ENGINEERS WITHOUT BORDERS USA
WORCESTER POLYTECHNIC INSTITUTE CHAPTER

Document 526
POST IMPLEMENTATION REPORT

CHAPTER: Worcester Polytechnic Institute
COUNTRY: Guatemala
COMMUNITY: Guachthu'uq
PROJECT: Rainwater Harvesting

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526- Post Implementation Report
Worcester Polytechnic Institute
Guachthu'uq, Guatemala
Rainwater Harvesting

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Part 1—Administration Information

**Note about this trip.

This implementation was made possible through a special EPA P3 Phase One grant. Phase Two of this grant is for the amount of $90,000. Due to the importance of a well written Phase Two application, this trip was handled a little differently than normal EWB-USA WPI trips. The four student travelers were not chosen through standard application process for travel; instead the team came together based on interests in working on the EPA P3 Phase Two application. This implementation was also not an EWB-USA sponsored trip. The trip was OK'd by our chapter's project manager, Tiffany Martindale, but it fell outside the typical EWB-USA guidelines did not receive any of the EWB-USA formalities (525/526 form submissions, mentor approval, etc.).

In accordance with WPI policy, most EWB-USA WPI trips must be approved through the Student Activities Office. This trip was different in that manner as well. The students traveling registered for a course under the guidance of Professor Elgert. The organization of this trip was then considered course work, and fell under the jurisdiction of WPI's IGSD Office.

1.0 Project Contact Information

Title	Name	E-mail	Phone	Organization
Project Lead	Tom Moutinho	tjmoutinho@wpi.edu	207-831-7011	EWB-USA WPI
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2.0 Travel History

Dates of Travel	Type of Trip	Description of Trip
7/20/2010-8/03/2010	Assessment	Initial assessment of community health and water sampling.
7/23/2011-8/07/2011	Assessment	Collection of data to evaluate water consumption rate, assessment of each home in community for water supply situation.
12/31/2012-1/10/2013	Implementation	Pilot implementation in two homes in order to evaluate socioculture reaction, efficiency of

		individual rainwater harvesting systems, as well as feasibility of construction in the community for large scale implementation.
5/03/2013-5/15/2013	Assessment/Evaluation	Analysis of pilot implementation trip, additional in-country preparations for next large scale implementation trip. Solidification of the role of the Guachthu'uq Water Committee, strengthened relationship with understanding of community.
1/02/2014-1/14/2014	Implementation	Implemented rainwater harvesting systems in two more homes in the community and made arrangements with future beneficiaries. Made improvements to pilot systems. Conducted water quality tests for bacteria. Held interviews with future beneficiaries and created relationship with municipality.

3.0 Travel Team

#	Name	E-mail	Phone	Chapter	Student/Professional
1	Pat Austin	Pat.austin@state.ma.us	508-284-4356	WPI	Professional
2	Laureen Elgert	lelgert@wpi.edu	508-450-3313	WPI	Professor
3	Michele Mensing	mlmensing@wpi.edu	732-977-3875	WPI	Student
4	Tom Moutinho	tjmoutinho@wpi.edu	207-831-7011	WPI	Student
5	Katie Picchione	krpicchione@wpi.edu	518-727-8024	WPI	Student
6	Tom Washburn	tmwashburn@wpi.edu	315-263-2363	WPI	Student

4.0 Health and Safety

4.0 Incident Reports

There were no health or safety incidents during this trip from any EWB-USA WPI travelers, CECEP volunteers, or community members involved with the project. Near the end of the trip there was one instance of traveler's sickness. That was resolved by plenty of rest and water.

4.1 Notes for Future Implementations

We introduced power tools to the community during this implementation: electric drill and saw. Proper instruction must be given to each user of the tool because many members of the community have never used power tools. Good practice would be to remove the battery from each power tool when it is not in use, because often kids in the community will pick them up to try and figure out how they work.

5.0 Budget

5.1 Expenditures

2014 Implementation Trip Budget

Item	Cost		Description of Cost
Currency	*Q*	*$*	
Airfare		3950.4	6 people, American Airlines
Airport Transport Boston		242	Worcester Limo, roundtrip
Ground Transport Guatemala		864.52	Roundtrip driver and van
Guatemala City Hostel		178.05	One night, nine people
Homestays		766.45	Ten nights, six people
Antigua Hotel		381.67	One night, four rooms
Translators		803.79	Ten days, two people, 300Q per day
Materials			Two full systems+two improvements
Pre-trip	13441.95	1712.35	
During trip	3912	498.3439	
Water Quality Tests		203	75 tests
Misc. Pre-Trip Costs		376.12	Gifts for people, preparation materials
Misc. During Trip Costs		254.1911	Printing, food, club items
Wire Charges for Sending Money		64	Through Western Union

TOTAL **$10294.89**

5.2 Source of Money

This trip's main source of funding came from the EPA P3 Phase One grant. Additional, secondary costs were funded through money from the EWB-USA WPI national account. The approximate cost distribution is show below.

EPA P3 Phase One Grant	$8963.23
EWB-USA WPI National Account	$1331.66

6.0 Project Discipline

This project is an ongoing water supply—storage project.

7.0 Project Location

Guachthu'uq is located on the outskirts of the municipality of San Cristobal, Alta Verapaz.

Longitude: 90º 29' 24.37" W *(Degrees, Minutes, Seconds)*
Latitude: 15º 22' 13.04" N *(Degrees, Minutes, Seconds)*

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Part 2—Technical Information

1.0 Executive Summary

Max two pages

1.0 Introduction

The report summarizes the goals and accomplishments of the January 2014 EWB-USA WPI Implementation trip. In addition, it will serve as a reference for future work on the project and implementation trips. The major accomplishments of this implementation trip included:

- Constructed rainwater harvesting systems on two homes
- Made necessary adjustments to the two pilot implementation systems
- Conducted water quality tests for existence of bacteria and harmful E. coli
- Interviewed twelve families to better contextualize the project's impact
- Facilitated community education on cross contamination and importance of boiling drinking water
- Finalized preparations to sustain large scale implementation in future trips

The travel team completed construction of two rainwater harvesting systems on the homes of Cristobal Coy Max and Oscar Vicente Laj. Oscar Vicente Laj's system needs follow up work which has been agreed upon to be finished during the May 2014 implementation trip. These two system implementations included certain newly redesigned aspects like a proper first flush, overflow, thinner concrete base, and more effective gutter clips. Work was done on the two pilot systems (January 2013) to make sure they stay up-to-date with adjustments made to the new systems. As a continuation of the water quality work done during the May 2013 assessment trip, additional water quality tests were also conducted to determine the difference, if any, in quality and drinkability of EWB tank, Government tank, and Finca water. Boiled and plain samples were compared to assess the community's boiling method. Extensive family interviews were conducted to gain insight on the project's impact, the community member's responses, and feedback on how we can operate better and sustain a mutually benefiting relationship between all parties involved. Finally, a large effort was made to ensure future implementations could be of larger scale and reach more families. This effect included figuring out bulk material orders before entering the country, creating a relationship with the San Cristobal Municipality to support our material transportation needs, and creating additional "contracts" to guide the families' home preparations before implementation.

3.0 Program Background

The Engineers Without Borders chapter at Worcester Polytechnic Institute aims to provide the community of Guachthu'uq, Guatemala with a sustainable, year round water supply. The community of Guachthu'uq is located in the Alta Verapaz region of Guatemala and is home to around 200 people in 36 families. Of the many problems they face daily, the absence of clean drinking water is the greatest concern. US Global Health Initiative reports that Guatemala has the highest child mortality rate in Central America due to severely contaminated water. The proposed program, Rainwater Harvesting: Guachthu'uq, will address these concerns using a holistic approach. EWB-USA WPI will focus directly on the water problem, and work with the community to learn more about environmental and social issues that affect their health and access to resources. When completed, this project will improve overall

community health and hygiene, and aims to better the quality of life for women and children who have the responsibility of collecting water.

During the dry season, approximately November to May, the community relies on a dam, located on a privately owned piece of land referred to as the Finca, which collects surface runoff water. This dam is located 1 km downhill from the nearest community home and 3 km downhill from the furthest home. Members from Guachthu'uq, Las Arrugas, and La Reforma use this source of water for drinking and washing clothes. In addition to being a contaminated source of water, the finca runs dry during the dry season, According to community members, this can impede water collection for a few days and occurs enough so that it creates a serious problem in the community. It is not fully known how often or for how long the finca water source runs dry; this will be a continued area of research on future trips. In 2009, 25 percent of the families in Guachthu'uq received rainwater harvesting tanks from the municipal government, which have been a beneficial form of additional water storage. However, improper design and implementation of these systems has led to a lack of routine maintenance and cleaning, which resulted in the systems inability to meet the drinking water needs of the Guachthu'uq community.
The first two assessment trips in the summers of 2010 and 2011 introduced our chapter to the members of Guachthu'uq and established a better understanding of their everyday life. Our team conducted in-house assessments, held community meetings, and conducted water quality studies. The trip also built the trust between EWB-USA WPI and the community necessary to helping with future communications and planning. Specifically on the second assessment trip in 2011, we conducted a community wide survey with the goal of determining a general water consumption rate for each family. Unfortunately, we were unable to find any trend that relates number of family members and water consumption across the community. Our team also thoroughly assessed the two homes chosen by the community for the pilot implementation. This included critical measurements of each home as well as in-depth discussions of the needs of each family.

One of the most critical tools developed during the first two assessments trips is our Excel model. This model looks at each home individually, comparing the average rainfall data for the area with the surface area of the roof and the survey data of family water consumption. We are thus able to predict a family's demand for water for an entire year, when their supplies will be depleted the most, and how much storage capacity is necessary to ensure sufficient water supply through the dry season.
Using the information gathered from the first two assessments, our Excel model results, and almost two years of research and design, our chapter constructed two pilot systems during our first implementation trip in January 2013. The aim of a pilot project was to ensure that our Excel model works properly and to provide a basis for future system design. Other benefits of a small scale implementation included setting up procedures for construction, and experimenting with community members working alongside our team in implementing the rainwater harvesting system. In order to accurately determine if these pilot systems served the families appropriately, a monitoring system was also established during this implementation trip. This monitoring system, which was conducted by a volunteer at our NGO, collected preliminary information on the success of the rainwater harvesting systems and verbal feedback from both families.

Our team completed the third assessment trip in May of 2013. The goal of this trip was to assess the success of the first implementation trip while also preparing for a second implementation. The monitoring system that had been established during the January implementation had evolved over the

months into a bi-weekly survey that asked residents about their water consumption habits. Follow-ups were conducted with the two pilot homes to ensure the systems were functioning correctly and, most importantly, fit each family's daily needs.

The team laid extensive groundwork with the community to ensure a successful, large scale future implementation. The relationship with the in-country partners was defined and strengthened. Our team spent a great deal of time in Guachthu'uq conducting census surveys, holding formal community meetings and informal "hangout" time in order to gain more community trust and understanding. Our team then reassessed the ten homes selected for the next implementation and met with the families of each home to ask about water use habits and to discuss preferred placement of tanks. Necessary details were also worked out with local hardware stores and water tank vendors to ensure availability of materials. The next step for our chapter and the community of Guachthu'uq is a large-scale implementation of ten rainwater harvesting systems in May 2014.

4.0 Trip Description

Specific goals were chosen for this implementation trip to address both the quantity and quality of water delivered by the EWB-USA WPI designed water harvesting systems. Additional work was done to ensure the successful continuation of the project on a larger scale in future trips. The major accomplishments of this implementation trip are listed below, followed by a general day by day itinerary.

1. Constructed rainwater harvesting systems on Cristobal Coy Max's home (27) and Oscar Vicente Laj's home (1). Both implementations included two tanks, first flush, overflow, gutters, and concrete base.
2. Conducted water quality tests to compare the bacteria in EWB tanks, and government implemented tanks, and various locations along the Finca stream. Boiled and plain samples were compared.
3. Facilitated education of the community about boiling water, separating containers, the operation of a first flush, and and maintaining a clean system.
4. Evaluated the effectiveness of the project in the community and learned about the social and political relations in the community through family interviews.
5. Finalized preparations to sustain large scale implementation on future trips.

The team's translators for this trip were organized through CeCEP (as always) and were Abelino and Alvaro. They were each compensated 300Q per day.

Day 1—Thursday, January 2nd

- Flight Boston→Guatemala City.
- Extreme weather caused delays; team stayed in Hostalios Logos Bed and Breakfast in Guatemala City.

Day 2—Friday, January 3rd

- Van transport Guatemala City→San Cristobal

- First team meeting at CeCEP with Sucy, Abelino, and Alvaro
    - Discussed plans for community meeting
    - Discussed plans for trip
- Went to Sucy's to check out the materials that had been purchased by Alvaro and Sucy in advance.

Day 3—Saturday, January 4th

- Trip to Millennium Hardware to gather thoughts on ordering more materials.
- Met with the Finca manager Don Julio to ask about using his access road (main road to community was having construction done).
- Finalized implementation plans with Cristobal Coy Max (27) and Oscar Vicente Laj (1).
- Held community meeting to reiterate goals of the project and goals of the trip.

Day 4—Sunday, January 5th

- Water quality tests were conducted on the EWB and government tanks at Roberto Chojob's home as well as the Finca water.
- In depth assessments were conducted at a few of the May 2014 homes to solidify plans for implementation.
- Re-evaluated the pilot systems at Roberto and Cristobal's homes to make plans for necessary improvements/adjustments.
- Put in large PVC order with Millennium for all tank connecting, first flush, and overflow materials.
- Cristobal Coy Max and Oscar Vicente Laj made necessary preparations for construction (clearing land, etc.).

Day 5—Monday, January 6th

- Construction materials were transported to Guachthu'uq for free by help of the San Cristobal Municipality. Additional materials were purchased at Macsam's (free transport with purchase).
- Concrete base was poured at Cristobal Coy Max's and the concrete base at Oscar Vicente Laj's was repaired.
- Water quality tests were evaluated.

Day 6—Tuesday, January 7th

- Gutters on both implementation homes were installed.

Day 7—Wednesday, January 8th

- Conducted family interviews.
- Duplicated water quality tests on Roberto Chojoc's system.
- May 2014 home assessment.
- Inventoried every tank in the community and photographed each home's roof.

Day 8—Thursday, January 9th

- Met with the Mayor of San Cristobal to gain future municipality support.
- Conducted family interviews.
- Connected tanks and installed first flush at Cristobal Coy Max's home.

Day 9—Friday, January 10th

- Completed rainwater harvesting system at Cristobal Coy Max's home with installation of overflow.
- Completed temporary rainwater harvesting system at Oscar Vicente Laj's home with installation of first flush and overflow.
- Conducted family interviews.

Day 10—Saturday, January 11th

- Toured Finca property, visited source, and took water samples to test.
- Conducted further water quality tests.
- Made improvements to Roberto Chojoc's pilot system and government system (first flushes and mosquito netting).
- Conducted family interviews.
- Finished home assessments for the May 2014 Implementation.
- Final community meeting.
- Dinner at Sucy's house.

Day 11—Sunday, January 12th

- Conducted family interviews.
- Took inventory of materials left at Roberto Chojoc's house.
- Collected signatures on contracts for finished implementations and preparations for May.
- Discussed possible improvements to the monitoring process with Alvaro.

Day 12—Monday, January 13th

- Van transport San Cristobal→Antigua
- Free afternoon in Antigua.

Day 13—Tuesday, January 14th

- Flight Guatemala City→Boston

5.0 Community Information

5.1 Description of Community

Steal/update from previous forms.
→Katie/Washburn, link to appendix with updated community profile

Guachthu'uq (pronounced Goo'atch-TOO) is a small community of about 200 people, located near the city of San Cristobal in the mountainous, impoverished Alta Verapaz region of Guatemala.

Here, rain falls most heavily during the winter, between May and August. Summer, the dry season, takes place in March and April. Water security is most tenuous during the dry season, when obtaining water from any source is a daily challenge. With few lakes or streams, natural water resources are in short supply. People in Guachthu'uq and other villages that do not have access to municipal water from San Cristobal rely on a few limited natural springs and individual rooftop rainwater harvesting systems to meet their water needs.

There is one spring near Guachthu'uq, located on an hacienda called *Finca la Primavera*, literally *Spring Farm*. Though the public is not allowed onto the Finca La Primavera property to access the spring, the water flows into a public water basin located just outside the Finca La Primavera. This water basin is called the *finca* since the water originates on the farm. However, the amount of water flowing into the finca can be controlled from the source on the Finca La Primavera property.

For some families in Guachthu'uq, the finca supplies the only source of water for all their needs: drinking, cooking, bathing, washing clothes and dishes. Depending on how far up the hill a family lives, a trip to the finca takes 30 minutes to two hours. Women and children (and occasionally men) spend up to six hours a day collecting water and washing laundry at the finca.

In the past, Guachthu'uq's local governing body, the Community Development Council, known as the COCODE (Consejo Comunitario de Desarrollo), has helped provide families with less expensive tanks for rainwater harvesting systems. The president of the COCODE is up for election every two years. He is responsible for developing policies and programs to benefit the village. The COCODE formed about seven years ago, around the time ownership of the finca changed, to initiate a program through which members of the Guachthu'uq community could purchase a tank and roof structure subsidized by the Municipality of San Cristobal. As a result of EWB's activities in Guachthu'uq, a Water Committee formed to act as an authority through which families can participate in EWB's program. The Water Committee holds authority similar to the COCODE.

5.2 Community Relations

Describe relationship with community during implementation. Identify key contributors. Discuss misunderstandings.

6.0 Project Summary

Commented [M1]: This will be the meat of the report. I changed its format quite a bit from what EWB-USA wants. If this trip had been purely implementation/construction, it would have been appropriate, but since we had so many other things going on it's better that we organize this section to our own needs.

6.1 Construction and Logistics

→Moutinho

What was built. Where we got materials. Any issues we ran into (how resulting implementation was different than planned). Add photos in as necessary.

Materials Acquisition, Storage, and Transportation

Construction

The general procedure of implementation of our rainwater harvesting systems is most efficiently implemented as a series of step. Although each house is differently and requires slightly different plans for implementation the process remains relatively constant.

The location must first be prepared for the system. On this trip we asked the home owners to prepare their land based on the plans that we discussed with them about the design and location of their system. The location of the system is based on the shape of the house (most obviously the slope of the roof) and the contour of the land. Many of the homes are not build to be level and one corner of the roof is lower than the other corner. The slant of the roof perpendicular to the slope of the roof is also a large factor in determining where the system will best fit. This often requires cutting away and leveling the land to provide adequate height for the tank down spout and first flush. All foliage that is in the area is cleared.

The location is then prepared for the concrete base. First 1-2 inches of gravel is laid on the cleared land. This provides a compact surface for the concrete to adhere to and additional drainage that may reduce erosion directly adjacent to the base. A wood frame is next constructed to create a base that will either hold 1 or 2 tanks. The wood boards used are 4 inches in height; however and adequate base thickness is 3 inches. The wood is set one inch into the gravel and leveled. The rebar is next places into the frame. The rebar is laid in a square grid with a bar roughly every foot. It is important to ensure that the rebar is not touching the wood frame because exposure of the steel will cause an increases rate of corrosion and may cause damage to the base. The rebar is ideally in the middle of the concrete base. To achieve this, the rebar is propped up with rocks. Larger rocks with a diameter of about 2 inches are next placed in the frame to consume space and reduce the necessary volume of concrete. The concrete is mixed in wheelbarrows and poured into the frame. The concrete that we used on this trip was ready mixed concrete bags. One based for two tanks used roughly 30 bags.

The gutters are attached using wood supports. We use 6 inch wide by 1 inch wood planks. A notch the size of the bottom of the gutter is cut out of the plank and then it is cut to length. The planks are attached to the vertical supports on the house to ensure stability. Many supports require additional support in the form of another board extending from the middle of the plank to a lower point on the vertical support of the house. The highest gutter support is secured first and then the lowest gutter support is placed on the other side of the house. The height of the lower support is determined by stretching a string from the first gutter support and then holding a level to ensure there is roughly a 2 degree angle. The string is left in place and the middle gutter supports are put into place. The gutter is place on the supports. They are adjusted as needed and then the gutter slope is tested by tossing water onto the roof and watching it flow out of the gutter.

Tank connections, first flush, overflow→Michele

Cristobal Coy Max, House 28

A complete system was implemented at Cristobal's house.

- (2) 2500 liter Rotoplas tanks
- (1) First flush
- (1) Overflow

- Gutters
- Additional roofing materials (10 Pieces)
- (1) two tank concrete base

Oscar Vicente Laj, House 1

The team did not complete Oscar's house because Oscar planned on changing his house in April. The team discussed with Oscar that if he changes his house to adequately accommodate the location of the existing concrete base, the next team in May 2014 would be able to help complete the system. At temporary system was implemented:

- (1) 2500 liter Rotoplas tank
- (1) First flush
- (1) overflow
- Two tank government base repaired

In May the team finish the implementation and the complete system will have the follow:

- (2) 2500 liter Rotoplas tanks
- (2) First flush
- (1) Overflow
- Gutters
- (1) two tank concrete base

Improvements to Pilot Systems of January 2013

In our first implementation trip in January of 2013 the team did a pilot implementation on two homes, Roberto Chojoc house [##] and Cristobal [insert last name] house [##]. It has become part of each trip to add any new aspects of the rainwater harvesting system design. This trip we implemented two first flushes at Roberto's house and improved his overflow system. At Cristobal's house we attached more roof area to his existing tanks, added a filter to two older government tanks, and tried to help seal entry holes into his government tanks. Each Roberto and Cristobal paid 5% of the cost for the materials we provided. Both Roberto and Cristobal are key members of the community and provide important support for the team when in country. It will continue to be part of our project to improve their systems on each trip.

Preparation for Future Trip

Logistics

Meeting with the Mayor to gain municipality support

Talk about the meeting with each of the next eight homes

Signed contract—link to later section about community agreements

Left-over Materials

Inventory of those at Roberto's and contract

Inventory of those at CECEP

6.2 Water Quality Testing

→ Michele

Procedure and results. How actual was different than planned.

Of all the tests taken, the only ones that had blue colonies were from the CeCep Tap and the finca wash basin discharge. There were, however, samples that fluoresced. The reason for this is believed to be because the sample size for the Petrifilm test was 1 mL as opposed to the 10 mL sample sizes of the Coliform tests. This is a significant sample size difference. Considering that the 10 mL Coliform test was qualitative, therefore only needed to show a minute sign of *E. Coli* to be positive, and that the Petrifilm test was qualitative, the smaller sample size could have prevented enough *E. Coli* growth for visible colonies.

In comparing the tanks, it can be noted that the EWB tanks have generally less bacteria growth and can be considered safer to drink from than the government tanks, and the finca. However, boiling the water proved to be a successful method of eliminating all bacteria and *E. Coli* no matter the source. This assures that the community members are boiling the water well enough.

In regards to the finca, the water travels above ground from the spring box, to the weir and then travels both above ground the finca basin and through piping to the finca tap. The water at the source has almost no traces of bacteria and no *E. Coli,* but by the time it reaches the finca it has collected both bacteria and *E. Coli,* reaching a maximum in the basin. Without boiling this water, it is not suggested that it is used for drinking.

6.3 Interviews

Interview Methodology (with key vocabulary words)-- Mensing

Summary of key findings-- Washburn

- Conflict of the Finca
- Current Habits
- What looking to gain
- Relationship with Don Domingo
- Past Project corruption
- Success of EWB project in community eyes

Link to entire transcripts in appendix

There is an important distinction between having a *tank* and having a working rainwater harvesting *system*. Systems must be designed to provide water throughout the year. Otherwise, one cannot say the quantity of water is adequate. Ensuring the system will work is different from helping a family afford a tank. For a given home, roof size, tank size, and number of family members all relate to how much water is captured and how much is used daily. Along with average rainfall, these factors must be considered to design an appropriate system. A tank with no gutters or a too-small roof will not be able to collect enough water to meet needs and will rarely be full. Proper rainwater harvesting systems reduce the time and energy spent collecting water by ensuring that drinking water, at the least, will always be available on site.

The skills community members possess are valuable for building and maintaining rainwater harvesting systems. In interviews, community members expressed displeasure with tanks and systems from past projects. One man said he had been educated in construction at a local vocational school and he was so displeased with a tank system a previous project had constructed that he planned to dismantle and rebuild it properly.

EWB students found that many community members have experience in construction. Once we presented our system designs, the community members got right to work. They took charge of setting up the frame for the base, cutting wood and rebar, laying concrete, and raising gutters. What is more, they made further modifications. Roberto modified his system from last implementation trip to essentially turn the overflow into a first flush. Cristobal Cojoc rearranged his system to feed into two smaller tanks. He also painted his roof to improve quality. Both technical skills and knowledge of system design have elevated some community members to new political status. Members of the Water Committee are considered experts on building rainwater harvesting systems.

In interviews, community members identified conservation practices as a major reason some people have more access to water than others. Some people know how to conserve water, and therefore have more of it than people who are wasteful with water. Many families interviewed claim to use tank water only for drinking and finca water for washing.

Knowing how to clean tanks is also important. There is currently no standard procedure for tank maintenance, but the interviews revealed that some families physically scrub the inside of the tanks every few months and use chlorine to disinfect the water on a weekly or biweekly basis. Many families inquired as to how frequently tanks should be cleaned and what process should be used. EWB is currently analyzing the effectiveness of different methods. In the meantime, through visual observation, it was clear that the more frequently a tank is cleaned, the cleaner the water is.

Family demographics play a role in water security in terms of household size, skills, social networks, and family history. Household size suggests a minimum amount of water a family needs. The World Health Organization recommends that a six-foot tall male needs to drink at least three liters of water daily. Each person requires water for bathing and washing clothes. Age can also affect access, since children often help collect water from the finca. Families who have relatives in the community sometimes have increased water access. During the rainy season in particular, families who have tanks tend to share water with their relatives. This type of social networking draws attention to the importance of family in the community.

Money, an elephant in the room, is a controversial social topic in Guachthu'uq since it is inextricably bound to political practices and technical infrastructure. Few community members mentioned money in interviews except to ask how much a system from EWB costs or to comment on the cost of previous systems.

At face value, money enables or prevents a family from being able to afford a rainwater harvesting system. Many families rent the land they live on and pay for commodities like electricity. If a streetlight is located on a family's property, they must pay to maintain that also. As can be expected of impoverished areas, the struggle for money is visible in the rough wooden walls of one-room homes, the clothes and shoes, or lack thereof, simple meals cooked over an open wood fire, to name a few indicators. Without the support of government programs or organizations like EWB, the cost of

rainwater harvesting systems, particularly tanks, is out of the budget for many families. Some families are able to pay people to collect water for them.

6.4 Update on the Finca

Commented [M2]: These might be closely related. Might need to consider reorganizing.

Perhaps the most surprising testimony revealed through the interviews was the common fear that access to the finca will be completely restricted. During the summer, when most families rely on the finca for both drinking and washing, it often runs dry. During the day, water evaporates and is used up quickly. Therefore, families make trips to the finca in the middle of the night. Nearly all women interviewed confessed regularly waiting on line at the finca at 3:00am to wash clothes before the water is gone. Unsurprisingly, verbal skirmishes often break out, tempers run high, and the finca becomes a contentious source of conflict.

Many claim that people from outside the community, the free riders, also visit the finca at this early hour. During the dry season, San Cristobal periodically turns off municipal water access in order to conserve. Citizens of Guachthu'uq claim that people come from as far as the outer districts of San Cristobal to use the finca during these times. Their sense of justice is enraged that people who have access to municipal water, albeit, limited access, come to take water from the finca, which is used by people who have no other access. Not long ago, a leader from the village just downhill of Guachthu'uq allegedly connected a pipe to the finca and channeled water partway down the mountain to the other village. This too was met with disdain.

Recently, other social issues have arisen around the finca. Cleaning the finca is an issue that came up time and again in interviews among leaders in the community and in a conversation with the manager of the Finca La Primavera, who holds boss status as the spokesperson of the owner. Community members claim to regularly help clean scum out of the finca; the manager claims he does most of the work himself. All agree only on the fact that far fewer people tend to the finca than take water from it. Garbage is regularly left around the washing station at the finca. Once, animal viscera were found strewn in and around it. Community members claim these are the activities of free riders. None are pleased with the abuse of public access.

Consequently, one walkway to access the finca was closed, and rumors fly that access to the finca will be entirely restricted if these problems are not resolved. Since the source of the finca water is located on the property of the Finca La Primavera, it would be easy for the owner to divert water flow. The manager of the Finca La Primavera and the COCODE tried to form an agreement to respect the finca, but were unable to compromise. If the owner decides to cut off public access to the finca, both the people in Guachthu'uq and others who rely on the finca will find themselves wanting of water security. All will suffer because of the actions of a few: the tragedy of the commons.

During the implementation trip, a significant number of changes occurred. The first encounter with these changes occurred on January 6th when the traveler's team first arrived in Guachthu'uq. The gate to the entrance of the finca (The plantation access road) had be shut and padlocked. These events forced members of the community to use an alternate access path, which was longer and less direct into the community.

During a conversation several days later with Elidia Esperanza Xona Yuja the travelers came to find that this closure had happened within the past few weeks, but it appears that it was not the first time in the communities history. Elidia expressed the fact that while the change was an inconvenience most people

were not overly concerned with it because the community still had access to the water source. As the conversation continued Elidia informed the travelers of some of the current issues with the finca. She informed us that somebody in one of the communities who uses the finca had been dumping animal carcasses by the water source. Through interviews during the trip, the animal carcases contamination expanded into chicken guts as well. It is not yet known if the contamination and closure of the gate to the finca were related. Elidia also informed me that the manager of the finca, Dom Julio) had been attempting to set up a meeting with the surrounding communities including Guachthu'uq, surrounding the finca, however the local political figure in the community (Dom Domingo) refused to agree to such a meeting.

Several members of the women's committee in the community, including Elidia, had made attempts to set up this meeting with Dom Julio however there was not a large enough show of support to have a meeting. Elidia expressed that there was not enough support from the rest of the community (She hinted at the men) to drive this meeting to occur. The started the conversation that there are gender perspectives associated with the finca.

Throughout several other conversations with community members, it was confirmed that many families in the community get up at 1,2,3 or 4 in the morning during the dry season to get water. In fact not only does it happen, but it is also very common. Rarely is water left in the finca during the dry season at 5:30 or 6 in the morning

Tensions with the finca and the people who use it mostly occur during the dry season when there is a lack of water. Waiting to use the finca or for water frequently causes tension with its users. Also, when the water is low community members become angry when "waste" water washing clothing so that others don't have any to drink. Through the interviews, it also became apparent that when water is rationed in the city of San Cristóbal, people with access to municipal water come to the finca for water when their taps are not working for half of the day. As one might image, this causes outrage among the community members. Not only does this occur with people from the city, but has also caused problems between those who have tanks in the community and those who do not. Mostly these disagreements end up in shouting matches where foul words are said.

During an interview with Juan Cac and Marcela Cal the topic of the fincas cleanliness came up. The travelers were informed that the women are responsible for cleaning the wash stations and the men are responsible for cleaning the creek, which feeds the finca. Apparently 3 to 4 times each year community members from Guachthu'uq and the surrounding communities get together to clean the finca really well. However, only around 25 men show up to actually participate in this cleaning and a community member lists participants. This person is currently unknown to us. These details are not concrete because during a later interview with the finca manager, Dom Julio, that he did most of the cleaning of the finca with only the help of a few others and he has been trying to promote this. One can infer that participation in this cleaning is mainly based upon each individual community member's perspective of cleanliness. Some community members said that it was dirty, while others stated that it was fairly clean.

Midway through the week during an interview with Ana Yuja and Elidia's wife Roberto, husband of Elidia, returned home from work with news about the finca. Roberto had a conversation with the finca

manager Dom Julio about opening the gates to allow passage of the buses, which run between San Cristóbal and the community. During January the main roadway was under construction and therefore the buses could not access the community. Since access to this service is so critical to the community, Dom Julio agreed to open the gate for bus passage back and forth to town only, not for accessing the finca. Roberto also informed us that the leader of the community "Las Arugas" had inserted a T into the tap, a PVC pipe that brings drinking water to the finca from up above the wash station. This man had been diverting a significant amount of water directly to his home. He apparently also opened the valve more than it was supposed to be opened in order to divert more water. These actions had sparked a lot of tension, but it is unclear if this is related to any of the other ongoing at the finca.

Later in the week Don Julio took us onto the fincas property to see the source of the finca. A computerized sketch is included noting the location of objects in this discussion. During this trip it was confirmed that the finca is indeed a spring, which is located round 150 yards from the finca wash station. The water then runs to down to a bog, then finally into a small man made dam and finally flows at a rapidly towards the wash station. Located at the dam is the beginning of the source of the PVC tap, which provides the drinking water for the community members that utilize the finca. It is also good to note that there is an on/off valve to the PVC pipe located on the planation's property. The bog is one of the main areas of concern because of the plant and algey growth on the water. It is also infested with bugs and mosquitos, which could be sources of contamination. A drainage ditch has been dug on the slope that leads down to the finca. Apparently during large rainstorms water actually flows from the upper fields down towards this low point, but the trench diverts the water so that it enters the stream below the dam. Finally there were several hoses located on the slope need the source of the finca. These hoses according to Dom Julio were used to pump water to the houses on the plantation, not to drain water from the homes.

During the trip a few other general facts came up. First of all in the life of the community there have been 3 owners to the finca. The last change of ownership occurred about 6 years ago and at that time access everything above the wash station was cut off to the community. In the past community members had been able to go right up to the spring to get their drinking water.

Also it came to our attention that the wash station and PVC pipe are actually located on public property. Only the spring is located on the private land of the plantation.

6.5 Education

Using water quality tests to instill need for boiling. Separation of containers for implemented families.

The images of our updated education posters should go here. Along with the fact that we talked to Alvaro, Sucy, and Abelino about each and any improvement we could make. We did not actually distribute these posters.

On the first day of the trip we met with our local NGO CeCep to discuss our plans for education. We brought four posters with us. The topics of these posters were, maintaining clean gutters and roofs, separation of containers, the importance of boiling the water and cleaning the first flush systems. Our NGO contacts told travelers that the posters needed to have more pictures and fewer words. Single word captions should be used for the poster in pocomchi and in Spanish. They also informed us that it

would be best to teach general education during a community meeting and with just a few posters to pass around, rather then giving one to each individual family. More specific education, like teaching the community to use the first flush systems properly needed to be done one on one with the families. This was because families would need practice with their personal systems and the first flush education is irrelevant for any family without the system.

Throughout the week the travelers worked to educate the community members during our interviews, while building the systems and while conducting water quality tests.

While conducting interviews the travelers learned that most people boiled their drinking water properly. Most boil their drinking water for 15-20 minutes at a rolling boil. See Section 6.2 for the results of the water quality testing for more information on boiled water quality. While interviewing the community midwife, María Mo, the travelers learned that she acts as a community health educator and attends seminars in San Cristóbal about health and sanitation. María Mo then communicates this knowledge to others in the members of the community. In the future EWB-WPI is hoping that she will work with us to continue educating the community since she already serves this purpose in the community.

Water quality tests were conducted throughout the trip and in numerous locations. While conducting these tests, the travelers worked with Elidia Esperanza Xona Yuja because she was willing and already had a tank implemented by EWB-WPI. Elidia is also a very social person in the community and would share the knowledge that she has. As the travelers tested the water explained to her what the purpose of the test. Elidia then helped to prepare several of the water samples so that she could understand how the test was conducted. In the future EWB-WPI needs to find a better way to explain the tests to the people in a more understandable manner. The concept of bacteria and microbes was too abstract for Elidia to totally understand.

When the results of the test were in the next day, a clean test tube verses a contaminated test tube became one of the best teaching tools. The community members were able to see a color change with the contaminated water and were able to associate it with bad practices and the clear water with good practices. One of the travel members choose to explain the results of the tests by associating the contaminated test tube with stomach pains that occur in the community by drinking water of poor quality. The clear tube was associated with good practices like boiling water and feeling healthy. Between a more basic explanation and the physical test tube with results, the family better understood the message that EWB-WPI was trying to convey to them. Some of the families were even more interested in the water quality because they were better able to understand how the water plays an impact on their health.

The topic of separation of containers was exposed to the community of Guachthu'uq during this trip. It became apparent during the interviews with community members that this was a new topic and idea to them. Many of the families understood the concept and why it was a good idea. The community expressed to us that something like this was not common practice because many families only have 1 or 2 tinajas to collect water. Limiting the family to 1 container to collect water from the finca could almost double the amount of time that it currently takes to collect water from the finca. It became apparent that the way EWB-WPI educates the community members about separation of containers

needs work and input from the community. The travelers also realized that educating families about separation of containers will need to happen as families receive their tanks and will be something that will need to happen over time.

Tom talk about education during the construction of the systems

7.0 Final Implementation Agreement

→Michele will do this section because I have all the signed contracts.

8.0 Lessons Learned

→Everyone

Organize by subject and then give useful advice. So there might be one section about Homestays, one about Travel, one about Construction. Imagine you will be traveling for the first time—what useful information would you want?

During interviews, it is useful to have one person speaking and one taking notes to avoid confusion.

Spanish is useful to know, but everyone is very accepting when you try. Whether in the homestays or the community, taking the risk to speak as well as you can is appreciated, and people don't expect that you will always know. Learning a few phrases in Pocomchi also helps. Time and again, when I thanked or greeted people in their own language, I could tell it was meaningful.

"Culture shock" is a phrase that seems to mean "you will be shocked by a culture you have never experienced." However, I found that the culture shock was worse coming home. Guatemala showed me a new way of life; coming home, I saw American culture differently. The effect America has on the rest of the world and the similarities between the perceptions and the truth shocked me most.

DO NOT DRINK THE WATER. Bring extra toothbrushes. Be prepared to take only a few showers the whole time. You only need a few pairs of clothes, although layers are definitely helpful, as well as a warm coat.

If you get sick, it's better to not do things you really aren't up to. I tried to plug through when I got sick, chalking it up to my stomach disagreeing with a certain type of food. I decided I would still try to work, even though I wasn't 100%. Ultimately, I got very little done, fell asleep cold on the floor at CeCEP, and puked on the steps of the church. It would not have been wise to go up to the community that day.

Education – On the trip one of the biggest things that the travelers learned is that education is going to work both ways. As much as we are educating the families on how to build the systems or maintain their water quality, they are also teaching us. Often times our community builders know more about how to build these rainwater-harvesting systems then the travelers do. For example the community members have taught us how to make more effective gutter clips out of wood. In fact the ones used on this past trip were designed by one of community members whose house was implemented on by EWB-WPI back in January of 2013. Right now two men in the community are learning how to design these

systems for other homes with the travelers help. During this past trip, they sometimes did not even need or saw a problem that the travelers did not foresee. One of these men even asked the travelers for a first flush for his own system before he had even heard of one. He said to us, "What I need is something that is going to collect the dirty stuff on my roof before it enters the tank, so that just clean water flows into the tank.

The travelers learned that some education can happen in a group, for example boiling water and cleaning their roof, while other topics like the first flush need to be taught to each individual family as they receive a tank. The families will need the one on one education and training on how to use the technology and to understand some difficult concepts.

While the travelers do educate when in Guatemala, a lot of the education needs to happen when EWB-WPI is not in Guatemala. For this reason EWB-WPI needs to continue to train community members so that there is an expert in the community in one field or another. Roberto Chojoc and Crístobal Laj Cojoe have become lead designers and contractors for these systems. They understand how the systems function and what needs to done to a home so that a new system can be implemented. Oscar Vicente Laj, Crístobal Coy Max, Ricardo Jor Xona, Ricardo Gualim have all helped with construction and have learned the entire process through construction at some of their houses. During this trip the travelers began training Elidia on how to test the water quality. In the future EWB-WPI would like to use María Mo as an educator because she already serves this purpose. In future trip EWB-WPI needs to continue to develop these talents so that the members of the community have someone to continue teaching them when EWB-WPI is not in Guatemala.

During the implementation trip, the travelers decided that EWB-WPI needed to be in charge of making the difficult choices. Through the interviews the corruption with past water projects was discovered and many community members are happy that EWB-WPI is in charge of this project because it is a just and fair system. However, a few past and current community members were attempting to bend the rules. One woman, whose home was to be implemented on, moved out of the community. She felt that she deserved a tank even though she no longer lived where EWB-WPI was working. Decisions like these need to remain in the hands of someone outside of the community if the project is to remain just.

Interviews – During this trip the interviews were conducted differently than in the past. On this trip, the travelers choose to strategically pick certain families to interview instead of going to every family to ask a series of specific questions. With these families the travelers spent between an hour to 2.5 hours spending time with each of the families. The interviewers had a list of general topics to bring up during the interviews. The interviewers allowed the interview to merge into a conversation. As the conversation got deeper and more detailed the interviewers were able to ask some specific questions in order to retrieve the information needed. In doing this, the conversation was brought to an entirely new level. The community members felt more comfortable and the interviewers were able to extract tons of really relevant information. Many times this brought up really important topics and information that never would have been discussed with the interviewers simply asking questions. After learning some of this prevalent information, the topics for discussion could then be modified so that more information on this topic could be discussed during the next interview. Overall this proved to be a huge success with the travelers gathering more information then ever before from the community. These

interviews also helped EWB-WPI to bond with the community like never before. On more then one occasion the interviewers were invited into the families homes and served a drink or snack. In the future methods like this need to be used for gathering information, rather then simply asking specific questions that community members may or may not understand.

9.0 Project Status

Implementation continues.

10.0 Completed Project Monitoring

10.1 Completed Project Status Table

Project Type	Project Discipline	Date of Completion	Functionality	Periodic Maintenance	Demonstration of Knowledge Transfer
Rainwater Harvesting	Pilot Implementation	January	100%	Yes	Yes

10.2 Project Functionality Indicators

10.3 Periodic Maintenance Indicators

10.4 Demonstration of Knowledge Transfer Indicators

10.5 Additional Information

During this trip the travel team worked closely with the two home owners of the pilot project implemented in January 2013: Roberto Chojoc and Cristobal Laj Cojoc. They were instrumental in the successful implementation of the two systems during this trip, demonstrating a significant amount of knowledge transfer. They each also said they clean their systems regularly. [DETAILS ON HOW ROBERTO/CRISTOBAL CLEAN THEIR SYSTEMS]

Improvements were made by EWB-USA WPI to each of their systems to keep them up to date with the current progression of the rainwater harvesting project. On Roberto's system the team installed two first flushes (one of the government tank and one on the EWB tank), added mosquito netting over all the gutter openings, and provided Roberto with the necessary valve to fix his EWB tank's overflow. Because of Roberto's involvement with the implementation, and his family's help throughout, we considered his above and beyond work to be payment for the 5% of the additional materials.

For Cristobal's system, the team provided him with various parts (about 200Q) so he could fix some of his system issues. The team also gave Cristobal the option to receive a first flush in May 2014, since he was not able to see the ones implemented during this trip before the team left.

Commented [M3]: The template from EWB-USA has this split up into separate tables. So we can either go with this, or just scratch and it keep it as a narrative like in section 11.5 Additional Information.

When the team implemented at Cristobal's home in 2013 the club thought Cristobal owned a government tank, so the decision was made to only implement one tank. In reality, that government tank is owned, and was taken, by a relative of Cristobal's who lives on the same plot of land. If that knowledge had been clear before the pilot implementation, Cristobal would have received a two tank system. This is a lesson for future implementations that it is of utmost importance to clearly understand the existing water situation at each home, because it is not uncommon for a family to have tanks that they do not own.

Both Cristobal and Roberto asked the travel team for an additional tank. The team's decision and response was that the project needed to stay fair and transparent, so our efforts had to be put towards others in the community before returning to the pilot systems. Cristobal asked for another tank because his son-in-law took the tank that EWB originally thought belonged to Cristobal; leaving Cristobal with just the EWB implemented tank. Roberto's reason for asking for more tanks was that his eldest daughter would be married soon and they were building her a house on his land. The team told him that his daughter's house would then be added to the list of homes eligible for rainwater harvesting systems. The team also told Roberto that because of his immense help to the project during construction and planning for future implementations (he took the entire week off of work to help, when we had only asked that he spare a few days), we would think of another way we could try to help him in the near future that would maintain the sense of the project's fairness and transparency within the community.

11.0 Next Phase of the Program

→Anyone

What are we doing next? Brief description about the goals of the May trip.

12.0 Professional Mentor Assessment

Something that Pat/Laureen would write. We don't need it for our purposes of this report.