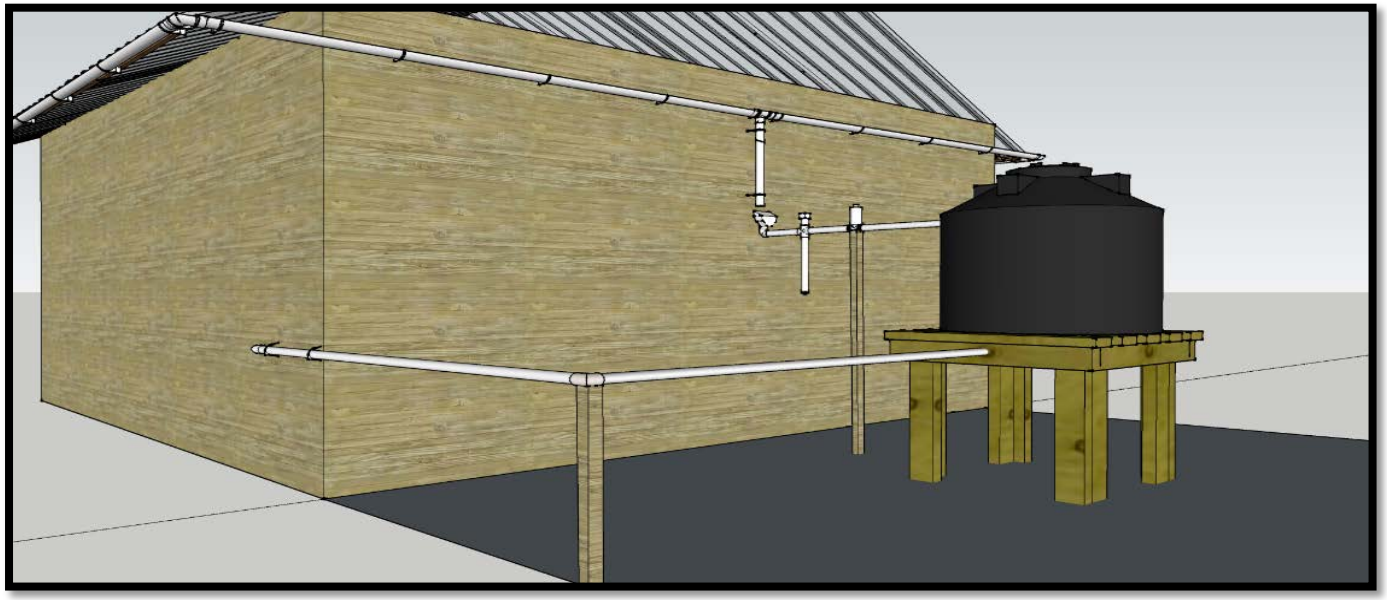


A. Mesh Filter

B. First Flush System

C. In line chlorinator

3D Model



Alternatives Analysis: Design Constraints

Technical

- Feasibility
- Constructability
- Cost

Social

- Responsibility within the community
- Routine maintenance
- Interest within the community

Failure Modes and Effects Analysis

- All possible failure modes are given a probability of occurrence and severity rating
- Risk Priority Number (RPN) is calculated as the product of the two ratings
- Alternative with lower RPN average is recommended

Probability of Occurrence of a Failure Mode	**Ranking**
Highly Unlikely	1-2
Unlikely	3-4
Neutral	5-6
Likely	7-8
Highly Likely	9-10

Severity of a Failure Mode	**Ranking**
Very less significant	1
Somewhat significant	2
Significant	3
Harms human health	4

Failure Modes and Effects Analysis

Alternative One : Ram Pump Design

- High risk failure modes
  - Check valve malfunction
  - Clogging of the pump
  - Loose pipes
  - Dislodging of the pipe network
- Risk Priority Number Average = 8

Failure Modes and Effects Analysis

Alternative Two: Rainwater Harvesting Systems

- High risk failure modes
  - Clogging of gutters
  - Leakage
  - Chlorination malfunction and improper mixing
  - First Flush malfunction
  - Particle build up in the bottom of storage tank
- Risk Priority Number Average = 6

QD's Recommendation

- Alternative Two: Individual Rainwater Harvesting Systems for all structures in Las Delicias

Constraint	**Alternative One**	**Alternative Two**
Feasibility and Constructability	Feasible but harder to construct	Feasible and easy to construct
Cost	3300 USD	800 USD (Structure A) 600 USD (Structure B)
Ownership of the system	Joint	Individual
Probability of system failure	RPN average = 8	RPN average = 6
Ease of repair and maintenance	High technical skill required	Technical skill not required
Water Quality	Fit for non-potable uses only	Fit for potable and non potable uses

Summary

Project Site: Las Delicias in Quebrada Pinzón, Bocas del Toro, Panama

- Alternative I: River Pump Design
- Alternative II: Rainwater Harvesting Systems
- Selection Criteria: Design Constraints and failure modes analysis results
- Final Recommendation: Alternative Two

References

[1] http://usfmi.weebly.com/uploads/5/3/9/2/5392099/users_manual_for_minsa_in-line_chlorinator.pdf

[2] http://www.aquabarrel.com/

[3] http://www.aquabarrel.com/product_downspout_filters_first_flush_inline.php


Thank you!
Questions?