

530 – Pre-Monitoring & Evaluation Report



Community:	Guachtuq
Country:	Guatemala
Chapter:	Worcester Polytechnic Institute
Project ID(s):	6871 WORCH-S-GUAT-00687
Submittal Date:	March 20, 2016
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Acknowledgements

The Project Leads and Mentor Team acknowledge that:

EMG The chapter reviewed the accompanying [530 – Pre-Monitoring & Evaluation Report Instructions](#) for accurate completion of this report.

KEM The PMEL lead has reviewed the [901B – Program Impact and Monitoring Report](#) Template as well as previously submitted versions and is prepared to complete the report on the upcoming trip. The chapter acknowledges that the completed 901B is required with the eventual submittal of the [531 – Post-Monitoring & Evaluation Report](#).

KEM The PMEL lead acknowledges that the [905 – Program Logic Framework](#) is required as an appendix to the 901 and 901B reports.

EMG The 600 – Health and Safety Plan Part I is submitted as a separate document with this report.

EMG The most current contact information is updated in this report and all other reports included with this submittal.

EMG Any new or additional member to the Mentor Team, has included their resume, [404 – Mentor Statement of Intent](#), and [408 – Application to become a Professional Mentor](#) for an EWB-USA Project.

EMG If the team intends for this to be the Final Monitoring & Evaluation Trip for the Program, the travel team is prepared to obtain signatures from the community acknowledging that the chapter will not return. The chapter is aware of the [907 – Community Acknowledgment of Closeout](#) for use as a guideline.

We, the project team leadership confirm that the above information and tasks have been completed and that this report does its best to prepare our chapter for the activities planned in the monitoring & evaluation (M&E) phase of this project.

Evelyn Grainger



3/20/2016

Project Lead Printed Name

Project Lead Signature

Date

Rodney Rookey

Mentor Printed Name

Rodney Rookey
Mentor Signature

3/20/2016

Date

Or

Faculty Advisor Printed Name

Faculty Advisor Signature

Date

It is the responsibility of the Responsible Engineer In Charge (REIC) to ensure that the team's preparation for this Pre-Monitoring & Evaluation Trip meets a reasonable standard of care for a project of this type. I have reviewed the subject project. I am qualified by education and experience to design and evaluate this type of project. In my best engineering judgement, this report does its best to prepare our chapter for sufficient data collection activities planned in the monitoring & evaluation phase of this project.

Rodney Rookey

REIC

Printed Name

Rodney Rookey

REIC Signature Date

3/20/2016

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Part I –Administrative Information

1.0 Contact Information

Correspondence regarding report reviews will be sent to the emails listed below.

Project Title	Name	Email	Phone	Chapter Name or Organization Name
Project Lead	Evelyn Grainger	emgrainger@wpi.edu	845-249-8847	EWB-USA WPI
President	Katherine Picchione	krpichionne@wpi.edu	518-727-8024	EWB-USA WPI
Responsible Engineer in Charge	Rodney Rookey	rodrookey@gmail.com	860-982-6567	Centurion Waterproofing, Inc.
Traveling Mentor	Rodney Rookey	rodrookey@gmail.com	860-982-6567	Centurion Waterproofing, Inc.
Faculty Advisor (if applicable)	Laureen Elgert	lelgert@wpi.edu	508-831-5452	EWB-USA WPI
Planning, Monitoring, Evaluation and Learning (PMEL) Lead	Kerry Muenchow	kemuenchow@wpi.edu	720-878-1397	EWB-USA WPI

2.0 Budget

Expenses Category	Estimated Expenses	Estimated Expenses
Direct Costs		
<i>Number of Travelers</i>	9	9
<i>Cost of Airfare (per person)</i>	800	600
<i>Hotel in Antigua</i>	12	12
Travel		
Airfare (total)	\$7,200	\$5,400
Flight Insurance (total)	\$360	\$360
Taxi to/from BOS	\$335	\$316
Taxi to/from GUA	\$654	\$654
Travel Logistics Sub-Total	\$8,549	\$6,730
CeCEP (Lodging and Support)		
Transportation to Antigua	\$118	\$118
Antigua Hotel	\$108	\$108
Homestays	\$1,812	\$1,647
Translators	\$1,647	\$1,373
Monitoring	\$588	\$588
Food & Beverage & Gifts	\$661	\$400
Food & Lodging Sub-Total	\$4,708	\$4,708
Contingency		
Medical Expenses	\$100	\$0
Local Taxis	\$50	\$0
Contingency Sub-Total	\$150	\$0
Project Materials & Equipment		
System Adjustments	\$1,871	\$1,871
Other Materials	\$120	\$120
Education	\$200	\$200
Water Quality Tests	\$450	\$450
Project Materials & Equipment Sub-Total	\$2,641	\$2,641
EWB Fees		
QA/QC	\$500	\$500
EWB Fees Total	\$500	\$500
TOTAL	\$16,548	\$14,579
	High Estimate	Low Estimate

3.0 Project Discipline(s)

Water Supply

- ☐ Source Development
- ☒ Water Storage
- ☒ Water Distribution
- ☐ Water Treatment
- ☐ Water Pump

Sanitation

- ☐ Latrine
- ☐ Gray Water System
- ☐ Black Water System
- ☐ Solid Waste Management

Structures

- ☐ Bridge
- ☐ Building
- ☐ Retaining Wall

Civil Works

- ☐ Roads
- ☐ Drainage
- ☐ Dams

Energy

- ☐ Fuel
- ☐ Electricity

Agriculture

- ☐ Irrigation Pump
- ☐ Irrigation Line
- ☐ Water Storage
- ☐ Soil Improvement
- ☐ Fish Farm
- ☐ Crop Processing Equipment

4.0 Professional Mentor Resume(s)

Rodney's professional experiences make him well suited for this type of project for many reasons. Rodney has 5 years working as an employee for a Construction Company that primarily installed concrete driveways, sidewalks, stairs, patios, pool surrounds, foundations. His duties included all aspects of the installation process from digging the hole, to forming, installing and compacting the subgrade material, installing the rebar and/or mesh, pouring and finishing the concrete.

Rodney then obtained an Associate Civil Engineering degree and upon graduation opened Northeast Industrial Floorings, Inc. (NIF) in 1984. NIF is a premier epoxy flooring contractor in the Northeast US. Not only do they install state of the art resinous floor systems and concrete repair, they also polish concrete.

Fifteen years ago, Rodney opened Centurion Waterproofing, Inc. (CW). CW installs a methyl methacrylate base spray applied waterproofing system. Primarily used under the ballast on railroad bridges as well as underneath asphalt on road bridges. Some projects completed by CW are waterproofing both tubes of the Queens Midtown Tunnel, the Triboro Bridge, center tube of the Lincoln Tunnel, various ports of the Manhattan, Williamsburg and Queensboro bridges, the Calvin Cooledge Bridge in Northampton, MA to name a few.

Rodney's duties at both companies, included blueprint reading, cost estimating, contract negotiations, union negotiations, material estimating, material procurement, project scheduling, all aspects of project management, equipment repair, punch list review and final project closeout.

Rodney's personal experiences also make him well suited for this type of project.

Rodney has been involved in racing of many types since an early age. He obtained his first motorcycle at the age of 9 and began racing motorcycles at 14. He eventually purchased a Porsche and raced that for many

years. In 1995 Rodney's son Ralle began racing go karts then atv motocross, now cars. During this time Rodney has maintained many different race vehicles as well as a wide array of construction equipment.

Rodney has completely remodeled 2 multi-family homes, renovations are down to studs, new electrical and plumbing (copper and pvc), roofing, and siding.

Rodney was a General Contractor for his 6,500 SF office/warehouse facility which included all site work and the design of a 5,000 SF radiant heating system.

Rodney helped design and install water collection systems at both brothers homes. This included shooting grades, installing pvc piping, installing a system.

This explains why Rodney is a great technical mentor for the May Monitoring trip to Guachtuq. A General Contractor is a good technical mentor, and his experience with construction management makes him ideal for this monitoring trip. Rod has lots of experience doing General Contractor, project management and people skills specifically valuable to the implementation. Included below is Rod's Resume:

RODNEY A. ROOKEY
278 East Street North
Suffield, CT 06078
(203) 668-6093

Experience:

1982 to Present	NORTHEAST INDUSTRIAL FLOORINGS, INC. Vice President, Co-Owner. <u>Duties include:</u> Equipment operator, driver, project management, material procurement and estimating.
1992 – Present	CENTURION WATERPROOFING, INC. Vice President, Co-Owner. <u>Duties include:</u> All administrative duties, laborer, driver.
1980 to 1982	BOUTIN CONST. ASPHALT PAVING COMPANY Laborer.
1975 to 1980	AYOTTE BROS. CONCRETE CONSTRUCTION Laborer, Driver.
1973 to 1977	NICHOLSON FUNERAL HOME Facilities, Maintenance.

Education:

Springfield Technical Community College
Associate's Degree - 1984
Major: Civil Engineering

Other:

Appointed to Who's Who of Community Colleges.
Math Tutor for Math Department.
Dale Carnegie Sales Course.
Dur-A-Flex University
Elite Crete Applicator Training

Hobbies:

Motorcycling, Auto Racing.

Part II – Pre-Monitoring and Evaluation Report

1.0 Executive Summary

Engineers Without Borders-USA Worcester Polytechnic Institute (EWB-USA WPI) is requesting approval to complete a Monitoring and Evaluation trip from May 7-23, 2016. The assessment trip involves the 34 rainwater harvesting systems within Water Supply Project 6871.

The May 2016 Monitoring and Evaluation Trip will focus on three major goals: (1) to empower community members to independently operate and maintain the rainwater harvesting systems via a training and certification program; (2) to make minor system adjustments for the purpose of improving water quality, quantity, and access; and (3) to ascertain whether the community's goals have been met and to continue project monitoring through water quality tests, interviews, system inspections, and focus groups. EWB-USA WPI will clearly communicate to the community that, following an additional six-month monitoring period, the club, community, and CeCEP will evaluate whether the program can be closed. Activities undertaken on the May 2016 Monitoring and Evaluation Trip will lay groundwork for the next six months of monitoring and provide insight as to whether six months will be a sufficient time frame for project closeout.

The proposed trip aims to collect information primarily for EWB-USA WPI and the community of Guachtuq to determine whether the project has met the community's goal of improved water quality, quantity, and access. If monitoring data fails to show that this initial goal has been fulfilled, EWB-USA WPI will continue to address any problems that may be preventing this objective from being achieved. Additionally, the project aims to collect information that may be useful to EWB-USA, major donors, WPI, and other NGOs looking to implement similar projects.

The program began in 2009 when EWB-USA WPI partnered with Guachtuq, a community that expressed lack of water security as a pressing problem. The Water Supply [Rainwater Harvesting] Project is the only open project in the Guachtuq program. EWB-USA WPI has partnered with the local NGO, El Centro Comunitario Educativo Pokomchi (CeCEP), which provides cultural information, translators, a work space, and communication with the community when the team is not in Guatemala. EWB-USA WPI identified individual rainwater harvesting systems as the most technologically and culturally appropriate solution to the problem. Community members previously gathered water from the *finca*, a large water basin located on private property at the bottom of the community. Since identification of this solution and modification to meet individual family needs, EWB-USA WPI has worked with community members to build systems with 34 families. The first two systems in the community were built in January 2013. Following that trip, the previously built 2013 systems were modified and two more systems were constructed in January 2014. Modifications were made to the design including the addition of the first flush and mosquito netting, the use of bulkhead connections to replace open holes with pipes, and an increase to the diameter of the overflow pipe. In May 2014, an additional eight systems were built. To finish the implementation phase, 22 systems were constructed in May 2015. Since the final implementation, a team from CeCEP has regularly visited the community to monitor all of the systems over the past year. Since the May 2015 implementation, each system has been inspected at least twice through this biweekly monitoring process.

On the May 2016 trip, monitoring and evaluation will be completed through several methods. EWB-USA WPI will conduct physical inspections of the systems to determine if any are experiencing problems that were not identified through past monitoring. Focus group discussion sessions will be held with various groups of community members, including women, men, children, and community leaders, to gather information on the community's views of and experiences with the program. In addition to focus groups,

individual interviews will be held to gather information about the experiences of specific community members. Water quality testing will also be conducted to determine if the water supplied by the systems has improved from the previously available source, the *finca*. A training and certification program will be held, focusing on system maintenance and operation to ensure that community members feel complete ownership of their systems and know how to troubleshoot problems that may arise. Community members certified through this program will work with the travel team to repair known technical problems, thus establishing their role as technical experts within the community who will help ensure the long term sustainability of the project.

Following the May 2016 Monitoring and Evaluation Trip, the program will enter a six-month monitoring period where the in-country monitoring team from CeCEP will continue using the monitoring system that has been successfully been in place since October, 2015. During this period, EWB-USA WPI will continue to receive information regarding the systems and will take a hands-off approach, encouraging CeCEP and the community to take the lead on solving any problems that arise. The information gained during this monitoring period will be used to determine if the certification program and other training within the May 2016 Monitoring and Evaluation Trip made community members independent enough to operate and maintain their systems. A major focus of this monitoring period will be to observe community independence and confirm that any system adjustments made during the May 2016 Trip are working effectively. At the end of this six-month period, if monitoring proves that the community is ready to maintain the systems independently and that all of the small modifications are working effectively, then the community, with the help of CeCEP, will sign the closeout agreement.

2.0 Projects to be Monitored and/or Evaluated

Project Type	Project ID Number	Project Discipline	Date of Completion
Water Supply	6871	Water Storage	5/22/15

3.0 Scope and Scale of Evaluation

3.1 Primary Purpose

The two-fold purpose of the May 2016 Monitoring and Evaluation Trip is to evaluate whether the 34 rainwater harvesting systems implemented by EWB-USA WPI are providing community members sufficient quantity, quality, and access to water to meet needs, and to ensure that community members have the skills and knowledge to sustain the systems in the long term. EWB-USA WPI will use a variety of methods to determine if this goal is being achieved and will assist community members to troubleshoot where this goal might not be fully met. The work of previous trips in conjunction with the continued maintenance and upkeep will be evaluated, providing insight to where EWB-USA WPI could improve in future work on EWB-USA projects.

3.2 Primary Audience

Though there are many parties that have varying degrees of interest in the outcomes of this project, the primary audience is the team of community members, CeCEP volunteers, and EWB-USA WPI members who have worked tirelessly to bring it to fruition. The information collected on this trip, in conjunction with data collected on past trips, can indicate both the successes and shortcomings of the project. All three parties are responsible for the degree of success of the project and, while many lessons have already been learned, all can glean insights into best practices for future projects and sustainability.

Other audiences are also worth noting briefly. EWB-USA can utilize the data collected on this trip and the cumulative data from previous trips to measure the impact EWB projects have on communities. Our chapter, EWB-USA WPI, is interested in applying lessons learned to future programs. Finally, CeCEP will benefit from the outcomes of this project as they facilitate future projects and maintain a long-term relationship with the community members.

3.3 Evaluation Scope

The May 2016 Monitoring and Evaluation Trip will study all three components of the community water goal of improved water quality, quantity, and access. EWB-USA WPI will work with community members to evaluate the 34 rainwater harvesting systems via technical inspections, water quality testing, and qualitative data collection.

To study water quality, EWB-USA WPI will conduct water quality testing on all of the systems and the *finca*, the previously used water source for the community. The water quality testing will identify if the water quality from the EWB-USA WPI systems is of better quality than the *finca*. The tests will also provide comparisons between different homes. EWB-USA WPI intends to also look at systems that have previous water quality data to see if there is a change over time in the quality of water. More information on the procedure and rationale of water quality testing can be found in Appendix B. The template used in the physical monitoring can be found in Appendix C.

To study water quantity and access EWB-USA WPI will inspect the systems to determine the amount of water in the systems. EWB-USA WPI will spend more time on homes that have technical problems or are not being well maintained or cleaned. This will be compared to past monitoring data on other trips as well as the monitoring data collected by our in country monitoring team. Interviews will help to determine the change in the quantity of water available to community members and obtain personalized perspectives on the project impact and process. Focus groups held by EWB-USA WPI will provide a community scale view of the change in quantity and access to water. Interview and focus group procedures and questions can be found in Appendices D-H.

3.4 Evaluation Scale

The EWB-USA WPI travel team will work with the majority of the community during the monitoring and evaluation of the water project. The team intends to briefly interview at least one representative of each of the homes with a system, conduct physical inspections of each system, and take water quality tests. As the systems exist at individual homes, it is intended that each system will be evaluated. Results with a high level of accuracy are expected in water quality measurements as turbidity tests and two sets of bacterial testing will be performed on each system. Community cooperation, such as people not being home or unwillingness to talk to EWB-USA WPI members due to social or political conflicts, may preclude interviews at some homes.

Additional analysis will be done on systems that have been in the community for multiple years, as the club has existing data on these systems and can provide insight into the short-term sustainability and maintenance of the systems. Water quality data of previous years will be compared to May 2016 results and previous system monitoring and interviews will be used to compare the current state of the system. The only data available for systems built in May 2015 is what has been collected by CeCEP volunteers since October 2015.

EWB-USA WPI will conduct a focus group of 6 to 8 men to gain insight on the maintenance of the systems. Men in the community often work outside of the community and are not present during the week but are an integral part of system maintenance. Men are responsible for cleaning gutters, flipping tanks, and other larger system repairs. It is only expected to see the majority of the men in the community for four or five days of the entire trip. Due to the lack of men in the community on a regular basis it is unclear how many men we will have the opportunity to work with in the focus groups which could potentially lower the amount of information collected from this target group. We intend to meet with 6-8 men in a focus group. Additional information regarding men's focus groups can be found in Appendix D.

EWB-USA WPI will conduct 4 focus groups with 6 to 8 women to gain knowledge about the maintenance and the impact of the systems on the lives of individuals and in the community. Since the women are often the ones who perform the maintenance on the systems, it is important to gauge their knowledge of the systems as well as the type and frequency of maintenance being performed at each house. With information collected from this group in both individual interviews, focus groups and past monitoring, the qualitative data collected from this group is expected to be extensive in determining system impact on achieving the community's goals. Additional information regarding women's focus groups can be found in Appendix E.

Through two children's focus groups, EWB-USA WPI will gain information about how the project has impacted the children's lives. The number of children will depend on availability of children at the time the focus group is held. EWB-USA WPI ideally would like to have 10 to 15 children included in each focus group. Additional information regarding the children's session can be found in Appendix F.

EWB-USA WPI is intending to meet with the COCODE, the governing body of the community. Through a focus group with the COCODE, EWB-USA WPI intends to target the leadership of the community and assess their capabilities in problem solving social, political and system related problems. Additional information regarding the COCODE meeting can be found in Appendix G.

EWB-USA WPI intends to conduct 16 individual family interviews. Through the interviews, EWB-USA WPI aims to determine the impact of the systems on the lives of the community members, to understand individuals' knowledge about the systems, and to evaluate system maintenance and technical weaknesses. Additional information regarding the rationale on families chosen and interview questions can be found in Appendix H.

4.0 Evaluation Framework

4.1 Evaluation Focus

During the May 2016 Monitoring and Evaluation Trip, all levels of the logical framework will be evaluated. The elements of change outlined in the Program Logical Framework include: changing the way community members use, perceive and obtain water; encouraging periodic maintenance of tanks, gutters, roofs, first flushes and overflows; and emphasizing community involvement in designating time, effort and resources to system maintenance. On the trip, these three elements will be addressed through: (1) ongoing educational discussions and the training and certification program, (2) system repairs and minor modifications, and (3) quantitative and qualitative data collection, including water quality testing, interviews, and focus groups.

To evaluate how the perception and use of water has changed in the community, the chapter will hold focus groups with leaders, men, women, and children in the community as well as conducting 16 individual family interviews. Information about the maintenance done on the tanks will be gathered through system inspections along with information from interviews and focus groups. By comparing the state of the physical systems with the information about how often and how families maintain their

systems, the chapter can assess the quality of periodic maintenance on the systems installed in the community.

The community's willingness to designate time and resources to system maintenance will be addressed through the certification program, facilitated by the chapter. Participants in the certification program will learn how to inspect, troubleshoot, and repair a system. There will be three trainings for men focused on gutters, tanks, and the first flush respectively. Women will have a single, separate training session focused on regular maintenance and technical problems that are easy to repair. They will then earn a certificate at a graduation-like ceremony after completion of the program. Community participation in the certification program will indicate the willingness of community members to dedicate their time to these systems, which ensure the sustainability of the project. Additional information on the certification program can be found in Appendix I.

The Change in Public Health cannot be directly measured, although an improvement in water quality can attribute to improved public health. Water quality data collected on the trip will be compared with data from previous trips to evaluate the impact of the project on not only the changes in the quality of water in addition to the quantity of water available to the community. Additional information on water quality testing can be found in Appendix B.

4.2 Key Questions

A chart with stakeholders and questions can be found in Appendix J.

4.3 Methods of Data Collection

EWB-USA WPI will use a variety of methods for data collection, both quantitative and qualitative. The primary methods of data collection include interviews, focus groups, water quality testing, and physical system monitoring.

Focus Groups/Interviews

Data will be collected from community members through focus groups. There will be 4 focus groups composed of women, 2 focus groups composed of men, 2 focus groups composed of children, and one focus group with CeCEP and leaders of the community. Questions will be specifically targeted for each of these demographics, and will be focused on gathering information regarding system maintenance and project effectiveness. In addition, 16 family interviews will be conducted to acquire more specific information concerning individual systems. Additional information on focus groups and interviews can be found in their respective appendices.

Men's Focus Group will gather information regarding the men's abilities to repair systems. It will be used to evaluate of the male community members' current understanding of the rain-water collection systems. This is important to ensure that maintenance and repairs can be made without the aid of EWB-USA WPI.

Women Focus Groups will focus on maintenance tasks that do not require large amounts of physical labor. In addition, information will be gathered regarding how the women community members view the impact of the project.

Children's Focus Groups will aim to gather information from the children of the community about their perspective on project outcomes. Information will be gathered through activities and games, and will pertain to system maintenance and project effectiveness. Through the activities created, such as games, it is expected that the children's responses will potentially portray a more accurate response.

Community Leader (COCODE) Focus Groups will aim to evaluate the changes in community dynamics. They will focus on evaluating the impact of the systems and project on the community as a whole. In addition, they will also focus on gaining an understanding of the community's perspective of the project's strengths and weaknesses.

Additional Information will be acquired from families through interviews. Unlike focus groups, interviews will focus on individual systems rather than all systems in the community. Questions will pertain to system maintenance, how quality of life has improved, and problems encountered with individual systems.

Water Quality Testing

Water quality testing will be used to compare the quality of water in the systems to the quality of water in the *finca*. Coli-ert and Petrifilm tests will also test for e-coli and other harmful bacteria to ensure water quality is optimal for drinking. Turbidity tests will look at particulate matter in the water using a turbidity meter. Turbidity tests will be used to evaluate the existing filters and the alternative filters that may be installed. Additional information on water quality testing can be found in Appendix B and additional information on changing filters can be found in Section 8.1 System Modifications: Filters.

Physical Inspections

Physical inspections of all systems will be used to collect both quantitative and qualitative information regarding the systems. The inspections will be similar to the information collected by our in-country monitoring team at CeCEP to allow it to be comparable to the previous data collected. The in-country monitoring team has collected information regarding connections, gutters, first flush, filters, and system maintenance. The data collection sheet for physical inspections can be found in Appendix K.

5.0 EWB-USA Project Monitoring

5.1 EWB-USA Project Status Table

Project ID	Project Type	Project Discipline(s)	Date of Completion	Functionality			Periodic Maintenance	Demonstration of Community Capacity
				0-50%	51-75%	76-100%		
6871	Water Supply	Water Storage	5/22/2015			x	yes	yes

5.2 EWB-USA Project Functionality Indicators

Project ID	Project Type	Project Functionality Indicator
6871	Water Supply	Number (or percentage) of community members satisfied with the project
		Quantity of water available to each household during dry and wet seasons
		Quality of the water at the water point

5.3 Periodic Maintenance Indicators

Project ID	Project Type	Periodic Maintenance Indicator
6871	Water Supply	Level of cleanliness of gutters feeding a rainwater harvesting system
		Level of cleanliness of water storage tanks

		Observed evidence of routine maintenance on the system done accurately without EWB-USA WPI
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5.4 Demonstration of Community Capacity Indicators

Project ID	Project Type	Community Capacity Indicator
6871	Water Supply	Community completed major repairs to the system accurately without EWB-USA WPI
		Chapter observed community members training others
		Existence of broken components

6.0 Roles and Responsibilities

Name	Role/Title	In-Country Specialty	In-Country tasks	Anticipated Completion Date
Laureen Elgert	Social Science Mentor	Focus Groups and Interviews	Development and execution of focus groups and interviews. Organization of collected information.	Throughout trip
Rodney Rookey	Technical Mentor/REIC	Technical Inspection/updates	Inspection of all existing systems. Leading community members to execute system updates	Throughout trip
Evelyn Grainger	Project Lead	Project Lead	Coordinate all project, monitoring, and evaluation efforts in the community.	Throughout trip
Amanda Gatz	Veteran Traveler	Water Quality	Take water quality tests at selected homes and locations in the community, analyze results and maintain the field incubator.	Turbidity testing: when filters are implemented, one week after filters are implemented Colilert & Petrifilm: May 10, 12, 16, 18
Aaron Pepin	Veteran Traveler	Filters & Repairs	Inspection of all existing systems and leading community members to execute system updates and replace existing filters with new filters.	Filters changed May 10, 11 Repairs not completed in certification program May 18, 19, 20
Andrew Petit	Health and Safety Officer	Separation of tank	Work with families to implement the separation of tanks on appropriate homes	Within first week of trip
Alana Sher	Health and Safety Officer	Certification & Education	Work with Abelino to execute Certification Program and work with individual family members to improve community	Saturday May 14- Tuesday May 17 with preparation prior and planning for ceremony after

			knowledge of maintenance of systems.	
Kerry Muenchow	PMEL Lead	Interviews & Focus Groups	Execute interviews and focus groups with selected groups and individuals within the community and organize the resulting data	Throughout entire trip
Evelyn Grainger	Project Lead	Community meetings	Execute community meetings to communicate updates on the project	May 8, 21
Sucely Ical Lem	Executive Director of CeCEP	Organization of trip logistics	Work with Evelyn to ensure project completion and logistical functionality.	Throughout entire trip and prior to trip
Abelino Cal	Translator and Teacher at CeCEP	Certification program instructor	Execute a rainwater harvesting system training and maintenance certification program for members of the community.	Saturday May 14- Tuesday May 17
Edgar Gua	Translator	Translate	Translate for interviews, focus groups, or for update teams in the community.	Needed for entire trip

7.0 Assumptions and Risks

Transport of materials:

While this is not an implementation trip, there are still logistics that need to be organized and planned. Materials needed for this trip include valves for the separation of tanks, and filters to replace the current cellulose filters (see Section 8.1 for details on planned minor technical adjustments). Potential difficulties include shortage of materials in country and potential theft or loss of materials. Last year EWB-USA WPI had problems with deliveries being late and preventing work from being accomplished. Beginning modifications early in the trip will allow for time if material problems arise.

Water Quality Errors:

While testing the water quality of the implemented systems, the team understands that potential errors may occur especially in regards to testing bacteria growth. Although the team will be well educated in testing procedures before travel, there is concern that tests may return misleading data through either false positives or conflicting data. EWB-USA WPI will be analyzing test results and cross checking them with previous data collected. If any tests have a large discrepancy with previous data or show poor water quality such as a level four or five, water tests will be rerun.

EWB-USA WPI will be using a turbidity meter to ensure that the newly implemented filters are functioning properly in removing sediments. This meter will be tested before being utilized in Guachtuq to guarantee that performance is optimal. The turbidity meter could get confiscated or stolen. Additionally, technical difficulties of operating the turbidity meter may be a concern.

Lack of Community Participation

A large assumption made by the team for this trip is there will be a high level of community interest and involvement in the monitoring of this project. Many of the planned methods of data collection to support the indicators depend on the involvement of the community. If community members are unwilling or unable participate in interviews or focus groups, it could be difficult to evaluate the social impact of the

project. A lack of willingness to participate in an interview could inhibit collection of data relating to important indicators of the system impact and system knowledge on an individual level. The chapter has continued working with CeCEP to maintain a constant monitoring process between annual trips. Because of this ongoing monitoring, the chapter has accumulated a large amount of individual system information and data, which may help fill information gaps if there is a lack of community participation in individual interviews. Translators for the interviews and focus groups will be confirmed ahead of time with CeCEP.

It will be difficult to facilitate community empowerment through knowledge transfer without participation in the certification program. To prevent lack of participation in the certification program, the chapter developed the idea to create a certificate and ceremony of recognition upon completion of the program. This will be an incentive for community members to participate as there is a high value associated with earning a certificate or official recognition in Guatemala. The team is also requiring that community members who plan to participate in the certification program put down a small collateral to gauge community interest and adjust the program for the number of participants.

Technology Failure

Working in Guatemala the team faces technology failures as a barrier to success. Computers, wifi, and phones will be used. On previous trips phones have broken, laptops have gotten viruses and the wifi has been down for extended periods of time. These are all challenges the EWB-USA WPI team anticipates to face again this year. Backing up documents and depending on technology as little as possible will make the team less likely to run into this problem. Paper records will be kept of interviews, water quality data, and system inspections and will be organized into binders by focus.

Community Dependence

During the May 2015 Implementation Trip, there were requests made by community members for additional tanks, systems, and supplies. This suggests that some community members have become dependent on EWB-USA WPI. During past trips and through internet communication, EWB-USA WPI members have noticed an increased dependency on the club. This is expected to be EWB-USA WPI's last time in the community. These community requests could increase as the community learns this is the last time EWB-USA WPI will be working there. This attitude from community members may deter the project from its goal of developing a system that community members can self-sustain. Increasing community interest in taking ownership of the systems through the certification program and including community members in physical monitoring will decrease the dependency on EWB-USA WPI.

Weather

The team recognizes that there are several issues that could result due to inclement weather. Guatemala is divided into three main regions: highlands, pacific coast, and jungle. The team will be spending most of the time in the highlands region. In this area, the rainy season occurs from May to October. This may cause travel throughout remote locations difficult due to poorly maintained roads. Additionally, during this time of year temperatures can drop sharply at night. The best way the team can prepare for these conditions is to bring appropriate clothing, which consists of lots of layers and rain gear. Another measure the team can take is to plan tasks that need to be completed outdoors for the morning, as rainstorms usually occur in the late afternoon.

Team Sickness or Injury

While traveling throughout Guatemala and working in the village of Guachtuq, the travel team is at risk of contracting diseases common to the country, acquiring illnesses resulting from the tropical location, and exposed to the possibility of several accidents. While these are all possibilities, the EWB-USA WPI will do much to ensure that the risks of these situations are minimal. In order to mitigate the possibility of contracting water-borne or food-borne diseases, EWB-USA WPI will utilize food and water transported to the site from previously designated safe sources. In the past food and water has been provided by homestays

within San Cristobal and there have been few health issues in the past. In order to avoid contracting diseases and parasitic organisms, all team members will be advised to be vaccinated for typhoid, hepatitis A, and hepatitis B.

Heatstroke, dehydration, and sunburn are all concerns for the trip as well. It is important for all team members to stay hydrated throughout the trip and use sunscreen. In the case that a member of the travel team is physically injured, the team has two designated health and safety officers: Alana Sher and Andrew Petit. One of these health and safety officers will have a medical kit in his or her possession at all times. Additionally, each group within the travel groups will have a smaller medical kit. If an injury or sickness is beyond the scope of the capabilities of the travel team, the Hospital Nacional is located only three minutes from CeCEP and Dr. Cortave's private clinic is located 8 minutes from CeCEP.

8.0 Schedule of Tasks

The chart below outlines a general itinerary for the travel team including the various tasks that will need to be accomplished during the May 2016 Monitoring and Evaluation Trip. Each row indicates a half day and each column represents a different traveler. There is unspecified times that will be used by the travel team as the team sees fit.

	1	2	3	4	5	6	Rodney	Laureen
Saturday 5/7	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
5/8/2016	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP
	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting
5/9/2016	turbidity testing	turbidity testing	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
	turbidity testing	turbidity testing	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
5/10/2016	system inspections	turbidity testing	interviews	filters	filters	system inspections	filters	interviews
	system inspections	water testing	interviews	filters	water testing	filters	filters	interviews
5/11/2016	separation of tanks	filters	interviews	filters	separation of tanks	interviews	filters	interviews
	separation of tanks	separation of tanks	interviews	separation of tanks	Water reading	Water reading	separation of tanks	interviews
5/12/2016	Certification Prep			separation of tanks	water testing	water testing	filters	
	Certification Prep	COCODE focus group	COCODE focus group	separation of tanks			separation of tanks	COCODE focus group
5/13/2016	Certification Prep		interviews	Certification Prep	Water reading	Water reading		interviews
	Certification Prep		interviews	Certification Prep				interviews
Saturday 5/14/201	certification program			certification program				
	certification program	Children's focus group		certification program	Children's focus group	Children's focus group	certification program	Children's focus group
5/15/2016	certification program		Men's Focus Group	certification program				Men's Focus Group
	certification program			certification program			certification program	
5/16/2016	certification program		Focus groups	certification program				Focus groups
	certification program		Focus groups	certification program	water testing	water testing	certification program	Focus groups
5/17/2016	certification program		Focus groups	certification program	general education	general education		Focus groups
	certification program		Focus groups	certification program	Water reading	Water reading		Focus groups
5/18/2016	Graduation Prep	Graduation Prep		Repairs	Repairs	Repairs	Repairs	
	Graduation Prep	Graduation Prep		Repairs	water testing	water testing	Repairs	
5/19/2016	turbidity testing	turbidity testing	interviews	Repairs	Repairs	Repairs	Repairs	interviews
	turbidity testing	turbidity testing	interviews	Repairs	Water reading	Water reading	Repairs	interviews
5/20/2016	general education	general education	general education	general education	general education	general education	general education	general education
	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
Saturday 5/21/201	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep
	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting
Sunday 5/22/2016	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
5/23/2016	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel

The chart below outlines the items in the itinerary that are not flexible and must occur at the times indicated. These times are unable or difficult to change and include things such as travel and already scheduled meetings.

	1	2	3	4	5	6	Rodney	Laureen
Saturday 5/7	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
5/8/2016	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP	CeCEP
	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting
5/9/2016	turbidity testing	turbidity testing	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
	turbidity testing	turbidity testing	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
5/10/2016	system inspections	turbidity testing	interviews	filters	filters	system inspections	filters	interviews
	system inspections	water testing	interviews	filters	water testing	filters	filters	interviews
5/11/2016	separation of tanks	filters	interviews	filters	separation of tanks	interviews	filters	interviews
	separation of tanks	separation of tanks	interviews	separation of tanks	Water reading	Water reading	separation of tanks	interviews
5/12/2016	Certification Prep			separation of tanks	water testing	water testing	filters	
	Certification Prep	COCODE focus group	COCODE focus group	separation of tanks			separation of tanks	COCODE focus group
5/13/2016	Certification Prep		interviews	Certification Prep	Water reading	Water reading		interviews
	Certification Prep		interviews	Certification Prep				interviews
Saturday 5/14/	certification program			certification program				
	certification program	Children's focus group		certification program	Children's focus group	Children's focus group	certification program	Children's focus group
5/15/2016	certification program		Men's Focus Group	certification program			certification program	Men's Focus Group
	certification program			certification program				
5/16/2016	certification program		Focus groups	certification program				Focus groups
	certification program		Focus groups	certification program	water testing	water testing	certification program	Focus groups
5/17/2016	certification program		Focus groups	certification program	general education	general education		Focus groups
	certification program		Focus groups	certification program	Water reading	Water reading		Focus groups
5/18/2016	Graduation Prep	Graduation Prep		Repairs	Repairs	Repairs	Repairs	
	Graduation Prep	Graduation Prep		Repairs	water testing	water testing	Repairs	
5/19/2016	turbidity testing	turbidity testing	interviews	Repairs	Repairs	Repairs	Repairs	interviews
	turbidity testing	turbidity testing	interviews	Repairs	Water reading	Water reading	Repairs	interviews
5/20/2016	general education	general education	general education	general education	general education	general education	general education	general education
	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections	system inspections
Saturday 5/21/	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep	Departure prep
	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting	community meeting
Sunday 5/22/20	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel
5/23/2016	Travel	Travel	Travel	Travel	Travel	Travel	Travel	Travel

8.1 System Modifications

To leave the community members with the highest quality, quantity and access to water, minor modifications will be made to the systems. These modifications include separating systems at the bottom of two tank systems to allow water to be conserved when cleaning as well as making it easier for families to flip the tanks over to clean them. The filters that were put on the system are in poor condition and community members have raised concerns about the quality of water resulting from the filters.

Separation of tanks

Community members with two tank systems that have a PVC connection at the bottom of the tank (shown in Figure 1), attached to the tap have expressed the concern that water security, especially during the dry season is compromised due to the inability to preserve water in one tank while cleaning the other. During the May 2015 Implementation Trip assessment was completed on previously implemented homes. One home did not have water in the tank due to the inability to flip the tank on its side for cleaning purposes. The family cut the PVC tank-to-tank connection at the bottom next to an elbow. This made it impossible to glue back together after cleaning and required the family to depend on the *finca* again. EWB-USA WPI assisted the family with the repair but became cognizant of this as a potential reoccurring problem if a solution to this problem was not developed.

EWB-USA WPI has determined the best method to separate tanks to mitigate both problems raised by community members is to use two unions and a ball valve to make the PVC located at the bottom of the tank separable, allowing tanks to be isolated from the system. Additional information on how EWB-USA WPI intends to complete the separation of tanks can be found in Appendix L, M, and N.



Figure 1 A two tank system qualified for the separation of tank modification to enable families to isolate tanks for improved cleaning and water security



Figure 2 The bottom of a two tank system cut next to an elbow to enable the family to flip the tank resulting in a system unable to properly store water

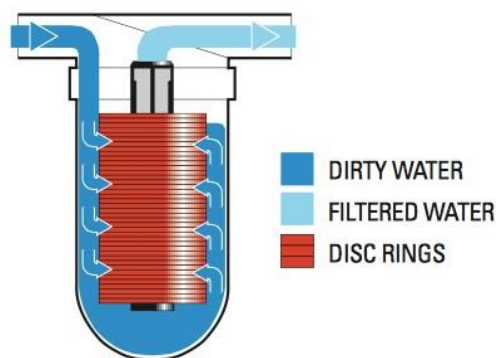
Filters

The community is currently using cellulose filters that came with the Rotoplas tanks to filter the water before boiling. The cellulose filters are not meant to last longer than six months, costing an additional \$34 USD per filter which is not economically feasible for many families in the community. The community has expressed concerns with the existing filters, breeding bacteria, ripping, having a dark color compared to implementation, as well as smelling foul. Although the purpose of a cellulose filter is, by definition, to purify water, there is a potential for water quality to decrease when using cellulose if filters are not replaced

within a certain time frame (namely a period of at least six months with proper maintenance). Since these filters can also not be reused, this presents an obvious problem in terms of cost as most community members will not be able to afford the constant price of replacing their filters. As such, the community members may continue reusing their existing filter, and, by doing so, will likely cause the water quality of their system to become unsafe for drinking. It is for these reasons, that EWB-USA WPI believes the current filters are not appropriate for these systems and should be replaced with a better design or removed altogether.



EWB-USA WPI has found a filter available in Guatemala that is already used by one family in the community as a replacement to the cellulose filter. The filter is currently being tested by EWB-USA WPI to confirm that it will be a better alternative to the current filter. Preliminary water testing was completed on a Netafilm Disk Filter which is comparable to the disk filter available in Guatemala. It follows the same principle. As dirty water enters the filter, the water pressure increases which compresses a group of rubber disk rings. The compression of the disks forces the water to flow through the grooves on the disks where sediments are filtered out of the water. This allows the clean water to pass through, as shown in the image below.



EWB-USA WPI will continue testing this filter, including completing biological tests to confirm that this is the best option for the community. If the filter tests determine that the filter is not an improvement to the current filters in the community, EWB-USA WPI will encourage families to remove their filter cartridges from the system. EWB-USA WPI will assist any families with either the change of filter cartridge from the cellulose to disk filter or the removal of the filter.

Appendices

Appendix A –Draft 907 – Community Acknowledgment of Program Closeout

We, the representatives of Guachtuq and CeCEP understand and acknowledge that the EWB-USA program with Worcester Polytechnic Institute is closing and that the chapter members will not be returning to work on any projects in the program.

The EWB-USA chapter has provided the following:

- Monitoring and evaluation of the project(s), (project title(s) – include all implemented), for a period of not less than one year post-construction.
- Project-specific operations and maintenance training in Spanish & Pokemchi
- A manual of operations and maintenance for all projects in Spanish & pictorial diagrams
- As-built drawings of implemented projects to Guachtuq in Spanish.

Representatives of Guachtuq acknowledge the following ongoing community responsibilities:

- Pay for 100% of the costs to operate and maintain the project(s), (project title(s) – include all implemented). This cost is estimated to be (XX) per year, local currency.
- The position/committee responsible for identifying maintenance needs is: the homeowner
- This position/committee will serve in this role for as long as they have the system.
- The position/committee responsible for performing maintenance is: the homeowner
- This position/committee will serve in this role for as long as they have the system.

Representatives of CeCEP acknowledge the following ongoing local partner responsibilities:

- Provide ongoing support to Guachtuq for minimum of 10 years after construction is complete, as needed.

On behalf of, and acting with the authority of the residents of Guachtuq and the NGO/local municipal partner CeCEP, the under-signed submit the above written acknowledge of program closeout.

Signature	Date
-----------	------

Printed Name

Contact Telephone Number (including country code)

Position in Community-Based Organization

Signature	Date
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Printed Name

Contact Telephone Number (including country code)

Position in Local Partner Organization

The Spanish version is currently getting checked by EWB-USA.

Appendix B -Water Quality Testing Analysis & Procedure

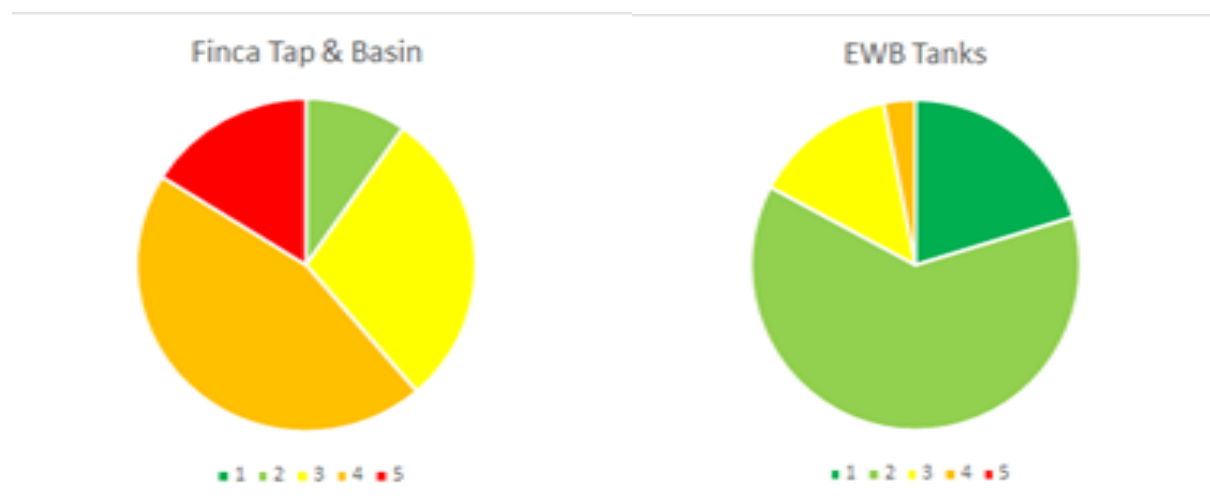
Previous Analysis

EWB-USA WPI has collected water quality data for the past four trips (January 2014, May 2014, January 2015, and May 2015) using Colilert and Petrifilm tests. During the previous trips, different homes and various parts within the system were tested. There has been continuous testing at some homes, but the number of homes that were tested consecutively was not enough to accurately measure a change in water quality over time.

Utilizing the World Health Organization's Guidelines (2nd Edition) a risk code was created with the water samples to simplify the data for analysis. The table below illustrates the process used to categorize the water quality tests. Tests that had discrepancies with this chart were scratched as an inconclusive test. For example if a test tube was clear but there were blue colonies on the petri dish, the test was not used in analysis.

Risk Number	Risk Level	Test Tube Indicator	Blue Colonies
1	Conform with drinking water standards	clear	none
2	Low	yellow	none
3	Moderate	yellow and fluoresce	none
4	High	yellow and fluoresce	1-10
5	Very High	yellow and fluoresce	10+

Data was organized by home and source. This showed the level of water quality by the component of the system as well as by individual homes. It could be observed that some overall systems were cleaner than others. The community's goal was to improve water quality, quantity and access. To compare the water quality component using the water quality data from the *finca*, the location where community members previously obtained water was compared to the water coming out of the tap of the EWB-USA WPI tanks. As shown in the graphs below, the majority of EWB tanks had water that met drinking standards or was low risk, while the majority of water samples from the *finca* were very high or high risk, (as classified by the above guidelines). EWB-USA WPI intends to continue studying the comparison of the overall water quality of the tanks and *finca* to ensure a higher quality of water is still being provided.



Water quality testing has been done on the first flushes of many of the systems. The data for the first flushes was sporadic and believed to be inaccurate due to the high variability of the maintenance of the systems. In May 2015, interviews, as well as monitoring by the in country team this 2015-2016 school year, it was

reported that families utilize their first flushes in very different ways. Some families empty it right before a rainfall, meaning the water sits and breeds bacteria for an unknown period of time. Other families empty it directly after a rainfall. The water quality data did not have information attached on the level of water in the first flush, the weather, or the length of time the water was in the first flush. This made the first flush data inconclusive. Additionally, families were taught to not use water from the first flushes for potable uses, (drinking, cooking or washing cookware), thus it is not essential that the quality of the water in the first flushes be evaluated.

It is not necessary to do water quality testing prior to the implementation of the new filter systems. The old filters have been shown to be potentially degrading the quality of the water and are being removed as a result. Testing these systems with the old filters would not be a productive use of water quality tests. Instead, comparative turbidity testing will be done. Turbidity tests will compare the level of sediments removed by the old filters and the new filters. The intended use of the cellulose filters is to separate out sediment and other particulate from the water coming out of the tanks. The turbidity tests will also be performed at the end of the trip to compare the newly implemented filters turbidity removal level to the turbidity after a week or more of use. The goal of the turbidity test is to demonstrate that the new disc filters are equally or more effective than the cellulose filters in removing particulate from the drinking water in the community. The turbidity test will solely focus on the ability of the filters to remove sediments as the micron rating of both the cellulose and the disc filters is not intended for them to filter bacteria. We will continue to educate the community to boil their water before using it for consumption, but the water quality in terms of particulate in the water will be monitored using the turbidity tests.

Continuous monitoring of water quality is essential to gauging the potability and quality of the water from the various sources accessible to the community and in evaluating the efficacy of the systems. Based on previous water quality tests conducted on EWB-USA WPI trips, bacteria presence is of concern. During the May 2016 Monitoring and Evaluation Trip, the team will continue using the Colilert Protocol tube tests and Petrifilm Protocol tests as used in January 2014, May 2014, and May 2015 to maintain consistency and allow for analyzing data over time. The Colilert test will indicate the presence of bacteria based on color change and presence of *E. coli* based on fluorescence under a blacklight. The Petrifilm test will indicate presence of bacteria colonies (red) and the presence of *E. coli* (blue). Each sample source will be subjected to two trial tests of each type on two different days, and results will be documented on the “Water Quality Data Sheet” forms in Appendix B.

Procedure for Colilert

To conduct the Colilert test, the following procedure will be used:

1. Collect water samples in special plastic bags, “Whirl-paks.” Hold “Whirl-pak” under desired testing site and fill $\frac{3}{4}$ of the bag.
2. Grasping the top of the bag spin the “Whirl-pak” to seal
3. Mark the test tube cap and body with location, sample number, date, and initials (record this information on the water quality form in Appendix C)
4. Take note of observations of both the water and the desired testing site. Write these notes in the note section of the water quality form in Appendix C.
5. Invert the “Whirl-paks” to homogenize the sample
6. Using new plastic dropper fill each tube with ~10mL from each “Whirl-pak” water sample. Do not touch the dropper tip
7. Tightly recap and invert until chemicals dissolve
8. Incubate for 21-22 hours
9. Check test color (yellow means coliform bacteria is present)
10. Shine a blacklight on the tubes in the dark (fluorescing means *E. coli* is present)
11. Take pictures of the sample test results in both steps 9 and 10.

Protocol for Petrifilm

To conduct the Petrifilm test, the following procedure will be used with the same “Whirl-pak” samples taken for the Colilert tests:

1. Collect water samples in special plastic bags, “Whirl-paks.” Hold “Whirl-pak” under desired testing site and fill $\frac{3}{4}$ of the bag.
2. Grasping the top of the bag spin the “Whirl-pak” to seal.
3. Take note of observations of both the water and the desired testing site. Write these notes in the note section of the water quality form in Appendix C.
4. Invert the “Whirl-paks” to homogenize the sample.
5. Lift the top white flap of the Petrifilm to expose the red circular region.
6. Dispense 1mL of liquid onto the center of the red region.
7. Manually remove any bubbles that may have formed using the dropper.
8. Set the white flap back down (sample will start to spread and fill the red region; additionally use the spreader if necessary)
9. Allow the Petrifilm to sit for 1 minute so the sample solidifies into a gel.
10. Place the Petrifilm between two pieces of cardboard (never touch the inside layer of the Petrifilm) and tape the four ends of the cardboard together temporarily.
11. Incubate for 21-22 hours
12. Remove Petrifilm from cardboard.
13. Count colony formation, recording only the number of blue colonies (blue colonies with gas bubbles are E. coli and red colonies are bacteria)
14. Record results in spreadsheet and take pictures.

Turbidity Protocol

1. Collect a water sample from the tap into the cuvette
2. Cap the cuvette and gently rotate the cuvette to ensure the water is fully mixed. Ensure that no water bubbles have created that might create false readings.
3. Place the cuvette in the turbidity meter and run the turbidity meter. Collect three data points from the sample.
4. Repeat this process three times.
5. Rinse the cuvette with purified water.

Methodology

One of the primary goals of the testing during the May 2016 Monitoring and Evaluation Trip is to address any prevalent concerns in water quality prior to closing the project. During this trip, there will be two water quality trials at each faucet; one set at the beginning of the trip and the last set in the last week of the trip. One trial is defined to be the summation of one colilert and one petrifilm test. The previous water quality tests collected in January and May 2015 will be referenced with the monitoring data on each system’s cleanliness for a full understanding of each individual system. Both sets of water quality data will be collected with the new disk filters installed on the system to ensure that there is no time induced adverse effect of installing the new filters on water quality. Assuming 25 test sets can be incubated at one time, samples from half of the homes in the community could be collected and incubated on the same day (see proposed schedule below).

In addition to the Petrifilm and Colilert tests, a total of two turbidity tests will be completed on each system to analyze the concentration of particulates in the collected water. The first turbidity test will be done with the cellulose filter on the system and the second will be administered after the replacement of the cellulose filters with the disk filters. These tests will be administered to determine the effectiveness of the newly installed disk filters in comparison to the previous cellulose filters with respect to the amount of particulate in the water. Turbidity data will additionally help draw conclusions on the overall quality of water in the community.

Bacteria Testing

The table below details definite test sources, the purpose for testing, and the number of trial tests (1 Colilert + 1 Petrifilm = 1 trial) to be conducted. During the course of the trip, two experiments will be conducted on separate days to ensure consistency of data collection.

Water Source	Purpose	# of Trials
Finca Tap	Compare bacteria levels overtime and with water from the tanks	2 each, 2 separate days
Finca Basin	Compare bacteria levels overtime and with water from the tanks	2 each, 2 separate days
House # 1, 5,8, 9,16, 21, 23a, 26, 29, 32	Compare water quality results over time from data collected on the January 2015 and May 2015 trips.	2 each, 2 separate days
House # 2, 3,4, 6, 7(?), 10, 12,17, 18, 19 (?), 20,22, 23b, 24,25, 27, 28, 30, 33, 34, 36, 40, 43	Monitor water quality and address any pressing water quality concerns	2 each, 2 separate days

Listed in the table below are houses which had very poor water quality as determined by data collected on previous trips. Water quality data from these houses will additionally be cross-referenced with monitoring data collected to see if there are any correlations or possible explanations for the poor water quality in the three houses.

Water Source	Purpose	# of Trials
House #26:	Cross-reference water quality data with monitoring data to describe discrepancies in water quality	2
House #29:	Cross-reference water quality data with monitoring data to describe poor water quality	2
House #30:	Address the poor water quality recorded from this system during prior monitoring	2

Justification for Bacteria Testing

Although water quality testing will be conducted at each house on the trip, the reasoning for testing varies between groups of houses. One of the objectives of water quality testing is to ensure that there are no drastic problems in water quality with relation to bacterial growth. For this reason, the water from each tap will be tested upon arrival in the community and again before the team leaves in May. The tests will be incubated and analyzed in Guatemala so that any immediate concerns can be addressed. The team additionally selected ten houses where the water quality data will be compared to that from previous years in order to analyze changes in the water quality over time in the community with the implementation of the systems. These houses were chosen based off the amount and quality of prior water quality data that was collected on prior trips. Finally using the data collected from all the houses in the community, a major goal of this trip will be to compare this collected data with previous trip's testing of the *finca*.

Schedule for Bacteria Testing

The following schedule for bacteria testing was created based off the assumption that 25 trials can be incubated at a time and the time required for incubation is around 24 hours.

Date to be tested	House Numbers	Number of Total Taps
May 10	1, 2, 3, 4, 5, 6, 7 (possibly), 8 (possibly), 40, 9, 10, 43, 12, 16, 20, 18, 21, 17 (if cannot get 8)	25
May 16		
May 12	17, 22, 23a, 23b, 24, 25, 26, 27, 28, 29, 30, 31, 32 33, 34, 36, finca tap, finca basin, 19?	23
May 18		(24 if 19 gets reconnected)

Test Result Analysis

All of the test results will be compiled to categorize the level of safety observed in each water source. The table below details the way the Colilert and Petrifilm test results should be interpreted to lead to this compilation.

Health Organization's Guidelines for Drinking Water Quality (2nd Edition):				CODE	
<u>Risk Level</u>	<u>E. coli /100 ml</u>	<u>Colilert MUG+</u>	<u># E. coli Colonies on Petrifilm</u>		Notes
Conformity with drinking water standard	<1	-	0	1	Clear
Low	1 - 10	-	0	2	Yellow, does not fluoresce
Moderate	10 - 100	+	0	3	Yellow, Fluoresce, No blue colonies on petri film
High	100 - 1000	+	1 - 10	4	Yellow, Fluoresce, 1 - 10 blue colonies on petri film
Very High	>1000 ml	+	>10	5	Yellow, Fluoresce, >10 blue colonies on petri film

Sediment (Turbidity Testing)

Water Source	Purpose	# of Trials
All Houses with Cellulose Rotoplas Filter	To determine the amount of sediment in the water coming from the tanks through the cellulose filters	1
All Houses with Disc Filter	To evaluate the amount of sediment in the water coming	1

	through the new disc filters and evaluate the functionality of these filters vs. the cellulose filters	
--	--	--

Schedule for Turbidity Testing

The turbidity testing will be completed on every house three times during the trip. The first turbidity tests will be completed on May 9th at every house in the community before the filter alternative/replacement is installed. The second round of turbidity tests will be completed following every implementation of the filters. This will see that the filters are initially removing sediments as expected. The final turbidity testing will be accomplished during the last days of the trip, seeing how the filters' ability to remove sediments has changed after a week or more of use.

Appendix C– Water Quality Data Collection Sheet

Water Quality – Data Sheet

House #:	Incubation Time (hours):
Source:	Collection Date:
Replicate #:	Collection Time:
Sample #:	Tester:
Colilert (Tube)	Petrifilm
Yellow (bacteria)? YES <input type="checkbox"/> NO <input type="checkbox"/>	Blue Colonies? YES <input type="checkbox"/> NO <input type="checkbox"/>
Fluorescent (e. coli)? YES <input type="checkbox"/> NO <input type="checkbox"/>	# Blue Colonies (e.coli):
Weather Notes:	
Tank Notes:	
Additional Notes:	

Water Quality – Data Sheet

House #:	Incubation Time (hours):
Source:	Collection Date:
Replicate #:	Collection Time:
Sample #:	Tester:
Colilert (Tube)	Petrifilm
Yellow (bacteria)? YES <input type="checkbox"/> NO <input type="checkbox"/>	Blue Colonies? YES <input type="checkbox"/> NO <input type="checkbox"/>
Fluorescent (e. coli)? YES <input type="checkbox"/> NO <input type="checkbox"/>	# Blue Colonies (e.coli):
Weather Notes:	
Tank Notes:	
Additional Notes:	

Appendix D –Men’s Focus Groups

Men’s Focus Groups

Goal

- Evaluate system maintenance and technical weaknesses
- Understand the community knowledge about the systems
- Evaluate any changes in the overall community dynamic as a result of the systems or that may have an effect on the systems
- Determine the impact of the systems on the lives of the community members

Interviewer

- Laureen and traveler

Translator

- Abelino or Edghar

Estimated time per focus group

- 2 hours

Number of focus groups

- 1

Groups & Justification

Location

Probing Questions

1. What do you do if there is a problem with your system?
 - Evaluate knowledge of the system/try to determine system “experts” in different familial groups
2. Have you had to make any repairs on the systems? (yours or others in the community)
 - Did you do it yourself?
 - What materials did you use?
 - Where did you get the materials?
3. Who is responsible maintaining the system?
4. How are the responsibilities surrounding the system distributed throughout your family?
 - a. who is responsible for emptying the first flush
 - b. who is responsible for cleaning the tanks
 - c. who is responsible for getting water
5. How do you think the construction teams worked in building the systems?
6. What do you think about the project process?
 - payment scheme/prices
 - CeCEP monitoring
 - house selection process
 - WPI presence in community
7. What do you think of the certification program?
8. How have the systems impacted your life?
9. How has the water board been involved in the process and the community?

Direct Questions

1. Is there a specific person responsible for fixing the system? Who usually fixes the system?
2. Do you ever repair your system? What materials did you use to repair your system? Where did you get the materials to fix your system?
3. Is a different person responsible for maintaining the system and repairing the system, or is a single family member responsible for both?
4. Who is responsible for emptying the first flush? Who is responsible for cleaning the tanks? Who is responsible for getting water?
5. What would you suggest to improve in the project process?

6. How did you like the payment scheme and the price of the system? How do you like CeCEP monitoring the systems? What did you think about the house selection process for determining who got the next system? What do you think about the EWB presence in the community?

Appendix E – Women’s Focus Groups

Goal

- Evaluate any changes in the overall community dynamic as a result of the systems or that may have an effect on the systems
- Determine the impact of the systems on the lives of the community members
- Evaluate system maintenance and technical weaknesses
- Understand the community knowledge about the systems

Interviewer

- Lauren and female traveler

Translator

- Lily (preferred)
- Abelino if not possible

Estimated time per focus group

- 2 hours

Number of focus groups

- 4 groups

Probing Questions

1. How do you like your system?
2. Who is responsible for maintaining the system?
3. How are the responsibilities involving the system distributed throughout your family?
4. How have the systems impacted your life?
5. Do you have enough water to meet your needs?
6. How interactive has the COCODE been in the process?
7. How has the water board been involved in the process/the community?
8. What do you do if there is a problem with your system?
9. What do you think about the project process?

Direct Questions

1. Are there problems with your system? How easy is your system to operate? How has having the system changed your/your family’s life?
2. How often do you clean the tanks/filter? Who collects the water? How often? How much and what maintenance has been done on your system? How much work do the kids do in cleaning the system?
3. Who is responsible for emptying the first flush? Who is responsible for cleaning the tanks and the filter?
4. Has there been a shift in your daily tasks? Do your kids have more time to go to school? Do you have more time to do tasks around the house or to work?
5. Is there more water at any point in the year? Do you ever have to go the *finca* to get enough water to meet your family’s needs?
6. Has there been a change in the COCODE leadership throughout the process?
7. How has the water board involved or is the water board involved in anything related to your system?
8. Is there someone in your family who has made a lot of repairs on a certain part of your system?
9. What can the WPI team improve with respect to the project? What did you like about the project process? How do you like having CeCEP monitoring your system?

Appendix F – Children’s Focus Groups

Children’s Focus Group

Goal

- To evaluate the impact of the systems on the children’s daily activities ie. if they go to school more or have more time to work
- To determine how involved the children are in system cleaning and maintenance
- To understand how much the children know about the system

Locations

- Houses-19,33,18,4,⅔,1,34

Interviewer

- Laureen +2 travelers

Estimated time per focus group

- 2 hours

Number of focus groups

- 2 (one at top of community, one at bottom of the community)

Translator

- Abelino and Edghar

Groups & Justification

- 15-20 kids per group

Plan for Children’s Program

Calendar Activity: We would give all the kids calendars and some different colored rocks or tacks. The different colors would represent school, how often you go to the *finca*, and how often the tanks are cleaned. We would then ask the kids to put the tacks or rocks on when they think they last did these things.

Questions:

1. Have you been attending school more since the program came in?
2. How often do you go to the *finca* for water?
3. How often are the tanks cleaned?

Drawing: Have the kids draw their favorite activity in the past week. This is supposed to help us see if the system is giving the families more free time.

Questions:

1. Do you have more free time? What do you do in your free time?

Cups: We would set out several cups with chores assigned to them. We would then give the children pebbles and ask them to put the pebbles in the cups that correspond with their daily chores.

Questions:

1. What daily chores do you have?

Show a picture: Pictures of different scenarios will be shown and the children will be asked to comment if it happens, yes or no. Pictures we would show include a person drinking water straight out of the tank, a child with a stomach ache, and a picture depicting no water. For picture of people drinking right out of the tank it would be a yes or no answer. For the pictures of a child with a stomach ache and the picture of no water these would be the children commenting on whether it happens.

Questions:

1. Have you gotten any stomach aches after drinking the water?
2. Do you drink water straight from the tank (not boiled)?

3. Do you ever run out of water?

Glasses of water: We would show the kids two different glasses of water. One of the glasses would be filled with tank water, the other will be filled with *finca* water. The group member would then ask which glass of water they would rather drink and why. Questions:

1. What is different about the water from the *finca* and the water from the tanks?

Skit: The focus group leader would split the kids into groups. Each group would create a skit covering a different part of cleaning the tanks. After they have been given a good amount of time to create the skit we will call all the groups together to perform the skits for the other groups.

Questions:

1. What is the process for collecting water? Do you help maintain the tanks? How so?

Demonstration: Have the person running the focus group to ask the children to give a demonstration on how to use the system. This is supposed to show if the system is easy to use.

Questions:

1. How easy is the system to use?

Materials Necessary

- calendars
- snacks/refreshments
- colored pebbles or tacks
- clear cups
- paper
- colored pencils or crayons
- print outs
- water
 - *finca* water
 - tank water
- props, system components
 - bucket
 - PVC pipes
 - cloth
 - sticks/other natural materials

Timeline:

- 10 Minutes: Name game introduction
- 10 Minutes: Calendar activity
- 10 minutes: Drawing
- 10 minutes: Demonstration
- 10 minutes: Break with Snacks
- 5 minutes: Show a Picture
- 10 minutes: Cups
- 20 minutes: Skits
- 5 minutes: Closing Activity

Children's Focus Group Supporting Materials and Instructions

Pictures Instructions:

Lack of Water

Show the children the picture of the tap with an “x” through it and ask them whether there has been a time since their system has been installed that they have not had enough water to supply their family. Record the number of children who claim they have previously had a water shortage.

Person Drinking water from Tank

Show the children the picture of the person drinking water out of the tank. Ask the children if it is okay if someone does this? Get responses, and if they answer correctly, the correct answer is no they should not drink water from tank, ask why? Then explain why it is dangerous to drink unboiled water, and stress the importance of always boiling the water before you drink it to avoid illness.

Person with Stomach ache

Show children the picture of the person with a stomach ache. Ask the children whether this happens, and what might be the cause of it be. Record responses, particularly taking note of whether they believe water consumption was the cause.

Calendar Instructions:

Get stickers in three different colors. Give each child their own calendar and set of stickers. Then tell the children what each of the differently colored stickers stands for, one color for *finca* visits, one color for school, and one color for tank cleaning. Then ask them to put the colored item on the day that they did this action. It does not have to be exact because it is expected that the *finca* and tank cleaning will happen less often if not at all. Take a couple of minutes to let children complete this action. And then let kids walk around and look at each other's work. Collect the calendars at the end of the activity.

Drawing Instructions:

Give children pieces of paper and pencils. Ask kids to draw their favorite activity. Take a few minutes to let them complete the drawing. Then have each child bring their drawing to the front of the room to show it off and tell the group what it is and how many times per week they get to do their activity. Record what they say is their favorite activities are and how often they get to do them.

Cups Instructions:

Set up empty cups and variety of small pebbles in the front of the room. Then ask the children what chores they do. Have translators write down the chore answers in Spanish on front of the cups, one chore per cup. Make sure “Carry Water” is a chore that is on one of the cups if none of the children mention it. Then ask the children to come up and put rocks in the chores that they regularly do, one rock per cup per child. Give a few minutes for all children to answer. Look at the types of chores completed and record the number of children completing these chores.

Glass of Water Instructions:

Set up two cups of water at the front of the room, one cup with water from the *finca* and the other with water from an EWB installed tank. Keep track of which cup holds which type of water. Then ask children which cup they would rather drink out of and why? Record their answers. Then reveal to the children which water is which, and ask the children again which water they would rather to drink, in order to see differences in their two answers. Record these answers.

Skit Instructions:

Split the children into four different groups. Tell each group of children to create a skit about how they clean the tanks using the props and space provided. Instruct the groups that every person has to have a part in their skit. Then give the children several minutes to put together a skit. While this is happening walk around to the different groups to see what they are doing and make observations. Then call all the groups back together and have them perform their skit to the group one at a time, recording how each group says they clean the tanks. Creativity is encouraged as long as the main focus of the skit is cleaning the tanks.

Demonstration Instructions:

Gather all the children near a tank. Call on several kids to give a demonstration to “teach” the others on how to use the system. Ask the demonstrators to pretend that the other children don’t previously know how to use the system, therefore they must explain every detail. Observe how demonstrators teach the others on how to use the tanks. If needed, ask questions to continue the conversation about the system, to see if they know how it properly works.



Abril - Mayo

Domingo	Lunes	Martes	Miércoles	Jueves	Viernes	Sábado
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
1	2	3	4	5	6	7

Appendix G – COCODE & CeCEP Focus Groups

COCODE Focus Group

Goal

- To evaluate the impact of the systems and the project process on the community as an entity
- To understand the attitude towards the WPI EWB team in the community
- To evaluate any changes in the overall community dynamic as a result of the systems or that may have an effect on the systems

Location

- community center

Interviewer

- Lauren + 2 travelers

Translator

- Ablenio or Edgar

Probing Questions

1. Are community members happy with the systems?
2. What is your role in the community as an organization?
3. Has your role changed with the implementation of the systems?
4. How has EWB WPI presence affected the community?
5. What do you think about the project process?
 - payment scheme/prices
 - CeCEP monitoring/translating/facilitating communications
 - house selection process
6. Has water security in the community improved?

CeCEP Focus Group

Goals:

- To evaluate the project process, on the community as an entity
- To understand the role and presence of EWB-USA WPI in the community
- To gain insight into the project strengths and weaknesses as seen by the NGO facilitator

Location

- CeCEP

Probing Questions

7. Overall, how would you describe the experience of working with EWB-USA WPI? What went well? What did not go well?
8. How effective was communication between EWB-USA WPI and CeCEP? How could communication be improved?
9. Do you feel that the original goals of the project have been met? How well?
10. Do you feel that the community members are prepared to operate and maintain the rainwater harvesting systems on their own? How well prepared?
11. What do you think the long term impacts of the project will be?
12. Does CeCEP plan on doing any future work in relation to this project? If so, what?

Appendix H- Individual Family Interviews

Goal of Interviews

- Determine the impact of the systems on the lives of the community members
- Evaluate system maintenance and technical weaknesses
- Understand individuals' knowledge about the systems

Interviewer: Laureen +1 traveler

Translator: Abelino or Edghar

Estimated time per interview: 1 hour

Number of Interviews

- 16 families (4/day for 4 days)

Questions (categorize the questions)

- *Finca*/Water use:
 - Do the tanks have enough water to meet your needs? Do you ever run out of water? (Summer/Winter)
 - How often do you go to the *finca*?
 - Is there a time of year that you go to the *finca* more?
 - What do you use *finca* water for?
 - Do you get water from anywhere besides the *finca* and the tanks? If you do, where?
 - Have weather patterns changed in the last few years? If so, have the changes impacted water supply? How?
- Roles and Activities:
 - How have your daily activities/tasks/responsibilities changed since the system was built?
 - Who is responsible for maintaining the tanks?
 - How much work do the kids do?
 - Tank cleaning
 - maintenance
 - water collection
 - filter cleaning
- Maintenance of System
 - Are there any issues with your system?
 - How have these problems been addressed? By whom?
 - How comfortable would you be fixing the system if something broke?
 - Can everyone use the system? Is it easy to use?
 - How do you clean the tanks? How often?
 - Do you face any challenges when cleaning the tanks? (OR What challenges do you face when cleaning the tanks?)
 - How often do you empty the first flush? What do you do with the water?
 - How comfortable would you be disassembling and reassembling the system?
 - Was there any community illnesses and what was it if there was?
- Social (need more questions here?)
 - Have there been any changes in community leadership?
 - Have there been any tensions relating to water access?
 - Who will you go to if you don't know how to fix a problem?
- Project Evaluation
 - What do you think of the Certification program?
 - What do you think about the project process?

Appendix I – Certification Program

Certification Program Goals:

- Community members will have the knowledge and skills to make repairs in three categories: a) Gutters, b) First Flush and Filters, c) Tank and Connections
- The Guachtuq program will become more sustainable because community members will be empowered to maintain systems independently

Lesson Objectives

Gutter Learning Objectives:

Community Men will be able to:

- inspect gutters and troubleshoot problems
- repair gutters that leak
- repair broken gutter clips
- adjust improper gutter and roof angles
- replace broken mosquito netting
- source/purchase new mesh and gutter parts
- help families create personalized gutter and roof maintenance plans

First Flush/Filters Learning Objectives

Students will be able to:

- inspect the First Flush and filters and troubleshoot problems
- secure a First Flush that falls down
- clean out a First Flush that has become clogged
- repair a filter that leaks
- replace the old filters with new ones
- clean the new filters properly
- source/purchase new parts for the First Flush or filters
- help families create personalized First Flush and Filter maintenance plans

Tank/Connections Learning Objectives

Students will be able to:

- inspect tanks and troubleshoot problems
- repair holes in the tank
- repair connections that leak
- rearrange fallen or ineffective path to tank and tank connections
- (x) insert a double-union ball valve into a tank-tank connection
- source/purchase materials for tank repairs and cleaning
- help families create personalized tank maintenance plans

Women's Learning Objectives

Students will be able to:

- inspect and troubleshoot problems with the gutters, first flush, tanks, and filters
- teach others how to clean the new filters
- orchestrate tank cleaning
- create a calendar for filter and tank cleaning
- replace mesh in the gutters
- source/purchase materials for tank cleaning and mesh replacement
- help other families make personalized roof/gutter/first flush/tank/filter maintenance plans

Agenda for all lessons

- 8:30am - 10:30am: CeCEP Classroom
- 11:00am - 12:00pm: San Cristobal hardware stores/materials search
- 12:00pm - 1:30pm: Lunch at CeCEP
- 2:00pm - 5:00pm: Guachtuq, working on systems

Instructors

Abelino will teach classes for the men, Lily will teach the classroom session for the women. EWB-USA WPI will pay Abelino and Lily appropriately as teachers for their time. Sucy will help determine an appropriate amount. Additionally an EWB-USA WPI member will be

Location

The classroom sessions will be held at either CeCEP or at a nearby location. Community members participating in the program will be asked to meet at that location prior to the certification program. There is a kitchen at CeCEP and Sucy will coordinate preparation of lunch for the four sessions.

Instruction Materials

Classroom:

- Lesson Plan
- White board
- Demonstration parts
 - First Flush parts
 - Gutter union and pieces of gutter
- Worksheets
 - System components that need prices
 - Handouts on system components

Registration

Community members will sign up ahead of time. Sucy and Edgar will solicit commitments beginning the last week of March.

A security deposit of 5Q is an appropriate amount to request that community members pay in advance to commit to attending the session. Community members can sign up between the end of March and April 31. We need to ask Sucy and Edgar to maintain a list of these people and keep the deposits in a pouch in the locked trunk at CeCEP.

Appendix J- Key Questions

Stakeholder	Key Questions	Justification
EWB Headquarters	<ul style="list-style-type: none"> What is the long term sustainability of this project? What are the benefits and drawbacks of a project completed on an individual basis? What were some of the impacts of the EWB-USA WPI team and project on the community? What was the importance and role of the NGO in this project? What is the reasoning and justification for closing out the project? What lessons have the chapter learned from this project and how will they be applied to future trips? 	In closing out the project, these are important questions to look into to reach conclusions about the overall success and scope of the project. These questions are also essential in order to write the 527 Program Closeout Report. Understanding the sustainability of the EWB-USA WPI project will aid EWB nationals in understanding the overall sustainability of EWB projects.
EWB-WPI	<ul style="list-style-type: none"> Is the community capable and willing to maintain the systems on their own? Are individuals who completed the certification programs qualified and recognized within the community? Did water security improve in the community in the eyes of the club and the community? 	The overall objective of the project in Guachtuq was to bring water security to the community. Therefore, it is important for the club to determine if this was achieved and if it will remain a long term improvement.
COCODE	<ul style="list-style-type: none"> Have there been changes in community leadership since the installation of the systems? How has the COCODE contributed to the community in regards to water security? What will the roles of the COCODE be in the future? 	In closing out the project, it is important to determine if the future of the community is left in good hands. The COCODE is the leadership organization in the community in terms of water security and it is crucial that these leaders are acting with the best interest of the community in mind and that the community respects this organization.
Women of the Community	<ul style="list-style-type: none"> Do the women have a sound understanding of how the systems work and the proper maintenance and minor repair techniques? Do the women feel comfortable with their role in regards to the systems? 	Women are capable and have been trained by EWB-USA WPI to do small repairs as well as maintenance on the systems but do not tend to do larger tasks such as cleaning gutters and flipping tanks.
Men of the Community	<ul style="list-style-type: none"> Do the men have a sound understanding of how the systems work and the proper maintenance and repair techniques? Do the men feel comfortable with their role in regards to the systems? 	The men play a crucial role in the community in regards to system maintenance and repairs. During the certification program these are important questions to be asking to ensure that the men will be willing and able to maintain the systems.
Children of the Community	<ul style="list-style-type: none"> Do the children have a basic understanding of tank function, proper maintenance, and repair techniques? 	The children are the future of the community and it is important that they have a basic understanding of how the systems function and how they can assist their families in maintaining them properly.

Appendix K System Inspection

Formulario de Monitoreo Ingenieros Sin Fronteras-USA WPI

Numero de Casa:

Fecha:

Tinacos:

	Si	No
¿Los tinacos están quebrados o desconectados?		
¿Los tinacos faltan las tapas?		
¿Las tapas están mal puestas/no están bien cerradas?		
¿El rebalse tiene un lugar que captura el agua para capacidad adicional?		

Si hay problemas con los Tinacos escribes notas aquí:

Cuan sucio están los tinacos (cuando hay más de un tinaco, enumerar los puntos donde apliquen y la numeración de los tinacos sigue del canal de bajada al rebalse)

- ☐ No hay suciedad
- ☐ Hay muy poca suciedad al fondo
- ☐ Hay suciedad que cubra parte del fondo
- ☐ Hay suciedad al fondo que hace que no se puede ver al fondo

Si tienes notas sobre la suciedad de los tinacos o el agua las escribes aquí:

Cuan sucio está el agua

- ☐ El agua está claro
- ☐ El agua está oscuro, pero aún se puede ver el fondo en parte
- ☐ El agua esta oscuro y no se puede ver el fondo

Otra suciedad

- ☐ Hay suciedad en los tinacos a los lados o en la tapa
- ☐ Hay insectos en el tinaco
- ☐ Otros animales

Nivel del agua en los tinacos (marque si los tinacos son separados o de concreto)

	Tinaco 1	Tinaco 2	Tinaco 3	Concreto
Vacio				
25%				
50%				
75%				
Lleno				

Si tienes notas sobre el nivel de agua las escribes aquí:

Base: la base está (marque todos que apliquen)

- ☐ Rajada
- ☐ No existe (la pancha de concreto)
- ☐ Faltan bloques
- ☐ Deslizándose por erosión
- ☐ Hay otro problema que hace que no funcione bien

Si hay problemas con la base las escriba aquí:

Chorro:

Que Chorro se usan?

- ☐ De Plastica
- ☐ De metala

Si hay problemas con el chorro las escriba aquí:

	Plastica Sí	Plastica No	Metala Sí	Metala Sí
¿El chorro está conectado?				
¿El agua sale bien de los tinacos (del chorro si hay)?				
¿Hay sedimentos en el agua que sale de los tinacos?				

Estado del filtro 1: (cuando hay mas de un filtro, la numeración sigue del canal de bajada al rebalse)

El cartucho del filtro esta:

- ☐ Puesto
- ☐ No está puesto
- ☐ Perdido (no tiene)
- ☐ Roto

Si hay problemas con filtro 1 escribes notas aquí:

Filtro (la parte plastica) está:

- ☐ Conectado
- ☐ Desconectado
- ☐ Perdido (no tiene)
- ☐ Roto

Olor del filtro:

- ☐ De cloro o jabón
- ☐ Sin olor
- ☐ Con mal olo

Mucosidad:

- ☐ No hay mucosidad
- ☐ Hay mucosidad, pero el filtro esta blanco
- ☐ Hay mucosidad, pero el filtro esta gris
- ☐ Hay mucosidad, pero el filtro esta casi negro
- ☐ Hay demasiado mucosidad y no quiero tocarlo

Oscuridad del filtro (1 limpio – 5 sucio): ____

Estado del filtro 1:

El cartucho del filtro esta:

- ☐ Puesto
- ☐ No está puesto
- ☐ Perdido (no tiene)
- ☐ Roto

Filtro (la parte plastica) está:

- ☐ Conectado
- ☐ Desconectado
- ☐ Perdido (no tiene)
- ☐ Roto

Olor del filtro:

- ☐ De cloro o jabón
- ☐ Sin olor
- ☐ Con mal olor

Mucosidad:

- ☐ No hay mucosidad
- ☐ Hay mucosidad, pero el filtro esta blanco
- ☐ Hay mucosidad, pero el filtro esta gris
- ☐ Hay mucosidad, pero el filtro esta casi negro
- ☐ Hay demasiado mucosidad y no quiero tocarlo

Oscuridad del filtro (1 limpio – 5 sucio): ____

Si hay problemas con filtro 2 escribes notas aqui:

Techo:

- ☐ Limpio
- ☐ Hay suciedad
- ☐ Ramas u hojas
- ☐ Otros objetos
- ☐ No puedo ver el techo (muy alto)

Si hay problemas con el techo escribes notas aquí:

Connecciones:

	<u>Si</u>	<u>No</u>
<u>¿Hay connecciones que gotean?</u>		
<u>¿Hay tubos desconectados?</u>		

Si hay problemas con los connecciones escribes notas aquí:

Canales (marque todos que apliquen)

- ☐ Bien puestos y conectados
- ☐ Canal está perdido
- ☐ Canal está roto
- ☐ Union de canal está roto
- ☐ Union de canal está goteando
- ☐ Gutter clip está quebrado

Si hay problemas con los canales escribes notas aquí:

Malla:

	<u>Canal</u>	<u>Rebalse</u>
<u>Funciona bien</u>		
<u>Poco roto</u>		
<u>Roto</u>		
<u>Mal puesto</u>		
<u>Perdido</u>		
<u>No se puede ver</u>		

Si hay problemas con la malla escribes notas aquí:

Primera lluvia:

	<u>1</u>	<u>2</u>
<u>Tiene agua</u>		
<u>Vacia</u>		
<u>Agua claro</u>		
<u>Agua tiene sedimentos</u>		
<u>Hay recipiente de agua</u>		
<u>Hay hoyo</u>		
<u>No hay hoyo</u>		

Si hay problemas con la primera lluvia escribes notas aquí:

Preguntas:

- ☐ ¿Hay problemas con el sistema? (tinacos, canales, tubos, primera lluvia, rebalse)
- ☐ ¿Hizo alguna reparación en el sistema? ¿Hay algo que no puede reparar?
- ☐ ¿Con que frecuencia va al finca?
 - ☐ Veces por día o semana:
 - ☐ Cantidad de gente que van cada vez:
- ☐ Como se usa agua de los tinacos? Del tanque concreto? De la primera lluvia? De la finca?

Uso	Tinacos	Concreto	Primera lluvia	Finca
Beber				
Cocinar				
Lavar trastes				
Lavar ropa				
Bañar				
Siembras/flores				
Otra (explicar)				

- ☐ ¿Como usan la cubetita de EWB? ¿La usan correctamente?
- ☐ Como limpian...

	Tinacos	Filtro	Canales	Techo
Cloro/Jabon/ Pashte/Tapos/ Mano				
¿Con que frecuencia limpian?				
¿Ha limpiado desde la ultima vez?				

- ☐ Estan usando correctamente la primera lluvia? (riegan el agua despues de cada lluvia? Como usan el agua?)
- ☐ ¿Hierven el agua antes de tomar?
- ☐ ¿Han percibido una diferencia en el flujo del agua del sistema? (mas agua/menos agua/mas rapido/mas despacio/etc.)
- ☐ ¿Tiene sugerencias?

Appendix L – Separation of Tanks Protocol

Purpose

Community members have expressed the concern that in a two tank system all of the water has to be drained to clean the tanks and that for some families it is difficult to clean the tanks because they cannot be flipped on its side when it is attached at the bottom. By separating the tanks with two unions and a ball valve, the tanks can be separated. This will allow a portion of the water supply to be saved from the tanks and to isolate one tank from the entire system.

Homes Qualified for Potential Implementation

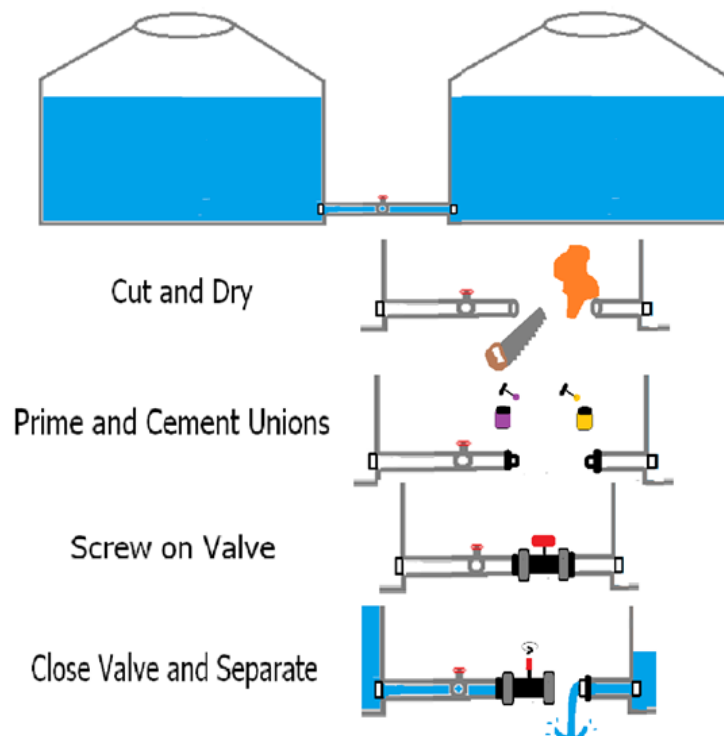
1,2,3,4,5,6,9 (2 separations),10,16,17,18,19,21,22,23a,27,33,34,36,40,43

Supplies

- Valves and unions
- PVC glue
- PVC saw
- Sandpaper
- Towel
- measuring tape
- Contract agreements
- Supporting drawings/explanation for education and community assistance

Preparations prior to traveling

- 1) Determine the number of homes that need implementation
- 2) Determine the availability of different types of valves in country and find the total cost of implementing the valves, including two additional valves in case there are any problems with the valves.
- 3) Determine the additional materials that will be needed for the implementation.
- 4) Have in-country monitoring team discuss the option of separation of tanks with eligible families to get a rough estimate of the number of valves needed. Community members eligible for the modification will be shown an example document of the modification agreement, as well as supporting drawings to describe the system modification. Drawing shown below.



In Country Procedure

1. Acquire all PVC fittings and supplies.
2. Complete contract with head of household. Explain to the family that this process will result in a loss of water, but will make future cleaning and water conservation easier.
3. Implement the modification with family member. Include women, if willing in the implementation process.
4. Drain water as necessary in order to make modifications.
5. Measure the area of the PVC that needs to be cut. Cut PVC using PVC saw.
6. Dry the PVC pipe with a towel and apply glue. Glue PVC fitting on to pipe.
7. Let the glue dry for a few minutes. Then test that the fitting can be opened and closed. Test that the piping can be separated as expected.
8. Explain the process of separating the tanks have families practice. ***Education of separation of tanks should be completed prior to moving to next system.

Appendix M – Separation of Tanks Permission Agreement Form

Permission to Install Ball Valve

Reason for Installation:

Many community members have voiced the concern that the fixed connection between the tanks makes it impossible to empty just one tank at a time, resulting in excess water loss and other difficulties. In order to resolve this problem, EWB-USA WPI has proposed installing a 1.5” PVC Ball Valve with attached unions between the two tanks. This will enable community members to empty one tank at a time and disconnect the tanks, thereby addressing their concerns.

Timeline for Installation:

Members of the EWB-USA WPI team will complete the installation. In order to do this, the holes connecting the two tanks to the piping must be plugged from the inside. This will be done using _____. Each installation will last about _____. This implementation will not require additional funds at the expense of the family, however, once installed, maintenance will be the responsibility of the family.

I _____, would like the assistance of EWB-WPI in installing this new valve.

Signature

of House

Owner Date

Permiso Para la Instalación de la Valvula de Bola

Propósito de la instalación:

Varios miembros de la comunidad han expresado preocupaciones sobre la actual configuración del sistema de almacenaje de agua ya que esta imposibilita la limpieza individual de los tanques. Esto resulta en la pérdida total agua almacenada en ambos tanques a la hora de la limpieza. Para resolver este problema, el equipo de EWB-USA WPI propone instalar una valvula de bola de PVC de 1.5” que permitiría aislar los tanques uno del otro a la hora de la limpieza. De esta manera un tanque podrá permanecer lleno mientras el otro se vacía.

Proceso de instalación:

Miembros del equipo EWB-USA WPI se encargaran de la instalación de las válvulas. Se tomarán medidas para intentar evitar la pérdida de agua durante la instalación de las válvulas. Se realizará utilizando _____. Cada instalacion tomará aproximadamente _____. Esta modificación del sistema no requerirá de aportes monetarios adicionales por parte de la familia, sin embargo una vez hecha la instalación, el mantenimiento del sistema pasará a ser nuevamente responsabilidad de la familia.

Yo, _____, le doy permiso al equipo de EWB-USA WPI de llevar a cabo la modificación del sistema actual.

Appendix N – Separation of Tanks Checklist for CeCEP Representative

Checklist for CeCEP Representative

House Number	Family Name	Agreed to System Modification (yes/no)	Additional Comments
1	Oscar Vicente Laj Lem		
2	Isabela Caj Pop		
3	Julio Cal Jalal		
4	Isabela Xona Suc		
5	Waldemar Quej Yuja		
6	Rosa Gualim Cal		
9	Cristobal Lem Suram		
10	Santiago Lem Mo		
16	Elvira Cal Chun		
17	Edgar Efrain Yuja Cal		
18	Domingo Caj Pop		
19	Victor Caj Cu		
21	Miguel Caj Pop		
22	Teresa Yuja Lopez		
23a	Abelino Chen		
27	Cristobal Coy Max		
33	Anjelina Quej		
34	Maria Magdalena Jom Yuja		
36	Luis Gilberto Cojoc Yuja		
40	Secundino Lem Mo		

43	Rigoberto Cac Caal		
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Appendix O – Filters: Netafilm Disk Filter Testing

Objective

In addition to mesh netting and a first flush, the current systems use cellulose cartridge filters as a last line of defense in preventing particulates from entering the water supply. EWB-USA WPI wants to investigate whether the filters in the community can be replaced with a disk filter made of plastic that will last longer and withstand cleaning maintenance better than the current cellulose filters.

Netafilm Filters

Netafilm filters can be selected as a filtration level of 115 microns to 55 microns. Both the 115 and 55 micron filters cannot filter out bacteria, it was determined to use the 55 micron test which is similar in micron level to the cellulose filters. The purpose of the Netafilm filter is to remove sediments from the water, not bacteria. Community members are instructed to boil their water so filtration of bacteria is not being looked at as a concern when testing the filter. The Netafilm filter comes in a cartridge case of a different size when compared to the case the cellulose filter cartridge. This means that not only the filter will have to be changed but also the case in which it is in. The operation however is similar to the cellulose filter and it is believed that families will easily understand how it is incorporated into the system. There will not need to be any changes in the tubing leading to the faucet, as the threaded pieces on both filters are the same. Cleaning maintenance would be the only minor adjustment families would have to make.

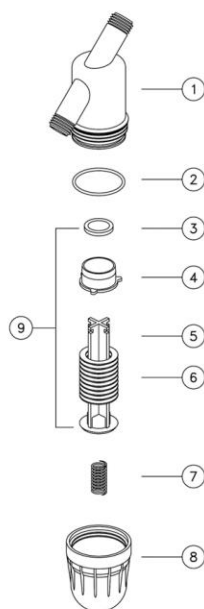


Figure 3 The pieces of filter within the casing that make up the disk filter, making it impossible to only replace the cartridge

The company gives no lifespan estimate. EWB-USA WPI believes that the largest risk to the lifespan of the filter is the loss of parts. There are seven parts plus a number of rings. This means there is a significant potential for losing parts when the system is disassembled. EWB-USA WPI believes the o-rings and spring have the greatest likelihood to break if abused or assembled improperly. The disks are made of polypropylene which will reduce the bacteria build-up significantly. Polypropylene is substantially better at resisting bacteria build up when compared to the current cellulose filters.

Setup

For lab testing, the Netafilm filter was attached to a five gallon bucket using $\frac{3}{4}$ " connections as used in Guatemala. A brass valve was attached at the front for the spigot. The hole was drilled lower than the hole in Guatemala as the diameter of the hole is smaller than on the system in Guatemala. During testing the weight of the filter was assisted by a plastic container. In Guatemala a wooden stick would be used to support the filter if the weight proved to be too much for the PVC to handle. Sticks have been effectively used at the first flush and other parts of the system where the PVC weight is pulling too much on a component of the system.



Figure 4 Set up for filter testing filter with 5 gallon bucket and Netafilm filter

Two turbidity tests were made available from the WPI Environmental Engineering Lab. A lab turbidity meter, the HACH 2000 and a field turbidity meter, the Neu Log was used for recording NTU. The results from each will later be referred to as lab (HACH 2000) and field (NeuLog).

Test 1-Known Quantity of Dirt

Experiment: 5000mL of water was added to the blue bucket. Although the filter had previously been cleaned, water was drawn through the filter to remove any remaining sediments. The quantity of water removed to pull through the filter was then added to the bucket. 250 mL were drawn from the bucket. The 250 mL were then put back into the bucket and 5.0 grams of dirt was added to the bucket. The bucket was well stirred. 250mL was pulled from the tap and two samples were taken from the 250mL to be tested using the field and lab turbidity meter. This water as well as the excess 250mL of water not used in the

testing was returned to the bucket to keep the 5000mL of water. This was then repeated adding another 5grams of dirt. In total 30 grams of dirt was added to the bucket for a 30g/5000mL dilution of sediments. This is believed to be far greater than the amount of contamination seen in the tanks in Guatemala.

Data: The following data was collected from the experiment.

Dirt in g	Bucket		Field	
	Field (NTU)	Lab (NTU)	Field (NTU)	Lab (NTU)
0	0	0	8	4.59
5	68	40.2	19	13
10	155	103	33	21.1
15	167	108	67.8	35.8
20	180	204	83	52
30	365	240	109	91.2

Analysis: The graph below shows the change in turbidity from the bucket to the water after filtration. The graph shows the field values in a darker shade and the lab values in a lighter shade. The bucket values are shown in orange and the filtered water values are shown in green. It can be seen as the quantity of dirt in the bucket increased the turbidity also increased. The assumption can be made that if the quantity of dirt is high in the EWB-USA WPI tanks, then the turbidity of the water leaving the tanks will be higher. Turbidity can be decreased by keeping a cleaner tank.

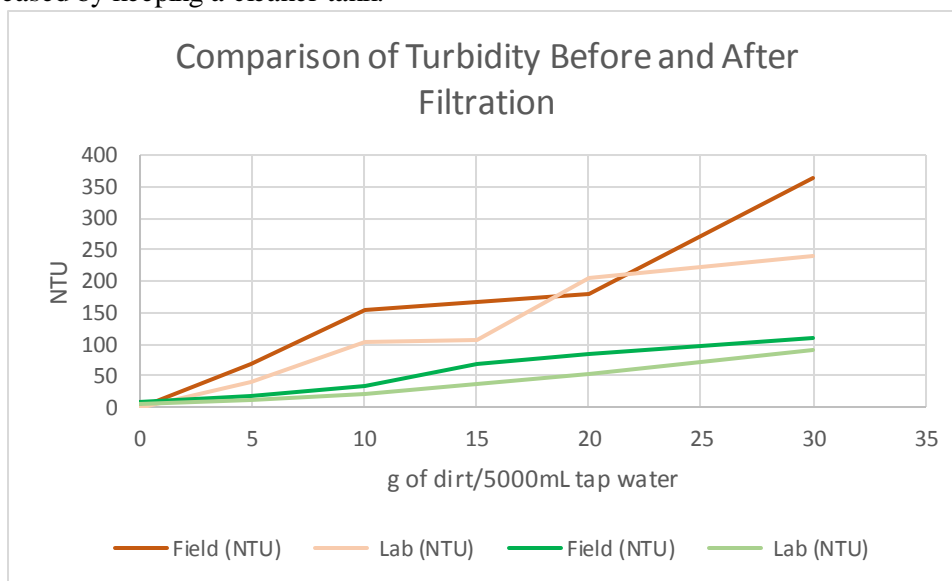


Figure 5 A graph showing the results from the filter testing

An analysis of the percentage of turbidity removed from the water was completed by subtracting the amount removed from the initial amount of turbidity in the bucket. That value was then divided by the entire quantity of turbidity in the bucket. This gave the following results shown in the graph below. There

was not a trend in the percentage of turbidity removed. Anywhere between 55 and 80% of turbidity can be expected to be removed from the water using the Netafilm filter.

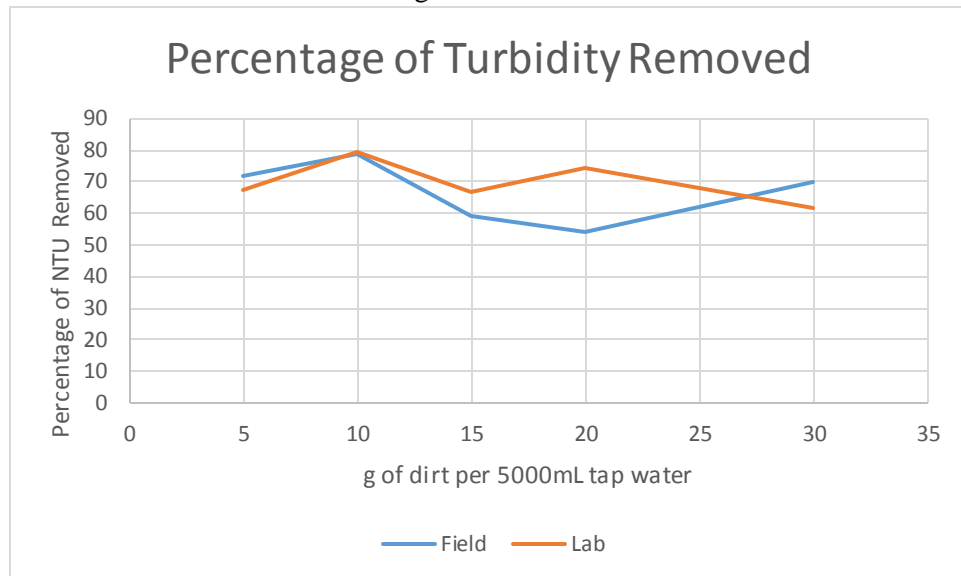


Figure 6 A graph showing the percentage of turbidity removed

The picture below shows the noticeable difference the filter has on removing turbidity from the water. The tube on the left has water filtered from 20g/5000mL of water. The tube on the right is the 20g/5000mL unfiltered.



Figure 7 Left tube shows water filtered with 20g/5000mL and right shows water from bucket containing 20g/5000mL of dirt

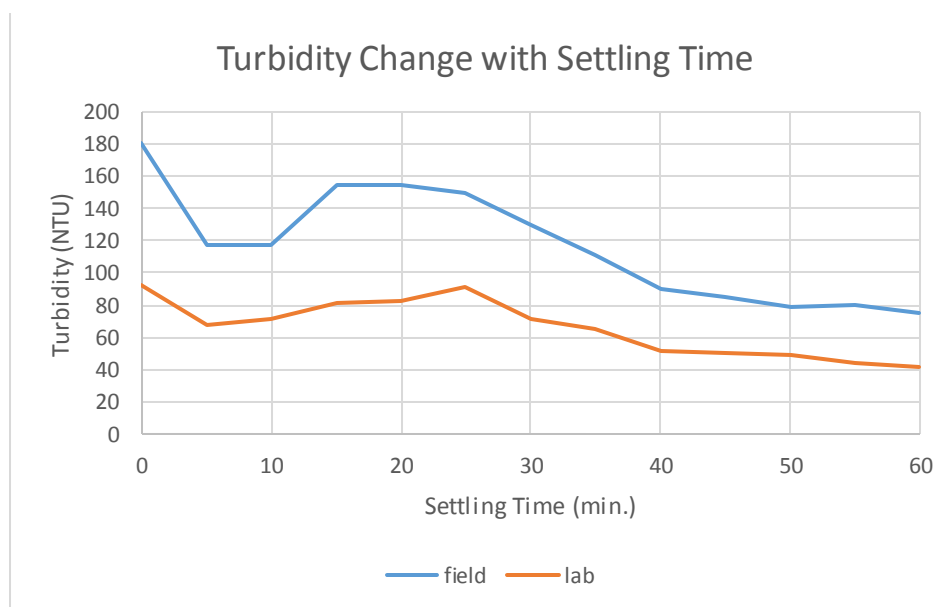
Test 2- Settling Impact

Experiment: The 30g/5000mL water was kept in the bucket from the previous experiment. The bucket was vigorously stirred before the first removal of water. 250mL of water was removed from the bucket at 5 minute intervals. The bucket was not touched between intervals to allow for settling to occur.

Data: The following data was collected from the experiment.

Time elapsed for settling	Field (NTU)	Lab (NTU)
0	180	92
5	117	67.4
10	117	71
15	155	81.7
20	155	82
25	150	91.5
30	130	71
35	111	65
40	90	51
45	85	50.7
50	79	49
55	80	43.5
60	75	41.1

Analysis: The graph below shows the change in turbidity as settling time increases. It can be observed that as the water settled, the turbidity of the water decreased.



Plans Prior to May: Prior to May, EWB-USA WPI will complete additional testing on the filter to determine whether the filter is appropriate to implement in the community. This will include working closely with our mentors to complete additional turbidity testing using dirt and other organics as well as using effluent water from a local waste water treatment plant to measure biological contamination in the filter that would exist in the systems in Guatemala. EWB-USA WPI has already located the filters in country and will send notice to in country contacts no later than April 15th if the filters are to be implemented in the community. If the further testing proves that the filters are not appropriate to be implemented in the community, the community members will be advised to remove the filters. Community members will be assisted by EWB-USA WPI to remove their filters if they choose to take the advice of EWB-USA WPI.