Document 525
Pre-Implementation Report

Chapter: Worcester Polytechnic Institute
Country: Guatemala
Community: Guachtuq
Project: Rainwater Harvesting
Travel Dates: May 9th - May 25th

Prepared By

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ENGINEERS WITHOUT BORDERS USA
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Pre-Implementation Report Part 1 – Administrative Information

1.0 Contact Information

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President	Thomas Moutinho	tjmoutinho@wpi.edu	(207)831-7011	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.
Additional Mentor	Patricia Austin	pat.austin@state.ma.us	(508)792-7423 x204	Worcester DPW
Faculty Advisor (if applicable)	Laureen Elgert	lelgert@wpi.edu	508-831-5452	EWB-USA WPI
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Assistant Health and Safety Officer	Sienna Mayer	sjmayer@wpi.edu	(603) 315-7062	EWB-USA WPI
Education Lead	Lenna Quackenbush	lmquackenbush@wpi.edu	(413)626-2966	EWB-USA WPI
Planning, Monitoring, Evaluation and Learning (PMEL) Lead	Karen Orton	kcorton@wpi.edu	(719) 216-6252	EWB-USA WPI
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In-country NGO Contact	Sucely Ical Lem	cecep@intelnet.gyt	(502)7950-4039	CeCEP
In-country Local Government Contact	Julio Romeo Suram Chun	cecep@intelnet.gyt	(502)7950-4039	Municipalidad de San Cristóbal

2.0 Travel History

Dates of Travel	Assessment or Implementation	Description of Trip
7/20/2010 - 8/03/2010	Assessment	This first trip consisted of meetings with the community members and town officials. Health surveys and water quality samplings were conducted.
7/23/2011 - 08/07/2011	Assessment	Collected more data on water consumption, existing rainwater harvesting practices, and developed a memorandum of understanding with the community
12/31/2012 - 1/10/2013	Implementation	Pilot implementation of rainwater harvesting systems on two homes, assessment of homes for future implementation, and established a monitoring system
5/2/2013 - 5/15/2013	Assessment	Assessment of pilot implementation, health survey and census of community. Also, home assessments for the next 10 homes and set up for next two implementations.
1/2/2014 - 1/14/2014	Implementation	This trip was funded by an EPA grant. Therefore there are no official EWB reports. The team implemented at 2 homes and re-assessed 8 homes for future implementation. Also, further monitored project success.
5/8/2014 – 5/25/2014	Implementation	Implemented on 8 homes in the community, conducted water quality tests, conducted family interviews and assessed the remaining homes for implementation.
1/3/2015 – 1/11/2015	Assessment	Verified home designs and MOUs with the remaining 22 homes in the community. Visited construction stores to get quotes for the quantity of materials needed for the planned May implementation.

3.0 Travel Team

#	Name	E-mail	Phone	Chapter	Student or Professional
1	Aaron Pepin	ajpepin@wpi.edu	(603) 689-3869	EWB-USA WPI	Student
2	Lenna Quackenbush	lmquackenbush@wpi.edu	(413) 626-2966	EWB-USA WPI	Student
3	Evelyn Grainger	egrainger@wpi.edu	(845) 249-8847	EWB-USA WPI	Student
4	Brandon Clark	bclark2@wpi.edu	(508) 455-8864	EWB-USA WPI	Student
5	Sienna Mayer	sjmayer@wpi.edu	(603) 315-7062	EWB-USA WPI	Student
6	Karen Orton	kcorton@wpi.edu	(719) 216-6252	EWB-USA WPI	Student
7	Rodney Rookey	rodrookey@gmail.com	(860) 982-6567	EWB-USA WPI	Professional
8	Laureen Elgert	lelgert@wpi.edu	(508) 450-3313	EWB-USA WPI	Professional

4.0 Health and Safety

The EWB-USA WPI May 2015 travel team will follow the site-specific Health And Safety Program (HASP) that has been prepared for this specific trip and has been submitted as a stand-alone document along with this pre-trip report.

5.0 Planning, Monitoring, Evaluation and Learning

5.1 The travel team has reviewed the 901B – Program Impact Monitoring Report template and has assigned travel team members to complete this report during the upcoming trip. We acknowledge that the completed 901B is required with the eventual submittal of the 526 – Post-Implementation Trip Report. _X_Yes ___No

5.2 The team has selected monitoring indicators from the 906 - Project Monitoring Indicators charts. These will be assessed on this trip and reported on in the 526 – Post-Implementation Trip report. _X_Yes ___No

5.3 Is the signed 903 - Implementation Agreement included as an appendix to this report? ___Yes _X_No

The 903 – Implementation Agreement is already signed with the community and the club's partner NGO CeCEP (El Centro Comunitario Educativo Pokomchi).

6.0 Budget

EWB-USA WPI May 2015 TRIP BUDGET

EWB-USA Chapter Name ::	Worcester Polytechnic Institute
Project Name ::	Guachtuq Water Supply
Type of Trip ::	I

Trip Type: A= Assessment; I= Implementation; M= Monitoring + Evaluation
NOTE: The fees associated with each trip type will auto-populate the EWB-USA HQ section.

	BUDGET *(PRE-TRIP)*
DIRECT COSTS	
Travel + Logistics	
Airfare	$5,590
Flight Insurance	$400
Homestays	$2,510
Shuttle to Boston Airport	$268
Shuttle from Guatemala City to San Cristobal	$654
Shuttle to Coban	$118
Overnight stay in Antigua	$100
Miscellaneous Travel and Taxis	$50
Food, Beverages, and Homestay Gifts	$650
Medical Exams	$100
Sub-Total	**$10,440**
Labor	
Translators	$1,882
Monitoring and Logistical Support	$2,353
Sub-Total	**$4,235**
EWB-USA HQ	
Program Quality Assurance/Quality Control + Infrastructure	$4,900
Less EWB-USA HQ Subsidy	$3,690
Owed by Chapter Sub-Total	**$1,210**
Project Materials + Equipment	
Water Quality Tests	$480
Cell Phones for Implementation Teams	$150
Construction Materials	$19,000
Sub-Total	**$19,630**
Misc.	
Printing Education Booklets, Reports, and Photos for Community	$100
Sub-Total	**$100**
TOTAL DIRECT COST	**$35,615**
IN-KIND CONTRIBUTIONS	
Community In-Kind Contributions to Project Costs	
Labor	$10,000
Materials and tools	$100
Logistics and materials transportation	$100

Sub-Total		**$10,200**
TOTAL IN-KIND CONTRIBUTIONS		
FUNDS RAISED		
Funds Raised for Project + Grants Received		
Cash from community		**$100**
Total $ in Project Fund at EWB-USA HQ	$35,000	
Total $ in Project Fund at University	$0	
Total		**$35,100**
Funds Raised for Chapter		
Total $ in Chapter General Fund at EWB-USA HQ	$6,212	
Total $ in Chapter General Fund at University	$500	
Total		**$6,712**

7.0 Project Discipline(s): Check the specific project discipline(s) addressed in this report. Check all that apply.

Water Supply
____ Source Development
__X_ Water Storage
__X_ Water Distribution
____ Water Treatment
____ Water Pump

Sanitation
____ Latrine
____ Gray Water System
____ Black Water System

Structures
____ Bridge
____ Building

Civil Works
____ Roads
____ Drainage
____ Dams

Energy
____ Fuel
____ Electricity

Agriculture
____ Irrigation Pump
____ Irrigation Line
____ Water Storage
____ Soil Improvement
____ Fish Farm
____ Crop Processing Equipment

Information Systems
____ Computer Service

8.0 Project Location

Latitude: -90.494921 W
Longitude: 15.372468 N

9.0 Number of People

Number of persons directly affected: 220
Number of persons indirectly affected: 220

10.0 Professional Mentor Resume

Rodney Rookey is the Responsible Engineer In Charge who will travel on the EWB-USA WPI May 2015 Implementation Trip. Mr. Rookey's professional experiences make him an ideal professional mentor for this project.

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. Duties include: Equipment operator, driver, project management, material procurement and estimating.
1992 – Present	**CENTURION WATERPROOFING, INC.** Vice President, Co-Owner. Duties include: 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.

Figure 1: Resume of Rodney Rookey

Mr. Rookey spent 5 years employed at a construction company that installs concrete driveways, sidewalks, stairs, patios, pool surrounds, and foundations. His duties included all aspects of the installation process from digging holes, to forming, installing and compacting subgrade material, to installing rebar and/or mesh and pouring concrete.

Mr. Rookey then obtained an Associate's degree in Civil Engineering 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.

In 1999, Mr. Rookey opened Centurion Waterproofing, Inc. (CW). CW installs a methyl methacrylate base spray applied waterproofing system that is 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, and the Calvin Coolidge Bridge in Northampton, MA.

At both companies, Mr. Rookey dealt with contract and union negotiations, designed blueprints and project timelines, compiled cost and materials estimates, procured materials, accomplished all aspects of project management, organized equipment repair, and completed final project review and closeout.

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

He has been involved in motor vehicle racing since an early age. He obtained his first motorcycle at 9 years old and began racing motorcycles at 14. He eventually purchased a Porsche and raced that for many years. Mr. Rookey has maintained many different race vehicles as well as a wide array of construction equipment.

Mr. Rookey has completely remodeled two multi-family homes. Houses were stripped to the studs and given new electrical wiring and plumbing (copper and PVC), roofing, and siding. He was the general contractor for his 6,500ft^2 office/warehouse facility which included all site work and the design of a 5,000ft^2 radiant heating system. In addition he helped design and install water collection systems at the homes of his two brothers. This included shooting grades, installing PVC piping, installing a cistern.

Mr. Rookey traveled with EWB-USA WPI on the January 2015 Assessment Trip. He facilitated as the team prepared all necessary work for the May 2015 Implementation Trip. He has valuable knowledge about the availability of construction materials in the San Cristobal area and an experienced understanding of the social dynamics surrounding the project. His knowledge about Guachtuq, general contracting, and construction management make Rodney Rookey the ideal Responsible Engineering In Charge during the May 2015 Implementation Trip.

Pre-Implementation Report Part 2 – Technical Information

1.0 Executive Summary

This is the pre-trip report for the Engineers Without Borders-USA Worcester Polytechnic Institute (EWB-USA WPI) May 2015 Implementation Trip for the Guachtuq Guatemala Rainwater Harvesting project, #6871. The goal of this project is to achieve water security—adequate quantity, quality, and access to water to meet needs—for each of the 34 families in Guachtuq, Guatemala by constructing individualized rainwater harvesting systems.

The Engineers Without Borders-USA WPI chapter is asking for approval to implement 22 rainwater harvesting systems with the community members of Guachtuq, Guatemala between the dates of May 9th and May 25th, 2015. Using the technical skills, enthusiasm, and support of the community, EWB-USA WPI proposes to scale up from an eight-home implementation in 2014 to a twenty-two-home implementation in 2015.

The community has identified lack of water security as their most pressing problem. During the dry season, January through April, the community historically relies on a single communal water source, called the finca, located approximately 1 km downhill from the center of the community. Women and children often spend 4-6 hours collecting water each day, walking up and down the steep slope. Socio-economic tension surrounds use of the finca, since the water runs from a nearby private farm. The finca has been known to run out of water during the dry season. Before the project began, some homes had rainwater harvesting systems, though few of these met the water needs of the families. Many existing systems were poorly designed, ignore basic principles of hydrostatics, and have openings that lead insect infestations in the tanks and contamination of the water. EWB USA WPI's goal is to help families achieve water security through the construction and proper maintenance of rainwater harvesting systems.

Guachtuq is a rural community of about 220 people, located on the outskirts of the San Cristobal Verapaz Municipality in the Alta Verapaz department of Guatemala, a mountainous region in the center of the country. The 34 families are dispersed over 1 km on a dirt road that leads up a mountain; there is approximately a 500ft elevation difference spanning the community. Many community members exclusively speak Pokomchi, an indigenous Mayan language, although some are also able to speak Spanish. All community members participating in this project have signed MOU contracts with EWB-USA WPI.

EWB-USA WPI began partnering with Guachtuq in 2009 when the community presented its concerns to EWB-USA. Past assessment trips in 2010 and 2011 determined that this project should focus on achieving water security. The team worked with the community to identify individual rainwater harvesting systems as the most technologically and culturally appropriate solution due to geology, community layout, the informal nature of community membership, and finances. EWB-USA WPI developed a relationship with El Centro Comunitario Educativo Pokomchi (CeCEP), a non-governmental organization that provides cultural information, translators, a work space, and communication with the community when the team is not in Guatemala. Systems have been iteratively engineered beginning with two pilot systems constructed in January 2013. Designs were modified based on feedback from an assessment trip in May 2013; two additional pilot systems were built in January 2014 to test new designs, including the "first flush." Protocols for system maintenance were established and tested when eight more systems were built in May 2014. The scope of the project was finalized in May 2014

with assessments at each of the remaining homes. Members of each beneficiary family were, and will be, heavily involved in the implementation, indicating commitment to the project. In January 2015 the team confirmed system designs, materials quantities, materials transportation, community involvement, and all other logistics necessary to complete the implementation phase of this project. The community is prepared for a 22-home implementation in May 2015.

The design requirements for each rainwater harvesting system are determined with a series of calculations. The EWB-USA WPI team created an excel model that allows the user to calculate the needed water storage capacity for each family based on roof area of the home, number of family members, local rainfall data, and water consumption rate. Gutter and pipe lengths are determined from measurements taken in country. The design calculations include analysis of the maximum water flow rate through the system using Bernoulli's equation to account for major and minor losses. These calculations are also used to determine the length of the first flush and the differential height between inflow and overflow needed for each system. Calculations of static forces on gutters are also carried out to ensure that the weight of water will be supported.

In preparation for the May 2015 trip, the EWB-USA WPI team worked with families in the community to design individualized systems to meet their water intake needs and house structure. EWB-USA WPI emphasizes the importance of the entire system, not just the tanks. Systems are designed with enough storage capacity to ensure that each family will have adequate quantity of water to meet cooking and drinking needs year round and minimal contamination. In January 2015, drawings of each proposed system were presented to the families for final approval. Drawings indicate roof areas and gradients, layout of gutters and pipes, and locations of first flushes and tanks.

The implementation of the 22 rainwater harvesting systems will take place in five stages: Phase I: Preliminary Data and Preparations, Phase II: Concrete Base Construction, Phase III: Materials Transport for System, Phase IV: System Construction and Education, Phase V: Wrap-up.

The construction of the rainwater harvesting systems will utilize the manpower, cooperation and knowledge of the community. As in past implementations, community members will lead the construction. The EWB-USA WPI team will work with CeCEP, the Water Committee, and the community members to ensure that each team has a balance of new and experienced community members to ensure efficiency and transfer knowledge. Since this is not the first implementation in the community, experienced members will be helping with the construction of the systems. During construction, EWB-USA WPI members will serve as project managers, supervising one of the five teams of community members and by managing materials, and ensuring that knowledge is properly shared.

With community members leading the implementation, the project is set up for sustainable, long-term success. Since families are required to pay 5% of the total system cost, they will develop a sense of ownership over the system; through participation in construction, they will have the knowledge to repair and maintain them. Since the systems are individualized, each family will be responsible for physical and financial maintenance. To date, interviews and water quality tests have shown that the rainwater harvesting systems have improved quality, quantity, and access to water for beneficiary families. Future monitoring and evaluation trips will confirm that the trend continues for many years to come. EWB-USA WPI believes that this project is life changing for the people of Guachtuq as the team has already been able to see the social, economic and medical impact the system has had on successfully implemented homes.

2.0 Program Background

2.1 Basic Project Description

The Engineers Without Borders-USA chapter at Worcester Polytechnic Institute (EWB-USA WPI) aims to provide the community of Guachtuq, Guatemala with water security. The community of Guachtuq is located in the Alta Verapaz region of Guatemala and is home to about 220 Pokomchi (Mayan descent) people, among 34 families. Of the many problems they face daily, a lack of water security was identified as their greatest concern. Water security can be described as having adequate quantity, quality, and access to water to meet a home's basic needs. Currently, many families rely on a water source called the *finca,* a polluted, spring-fed water basin located a half-hour walk downhill from most families in the community. During the dry season, which lasts from February to May, the finca often dries up, forcing families to find other, more distant sources of water.

The solution that EWB-USA WPI has developed to mitigate the lack of water security in Guachtuq is the implementation of individual rainwater harvesting systems with each home in the community. This project is focused on implementing high functioning rainwater harvesting systems, rather than simply providing tanks to increase storage capacity for families. This is in contrast to other rainwater harvesting projects that the people of Guachtuq have experienced in the past, namely governmental initiatives. With the help of an Excel computation model, described in the Facility Design, EWB-USA WPI calculates the necessary system requirements for each home determined by their specific situation. The team determines the necessary storage capacity, roof area, gutter lengths, first flush volumes, and overflow specifications based on parameters such as available storage, available roof area, family size, daily consumption rate, and 30 years of rainfall data. EWB-USA WPI rainwater harvesting systems are designed to be closed systems that maintain water quality and maximize rainwater collection and storage. The systems are designed to be partially self-cleaning and resist the infiltration of insects. The components and design of the system are described in Facility Design below.

2.2 Additional Program Background

EWB-USA WPI completed two assessment trips in 2010 and 2011, where the team started to form a relationship with the community members of Guachtuq. The team conducted in-house assessments, held community meetings, and undertook water quality studies. In 2011, the team conducted a community wide survey to determine a water consumption rate for each family. Unfortunately, no trends emerged that related the number of family members to water consumption across the community, so the team has since followed WHO standards for determining water consumption rates. The team also thoroughly assessed the two homes chosen by the community for pilot implementation. This included measurements of each home as well as in-depth discussions of the needs of each family.

Throughout the project, one of the most important tools that the team has developed is an Excel model to assist the team when creating the metrics for each system. Using a variety of parameters, the model helps the team design systems to fit the specific needs of each family. Considering average regional daily rainfall, roof area of a home, number of family members, and water consumption rate, this model can be used to determine how many additional tanks each family needs to ensure sufficient water for drinking and cooking throughout the dry season.

Using information gathered from the first two assessment trips, Excel model results, and nearly two years of research and design, the team constructed two pilot systems during the first implementation trip in January 2013. The goal of the pilot project was to ensure that the Excel model worked properly and to provide a basis for future system design. Other benefits of a small-scale implementation included developing methods for construction and beginning to establish a knowledge base about constructing rainwater harvesting systems within the community. In order to accurately determine if these pilot systems served the families appropriately, a monitoring system was also established during this implementation trip. A volunteer at CeCEP (El Centro Comunitario Educativo Pokomchi), EWB-USA WPI's partner NGO, visited the community while the team was out of the country, collected preliminary information on the efficacy of the rainwater harvesting systems, and received verbal feedback from both families.

The team completed a third assessment trip in May 2013. The goal of this trip was to evaluate the success of the pilot systems and assess homes for the second implementation. In addition, a thorough census was conducted to gather demographic information about every family and to learn general information about the community. Water quality tests were also collected at various water sources throughout the community. The monitoring system established during the January 2013 trip evolved into a bi-weekly survey that asked residents about their water consumption habits. Follow-ups were conducted with the two pilot homes to ensure the systems functioned properly and, most importantly, satisfied each family's daily needs.

The second implementation trip, EWB-USA WPI's fifth trip to Guachtuq, took place in January, 2014. Though not an official EWB trip since it was funded by a grant through the EPA P3 program, this trip was essential to the progress of the project. The team constructed two rainwater harvesting systems, conducted water quality tests, held in-depth, semi-structured interviews, established a connection with the mayor of the Municipality of San Cristobal, developed stronger relationships with CeCEP and community members, and further assessed the eight homes scheduled to receive systems during the May 2014 implementation trip. Necessary details were also discussed with local hardware stores, water tank vendors, and the Municipality to arrange availability of materials and plan for transportation.

EWB-USA WPI's sixth trip to Guachtuq, the third implementation trip, took place in May 2014. In under ten days, the team and community members built eight rainwater harvesting systems, updated systems of previous beneficiaries, conducted two rounds of water quality testing, interviewed almost every family in the community, met with the mayor of the Municipality, held multiple community meetings, strengthened relationships with local NGO partner CeCEP, and assessed the homes of the remaining families.

In January 2015, the club had an additional assessment trip in order to prepare the community for the upcoming 22 home implementation in May 2015. This was done by confirming the home designs with each family in order to be sure the compiled materials list is accurate. The preparations in each family's MOU were also confirmed in order to be sure that each home and EWB-USA WPI were on the same page with what the family was receiving and what they needed to have completed before the travelers arrived in May 2015. The team also worked with CeCEP to locate and retrieve quotes for materials from various local construction stores for the quantity of materials needed for the remaining 22 systems. They also talked with the Municipality of San Cristóbal about the transportation of materials from the stores to the community.

Furthermore, the team strengthened ties with the community to ensure success in the May 2015 implementation. Additional time spent with children in learning sessions resulted in an immense transfer of knowledge such that nearly the entire community has a basic understanding of the construction of these systems. The next step for EWB-USA WPI and the community of Guachtuq is to complete implementation of the remaining 22 rainwater harvesting systems in May 2015.

3.0 Facility Design

3.1 Description of the Proposed Facilities

On the May 2015 Implementation Trip, EWB-USA WPI plans to improve water security for 22 families in Guachtuq by constructing individual rainwater harvesting systems. Rainwater harvesting systems collect rain that falls on the roof of a home and store it for later use. The systems are designed to supply a family with enough water for drinking and cooking year round. There are four main components of an EWB-USA WPI rainwater harvesting system: gutters, first flush, water storage tanks, overflow, and concrete bases. The components and subcomponents are explained in detail in the next section and are summarized below. Figure 3 and Figure 4 respectively show computer-generated and hand-drawn schematics of the general rainwater harvesting system. Figure 2 illustrates a completed rainwater harvesting system and beneficiary family (House 5, May 2014).

Figure 2: Image of completed Rainwater Harvesting System in Guachtuq (House 5)

3.1.1 Concrete Base

Water storage tanks sit on bases made of reinforced concrete and cinder blocks. Once the earth is leveled, a thin layer of crushed stone is spread over the area where the base will rest. 2x4 wooden beams are used to create a square frame for the base. A rebar network is formed to add structural support. Large stones are placed under intersections in the rebar to position the network at the center of the concrete slab. The concrete is mixed and poured; it cures for three days. Then, a layer of cinderblocks is set on top of the base to add height. It is important that the tanks sit high enough for a bucket to be placed under the faucet at the bottom so families can access water easily. Bases are important for providing structural support to the water storage tanks and protecting them from erosion. If on uneven ground, the forces exerted by water on the inside of the tank can cause the plastic to deform and fracture.

3.1.2 Gutters

Gutters are attached to the side of a house at the edge of the roof. All homes in the community have roofs made of corrugated zinc-galvanized steel. Gutters are positioned to collect rainwater as it flows off the roof in channels created by the corrugation. They are held in place by wooden

gutter clips that were designed by a community member in January 2013. The gutters are secured at an angle that prevents water stagnation in order to minimize EWB-USA WPI uses colonial-style plastic gutters and the accompanying downspout and end cap fittings. These can be purchased at local hardware stores in San Cristobal and do not corrode. Water flows through plastic mosquito netting, into the downspout connector, and down the PVC piping that leads towards the water storage tanks.

3.1.3 First Flush

The “first flush” is a system component adopted in January 2014 that reduces contamination from the roof. During non-rainy times, dirt, debris and other contaminants collect on the roof and are washed into the system when the rain falls. The first flush is a PVC tube that extends downward from the downspout of the gutter and captures a measured amount of the “first rain” that rinses the roof. There is a water bottle inside the first flush that floats as the tube fills with rainwater. When the first flush is full, the water bottle creates a stopper that allows cleaner rainwater to bypass and flow into the tank. When full, the first flush can be emptied from the through an “Italy valve” at the bottom of the tube and used in other ways.

3.1.4 Water Storage Tanks

Water is stored in 2500L high-density polyethylene (HDPE) tanks. The EWB-USA WPI systems use tanks manufactured by Rotoplas. Tanks will be ordered in advance and delivered directly from the Rotoplas distributor in Guatemala City to Guachtuq. To connect the tanks to the PVC piping, a 1½ bulkhead is secured through a hole cut in the plastic. PVC adapters are screwed into the bulkheads to ensure the tanks are closed systems. The inlet is connected towards the top of the tank, and a spigot is attached at the bottom with a sediment filter. For systems where multiple tanks are connected together, the outlets are joined using additional PVC piping. The team has designed a mechanism called the “waterfall” by which tanks can be connected so that one fills completely before overflowing into the adjoining tanks. This method is used when connecting a new EWB-USA WPI tank to existing tanks from past programs.

3.1.5 Overflow

During the rainy season, water storage tanks often fill quickly and overflow. An “overflow” pipe is connected to the tanks to divert excess water away from the base, where running water would erode the land and decrease the longevity of the system. The end of the overflow pipe is covered in mosquito netting to prevent insect infestations. Inside the tank, there is a pipe that extends to the bottom where debris tends to settle as water sits. When the tank overflows, the water at the bottom will be expelled first, carrying the sediment with it. Often times the families will position a 55 gallon drum at the end of the overflow to try and collect the extra water coming out of the system, however, since that is not a part of the closed system, it is recommended that this water only be used for washing and bathing.

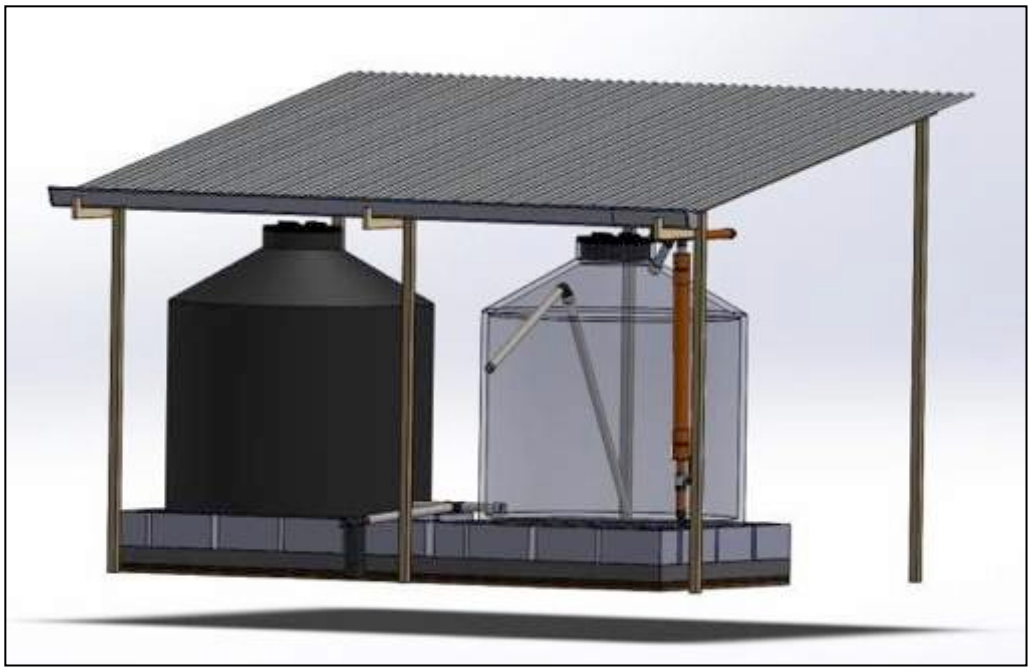


Figure 3: Computer generated model of general rainwater harvesting system

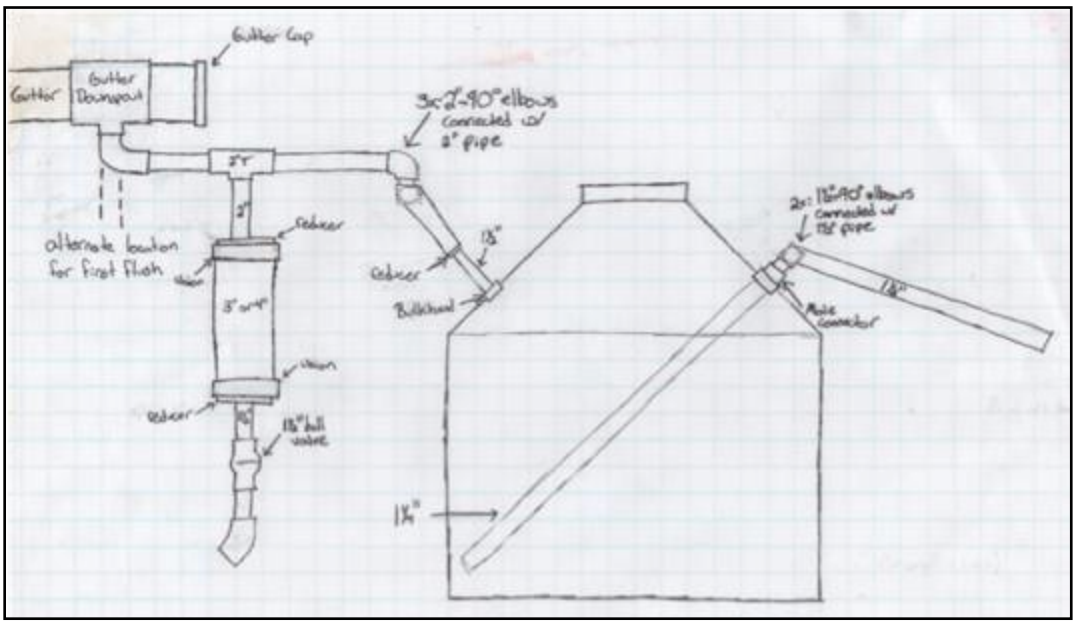


Figure 4: Schematic of General RWH System

3.2 Description of Design and Design Calculations

3.2.1 Gutters and Gutter Clips

The gutters on EWB-USA WPI rainwater harvesting systems are held in place by wood gutter clips designed by Cristobal Laj Cojoc (House 8, Water Committee President). These gutter clips have been working for over two years at his house. However, a static analysis of the system has been done in order to verify the system.

Figure 5: Gutter clip designed by community member

Figure 6: Raised gutter

Static Force Analysis of Water in Gutters

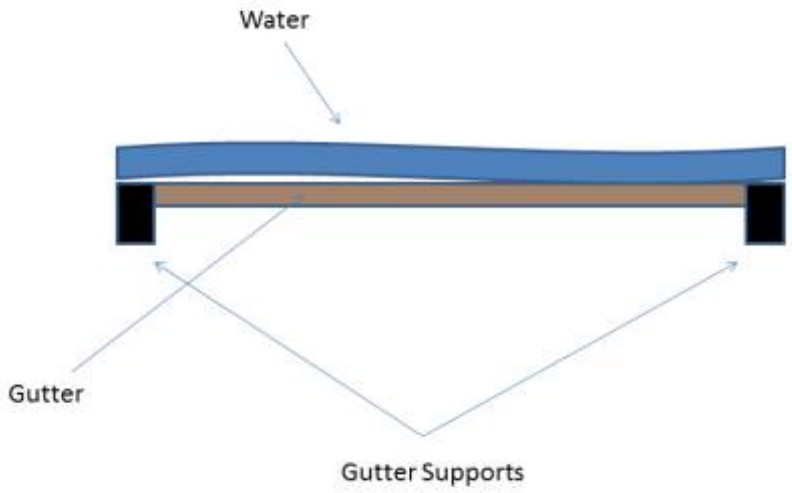


Figure 7: Schematic of Gutter

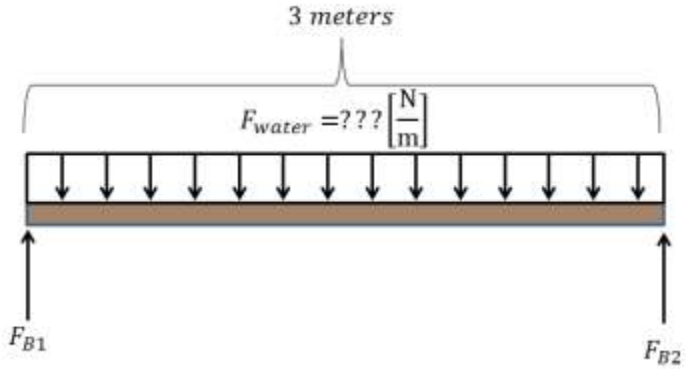


Figure 8: Free Body Diagram of Gutter

To Solve for F_{water}:

$$Mass = Volume \cdot Density$$

$$Where: Volume = (3\,m) \cdot (.089\,m) \cdot (.0254\,m) = \mathbf{0.00678\,m3}$$

$$Density = \mathbf{997\,kg/m3}\ at\ 25°\,C$$

Therefore:

$$Mass = (.00678\,m3) \cdot (997\,kg/m3) = \mathbf{6.76\,kg}$$

Now F_{water} can be solved:

$$Fwater = (6.76\,[kg]) \cdot \left(9.81\,\left[\frac{m}{s_2}\right]\right) = \mathbf{66.3}\,[\boldsymbol{N}];\ where\ gravity = 9.81\,\left[\frac{m}{s_2}\right]$$

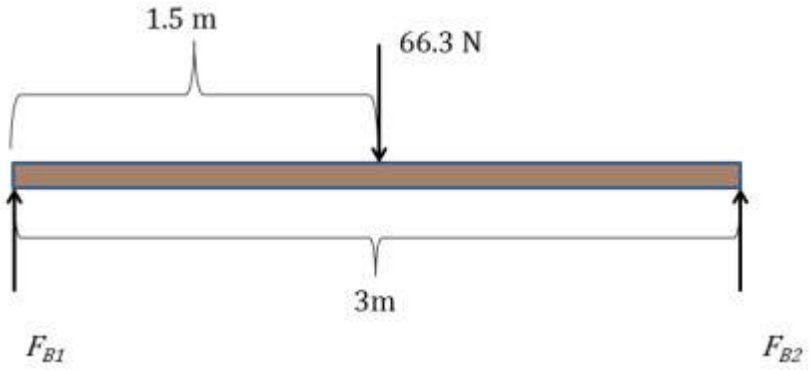


Figure 9: Static Analysis

$$\sum MF_{B1}: \ -(1.5\ m)\cdot(66.3\ N)+(3\ m)\cdot(F_{B2})=\ 0;\ \ F_{B2}\ =\ 33.15\ N$$
$$\sum Fy:\ \ FB1-\ (66.3\ N)+\ (33.15\ N)=\ 0;\ F_{B1}=F_{B2}=33.15\ N$$

It is vital to measure the static forces acting upon the gutter supports to ensure they do not fail due to the weight of the water. This analysis was conducted schematically using a 3 meter long section of gutter with supports on either end. The dimensions of water running through it are approximately 3m x .089m x .0254m. As determined mathematically, the forces acting upon each gutter support are approximately 33.15 N (7.45 lbf). It has been determined that the supports are plenty strong enough to hold this weight.

3.2.2 System Water Flows

Water flows into the system from the gutter downspout, through the first flush, and into the water storage tanks. The photos in this section show the piping that leads from the downspout at the end of the gutters to the bulkhead connection into the tank. The overflow is shown coming out of the top of one of the systems photographed with a similar bulkhead connection. The end of the overflow is covered in mosquito netting to preserve the closed system. Similarly, a waterfall connection can be used to connect two tanks where one tank overflows into the second tank, rather than having the two tanks connected at the bottom.

To create an adequate overflow system, the amount of water exiting the tank through the overflow pipe must equal the amount of water entering the tank from the gutters/downspout. To achieve this balance, the overflow pipe must be positioned a certain distance below the maximum water level in the tank. This height of overflow, shown below in Figure 10, is determined through a series of calculations, explained below. In addition, precautions must be taken to prevent a siphon from forming. A small hole must be drilled at the highest point of the overflow to prevent the tank from draining via an unintended siphon.

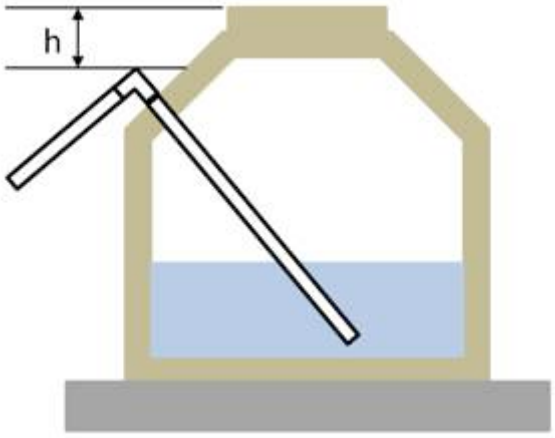


Figure 10: Typical tank with overflow pipe pulling water from the bottom of the tank to increase circulation of water in the tank.

Figure 11: Downspout leading to first flush

Figure 12: Bulkhead connection from the downspout to the HDPE Rotoplas tanks.

Figure 13: Sediment filter and spigot

Figure 14: The Waterfall connection between tanks.

Figure 15: Overflow pipe on the outside of the tank

Figure 16: Overflow pipe inside the tank

Step One: Inputs

Roof area
Maximum Average Rainfall
Desired overflow pipe diameter
Length of overflow pipe (inside tank)

While the roof area will be different for all homes, the other three inputs are the constant for the calculations. Maximum average rainfall was determined to be 0.072 cm/minute from 5 months of data the EWB-USA WPI rain gauge stationed in San Cristobal. The desired overflow pipe diameter and length are 1.5 inches and 2 meters, respectively. From these inputs the flow rate necessary can be computed with the relationship below.

$$Q_{in} = Roof\ Area \cdot Rainfall$$
$$Q_{in} = Q_{out}$$

Step Two: Bernoulli's Equation

To determine the necessary space (h) between the very top of the tank and the overflow pipe, Bernoulli's equation was used. The left side of the equation assumes conditions inside the tank as the water level is rising, and the right side of the equation assumes conditions at the end of the overflow pipe.

$$\frac{P_1}{\rho} + \frac{{V_1}^2}{2} + gz_1 = \frac{P_2}{\rho} + \frac{{V_2}^2}{2} + gz_2 + H_{losses}$$
$$P_{1,2} = Pressure\ (Pascals)$$
$$\rho = Density\ \left(998 \frac{kg}{m^3}\right)$$

$$V_{1,2} = Velocity\ \left(\frac{m}{s}\right)$$
$$g = gravity\ \left(9.81\frac{m}{s^2}\right)$$
$$z_{1,2} = Height\ (meters)$$
$$H_{losses} = frictional\ losses\ (meters)$$

The losses in the overflow pipe were removed from this set of calculations and computed separately. The outlet of the overflow pipe is atmospheric. The tank is designed for atmospheric conditions, and will operate as such as long as the inlet to the tank does not become clogged. The velocity of the water level inside the tank can be set to zero because during an overflow situation, the water level should not be rising or falling.

$$P_1 = P_2 = P_{atm}$$
$$z_1 - z_2 = h$$
$$V_1 = 0$$

With those assumptions and changes in variables, the following relationship between height of overflow and velocity of overflow water can be determined (see Equation 0 below).

$$V_2 = \sqrt{2gh}$$
$$Q_{out} = A_{pipe} \cdot V_2$$
$$V_2 = \frac{Q_{out}}{A_{pipe}}$$
$$h = \frac{{V_2}^2}{2g}$$

Step Three: Frictional Losses

Once the baseline overflow height is determined through Bernoulli's equation, the pressure (and effectively height) lost by friction in the pipe and fittings is calculated. Before losses can be calculated, the Reynolds number of the water in the overflow pipe is found.

$$Re = \frac{4 \cdot Q}{\pi \cdot D \cdot \nu}$$
$$Q = flow\ rate\ \left(\frac{m^3}{s}\right)$$
$$D = pipe\ diameter\ (m)$$
$$\nu = viscosity\ \left(10^{-6}\frac{m^2}{s}\right)$$

Unless the roof area is less than 10 square meters, the flow of water through the overflow pipe will be turbulent (laminar losses are typically much less than turbulent). The turbulent losses are computed through the following equations.

Major Losses

$$Straight\ pipe\ losses = f \cdot \frac{L}{D} \cdot \frac{V^2}{2 \cdot g}$$

$$f = 0.316 * Re^{\frac{1}{4}}$$
$$L = pipe\ length$$
$$D = pipe\ diameter$$
$$V = velocity\ of\ water$$
$$g = gravity\ \left(9.81\ \frac{m}{s^2}\right)$$

Minor Losses

Minor losses due to entrance effects at the bottom of the overflow pipe and the 45 degree elbow in the overflow.

$$Minor\ losses = k \cdot \frac{V^2}{2 \cdot g}$$
$$k = 0.4\ for\ water\ on\ PVC$$
$$V = velocity\ of\ water$$
$$g = gravity\ (9.81 \frac{m}{s^2})$$

Final Result

$$h = Bernoulli\ height + straight\ pipe\ losses + minor\ losses\ (entrance\ and\ elbow)$$
$$h = \frac{V^2}{2g} + f \cdot \frac{L}{D} \cdot \frac{V^2}{2 \cdot g} + 2 \cdot\ k \cdot \frac{V^2}{2 \cdot g}$$

The relationship between roof area and overflow height is shown below in Figure 17. The blue line is the direct results, and the orange and gray lines are the heights with a safety factor of 1.5 and 2, respectively.

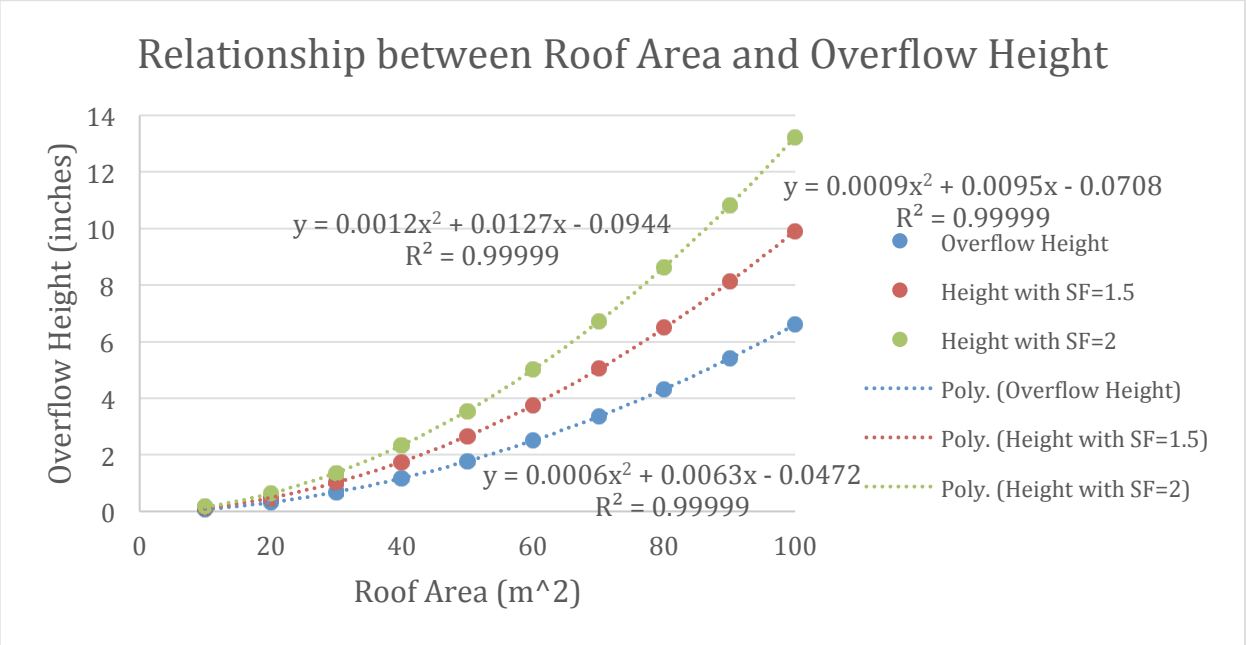


Figure 17: Graph of roof area and overflow height.

3.2.3 First Flush Unit

The EWB-USA WPI first flush consists of a 4 inch diameter PVC pipe that has a liter plastic water bottle inside to block mixing when the first flush is full. It does this by floating up to the top of the main chamber and sealing against the PVC reducer at the top of the first flush. There is a ball valve at the end of the 4 inch pipe that allows community members to empty the system after each rainfall. The system is supported at the bottom by a stick. EWB-USA WPI educates all families to collect the water that is removed from the first flush for bathing and washing after each rainfall. The system removes 0.2 [L] of water per 1 [m^2].

Figure 18: EWB-USA WPI First Flush

The relationship between roof area and length needed for first flush is shown below in Figure 19. Depending on the amount of vertical space, the graph shows options for a 3” diameter or 4” diameter first flush.

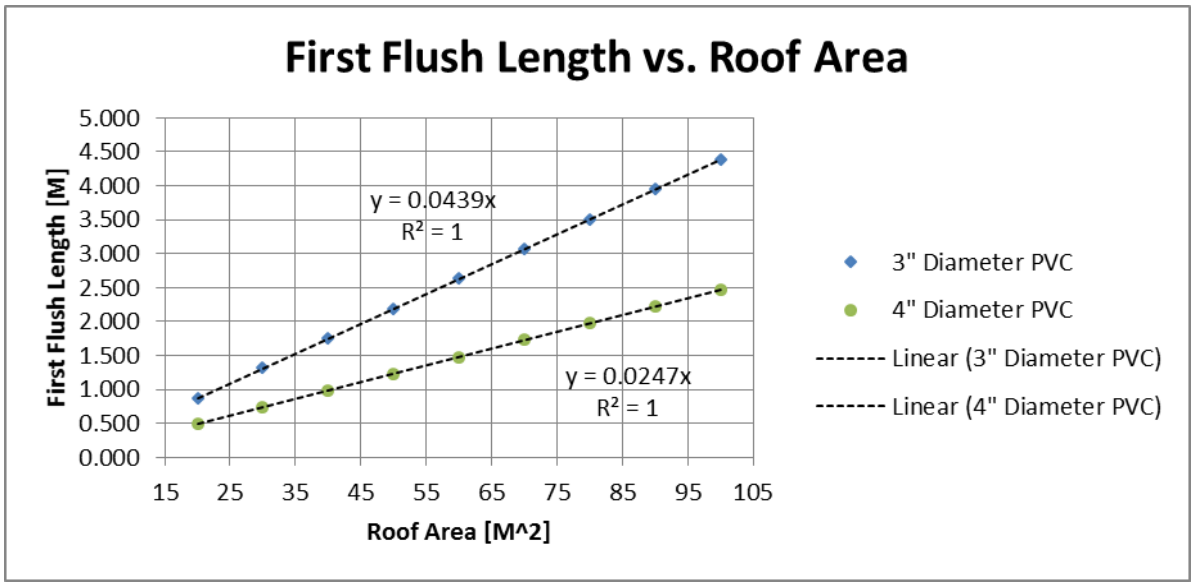


Figure 19: Graph of relationship between length of first flush and roof area.

3.2.4 Excel Model System Design Input Parameters

Calculating Flow In:

Width, Length, and Surface Area				
length of roof 1	5	m	0	m
width of roof 1	5.6	m	0	m
length of roof 2	8.8	m	0	m
width of roof 2	6.6	m	0	m
length of roof 3	0	m	0	m
width of roof 3	0	m	0	m
Total Surface Area	86.08	m2	0	m2

Total Storage Volume

Tank Volume & Flush Volume				
Volume of Tank 1	1700	L	0	L
Volume of Tank 2	1700	L	0	L
Volume of Tank 3	2500	L	0	L
Volume of Tank 4	0	L	0	L
Flush Volume (5 gal)	17.216	L	0	L
Total Storage Volume	5900	L	0	L

First Flush Length				
First Flush length (5 gal) 4"	212.351	cm	0.000	cm
First Flush length (5 gal) 3"	377.513	cm	0.000	cm
First Flush Volume Constant	0.2	L/m^2		

Calculating Flow Out

Other Information				
Number of People	8			
Regular Consumption Rate	96	L/Day	0	L/Day
Consumption Rate on Rations	24	L/Day	0	L/Day
Efficiency Rate	80%		80%	

Overflow		
Pipe Diameter	0.0381	m
Roof Area	86.08	m^2
Maximum Rainfall: Final Height	4.22606	m
	12.62355	cm
	4.96991	in

Figure 20: Example of Excel Model Inputs page used to calculate system requirements

This first sheet in the Excel model describes the factors that determine a system's water level at any given time. The possible input parameters on this sheet are:

- Roof Area
- Number of Family Members in a home
- Total Storage Capacity
- Daily Individual Water Consumption Rate

The flow into a tank is based on how much water the specified roof area can collect in its gutters and the rainfall data located in another sheet of the Excel file. However, there is a limit to the relationship between increasing the size of a roof and improving its efficiency at collecting water,

due to the amount of implemented tanks. The same goes for the amount of tanks implemented at a house, there is a point where adding more tanks to a system will not increase the amount of water in the system without also increasing the roof area supplying them. The rainfall data in this model was taken from 30 years of rainfall data collected by a local university and 5 years of data that EWB-USA WPI has collected in San Cristobal.

First Flush Length
The first flush length is determined by the size of the roof area that feeds it. Increasing the area of roofs means that there is a greater volume of water that needs to be drawn off in order to effectively rinse the roof.

Water Consumption Rate
The flow of water out of the system, how much water is being used, is determined by the number of people living in a house, multiplied by the standard consumption rate per person per day. This standard consumption rate, 2.0 L per day, has been taken from the World Health Organization's standard for adult male recommended water consumption. This number can be changed if the model is told to have the family ration for a certain period of time, however, if the family is required to ration than the system is not considered to be an effective and functioning system.

Figure 21: Chart of water capacity over the course of a year and five years

The graph in the figure above describes the volume of water contained in the system as defined by the inputs in the Excel model over the course of one year and five years. The one year span is based on averaging all the years of rainfall data that EWB-USA WPI has collected and that the club has received from a local university. The five year span allows the club to see the differences between a drier year and a wetter year. EWB-USA WPI defines a successful system as a system that won't run dry even once over the shown average or five year span.

3.2.5 Concrete and Cinder Block Base

The concrete base is comprised of a 4 inch, steel reinforced, concrete pad with a 24 cinderblock array on top. The cinderblocks raise the tank 8 additional inches off the ground in order to allow families to access water at the spigot located at the base of the tank. There is a layer of stone that is laid down before the concrete is poured. This layer of rocks acts as a level surface with high drainage to reduce erosion. The rebar is placed in the concrete one third from the top surface by using larger rocks to support it. Larger rocks are placed within the concrete base to reduce the total necessary volume of concrete.

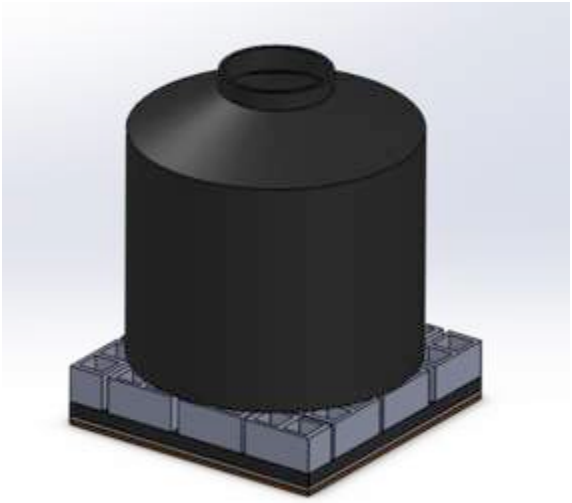


Figure 22: EWB-USA WPI Concrete Base

Figure 23: Concrete base ready for tanks

3.3 Design

This section contains designs for each house that will be receiving a system on the May 2015 Implementation Trip. The dimensions and roof areas are from home assessments completed at the end of the May 2014 trip and confirmed during the January 2015 assessment trip. Each design is based off of results from the club's Excel model, and tanks are located where each family has decided they would be most convenient. For any homes with piping running through the house, the family was consulted in the January 2015 assessment trip to be sure they found that design acceptable. Each family for whom a system was designed was given the chance to verify their system design and request any changes that they would want to make the system better suit their needs.

Following are home profiles for each of the homes that are planned to receive a system on the May 2015 Implementation Trip. Each home has been assigned a number in order to simplify the planning process. The home number related to their location in the community can be seen in the community map below. The home profiles include the family name, system design, excel model outputs, and basic construction plan. In the system designs, the roof slope is defined by the black arrows on each of the roof areas. The blue rectangles at the edge of each roof area are the planned locations of the gutters for each system. The blue lines are PVC piping leading to the tank, and finally, the red circles are the locations of the first flushes in each system.

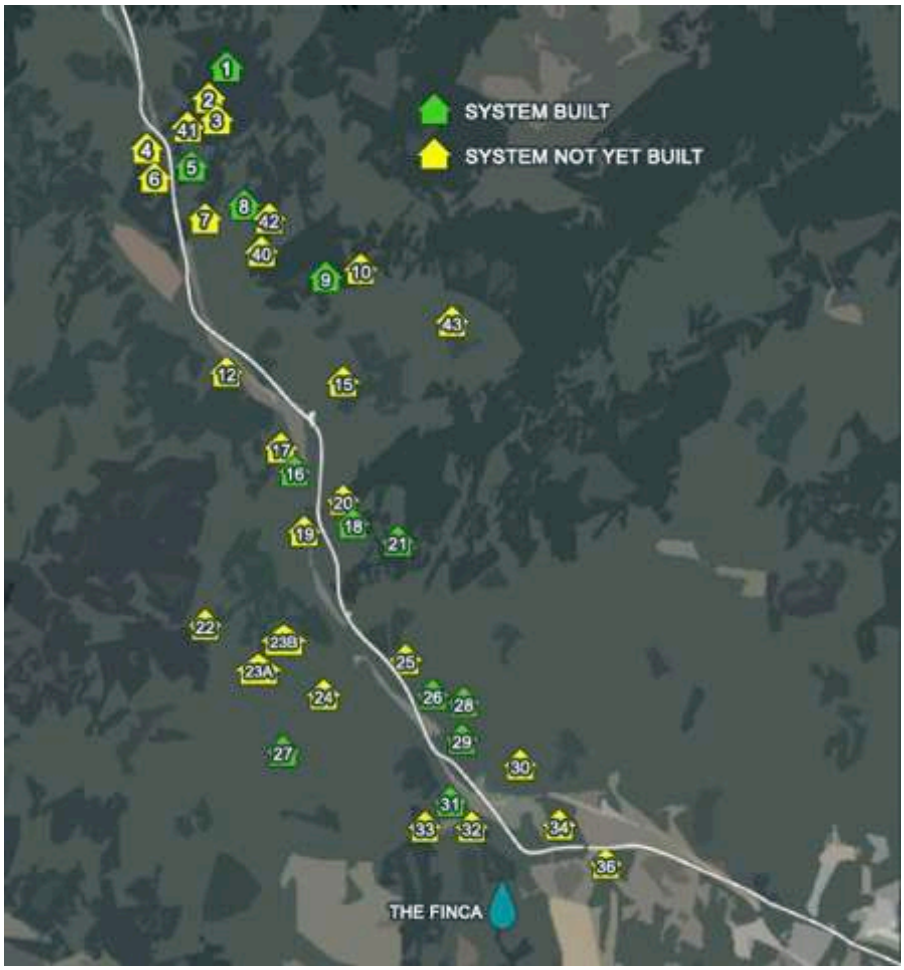


Figure 24: Community Map with Home Numbering

Mateo Cal Cal (House #2)

Man of the house: Mateo Cal Cal
Woman of the house: Isabela Caj Pop

8 people live in the house

Existing Tanks:
Government 2

Embassy 0

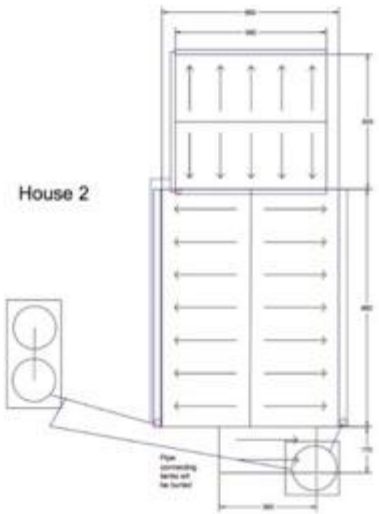
Other: EWB 0

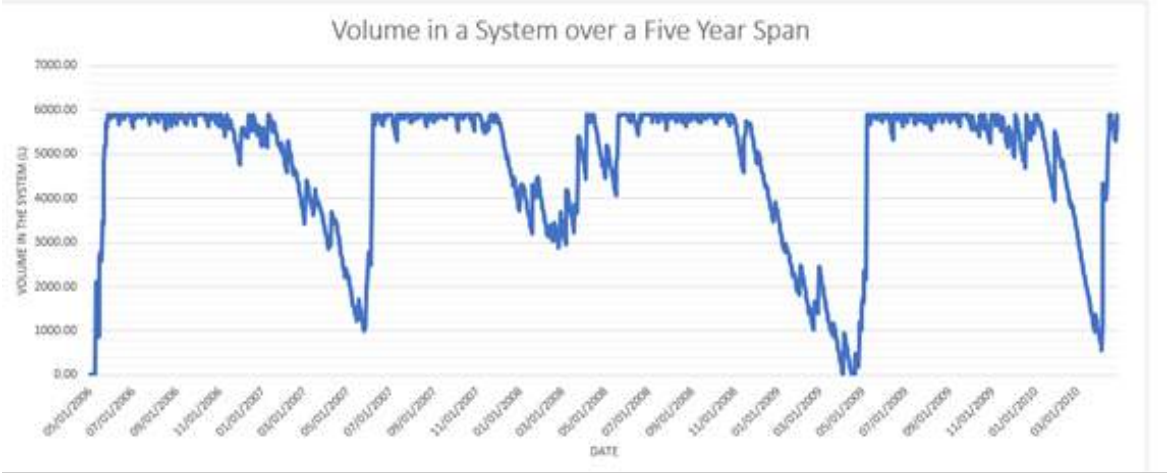
Plan for Implementation:

Gutter Lengths	
	Two gutters of length 560 cm
	Two gutters of length 880 cm
First Flush Length	
	First Flush Fed from Small roof – 69 cm
	Two each fed from half the large roof – 72 cm each
Overflow Height	12.75 cm
Existing System Capacity	**2**
Number of Tanks Being Added	**1**
Concrete Base	**1 tank base and 1 two tank base**

Agreed work to be done before May:

- **Prepare an area for the base 2 meters by 2 meters and 2.5 meters deep**
- **Prepare an area for a base 2 meters by 3.5 meters**
- **Collect 2m^3 of rocks**
- **Prepare to clean your tank**





Julio Cal Jalal (House #3)

Man of the house: Julio Cal Jalal
Woman of the house: Celestina Cal Caj
6 people live in the house

Existing Tanks:
Government 0

Embassy 0

Other: EWB 2

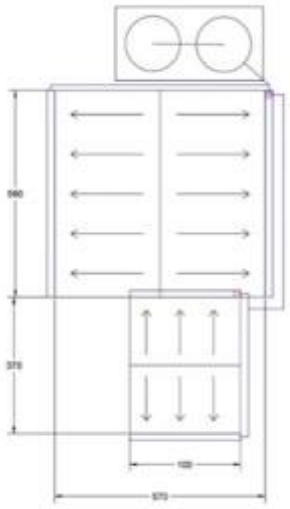
Plan for Implementation:

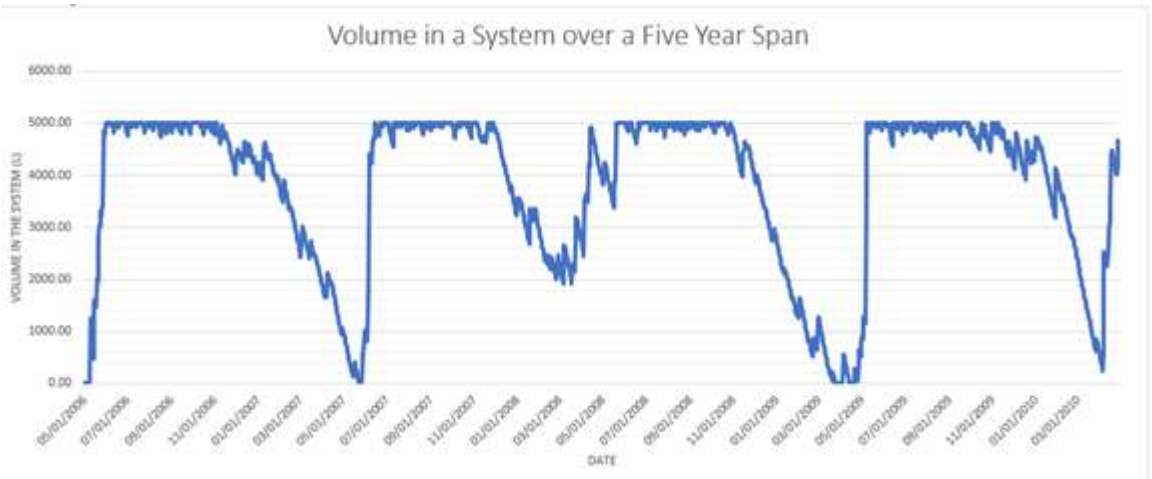
Gutter Lengths	
	2 Gutters of length 100 cm
	2 Gutters of length 560 cm
First Flush Length	
	First flush from large roof - 78.75 cm
	First flush from smaller roof - 9.25 cm
Overflow Height	5 cm
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

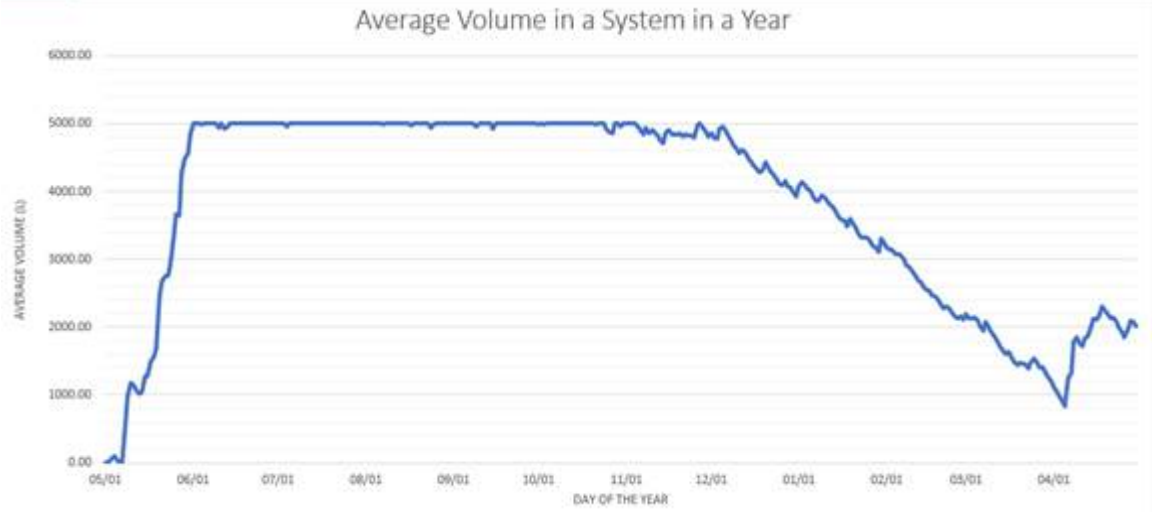
Agreed work to be done before May:

- **Maintain the area of the roof size**
- **Increase the pitch of the roof**
- **Prepare an area for the base 2 meters by 3.50 meters and 2.5 meters deep**
- **Collect 1.5 meters of rocks**
- **Prepare to empty and clean tanks**

House 3







Estanislao Caal Mo (House 4)

Man of the house: Estanislao Caal Mo
Woman of the house:

7 people live in the house

Existing Tanks:

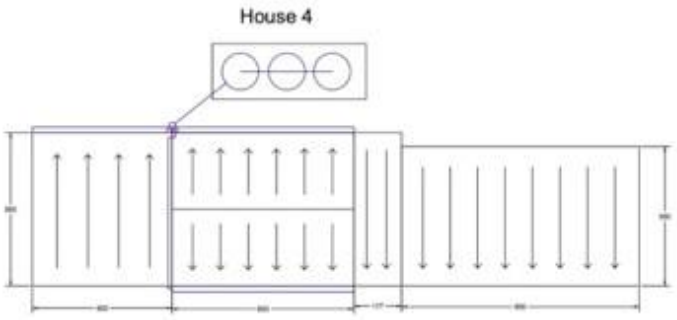
Government	**1**
Embassy	**0**
Other: EWB	**0**

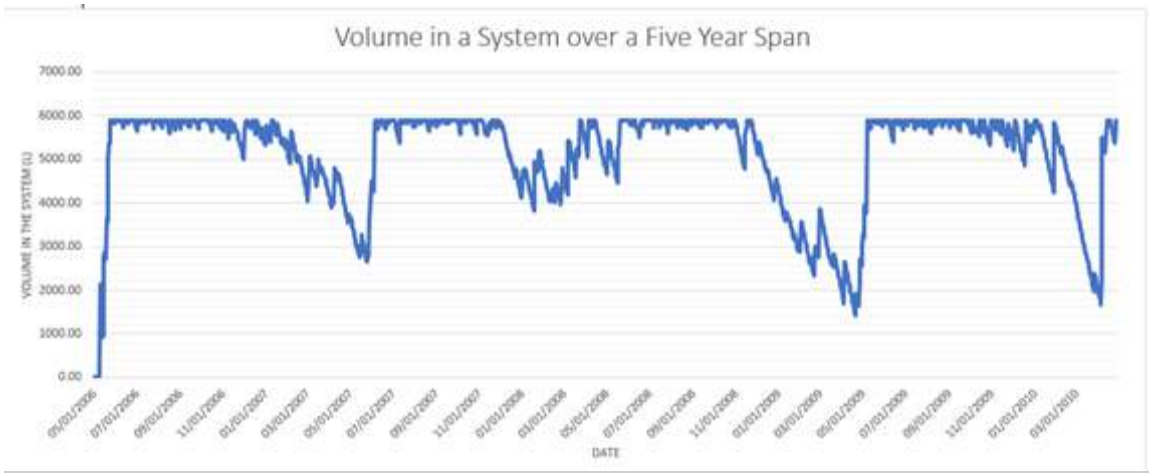
Plan for Implementation:

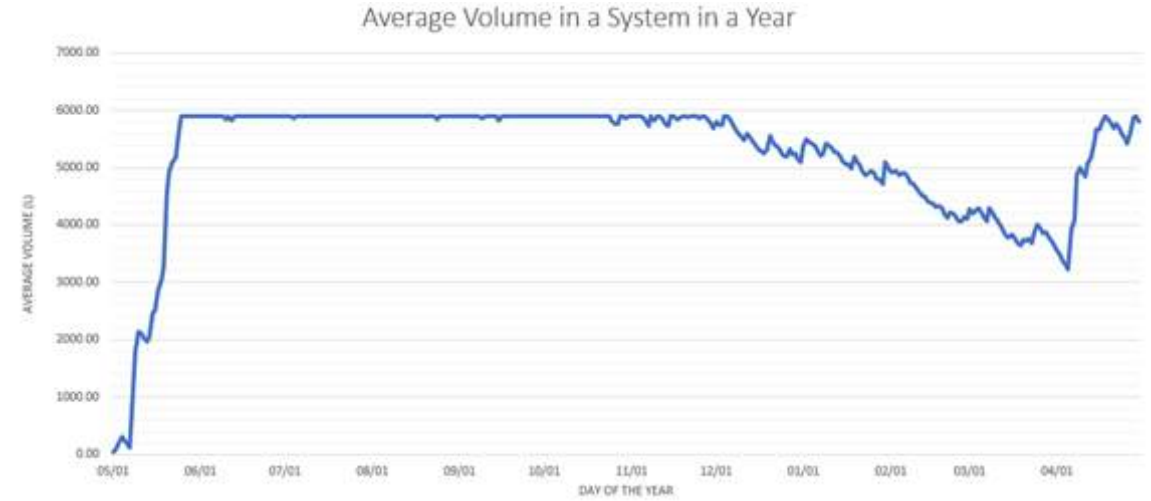
Gutter Lengths	
	2 gutters of length 650cm
	1 gutter of length 500cm
First Flush Length	
	First flush from roof 1 - 82cm
	First flush from roof 2 - 88cm
Overflow Height	
	height for new tanks 7cm
	height for old tank10cm
Existing System Capacity	**1**
Number of Tanks Being Added	**2**
Concrete Base	**1 three tank base**

Agreed work to be done before May:

- **Prepare the roof to maintain the area, do not make the roof area any smaller and ensure that the lowest point of the roof is 250 cm above the area for the base**
- **Prepare an area in the soil with the measurements of 200 cm x 600 cm for the base**
- **Collect rocks for the base**
- **Prepare to empty and clean existing tank**







Carlos Jom Yuja (House 6)

Man of the house Carlos Jom Yuja
Woman of the house: Rosa Gualim Cal

8 people live in the house

Existing Tanks:

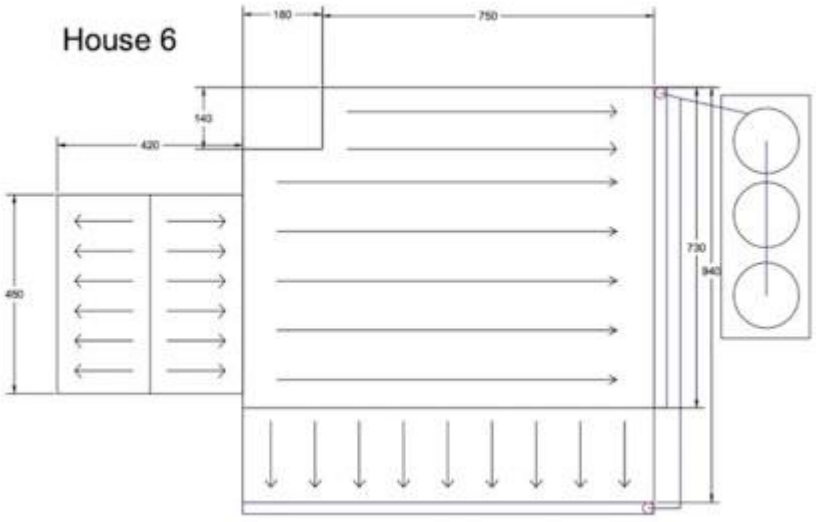
Government	**1**
Embassy	**1**
Other: EWB	**0**

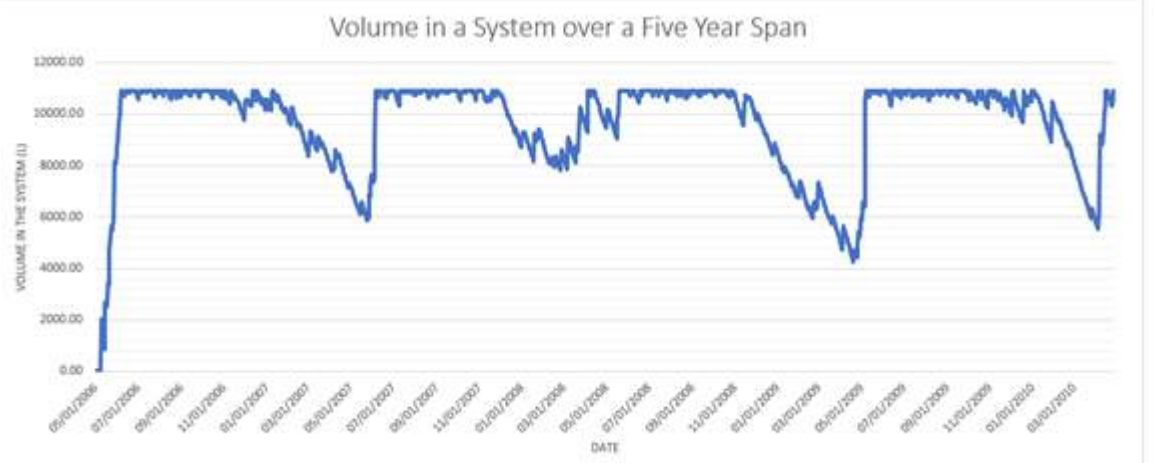
Plan for Implementation:

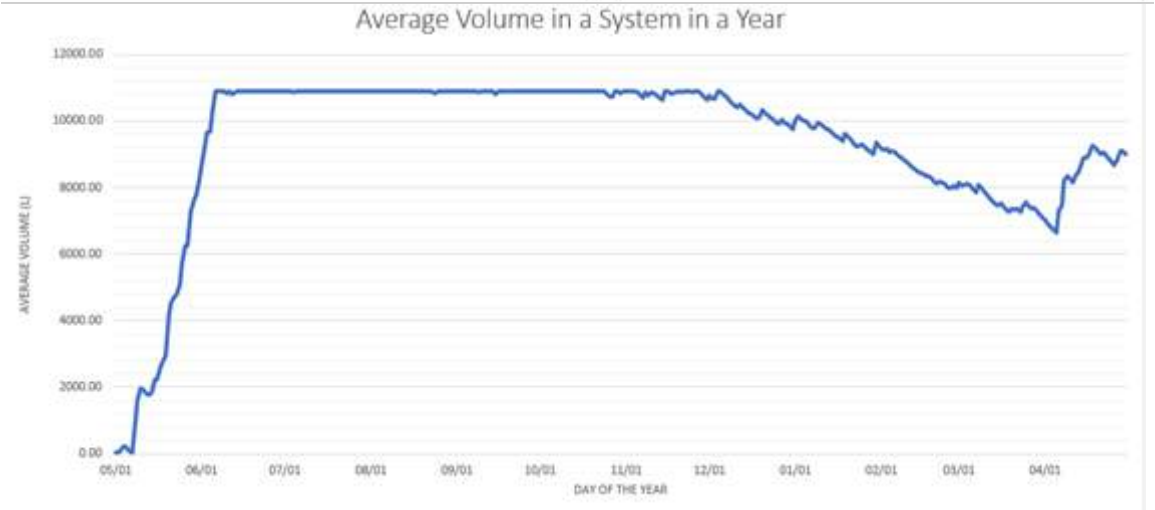
Gutter Lengths	
	1 Gutter of length 930 cm
	1 Gutter of length 730 cm
First Flush Length	**372 cm**
Overflow Height	**12.5**
Existing System Capacity	**2**
Number of Tanks Being Added	**1**
Concrete Base	**1 three tank base**

Agreed work to be done before May

- **Level the area near the government tanks (1700L)**
- **Collect 1.5 m^3 of rocks for the base**
- **Remove the water from the tanks days before Engineers Without Borders come**







Jose Sis Xuc (House 7)

Man of the house: Jose Sis Xuc
Woman of the house Graciela Cardona Valezquez
5 people live in the house

Existing Tanks:
Government **1**

Embassy **0**

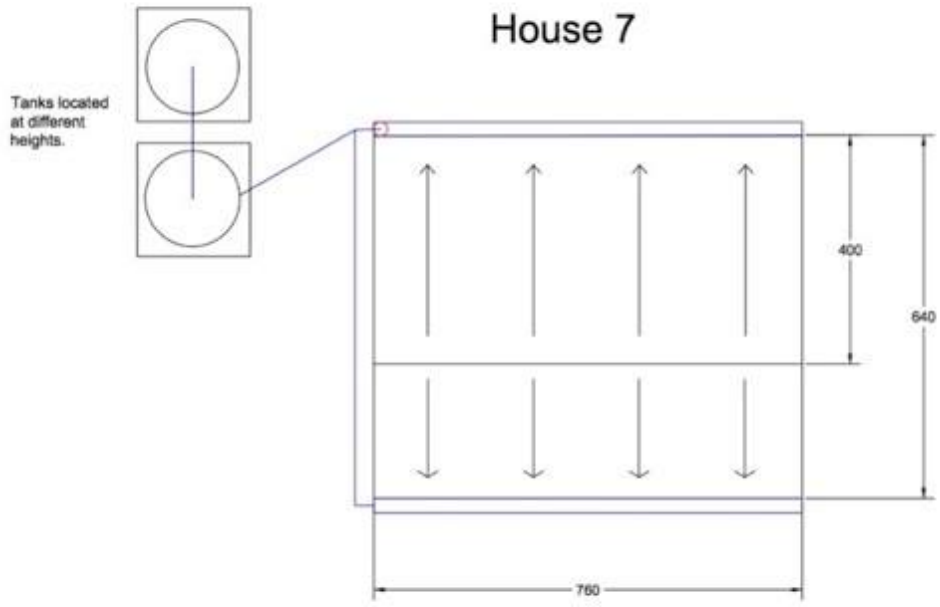
Other: EWB **0**

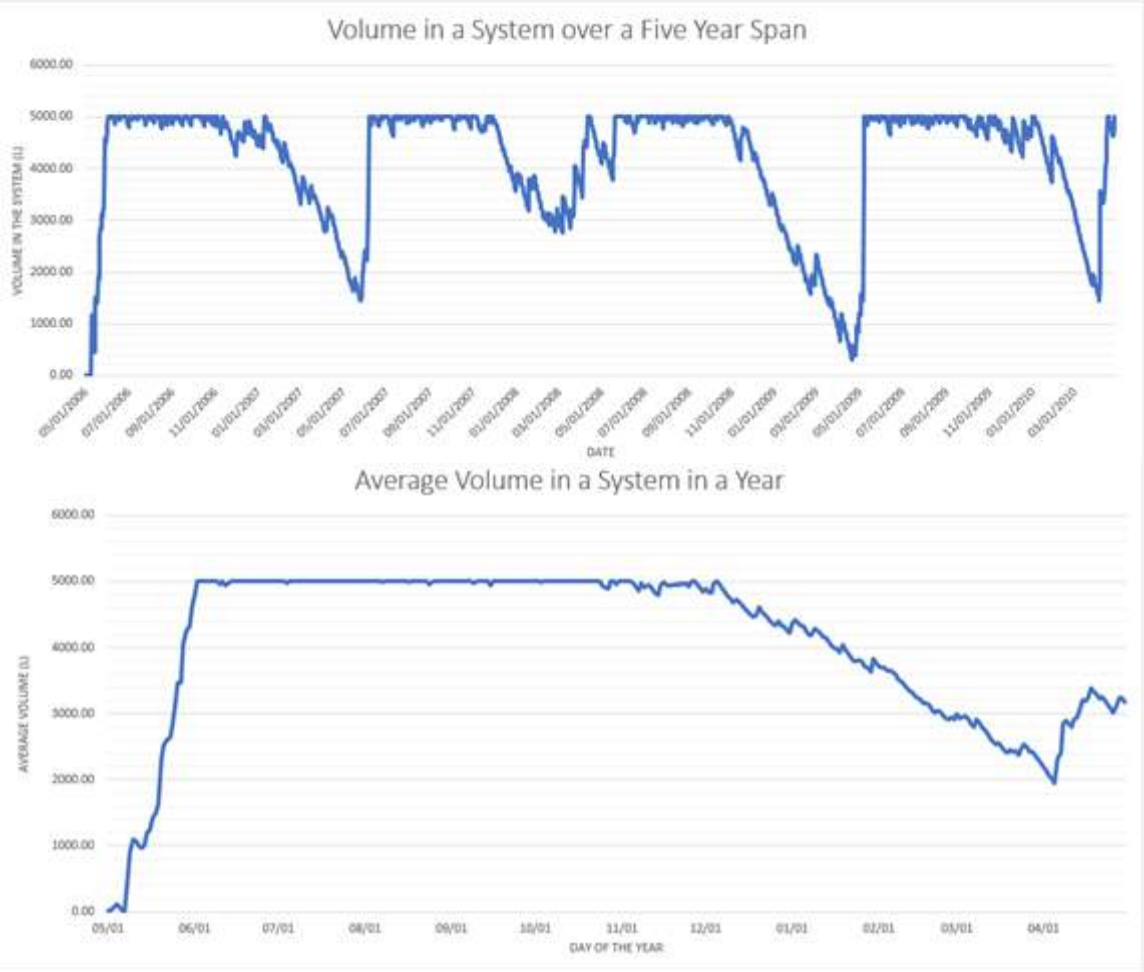
Plan for Implementation:

Gutter Lengths	2 gutters of length 760cm
First Flush Length	**120cm**
Overflow Height	**4cm**
Existing System Capacity	**1**
Number of Tanks Being Added	**1**
Concrete Base	**1 one tank base**

Agreed work to be done before May:

- **Prepare a place for the other tank to go with a base area of 4 meters by two meters**
- **Collect rocks for the cement base**
- **Prepare to empty and clean your tank**





Santiago Lem Mo (House 10)

Man of the house: Santiago Lem Mo
Woman of the house: Margarita Pop Jom

11 (12, new baby coming soon) people live in the house

Existing Tanks:
Government 2

Embassy 0

Other: EWB 0

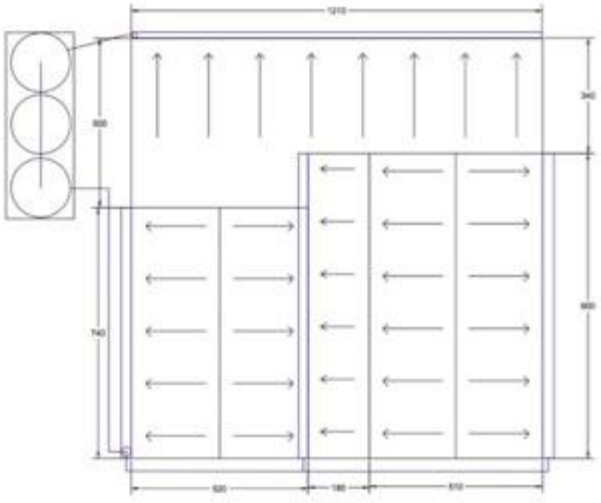
Plan for Implementation:

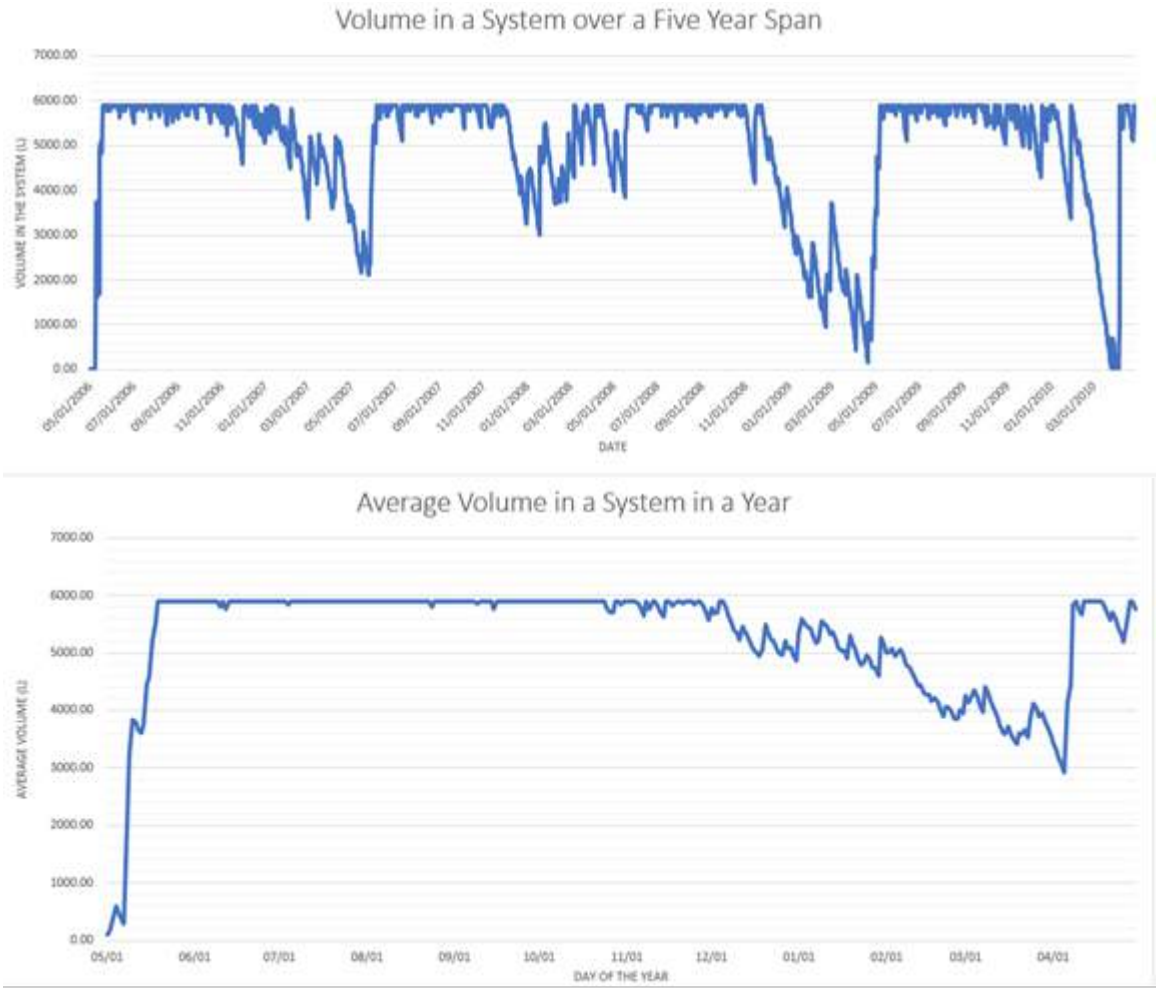
Gutter Lengths	
	2 gutters of length 900 cm
	1 gutter of length 1210 cm
	1 gutter of length 740 cm
First Flush Length	
	Bottom left corner of the house is 150 cm
	Top left corner of the house is 170 cm
Overflow Height	**36 cm**
Existing System Capacity	**1**
Number of Tanks Being Added	**2**
Concrete Base	**One 3 tank base**

Agreed work to be done before May:

- **Clear an area for the base (500 cm x 200 cm**
- **Collect 1.5 m of rocks for the base**
- **Raise the roof in front of the house so the water moves in the direction of the tanks**

House 10





Edin Raul Coc Chub (House 12)

Man of the house: Edin Raul Coc Chub
Woman of the house: Alejandrina Yuja Lem

4 people live in the house

Existing Tanks:

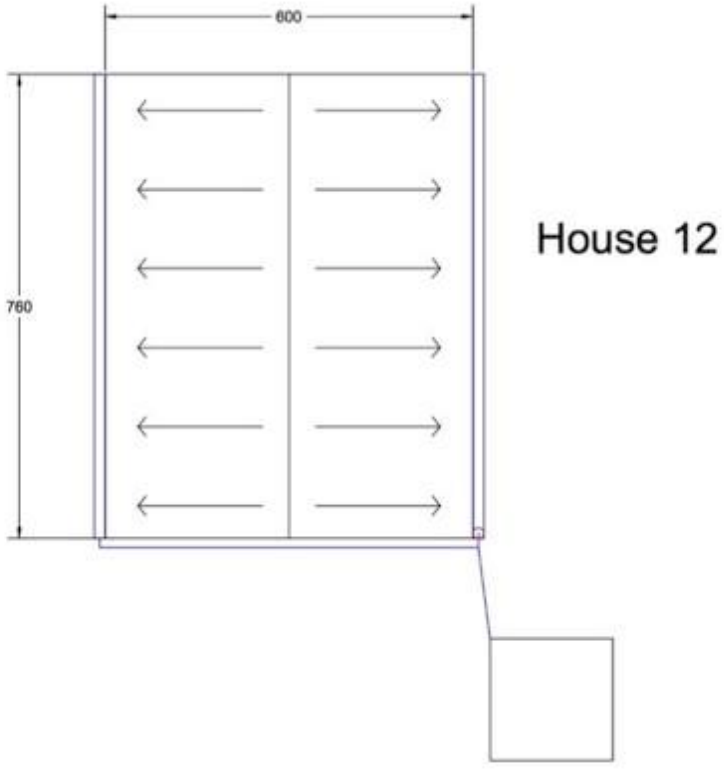
Government	**0**
Embassy	**1**
Other: EWB	**0**

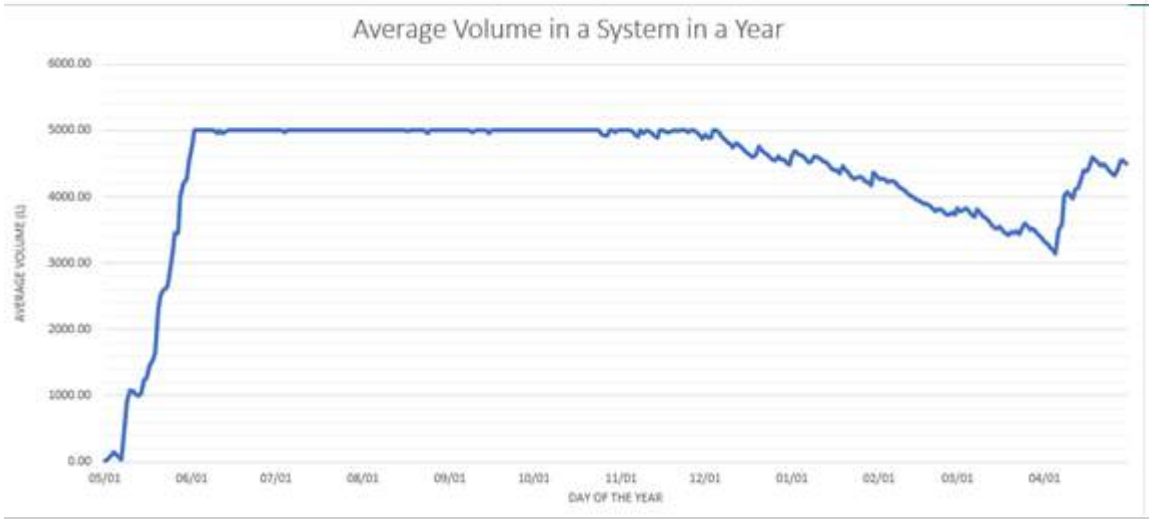
Plan for Implementation:

Gutter Lengths	2 Gutters of length 760 cm
First Flush Length	112.5 cm
Overflow Height	4 cm
Existing System Capacity	**1**
Number of Tanks Being Added	**0**
Concrete Base	**N/A**

Agreed work to be done before May:

- **Maintain your house**





Edgar Efrain Yuja Cal (House #17)

Man of the house: Edgar Efrain Yuja Cal
Woman of the house: Macz Calel

6 people live in the house

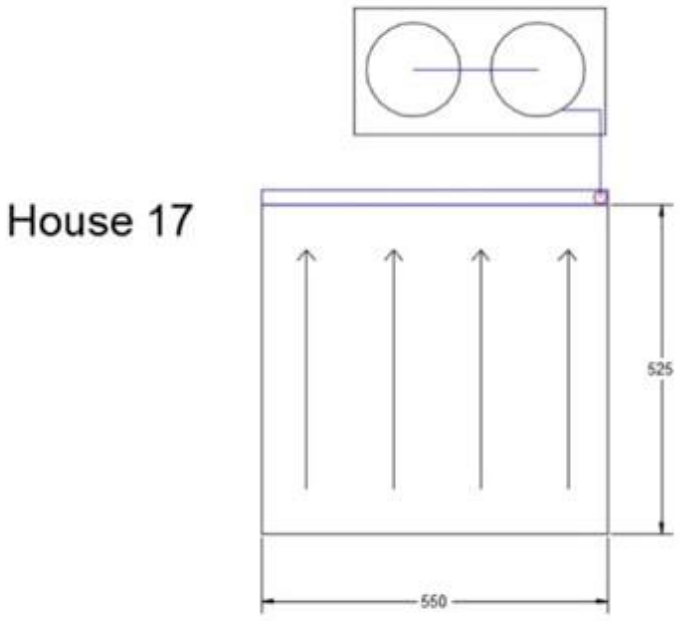
Existing Tanks:
Government 0
Embassy 0
Other: EWB 0

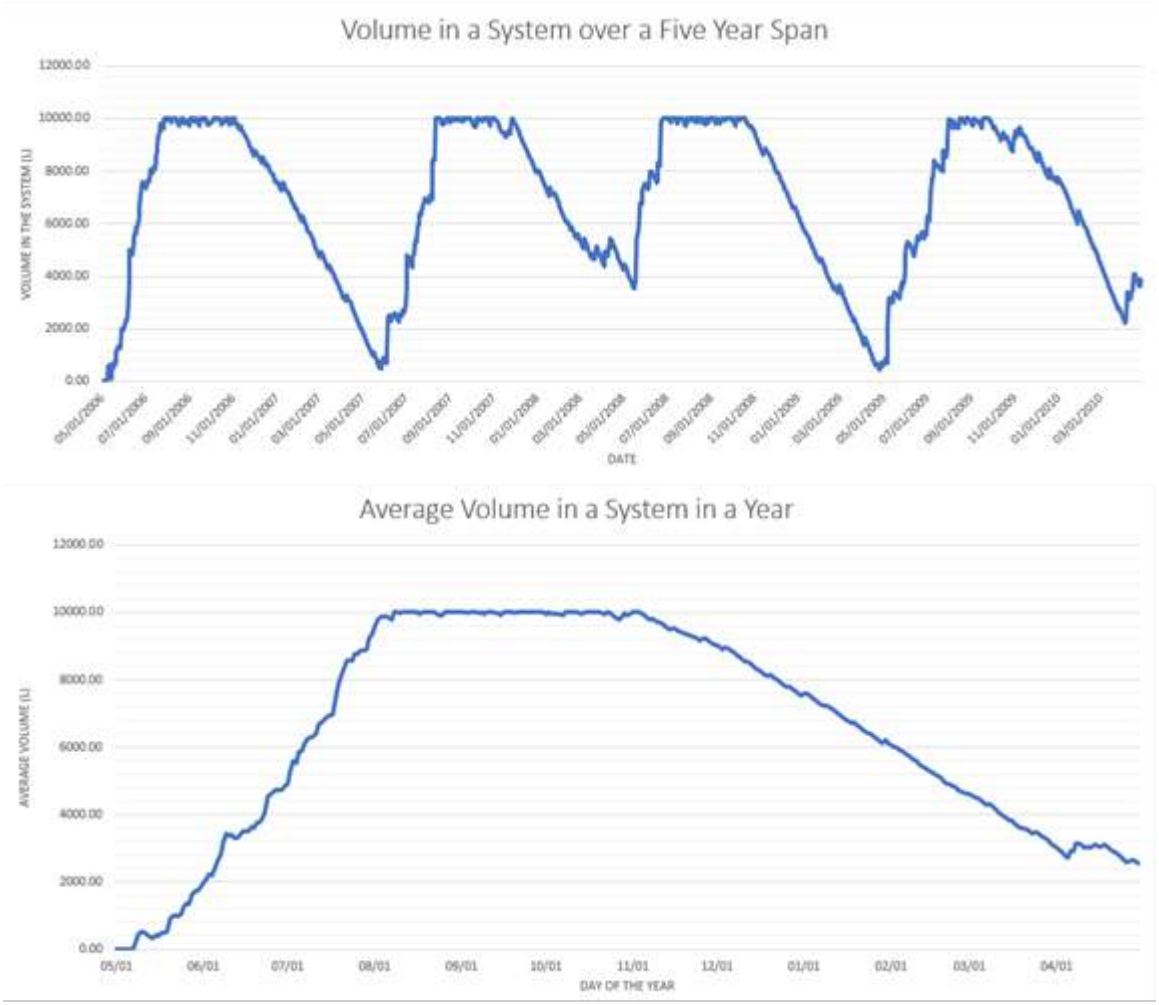
Plan for Implementation:

Gutter Lengths	1 gutter of length 415 cm
First Flush Length	65 cm
Overflow Height	8 cm
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

Agreed work to be done before May:

- **Collect 1.5 meters of rocks**
- **Prepare an area for the base of 2x4 meters**
- **Fix the roof**





Victor Caj Cu (House #19)

Man of the house: Victor Caj Cu
Woman of the house: Matilde Jor Yuja

4 people live in the house

Existing Tanks:

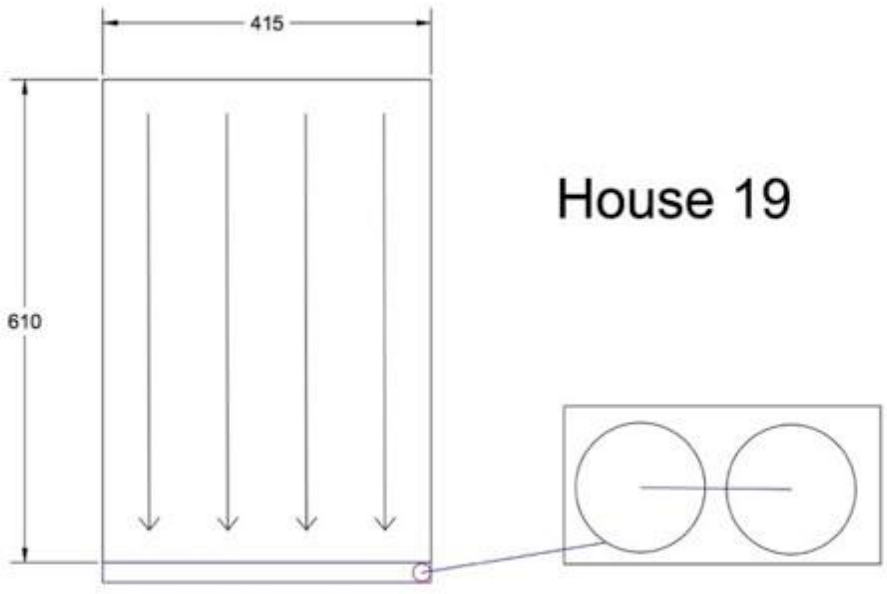
Government	**0**
Embassy	**0**
Other: EWB	**0**

Plan for Implementation:

Gutter Lengths	1 gutter of length 415 cm
First Flush Length	**65cm**
Overflow Height	**8cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

Agreed work to be done before May:

- **Level the land where the base will go (330 cm x 174 cm)**
- **Collect 1.5 m^3 of rocks for the base**
- **Raise the roof 500cm for the tanks**



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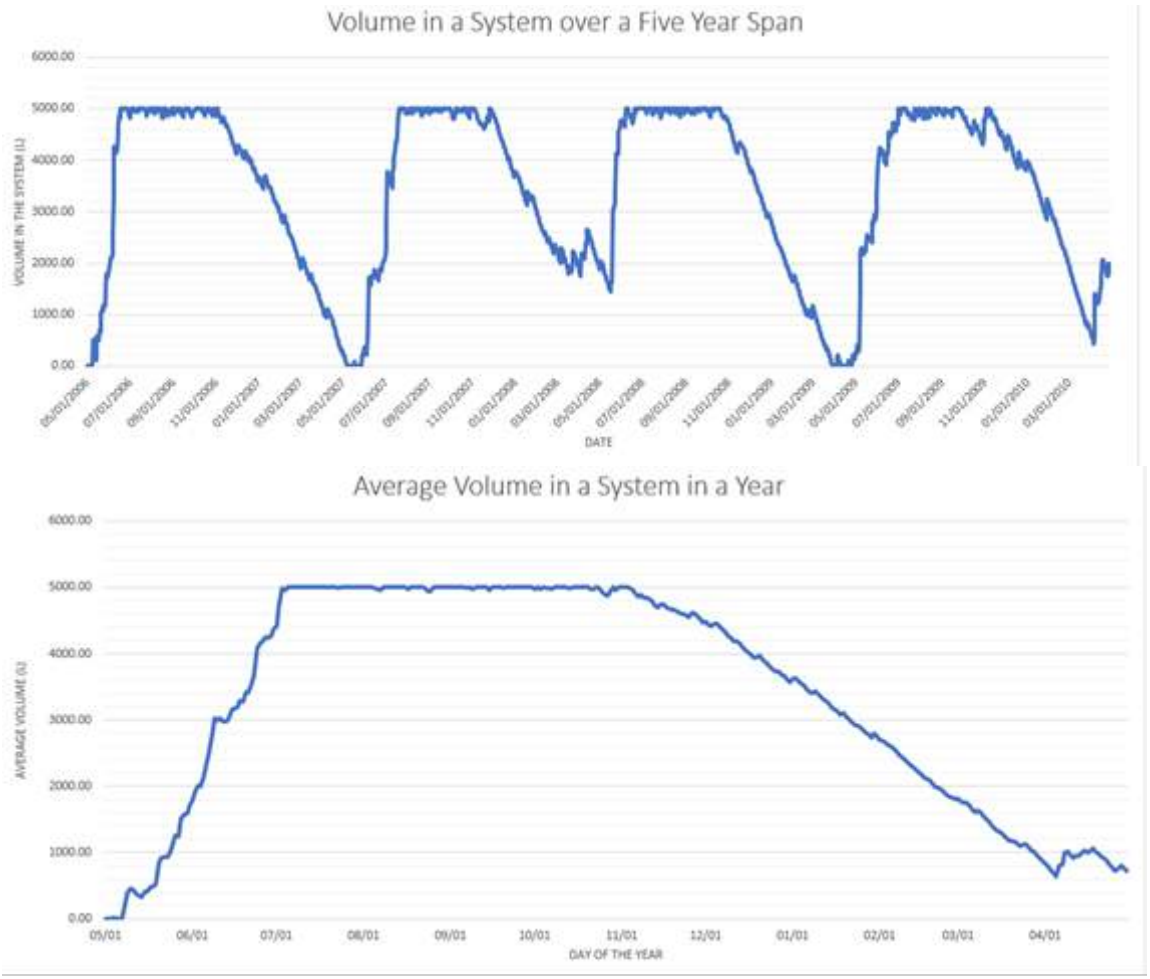


Mario Enrique Chul Laj (House #20)

Man of the house: Mario Enrique Chul Laj
Woman of the house: Clara Caj Cu

4 people live in the house

Existing Tanks:

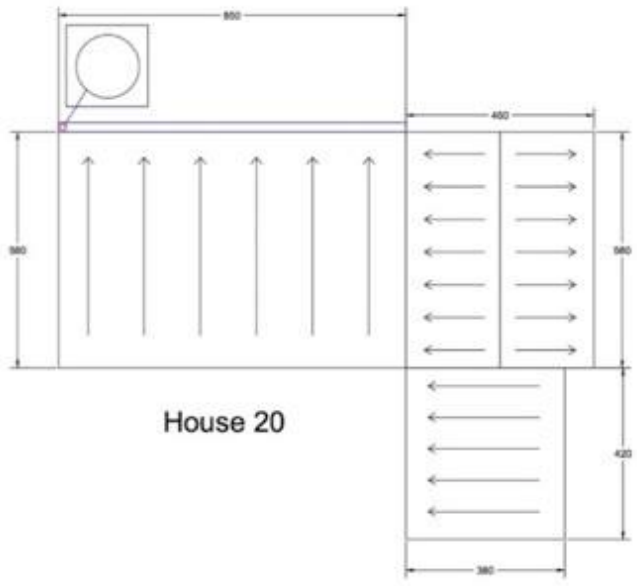
Government	**0**
Embassy	**0**
Other: EWB	**0**

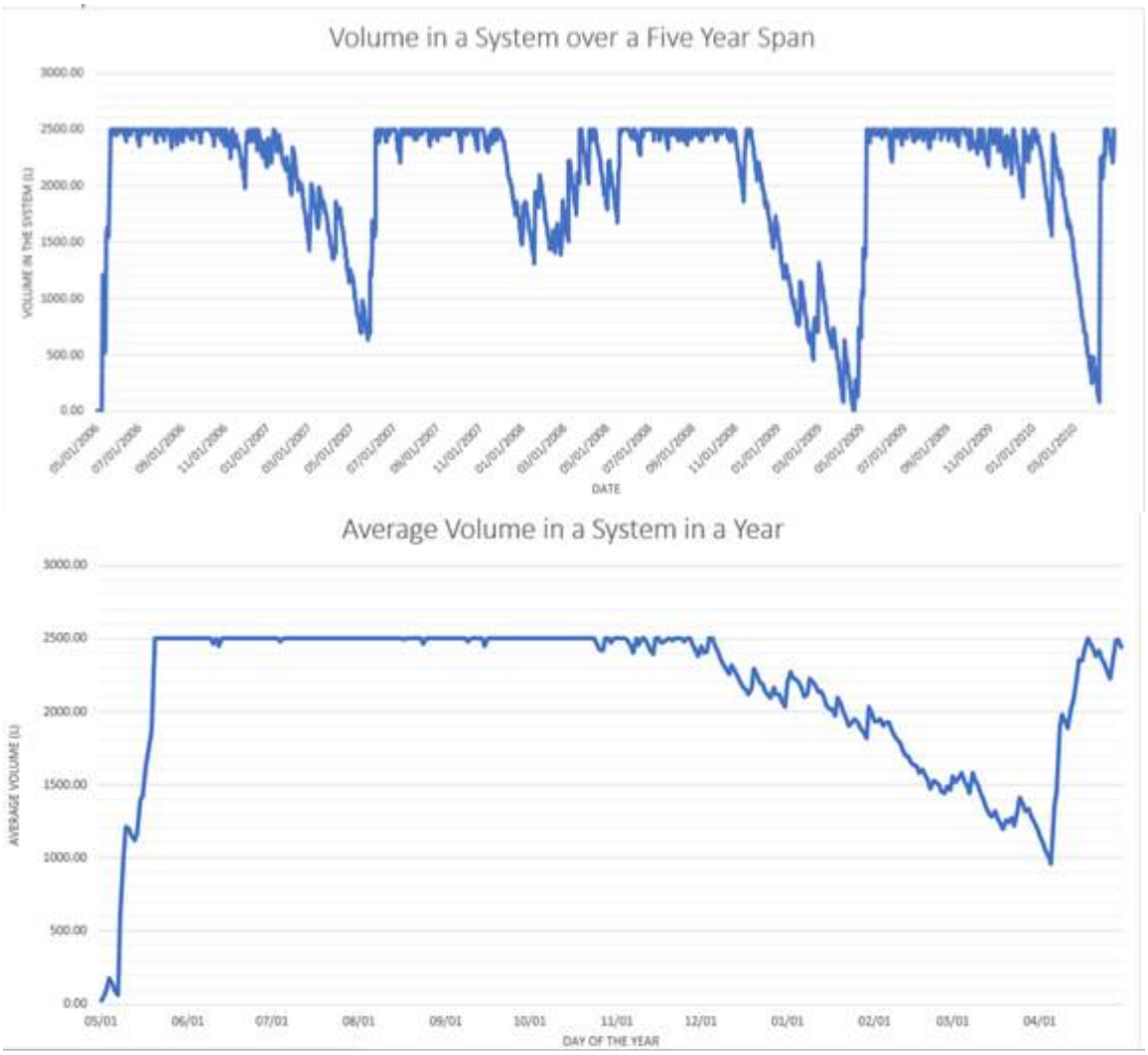
Plan for Implementation:

Gutter Lengths	1 gutter of length 850cm
First Flush Length	217cm
Overflow Height	**4.4cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**1**
Concrete Base	**1 tank base**

Agreed work to be done before May:

- **Prepare the roof and remove the extension of the roof from the house**
- **Dig a spot for the tank ½ a meter deep**
- **Collect 1.5 m^3 of rocks for the base**





Teresa Yuja Lopez (House #22)

Man of the house: N/A
Woman of the house Teresa Yuja Lopez

5 people live in the house

Existing Tanks:
Government 0

Embassy 0

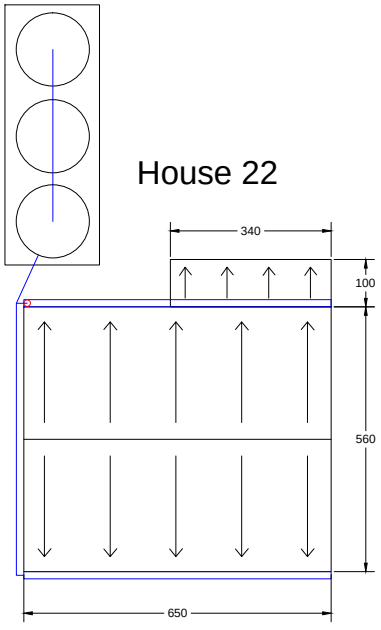
Other: EWB 0

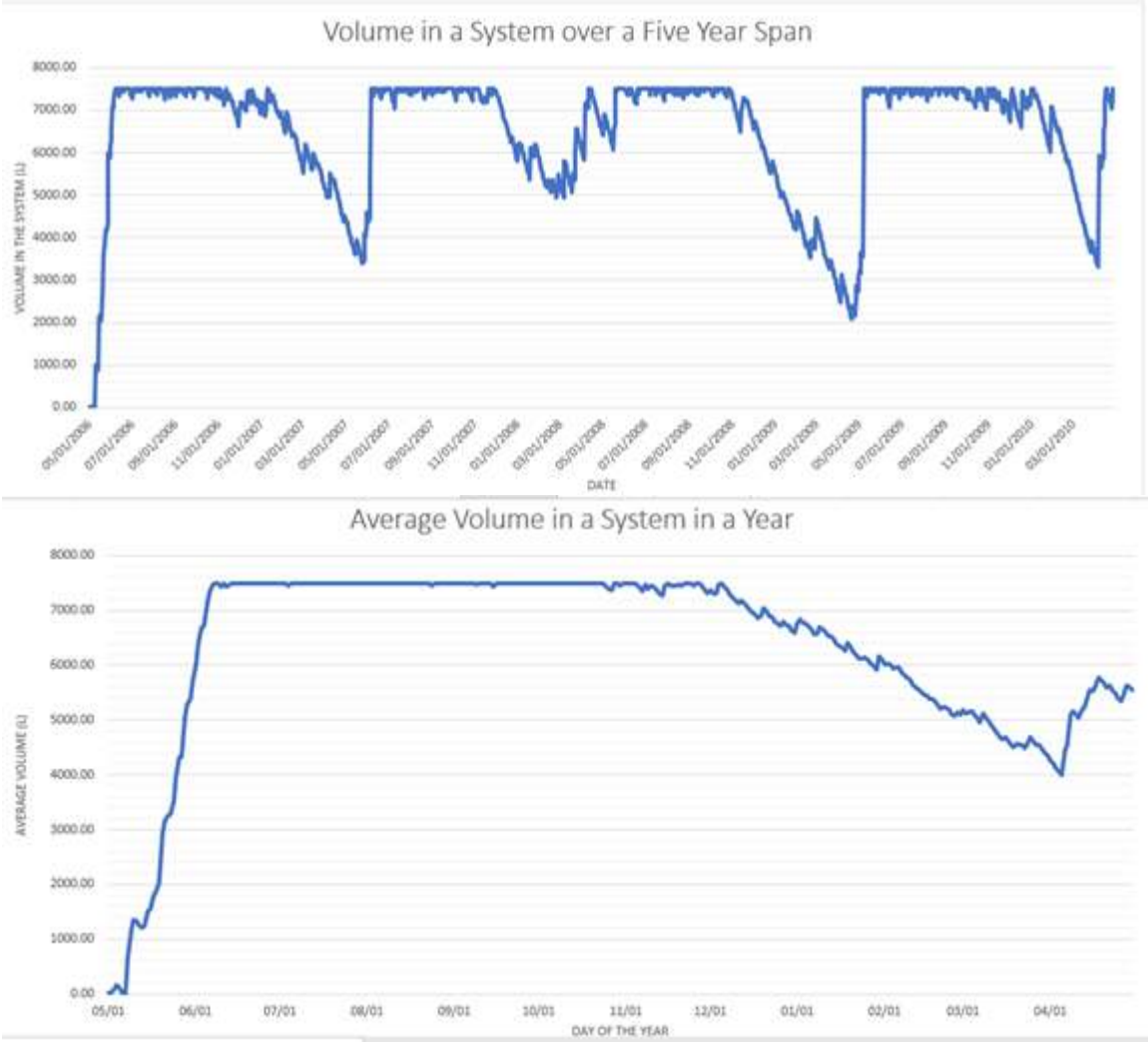
Plan for Implementation:

Gutter Lengths	**2 gutters of 6.5 m**
First Flush Length	**98 cm**
Overflow Height	**10cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**3**
Concrete Base	**1 three tank base**

Agreed work to be done before May:

- **Level 2 meters by 4 meters**
- **Level 2 meters by 2 meters at the entrance of the house and kitchen**
- **Collect medium size rocks**
- **Move the pile to a place that the tank won't be obstructed**





Abelino Caal Ical (House #23 A)

Man of the house: Abelino Caal Ical
Woman of the house: Marcela Toc

3 people live in the house

Existing Tanks:

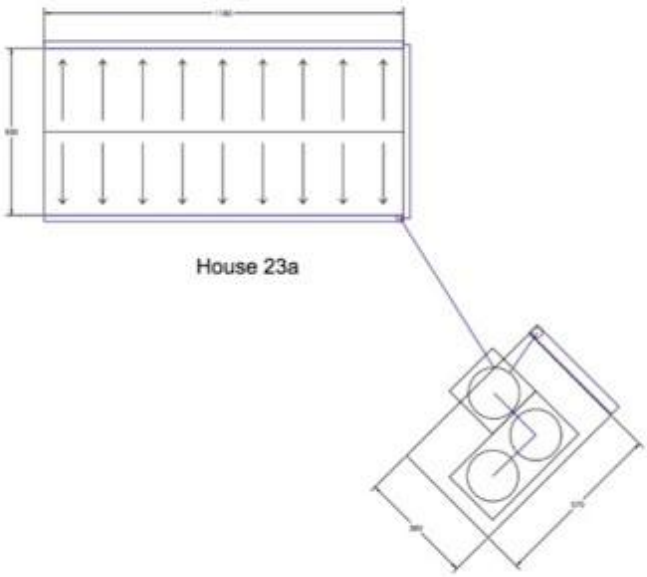
Government	**3**
Embassy	**0**
Other: EWB	**0**

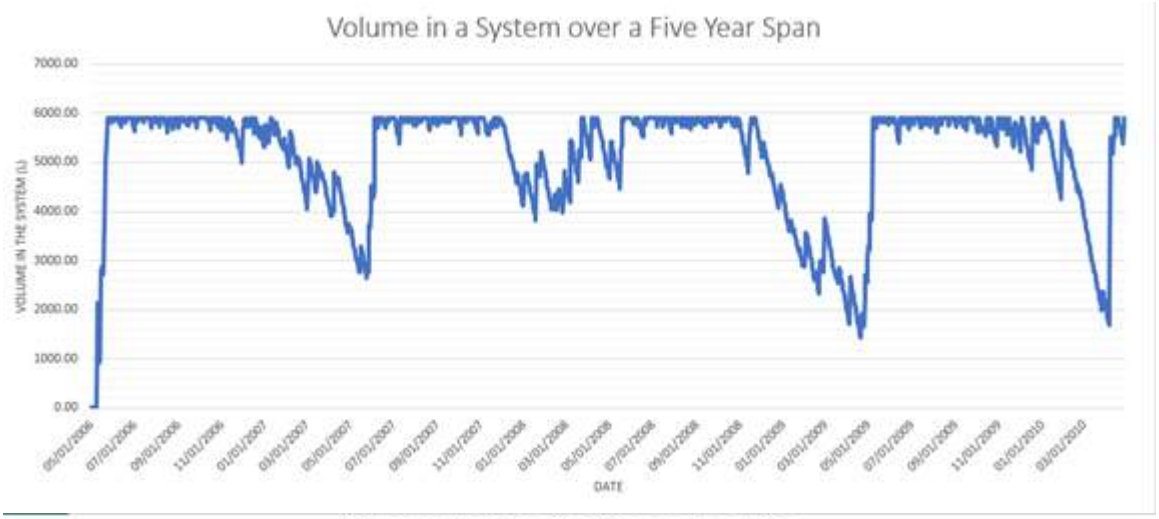
Plan for Implementation:

Gutter Lengths	
	2 gutters at length of 1180cm
	1 gutter at length of 380cm
First Flush Length	380cm
Overflow Height	**12.8cm**
Existing System Capacity	**2**
Number of Tanks Being Added	**1**
Concrete Base	**1 tank base**

Agreed work to be done before May:

- **Level the land near the government tanks**





Mario Xim Laj (House #23 B)

Man of the house: Mario Xim Laj
Woman of the house: Chen Toc

3 people live in the house

Existing Tanks:

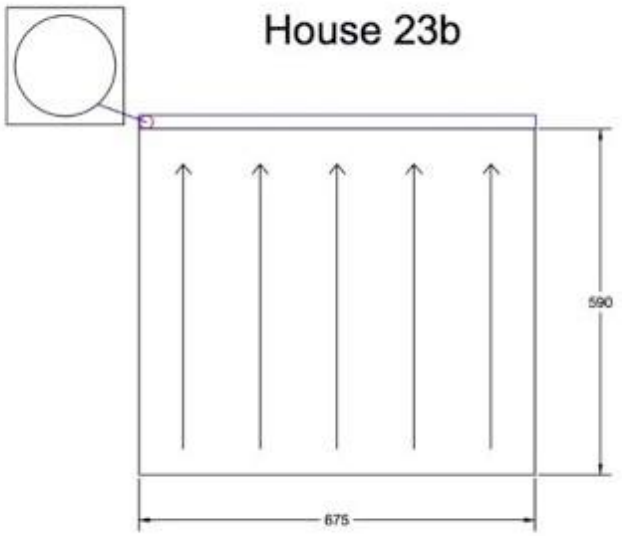
Government	**0**
Embassy	**0**
Other: EWB	**0**

Plan for Implementation:

Gutter Lengths	**675 cm**
First Flush Length	**175 cm**
Overflow Height	**3.0 cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**1**
Concrete Base	**1**

Agreed work to be done before May:

- **Level the land for a base 2x2 meters**
- **Collected medium sized rocks**
- **Remove the land for the base**



Cerapio Caal Caal (House #24)

Man of the house: Cerapio Caal Caal
Woman of the house: Alicia Chen Toc Chub

5 people live in the house

Existing Tanks:

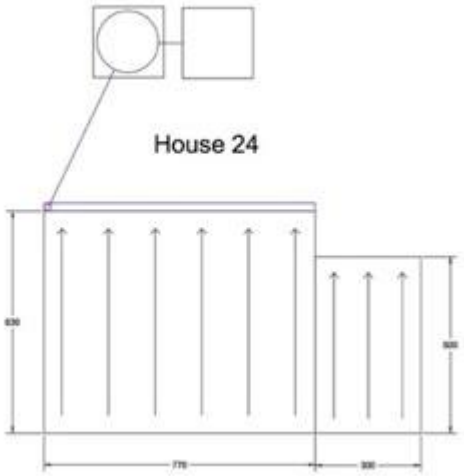
Government	**0**
Embassy	**1**
Other: EWB	**0**

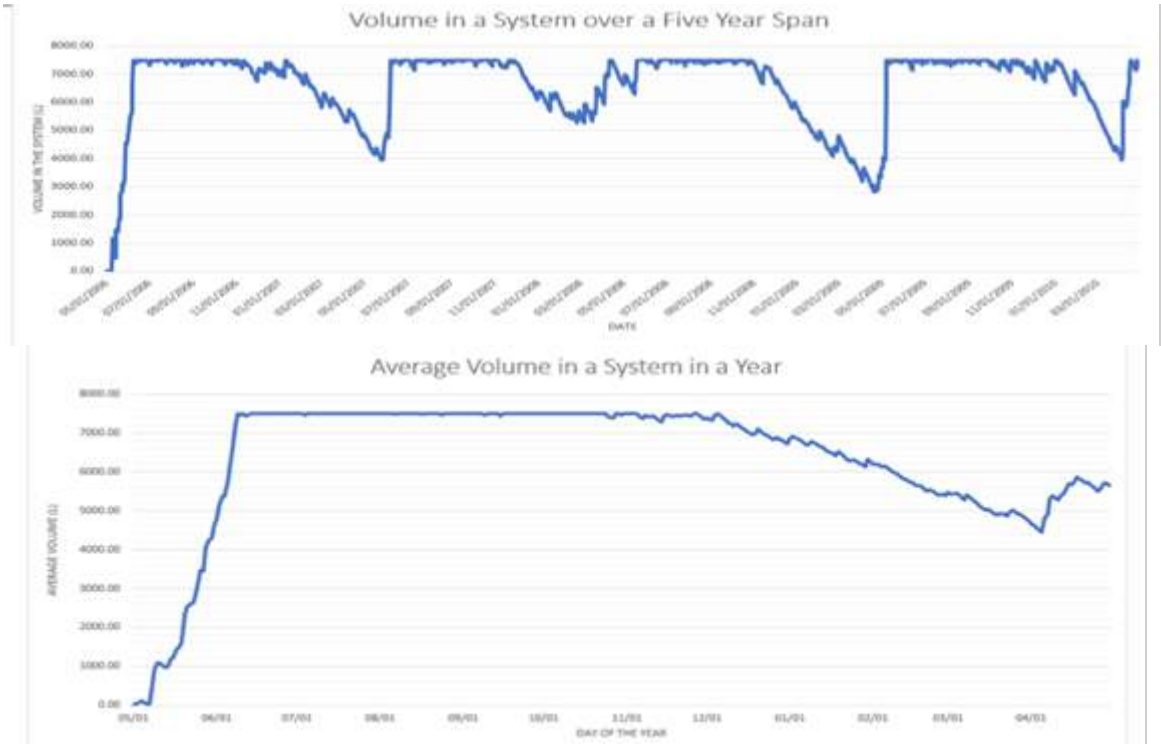
Plan for Implementation:

Gutter Lengths	**770cm**
First Flush Length	**213 cm**
Overflow Height	**4.3 cm**
Existing System Capacity	**1**
Number of Tanks Being Added	**1**
Concrete Base	**1 one tank base**

Agreed work to be done before May:

- **Level the land for a base 200cmx 200cm**
- **Collect 1.5 m of rocks for the base**





Emilio Chen Gualim (House #25)

Man of the house: Emilio Chen Gualim
Woman of the house: Elvira Choc Lem

6 people live in the house

Existing Tanks:

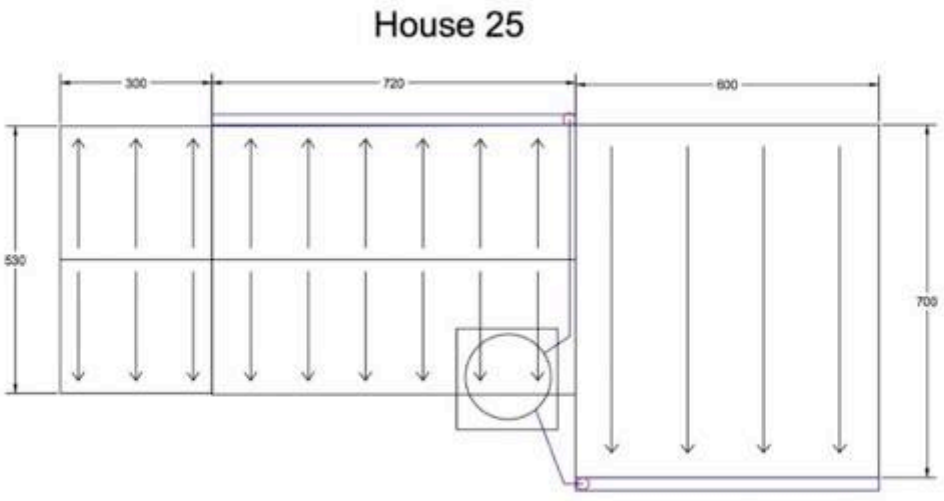
Government	**0**
Embassy	**0**
Other: EWB	**0**

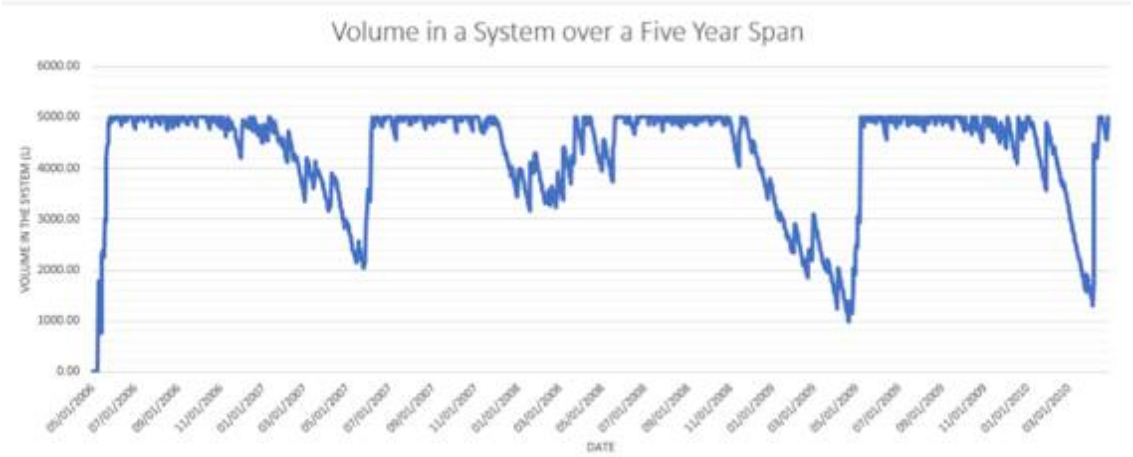
Plan for Implementation:

Gutter Lengths	
	1 gutter at length of 720cm
	1 gutter at length of 600cm
First Flush Length	**317 cm**
Overflow Height	**9.0cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**1**
Concrete Base	**1 one tank base**

Agreed work to be done before May:

- **Nothing listed**





Martolo Jom Velsques (House #30)

Man of the house: Martolo Jom Velsques
Woman of the house : Herlinda Valasques Xona

9 people live in the house

Existing Tanks:

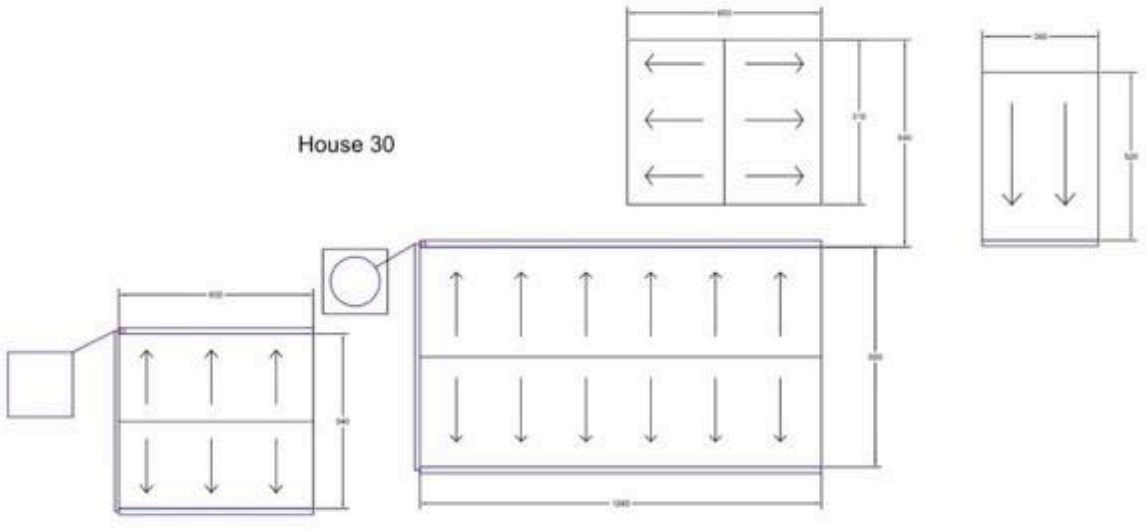
Government	**1**
Embassy	**0**
Other: EWB	**0**

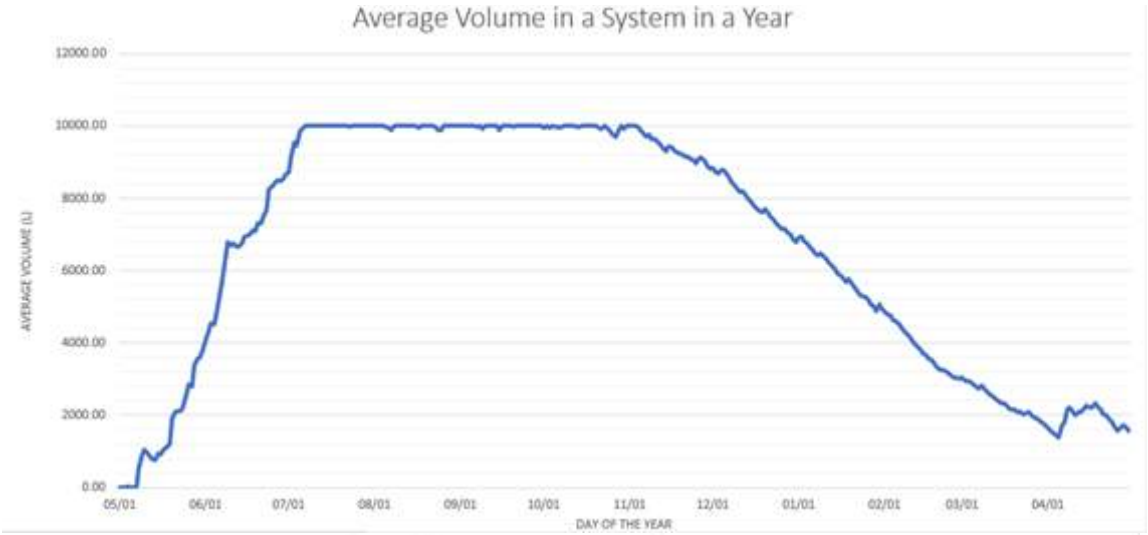
Plan for Implementation:

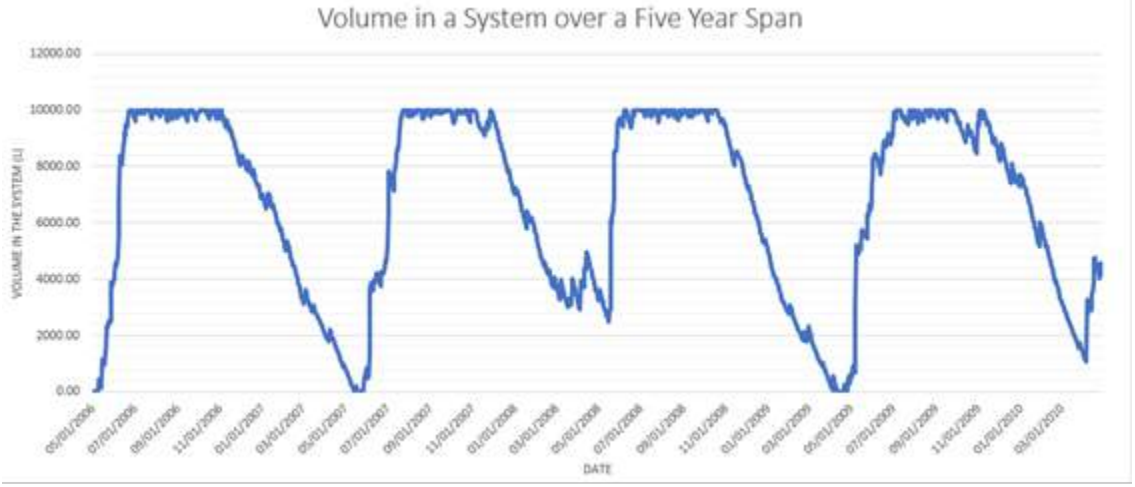
Gutter Lengths	1 gutter of length 4040cm
First Flush Length	**86 cm**
Overflow Height	**0.8 cm**
Existing System Capacity	**1**
Number of Tanks Being Added	**1**
Concrete Base	**1 one tank base**

Agreed work to be done before May:

- **Level an area of land 4m x 2 m where the cement base will go**
- **Collect small rocks for the cement base**
- **Prepare the existing tanks for implementation**







Emilio Gualim Cal (House #32)

Man of the house: Emilio Gualim Cal
Woman of the house: Ana Maria Quej Cal

6 people live in the house

Existing Tanks:

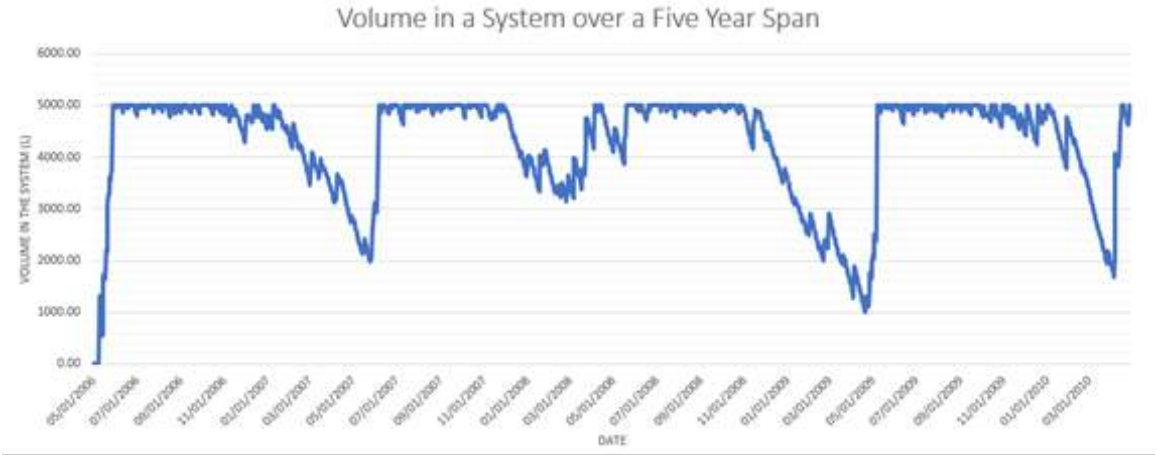
Government	**2**
Embassy	**0**
Other: EWB	**0**

Plan for Implementation:

Gutter Lengths	1 gutter of length 557cm
First Flush Length	**239 cm**
Overflow Height	**5.3 cm**
Existing System Capacity	**2**
Number of Tanks Being Added	**0**
Concrete Base	**No concrete base**

Agreed work to be done before May:

- **Prepare the roof with space for the gutters**
- **Prepare the existing tanks before Engineer Without Borders-USA WPI team comes**
- **Collect 1 ½ m^3 of rocks**



Anjelina Quej Ical (House #33)

Man of the house N/A
Woman of the house: Anjelina Quej Ical

4 people live in the house

Existing Tanks:

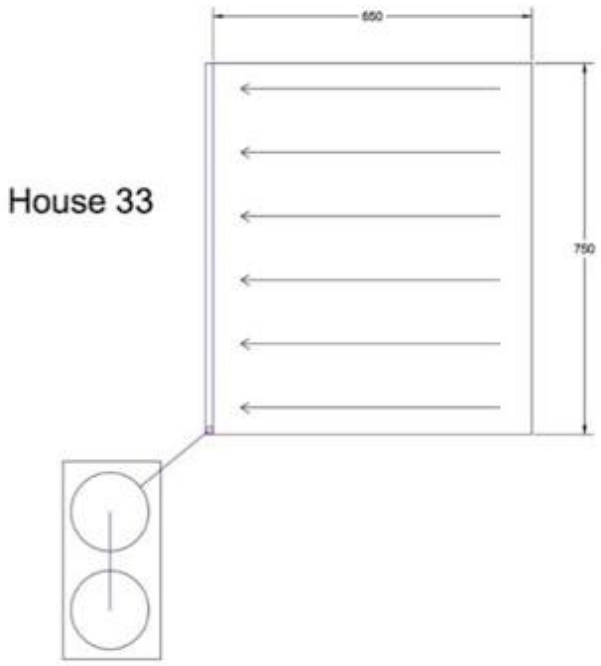
Government	**0**
Embassy	**0**
Other: EWB	**0**

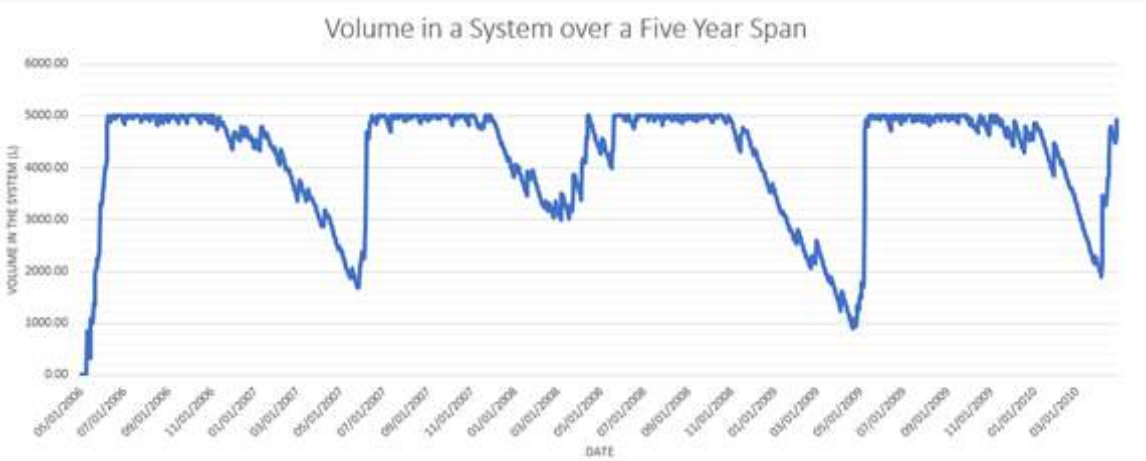
Plan for Implementation:

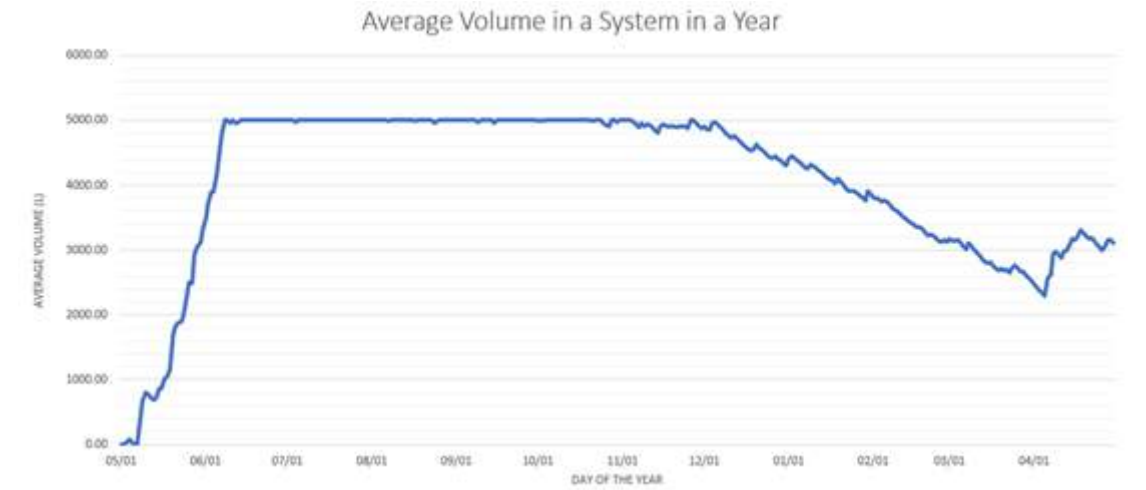
Gutter Lengths	1 gutter of length 750cm
First Flush Length	158cm
Overflow Height	**2.5 cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**2 tank base**

Agreed work to be done before May:

- **Prepare the roof**
- **Prepare land for the tanks with the area of 2x4 meters**
- **Collect 1.5 m^3 of rock**







Lerando Gualim Cal (House #34)

Man of the house: Lerando Gualim Cal
Woman of the house: Maria Magdelena Jom Yuja

7 people live in the house

Existing Tanks:

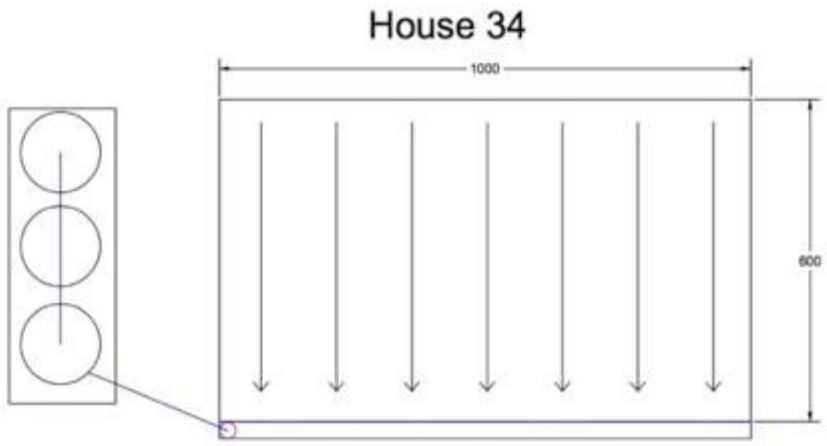
Government	**2**
Embassy	**0**
Other: EWB	**0**

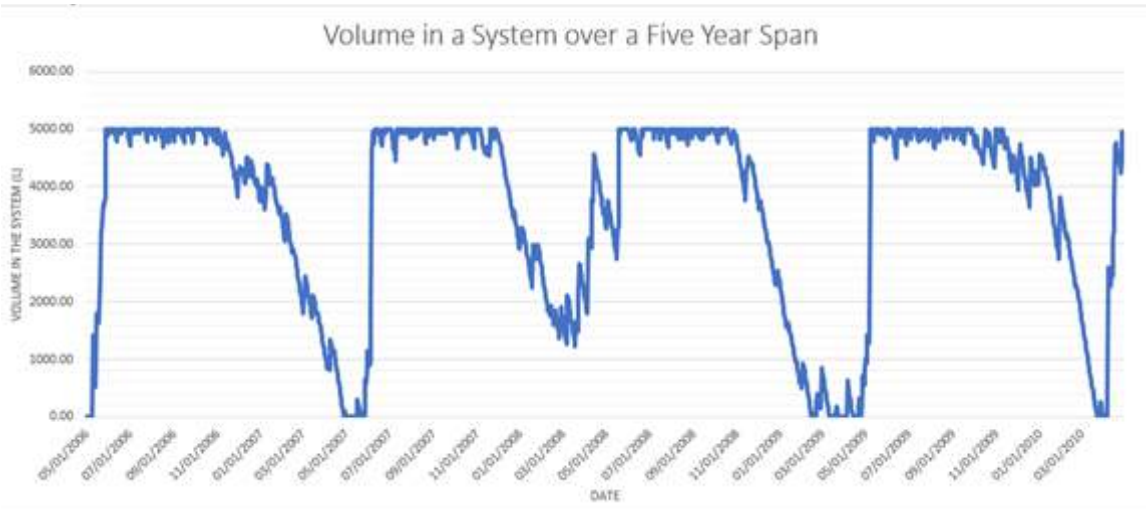
Plan for Implementation:

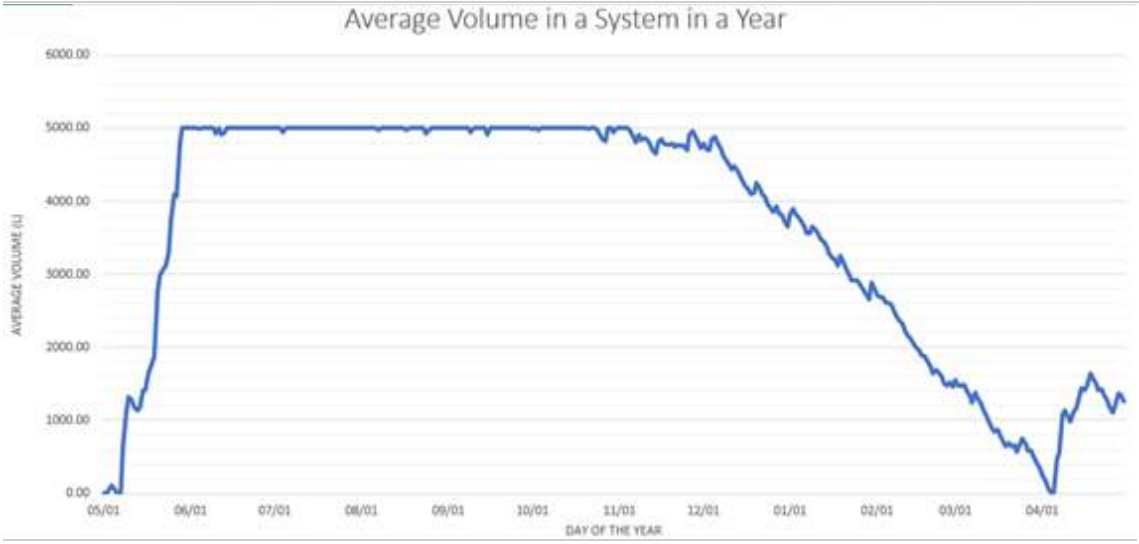
Gutter Lengths	1 gutter of length 1000cm
First Flush Length	148cm
Overflow Height	**6.4 cm**
Existing System Capacity	**2**
Number of Tanks Being Added	**1**
Concrete Base	**1 three tank base**

Agreed work to be done before May:

- **Construct a house with the roof area of 3 meters**
- **Level the land for the system**
- **Collect 1.5 m^3 of rocks**







Luis Gilberto Cojoc Yuja (House #36)

Man of the house: Luis Gilberto Cojoc Yuja
Woman of the house: Zoila Esperanza Ical Cojoc

6 people live in the house

Existing Tanks:

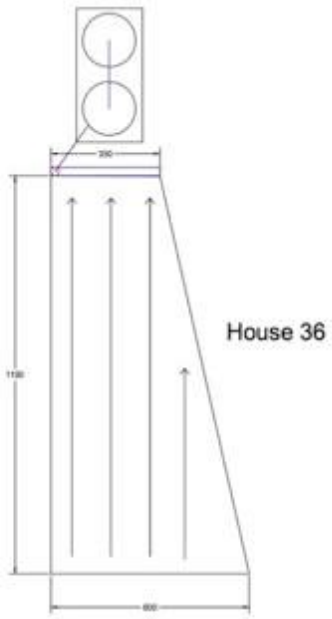
Government	**0**
Embassy	**0**
Other: EWB	**0**

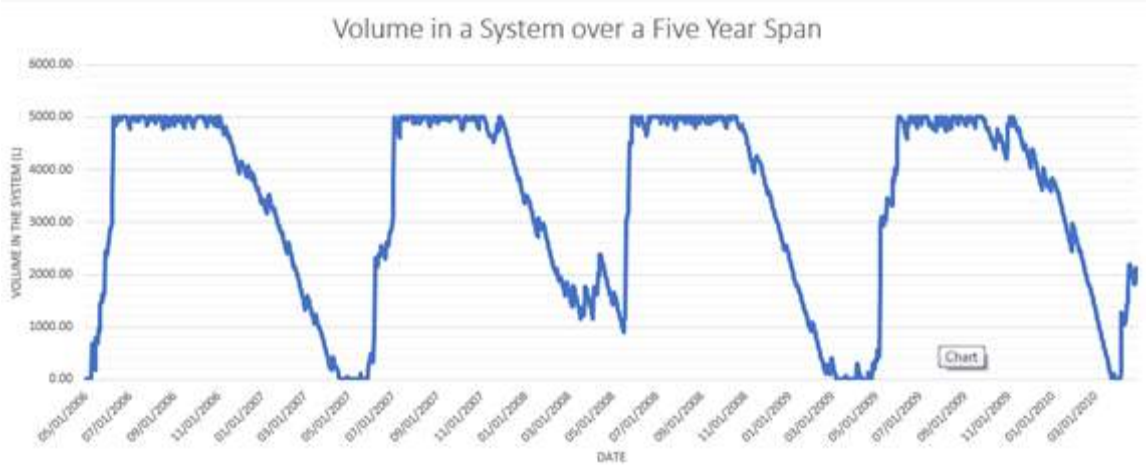
Plan for Implementation:

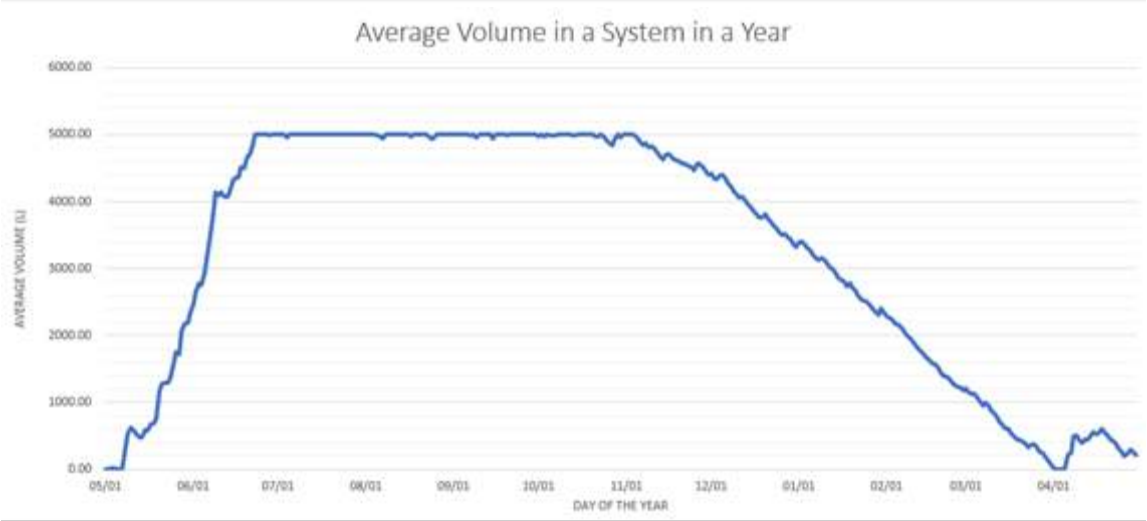
Gutter Lengths	1 gutter of length 330cm
First Flush Length	**76 cm**
Overflow Height	**2.25 cm**
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

Agreed work to be done before May:

- **Level the land 4 meters by 2 meters**
- **Fix the roof so the channels in the corrugated metal are all going the same direction**
- **Collect rocks for the cement base**







Secundino Lem Mo (House #40)

Man of the house: Secundino Lem Mo
Woman of the house: Lucia Cal Suram

11people live in the house

Existing Tanks:

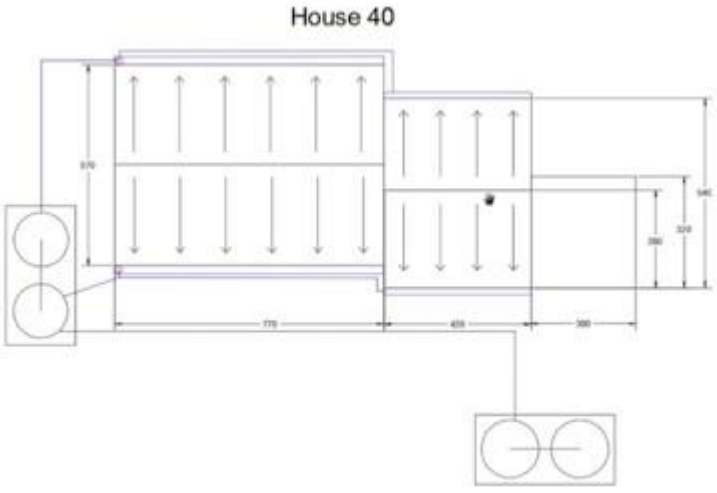
Government	**0**
Embassy	**0**
Other: EWB	**0**

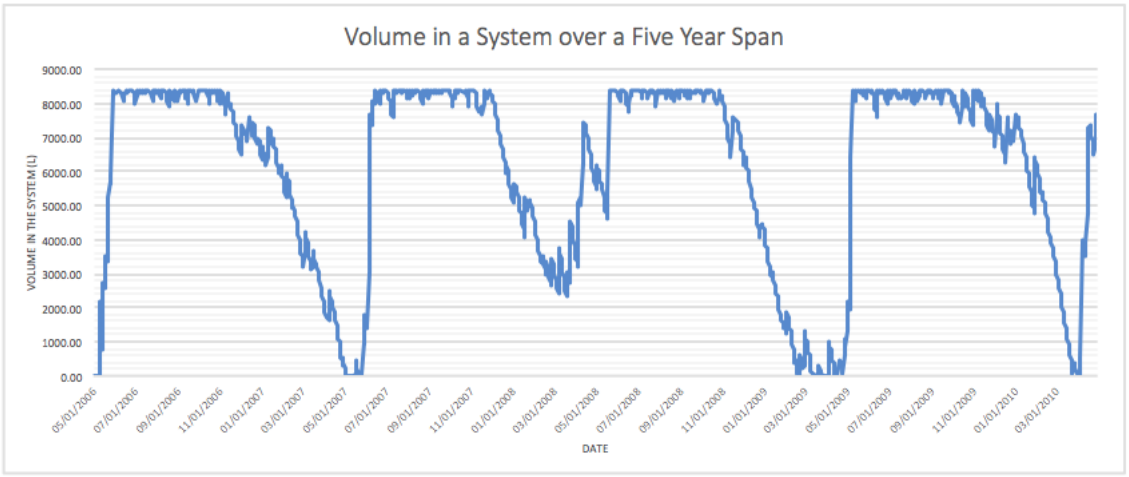
Plan for Implementation:

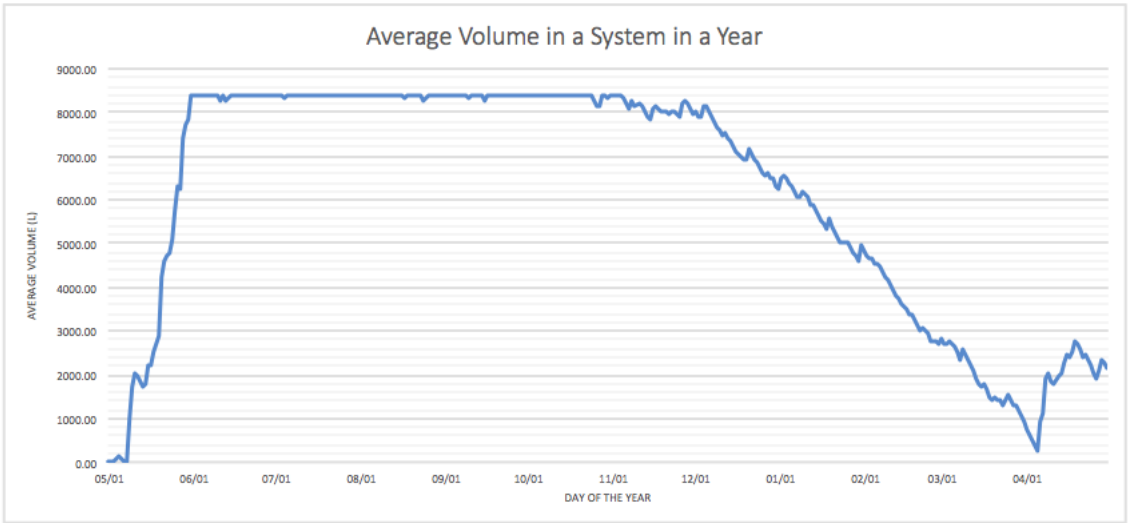
Gutter Lengths	2 gutters of length 750cm
First Flush Length	84 cm
Overflow Height	2.25 cm
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

Agreed work to be done before May:

- **Level the land for the system 0.5 meters**
- **Rearrange the roof and align the roof panels**
- **Collect 1.5 m^3 of rocks for the base**
- **Remove the tree from the entrance of the house**
- **Level the land near the tanks**







Rigoberto Cac Caal (House #43)

Man of the house: Rigoberto Cac Caal
Woman of the house: Elsa Marta Yuja Lem

3 people live in the house

Existing Tanks:

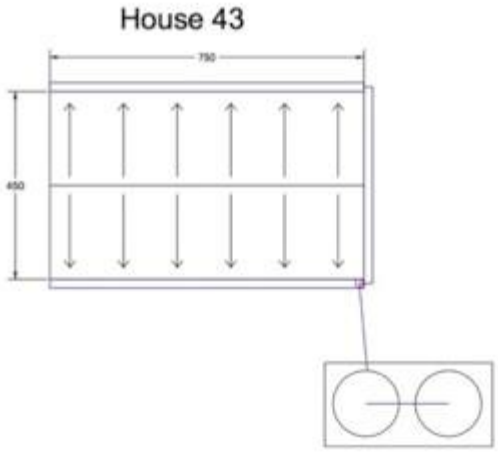
Government	**0**
Embassy	**0**
Other: EWB	**0**

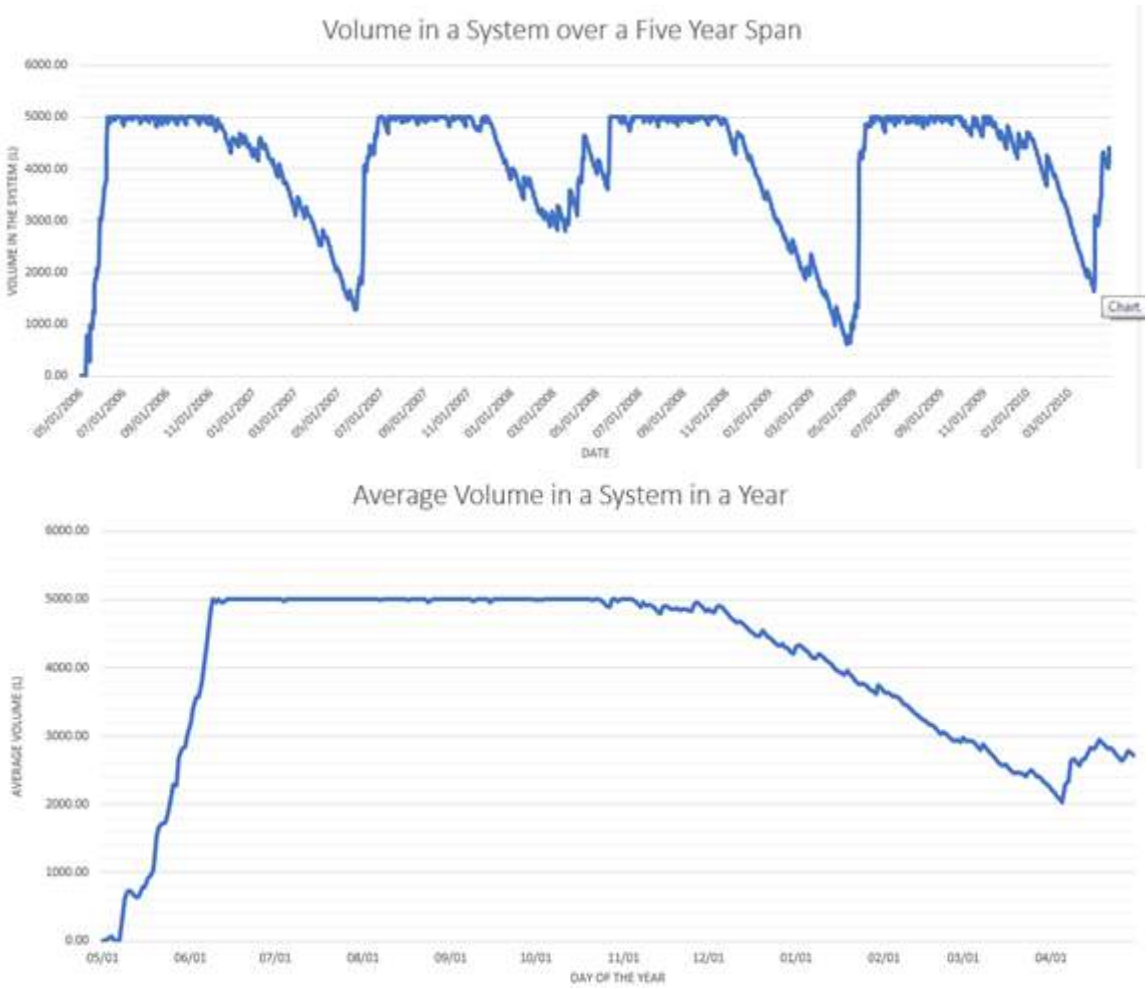
Plan for Implementation:

Gutter Lengths	2 gutters of length 750cm
First Flush Length	84 cm
Overflow Height	2.25 cm
Existing System Capacity	**0**
Number of Tanks Being Added	**2**
Concrete Base	**1 two tank base**

Agreed work to be done before May:

- **Prepare space for the systems**
- **Prepare the roof for the gutters**
- **Prepare a place for the base 200 cm x 400 cm**
- **Collect rocks for the base (1.5 m^3)**





3.4 Names and Qualifications of Designers

Name	Student or Professional	Qualifications	Work Done
Aaron Pepin	Student	Majoring in Mechanical Engineering	Led creation of designs based on his site assessments of some homes.
Thomas Moutinho	Student	Former Project Lead and 3 years of experienced in RWH implementations with Guachtuq	Construction Plan logistics, general system design and calculations
Rita Newman	Student	Majoring in Civil Engineering	Created the drawings on AutoCAD software.
Jessie Ciulla	Student	Majoring in Mechanical	Led creation of designs based on her

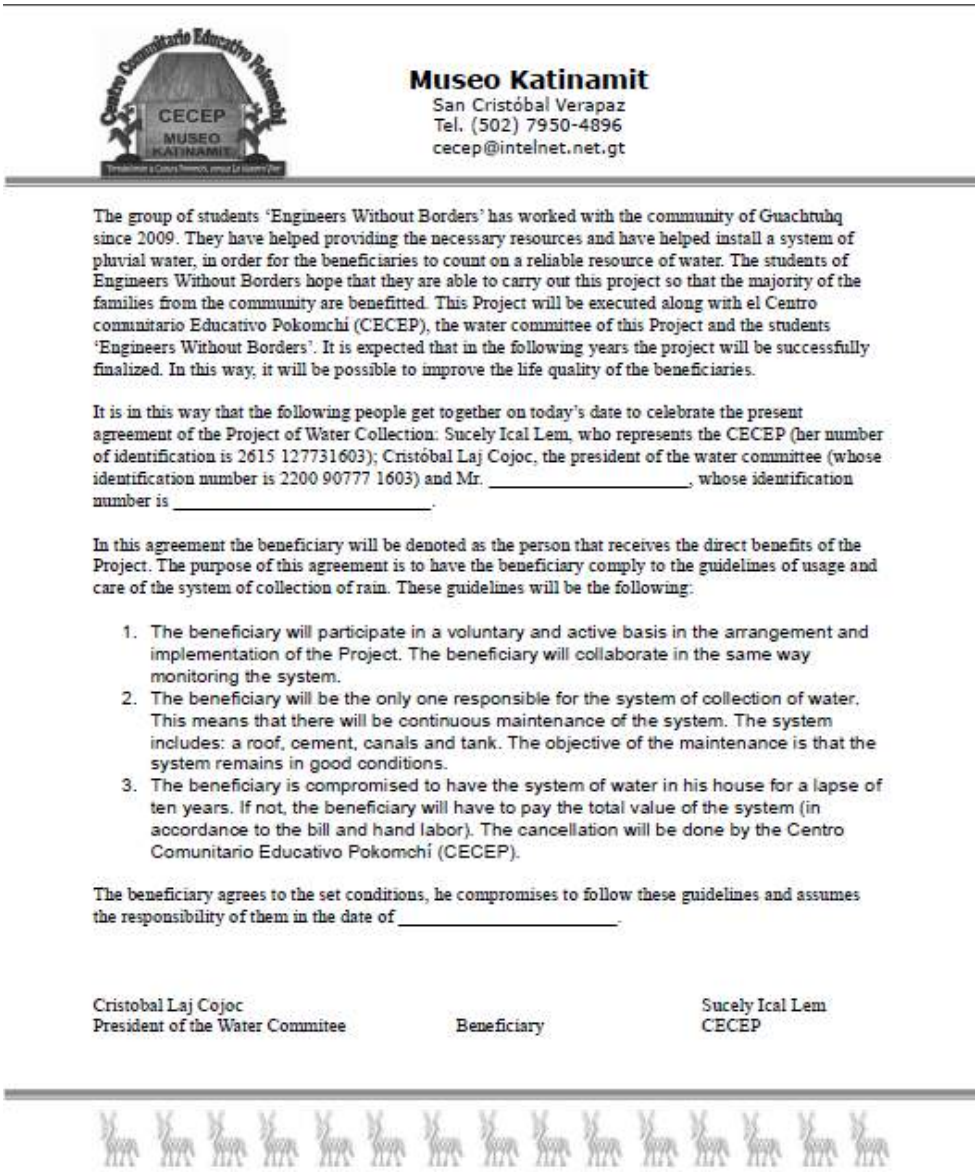
		Engineering	site assessments of the remaining homes.
Camden Knoff	Student	Majoring in Mechanical Engineering	Systems calculations and design, organization of community information
Amanda Gatz	Student	Majoring in Electrical Engineering	Overflow calculations
Chris Sontag	Student	Majored in Electrical Engineering	General system design
Jennifer Moutinho	Student	Majored in Chemical Engineering	General system design
Patricia Austin	Professional	Water Distribution Engineer	Analysis of water quality data to determine feasibility of clean water from each system.
Mike Reiter	Professional	Responsible Engineer in Charge	Oversaw the designs based on personal experience with the systems in the community.
Matt Gamache	Professional	Mechanical Engineer	Creation of original RWH Excel model

3.5 524 – Draft Final Design Report Comments

The design has not been changed since the pilot TAC approval and therefore there are no additional 524 Design Report Comments to list here.

4.0 Project Ownership

As a rainwater harvesting system is to be implemented on individual homes, the ownership of each system falls to the household where the system is located. The family is responsible for maintaining and repairing their own system once EWB-USA WPI completes the project in the community. If the family moves within the community they can take their system with them. However, if they move outside of the community within the first ten years the system belongs to CeCEP, as is stated in the MOUs signed by each household receiving a system. Copies of each of these signed MOU's for the May 2015 Implementation Trip can be seen in Appendix B: Signed MOUs for May 2015 Beneficiary Families:. These MOUs also clarify the beneficiaries' responsibilities for their individual systems once the EWB-USA WPI project reaches completion. The English MOUs are below.



Museo Katinamit
San Cristóbal Verapaz
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The group of students 'Engineers Without Borders' has worked with the community of Guachtuhq since 2009. They have helped providing the necessary resources and have helped install a system of pluvial water, in order for the beneficiaries to count on a reliable resource of water. The students of Engineers Without Borders hope that they are able to carry out this project so that the majority of the families from the community are benefitted. This Project will be executed along with el Centro comunitario Educativo Pokomchí (CECEP), the water committee of this Project and the students 'Engineers Without Borders'. It is expected that in the following years the project will be successfully finalized. In this way, it will be possible to improve the life quality of the beneficiaries.

It is in this way that the following people get together on today's date to celebrate the present agreement of the Project of Water Collection: Sucely Ical Lem, who represents the CECEP (her number of identification is 2615 127731603); Cristóbal Laj Cojoc, the president of the water committee (whose identification number is 2200 90777 1603) and Mr. _____, whose identification number is _____.

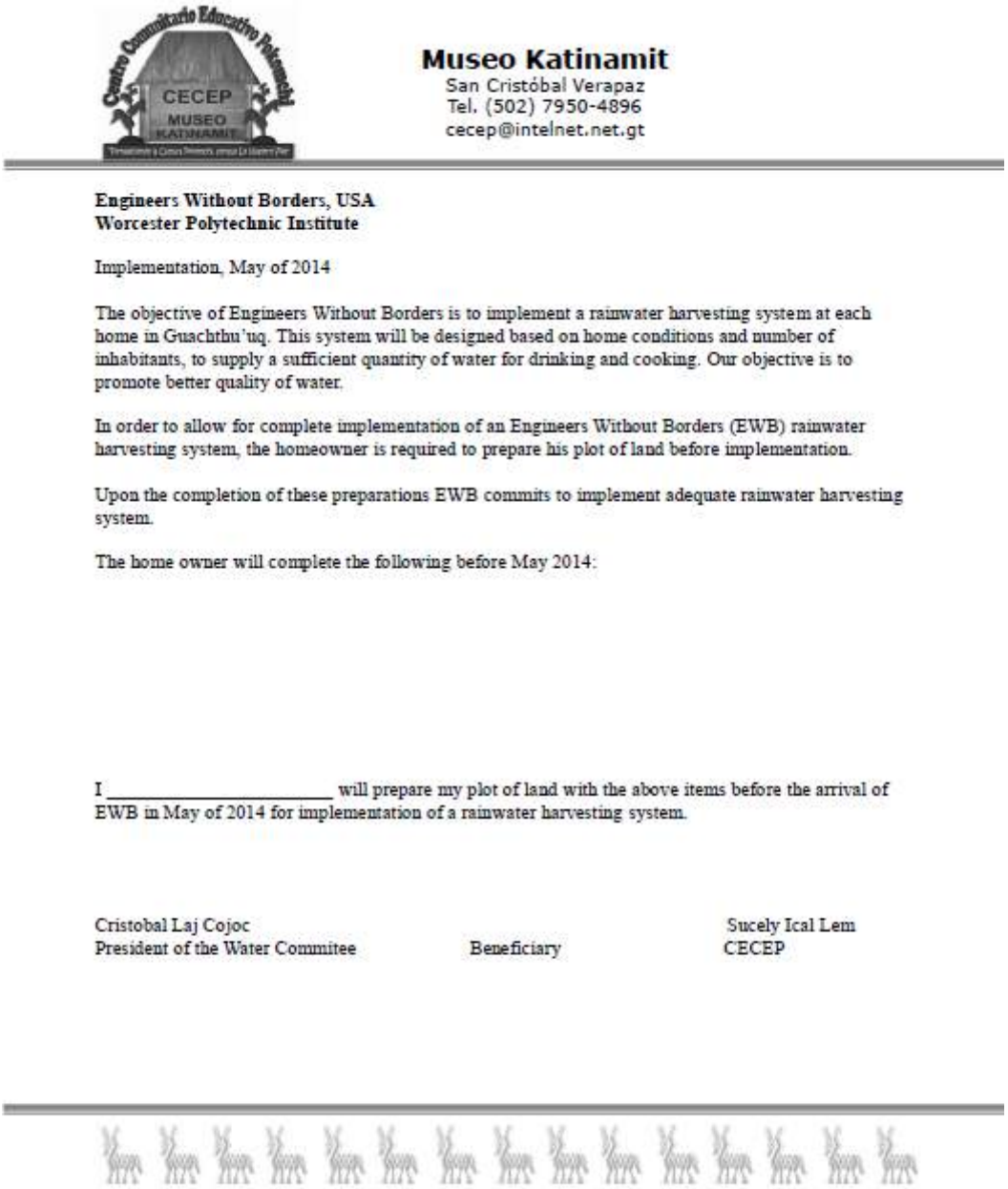
In this agreement the beneficiary will be denoted as the person that receives the direct benefits of the Project. The purpose of this agreement is to have the beneficiary comply to the guidelines of usage and care of the system of collection of rain. These guidelines will be the following:

1. The beneficiary will participate in a voluntary and active basis in the arrangement and implementation of the Project. The beneficiary will collaborate in the same way monitoring the system.
2. The beneficiary will be the only one responsible for the system of collection of water. This means that there will be continuous maintenance of the system. The system includes: a roof, cement, canals and tank. The objective of the maintenance is that the system remains in good conditions.
3. The beneficiary is compromised to have the system of water in his house for a lapse of ten years. If not, the beneficiary will have to pay the total value of the system (in accordance to the bill and hand labor). The cancellation will be done by the Centro Comunitario Educativo Pokomchí (CECEP).

The beneficiary agrees to the set conditions, he compromises to follow these guidelines and assumes the responsibility of them in the date of _____.

Cristobal Laj Cojoc President of the Water Commitee	Beneficiary	Sucely Ical Lem CECEP

Figure 25: Contract MOU signed by Guachtuq families who work with EWB-USA WPI to implement a RWH system.



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Engineers Without Borders, USA
Worcester Polytechnic Institute

Implementation, May of 2014

The objective of Engineers Without Borders is to implement a rainwater harvesting system at each home in Guachthu'uq. This system will be designed based on home conditions and number of inhabitants, to supply a sufficient quantity of water for drinking and cooking. Our objective is to promote better quality of water.

In order to allow for complete implementation of an Engineers Without Borders (EWB) rainwater harvesting system, the homeowner is required to prepare his plot of land before implementation.

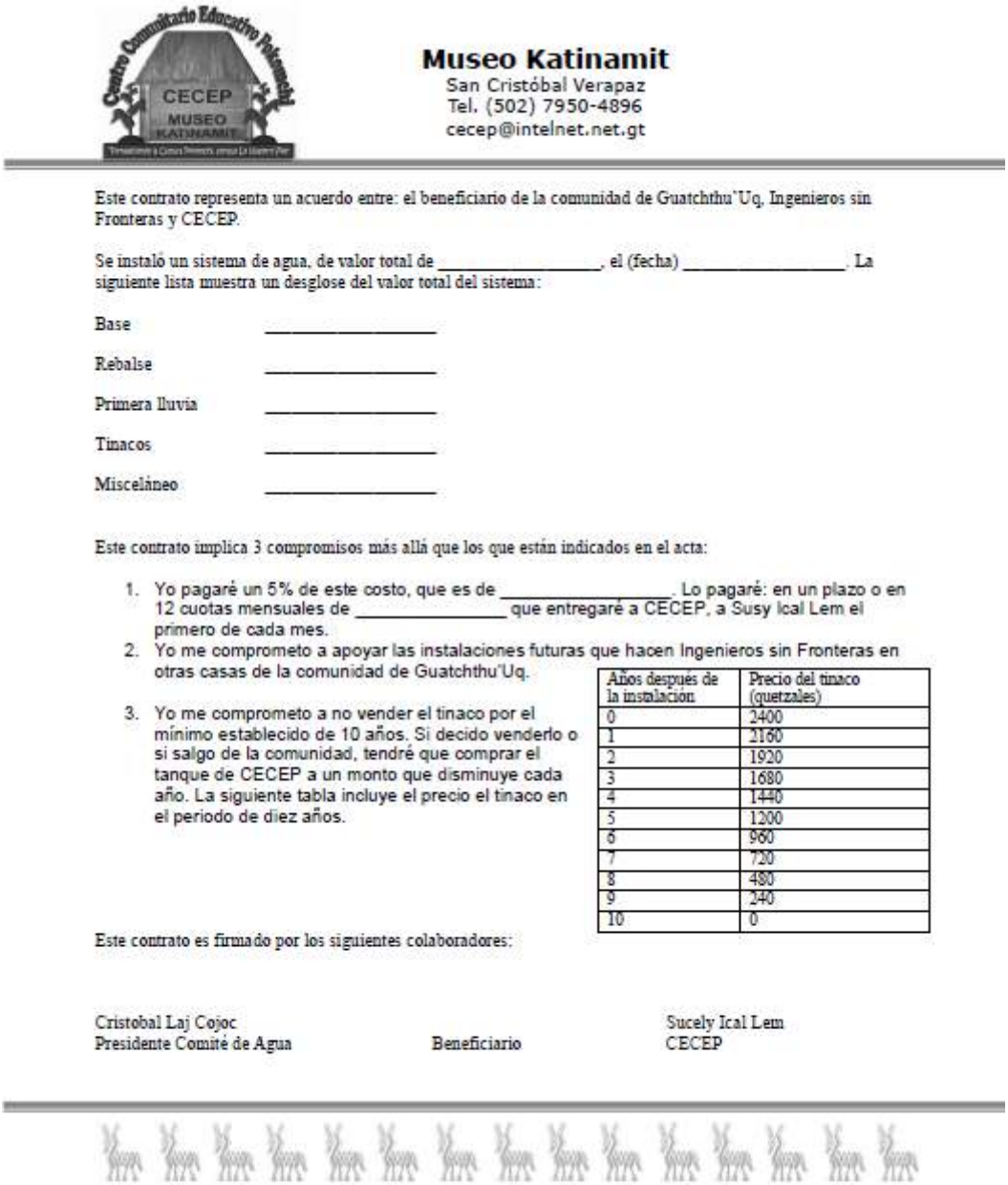
Upon the completion of these preparations EWB commits to implement adequate rainwater harvesting system.

The home owner will complete the following before May 2014:

I _____ will prepare my plot of land with the above items before the arrival of EWB in May of 2014 for implementation of a rainwater harvesting system.

Cristobal Laj Cojoc		Sucely Ical Lem
President of the Water Commitee	Beneficiary	CECEP

Figure 26: Home Preparation MOU signed by Guachtuq families who work with EWB-USA WPI to implement a RWH system.



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Este contrato representa un acuerdo entre: el beneficiario de la comunidad de Guatchthu'Uq, Ingenieros sin Fronteras y CECEP.

Se instaló un sistema de agua, de valor total de _____, el (fecha) _____. La siguiente lista muestra un desglose del valor total del sistema:

Base _____

Rebalse _____

Primera lluvia _____

Tinacos _____

Misceláneo _____

Este contrato implica 3 compromisos más allá que los que están indicados en el acta:

1. Yo pagaré un 5% de este costo, que es de _____. Lo pagaré: en un plazo o en 12 cuotas mensuales de _____ que entregaré a CECEP, a Susy Ical Lem el primero de cada mes.
2. Yo me comprometo a apoyar las instalaciones futuras que hacen Ingenieros sin Fronteras en otras casas de la comunidad de Guatchthu'Uq.
3. Yo me comprometo a no vender el tinaco por el mínimo establecido de 10 años. Si decido venderlo o si salgo de la comunidad, tendré que comprar el tanque de CECEP a un monto que disminuye cada año. La siguiente tabla incluye el precio el tinaco en el periodo de diez años.

Años despues de la instalación	Precio del tinaco (quetzales)
0	2400
1	2160
2	1920
3	1680
4	1440
5	1200
6	960
7	720
8	480
9	240
10	0

Este contrato es firmado por los siguientes colaboradores:

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 27: Payment Plan MOU, signed by Guachtuq families are working with EWB-USA WPI

Each family in the community, by the end of implementation, will have the knowledge to maintain and care for their system. EWB-USA WPI ensure that families have all questions answered and fully understand how the system works and should be maintained, as outlined in the Operations and Maintenance section (Section 7) of this document. In the past year the community moved a families system and completely re-built it at their new home. Pictures of the system where EWB-USA WPI constructed it and pictures of the system at the new home can be seen in Appendix C: House 27 System Reconstruction. In this instance the community

demonstrated that they have the knowledge to re-construct a system. They also demonstrated the fact that they know that every part of the system is crucial, not just the tank(s), because they took the time to reconstruct the entire closed system. When the January 2015 travelers went to check on this system, they found that each piece was assembled correctly and the system was fully functional as designed.

The data from the club's trip in January 2015 shows many clean samples relative to years past, suggesting that the most of the families who have an EWB-USA WPI system are cleaning their gutters, first flushes, and their tanks regularly. The increased cleanliness of the systems suggests that they are already getting in the habit or maintaining their own system. This regular maintenance shows that beneficiary families are assuming ownership of and responsibility for their systems. The monitoring data from the January 2015 trip is in Appendix D: Monitoring Information from January 2015 and also described in more detail in the January 2015 522 post trip report. Each family also contributes 5% of the cost of their system, which increases their stake in the success of the system and increases their sense of ownership. This is believed to show that the family is financially able to maintain their system after the project is completed, since any part, with the exception of the tank, falls within the price range of that 5%.

In addition, families are required to provide in-kind labor in the construction of the systems, which also produces a sense of ownership. Many members of the community have now helped construct multiple systems. Shortly after this form is submitted EWB-USA WPI will have a list of names of the construction team representative from each family in Guachtuq who will be receiving a system in the May 2015 implementation. This means that at least one member of each household with a system will have the direct knowledge of how to properly construct and maintain their system. In many cases there are multiple members of the family with this knowledge, either from additional family members helping out at that families home, or from the education session run with each family after their individual implementation. Through this process of having the community members constructing their own systems, it shows that these systems were not just thrust upon them, leading to a greater motivation to maintain them. The community put in the majority of the manual labor to construct them and EWB-USA WPI focused on working as project management, passing on designs to the community and assisted in distributing the materials. For these reasons they are extremely invested in their system and keeping it maintained and functioning properly.

5.0 Construction Plan

The following section contains a description of all the stakeholders that are involved in the EWB-USA WPI May 2015 Implementation Trip. The stakeholders include CeCEP, the Water Committee, the COCODE, and the Community Families. In addition this section thoroughly explains the construction plans using a Gantt chart, trip itinerary and contingency plans.

5.1 Stakeholders

5.1.1 CeCEP

El Centro Comunitario Educativo Pokomchi, or CeCEP, is EWB-USA WPI's most important partner organization. A cultural museum focused on education and raising awareness about the indigenous communities in Alta Verapaz, CeCEP offers a unique insight on Guachtuq and the rainwater harvesting project. They provide social and educational services to the local Pokomchi communities. Since establishing itself as the team's NGO, CeCEP has provided EWB-USA WPI with vital resources and guidance. Sucely Ical Lem and Alvaro Caal Lopez have been invaluable team members. The residents of Guachtuq speak Pokomchi, the local Mayan dialect. CeCEP ensures that the travel teams are equipped with translators on each trip. Often, these translators are the same from trip to trip. This allows translators to have a heightened understanding of the project and allows for a more productive dynamic in the community. CeCEP also ensure that all travelers have a proper debriefing of the community before their first in country visit.

Sucely is the director of CeCEP and has generously allowed the travel teams to use a classroom in the museum as a workspace to plan and meet during trips. Additionally, she understands the scope of the project, provides insight about socio-cultural interactions in Guachtuq, and answers questions that travelers have about all aspects of the community. She communicates with EWB-USA WPI via email and ensures that the team has updates about Guachtuq as needed. Sucy also coordinates homestays, transportation to and from Guatemala City, and translators for WPI travelers. She plans to continue to provide assistance throughout the duration of the project.

Alvaro is a university student who works closely with EWB-USA WPI. His contributions to the project include distributing and collecting monitoring forms among families, tracking system functionality, and communicating with EWB-USA WPI via email. He is a year-round presence of the project and visits the community 2 – 3 times each month.

5.1.2 Water Committee

The Water Committee formed between the January 2013 Implementation trip and the May 2013 Monitoring trip. Its purpose is to act as a liaison between the beneficiary families and EWB-USA WPI. Members of the Water Committee are past and future beneficiaries, and their role has become more defined over the past two trips. One of the major goals of the Water Committee is to help families prepare their homes to be functioning sites for rainwater harvesting systems. For this upcoming trip, the committee agreed to oversee families clearing the area for their concrete bases, gathering stones for bases, and preparing any existing tanks for cleaning. It was also established that the committee will not be paid for their services and will serve terms such that there is not a complete change of officers from year to year.

5.1.3 COCODE

In the past the EWB-USA WPI chapter has tried to use the current community government as a mode of communication. The Community Development Council (COCODE) is a small group of community members who are elected every two years by the community to politically represent Guachtuq to the Municipal government of San Cristobal. The COCODE members do not receive any form of monetary compensation for their positions. This stratified government program is meant to allow communities to more effectively communicate their needs to higher government officials. Guachtuq recognizes that their limited access to water is a major problem within the community. Thus, members of the COCODE reported this problem to the municipality government. After several years of work, these efforts developed into the government tank program. However, this problem is not isolated to Guachtuq; it affects all citizens living in and around San Cristobal.

Within the community, there is concern over the role of the COCODE. Some members of the community wish to remain removed from politics. Some raise concerns over the COCODE's ability to charge fees for community meetings, absence from activities like cleaning the finca, and maintaining the road. During interviews in January 2014, many community members reported that the COCODE charged extra fees to keep one's name on the list for the government tank program. These accounts varied widely, which may indicate political corruption within the COCODE. During interviews in May 2014, there were reports that the then-president of the COCODE, Domingo Caj, tried to charge community members for being part of the EWB-USA WPI program.

The EWB-USA WPI team has found that working with the COCODE as the major line of year round communication is largely ineffective since members of the COCODE have limited access to technology and lack means of intra-community information distribution. CeCEP has moved into this role as EWB-USA WPI's major line of communication with the community.

5.1.4 Community Families

Families are one of the main stakeholders in this project. Families who receive EWB-USA WPI rainwater-harvesting systems will spend significantly less time collecting water from the finca. Water will also be of higher quality, potentially reducing the need to spend money on firewood and chlorine to clean the water. Families will be able to spend more time on education, entrepreneurial endeavors, family, and recreation when they no longer need to go to the finca as often. In addition, this increased quality of water leads to a lower risk of regular sickness.

Rainwater harvesting systems will also mitigate problems that arise around the finca. If women and children no longer need to go to the finca in the early hours of the morning (2:00-5:00 am), there will be fewer conflicts with waiting on line, fewer occurrences of water running out, less controversy over water rights, less worry about dirty water from needing to drink what other people use to wash their clothes. There will be improved access to water all around.

5.2 Construction Summary

During the construction of the systems the EWB-USA WPI travel team will oversee the implementation process in a way that ensures that community members take full ownership of each implementation. The team is responsible for passing on the information from the technical designs and for overseeing the distribution of supplies and materials. The community members working on the systems have shown in previous implementations that they have the appropriate skills and knowledge to carry out the construction. These skills include carpentry, concrete

laying and an understanding of the system design and operation. In August 2014, the family of Cristobal Coy Max (House 27, January 2014 beneficiary) moved their house to a different location in Guachtuq. The community re-constructed the system without the assistance of the EWB-USA WPI team. This proved to the club that they have the skills to effectively construct the systems on their own. The construction plan heavily focuses on the members of the community transferring knowledge from experienced to inexperienced beneficiaries. This allows the community members to learn from people they trust, in their native language, and also means that the community will collaboratively have all the knowledge on the systems.

5.2.1 Technical Design Approval

The technical designs have previously been approved by the technical advisory committee and there have not been any major design changes. On February 25th, 2015, the travel team will meet with professional mentors to review the technical plans and make sure that all the travelers understand the plans fully. At that time the technical mentors will also give any suggestions or comments they have. To ensure that the travel team is prepared to manage the construction of the systems travelers will participate in a practice build in Massachusetts this spring, prior to the trip.

5.2.2 Guachtuq RWH Construction Teams

EWB-USA WPI will work with the Water Committee and the community members to create 5 construction teams of community members. Parameters for dividing the teams include:

Home Ownership: Each participant will work on the house he represents and the homes of the others on his construction team.

EWB-USA WPI Experience: Community members who own and/or have participated in building EWB-USA WPI rainwater harvesting systems system in the past will be leaders on the construction teams. At least one past beneficiary will be included in each construction team.

Personal Skills: Each team will have at least one member knowledgeable about all the basic skills needed to construct a system i.e. laying concrete, wood working, and using PVC. Team members will be determined in part by their experience with construction techniques.

System Design Difficulty: Some systems will require more far more work than others. It will be important to have uniform distribution of labor throughout the community to maximize efficiency. If one team finishes early, members can be reassigned to other teams.

Intra-community Relations: Another important parameter is respecting existing friendships and enmities among community members. There are some people who will not work together. The advice of the Water Committee and community members will be necessary to avoid social faux pas.

Location: Least important, the relative location of homes within the community should be considered to make as efficient as possible. It takes a lot of time and energy to carry tools back and forth between houses. However, most other materials will be delivered directly to each house.

All five groups will on Sunday May 17th for orientation. The EWB-USA WPI team will work with the groups to review how to construct each element of the system and the designs for the homes. During the meeting, all questions that the community members have about the system will be addressed before construction begins to improve efficiency. By learning the designs of each home in advance, community members should be more confident during construction. Higher confidence will reduce idle time and material waste, since there is a higher chance that the system will be constructed exactly as designed. Proper preparation will also ensure that all knowledge will be transferred to the community members to ensure project success.

5.2.3 Materials Acquisition and Delivery

The materials will be coming from various venders in San Cristobal and Coban:

Macsams, San Cristobal: Concrete base materials, 55 gallon drums, tarps

Macsams offers materials transport with the purchase of stone, cinder blocks, and rebar. However, they will not transport any bags of concrete bought at the location.

Lucky's Multiservicios, San Cristobal: Provider of the lumber used to make the concrete base frames and gutter clips

Lucky's is located on the road that leads to Guachtuq from San Cristobal. It is a store EWB-USA WPI has used in the past. They have had a positive experience with both quantity and quality of the wood available.

Construfacil, Coban: All PVC parts and gutters for RWH systems

Construfacil is a large construction store that EWB-USA WPI utilized in the past. However, the cost of materials transport from Coban limited the team in May 2014, this is no longer a problem for May 2015. They carry all of the PVC parts EWB-USA WPI needs when implementing with the families of Guachtuq.

Rotoplas: All tanks for the systems

Rotoplas takes direct orders and delivers from Guatemala City. They were prompted delivering the tanks ordered in May 2014.

5.2.4 Communication among Teams

EWB-USA WPI will have 6 phones distributed among the travelers to ensure that communication is sufficient at all time during the implementation. This number of phones is required since it is possible for the travel team to be spread thinner than on previous trips in order to cover the 5 construction teams working simultaneously.

5.3 Trip Timeline

The trip has been organized into a Gantt chart to help the team identify major checkpoints throughout the implementation, ensuring the success of the project. The chart includes pre-trip deadlines and details of the implementation, divided into five phases; Phase I: Preliminary Data and Preparations, Phase II: Concrete Base Construction, Phase III: Materials Transport for Systems, Phase IV: System Construction and Education and Phase V: Wrap-up. The Gantt charts (Figures 19-22) explain each of the five phases, identifying how many team members are necessary and when community members are needed. This will be a useful tool in time management for the team, especially if there is a delay of materials or some other unforeseen setback.

5.3.1 Gantt Chart

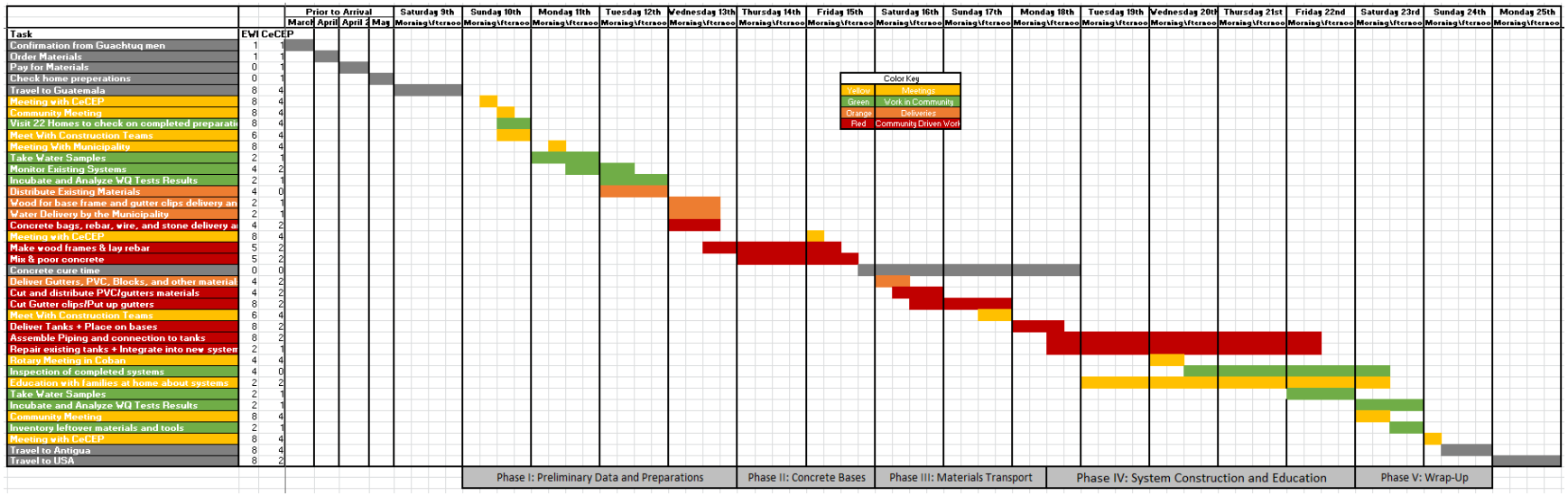


Figure 28: Complete Trip Gantt Chart

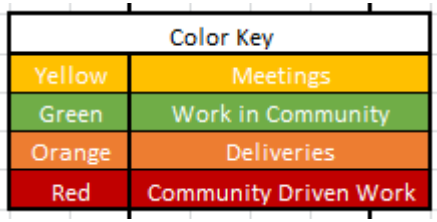


Figure 29: Gantt Chart Key

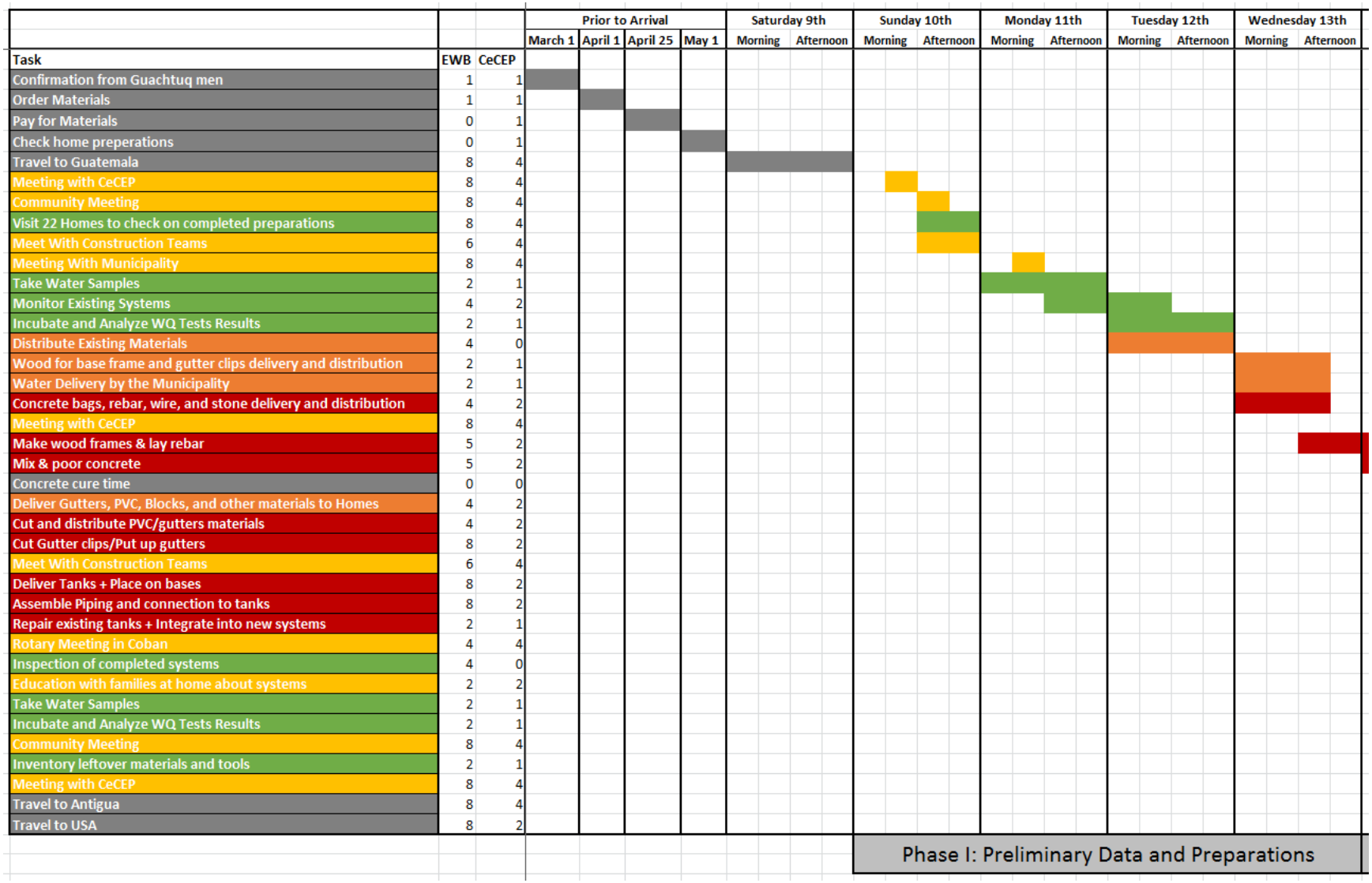


Figure 30: Pre-trip preparations, travel to Guatemala, and Phase I of trip

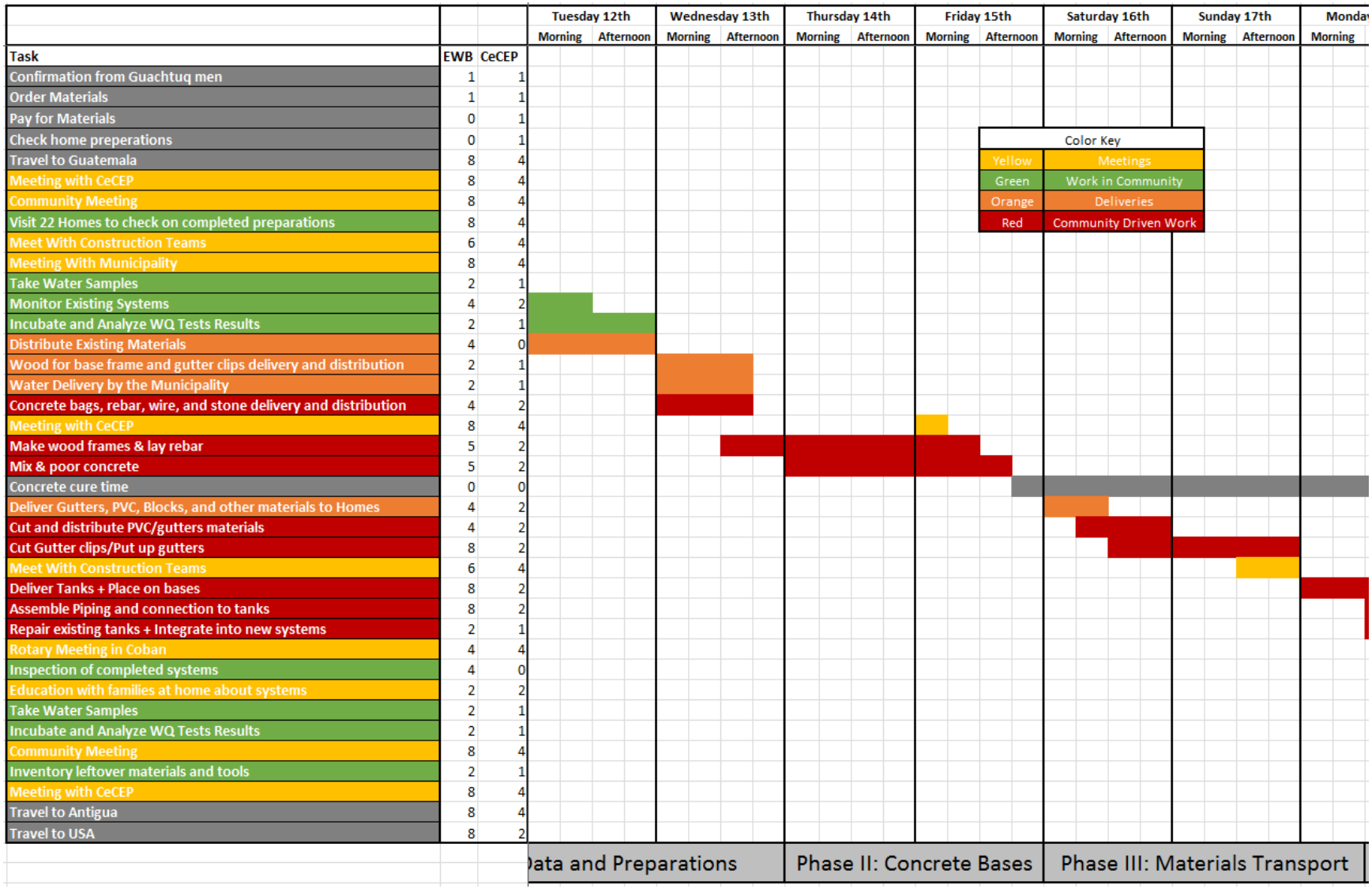


Figure 31: Phase II and Phase III of trip

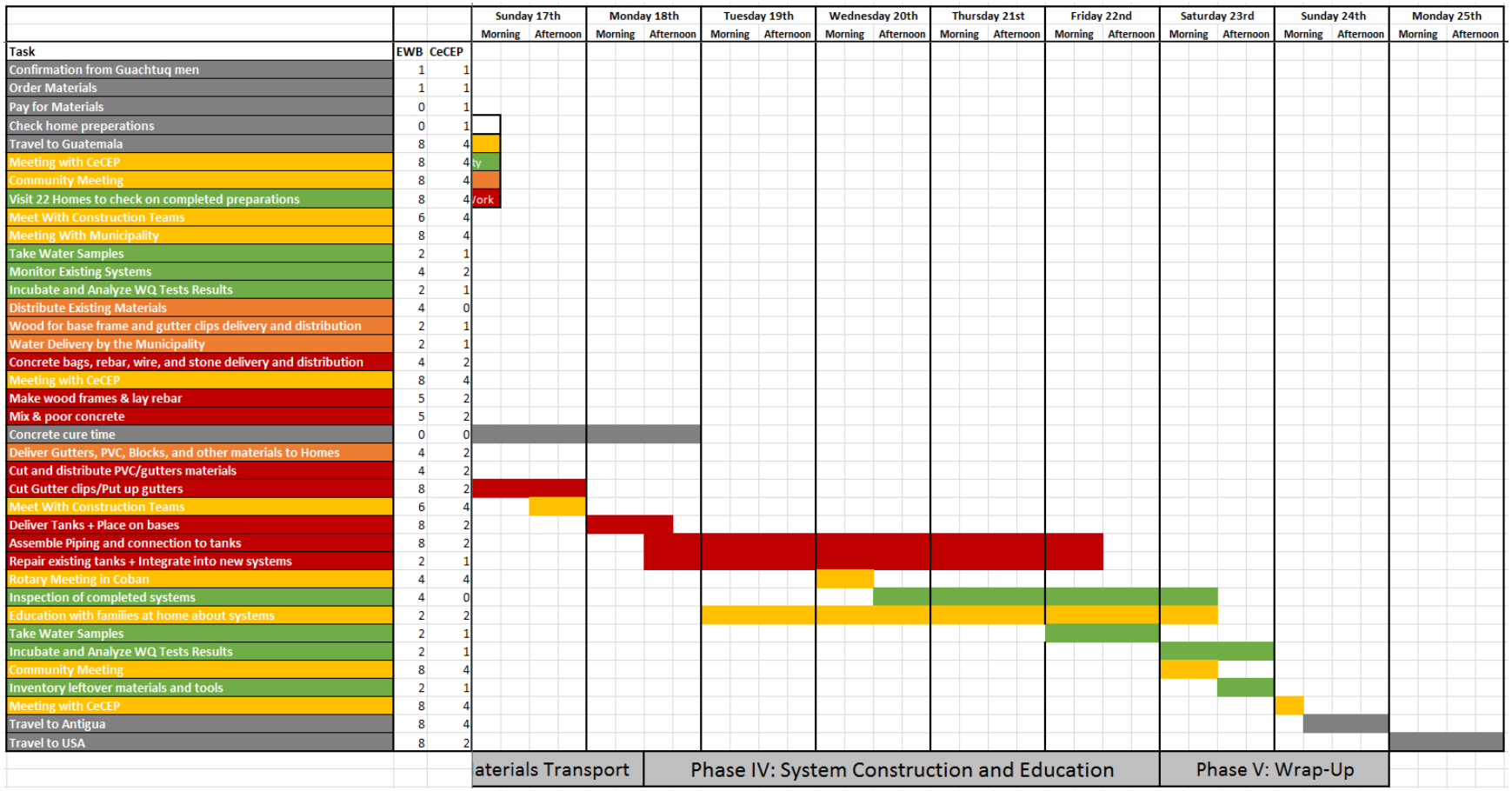


Figure 32: Phase IV and Phase V of trip

Pre-Trip Preparations

Confirmation from Guachtuq Men (by March 1st)

Each beneficiary is required to provide one able bodied individual for full participation in the construction on this trip. The beneficiaries from previous EWB-USA WPI implementation trips are also required to assist in the construction of the rainwater harvesting systems. Alvaro, the Guatemalan, EWB-USA WPI-to-community liaison will be meeting with each family to communicate the required construction days of May 13th -22nd. He will create a list of all the men's names who will be working with EWB-USA WPI during the construction. This list will include both the experienced men from past implementations and the men for the beneficiaries this year.

Ordering of Materials from Venders (by April 1st)

The completed materials lists will be sent to Alvaro at CeCEP by April 1st. He will take these lists to order the materials from the respective stores. All of the concrete base materials will be ordered from Macsams in San Cristobal. The wood will be ordered from a local store near Guachtuq called Lucky's Multiservicios. The PVC will be ordered from Construfacil in Coban and the Rotoplas tanks will be ordered from Rotoplas and delivered from Guatemala City. When the request for these materials is made at each of these venders, it will be stated up front that EWB-USA WPI will pay for the materials in the fourth week of April. EWB-USA WPI is sending and requesting the materials early to give stores sufficient time to order additional materials from manufacturers.

Pay for Materials (by April 25th)

Once the orders have been made at each of the venders, EWB-USA WPI will negotiate with the venders when and how to pay for the materials. EWB-USA WPI expects to pay for the tanks, PVC and concrete base materials before arriving in Guatemala.

Check Homes for Completion of Preparations (by May 1st)

EWB-USA WPI will ask Alvaro to go check in with all of the beneficiaries in Guachtuq. He will check that beneficiaries have completed the necessary home preparations that are stated in the signed MOUs. Alvaro will be asked to report if there have been any changes at the homes that EWB-USA WPI does not expect. Alvaro will also remind and confirm that there will be an able bodied man ready to participate in the construction between May 10th and 22nd. In addition he will confirm with beneficiaries from past trips to be sure that they will be participating in the construction as well. These community members are vital to the success of the implementation because they have experience constructing RWH systems and they will be able to help lead the construction teams. Alvaro will also talk to each family about the dates and times of the community meetings during this trip. It is vital that he informs all families about the first community meeting that will occur on May 10th.

Phase I: Preliminary Data and Preparations

Meeting with CeCEP

The first meeting with CeCEP will help the team identify and confirm any social, political, or technical changes that have occurred in the community, San Cristobal, or Coban that will affect the RWH system implementations. EWB-USA WPI will also discuss the trip itinerary and plans in full to be sure that everything is on track to be executed successfully on the planned dates. At

this time the team will also discuss with CeCEP when the translators will be available to work with the team.

Community Meeting
This first community meeting will be to reaffirm with the community the trip plans and time frame during which EWB-USA WPI will be working with them to complete the construction of the rest of the RWH systems. The team will again discuss the dates when past and present beneficiaries are required to provide an able bodied person to contribute to the construction of the RWH systems. They will be reminded that the construction will be completed between May 13th and May 22nd. During the meeting the team will read the names of the representatives who confirmed with Alvaro that they would be available and present for the implementation.

Meeting with the Construction Teams
The purpose of the meeting with the construction teams is to confirm that everyone in each construction team is familiar with the designs for each of the homes they will be constructing RWH systems at. In addition, general practices for constructing the PVC part of the system will also be covered in this meeting. This is a chance for the more knowledgeable members of the community in each group to teach the rest of the men about constructing RWH systems Guachtuq men will benefit from having men in the community teach them because they will be able to speak in Pokomchi, their native language, using terms that they will understand because they have all worked on construction before.

Visit 21 Homes to check on completed preparations
The travel team will split into two groups and visit each of the 21 homes that will be implemented on. EWB-USA WPI team members will confirm that the preparations from the MOUs are complete and will review the system plans. The family's current water security situation with the families will also be evaluated, recording the number of trips to the finca, any sickness they have been experienced that they believe is associated to water, and amount of water at the finca. This baseline data will be used to compare to data taken on the first monitoring trip. It will be used to assess the impact that EWB-USA WPI RWH project has had on water security in Guachtuq.

Since the travel team is composed of several new travelers, this walk through the community to each home will act as in introduction to Guachtuq and begin to familiarize them with the homes in the community.

Meeting with the San Cristobal Municipality
The purpose of the meeting with the San Cristobal Municipality is to confirm with the mayor of San Cristobal that they will support the implementation by transporting materials and providing water. This support was pledged at the end of the January 2015 trip. CeCEP will confirm with the municipality about their support in advance of EWB-USA WPI arriving. However, the EWB-USA WPI team will be meeting with the mayor to express gratitude and to confirm the plans with locations, times and dates of when his support is needed. Specifically, the travelers will confirm the time that the water truck will be arriving in the community to bring water for concrete bases, and the amount of trucks needed for the materials transport.

Take Water Samples; Incubate and Analyze WQ Tests Results

This is the first round of water quality testing on this trip. Samples will be taken from specified systems as shown in Appendix I: Water Quality (WQ) Planned Testing Locations. These systems will be water samples from any non-EWB-USA WPI RWH system that is present in the community before the beginning of the construction. This water data will be used as baseline data for future monitoring trips that will compare the EWB-USA WPI RWH systems to any previous systems in the community.

The water samples will be tested using the methods described in section 9.2. The tests will be incubated for 20-22 hours and then the results will be analyzed and recorded. The tests determine the presence of bacteria and pathogenic E. coli in the water samples.

Monitor Existing Systems
The travelers will visit each previously implemented EWB-USA WPI system to visually inspect it for any changes made and assess proper maintenance of the first flush units, gutters, filters & tanks. The system will be inspected for broken parts and the team will suggest possible solutions to fix any issues. The team will have a conversation with the families to be sure that the system is functioning properly, in the case that there is an issue that is not visually obvious. The team will also look for any technical design flaws that might require future intervention from EWB-USA WPI. This data will be used to begin the monitoring of this project and to set up protocols for the future travel teams to use when monitoring the success of this project.

Distribute Existing Materials
Currently, there are excess materials from previous implementations that are stored in the community. The majority of these materials are PVC pipes and fittings. The inventory sheet for these materials are in Appendix J. These materials will be accounted for when ordering materials and will be used during this implementation trip. They will be divided up and distributed to the homes that will be implemented on during this trip. The parts delivered to the houses will be recorded so there are not excess materials when the rest of the parts arrive on Sunday May 16th.

Phase II: Concrete Base Construction

The second phase of this implementation trip is the construction of the concrete bases. This is the point in the trip when the men are required to begin assisting with construction. They will participate in the transportation of these materials and do the vast majority of the work to construct the concrete bases. The EWB-USA WPI team will identify the simplest home for each Construction Team to begin working on. This will allow the Construction Team to build confidence, team dynamics, and technical skills on a simpler design before working on more complicated designs.

Wood for base frame and gutter clips delivery and distribution
EWB-USA WPI travelers and several Guachtuq men will visit the wood store, Lucky's Multiservicios, near Guachtuq in order to load the wood into one of the municipality supplied trucks. This wood will be delivered to the community in conjunction with the water and other concrete base materials and distributed appropriately. This delivery will include all of the wood needed for the concrete base frames and gutter clips.

Water Delivery by the Municipality

For each one tank base, approximately 42 liters of water is needed to mix the concrete. Since the club does not want to make families use their own water for this part of the construction, this water will be transported by a municipality water truck just as it was during the last May 2014 implementation trip. The water will be stored in 55 gallon drums that EWB-USA-WPI will provide in the community.

Concrete bags, rebar, wire, and stone delivery and distribution

The concrete bags, concrete blocks, rebar, wire, and stone will be delivered to each home. These materials will all be ordered from Macsams in San Cristobal. Macsams trucks and municipality trucks will transport the materials. The municipality will also be providing men to help with the unloading of these materials in conjunction with men from the construction teams. All of these materials will be unloaded onto the road in front of each house and then carried to the site of construction by the community men. This will take a significant amount of time since there are many heavy materials that need to be moved. All of the transport and moving of materials must occur in one day because it is not safe to leave any materials on the road in front of a house. All of the men will not yet be divided up into their individual construction teams for this delivery.

Meeting with CeCEP

The team will meet with CeCEP to be sure that all of the PVC materials and tanks are on track for delivery on the desired days of the 16th and the 18th respectively. It will also serve as a meeting to check in with CeCEP and be sure that all of the translators know exactly how the next 8 days will proceed.

Spreading stone, making wood frames and laying rebar

At this point the men will divide up into their respective construction groups. The construction teams will spread the stone to create an adequate site with proper drainage to lay the concrete. The wood frames will next be constructed using the wood boards along with stakes and line to make it square. The wood used in the frames is rough cut 2x4s therefore the bases end up being 4 inches thick. After the frames are made the rebar will be cut to length and tied into a mesh. It is then placed into the frame with rock propping it up to make sure that it is located in the mass of the concrete. Larger rocks collected by the community members, as agreed upon in the site preparations of the MOU, are then placed in the frame and around the rebar to reduce the volume of concrete required.

Mix & pour concrete

After the rebar has been completed the concrete will be mixed and poured into the base. The concrete is hydrated and mixed on site in wheelbarrows; each construction team will have 2 wheelbarrows for mixing concrete. From past trips it has been observed that 2 wheelbarrows and 5 men is the ideal amount of activity that does not cause crowding around the base. A single tank base requires 14 bags of ‘Listo Mixto’ (ready mix) concrete and a double requires 28 bags. Many of the men in the community have extensive experience mixing and pouring concrete. The wet concrete will be protected from rain using plastic tarps held up by wood over them.

Concrete cure time

The concrete bases will be given roughly two days and three nights to cure before the cinder blocks and tanks are placed on them. In past implementations this was a sufficient amount of time to allow the concrete to cure for to support the weight of a layer of cinder blocks and an empty tank.

Phase III: Materials Transport for Systems

While the concrete bases are drying, EWB-USA WPI and the Guachtuq men will use these days to deliver and distribute the gutters, PVC, and other materials to each home.

Deliver Gutters, PVC and other materials to Homes

The delivery of these materials will be provided by Construfacil in Coban. These materials include all of the PVC tubes, gutters, and fittings. There are also several other materials such as the bulk heads and metal valves for the first flush units. All of the small materials will be delivered to the middle of the community where they will be organized by home. The sorted materials will then be distributed to each of the homes in sturdy boxes by the Construction Teams and the EWB-USA WPI travelers.

Cut and Distribute PVC Tubes and Gutters

While the small individual pieces of materials are divided up and distributed, the Construction Teams and EWB-USA WPI will then cut the PVC tubes and gutters to length and make bundles for each house. Again this will be done at a central location in the community. Cutting the PVC tubes and gutters will reduce the amount of excess materials. These will then be delivered to the appropriate homes in the community.

Putting up the Gutters and Cleaning Existing Tanks

After all of these materials are at their respective homes, the construction teams will re-assemble and begin constructing the gutters. Each gutter clip is unique due to its placement along the home, and therefore the gutter clips must be measured out and cut during the gutter installation process. This is estimated to take 1.5 days of work from the construction team. Before putting up the gutters, each construction team, with consultation from an EWB-USA WPI member, will confirm which roof sections require gutters and if the house needs alteration to accommodate the gutter clips. They will then make the first and last gutter clips for each of the gutters out of wood. Using a line and level they will position the first and last gutter clips to create the desired slope of 2˚. They will then create gutter clips to support the middle section of the gutter and maintain an even slope along the entire gutter. The construction of the gutter clips at all of the homes is estimated to take 1.5 days of work. Any existing tanks will also be emptied and cleaned at this point in time. These tanks will be integrated into the new systems in Phase IV of implementation.

Meet With Construction Teams

After all of the homes have gutters, concrete bases, and all of the other materials, the construction teams will regroup with EWB-USA WPI and discuss the plans for the next phase of construction. They will discuss the delivery of the tanks, the design of the complete systems, and the reasoning behind the customized system design for the specific home. They will focus on the aspects that make the EWB-USA WPI system a closed system to prevent insects and debris from entering; how to put mosquito netting in the down spout and on the overflow, and the importance of keeping the cap on the tank. They will also focus on how the design helps to

keep the tanks clean by overflowing from the bottom of the tank. In addition, they will discuss the limitations of the system and why it requires continual maintenance and care; specifically cleaning: gutters regularly, the first flush units every rainstorm, the filters every month and the tanks periodically throughout the year.

Phase IV: System Construction and Education

This phase marks the completion of the systems. The cinder blocks and then tanks will be placed on the cured concrete bases, the first flush units will be constructed, the gutters will be connected to the tanks, the overflows will be integrated, and the tanks will be joined. When these systems are being constructed, they will be integrated with any existing tanks that are present at each home. The design accounts for this integration. See section 3 The EWB-USA WPI team will identify the simplest home for each Construction Team to begin working on in order to allow the Construction Team figure out team dynamic and actual technical construction of these rainwater harvesting systems on an easy example.

Tank Delivery and Placement on Bases

The tanks will be delivered from Guatemala City. This delivery has the highest potential to be delayed due to the long distance the tanks will be travelling. It is a necessary risk that cannot be avoided because the only truly safe place to store these tanks is at each of the homes in the community. The tanks are scheduled to arrive on Monday morning, this will allow the construction teams to check the concrete bases and begin placing the cinderblocks.

Assemble Piping and Connection to tanks

Each construction team will work to connect the gutters to the tanks. They will construct the first flush units and cut all of the PVC tubing to length. An EWB-USA WPI member will be there to assist each team with the design of the system. They will add overflows, and connect the tanks in multi-tank systems. Some of these connections will be direct connections at the bottom of the tanks, making in essence one 5000 liter tank, whereas the other tank connections are named waterfalls when a new tank overflows into an older tank. This system better maintains tank cleanliness and separates the water in the old tanks from the new tanks.

Repairing the Existing Tanks and Integrating them into the New Systems

Many of the homes in the community have some form of existing rainwater collection system from a government sponsored tank project or from a concrete tank implementation. EWB-USA WPI includes this storage capacity in the design for the system, and so existing tanks that are not functional closed systems will be repaired to ensure the integrity of the whole system. For government tank projects, this often means replacing gutters and downspouts and patching hole in the tanks. For concrete tanks, this entails fixing water pumps and concrete covers that are too heavy to lift.

Rotary Meeting in Coban

Wednesday morning is the regular meeting time for the Rotary Club of Coban. On Wednesday, May 20th, EWB-USA WPI will be making a presentation about the project, showing the progress of the implementation so far and discuss where it is going next. EWB-USA WPI is making this presentation because the Rotary Club of Coban assisted in helping EWB-USA WPI acquire the Rotary Global Grant that is funding this trip.

Inspection of completed systems

The EWB-USA WPI team will be monitoring the quality of the constructed systems throughout the construction phase, but most thoroughly in the last two days of this phase of construction. They will check that all parts of the systems are constructed properly. This will ensure that none of the minor details in construction have been overlooked. The EWB USA WPI team will take the time to thoroughly inspect every part of each system so be sure that all fittings are glued, all mosquito netting is present, all overflows are at the appropriate height, and all families are satisfied with their system.

MOUs for Payment Plans

Upon the completion of each home, an EWB-USA WPI member will evaluate total cost of the each individual system. A total cost will be calculated on a house to house basis, dependent on the number of pieces used for each system. This process will be done incrementally as each of the homes are finished. The families, as stated in the MOUs, will be responsible for paying 5% of the total cost of the materials of the system. With the help of a translator, a payment plan will be created between CeCEP and the family.

Education with families at home about systems

During this part of implementation phase, the EWB-USA WPI members will discuss with the owners of the newly finished systems all of the aspects of the system and required maintenance. They will spend time explaining the operation and maintenance of the systems to the families, just as was done on the May 2014 Implementation Trip. They will step through each page of the education booklet to ensure that there is a verbal explanation that is attached to the words and images on each page of the booklet. The travelers and translators that explain the system maintenance will be specifically trained to administer this education and explanation in order to ensure uniform understanding throughout the community. The education materials that will be distributed to each family are in Appendix F: EWB-USA WPI RWH System Maintenance Manual.

Phase V: Wrap-up

Take Water Samples, Incubate and Analyze WQ Tests Results

The EWB-USA WPI team will take another set of water quality tests at the end of the trip to establish another data point for each of the existing RWH systems that were implemented during previous trips. The tanks that have just been implemented are not able to be tested since any water collected in them will be too fresh. However, if there is a rain, the team will visit each home to make sure the family has emptied the first flush units.

Community Meeting

After the completion of the construction and the education of each family, everyone will gather for one last meeting on May 23rd to discuss the monitoring stage of the project and to say farewell. The EWB-USA WPI team will work to empower the community to understand that they have successfully accomplished an amazing feat and that maintenance and care is essential to the integrity of their new water supply.

Inventory of Leftover Materials and Tools

A complete set of tools will be stored in the community building maintained by the Water Committee. All families will be able to access these tools if any repairs are needed. The excess

materials will be either returned to the construction store or left with the families for any repairs if needed.

Meeting with CeCEP

The final day of the trip, the EWB-USA WPI team will meet with CeCEP to wrap-up any financial payments that are needed for the homestays and translators. They will also discuss the monitoring phase of EWB projects and the next steps.

5.3.2 Trip Itinerary

Date	Action
Saturday, May 9th	• 12:00 Arrive in Guatemala City, van organized by CeCEP • 17:00 Arrive in San Cristobal at homestays
Sunday, May 10th	• 9:00 Meeting with Sucy, Alvaro, and Abelino at CeCEP • 12:00 Visit the 22 homes being implemented at to check completion of preparations • 13:00-15:00 Community Meeting • 15:00 o Group 1: Meeting with Construction Teams o Group 2: Visit remaining homes being implemented on that were not checked earlier in the day • 17:00 Return to CeCEP
Monday, May 11th	• 7:00 Group meets at CeCEP • 8:00 o Group 1: Meeting with San Cristobal Municipality o Group 2: Goes to community to monitor existing systems-assess proper maintenance of first flush, gutters, filters, and tanks, talk to families about system o Group 3: Take water samples at all non-EWB-USA WPI tanks in the community* • 1:00 o Group 1: Joins monitoring team to complete assessment of EWB-USA WPI systems • 17:00 Return to CeCEP • 18:00 Prepare water tests and incubate samples *Water samples incubate overnight

Date	Action
Tuesday, May 12th	• 7:00 Group meets at CeCEP • 8:00 o Group 1: Sort, inventory and determine which houses will receive existing materials o Group 2: Finish monitoring existing systems in the community • 13:00 Distribute materials left over in the community to houses where RWH systems are being implemented • 17:00 Return to CeCEP • 18:00 Analyze water tests
Wednesday, May 13th	• 7:00 Group meets at CeCEP to go to the community • *8:00-12:00 Macsams and Lucky's delivery of construction materials for concrete base and gutter clips • *12:00 Distribute materials • *13:00 Water delivery by municipality distributed among the community for concrete bases • *15:00 Depending on time of delivery, begin to construct wood frames and lay rebar • 17:00 Return to CeCEP *Dependent on delivery times
Thursday, May 14th	• 7:00 Group meets at CeCEP to go to the community • 8:00 Construction groups 1-5 work on making wood frames, laying rebar and mixing/pouring concrete bases • 17:00 Return to CeCEP
Friday, May 15th	• 7:00 Group meets at CeCEP to go to the community • 8:00 Construction groups 1-5 work on making wood frames, laying rebar and mixing/pouring concrete bases • 9:00 Meeting with CeCEP • 17:00 Return to CeCEP *Concrete bases cure
Saturday, May 16th	• 7:00 Group meets at CeCEP to go to the community • *8:00 Gutters, PVC, Blocks, and other materials delivered to the community • 12:00 PVC cut and gutters rough cut to appropriate size, fittings counted • 15:00 Materials delivered to homes respective homes • 17:00 Return to CeCEP *Dependent on delivery time **Concrete bases cure
Sunday, May 17th	• 7:00 Group meets at CeCEP to go to the community • 8:00 Meet with construction teams to verify construction techniques and designs for each of the homes • 9:00 Gutter clips are cut on site at put up • 17:00 Return to CeCEP *Concrete bases cure

Date	Action
Monday, May 18th	• 7:00 Group meets at CeCEP to go to the community • *8:00 o Construction Team 1: Handle the delivery of the Rotoplas Tanks and place the tanks on bases o Construction Team 2-5: Finish putting up gutters or any other unfinished tasks • 15:00 Begin assembling piping and connection to tanks, repair existing tanks and integrate them into new systems *Dependent on delivery time **Concrete bases cure
Tuesday, May 19th	• 7:00 Group meets at CeCEP to go to the community • 8:00 • Continue assembling piping, connections to tanks, repairing existing tanks and integrating government tanks into systems • *Educate families about the system and explain and give family RWH booklet • 17:00 Return to CeCEP *Education occurs at the completion of each system
Wednesday, May 20th	• 6:00 Group meets at CeCEP to go to Coban • 7:00 Rotary meeting in Coban • 8:00 Construction Teams 1-5: Continue assembling piping, connections to tanks, repairing existing tanks and integrating government tanks into systems • 12:00 EWB Team returns to community o *Educate families about the system and explain and give family RWH booklet o **Inspect each system as completed o ***Fill out payment plan MOU with families • 17:00 Return to CeCEP *Education occurs at the completion of each system **Inspection occurs at the completion of each system ***Payment Plan MOUs are filled out at the completion of each system
Thursday, May 21st	• 7:00 Group meets at CeCEP to go to the community • 8:00 Construction Teams 1-5: Continue assembling piping, connections to tanks, repairing existing tanks and integrating government tanks into systems o *Educate families about the system and explain and give family RWH booklet o **Inspect each system as completed o ***Fill out payment plan MOU with families • 17:00 Return to CeCEP *Education occurs at the completion of each system **Inspection occurs at the completion of each system ***Payment Plan MOUs are filled out at the completion of each system

Date	Action
Friday, May 22nd	• 7:00 Group meets at CeCEP to go to the community • 8:00 o Construction Teams 1-5: Continue assembling piping, connections to tanks, repairing existing tanks and integrating government tanks into systems ▪ *Educate families about the system and explain and give family RWH booklet ▪ **Inspect each system as completed ▪ ***Fill out payment plan MOU with families o Group 2: Take water samples of the 12 implemented homes of tanks and first flush • 17:00 Return to CeCEP • 18:00 Prepare water tests and incubate samples +Water samples incubate overnight *Education occurs at the completion of each system **Inspection occurs at the completion of each system ***Payment Plan MOUs are filled out at the completion of each system
Saturday, May 23rd	• 7:00 Group meets at CeCEP to go to the community • 8:00 o Group 1: Inspect completed systems and complete education at any homes that hadn't received it after the completion of their system construction o Group 2: Wrap up at homes that ran into issues during construction and complete education at any homes that hadn't received it after the completion of their system construction o Group 3: Inventory any leftover materials and tools* • 16:00 Final Community Meeting o Remaining Payment Plan MOUs signed by families • 17:00 Return to CeCEP • 18:00 Analyze water tests *Join group 1 or 2 after completing inventory
Sunday, May 24th	• 9:00 Group meets at CeCEP to say goodbye and finish any last minute details • 10:00 Van ride from San Cristobal to Antigua • 16:00 Overnight stay in Antigua
Monday, May 25th	• 7:00-10:00 Van ride from Antigua to Guatemala City • 13:00 Flight from Guatemala to Boston

5.3.3 Plan For Project Scaling

The May 2015 Implementation Trip will be unlike past EWB-USA WPI trips for many reasons, explained here in detail. In light of the January 2015 Assessment Trip, the team has taken care to plan and prepare for all possible logistical setbacks. The plan for scaling ensures that the implementation will be successful by considering the following:

- Project Scope
- Materials Acquisition
- Materials Transportation
- Phased Construction
- Knowledge Transfer

Project Scope

In May 2014, the team constructed eight rainwater harvesting systems in two weeks. Though the team plans to implement nearly three times the number of systems in the same amount of time, there are many differences in the type and size of the systems. Not all of the systems require bases, and not all require new tanks. While the bill of materials is still much larger than in the past, the team now has experience working with materials providers and transportation.

Materials Acquisition

During the May 2014 Implementation Trip, EWB-USA WPI pre-ordered the necessary materials from three venders in San Cristobal: Macsams, Millenium, and Lucky's. The Rotoplas tanks were ordered directly from Rotoplas, located in Guatemala City. In May 2015, EWB-USA WPI will, again, pre-order all materials from several vendors. PVC parts will be sourced from Construfacil, a construction store in Coban. During the January 2015 Assessment Trip the team visited Construfacil to confirm that they will be able to supply all of the necessary materials. Quotes have been obtained from Macsams and Rotoplas as well, confirming that these suppliers will be able to provide adequate quantity of materials with advanced notice.

Materials Transportation

On the May 2014 Implementation trip EWB-USA WPI relied on donated transportation from the Municipality of San Cristobal and will again utilize their services in May 2015. The team will work with Sucely Ical Lem to clearly communicate plans for the timing and quantity of materials transport. For the majority of the materials, EWB-USA WPI will pay Macsams and Construfacil for the transportation. Macsam's provides delivery of materials to a desired location for stone, cinder blocks, rebar, and 55 gallon drums. However, they will not provide transport for the bags of concrete. The municipality will be assisting EWB-USA WPI with transporting the concrete. When ordering materials from Construfacil in Coban, EWB-USA WPI will be purchasing transportation. With purchased material transport, EWB-USA WPI will have more control over when the transportation of said materials arrival in Guachtuq occurs.

Phased Construction

Using a multi-phased construction plan, EWB-USA WPI and the people of Guachtuq will execute the implementation systematically and efficiently. Having five distinct phases will ensure that construction teams complete each stage at every home thoroughly before moving on to the next part. The timing of the phases will correlate with delivery of specific materials. This will help keep materials organized as they are distributed among the houses. The phased construction also sets manageable milestones for the construction teams to accomplish. Overall, the improvement in organization and thoroughly thought out plan will ensure that the implementation is executed as smoothly as possible.

Successful Knowledge Transfer

The most significant difference between May 2014 and 2015 that will facilitate the successful scale-up of implementation is the success EWB-USA WPI has seen in terms of knowledge transfer within Guachtuq. When there were on 4 community member knowledgeable about

implementing rainwater harvesting systems from prior EWB-USA WPI trips, now there are 12 men who are knowledgeable about RWH system implementation. These men have each signed an MOU stating that they will help EWB-USA WPI and their neighbors during the May 2015 implementation trip. All 12 of these men participated in the May 2014 implementation where they developed a working understanding about how to implement the EWB-USA WPI RWH system. With these men helping during the construction, they will significantly increase the rate at which EWB-USA WPI is able to teach the others about how to system is designed, constructed, and maintained.

5.3.4 Proactive Contingency Planning

The team has planned the schedule so that if there are any problems with materials, transportation or labor there is flexibility in timing for the team to address and find a solution to the problem while still completing the construction on time.

Materials

All of the materials are scheduled to arrive at least one day in advance of when the travel team plans to use them for construction. Therefore, if there are any problems or unforeseen shortages with the materials, the team has time to get the correct materials. The materials are also coming in over the course of multiple days. This choice was made after the past implementation trip so that if there is a mistake with one of the material deliveries the team will be able to focus on fixing the problem without having to deal with other incoming materials at the same time. Furthermore, the team has quotes from three building supply stores in the area that all carry most of the supplies in stock, as seen in Appendix E: Quotes from building supply stores. If a problem occurs with one of the materials, the team will be able to get the material from one of the other stores at short notice, whether from Coban or immediately in San Cristobal. The concrete base materials come from Macsams in San Cristobal, Guatemala. EWB-USA WPI has worked with Macsams before so they have experience filling orders for this project. The travelers on the January 2015 trip also visited Macsams to confirm that they could handle the expected order quantity, and they were confident they could without any issue. The concrete blocks are also made on site at Macsams so more can be made and obtained relatively quickly if needed.

Labor

To ensure that there are enough community members to do the labor for the construction the travel team will be sending the construction dates to the community in February, that way they have three months to plan their schedule to take the time off work. The travel team will be receiving a list of community members that will be taking part in the construction soon after the submission of this form as well**.** This list will be a formal commitment from a member of the family, or a representative for the family, to participate in the construction of the systems, guaranteeing a minimum work force that EWB-USA WPI can count on. Before EWB-USA WPI travels in May, CeCEP will be having a meeting with each of the community members who committed themselves to be on construction teams to be sure they have made arrangements to take work off and understand what the trip will entail for them. As a final check, Alvaro will be traveling to the community in the week before travel to confirm again that the proper people are prepared to be on construction teams. On the first day the travel team arrives in the community, they will meet with each family that will have a system implemented. At that time the team will reaffirm the name that each house has supplied for who will take part in the construction. This

gives the team a week to find another laborer before the construction of the PVC system begins if needed.

Currently Saturday May 23rd is scheduled to be a day where the travel team will check in with each family that has had a system implemented during the trip. At this time the team will also solve any unexpected problems or complications that occurred during construction. Furthermore, the team currently has scheduled Sunday May 24th to be a travel day, in which the team travels to Antigua to make traveling to Guatemala City easier. While this would make travel easier for the team, if needed the team could stay in Guachtuq on Sunday and then travel to Guatemala City on Monday so that they could fix any remaining issues that may have arisen during construction. While EWB-USA WPI does not foresee any problems or major complications with the implementation, it is always best to be prepared for the unexpected, which is why the club has carefully planned in so much contingency time.

5.3.5 Contingency Plans

The EWB-USA WPI team has spent time to plan for possible unforeseen roadblocks that might significantly impact the itinerary and ways to work around these roadblocks with minor negative impacts to the ultimate success of the implementation trip.

If the Municipality is unable to provide trucks for transportation…
In this case, the lack of municipality involvement will likely cost the team a day of construction before the concrete bases are poured. If this occurs it will take one day away from the end of the trip when the systems are coming to completion. To mitigate this risk, EWB-USA WPI is ready to pay for transportation of all of the materials from Macsams. With transportation from Macsams, it will take more trips to deliver all of the materials and it will cost significantly more, however EWB-USA WPI is able to absorb the extra cost with extra funds budgeted in.

In the case that the Municipality water truck will also be inaccessible, it will take more time to acquire sufficient water for the concrete bases. However, the dry season will just be ending therefore the families, just as they were last trip, will likely be willing to use water in their existing storage capacity. Also, there are the past beneficiaries with fully functional systems that will likely have water as well. In the worst case scenario several men and EWB-USA WPI travelers will need to take trips to the finca to gather water.

If there is not enough wood at the wood store EWB-USA WPI always goes to…
In this case, the wood store does not have a sufficient supply of wood the project needs. The solution to this would prove to be quite simple. There are other wood stores around San Cristobal that have a sufficient supply of wood. If there is just not enough wood in the San Cristobal area, EWB-USA WPI will have to take the time to travel to Coban and order more wood. Fortunately, the Construction Teams will be able to start the first few concrete bases while a contingent of the travel team traveled to procure the needed quantities of wood.

If a home is has not completed the preparation work that was agreed upon in the signed MOU…
In this case, a family did not complete the agreed upon work and is not ready for implementation. The EWB-USA WPI team is checking all of the homes for this on the first day in the community, this should give any families sufficient time to complete the preparations. If the

family is unable due to legitimate reasons, such as old age, EWB-USA WPI will ask some of the men who will be working on the implementation to help. If the family has chosen to disregard the preparation work intentionally, EWB-USA WPI will make a decision based on the circumstances and plan accordingly for the construction phase of this trip. It is not out of the question for EWB-USA WPI to not implement at a house that break what is agreed upon in an MOU.

If Constufacil does not have all of the materials they promised…
In this case, the construction store in Coban that is providing all of the PVC pieces does not have everything that they promised. The team will take a trip to the local San Cristobal stores to buy the missing parts and or take a trip to another store in Coban. If this happens, the response and negative impact on the implementation will depend upon the part. There are multiple different pieces of the system, that if there are not enough, construction will be delayed while the travel team works to acquire the necessary components. Fortunately, because of the materials distribution to each of the homes early in the trip, Construction teams can move on to another home while waiting for a replacement part.

If the construction is not completed before the EWB-USA WPI team needs to leave…
The community members will know everything that EWB-USA WPI can teach them about constructing RWH systems by May 25th. They will have all of the necessary tools and materials to complete the implementation without EWB-USA WPI if necessary. Alvaro and CeCEP will be able to step in to ensure that the final stage of the implementation comes to a successful completion.

6.0 Materials List and Cost Estimate

The following figures show the total materials per house, and then total materials for the entire trip in an excel spreadsheet. This spreadsheet has different sheets devoted to each section of the system, and then references each of those when calculating the total per home. On the right side of the second figure, it sums up the rows to find the total number of that kind of material for the entire trip. Next to that is the price per part as reflected from the quotes received from stores and receipts from the past implementation trip. Since costs fluctuate, the club understands this is only an estimate, but puts the cost of construction at a total of $19,000.

Materials	Spanish	House 2	House 3	House 4	House 6	House 7	House 10	House 12	House 17	House 19	House 20	House 22	House 23A
Plastic Covering for Concrete (ft)	Nylon blanco (60")	15	10	15	15	6	15	0	10	10	6	15	6
Tie Wire [ft]	Alambre de Amarre	3	3	3	3	3	3	0	3	3	3	3	3
Cinder Blocks	Block de Piedra 15*20*40	75	50	75	75	25	75	0	50	50	25	75	25
Ready Mix Concrete 50kg	Concreto 3001 50kg 3/8" Mixto Lis	32	28	32	32	14	32	0	28	28	14	32	14
2"x4"x12' wood	Madera 2" x 4" x ?'	2	2	2	2	0	2	0	2	2	0	2	0
2"x4"x5' wood	Piedras	2	2	2	2	4	2	0	2	2	4	2	4
Rocks [m3]	Botellas 2L	1	0.5	1	1	0.5	1	0	0.5	0.5	0.5	1	0.5
2 L Bottles	Hierro 1/4 commercial	4	4	4	4	4	4	0	4	4	4	4	4
1/4" Rebar	Piedrin Triturado de 3/4	12	8	12	12	3	12	0	8	8	3	12	3
3/4" Crushed Stone [m^3]	Agua	1	0.5	1	1	0.5	1	0	0.5	0.5	0.5	1	0.5
Water [L]	Bajada Colonial 3"	225	150	225	225	75	225	0	150	150	75	225	75
2" Downspout	Bajada Colonial 2"	4	4	3	2	2	3	2	1	1	1	3	2
Gutter Caps [Pair]	Par tapa canoa	4	4	3	2	2	3	2	1	1	1	3	2
Gutter Unions	Tapaderas PVC Para Canal Coloni	2	0	2	2	2	3	2	0	0	1	2	2
Gutter Clips	Reglas	20	16	16	8	8	30	8	3	4	7	20	12
Gutters (6m)	Canal Colonial Amarco	5	3	3	3	3	5.5	3	1.5	1	1.5	4	5
2" PVC Elbow	Codo PVC 2"	12	6	6	4	4	3	3	1	1	2	6	5
2" PVC Tee	Tee PVC 2"	3	3	3	3	3	1	3	1	1	1	2	2
2" PVC Tube (6m)	Tubo PVC 2"	3210	1810	910	1210	1010	2010	1010	610	210	210	520	1810
2" x 1.5" Reducer	Reductor 2" x 1.5"	2	1	1	1	1	1	0	1	1	1	2	1
1.5" PVC Tube (cm)	Tubo PVC 1.5"	610	450	610	510	360	530	10	470	470	300	1170	660
Rotoplas Tank Inlet	Roscas por Rotoplas 1.25"	4	3	3	3	4	2	0	5	2	2	8	2
1.5 Male Adaptor	Adaptor Macho 1.5"	7	7	8	7	7	7	2	6	6	5	13	7
Mosquito Netting	Malla	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk
2" PVC Coupling	Union Naranja 2"	2	0	0	0	0	0	0	0	0	0	2	1
1.5" Elbow	Codo PVC 1.5"	1	1	2	2	2	2	0	2	2	1	5	4
1.5" Tee	Tee PVC 1.5"	1	1	1	1	0	1	0	1	1	0	0	1
3" x 2" Reducer	Reductor 3" x 2"	0	0	0	0	0	0	0	0	0	0	1	0
4" x 2" Reducer	Reductor 4" x 2"	1	1	1	1	1	1	1	1	1	1	1	1
3" x 1.5" Reducer	Reductor 3" x 1.5"	0	0	0	0	0	0	0	0	0	0	1	1
4" x 1.5" Reducer	Reductor 4" x 1.5"	1	1	1	1	1	1	1	1	1	1	1	0
3" PVC Tube (cm)	Tubo PVC 3"	0	0	0	0	0	0	0	0	0	0	50	0
4" PVC Tube (cm)	Tubo PVC 4"	140	100	170	210	120	370	115	170	80	217	100	380
1.5" Italy Valve (metal)	Llave Paso Italy 1.5"	1	1	1	1	1	1	1	1	1	1	2	1
1.5" x 45 deg elbow	Codo PVC 1.5" 45 deg	8	8	5	7	4	5	1	5	5	4	12	5
3" union (coupling)	Union Naranja 3"	0	0	0	0	0	0	0	0	0	0	2	0
4" union (coupling)	Union Naranja 4"	2	2	2	2	2	2	2	2	2	2	2	2
Water Bottle	Botella de Agua	1	1	1	1	1	1	1	1	1	1	2	1
Stick	Palo	1	1	1	1	1	1	1	1	1	1	2	1
1.25" PVC Tube (cm)	Tubo PVC 1.25"	400	400	400	400	400	400	0	400	400	400	400	400
1.5" Female Connector	Adaptor Hembra 1.5"	1	1	1	1	2	1	0	1	1	0	0	1
1.5" union	Union Naranja 1.5"	0	0	0	0	0	0	0	0	0	0	0	0
.5" Faucet	Llave Chorro .5"	1	1	1	1	2	1	0	1	1	1	3	1
Rotoplas Tank	Tanque Rotoplas	2	2	2	2	1	2	0	2	2	1	3	2
2 in Threaded Caps	Tapon Macho 2" con roscas	2	2	2	2	2	2	0	0	0	0	0	4
Plastic to Patch Holes	Plastico	1	1	1	1	1	1	0	0	0	0	0	2

Figure 33: Construction material parts list for each of the 22 homes planned

Materials	Spanish	House 23B	House 24	House 25	House 30	House 32	House 33	House 34	House 36	House 40	House 43	Total Amount	Price/Part (Q)
Plastic Covering for Concrete (ft)	Nylon blanco (60")	6	6	6	6	0	10	15	10	20	10	212	15
Tie Wire [ft]	Alambre de Amarre	3	3	3	3	0	3	3	3	6	3	63	5
Cinder Blocks	Block de Piedra 15*20*40	25	25	25	25	0	50	75	50	100	50	1025	3.2
Ready Mix Concrete 50kg	Concreto 3001 50kg 3/8" Mixto Lis	14	14	14	14	0	28	32	28	56	28	514	42.5
2"x4"x12' wood	Madera 2" x 4" x 7'	0	0	0	0	0	2	2	2	4	2	28	16.66
2"x4"x5' wood	Piedras	4	4	4	4	0	2	2	2	4	2	56	9
Rocks [m3]	Botellas 2L	0.5	0.5	0.5	0.5	0	0.5	1	0.5	1	0.5	13.5	0
2 L Bottles	Hierro 1/4 commercial	4	4	4	4	0	4	4	4	4	4	80	0
1/4" Rebar	Piedrin Triturado de 3/4	3	3	3	3	0	8	12	8	16	8	157	13
3/4" Crushed Stone [m^3]	Agua	0.5	0.5	0.5	0.5	0	0.5	1	0.5	2	0.5	14.5	250
Water [L]	Bajada Colonial 3"	75	75	75	75	0	150	225	150	300	150	3075	0
2" Downspout	Bajada Colonial 2"	1	1	2	5	1	1	1	1	2	2	45	28
Gutter Caps [Pair]	Par tapa canoa	1	1	2	5	1	1	1	1	2	2	45	16
Gutter Unions	Tapaderas PVC Para Canal Coloni	1	1	2	2	0	0	0	1	2	2	29	16
Gutter Clips	Reglas	6	6	12	25	4	6	6	6	10	10	243	0
Gutters (6m)	Canal Colonial Amarco	1.5	1.5	3	7	1	1.5	2	1	4	2.5	63.5	4
2" PVC Elbow	Codo PVC 2"	1	3	2	3	2	2	4	2	6	1	79	9.4
2" PVC Tee	Tee PVC 2"	1	1	2	3	1	1	1	2	3	1	42	15.8
2" PVC Tube (6m)	Tubo PVC 2"	210	810	820	1810	210	610	2410	220	2420	410	40.76666667	95.8
2" x 1.5" Reducer	Reductor 2" x 1.5"	1	1	2	2	1	1	1	1	2	1	26	15
1.5" PVC Tube (cm)	Tubo PVC 1.5"	320	360	330	320	470	450	660	480	1620	470	19.38333333	68
Rotoplas Tank Inlet	Roscas por Rotoplas 1.25"	2	2	3	3	2	2	3	2	10	2	69	20
1.5 Male Adaptor	Adaptor Macho 1.5"	5	5	8	6	6	6	8	8	17	6	157	5.6
Mosquito Netting	Malla	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	Bulk	0	22
2" PVC Coupling	Union Naranja 2"	0	0	0	0	0	0	4	0	1	0	10	6
1.5" Elbow	Codo PVC 1.5"	2	2	3	3	2	3	5	3	5	2	54	9
1.5" Tee	Tee PVC 1.5"	0	0	0	0	1	1	1	1	2	1	15	9.75
3" x 2" Reducer	Reductor 3" x 2"	1	0	0	0	0	0	0	0	0	0	2	30
4" x 2" Reducer	Reductor 4" x 2"	0	1	2	1	1	1	1	2	2	1	24	14
3" x 1.5" Reducer	Reductor 3" x 1.5"	1	1	2	1	1	1	1	2	2	1	15	31
4" x 1.5" Reducer	Reductor 4" x 1.5"	0	0	0	0	0	0	0	0	0	0	11	48
3" PVC Tube (cm)	Tubo PVC 3"	175	0	0	0	0	0	0	0	0	150	0.625	74
4" PVC Tube (cm)	Tubo PVC 4"	175	215	200	86	240	160	150	80	170	85	6.221666667	120
1.5" Italy Valve (metal)	Llave Paso Italy 1.5"	1	1	2	1	1	1	1	2	2	1	26	90
1.5" x 45 deg elbow	Codo PVC 1.5" 45 deg	4	4	6	5	5	6	8	7	11	5	130	12
3" union (coupling)	Union Naranja 3"	2	0	0	0	0	0	0	0	0	2	6	14
4" union (coupling)	Union Naranja 4"	0	2	4	2	2	2	2	4	4	0	46	19
Water Bottle	Botella de Agua	1	1	1	1	1	1	1	2	2	1	25	0
Stick	Palo	1	1	1	1	1	1	1	2	2	1	25	0
1.25" PVC Tube (cm)	Tubo PVC 1.25"	400	400	400	400	400	400	400	400	400	400	14	48
1.5" Female Connector	Adaptor Hembra 1.5"	0	0	0	0	1	1	1	1	2	1	17	10
1.5" union	Union Naranja 1.5"	0	0	0	0	0	0	0	0	0	0	0	5
.5" Faucet	Llave Chorro .5"	1	1	1	1	1	1	1	1	2	1	25	17
Rotoplas Tank	Tanque Rotoplas	1	1	1	1	2	2	2	2	4	2	39	2400
2 in Threaded Caps	Tapon Macho 2" con roscas	0	0	0	2	4	0	4	0	4	0	30	15
Plastic to Patch Holes	Plastico	0	0	0	1	2	0	2	0	2	0	15	0

Figure 34: Construction material parts list for each of the 22 homes planned continued with totals

6.1.1 Tools and Fasteners

Tools Needed Per Team

- 2 Wheelbarrows for mixing concrete
- 3 Shovels
- Pick Axe (for cutting rebar)
- 2 Wire Tie Pliers (pliers/wire cutters to tie rebar together)
- 2 Hand Saws (for cutting wood and PVC)
- 3 Hammers
- 2 Machetes
- 2 Line and Levels (for placement of gutters)
- 2 Concrete Spreading Tools
- 2 Tape Measures
- 1 Pair of Scissors (for cutting mosquito netting)
- 1 Chisel (to make notch in gutter clips)
- 3 Pieces of Sandpaper
- 2 55 gallon drums (for water)
- 5 Tarps

Fasteners Per Team

- 1 Container of Epoxy
- 1 Container of PVC glue
- 3 Rolls of Teflon tape
- 3 lbs. of 4 Inch Nails

There is one tool that will need to be shared among the teams:

- 2 drills and hole saws for cutting holes in the tanks to connect the bulkheads.

A consolidated list of tools is located on the following page for quick reference during implementation.

Table 1: Tools needed for implementation

Tools	Per Team	Total	Own	Needed
Wheelbarrows	2	10	4	6
Shovels	3	15	5	10
Pickaxe	1	5	0	5
Wire Tie Pliers	2	10	2	8
Hand Saws	2	10	4	6
Hammers	3	15	2	13
Machetes	2	10	**	0
Level	2	10	4	6
Line (Use with level)	2	10	0	10
Concrete Tool	2	10	7	3
Tape Measures	2	10	0	10
Scissors	1	5	0	5
Chisel	1	5	0	5
Sand Paper	3	15	2	13
55 Gallon Drums	2	10	3	7
Tarps	5	25	0	25
		** Guachtuq Owned		

Table 2: Fasteners needed for implementation

Fasteners	Per Team	Units	Total
Epoxy	1	Container	5
Nails (4 inch)	3	Pounds	15
PVC Glue	1	Container	5
Teflon Tape	3	Rolls	15

7.0 Operation and Maintenance

Each family is responsible for the operation and maintenance of their own system. Improper use or failing to maintain the rainwater harvesting systems can only hurt the responsible family's health and well-being. EWB-USA WPI believes this fact will drive the family to regularly maintain their system and be proactive in identifying areas requiring repair. Per the MOU, it is required that one member of each family be present and active during system implementation at their own home and other community member's homes. Through hands-on implementation experience, this helps to ensure each family has sufficient system working knowledge which will be critical for system maintenance.

While the rainwater harvesting systems are constructed with durable, long lasting materials, it is possible for items to break during routine use. Excluding the Rotoplas storage tanks, all of the system materials are relatively inexpensive and locally sourced. Post system implementation each family is provided a list of materials and corresponding local vendors to facilitate system repair. Stated in the MOU, the family's 5% contribution to the initial system cost is representative of typical system repair costs. The Rotoplas storage tanks are the most expensive component of the system, but under proper use they have a typical lifespan of 35 to 45 years. While the Water Committee has a limited role in maintenance and operation, they will serve as a source of general knowledge of proper system operation. The Water Committee will also host an inventory of tools, previously used during system construction, which will be able for families to borrow to make system repairs.

Ideal operation includes proper daily use of the tank water, regular use of the first flush, regular gutter cleanings, and annual chlorine shocking. Post-construction, EWB-USA WPI and each family discuss the specific operation tasks and the family is given an educational booklet, included in Appendix F: EWB-USA WPI RWH System Maintenance , which visually demonstrates expectations for a properly maintained rainwater harvesting system. Below is a list of the tasks expected of the family for proper system operation:

1. All drinking water must be boiled.
   While nearly every family in the community boils their drinking water due to societal norms, EWB-USA WPI reinforces the benefits of boiling water through discussions and visual results of water quality tests.
2. Separate containers will be used for the transport of different quality water.
   This is to help prevent cross contamination of smaller water containers. It is communicated that the tank water is the cleanest, followed by the first flush/overflow water, and then other sources like the finca. The issue of cross contamination arises if the family uses the same bucket to carry water from their storage tanks and from the finca. To help prevent this contamination, it is suggested to each family that they dedicate a new bucket to be used exclusively with their rainwater harvesting system.
3. The water from the storage tanks should be used primarily for drinking and cooking. If possible, lesser quality water from the first flush, overflow, or finca should be used for bathing and laundry.
   The systems are designed to provide each family sufficient drinking and cooking water year round. It is unlikely that during the dry season there will be excess water from the system to fulfill the family's bathing, laundry, and other water needs. The rainwater harvesting systems typically provide the best quality water

compared to other sources, and it is therefore encouraged this water be saved for drinking and cooking.

4. The first flush must be drained after every rainfall.
   The first flush collects a lot of the contaminants and debris from the beginning of each rain storm. If the first flush is not emptied between storms it cannot perform its duties and more contaminants will be introduced to the storage tanks. The families are free to use the water from the first flush for purposes other than drinking and cooking.
5. Clean the filter on the storage tank spout every two weeks.
   Each Rotoplas tank comes with a sediment filter that connects to the spout of the tank. While these filters are not a key component of the EWB-USA WPI rainwater harvesting system, most families prefer to use them on their storage tanks. If the filter is not regularly cleaned with chlorine it runs the risk of becoming a source of bacterial growth. With minimal disassembly, the filter can be taken out of the spout and disinfected with chlorine and water. These filters, while not cheap, can also be replaced at local hardware stores.
6. Chlorinate the tank when full.
   To prevent bacteria growth inside the tank, it is recommended that the families add chlorine to the tanks when full. Bacterial growth will not only contaminate the stored water, but also potentially damage the tank interior. The Rotoplas tanks are designed to be cleaned with chlorine.
7. Regularly remove debris the gutters and downspout.
   Mosquito netting is in place on the downspout to prevent large debris from emptying the tank. If large debris is left to accumulate in the gutters or downspout, this could cause another source of contamination as all the rainwater must pass over the clogged area to enter the tank. It is recommended the family visually check the gutters once a month.
8. Empty the storage tank and scrub the interior with chlorine solution at the start of each rainy season.
   Annual tank cleanings will not only promote clean drinking water, but will help prevent premature deterioration of the tank interior. Families with more than one storage tank can stagger cleanings.

8.0 Sustainability

8.1 Background

One major sustainability issue is the cost of the system. Families are responsible for paying for 5% of the system. Technical knowledge is another sustainability issue associated with the project. To sustain the systems the families need to seek technical advice and assistance if parts of the system break. The transfer of information from people who understand the technical aspects and maintenance of the system is important to sustain the project. This includes proper communication between community members, CeCEP and the EWB-USA WPI team. The staggered implementation of the systems in the community has made the later systems more sustainable, enabling the team to make design alterations to systems.

8.2 Organizational Capacity of the Community

The community of Guachtuq has a water committee, which was formed in 2013 to communicate with and advise the EWB-USA WPI team in making important decisions about the rainwater harvesting project. The Water Committee is a main internal authority on the project.

In May 2014, the Water Committee was consulted to decide the order in which houses would receive systems. The Water Committee is helping in the organization of effective construction teams for the 2015 implementation. The Water Committee will oversee that there is equal knowledge distribution amongst the teams to make the implementation teams as effective as possible.

The president of the Water Committee is Cristobal Cojoc. Roberto Chocoj is the vice president of the Water Committee and is a source of knowledge on rainwater harvesting systems in the community. He was one of the first people to receive a rainwater harvesting system and has become very knowledgeable about operation, maintenance and design of the systems. People go to Roberto when they have questions and he is able to advise and assist members of the community with their systems.

During the last implementation trip in May of 2014, the community members involved in construction organized themselves into productive and cohesive construction teams, and were able to finish the implementation significantly faster than expected. Although this was successful in the previous implementation trip, the advice and support of the Water Committee will be used for this implementation since it is a larger implementation than in the past. Knowing this, the Water Committee will insure the EWB-USA WPI team that groups will be cooperative and composed of community members with diverse skills.

Alvaro, a main contact at CeCEP checks in on the systems in the community three times per month. The community works to provide Alvaro with organized feedback, working with others to solve any problems that arise with the system before presenting them to Alvaro. Community members are aware that Alvaro and CeCEP are there for assistance but they collaborate and problem solve using their neighbors before asking for the assistance of the non-profit or Engineers Without Borders USA-WPI. This has been seen at House 9, the midwife's house of Cristobal Lem and Maria Mo. This system had a filter that was not working properly. The family first went to a neighbor, then Roberto to try to fix it. When they were unable to solve the problem they asked Alvaro who gained assistance from CeCEP and EWB-USA WPI. This situation

exemplifies the growth of the community's collaboration and understanding of how to problem solve issues regarding the systems.

This project requires at least one representative from every family who has received a system help with construction of new systems. Though it is part of the MOU, some men are unable to be present for the length of implementation. On past implementation trips, cousins and brothers have provided labor when the man of the house was unavailable. This has been a successful alternative in past trips, so the team is confident that there will be involvement and commitment to the implementation. The team will be receiving a list of names of people who will be participating in the May implementation shortly after this form is finished.

8.3 Financial Capacity of the Community

Each family signs a Memorandum of Understanding, which states that families are willing to pay 5% of the total cost of the system which is approximately 400Q, equivalent to approximately $80. This money is paid to CeCEP through a payment plan. The average daily income is $10 per person working in the home. The average household is 6.2 people and their income depends on the number of men able to work. Families receiving the systems are asked to take off work for a week to work to construct the systems with the team instead of working at their normal jobs. The men sacrifice a week of work to get these systems as they are seen as a financial investment for the families. With the system, women have more time to have jobs and children can spend their time in school getting an education, opposed to walking long distances for collecting water from the finca. The project is designed to be sustainable but inevitably, pieces of the system will break and parts will have to be replaced. This cost will be the responsibility of the individual community members to replace and maintain. At the beginning of the project the team discussed with the community what the best payment option would be and they unanimously decided that a payment plan would be the best option.

8.4 Technical Capacity of the Community

The team believes that the entire community is very familiar with the rainwater harvesting systems being implemented in the community. Over the past 2 years, families with systems have been able to maintain their systems and ask for help when necessary. The team strongly believes that given the materials and design, the community members could successfully build the design without the help of the Engineers Without Borders USA-WPI team.

One reason that the team is confident in the skills of the community is that House 27, the home of Cristobal Coy Max, was required to move their home to a different location in the community. With the help of the community, they were able to successfully relocate the family's rainwater harvesting system. The rainwater harvesting system was successfully moved without any knowledge or assistance from EWB-USA WPI. When the team returned and inspected the system it was in working condition, properly reconstructed with only one alteration needing to be made. There was a small hole that needed to be drilled in the overflow to keep it from becoming a siphon when the tank is full. The successful relocation of a family's system to a new location by members of the community without any assistance from EWB-USA WPI proved that the community members are in fact knowledgeable concerning the construction of these systems.

From the monitoring done on the January 2015 trip, travelers were able to confirm that families were doing an exemplary job maintaining the systems. The first flush had been emptied and all of the tanks had been cleaned at least once since May. The team has seen families clean and

reassemble the system. During the January 2015 assessment trip, when travelers first arrived at House 8, the house of Cristobal Cojoc, the system was disassembled and members of the family were cleaning the system. When the team returned later to House 8 the system was properly reassembled.
The community members have also been able to replace broken pieces of the system. Roberto, from House 26 noticed that mosquito nets in the gutters were broken. He replaced all of the mosquito nets and taught each family how to replace their nets and the team noted that each of the nets were replaced correctly. When community members are unable to figure out how to fix pieces of the system they ask neighbors, especially Roberto for help. When they are unable to find a solution they seek the help of Alvaro. If Alvaro is unable to find a solution he consults the EWB-USA WPI team. This was seen at house nine, where water flow did not seem right. While in country on the January 2015 assessment trip the team was able to make the filter functional again. (For more information reference section 9.2) This problem solving shows the amount the community cares about having a proper system and the knowledge that the community has was showcased by the way that they were consulted instead of going straight to asking the club.

Finally, from the beginning, the community has been deeply involved in not only the construction, but also the design of the systems. The design for the wooden gutter clips still used for systems in the community was created by Cristobal Cojoc, the current president of the water committee and a pilot system participant. When the club was building the system at his home, they left one evening, planning on designing gutter clips the next day, possibly buying

8.5 Education

In order to sustain the project, knowledge transfer through education and reminders to the community about the maintenance of the systems is important. The systems that are being implemented are different than what the community is used to. There is a fundamental difference in how projects are being conducted compared to projects in the past. Some members of the community still view this project as a tank project, not a system project. The team would like to work to improve the notion of why families are receiving what they are receiving and working on changing the tank mentality. Some people have rejected the project because they are not receiving a tank because they have preexisting tanks. However, most existing tanks are connected to dilapidated “systems’ that show little planning and are in disrepair. An important concept is that every part of the system must be maintained and cleaned regularly.

The team will hold learning sessions with members of the community who have rainwater harvesting systems. These sessions will focus on 3 major topics: water quality management, system maintenance and system design. The water quality management will reinforce the concept of separating containers so the water coming from the system is not being cross contaminated with containers still being used at the finca. Community members will be encouraged to continue to boil their water. Water testing will also be discussed. In regards to system maintenance the team will discuss cleaning the system including the tank and gutters. They will explain how the first flush is maintained and the importance of emptying it after each rainfall. The team will also address tank repairs. Finally, the team will discuss the system design with the community. The team will review the implementation plans. The team will explain the rationale behind the tank placement and the base sizes. The gutter clip, designed by a community member, will be explained. In addition the first flush design will be explained as the team feels this is the most complex component of the design.

In addition to learning sessions, the team will hold discussions with each family after the systems are complete. These will reinforce the concepts of maintaining and cleaning the systems. Booklets similar to the booklets handed out on past trips will be distributed. See Appendix F: EWB-USA WPI RWH System Maintenance Manual. These booklets will use pictures and simple text to describe the maintenance of the systems. Booklets will be handed out in plastic bags to prevent water damage.

9.0 System Monitoring Activities

Water quantity and quality are both important factors of water security. Ideally, water collected by the rainwater harvesting systems will be ready to drink and of higher quality than water from the finca. To analyze the water quality, EWB-USA WPI monitors the implemented systems in addition to running bacterial and E. coli tests. Colilert coliform tests are used since they are simple field tests that yield reliable, quantifiable results.

9.1 Monitoring of Implemented Systems

To check that families are taking care of their systems, EWB-USA WPI observes the condition of different parts of the system. Gutters, tanks, the first flush, and filters are all checked to ensure they are being cleaned. Results from this portion of the monitoring on the January 2015 trip showed that all of the gutters and first flushes were being regularly cleaned, the majority of tanks were being cleaned (only 5 tanks had a small presence of dirt collected in the bottom), and half of the filters were clean. EWB-USA WPI members also talked to the families about their tanks and education booklets, results from these discussions can be seen in Appendix D: Monitoring Information from January 2015.

9.2 Water Quality Tests

Continuous monitoring of water quality is essential to gauging the potability of water from the various sources accessible to the community and improving system design as necessary. Based on previous water quality tests conducted on EWB-USA WPI trips, bacteria presence is of primary concern. During this implementation trip, the team will continue using the Colilert Protocol tube tests and Petrifilm Protocol tests as used during the January/May 2014 and January 2015 trips. The Colilert test indicates the presence of bacteria based on color change and presence of E. coli based on fluorescence under a black light. These 10 mL test tubes are supplied with a chemical powder that enables bacterial growth. The Petrifilm test indicates presence of bacteria colonies (red) and the presence of E. coli (blue). The Petrifilm tests hold 1 mL of water on a flat, circular test paper that has a small amount of agar. Both tests can be incubated through body heat for 22 hours. EWB-USA WPI made special shirts to facilitate one person wearing upwards of 20 test samples on their midsection without interruption of regular body movement.

The results of the tests from previous EWB-USA WPI trips can be seen in Appendix G: January 2015 Water Quality Data.

On this trip, the team will be conducting water quality tests at each of the 12 systems implemented by EWB-USA WPI, the finca, and 5 other homes in the community that had existing systems before the EWB-USA WPI rainwater harvesting program. Within these 5 homes, 2 will be at concrete tanks, and the other 3 will be at existing government tank systems. At each of these systems, the tank will be tested, along with the first flush if it is a government tank system. Three trials will be performed at each source, with one trial being both a colilert test and a petrifilm test. All three trials may use one “Whirl-pak” bag of sample water. The spreadsheet detailing test locations is in Appendix I: Water Quality (WQ) Planned Testing Locations.

The specific Procedures for each for the Colilert and Petrifilm protocols are as follows:

Colilert Protocol

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

1. Collect water samples in special plastic bags, “Whirl-paks”
2. Mark the test tube cap and body with location, sample number, date, and initials
3. Invert the “Whirl-paks” to homogenize the sample
4. Insert a new plastic dropper into the “Whirl-pak” water sample, so liquid will be collected in the dropper (do not touch the dropper tip)
5. Each tube will be filled to ~10mL
6. Tightly recap and invert until chemicals dissolve
7. Incubate for 21-22 hours at body temperature (tests can be placed close to the body as seen in Figure 30)
8. Check test color (yellow means coliform bacteria is present)
9. Shine a black light on the tubes in the dark (fluorescing means E. coli is present)
10. Take pictures of test results

Figure 35: An EWB-USA WPI student member is shown wearing the Colilert tests for incubation.

Petrifilm Protocol

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

1. Remove test from bag (do not touch the layer between film)
2. Mark the test on the white layer with location, sample number, date, and initials
3. Insert a new plastic dropper into the “Whirl-pak” water sample, so liquid will be collected in the dropper (do not touch the dropper tip)
4. Lift the top white flap of the Petrifilm to expose the red circular region
5. Dispense 1mL of liquid onto the center of the red region
6. Manually remove any bubbles that may have formed using the dropper
7. Set the white flap back down (sample will start to spread and fill the red region; additionally use the spreader if necessary)
8. Allow the Petrifilm to sit for 1 minute so the sample solidifies into a gel
9. 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
10. Incubate for 21-22 hours at body temperature. The test method used (developed by Prof. Robert Metcalf) can be incubated in a pouch using a person’s body heat, as seen in Figure 35: An EWB-USA WPI student member is shown wearing the Colilert tests for incubation. This eliminates the need for procuring an incubator.

11. Remove Petrifilm from cardboard
12. Count colony formation (blue colonies with gas bubbles are E. coli and red colonies are bacteria)
13. Record results in spreadsheet and take pictures

9.2.1 Test Result Analysis

All of the test results will be compiled to categorize the level of safety observed in each trial. This way, it will be clear how many trials were collected before indicating varying levels of safety at each source. The table below details the way the Colilert and Petrifilm test results should be interpreted to lead to this compilation.

Risk Level	E. Coli/sample	Colilert Fluourescence	Petrifilm # Blue&gas
Low	<1/10 ml	-	0
Moderate	1-10/10 ml	+	0
High	1-10/ml	+	1-10
Very High	>10/ml	+	>10

The data from Appendix G: January 2015 Water Quality Data was used to assess the risk associated with water from different locations using Health Organization's Guidelines for Drinking Water Quality. After applying these metrics EWB-USA WPI was able to conclude that 84% of the implemented tanks were low risk and the remaining 16% of tanks were medium risk compared to water from the finca that was 67% high risk and 33% medium risk. Figure H shows the risks associated with water samples from different locations.

Figure 36: This shows the process for collecting water for both kinds of tests in "Whirl-pak" bags.

Figure 37: Demonstration of using pipettes to transfer 10 mL of sample from the "Whirl-pak" bag to the Colilert test tubes. The same method is used for the 1 mL Petrifilm sample.

Figure 38: Incubated Colilert tests indicating presence or absence of bacteria.

Figure 39: Shows how some samples fluoresce (indicating presence of E. coli) and others do not. Starting at the left, the 3rd, 4th, 6th, and 7th tubes fluoresce.

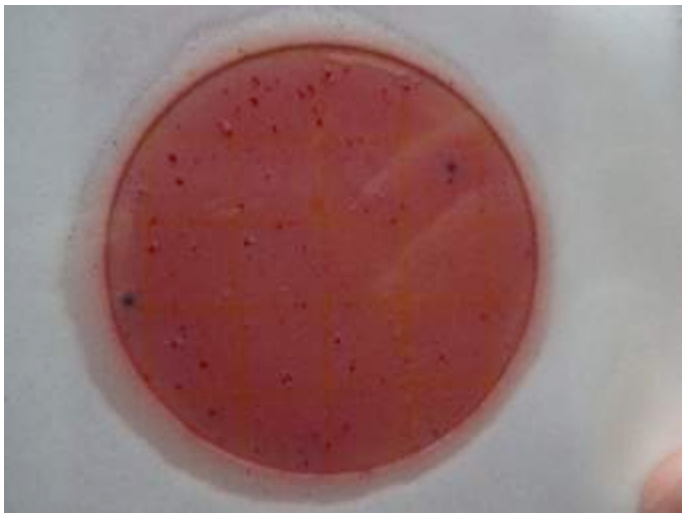


Figure 40: Sample of the results of a Petrifilm test after 24 hours of incubation. The blue dots indicate E. coli presence while the smaller red dots indicate other bacteria.

10.0 Professional Mentor Assessment

10.1 Professional Mentor Name and Role

Rodney Rookey
Responsible Engineer In Charge (REIC)
Traveling Professional Mentor

10.2 Professional Mentor Assessment

The students have done a tremendous job getting ready for this implementation trip. Each home implementation was thought out in detail to the point where we are comfortable ordering building materials before we go so they are waiting for us when we get on location. This trip is the culmination of every assessment and implementation trip that came before it. The reason we did previous implementations on a smaller scale was to work out all the bugs in our construction approach and process. With this trip we are now confident we can quickly and efficiently install all of the systems you read about in this report.

All of the students contributed equally to the writing and assembly of this report. Over the past few years I have seen this chapter grow into an extremely efficient group for managing all the technical aspects of this project, as well as understanding the importance of risk assessment and finding the right experts to work with. They have leveraged professionals in the community and professors at WPI to put together a true team of mentors to review the technical aspects of this report, every technical aspect has been vetted by at least one professional besides myself.

I look forward to the next few months of working with these students to continue practicing how to work with the building materials, water test procedures and logistics of this implementation trip.

10.3 Professional Mentor Affirmation

I have helped the students put this plan together and I am confident that it will be executed properly.

Appendices

1.0 Appendix A: Community Map

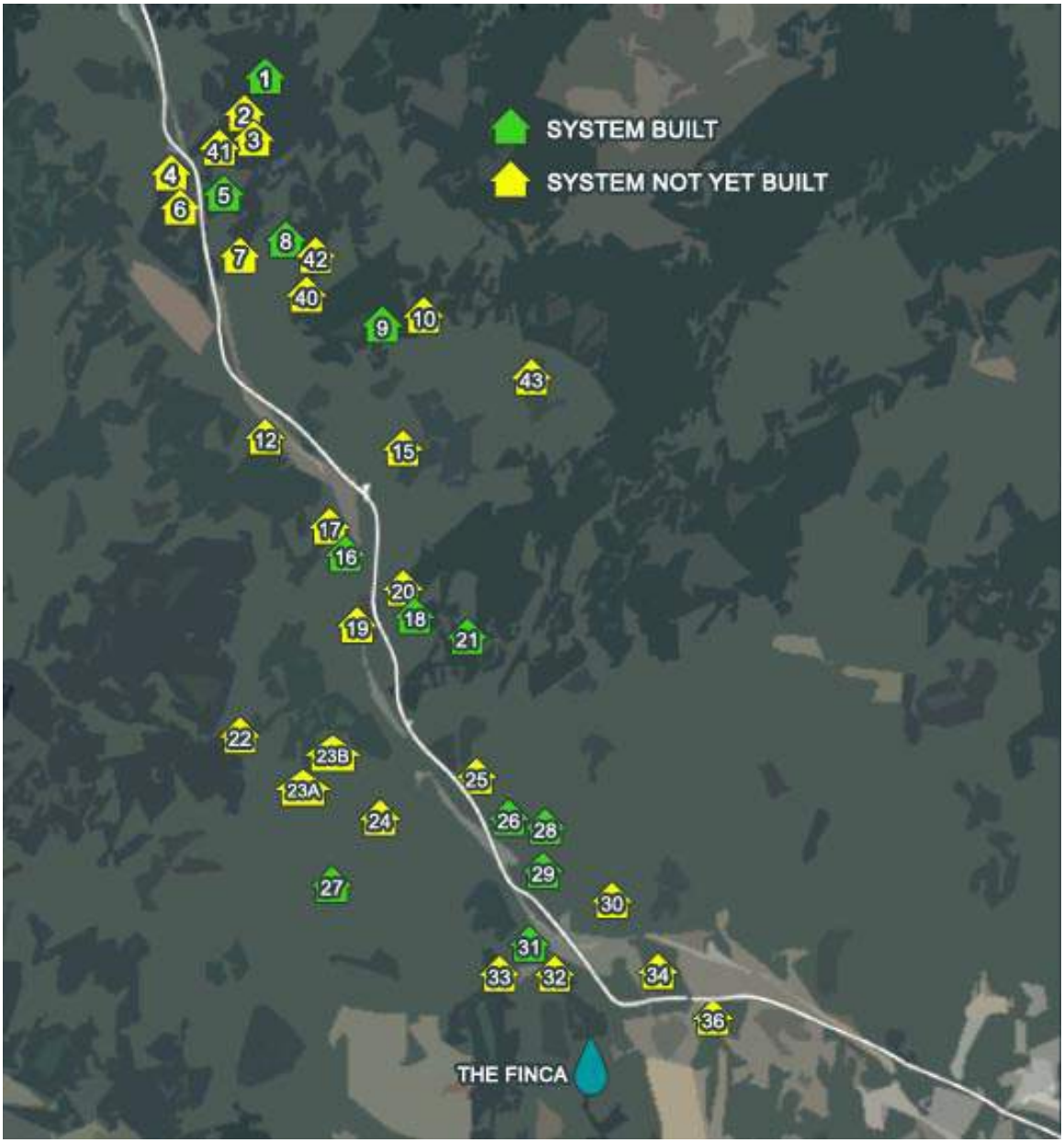
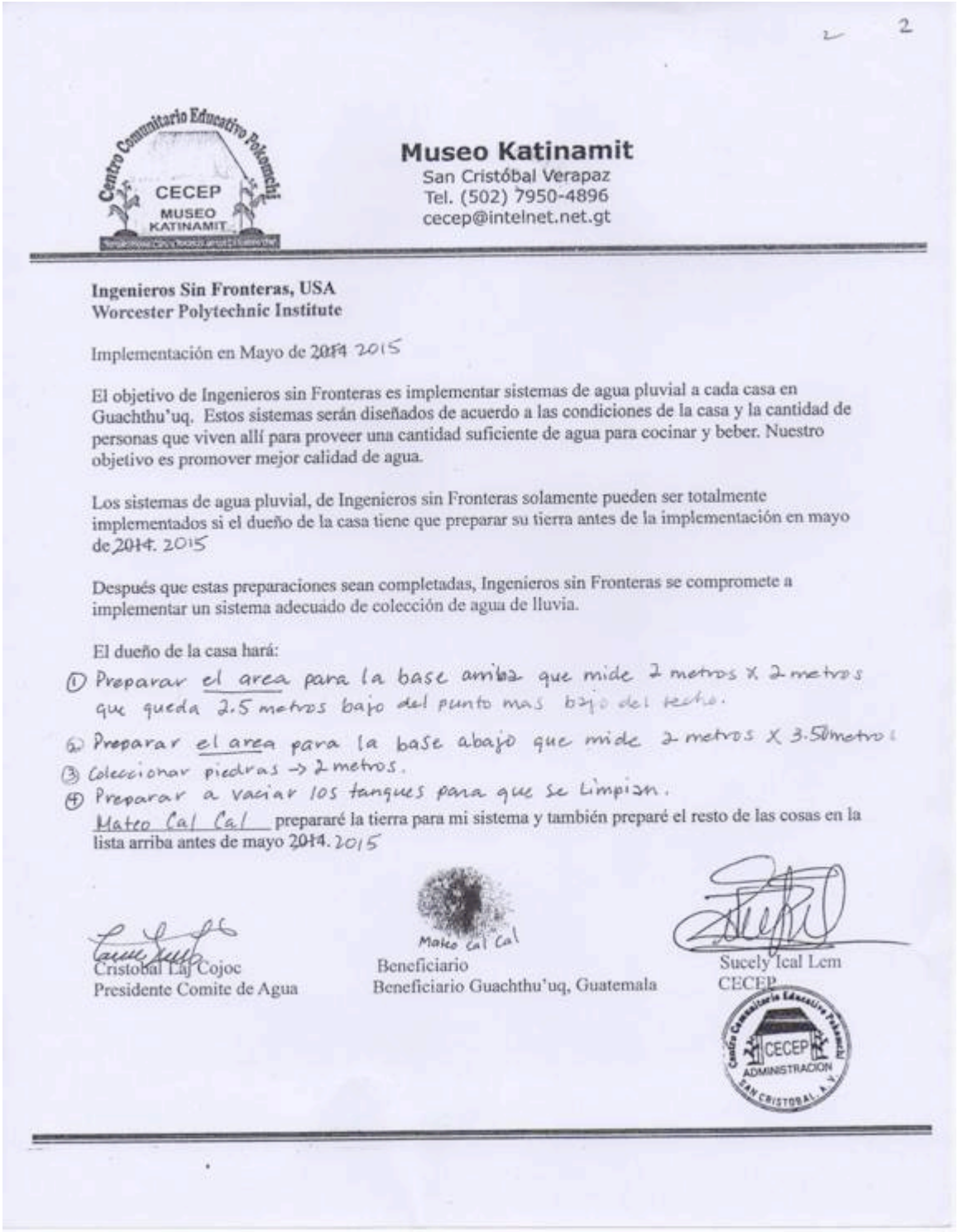


Figure 41: Community Map

This is a map showing the layout of the community in Guachtuq. Each green house is a house that has been implemented on by EWB-USA WPI and each yellow home represents a home that has not been implemented on by EWB-USA WPI. At the bottom of the community, their current main source of water, the finca, is marked with a blue water drop.

2.0 Appendix B: Signed MOUs for May 2015 Beneficiary Families:



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

① Preparar el area para la base arriba que mide 2 metros X 2 metros que queda 2.5 metros bajo del punto mas bajo del techo.
② Preparar el area para la base abajo que mide 2 metros X 3.5 metros
③ Coleccionar piedras -> 2 metros.
④ Preparar a vaciar los tanques para que se limpian.

Mateo Cal Cal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

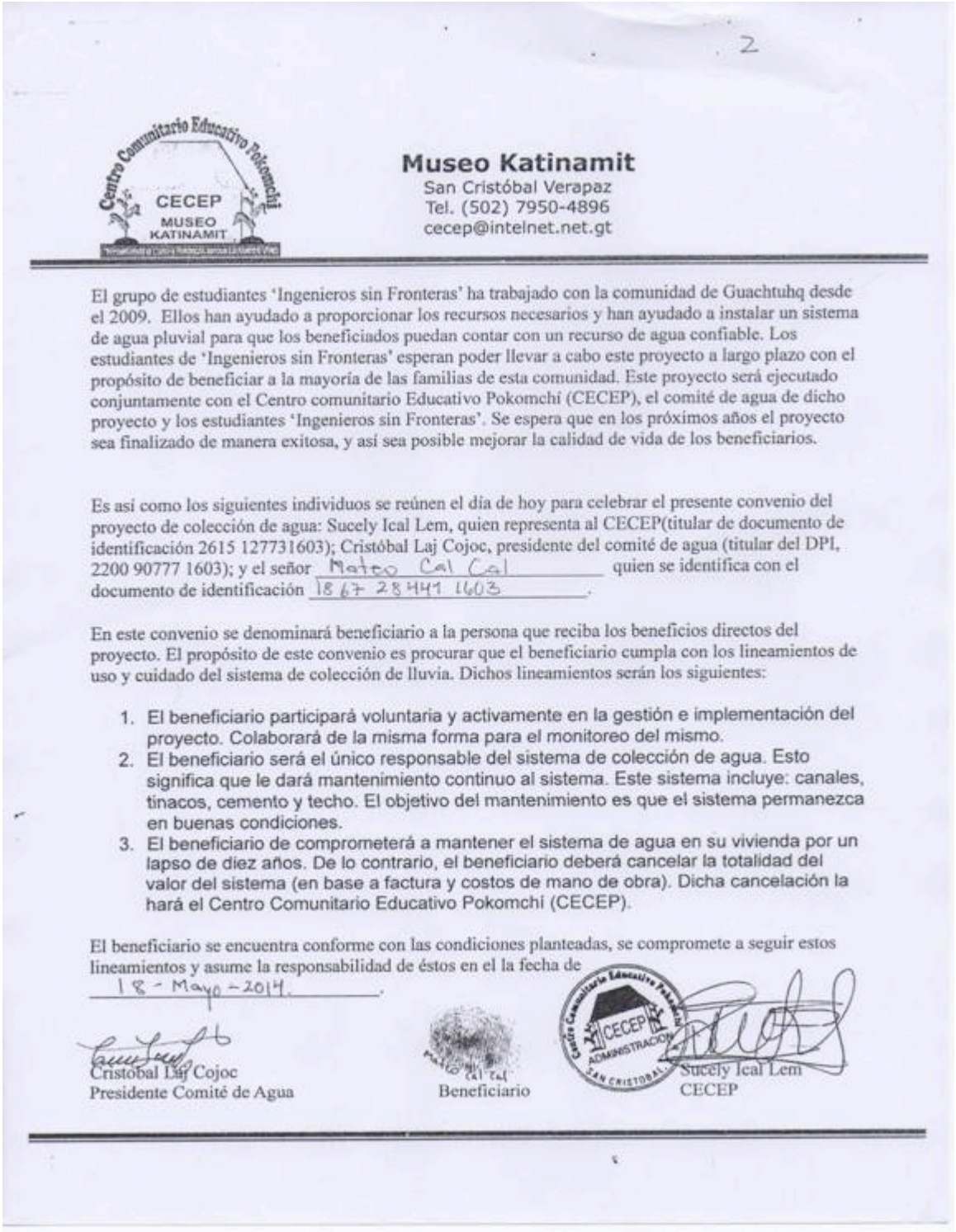
Cristobal Laj Cojoc
Presidente Comite de Agua

Mateo Cal Cal
Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A. V.

Figure 42: House 2 of Mateo Cal Cal Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Mateo Cal Cal quien se identifica con el documento de identificación 1867 28441 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

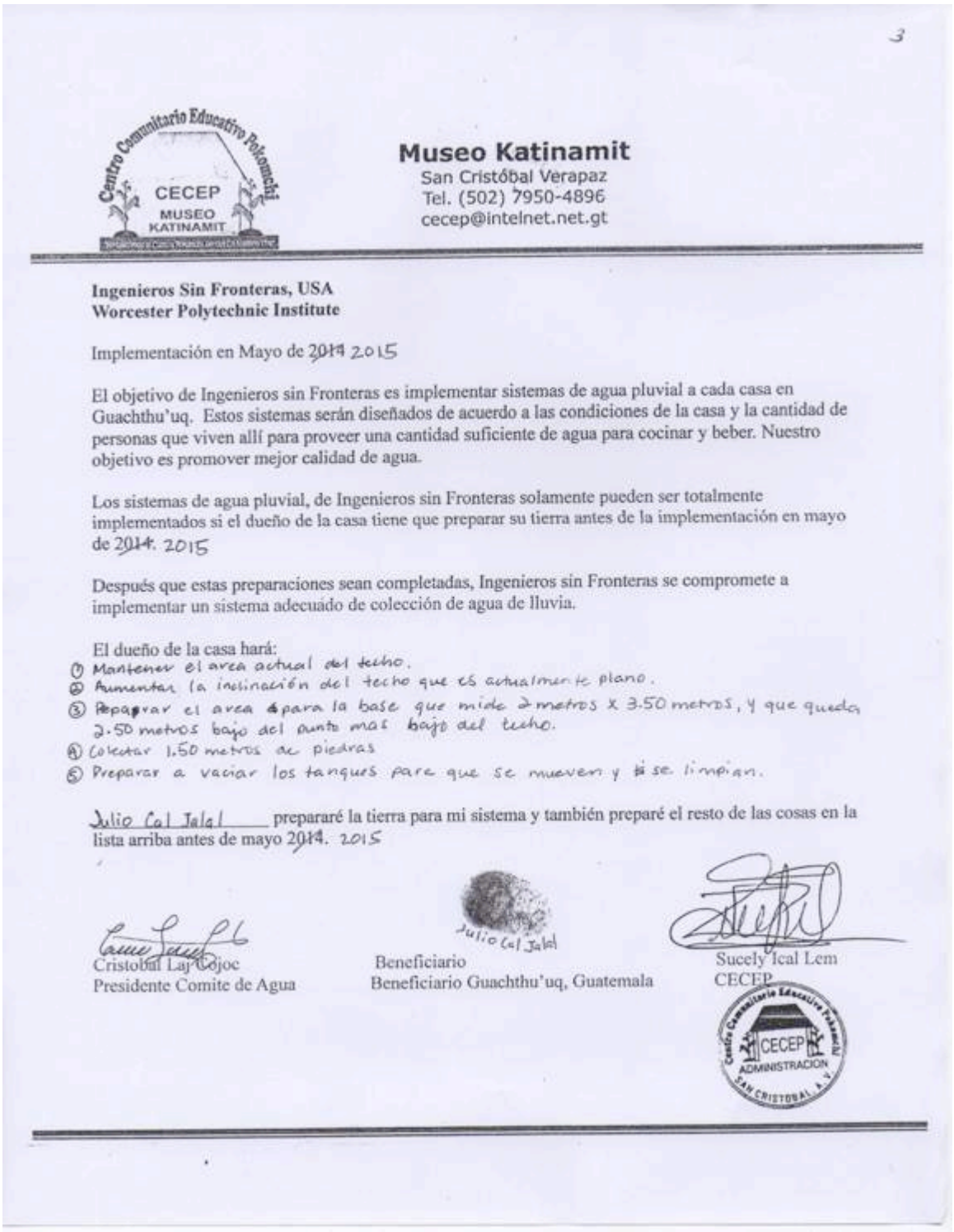
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 - Mayo - 2014.

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 43: House 2 of Mateo Cal Cal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
① Mantener el area actual del techo.
② Aumentar la inclinación del techo que es actualmente plano.
③ Preparar el area para la base que mide 2 metros x 3.50 metros, y que queda 2.50 metros bajo del punto mas bajo del techo.
④ Colectar 1.50 metros de piedras
⑤ Preparar a vaciar los tanques para que se muevan y se limpian.

Julio Cal Jalal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

Julio Cal Jalal

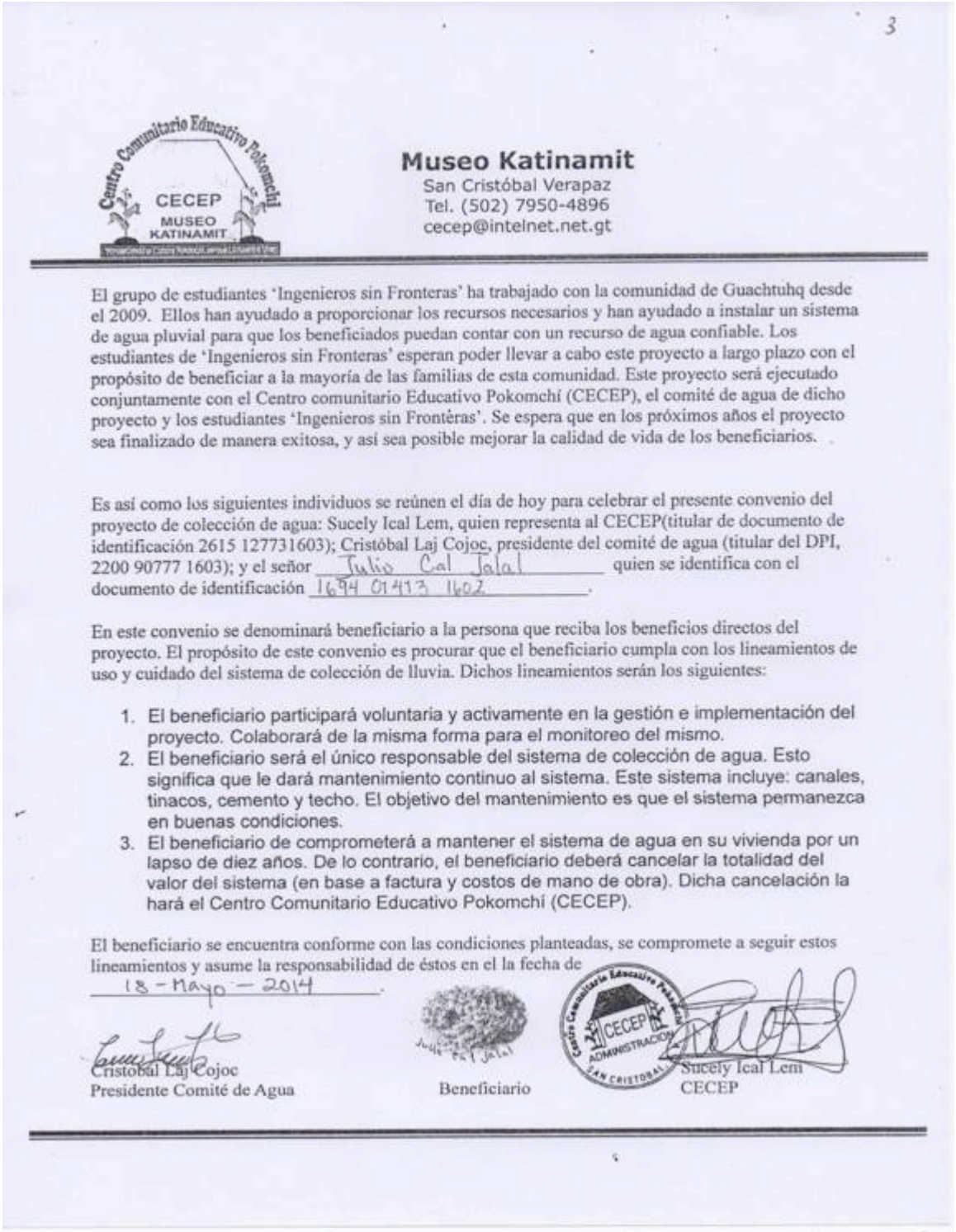
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL V. V.

Figure 44: House 3 of Julio Cal Jalal Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Julio Cal Jalal quien se identifica con el documento de identificación 1694 01413 1602.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

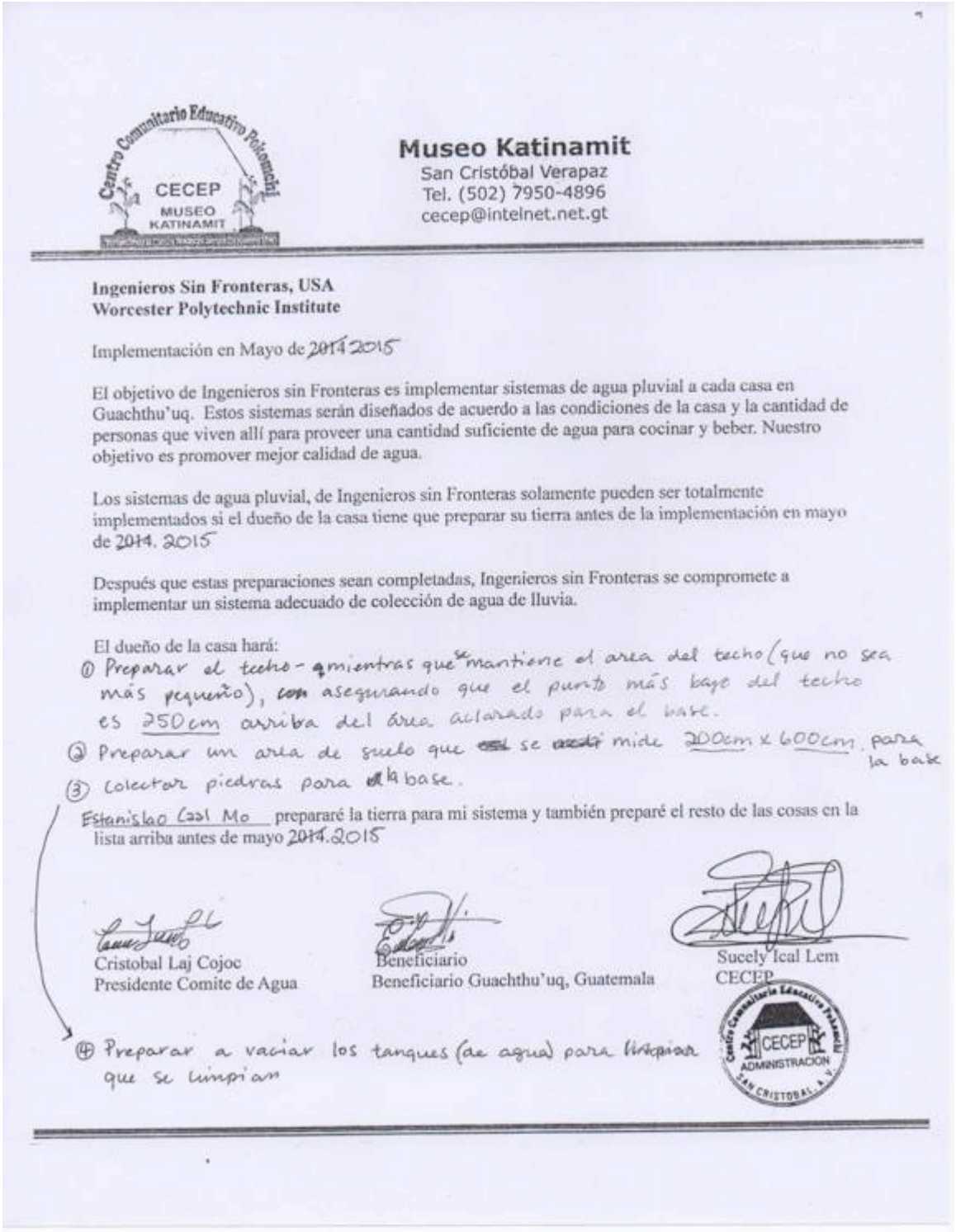
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 - Mayo - 2014.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 45: House 3 of Julio Cal Jalal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

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Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

① Preparar el techo - mientras que se mantiene el area del techo (que no sea más pequeño), asegurando que el punto más bajo del techo es 250cm arriba del área aclarado para el base.

② Preparar un area de suelo que ~~es~~ se ~~ocupa~~ mide 200cm x 600cm para la base

③ Colectar piedras para ~~el~~ la base.

Estanislao Caal Mo prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~.2015

Cristobal Laj Cojoc
Presidente Comite de Agua

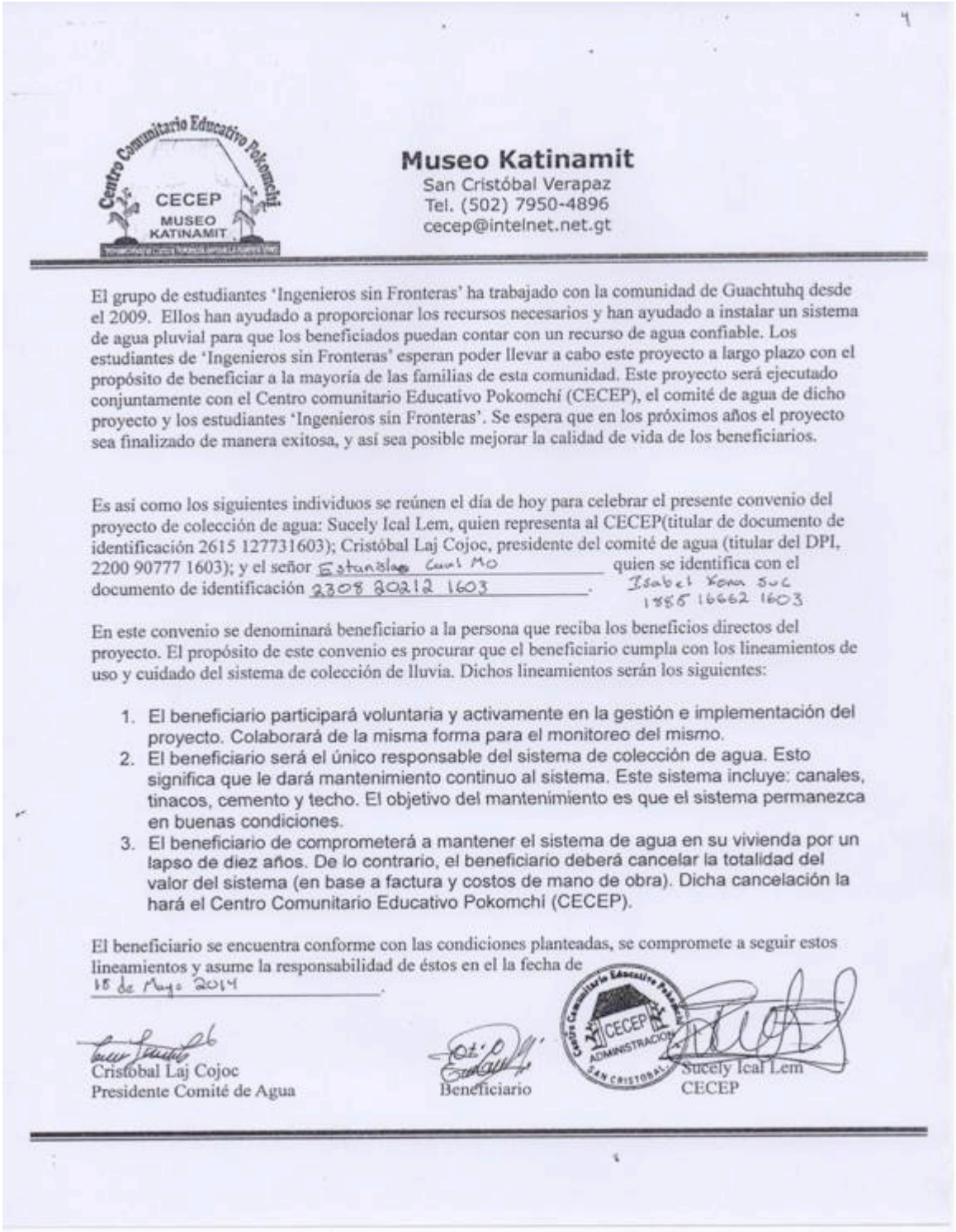
Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

④ Preparar a vaciar los tanques (de agua) para limpiar que se limpian

CECEP ADMINISTRACION SAN CRISTOBAL, A.V.

Figure 46: House 4 of Estanislo Caal Mo Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Estanislao Caal Mo quien se identifica con el documento de identificación 2308 80212 1603. Isabel Xoca Suc 1856 16662 1603

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

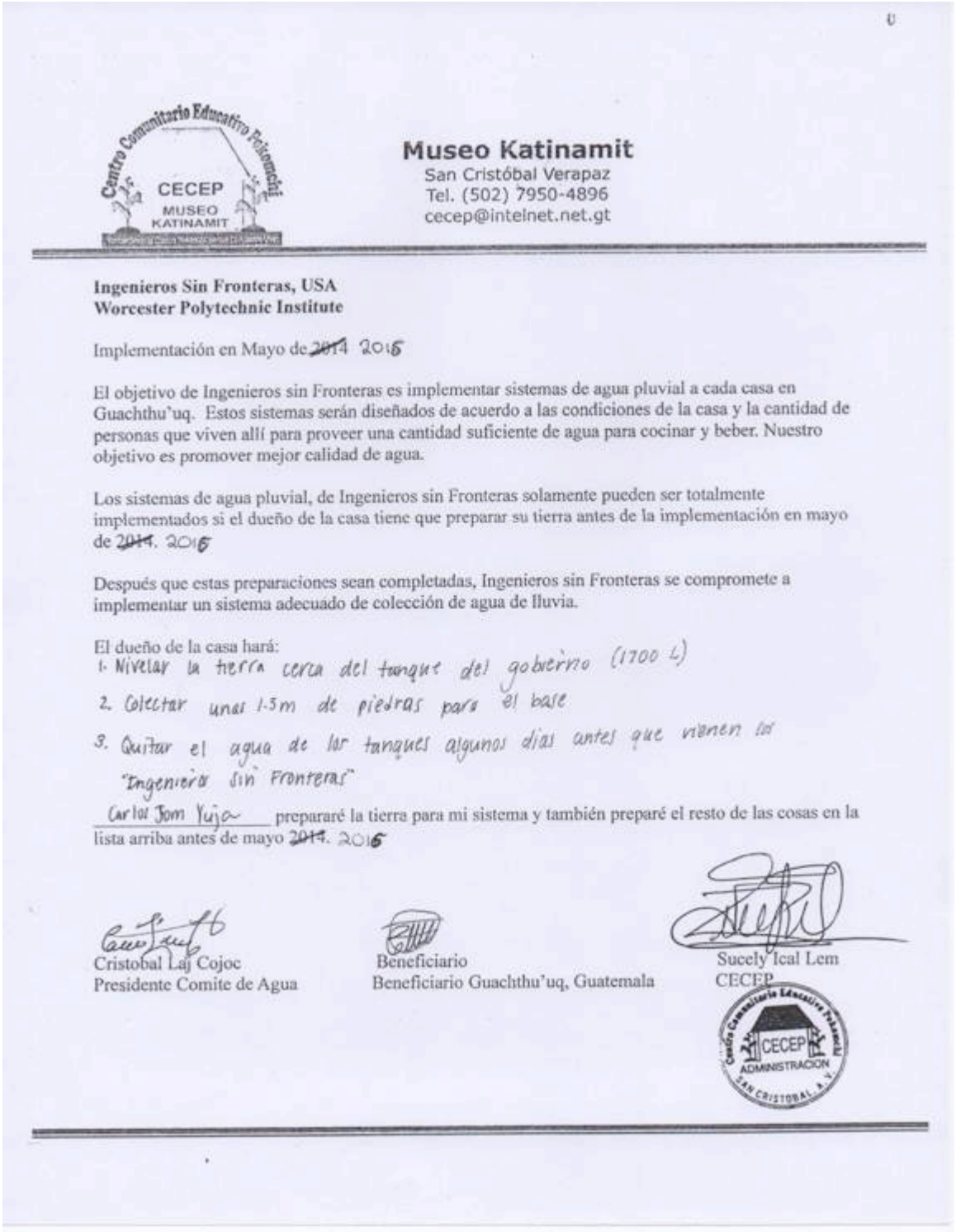
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 15 de Mayo 2014.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 47: House 4 of Estanislo Caal Mo Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

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Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
1. Nivelar la tierra cerca del tanque del gobierno (1700 L)
2. Colectar unas 1-3m de piedras para el base
3. Quitar el agua de los tanques algunos días antes que vienen los "Ingenieros sin Fronteras"

Carlos Jom Yuja prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

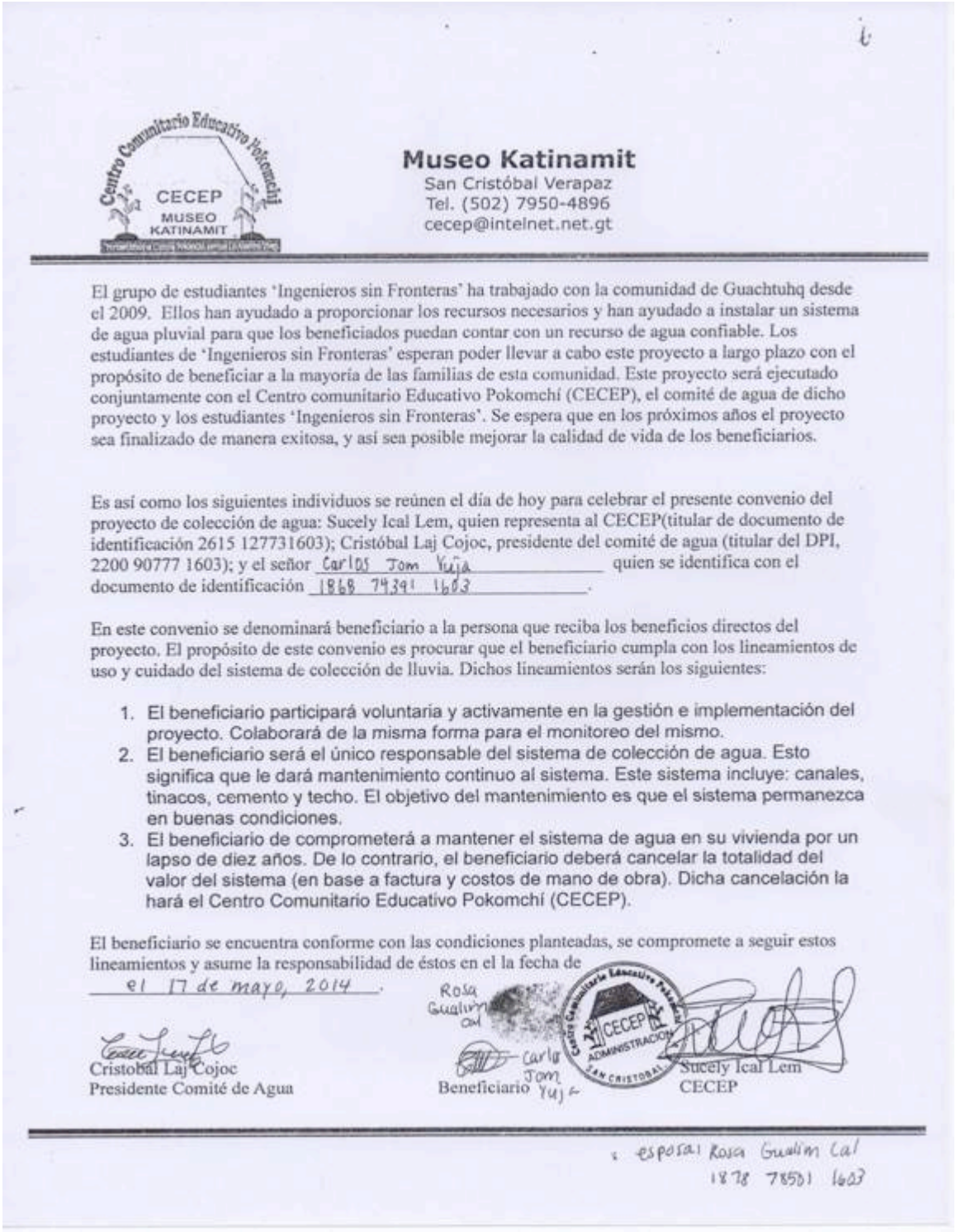
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION

Figure 48: House 6 of Carlos Jom Yuja Home Preparation MOU



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San Cristóbal Verapaz
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cecep@intelnet.net.gt

El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Carlos Jom Yuja quien se identifica con el documento de identificación 1868 79391 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de el 17 de mayo, 2014.

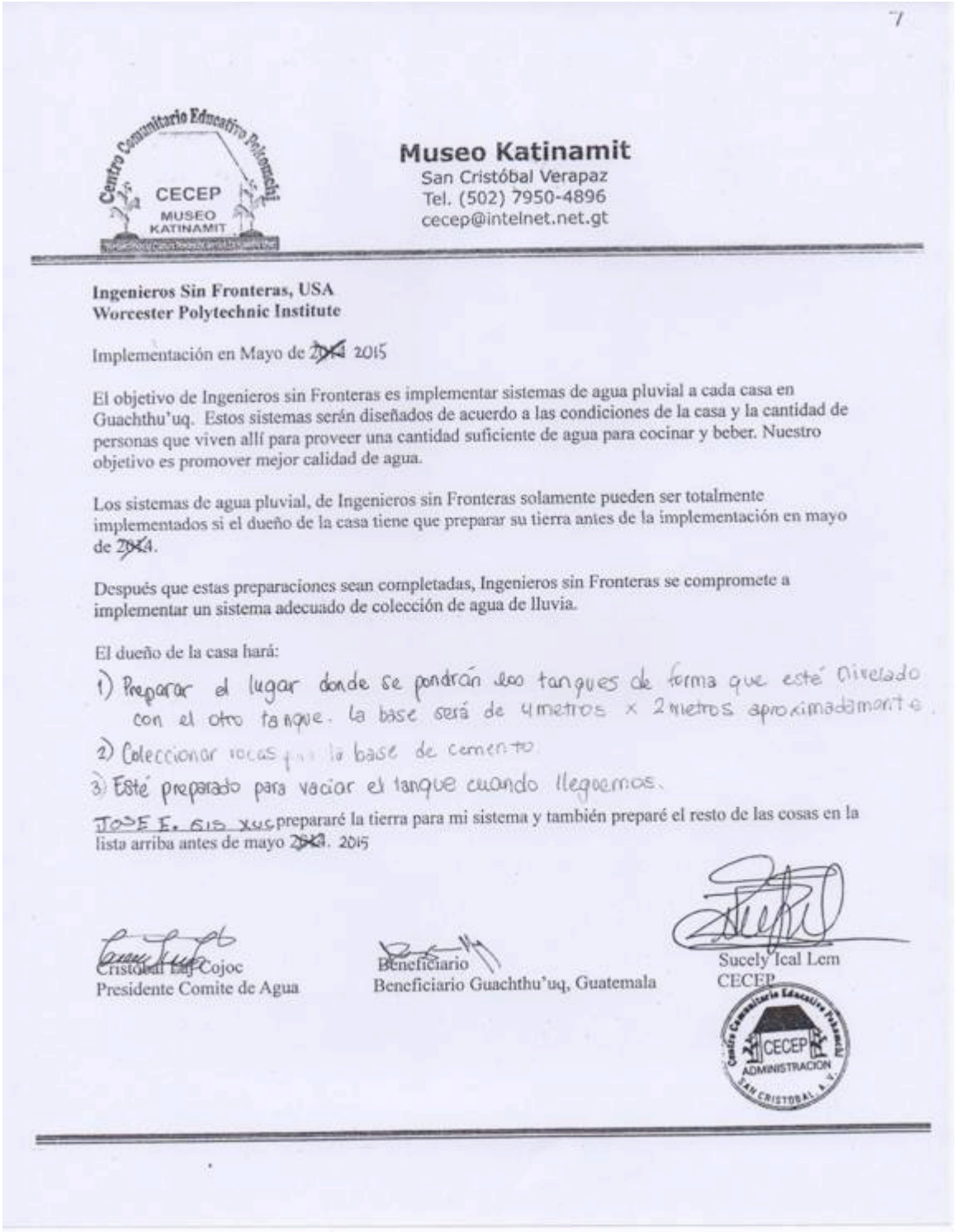
Cristobal Laj Cojoc
Presidente Comité de Agua

Carlos Jom Yuja
Beneficiario

Sucely Ical Lem
CECEP

esposa: Rosa Gualim Cal
1878 78501 1603

Figure 49: House 6 of Carlos Jom Yuja Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1) Preparar el lugar donde se pondrán los tanques de forma que esté Nivelado con el otro tanque. La base será de 4metros x 2metros aproximadamente.
2) Coleccionar rocas para la base de cemento
3) Esté preparado para vaciar el tanque cuando llegemos.

JOSE E. SIS XUC prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

Cristóbal Ical Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
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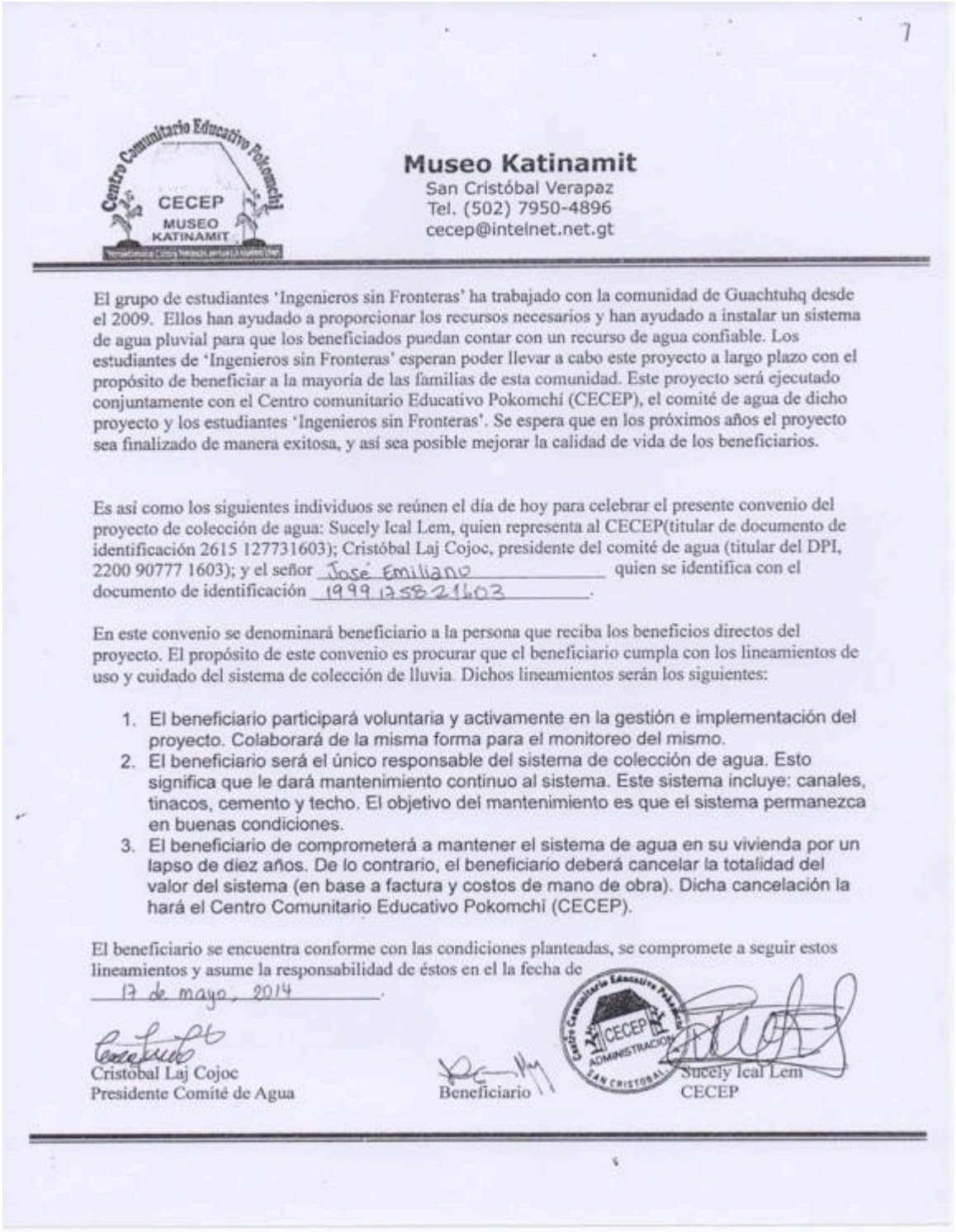
CECEP ADMINISTRACION SAN CRISTOBAL

Figure 50: House 7 of Jose Sis Xuc Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor José Emiliano quien se identifica con el documento de identificación 1999 12582 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 17 de mayo, 2014.

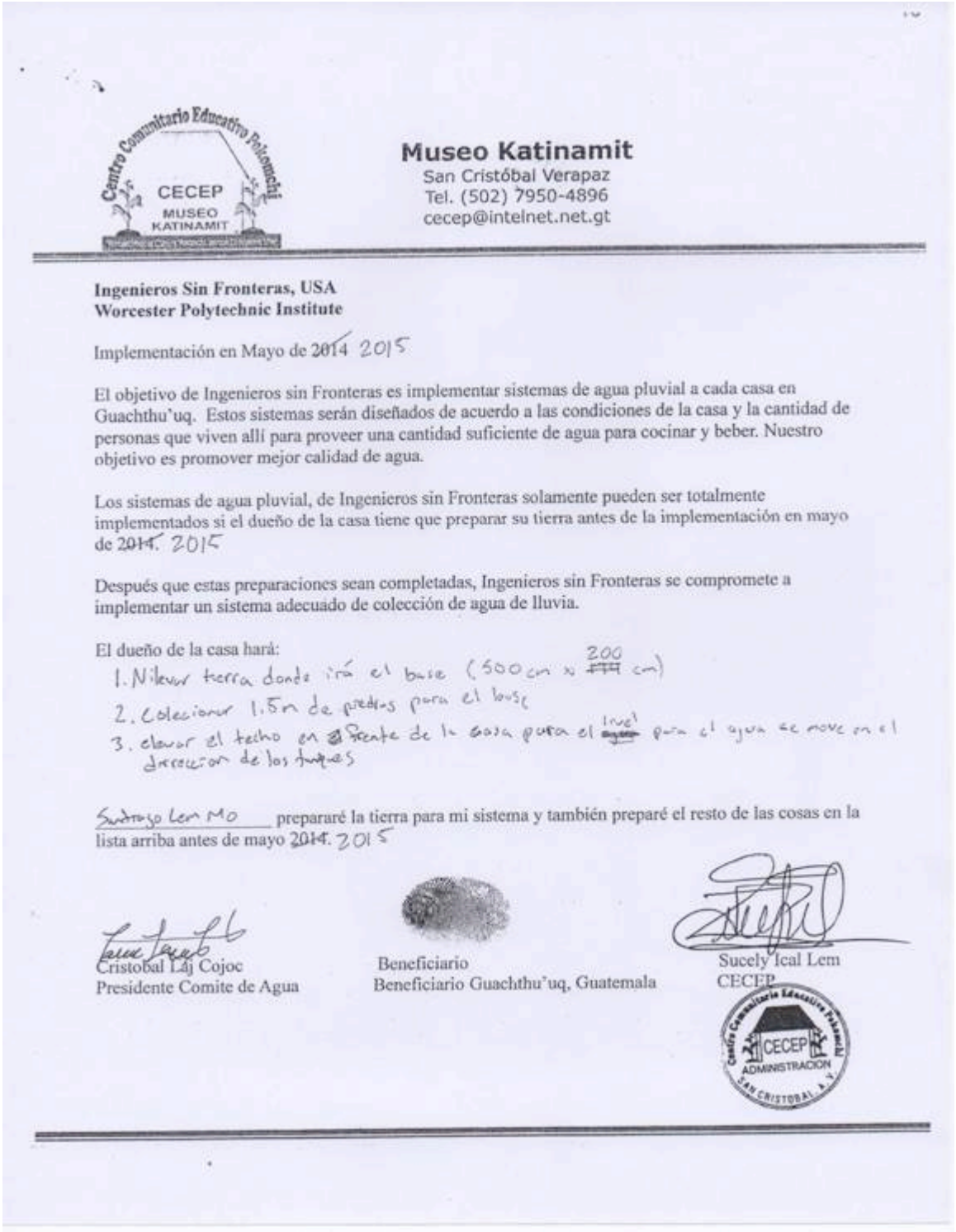
Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 51: House 7 of Jose Sis Xuc Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014.~~ 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Nivelar tierra donde irá el base (500 cm x ~~444~~ 200 cm)
2. Colecionar 1.5m de piedras para el base
3. elevar el techo en frente de la casa para el nivel para el agua se mueve en el direccion de los tuques

Santiago Lem Mo prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014.~~ 2015

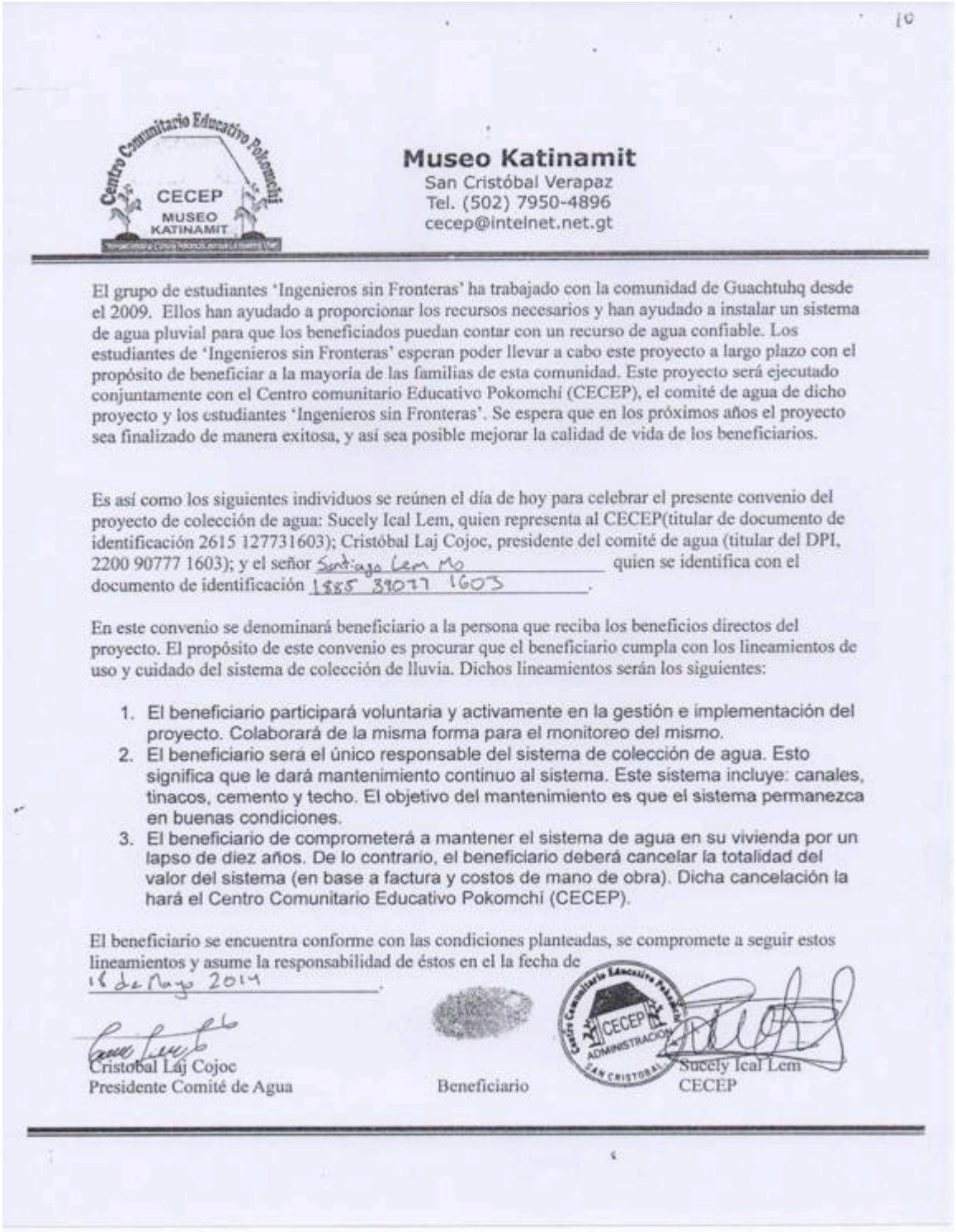
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A. V.

Figure 52: House 10 of Santiago Lem Mo Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Santiago Lem Mo quien se identifica con el documento de identificación 1885 39077 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 16 de Mayo 2014.

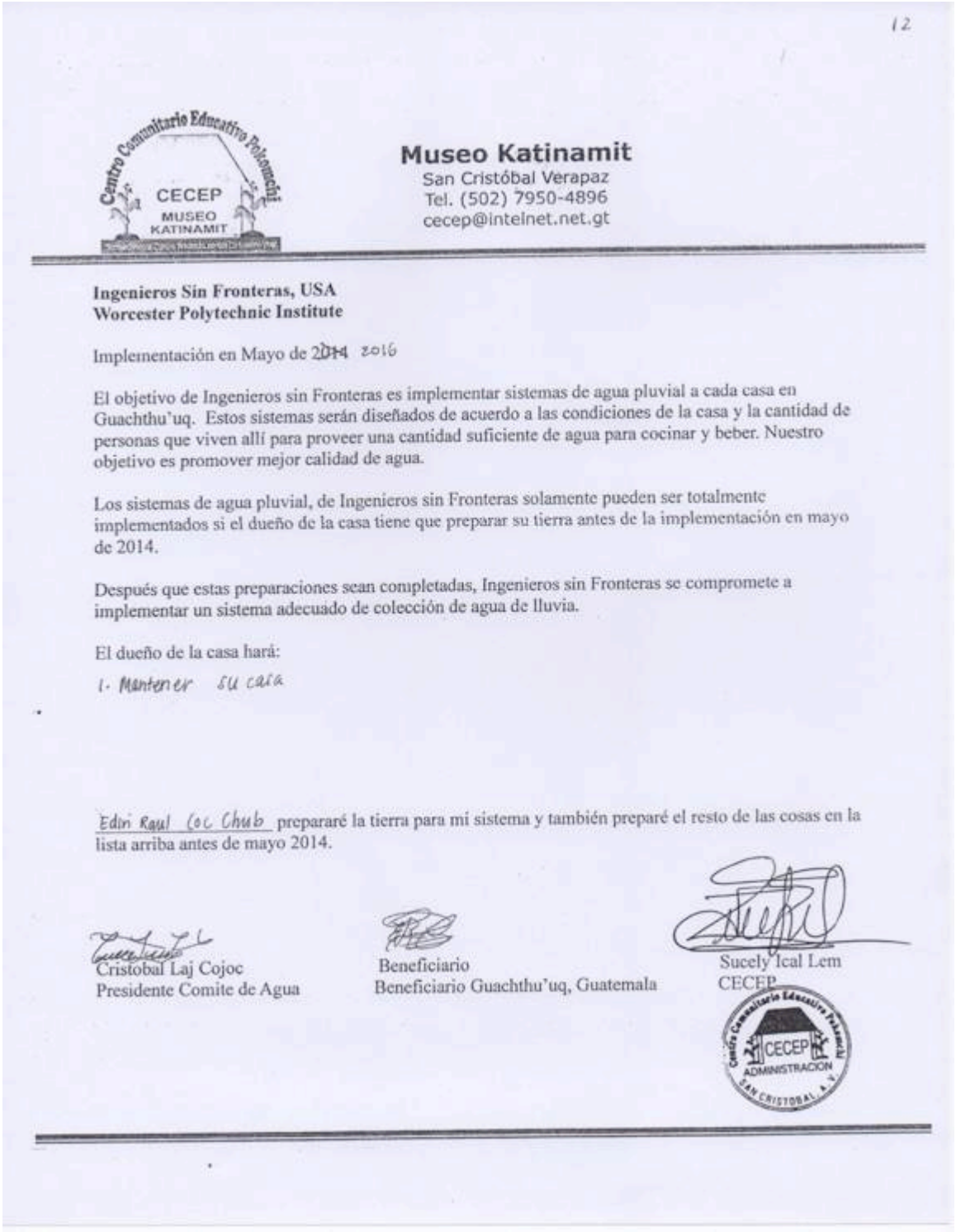
Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 53: House 10 of Santiago Lem Mo Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

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Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2014.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Mantener su casa

Edin Raul Coc Chub prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2014.

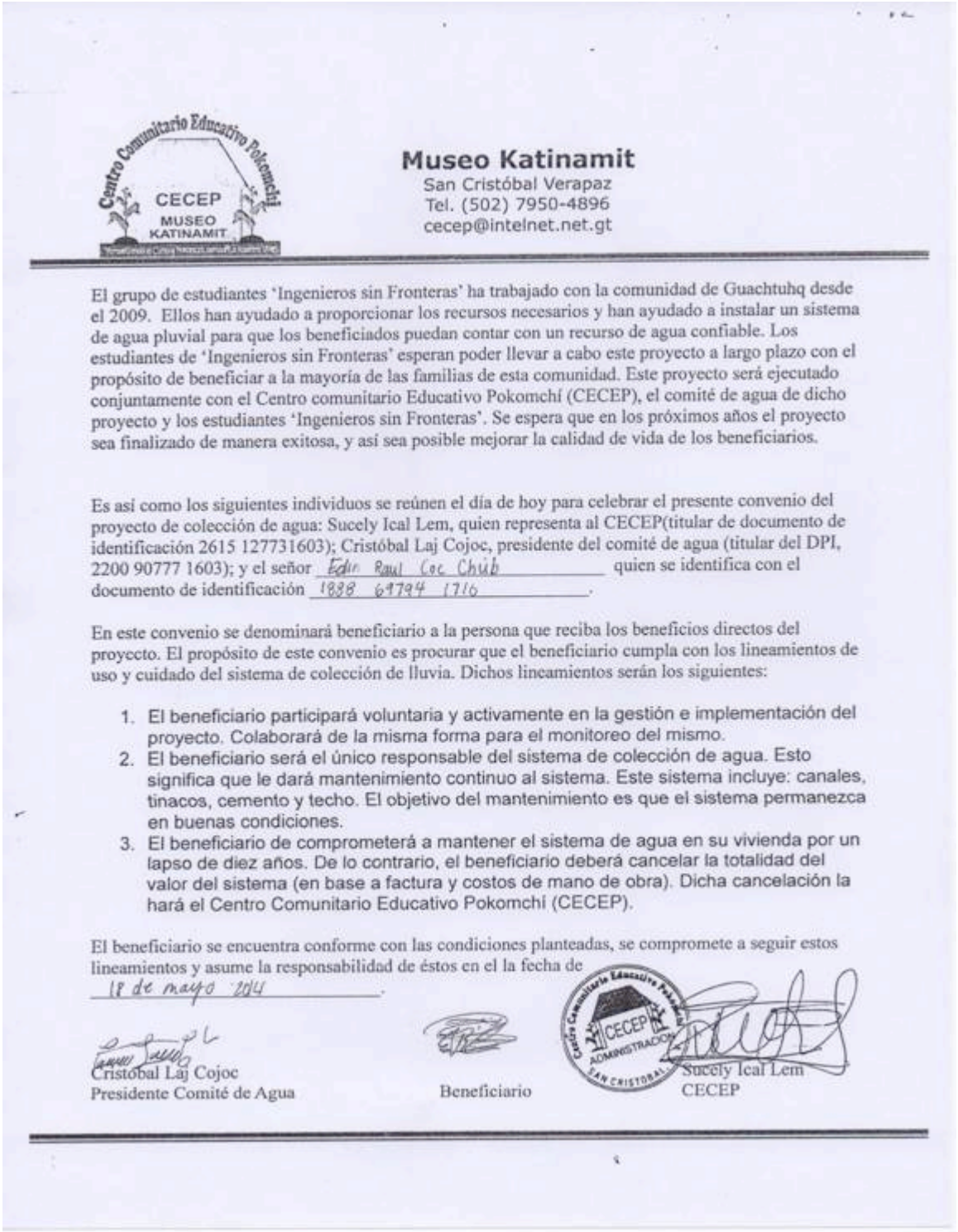
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL

Figure 54: House 12 of Edin Raul Coc Chub Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Edin Raul Coc Chub quien se identifica con el documento de identificación 1838 64794 1710.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 de mayo 2014.

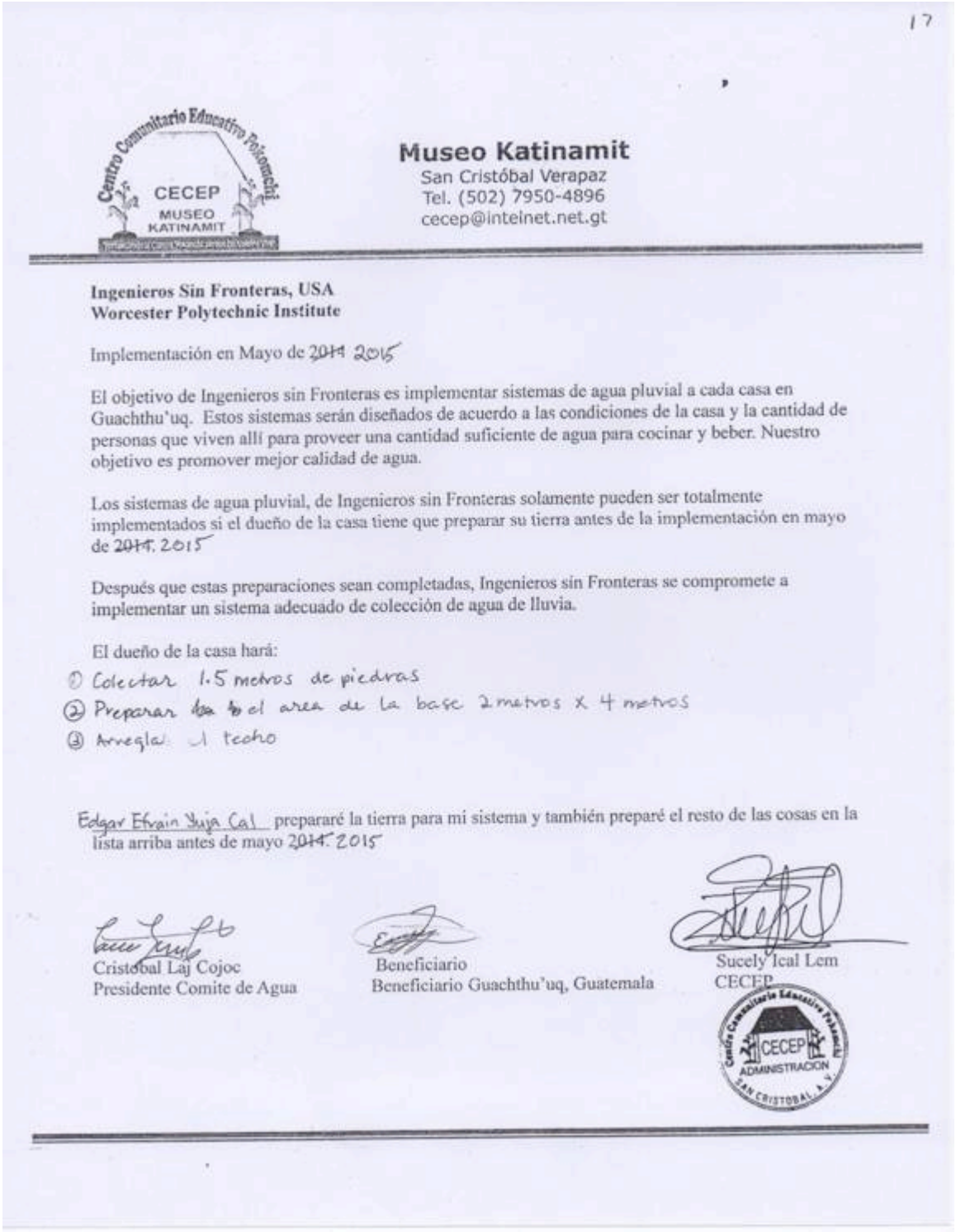
Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 55: House 12 of Edin Raul Coc Chub Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

① Colectar 1.5 metros de piedras
② Preparar ~~la~~ el area de la base 2 metros x 4 metros
③ Arreglar el techo

Edgar Efrain Yuja Cal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

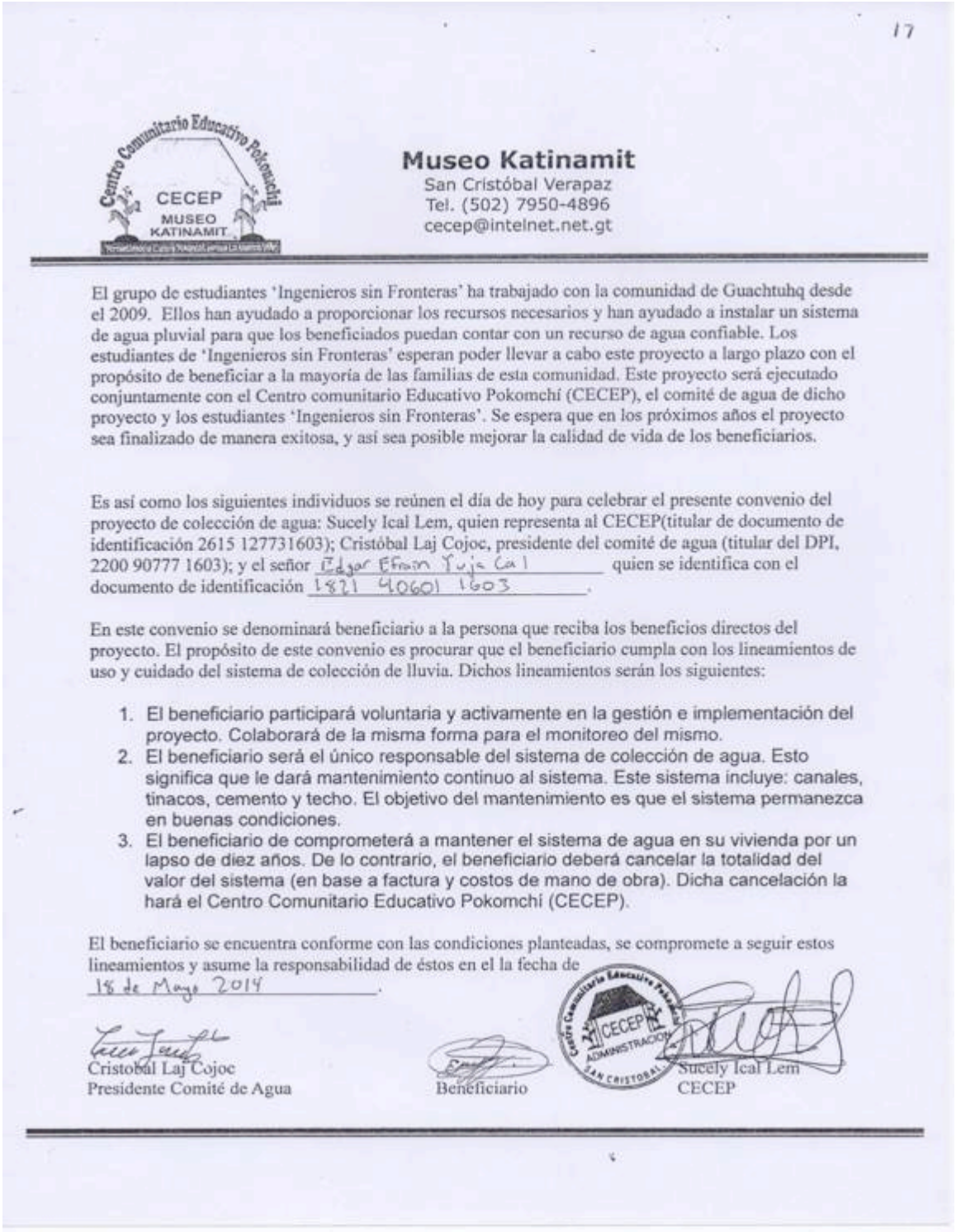
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

Comité Comunitario Educativo Poqomchi'
CECEP
ADMINISTRACION
SAN CRISTOBAL, A. V.

Figure 56: House 17 of Edgar Efrain Yuja Cal Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Edgar Efrain Yuja Cal quien se identifica con el documento de identificación 1821 40601 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

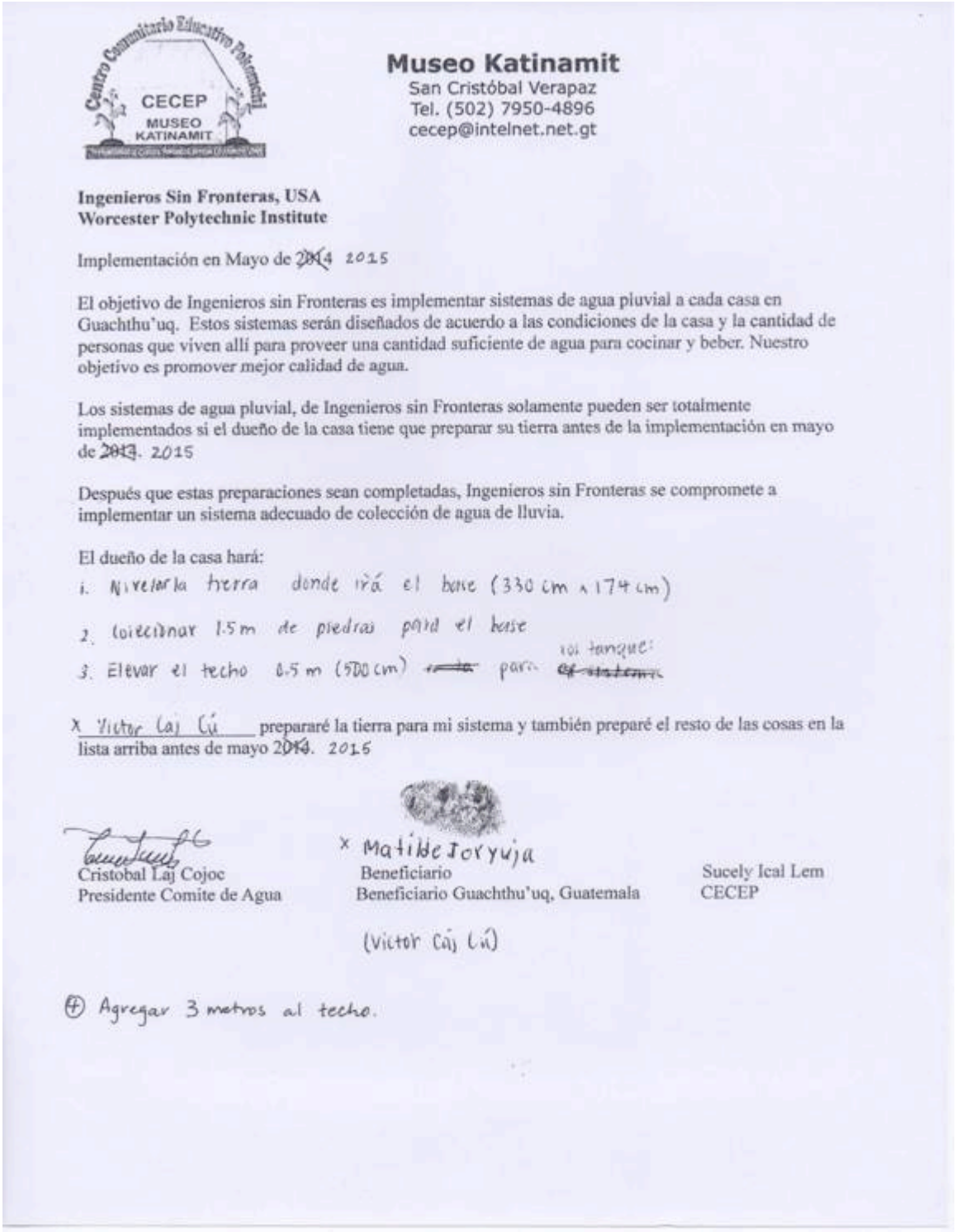
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 14 de Mayo 2014.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 57: House 17 of Edga Efrain Yuja Cal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

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Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2013~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

i. Nivelar la tierra donde irá el base (330 cm x 174 cm)
2. Colecionar 1.5 m de piedras para el base
3. Elevar el techo 0.5 m (500 cm) ~~para~~ para 101 tanque: ~~el sistema~~

x Victor Caj Cú prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

Cristobal Laj Cojoc
Presidente Comite de Agua

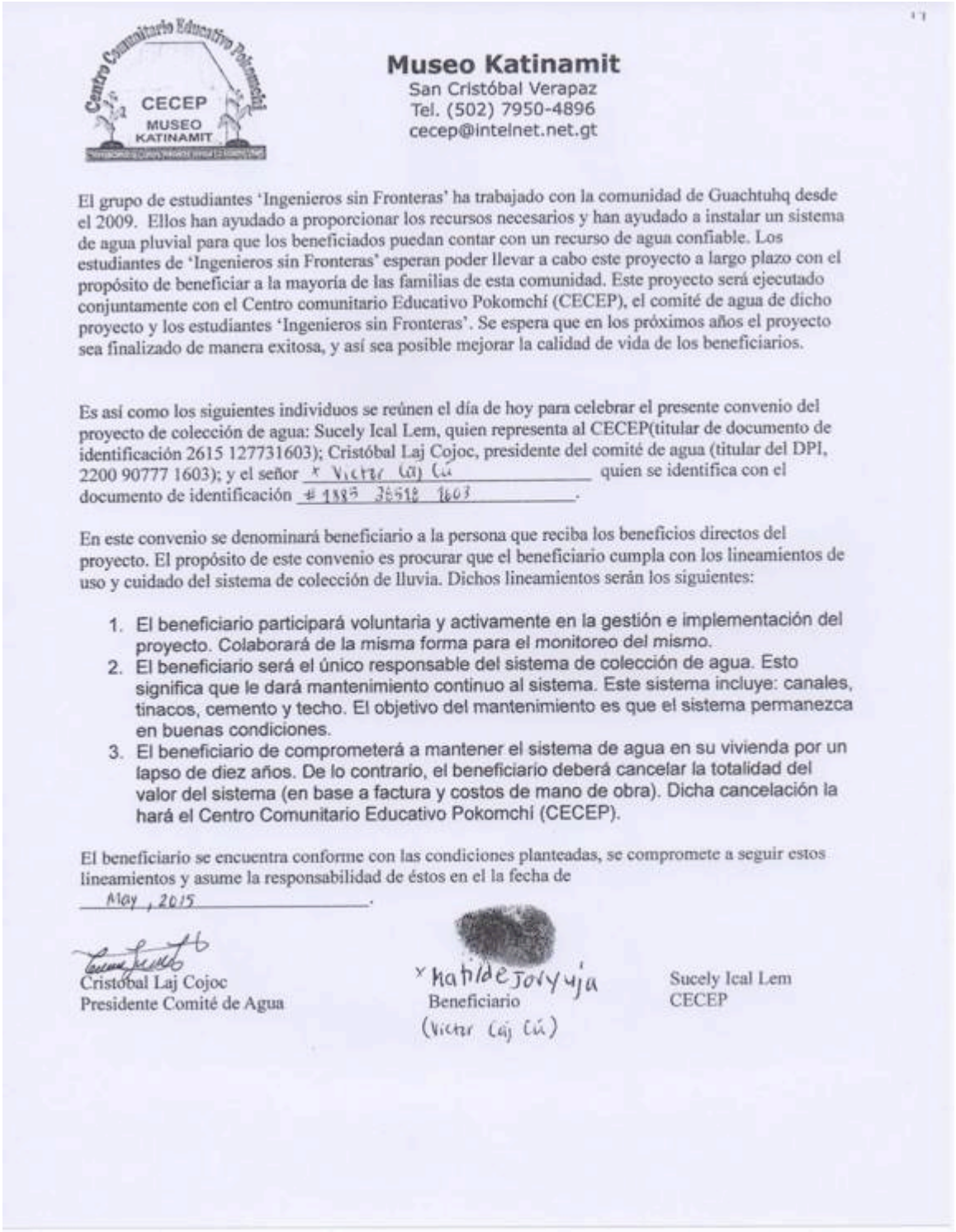
x Matilde Toryuja
Beneficiario
Beneficiario Guachthu'uq, Guatemala

(Victor Caj Cú)

Sucely Ical Lem
CECEP

⊕ Agregar 3 metros al techo.

Figure 58: House 19 of Victor Caj Cu Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor x Victor Caj Cu quien se identifica con el documento de identificación # 1885 36518 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

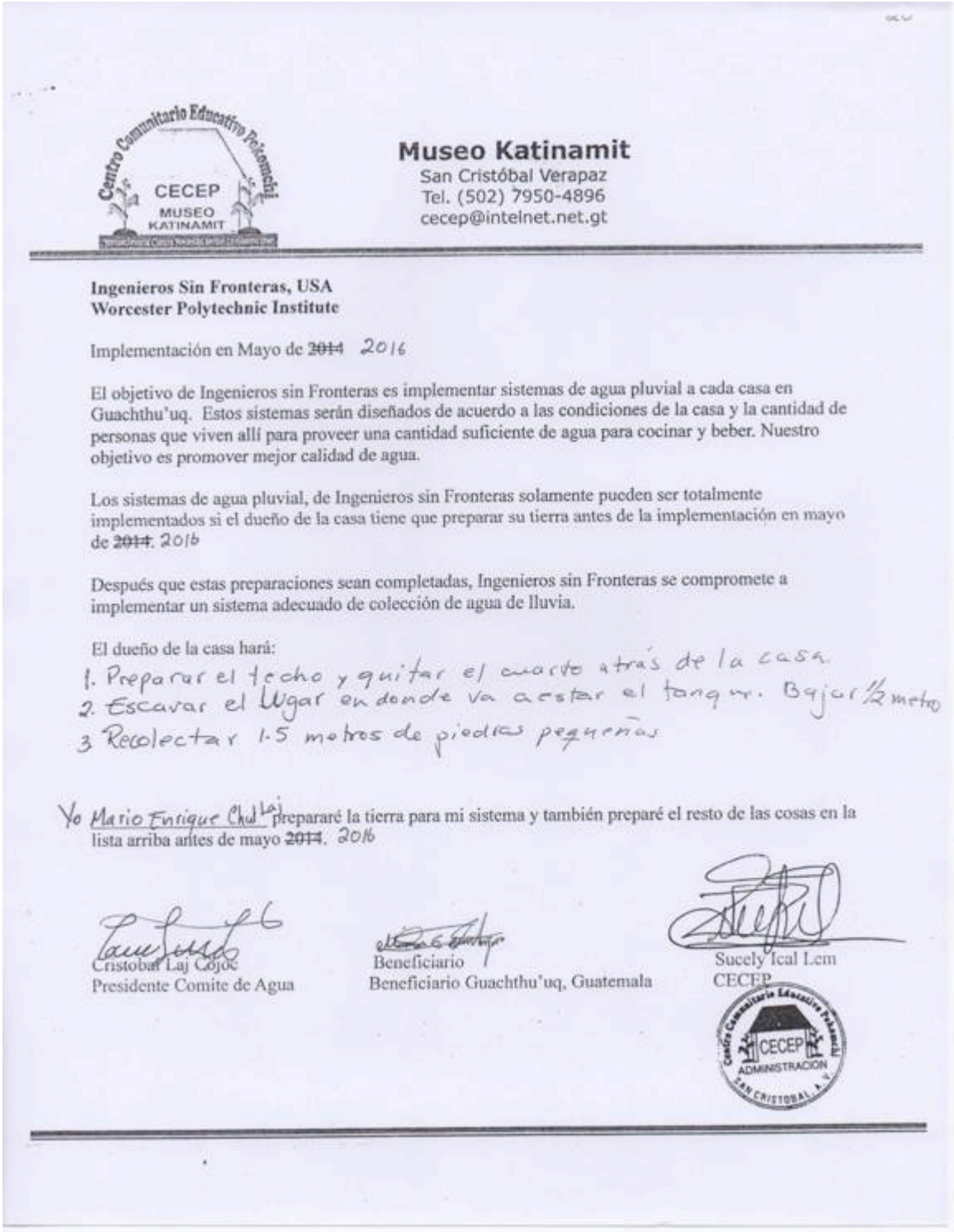
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de May, 2015.

Cristóbal Laj Cojoc
Presidente Comité de Agua

x Victor Caj Cu
Beneficiario
(Victor Caj Cu)

Sucely Ical Lem
CECEP

Figure 59: House 19 of Victor Caj Cu Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Preparar el techo y quitar el cuarto atrás de la casa.
2. Escavar el lugar en donde va a estar el tanque. Bajar ½ metro
3. Recolectar 1.5 metros de piedras pequeñas

Yo Mario Enrique Chul Laj prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2016

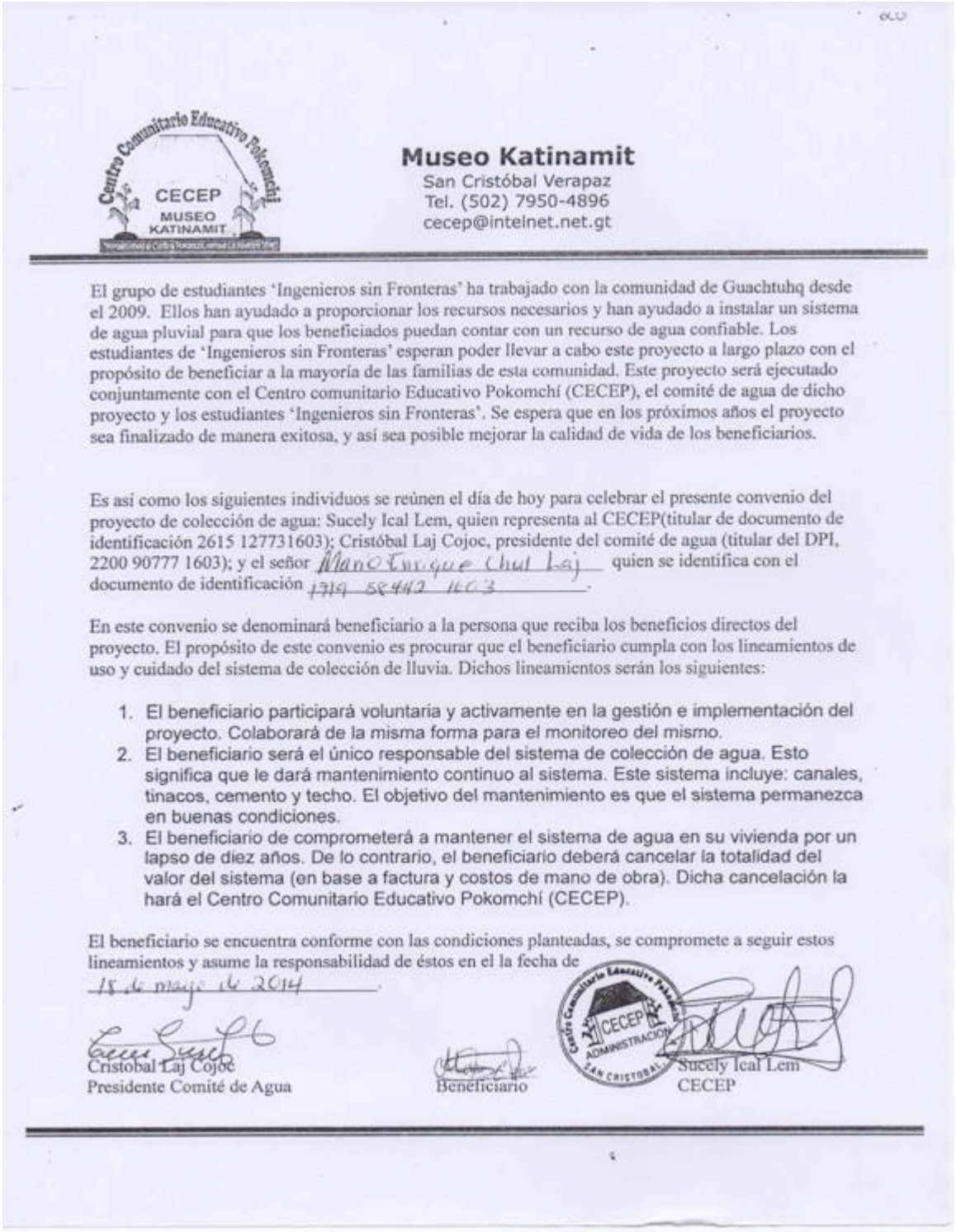
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A.V.

Figure 60: House 20 of Mario Enrique Chul Laj Home Preparation MOU



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cecep@intelnet.net.gt

El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Mario Enrique Chul Laj quien se identifica con el documento de identificación 1719 58442 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 15 de mayo de 2014.

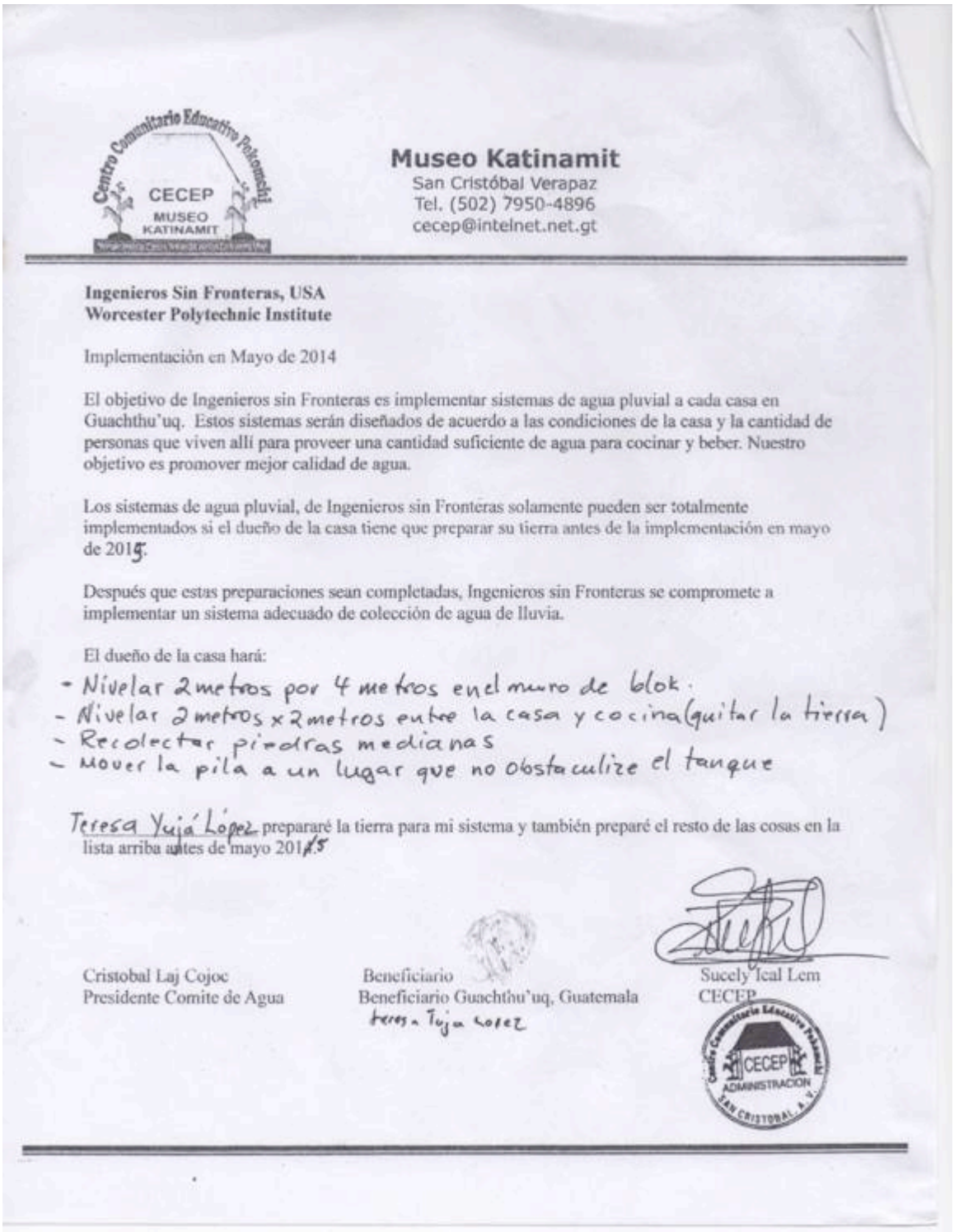
Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 61: House 20 of Mario Enrique Chul Laj Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de 2014

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2015.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

- Nivelar 2 metros por 4 metros en el muro de blok.
- Nivelar 2 metros x 2 metros entre la casa y cocina (quitar la tierra)
- Recolectar piedras medianas
- Mover la pila a un lugar que no obstaculize el tanque

Teresa Yuja López prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2015

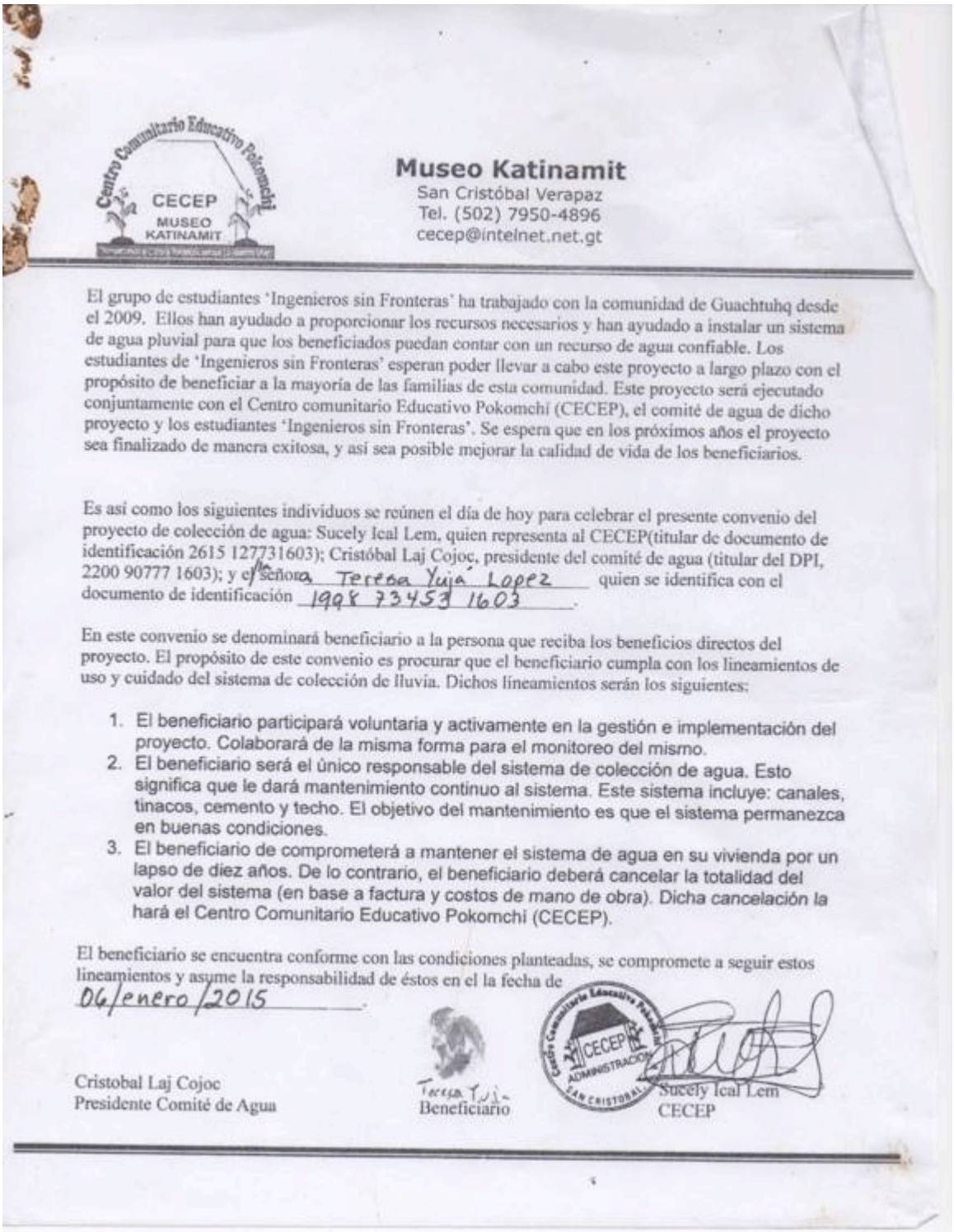
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala
Teresa Yuja Lopez

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A.V.

Figure 62: House 22 of Teresa Yuja Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchi (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el/la señora Teresa Yuja Lopez quien se identifica con el documento de identificación 1998 73453 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchi (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 06/enero/2015.

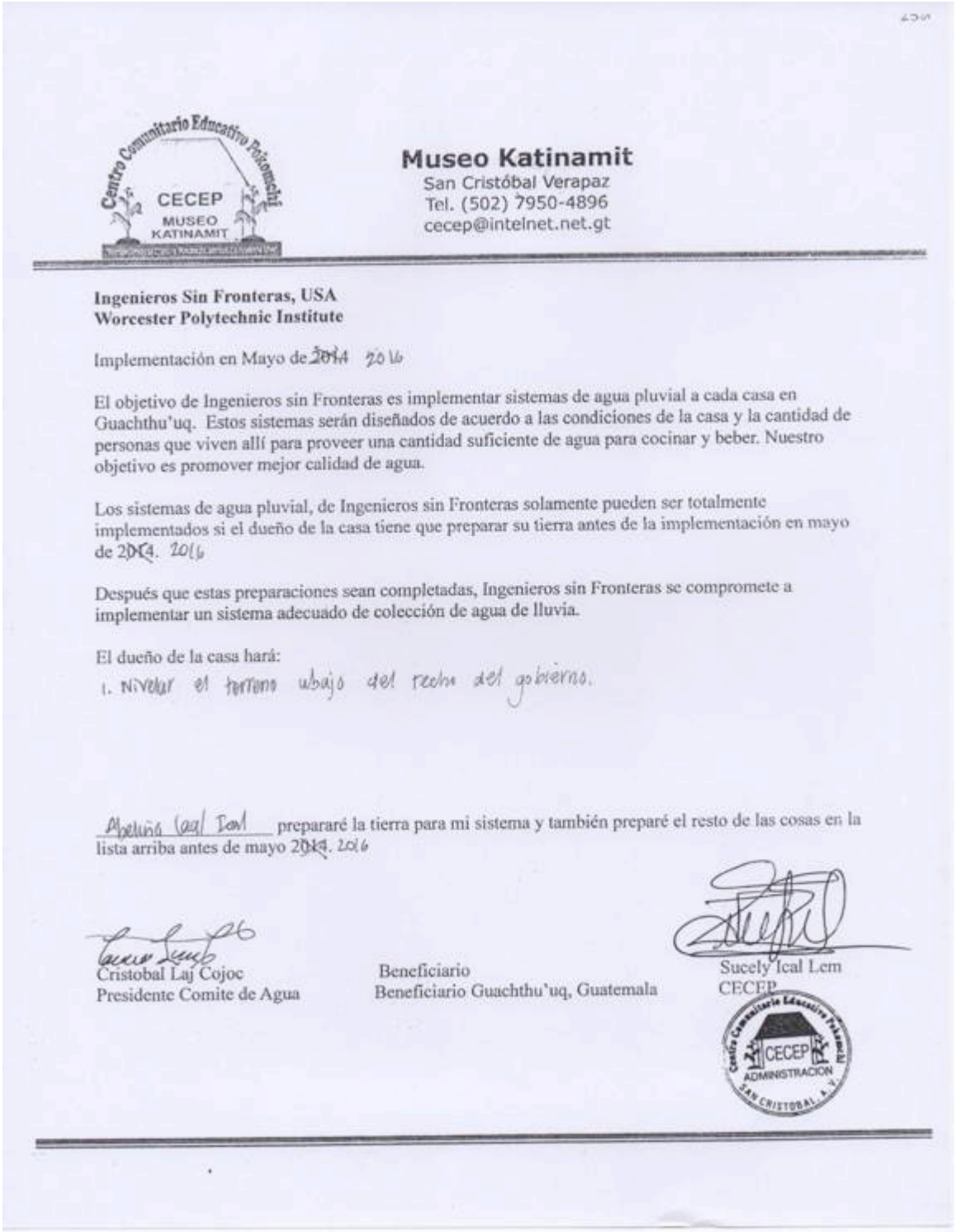
Cristobal Laj Cojoc
Presidente Comité de Agua

Teresa Yuja
Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 63: House 22 of Teresa Yuja Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
1. Nivelar el terreno abajo del techo del gobierno.

Abelino Cal Ical prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2016

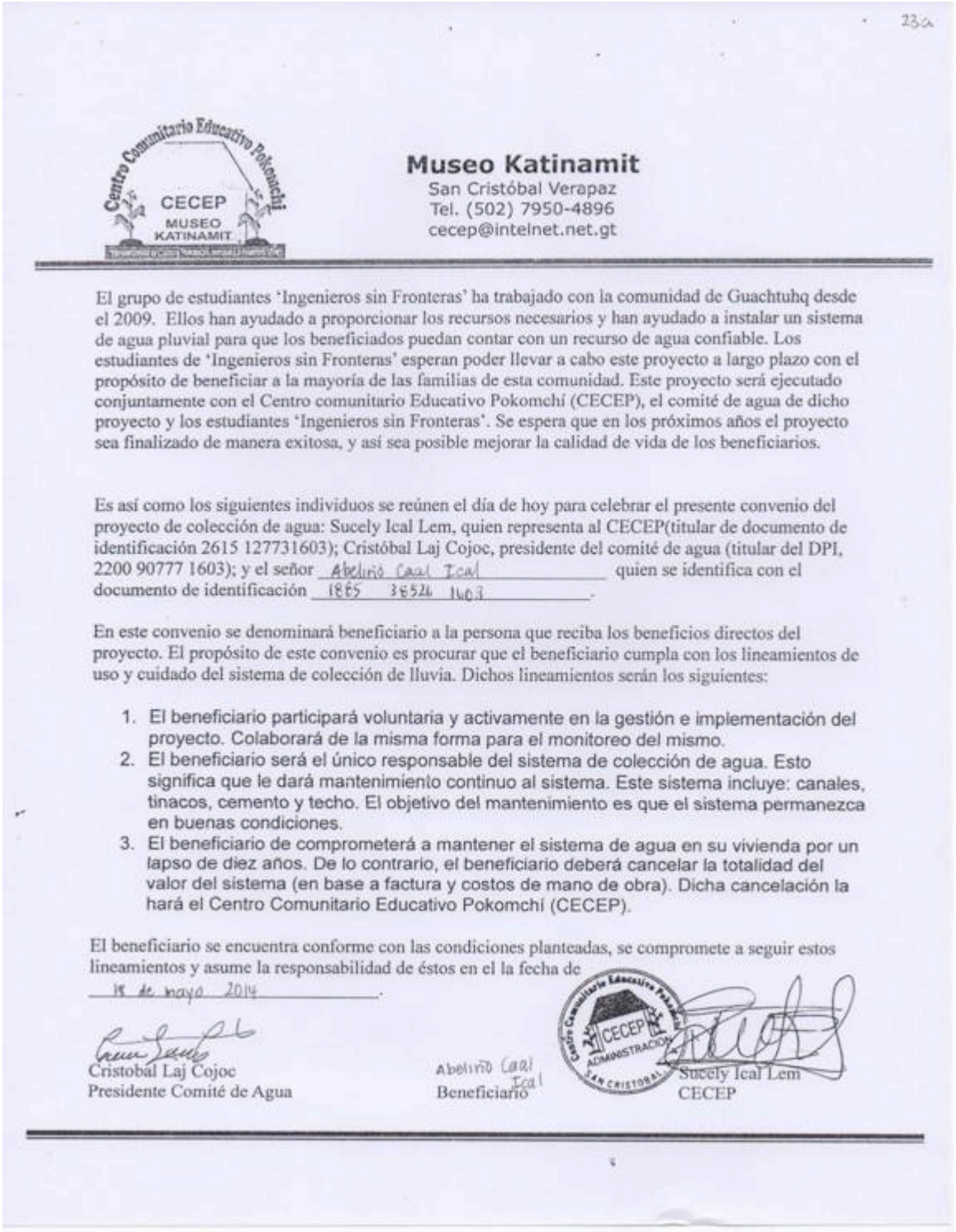
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A. V.

Figure 64: House 23a of Abelino Cal Home Preparation MOU



23a

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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Abelino Cal Ical quien se identifica con el documento de identificación 1865 38524 1403.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 de mayo 2014.

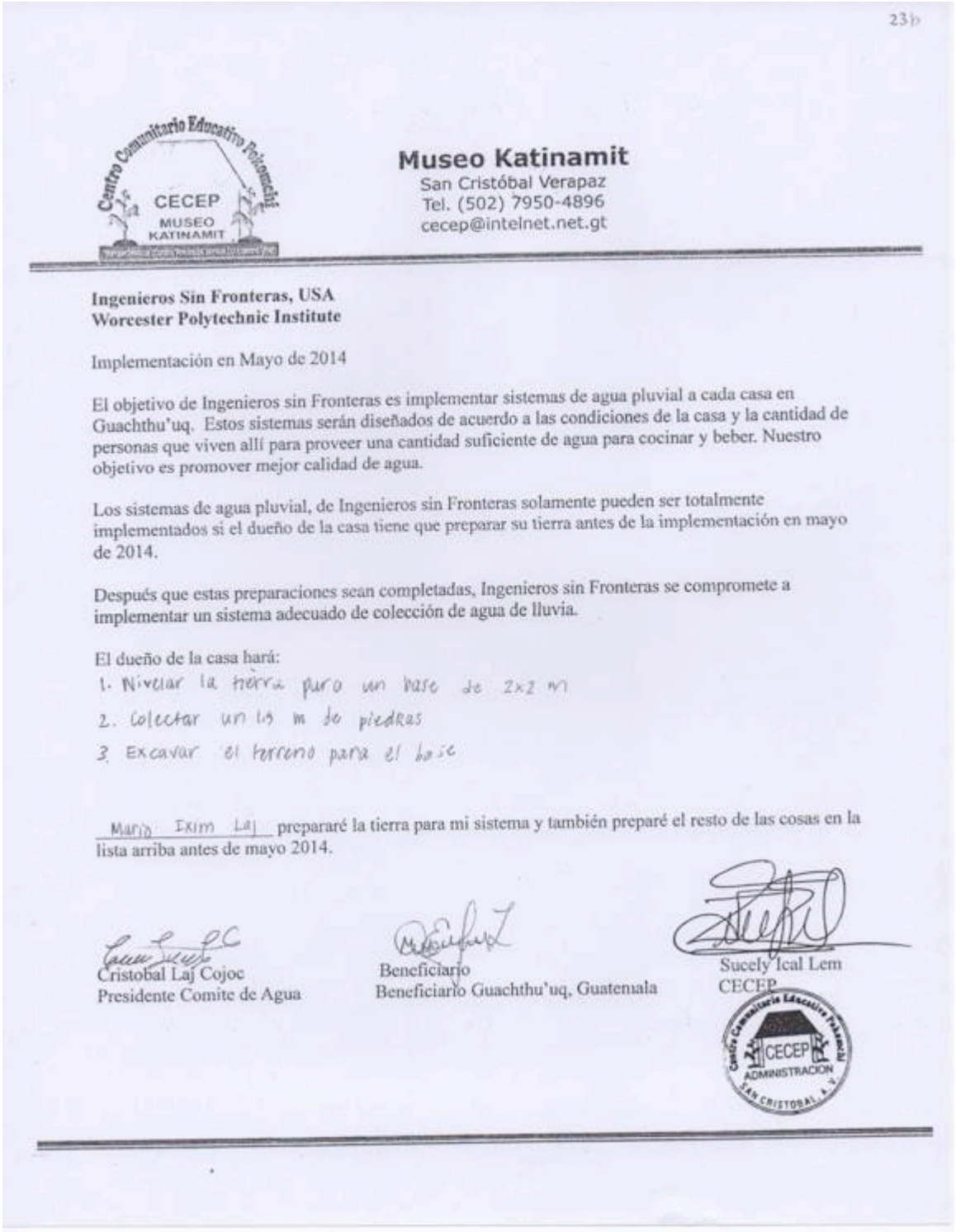
Cristobal Laj Cojoc
Presidente Comité de Agua

Abelino Cal Ical
Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 65: House 23a of Abelino Cal Contract MOU



23b

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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de 2014

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2014.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
1. Nivelar la tierra para un base de 2x2 m
2. Colectar un 1.5 m de piedras
3. Excavar el terreno para el base

Mario Xim Laj prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2014.

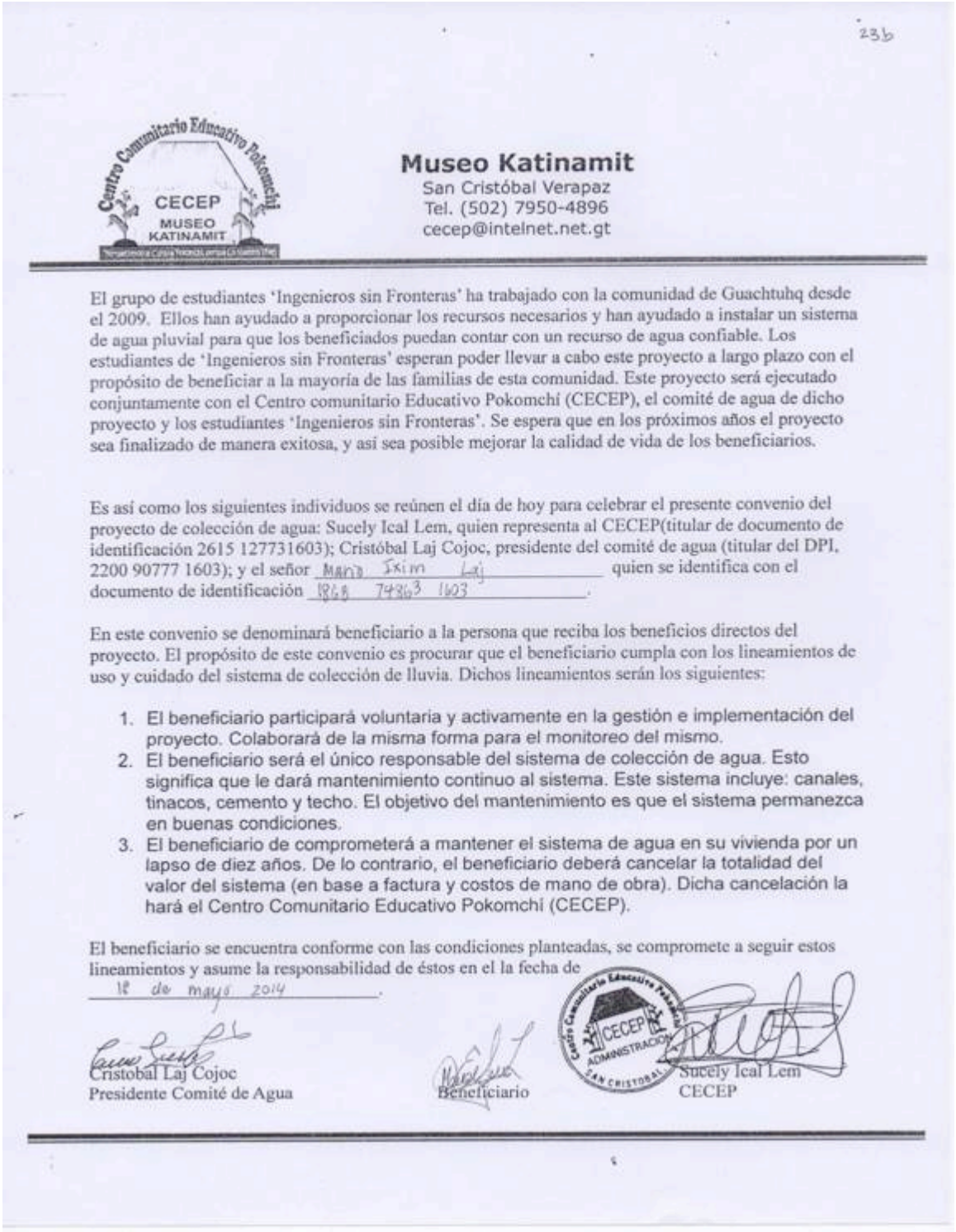
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL

Figure 66: House 23b of Mario Xim Laj Home Preparation MOU



23b

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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Mario Xim Laj quien se identifica con el documento de identificación 1868 74363 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 12 de mayo 2014.

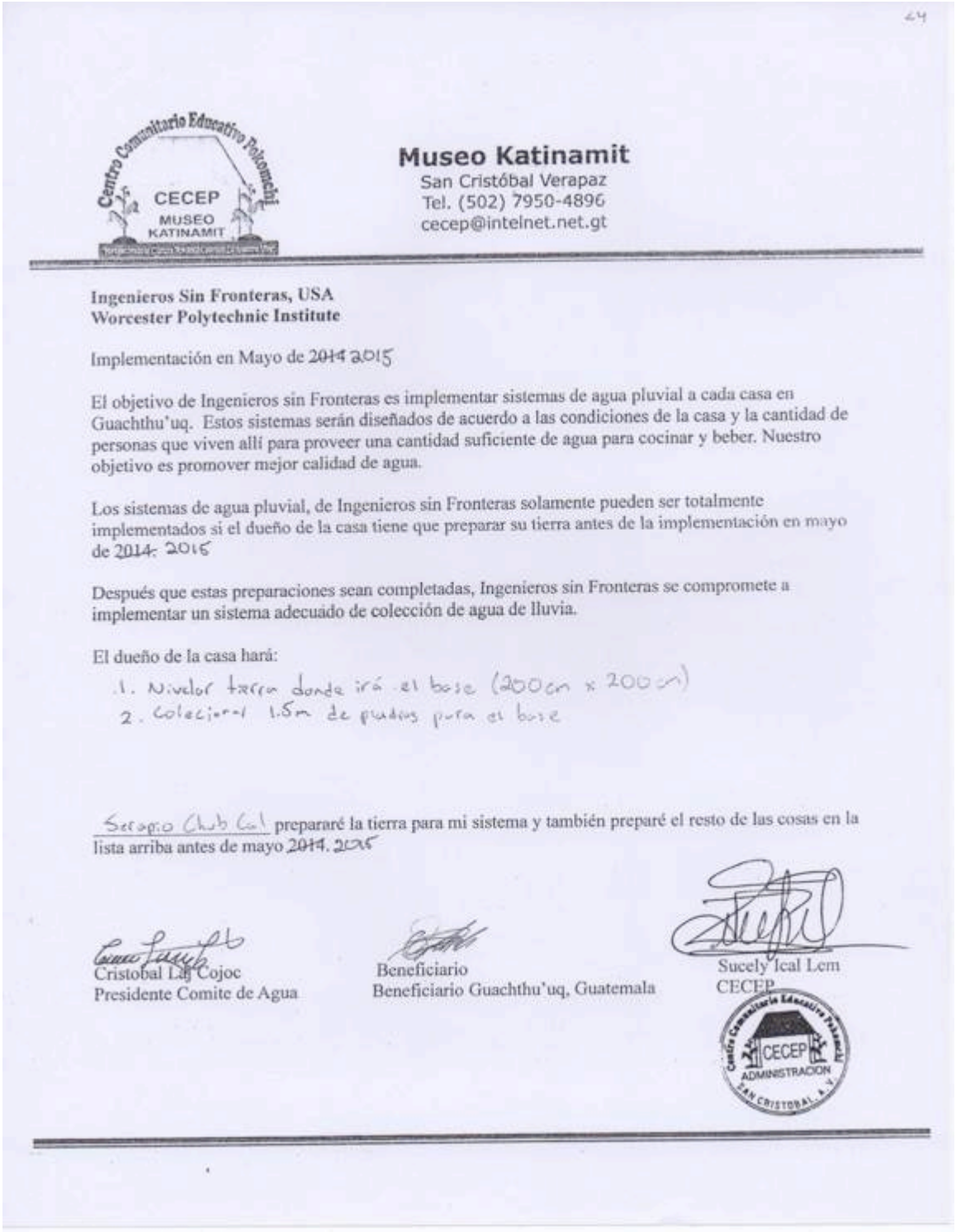
Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 67: House 23b of Mario Xim Laj Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014.~~ 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Nivelar tierra donde irá el base (200cm x 200cm)
2. Colocar el 1.5m de piedras para el base

Serapio Chulb Caal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014.~~ 2015

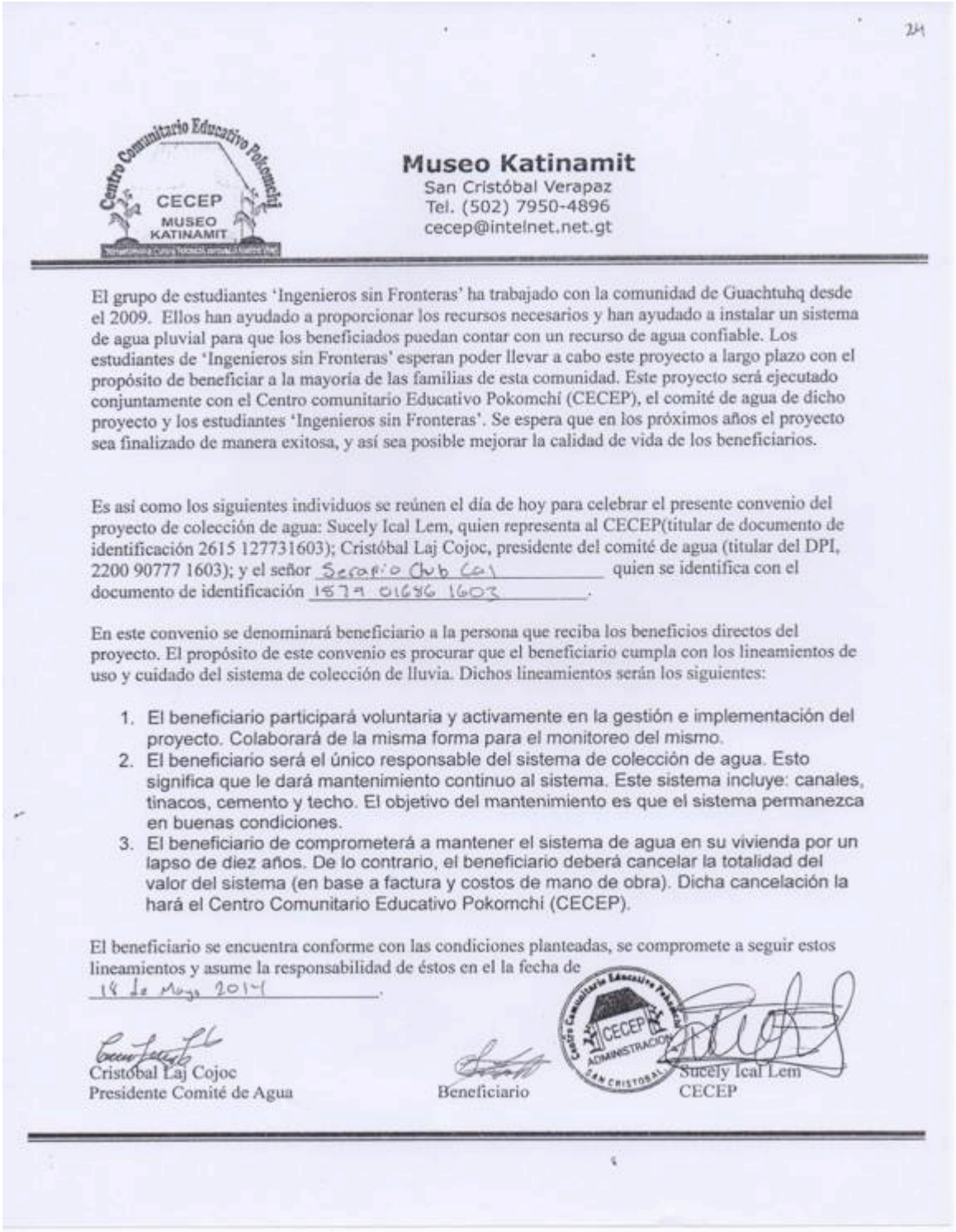
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL

Figure 68: House 24 of Cerapio Chulb Caal Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Serapio Chub Caal quien se identifica con el documento de identificación 1879 01686 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

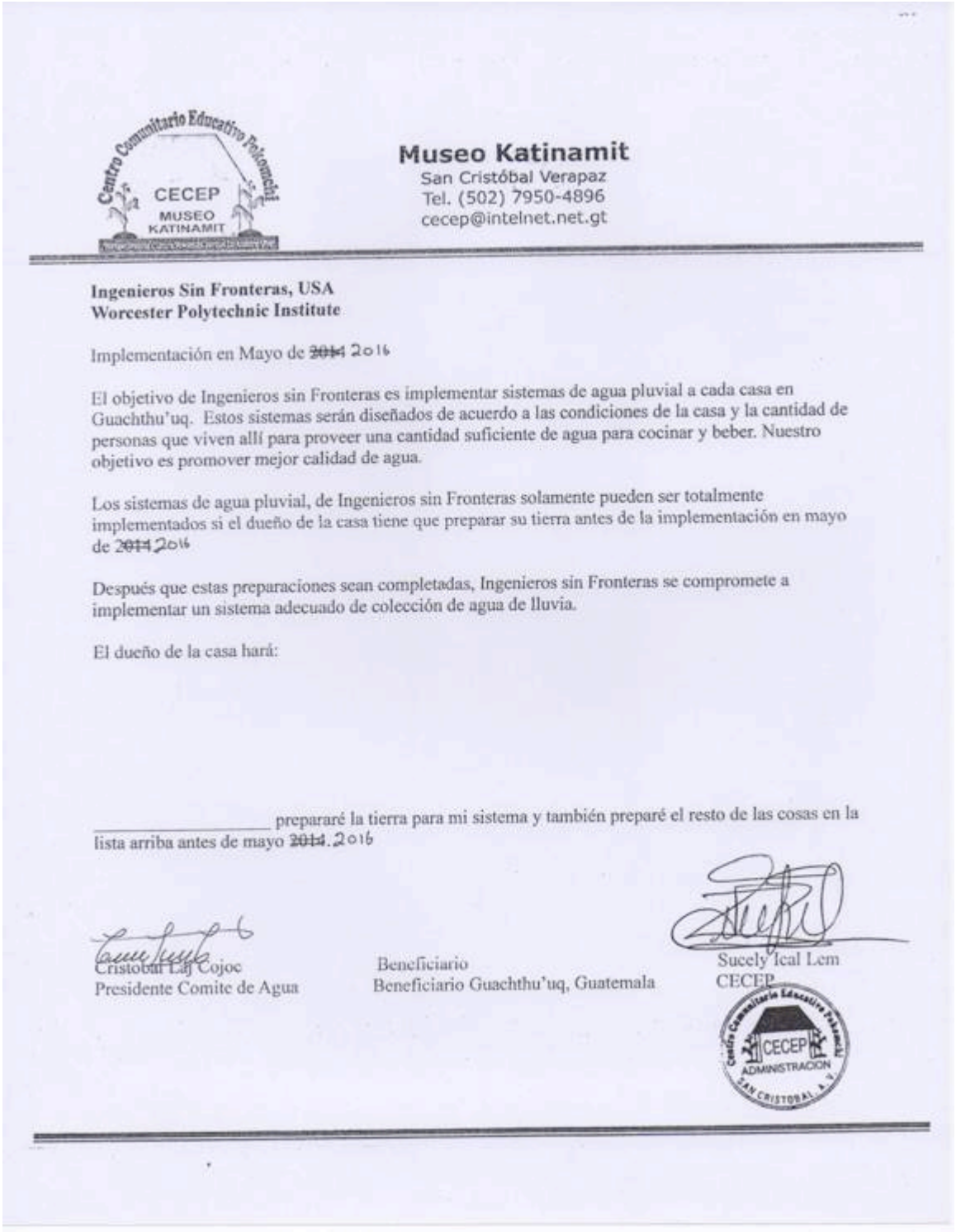
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 14 de Mayo 2014.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 69: House 24 of Cerapio Chulb Caal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~ 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

_____ prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~ 2016

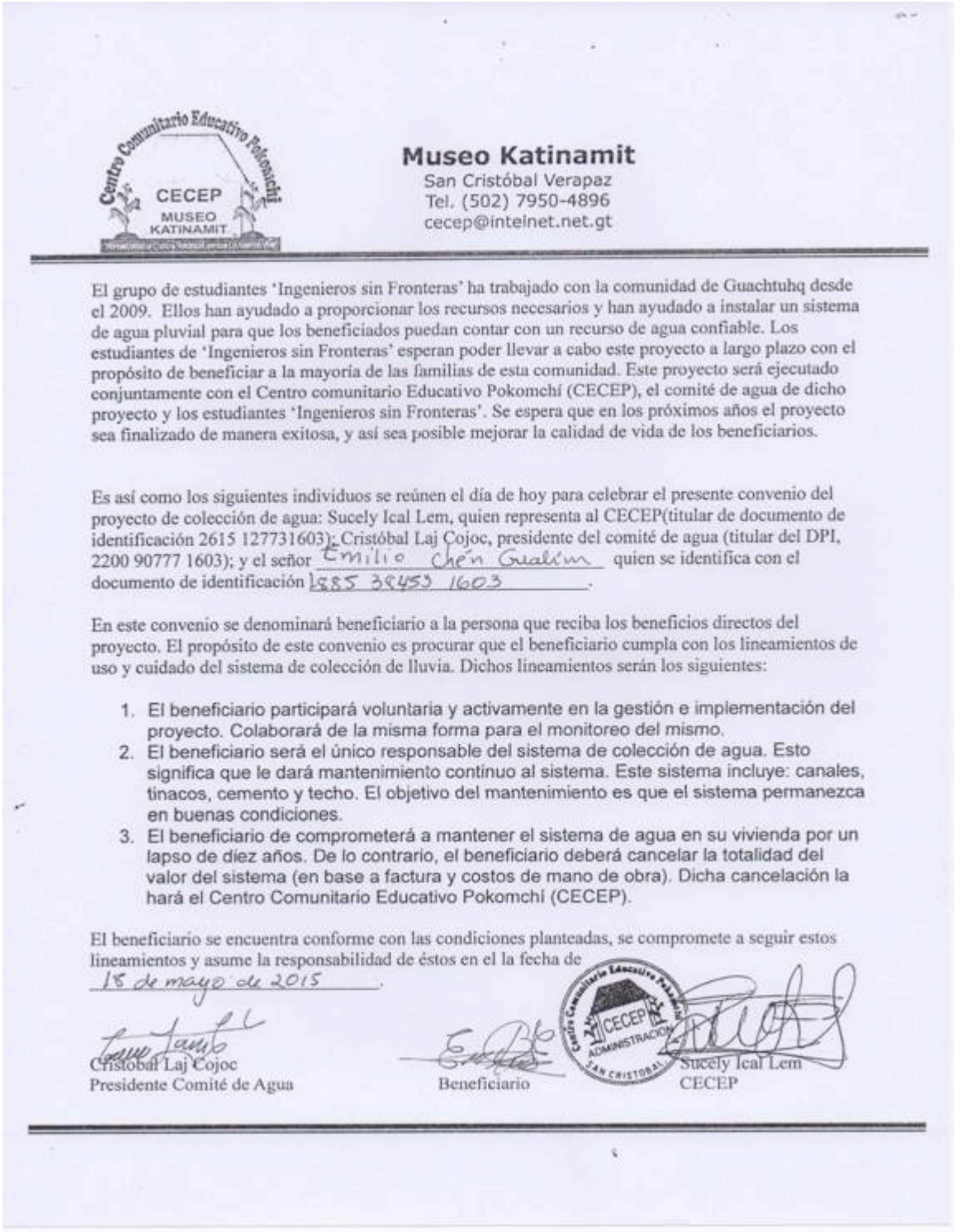
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A. V.

Figure 70: House 25 of Emilio Chen Gualim Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Emilio Chén Gualim quien se identifica con el documento de identificación 1885 39453 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

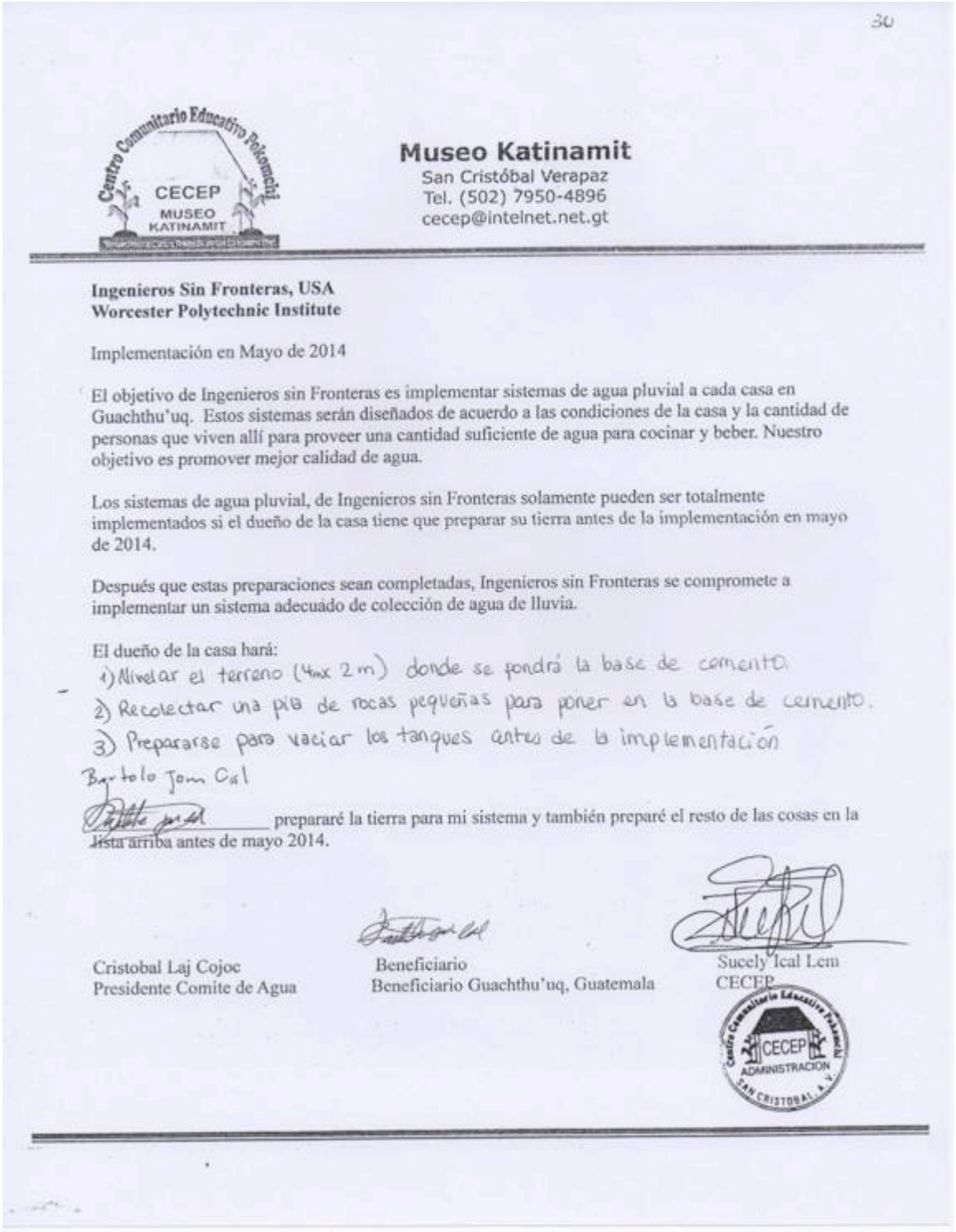
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 de mayo de 2015.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 71: House 25 of Emilio Chen Gualim Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de 2014

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2014.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
1) Nivelar el terreno (4mx 2m) donde se pondrá la base de cemento.
2) Recolectar una pila de rocas pequeñas para poner en la base de cemento.
3) Prepararse para vaciar los tanques antes de la implementación

Bartolo Jom Cal

_____ prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2014.

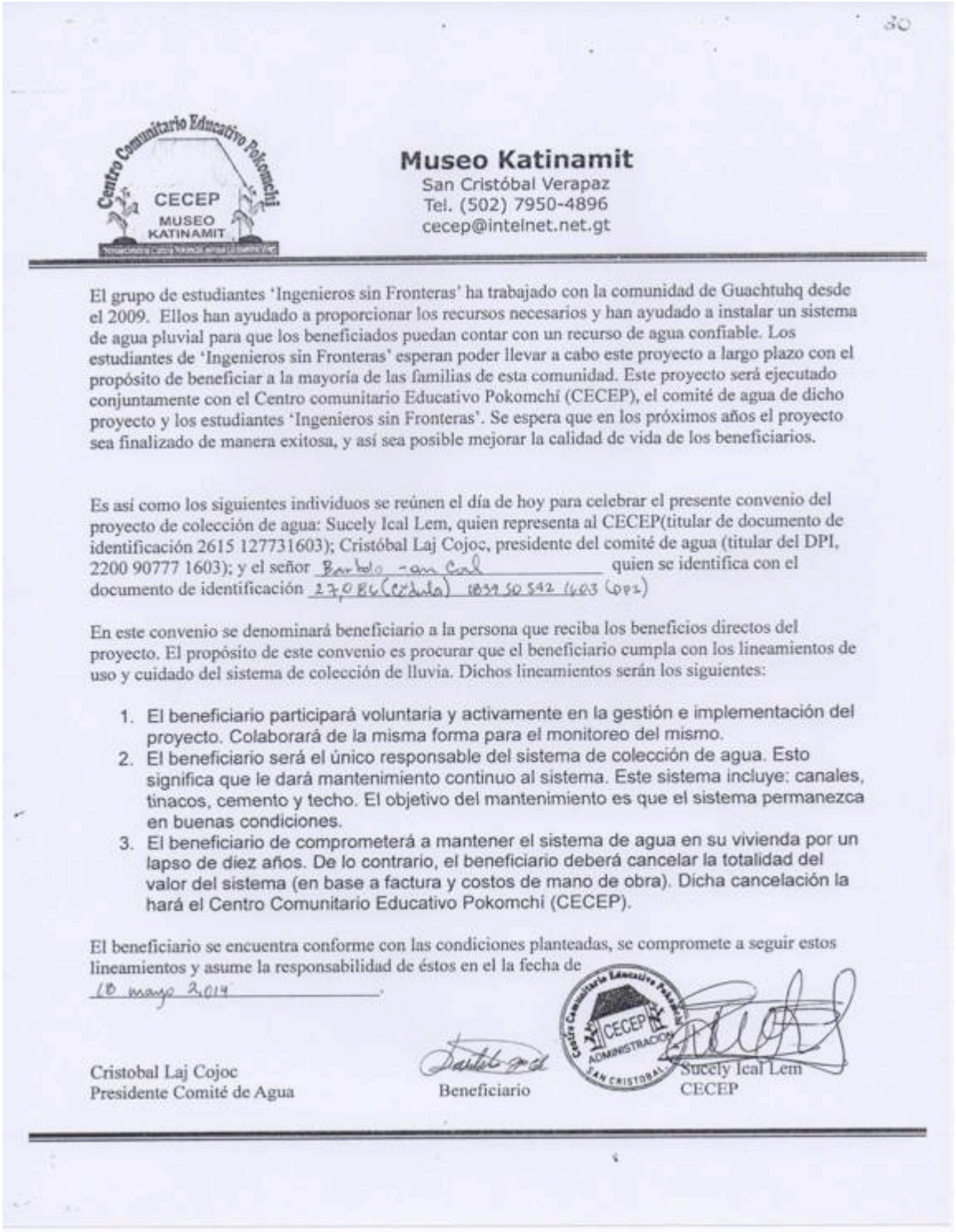
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL

Figure 72: House 30 of Bartolo Jom Velasques Home Preparation MOU



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San Cristóbal Verapaz
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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Bartolo - am Cal quien se identifica con el documento de identificación 2708 (cédula) 1839 50 542 1603 (Qpz)

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de
10 mayo 2014.

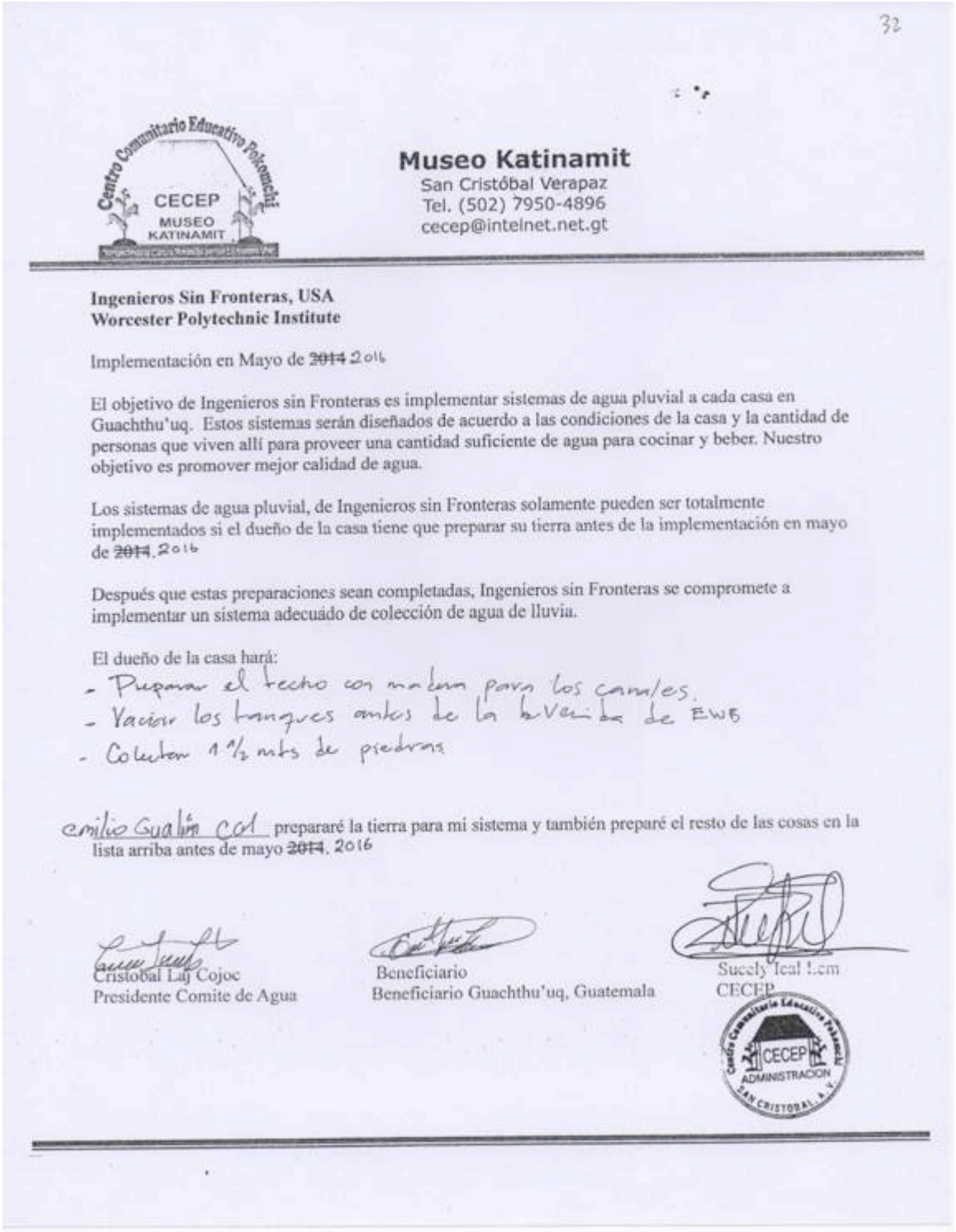
Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Centro Comunitario Educativo Pokomchí CECEP ADMINISTRACIÓN SAN CRISTÓBAL

Sucely Ical Lem
CECEP

Figure 73: House 30 of Bartolo Jom Velasques Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
- Preparar el techo con madera para los canales.
- Vaciar los tanques antes de la llegada de EWB
- Colectar 1 ½ mts de piedras

Emilio Gualim Cal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2016

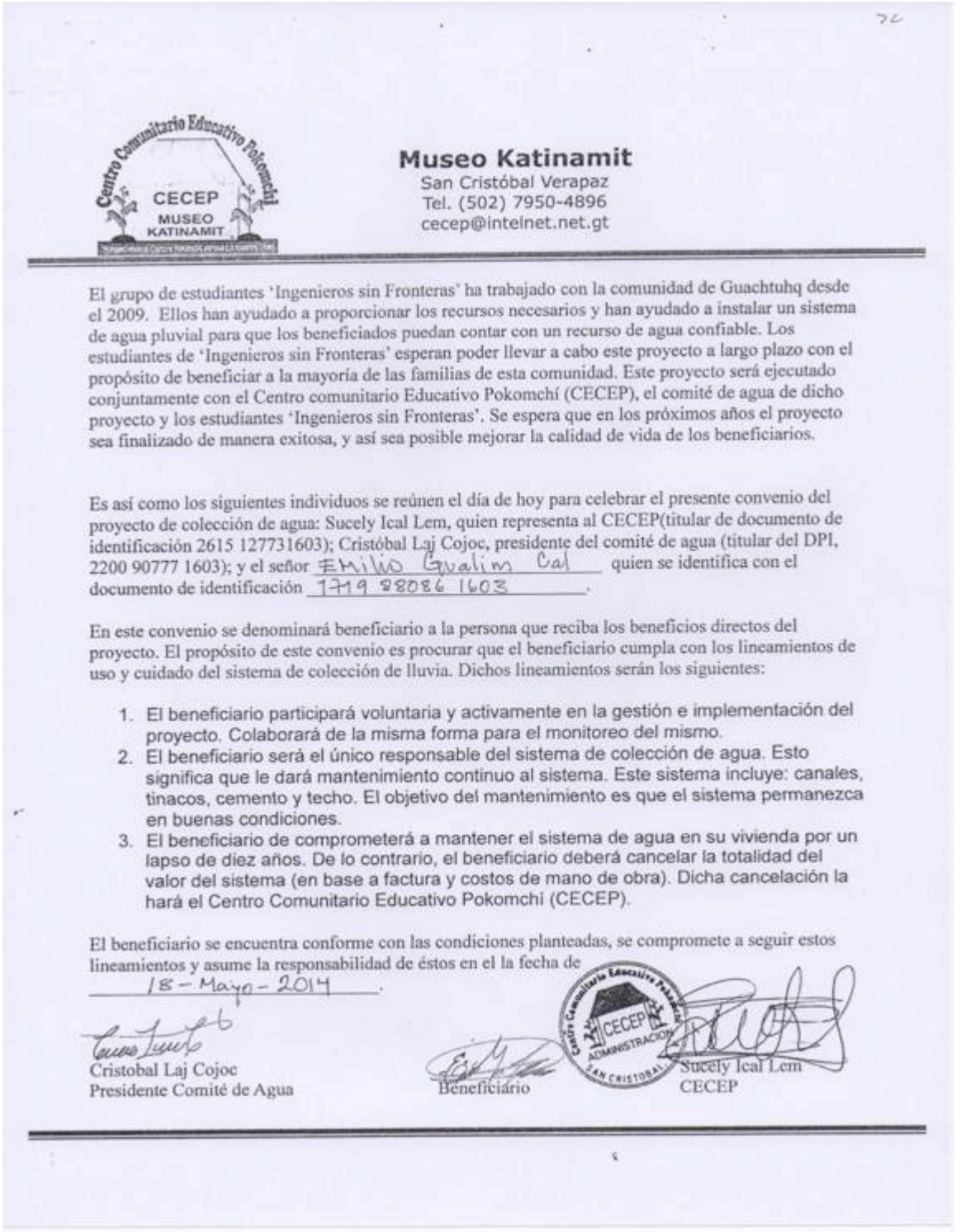
Cristóbal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL V. V.

Figure 74: House 32 of Emilio Gualim Cal Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Emilio Gualim Cal quien se identifica con el documento de identificación 1719 28086 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

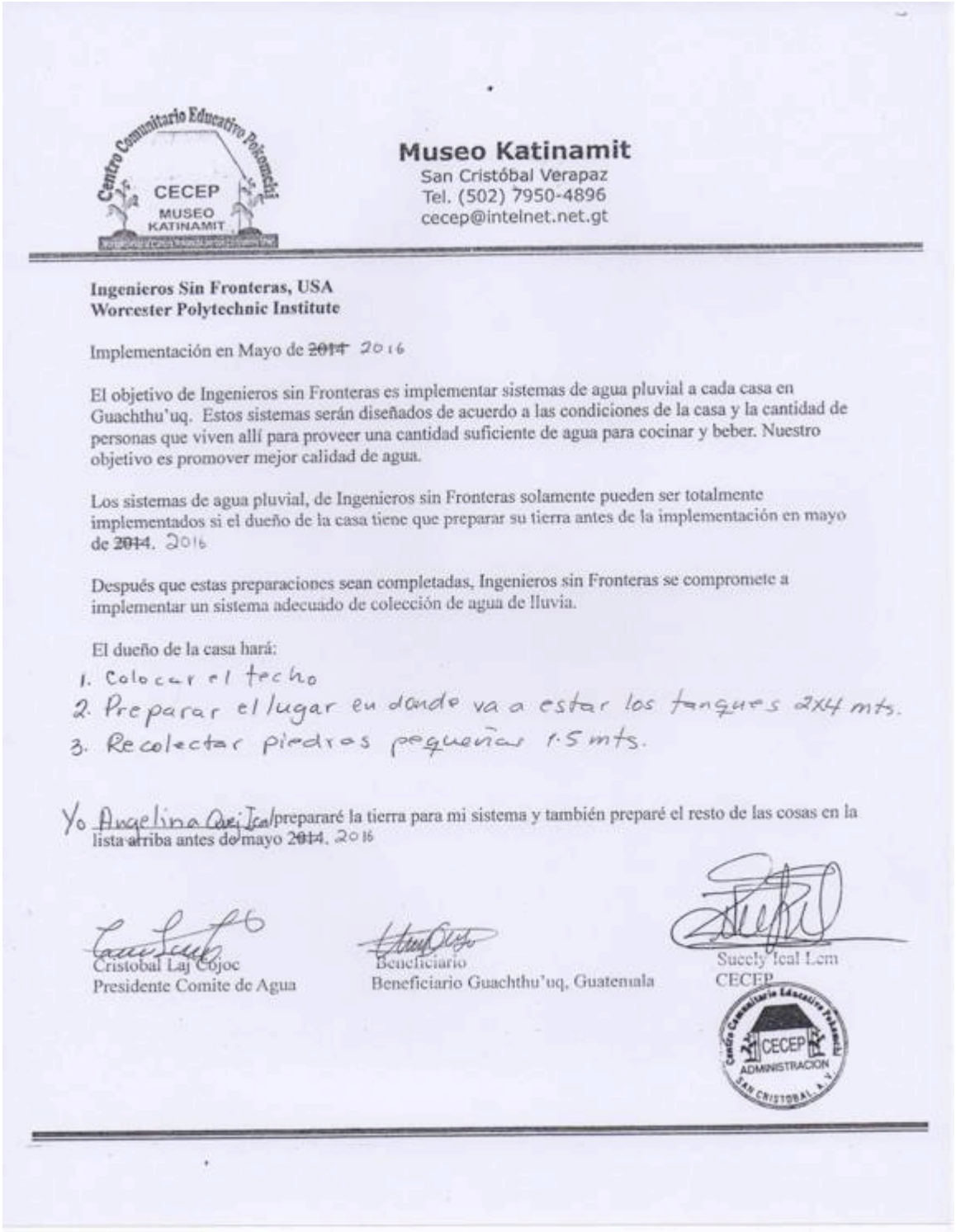
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 - Mayo - 2014.

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 75: House 32 of Emilio Gualim Cal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Colocar el techo
2. Preparar el lugar en donde va a estar los tanques 2x4 mts.
3. Recolectar piedras pequeñas 1.5 mts.

Yo Angelina Quej Ical prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista ~~a~~rriba antes de mayo ~~2014~~. 2016

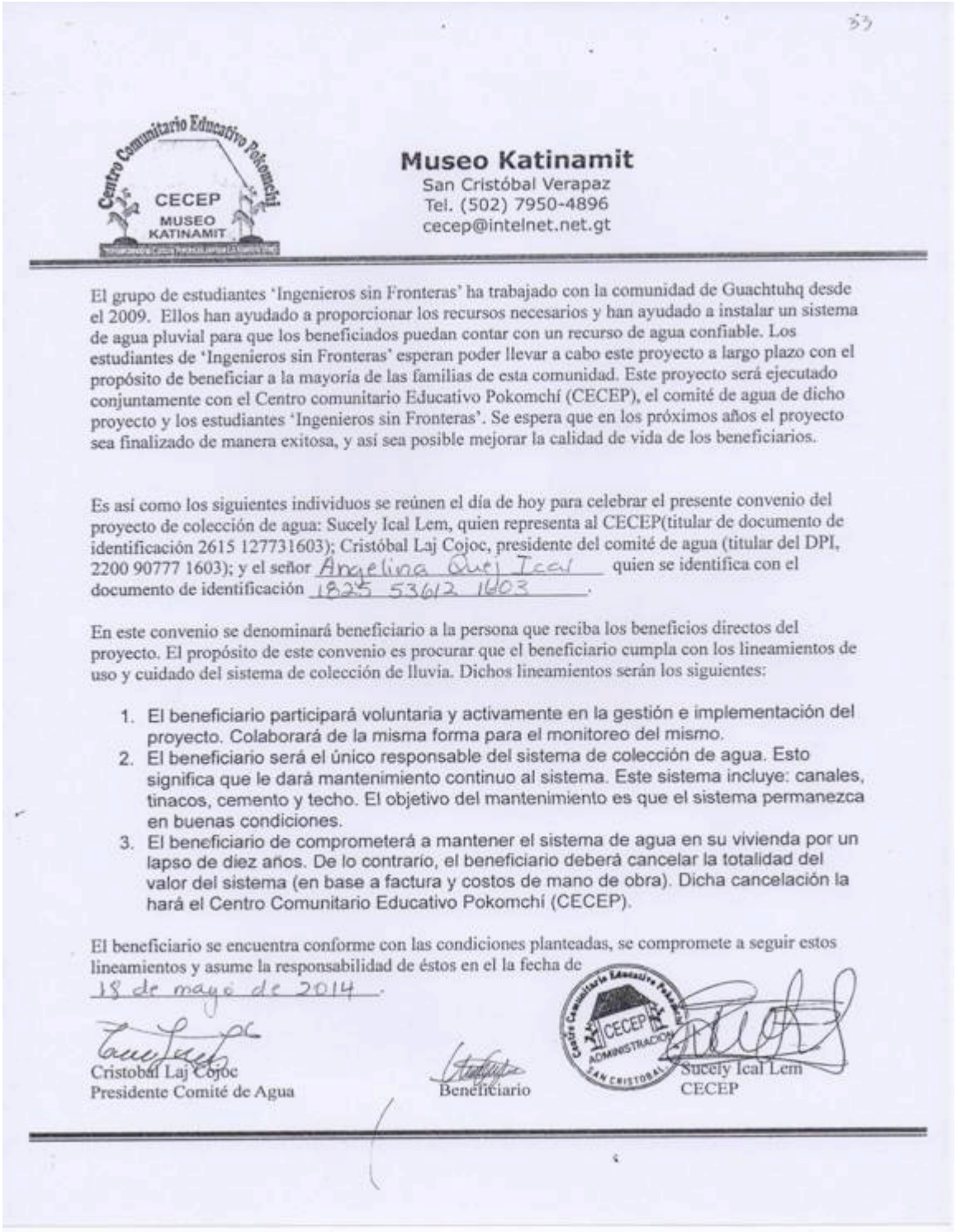
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A. V.

Figure 76: House 33 of Angelina Quej Home Preparation MOU



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San Cristóbal Verapaz
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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Angelina Quej Ical quien se identifica con el documento de identificación 1825 53612 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

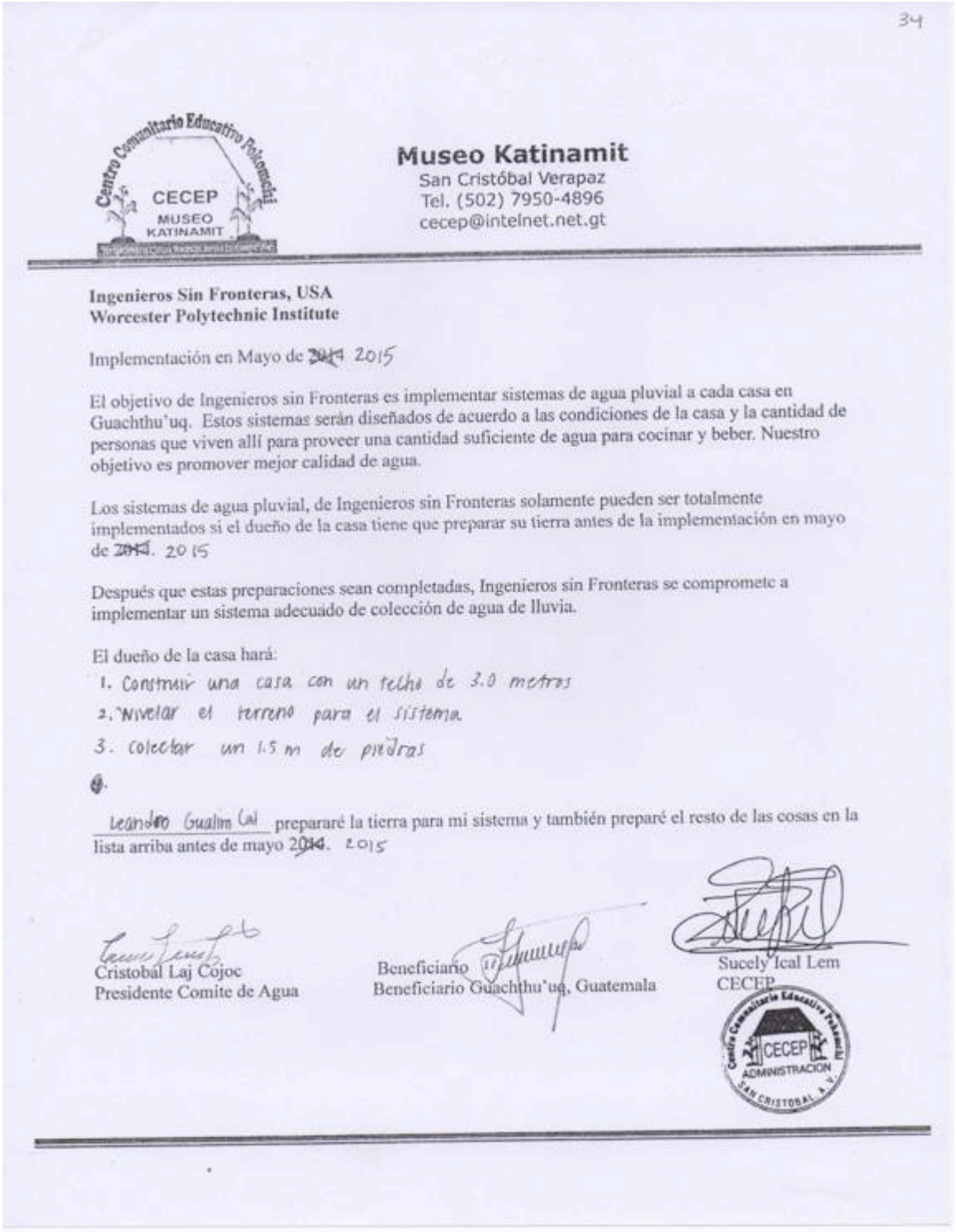
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 de mayo de 2014.

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Centro Comunitario Educativo Pokomchí CECEP ADMINISTRACIÓN SAN CRISTÓBAL
Sucely Ical Lem
CECEP

Figure 77: House 33 of Angelina Quej Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2015

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~. 2015

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

1. Construir una casa con un techo de 3.0 metros
2. Nivelar el terreno para el sistema
3. Colectar un 1.5 m de piedras
4.

Leandro Gualim Cal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2015

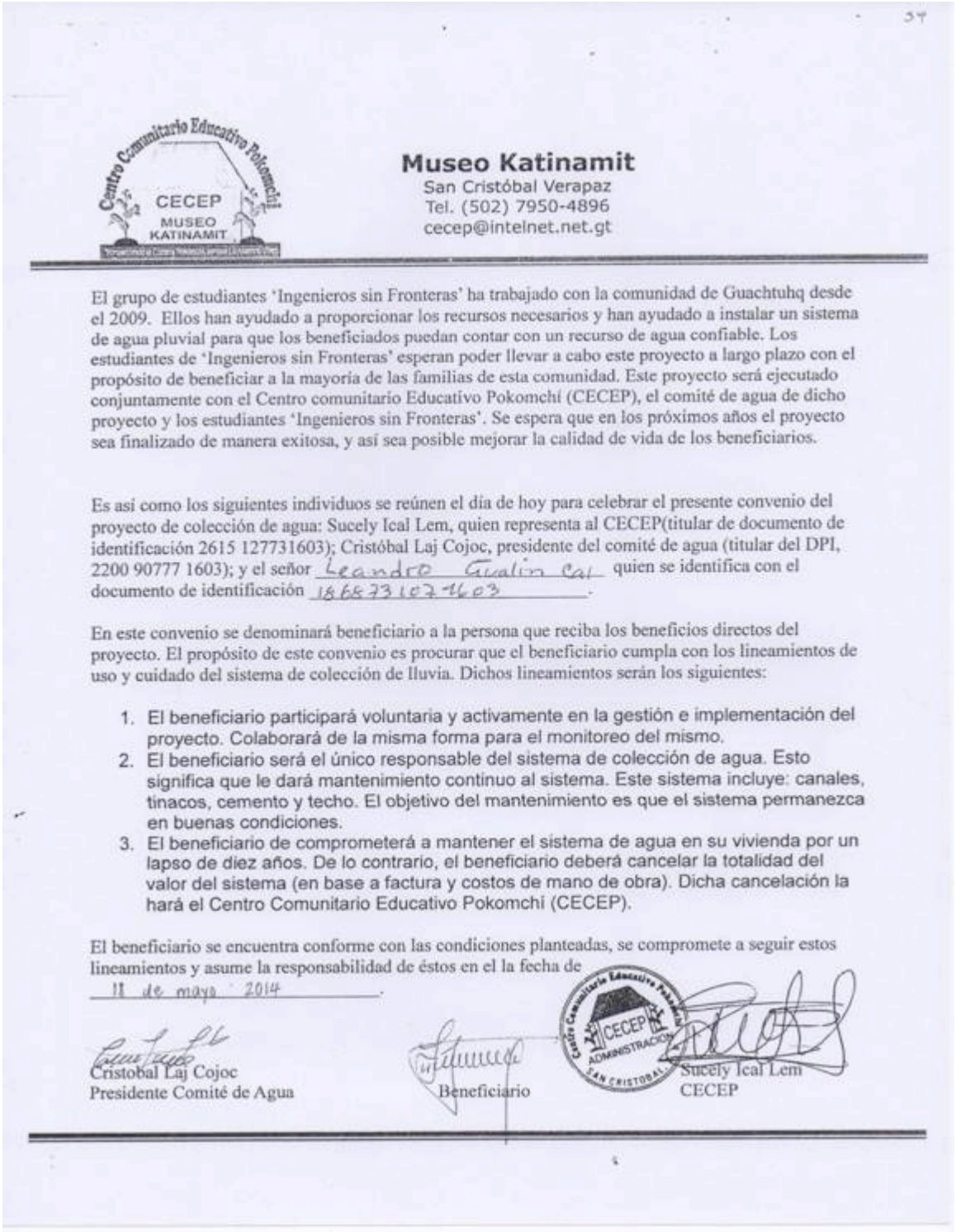
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL

Figure 78: House 34 of Leandro Gualim Cal Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Leandro Gualim Cal quien se identifica con el documento de identificación 1668731076 03.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

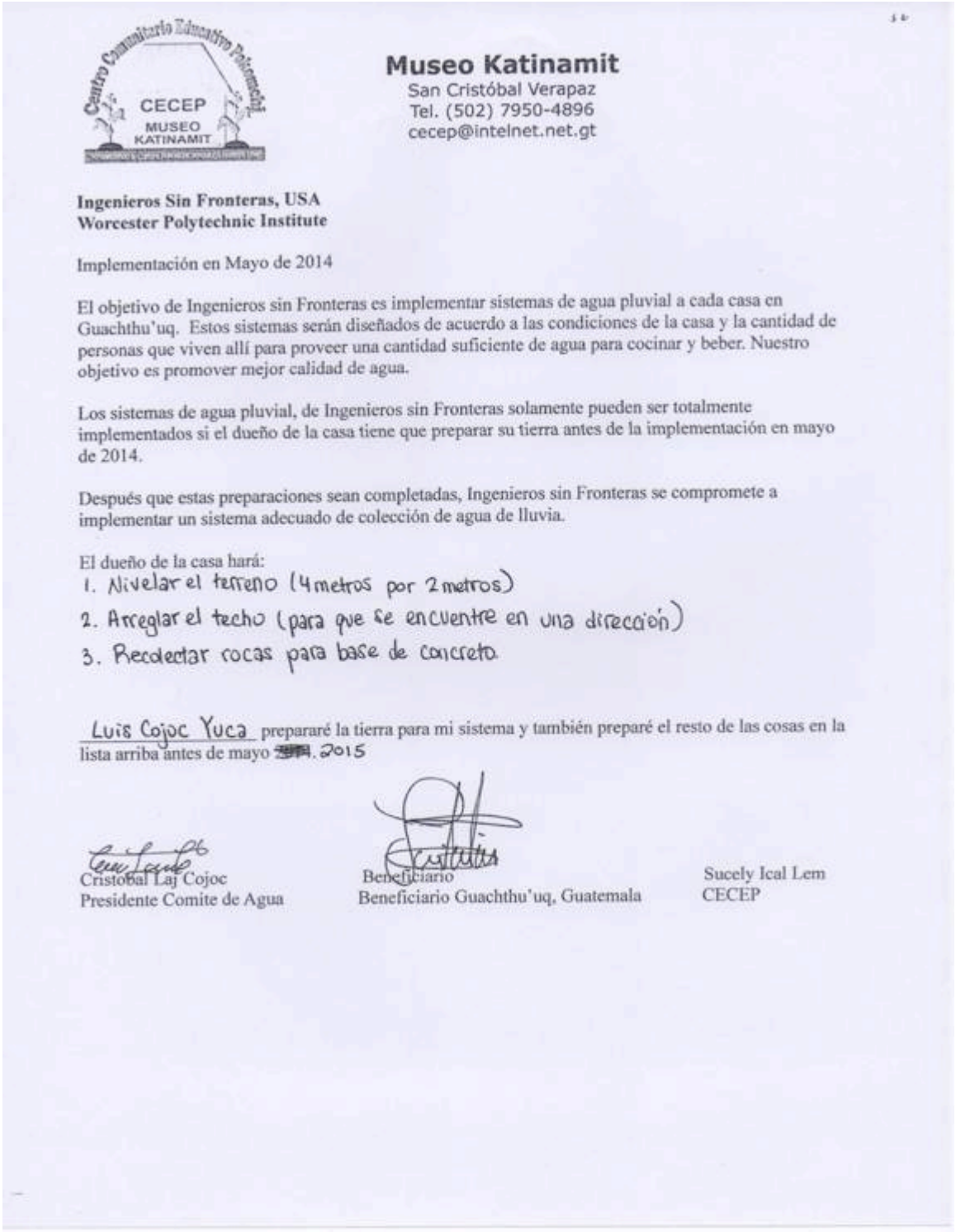
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 11 de mayo 2014.

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 79: House 34 of Leandro Gualim Cal Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de 2014

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2014.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
1. Nivelar el terreno (4 metros por 2 metros)
2. Arreglar el techo (para que se encuentre en una dirección)
3. Recolectar rocas para base de concreto

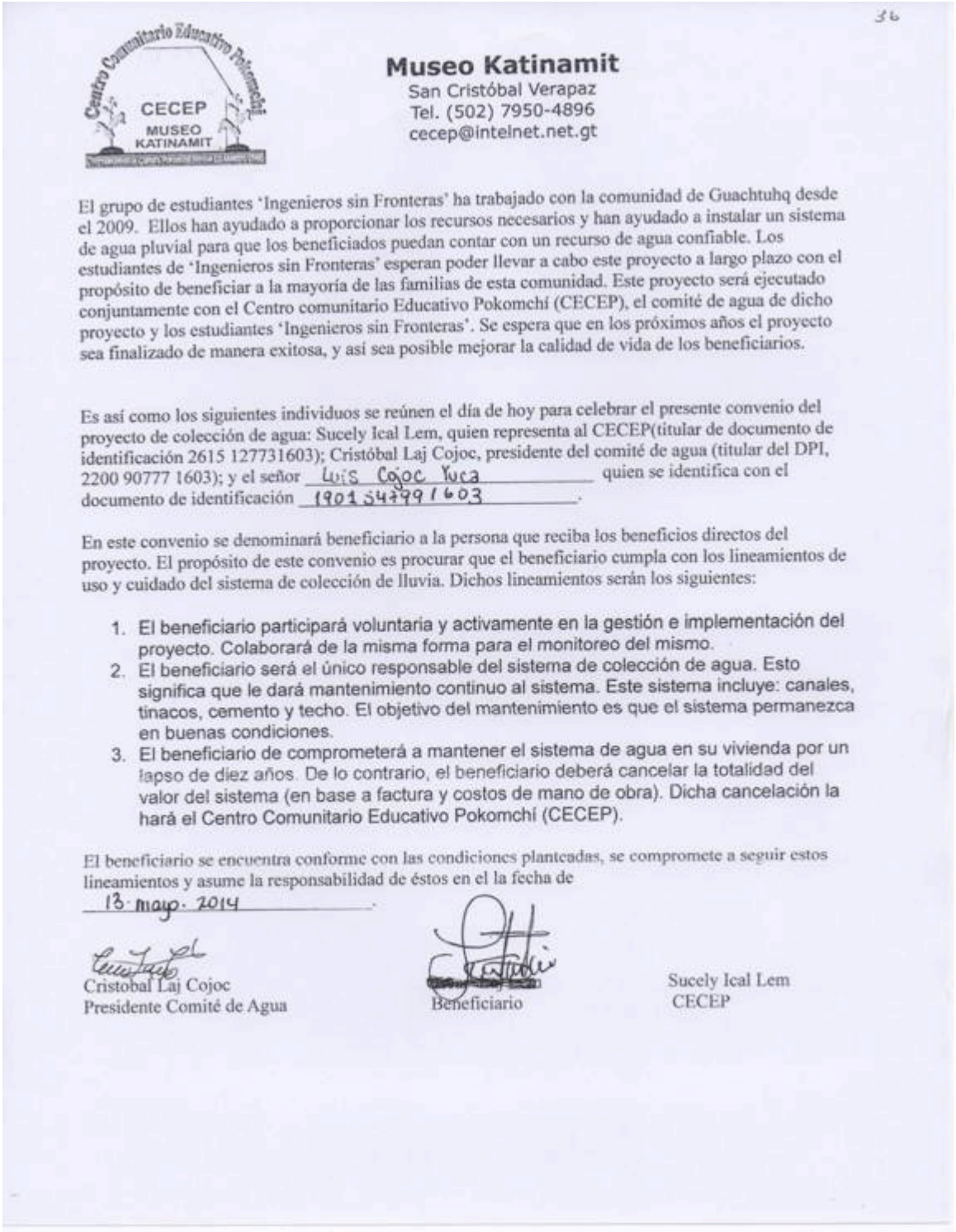
Luis Cojoc Yuca prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2015.

Cristóbal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

Figure 80: House 36 of Louis Gilberto Cojoc Yuja Home Preparation MOU



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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Luis Cojoc Yuca quien se identifica con el documento de identificación 1901 54799 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

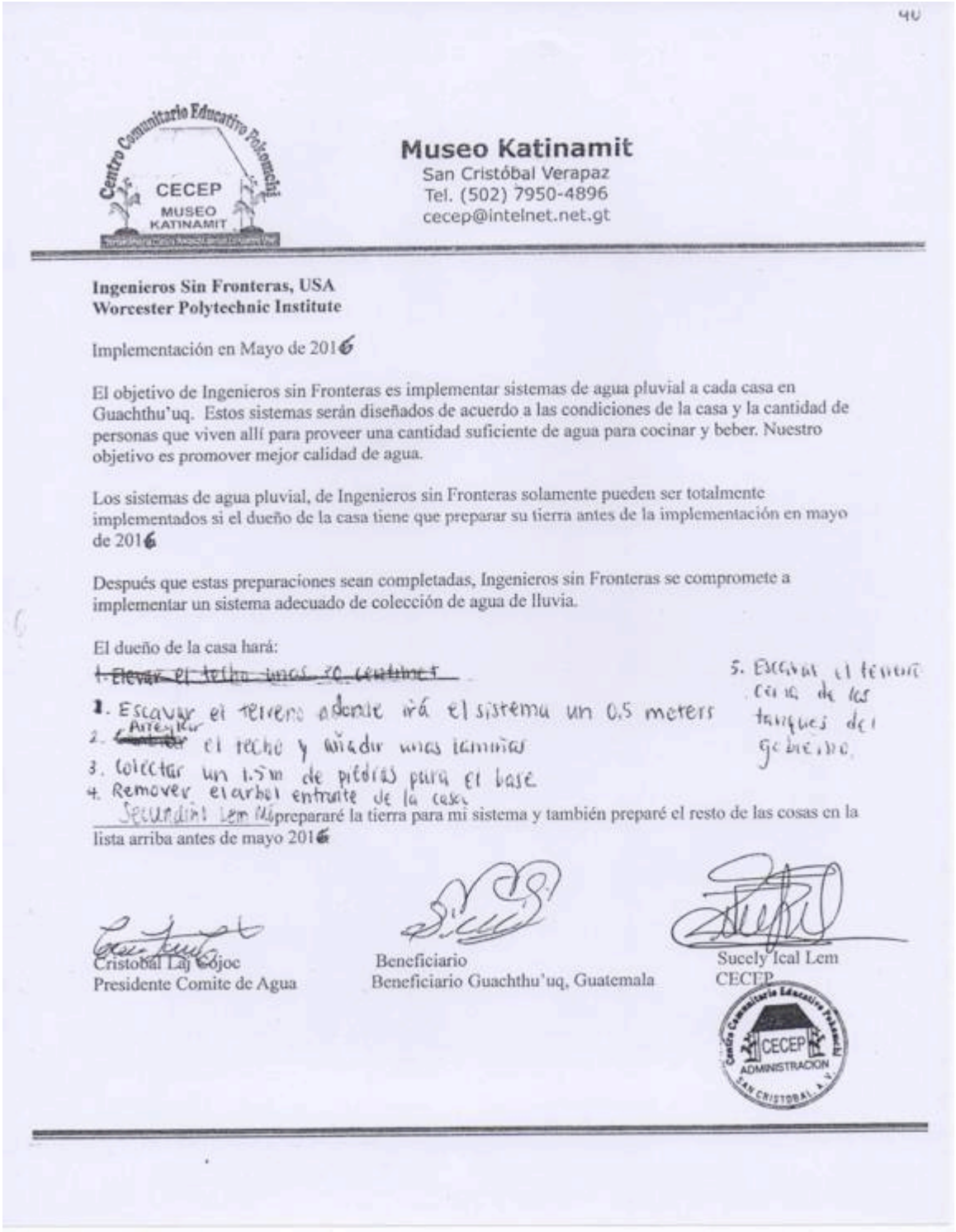
El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 13 mayo 2014.

Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

Sucely Ical Lem
CECEP

Figure 81: House 36 of Louis Gilberto Cojoc Yuja Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de 2016

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Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

~~1. Elevar el techo unos 20 centimet~~

1. Escavar el terreno adonde irá el sistema un 0.5 meters
2. ~~Cambiar~~ Asegurar el techo y añadir unas laminas
3. Colectar un 1.5m de piedras para el base
4. Remover el arbol entrante de la casa
5. Escavar el terreno cerca de los tanques del gobierno.

Secundino Lem Mo prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2016

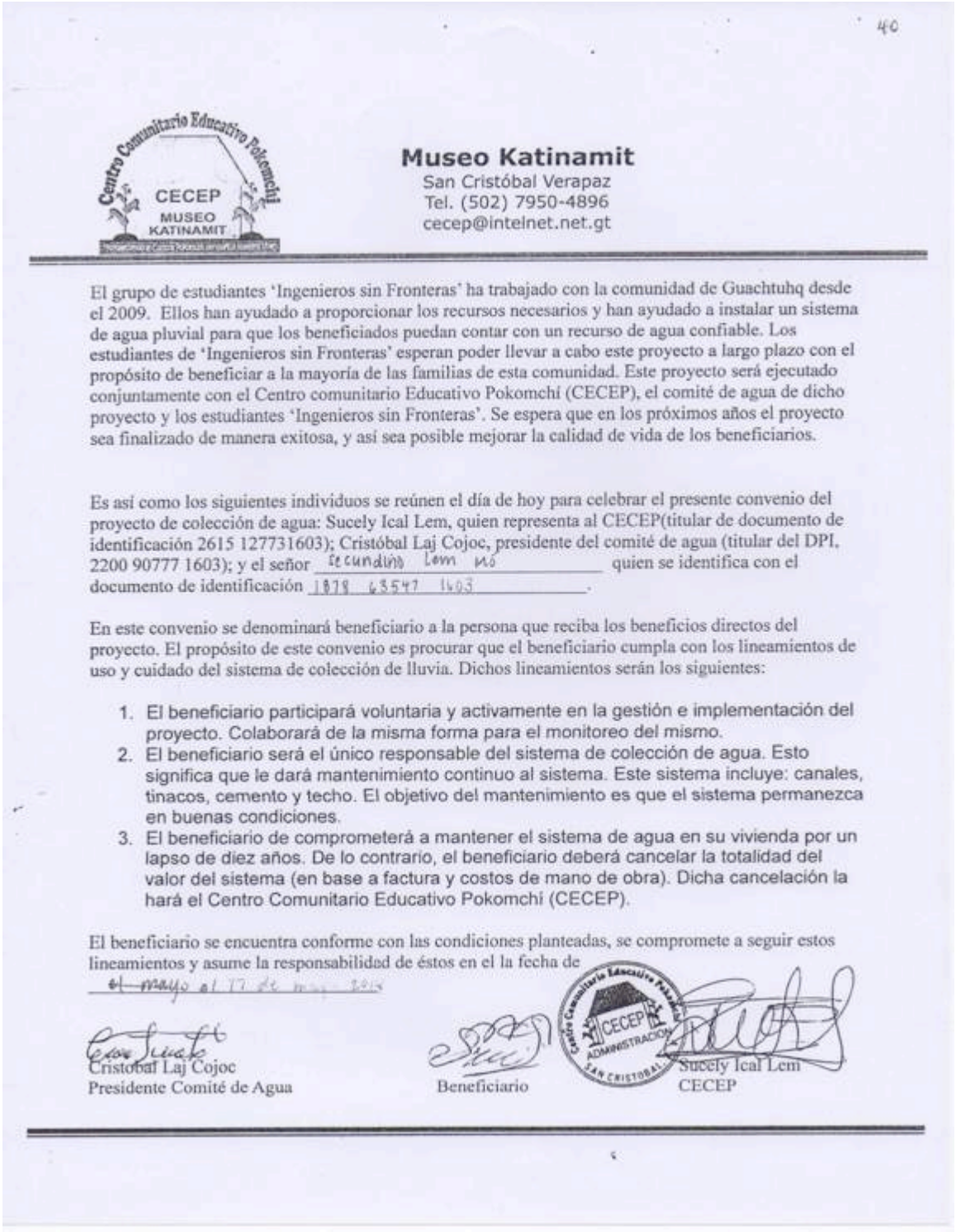
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACION SAN CRISTOBAL, A.V.

Figure 82: House 40 of Secundino Lem Mo Home Preparation MOU



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En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de
el mayo al 17 de mayo 2015

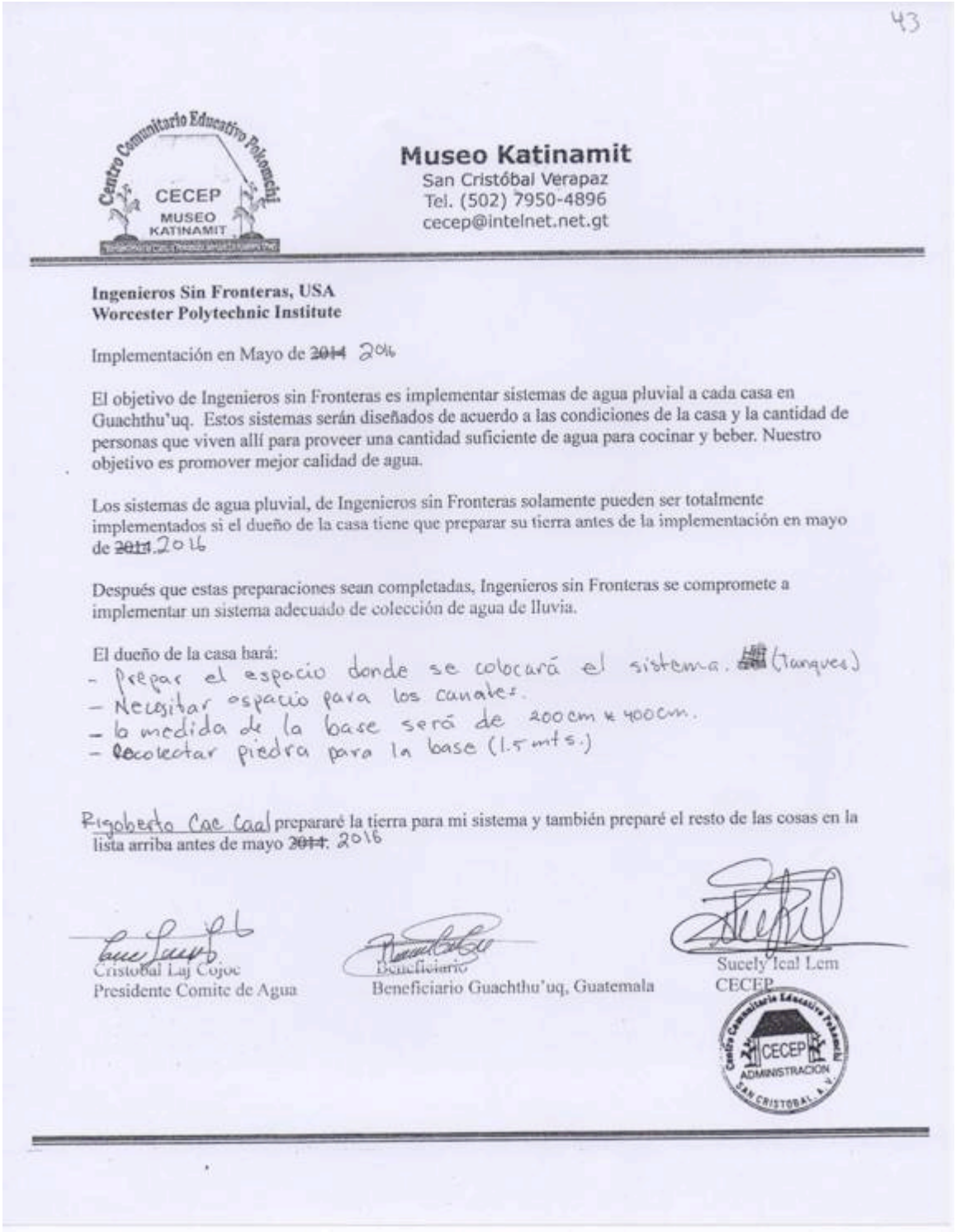
Cristobal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 83: House 40 of Secundino Lem Mo Contract MOU



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Ingenieros Sin Fronteras, USA
Worcester Polytechnic Institute

Implementación en Mayo de ~~2014~~ 2016

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Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de ~~2014~~ 2016

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:
- Prepar el espacio donde se colocará el sistema. (Tanques)
- Necesitar espacio para los canales.
- la medida de la base será de 200cm x 400cm.
- Recolectar piedra para la base (1.5 mts.)

Rigoberto Cac Caal prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo ~~2014~~. 2016

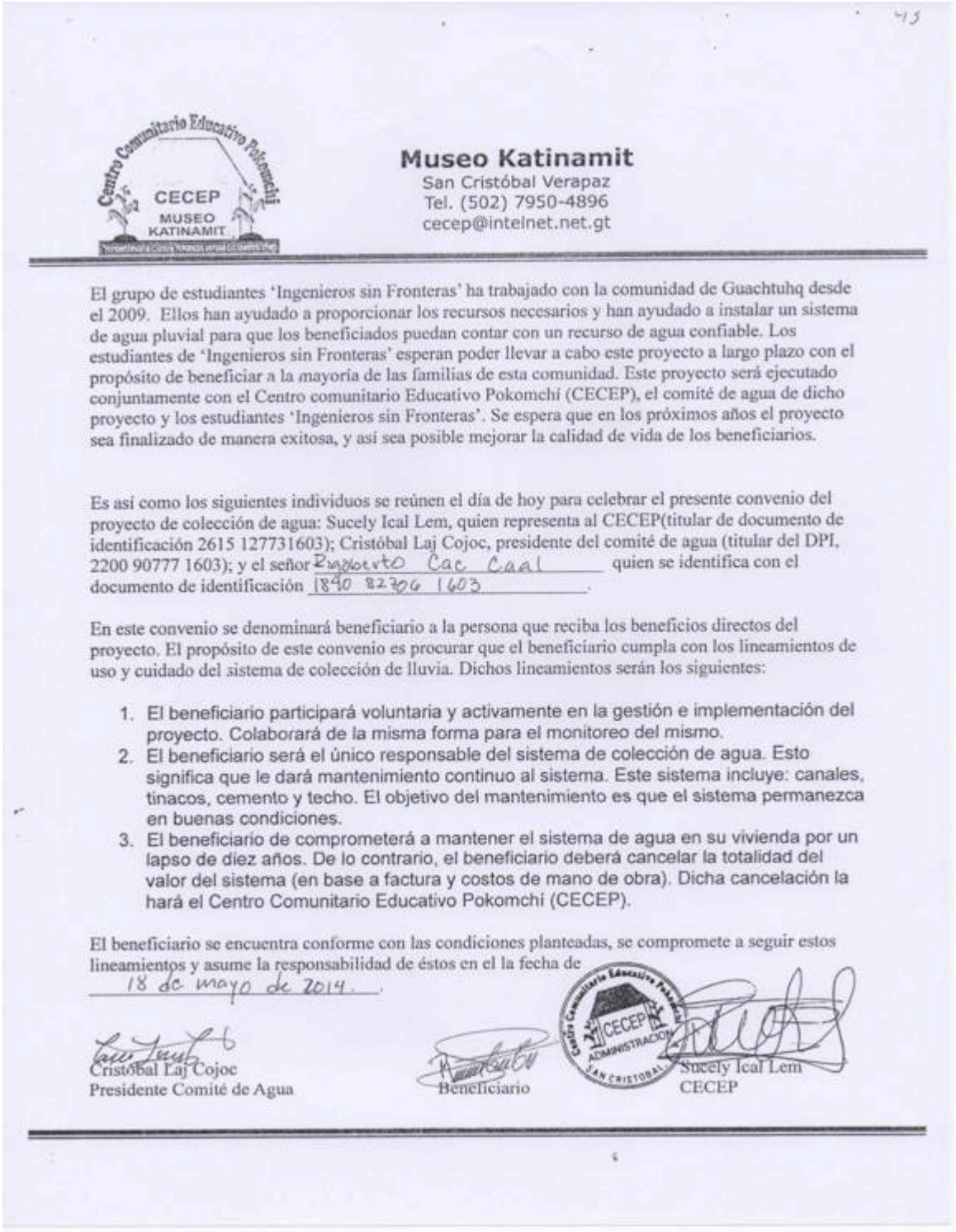
Cristobal Laj Cojoc
Presidente Comite de Agua

Beneficiario
Beneficiario Guachthu'uq, Guatemala

Sucely Ical Lem
CECEP

CECEP ADMINISTRACIÓN SAN CRISTOBAL

Figure 84: House 43 of Rigoberto Cac Caal Home Preparation MOU



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Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor Rigoberto Cac Caal quien se identifica con el documento de identificación 1840 82306 1603.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de 18 de mayo de 2014.

Cristóbal Laj Cojoc
Presidente Comité de Agua

Beneficiario

CECEP ADMINISTRACION SAN CRISTOBAL

Sucely Ical Lem
CECEP

Figure 85: House 43 of Rigoberto Cac Caal Contract MOU

3.0 Appendix C: House 27 System Reconstruction

The family of Cristobal Coy Max (House 27) was asked to leave the land they rented shortly after a system was built at their home in January 2014. The family relocated their house and rainwater harvesting system to a different place in the community. The system was completely reconstructed without aid or knowledge from EWB-USA WPI, and the only issue with the system was the upward facing overflow, a point that was resolved in January 2015.

Figure 86: Original system at the home of Cristobal Coy Max (House 27)

Figure 87: Reconstructed home of Cristobal Coy Max (House 27)

4.0 Appendix D: Monitoring Information from January 2015

House 31:

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean, with divot in the ground
Filter: Clean with strong smell of chlorine

Conversation about the tank:

Only complaint was that there was no water when it wasn't raining, dry for 10-15 days in a row, when there is water in the tank they use it for everything including bathing and washing, it was clarified with the family that this is not how their system was designed
Don't clean the system in the rainy season
Uses the First Flush water to bathe and for the bathroom

House 29:

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean, with divot in the ground
Filter: very dirty and slimy
Old tank in the back feeding off of a government roof that we hadn't made a closed system but did add a FF to
Union on the new gutters leaked

Conversation about the system:

Very happy with the system and have plenty of water
Haven't changed anything, just that the union leaks
Uses the government tank to bathe, uses the EWB tank for drinking and cooking
Don't use the water from the First Flush but do empty it
Cleaned the tanks 20 days ago with a kid, and they conserve all the water when they do

House 28:

Actual Observations:

Gutters: Clean
Tank: Clean, maybe use more chlorine (saw more likely small growth than dirt)
First Flush: full but clean, with divot in the ground
Filter: Clean and odorless
Needs a cap for the small hole at the top of the tank
Gutter continues for ~14" past the downspout, possible stagnant water, and should be cut.

Conversation about the system:

Happy with how the system functions
Gone to the finca 3 times since May to wash clothes
Use the tank only for drinking and use the concrete tank for washing
Haven't changed anything about the system

Use the First Flush water for the bathroom
Washed the tanks a month and a half ago, waited until the water got low to clean it
Cleans the tanks with chlorine and soap

House 26

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean, and inside was non functional
Filter: dirty
Overflow (open) and FF (closed) valves don't work
Needs mosquito netting on the old overflow
Also need a cap for the small hole at the top
.5" male adaptor for faucet broke and so until he buys a new one, no use old tank 15-20 days ago
3 italy valves for the FF and inside

Conversation about the system:

Use the EWB tank for drinking
Use the government tank for washing
Haven't had to go to the finca since May
Use the 55 gallon drums to hold the water when they empty the tanks
Use the First Flush for washing
Clean the tanks on different days but more or less at the same time
Secondary overflow is a problem – when the system is really full, they will angle it down to use the water to wash dishes

House 27

Actual Observations:

Gutters: Clean
Tank: first tank was a bit dirty (dirt accumulation in the bottom), second was cleaner
First Flush: full but clean
Filter: dirty and slimy
We need to drill a hole in the elbow of the first flush because right now it's acting as a siphon

Conversation about the system:

They use the tanks for cooking and drinking
They use the First Flush for bathe
They go to the finca for washing
Empty the First Flush after major rainfall or a couple of smaller rainfalls
When they do have to use the overflow, they put the water in separate containers
Leaks at the old gutter union

House 21

Actual Observations:

Gutters: Clean
Tank: Both tanks have some settled dirt in the bottom

First Flush: full but clean, with divots in the ground
Filter: clean with slight smell of chlorine

Conversation about the system:

System functions well
They use the tank for everything
They use the First Flush for bathing
Not going to the finca at all since May
Cleaned the tanks two times since May
Empty the tank into other containers when they clean it
Said the old roof First Flush would fall when it was opened, not observed
Older brother cleans the tanks
Took down the gutter and cleaned it as well

House 18

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean, with divots in the ground
Filter: Very dirty, smells
Using house 20's roof
Additional gov't tank using small roof gutter

Conversation about the system:

System works well
They cleaned the tanks 2 days previous to the visit for the third time since may
Have only gone to the finca once to wash since May
They keep extra water in small containers when cleaning
They use the First Flush for showering
Have replaced mosquito netting twice
Cleaned with chlorine, noticed that they couldn't get the inside of the tank back to perfect white

House 16:

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean
Filter: clean with slight smell of chlorine

Conversation about the system:

One of the problems is that when they clean it they don't have enough water
Harder for the daughter to clean them because she is getting too big
They empty it out and clean it with chlorine and a brush
Use water in tanks for everything
Don't use the First Flush water
Still go to the finca but not nearly as frequently
When they wash the tanks they wash the filter

House 9

Actual Observations:

Gutters: Clean
Tank: Both EWB tanks were dirty with some settled dirt in the bottom, old government tanks appeared clean
First Flush: full but clean (larger one had cobwebs on the ball valve handle)
Filter: not being used because it was causing a slower flow that continued to get slower as time passed
Tops of old tanks fit poorly and weren't on all the way, was fixed
Old tanks were empty
The overflow pipe in the second new tank had fallen out

Conversation about the system:

Cleaned the gutters the Thursday before
There were problems with the filter- was fixed
Uses the First Flush to wash clothes
When the filter wasn't working they tried to have Roberto fix it
Haven't had to go to finca at all since May 2014
Don't have to find someone to watch their kids when she goes to the finca

House 8

Actual Observations:

Gutters: Clean
Tank: Clean
First Flush: full but clean
Filter: nonexistent

Conversation about the system:

Said the system functioned well
Washed the EWB tank 3 months ago
Washed the government tank twice since may
Cristobal washes them himself
Only gone to the finca twice since may
Use tanks for everything
First Flush for washing clothes
Connections from the gutters to the tank popped out so they glued it in.

House 5

Actual Observations:

Gutters: Clean
Tank: First tank quite dirty, second tank was much cleaner
First Flush: Empty
Filter: clean with slight smell of chlorine
Water is having a capillary effect at the edge of the roof and missing the gutter
Possible to cut and or bend down the roof, thought currently planning on raising the roof

Conversation about the system:

Have not washed or emptied the tank since May, waiting on it to get low before they emptied it
Washed the filter 3 times with chlorine
Empty the First Flush when it rains – use the water to wash and water plants
Lest water sit sometimes before they use it so that dirt can settle out of it
Only gone to the finca once since May to wash clothes
Use the tank for everything
Washed the gutters one month ago

House 1

Actual Observations:

Gutters: Clean
Tank: First tank has some settled dirt, second tank was cleaner
First Flush: full but clean
Filter: clean with slight smell of chlorine

Conversation about the system

Cleaned the tank 5 months ago
Wait for the tanks to empty before cleaning
Use tanks for everything – but prioritize drinking and cooking
Used the finca for the first time since May to wash clothes
Cleaned the gutters – took down and put them back up
Cleaned the filter every 15 days – was torn

5.0 Appendix E: Quotes from building supply stores

Table 3: Materials quote from Salvaje S.A., located 15 minutes from San Cristobal in Santa Cruz

DESCRIPCION	U/M	P.U.	TOTAL
NYLON NEGRO	MTS	Q11.50	Q2,334.50
ALAMBRE DE AMARRE	LBS	Q6.50	Q409.50
VARILLAS DE HIERRO 1/4 7/32 COMERCIAL	VARILLA	Q7.80	Q624.00
CODO PVC DE 2'' PARA AGUA POTABLE	UNIDAD	Q15.00	Q840.00
TEE PVC DE 2'' PARA AGUA POTABLE	UNIDAD	Q12.50	Q462.50
TUBO PVC DE 2'' PARA AGUA POTABLE	UNIDAD	Q69.00	Q2,070.00
REDUCIDOR PVC DE 2X 1 1/2	UNIDAD	Q10.00	Q290.00
TUBO PVC DE 1 1/2 PARA AGUA POTABLE	UNIDAD	Q52.00	Q988.00
ADAPTADOR PVC 1 1/2 MACHO A.P	UNIDAD	Q3.75	Q618.75
CEDAZO MOSQUITERO GALV. METALICO	MTS	Q14.50	Q14.50
UNION PVC DE 2'' PARA DRENAJE	UNIDAD	Q5.00	Q40.00
CODO PVC DE 1 1/2 PARA AGUA POTABLE	UNIDAD	Q5.80	Q313.20
TEE PVC DE 1 1/2 PARA AGUA POTABLE	UNIDAD	Q11.00	Q143.00
REDUCIDOR PVC DE 2X3 PARA DRENAJE	UNIDAD	Q8.25	Q16.50
TUBO PVC DE 3'' PARA DRENAJE	UNIDAD	Q70.00	Q70.00
TUBO PVC DE 4'' PARA DRENAJE	UNIDAD	Q105.00	Q630.00
CODO PVC DE 1 1/2 G45'	UNIDAD	Q5.00	Q640.00
TUBO PVC DE 1 1/4 PARA AGUA POTABLE	UNIDAD	Q38.00	Q570.00
ADAPTADOR PVC 1 1/2 HEMBRA A.P	UNIDAD	Q6.00	Q90.00
CHORRO DE 1/2 CAIMAN	UNIDAD	Q24.00	Q576.00
SERVICIO DE FLETE	VIAJE	Q150.00	Q150.00

División DMC Guatemala, S.A.
1a.Calle 16-97 zona 1 Coban A.V

PROFORMA

Orden Comp:
Fecha: **23/01/2015**
Proforma: 350820
Pagina 1 de 2

Cliente CENTRO EDUCATIVO COMUNITARIO POQOMCHI **Cuenta:** **81827**
Dirección 0 calle 0-33, San Cristobal Verapaz.
Teléfono: 5785 5756 -5 *Nit Cliente: 2016401-7* CONDICIONES DE COMPRA

CODIGO	BODEGA	CANTIDAD	DESCRIPCION DE LA MERCADERIA	U/M	PRECIO UNIT.	TOTAL Q
28647	43	63.00	ALAMBRE DE AMARRE	LIBRA	4.40	277.20
24724	43	975.00	BLOCK (NO ESTRUCTURAL) 14x19x39 25 KGS. PRE	UNIDAD	4.55	4,436.25
34212	43	496.00	BOLSA DE CONCRETO 3001 MAXIPASTA DE 50KG. Coban	UNIDAD	44.00	21,824.00
22236	43	80.00	VARILLA 7/32" X 6.00 MTS	VARILLA	7.40	592.00
24071	43	47.00	BOQUILLA PVC REDONDA 3" PARA CANAL COLONIAL	UNIDAD	30.25	1,421.75
24070	43	47.00	BOQUILLA PVC REDONDA 2" PARA CANAL COLONIAL	UNIDAD	30.25	1,421.75
24068	43	28.00	TAPADERAS PVC PARA CANAL COLONIAL	UNIDAD	16.65	466.20
24081	43	47.00	UNIÓN PVC PARA CANAL COLONIAL	UNIDAD	10.35	486.45
24067	43	11.00	CANAL COLONIAL PVC 6M BLANCO	UNIDAD	278.40	3,062.40
08232	43	56.00	CODO PVC DRENAJE 90 GRADOS 2" PVC	UNIDAD	6.80	380.80
12210	43	37.00	TEE PVC DRENAJE 2" PVC	UNIDAD	9.25	342.25
12454	43	30.00	TUBO PVC BAJADA PLUVIAL 2" PVC	TUBO	46.35	1,390.50
28305	43	29.00	REDUCIDOR PVC LISO 2"X1 1/2" PVC	UNIDAD	16.30	472.70
12442	43	19.00	TUBO PVC 160 PSI 1 1/2" PVC	TUBO	67.50	1,282.50
10578	43	76.00	MULTICONECTOR + VALVULA ESFERA ROTOPLAS	UNIDAD	62.70	4,765.20
28198	43	165.00	ADAPTADOR MACHO PVC 1 1/2" PVC	UNIDAD	4.05	668.25
08396	43	8.00	COPLA PVC DRENAJE 2" PVC	UNIDAD	4.80	38.40
08218	43	54.00	CODO PVC 90 GRADOS LISO 1 1/2" PVC	UNIDAD	5.50	297.00
12196	43	13.00	TEE PVC LISO 1 1/2" PVC	UNIDAD	10.85	141.05
11731	43	2.00	REDUCIDOR PVC DRENAJE 3"X2" PVC	UNIDAD	7.60	15.20
11733	43	26.00	REDUCIDOR PVC DRENAJE 4"X2" PVC	UNIDAD	12.60	327.60
28298	43	17.00	REDUCIDOR PVC DRENAJE 3"X1 1/2" PVC	UNIDAD	6.35	107.95
11733	43	11.00	REDUCIDOR PVC DRENAJE 4"X2" PVC	UNIDAD	12.60	138.60
28298	43	11.00	REDUCIDOR PVC DRENAJE 3"X1 1/2" PVC	UNIDAD	6.35	69.85
12455	43	6.00	TUBO PVC BAJADA PLUVIAL 3" PVC	TUBO	77.40	464.40
12456	43	6.00	TUBO PVC BAJADA PLUVIAL 4" PVC	TUBO	126.00	756.00
17506	43	28.00	LLAVE DE COMPUERTA RED-WHITE 1-1/2" (USA)	UNIDAD	225.00	6,300.00

Figure 88: Quote from Construfacil, Coban, 30 minutes from San Cristobal

División DMC Guatemala, S.A.
1a.Calle 16-97 zona 1 Coban A.V

PROFORMA

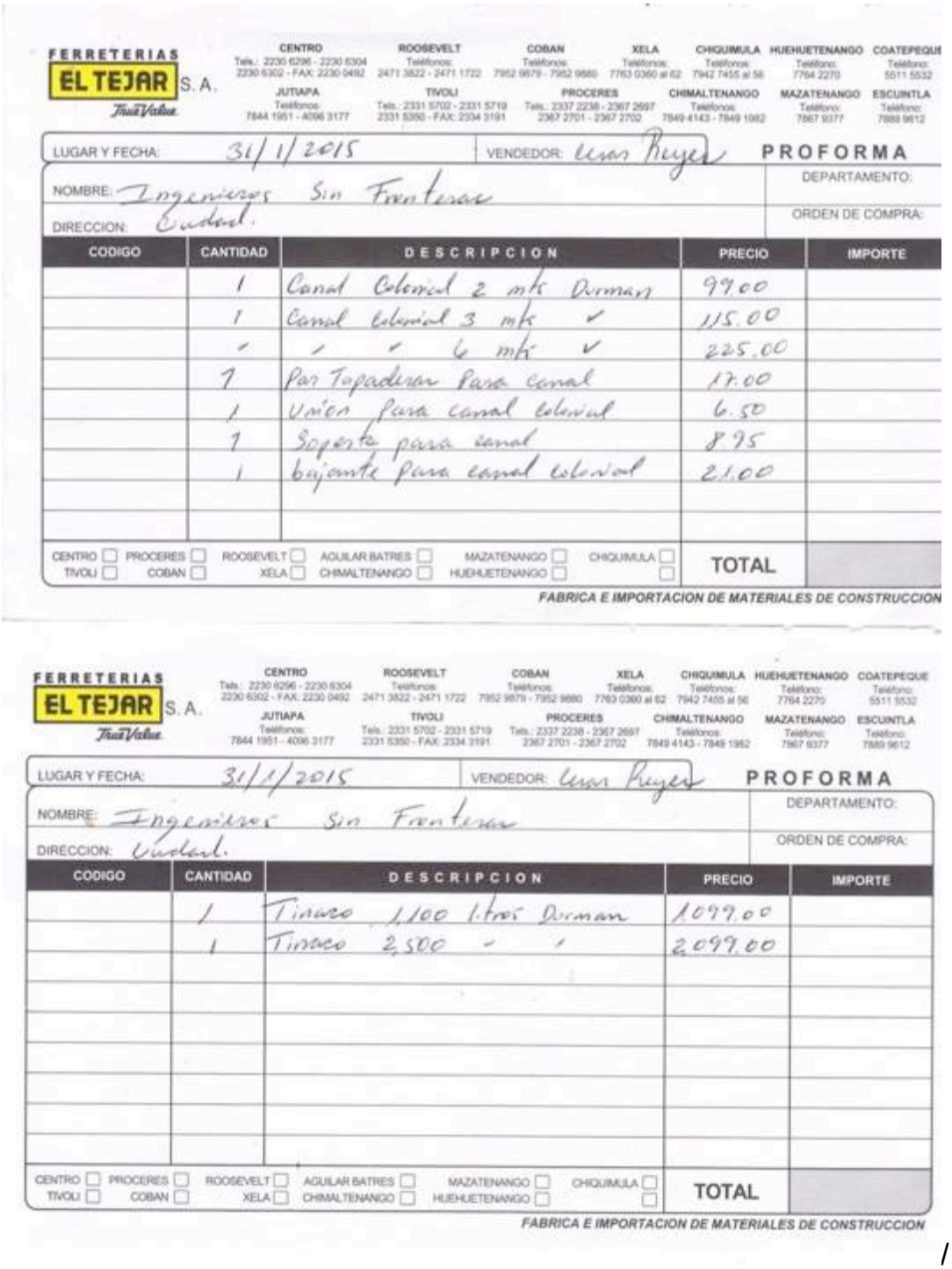
Orden Comp:
Fecha: 23/01/2015
Proforma: 350820
Pagina 2 de 2

Cliente CENTRO EDUCATIVO COMUNITARIO POQOMCHI **Cuenta:** 81827
Dirección 0 calle 0-33, San Cristobal Verapaz.
Teléfono: 5785 5756 -5 *Nit Cliente: 2016401-7* CONDICIONES DE COMPRA

CODIGO	BODEGA	CANTIDAD	DESCRIPCION DE LA MERCADERIA	U/M	PRECIO UNIT.	TOTAL Q
08204	43	128.00	CODO PVC 45 GRADOS 1 1/2" PVC	UNIDAD	7.90	1,011.20
08393	43	6.00	COPLA PVC DRENAJE 3" PVC	UNIDAD	10.00	60.00
08394	43	50.00	COPLA PVC DRENAJE 4" PVC	UNIDAD	18.30	915.00
12442	43	15.00	TUBO PVC 160 PSI 1 1/2" PVC	TUBO	67.50	1,012.50
06968	43	15.00	ADAPTADOR HEMBRA PVC 1 1/2" PVC	UNIDAD	4.00	60.00
08395	43	1.00	COPLA PVC DRENAJE 1 1/2" PVC	UNIDAD	6.00	6.00
29783	43	24.00	LLAVE CHORRO DE 1/2" PVC BLANCO CASTEL	UNIDAD	26.00	624.00
08481	43	36.00	DEPOSITO AGUA M/AGUA 2500LTS ROTOPLAS	UNIDAD	2,430.00	87,480.00
20421	43	1.00	TAPON PVC MACHO C/ROSCA DE 2"	UNIDAD	19.50	19.50
10642	43	225.00	NYLON 72 X 6 NEGRO	YARDA	10.10	2,272.50
31509	43	1.00	CEDAZO MOSQUITERO FIBRA DE VIDRIO 1/16 VERDE (YARD	YARDA	4.70	4.70

Ultima Línea

Figure 89: Quote from Construfacil continued



FERRETERIAS EL TEJAR S. A. True Value

CENTRO Tels.: 2230 6296 - 2230 6304 2230 6302 - FAX: 2230 0492 | ROOSEVELT Teléfonos: 2471 3822 - 2471 1722 | COBAN Teléfonos: 7952 9879 - 7952 9880 | XELA Teléfonos: 7763 0360 al 62 | CHIQUIMULA Teléfonos: 7942 7455 al 56 | HUEHUETENANGO Teléfono: 7764 2270 | COATEPEQUE Teléfono: 5511 5532

JUTIAPA Teléfonos: 7844 1951 - 4096 3177 | TIVOLI Tels.: 2331 5702 - 2331 5719 2331 5350 - FAX: 2334 3191 | PROCERES Tels.: 2337 2238 - 2367 2697 2367 2701 - 2367 2702 | CHIMALTENANGO Teléfonos: 7849 4143 - 7849 1982 | MAZATENANGO Teléfono: 7867 9377 | ESCUINTLA Teléfono: 7889 9612

LUGAR Y FECHA: 31/1/2015 VENDEDOR: Luis Reyes **PROFORMA**

NOMBRE: Ingenieros Sin Fronteras DEPARTAMENTO:

DIRECCION: Ciudad. ORDEN DE COMPRA:

CODIGO	CANTIDAD	DESCRIPCION	PRECIO	IMPORTE
	1	Canal Colonial 2 mts Dirman	99.00	
	1	Canal Colonial 3 mts ✓	115.00	
	1	" " 6 mts ✓	225.00	
	1	Par Tapaderas Para canal	17.00	
	1	Unión para canal colonial	6.50	
	1	Soporte para canal	8.95	
	1	bajante para canal colonial	21.00	

CENTRO ☐ PROCERES ☐ ROOSEVELT ☐ AGUILAR BATRES ☐ MAZATENANGO ☐ CHIQUIMULA ☐
TIVOLI ☐ COBAN ☐ XELA ☐ CHIMALTENANGO ☐ HUEHUETENANGO ☐

TOTAL

FABRICA E IMPORTACION DE MATERIALES DE CONSTRUCCION

FERRETERIAS EL TEJAR S. A. True Value

CENTRO Tels.: 2230 6296 - 2230 6304 2230 6302 - FAX: 2230 0492 | ROOSEVELT Teléfonos: 2471 3822 - 2471 1722 | COBAN Teléfonos: 7952 9879 - 7952 9880 | XELA Teléfonos: 7763 0360 al 62 | CHIQUIMULA Teléfonos: 7942 7455 al 56 | HUEHUETENANGO Teléfono: 7764 2270 | COATEPEQUE Teléfono: 5511 5532

JUTIAPA Teléfonos: 7844 1951 - 4096 3177 | TIVOLI Tels.: 2331 5702 - 2331 5719 2331 5350 - FAX: 2334 3191 | PROCERES Tels.: 2337 2238 - 2367 2697 2367 2701 - 2367 2702 | CHIMALTENANGO Teléfonos: 7849 4143 - 7849 1982 | MAZATENANGO Teléfono: 7867 9377 | ESCUINTLA Teléfono: 7889 9612

LUGAR Y FECHA: 31/1/2015 VENDEDOR: Luis Reyes **PROFORMA**

NOMBRE: Ingenieros Sin Fronteras DEPARTAMENTO:

DIRECCION: Ciudad. ORDEN DE COMPRA:

CODIGO	CANTIDAD	DESCRIPCION	PRECIO	IMPORTE
	1	Tinaco 1,100 Litros Dirman	1099.00	
	1	Tinaco 2,500 " "	2099.00	

CENTRO ☐ PROCERES ☐ ROOSEVELT ☐ AGUILAR BATRES ☐ MAZATENANGO ☐ CHIQUIMULA ☐
TIVOLI ☐ COBAN ☐ XELA ☐ CHIMALTENANGO ☐ HUEHUETENANGO ☐

TOTAL

FABRICA E IMPORTACION DE MATERIALES DE CONSTRUCCION

/

Figure 90: Materials quote El Tejar

6.0 Appendix F: EWB-USA WPI RWH System Maintenance Manual

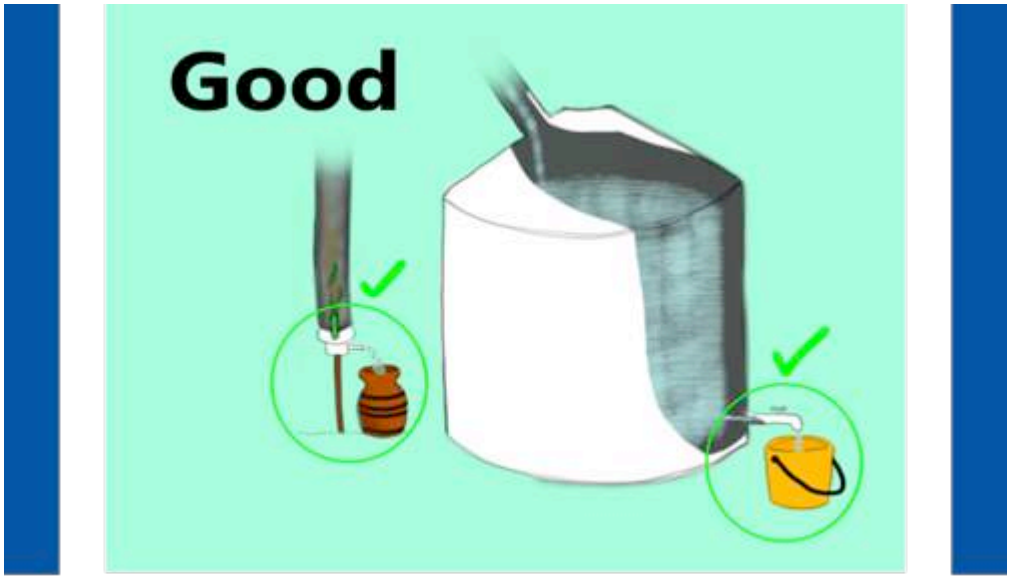
Figure 91: Rainwater Harvesting System Maintenance Manual

This education manual was distributed to every family in the community, regardless of their status as a system owner. The diagrams used on each page were further explained on a house-to-house basis.

Figure 92: Boiling Water

The first page in the manual depicts the most important message: boil water. Until the team can guarantee that tank water is potable, boiling water is an excellent precaution to prevent illness. Thankfully, this message is something that has been reinforced culturally for years. Based on information gathered through community interviews, nearly every family knew to boil their water

before the EWB-USA WPI team first arrived. The reason this message is still included in the booklet is due to its importance.



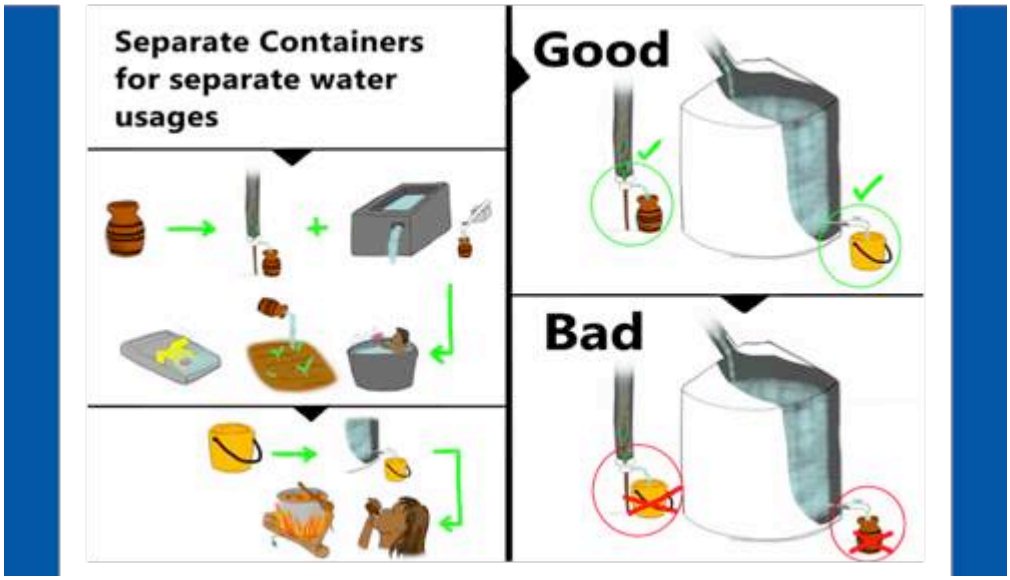


Figure 93: Separation of Containers

The next two pages encourage the practice of separation of containers. It is important to use separate containers to collect water from the tanks (cleaner), the first flush (less clean), and the finca (dirty) to reduce cross-contamination. Each water source also has its specific uses (diagramed on the bottom page).

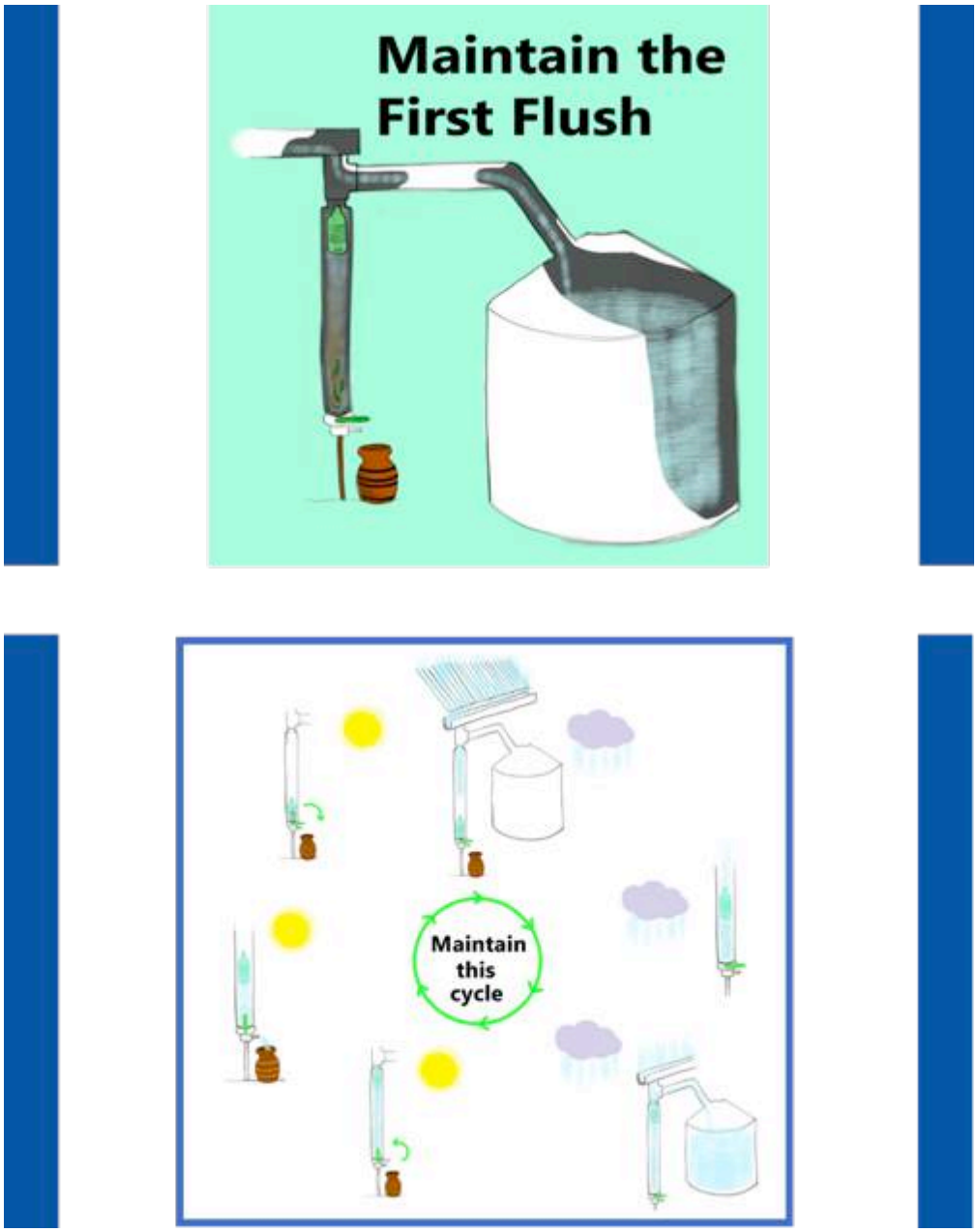


Figure 94: First Flush Unit Maintenance

In order for the first flush to effectively serve as the initial catchment for dirty water, the system must be maintained regularly with the weather. These pages emphasize the importance of taking action to maintain the first flush as weather dictates. Much like the education system used for communicating separation of containers, description and demonstration were used to further explain this process.

Figure 95: Filter Maintenance

Maintaining the sediment filter is simple, but something easy to neglect. This diagram encourages regular cleaning of this filter, as seen in the miniature calendar. Families who received systems in prior years have already become acquainted with the idea of cleaning this filter and do so regularly. Hopefully, the trend will continue.

Figure 96: Tanks Cleaning and Maintenance

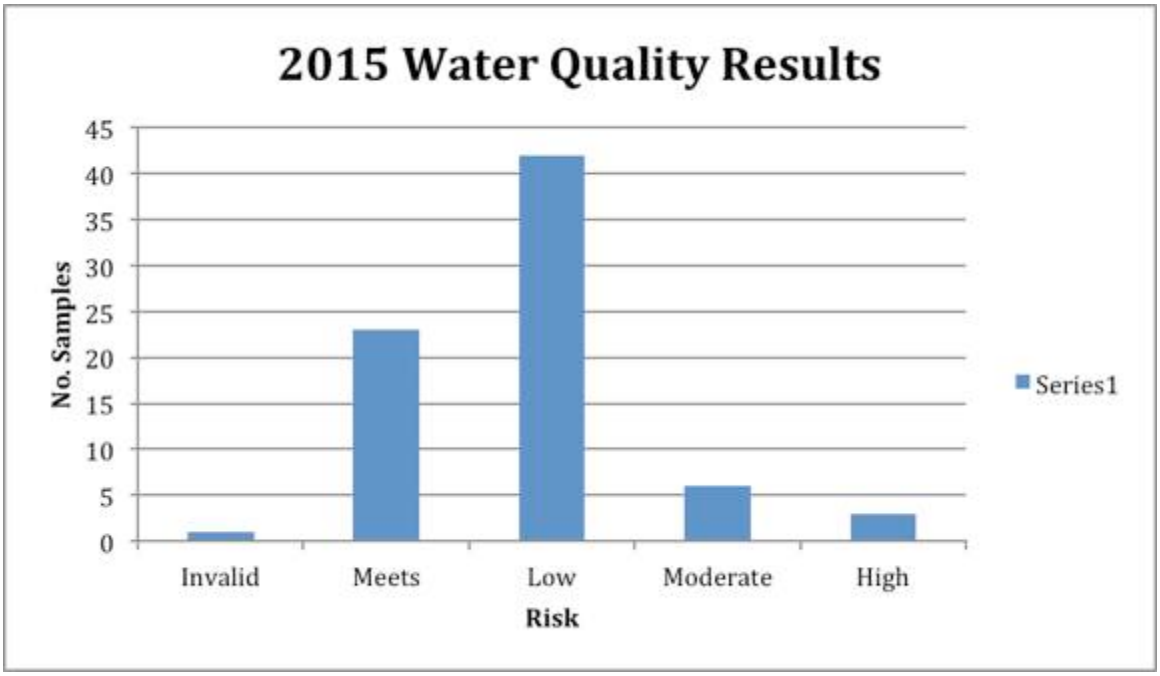
The tanks themselves must also be regularly cleaned. Ideally, at the start of the rainy season, every family will chlorinate their tank water as pictured above. The reason for this timing is that the increased rainfall will be able to flush out the chlorine through the overflow more quickly, thereby removing the chlorine flavor from the water faster. Overall, this concept is a difficult one for community members to agree with as water is such a precious resource, sacrificing any amount of it for cleaning purposes sounds unreasonable. To make the process seem less

painful and more familiar, the team cleaned a few of the older tanks with various families throughout the community by completely emptying the tanks and scrubbing the interiors.

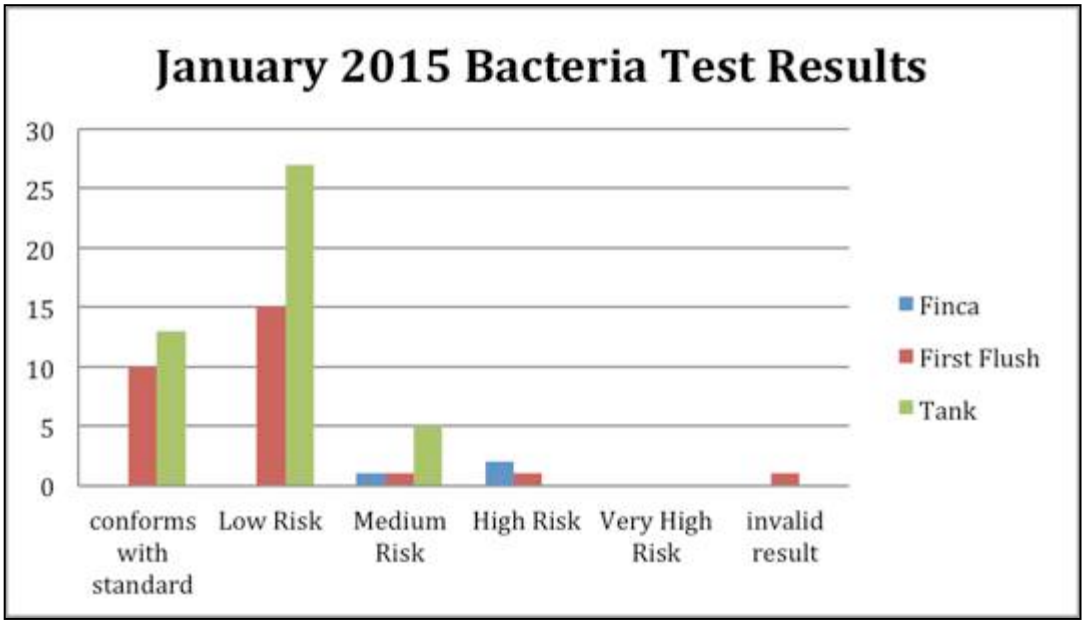
7.0 Appendix G: January 2015 Water Quality Data

Date	Number	Location	Yellow/Clear	Fluoresce	Blue Colonies	Red Colonies	Number	Notes
1/6/2015	1	House 1 EWB Tank	clear	no	0	TMC	1	
1/6/2015	2	House 1 EWB Tank	clear	no	0	TMC	2	
1/6/2015	3	House 1 EWB Tank	clear	no	0	2	3	
1/6/2015	4	House 1 EWB First Flush	clear	no	0	11	4	
1/6/2015	5	House 1 EWB First Flush	clear	no	0	TMC	5	
1/6/2015	6	House 1 EWB First Flush	clear	no	0	TMC	6	
1/6/2015	7	House 5 EWB Tank	clear	no	0	2	7	
1/6/2015	8	House 5 EWB Tank	clear	no	0	0	8	
1/6/2015	9	House 5 EWB Tank	clear	no	0	0	9	
1/6/2015	10	House 5 EWB First Flush	yellow	no	0	TMC	10	
1/6/2015	11	House 5 EWB First Flush	yellow	no	0	TMC	11	
1/6/2015	12	House 5 EWB First Flush	yellow	no	0	TMC	12	
1/6/2015	13	House 8 EWB Tank	yellow	no	0	3	13	2 counts illegible (red colonies)
1/6/2015	14	House 8 EWB Tank	clear	no	0	4	14	
1/6/2015	15	House 8 EWB Tank	clear	no	0	3	15	
1/6/2015	16	House 8 EWB First Flush	clear	no	0	33	16	
1/6/2015	17	House 8 EWB First Flush	clear	no	0	40	17	
1/6/2015	18	House 8 EWB First Flush	clear	no	0	29	18	
1/6/2015	19	House 27 EWB Tank	yellow	no	0	4	19	
1/6/2015	20	House 27 EWB Tank	yellow	no	0	11	20	
1/6/2015	21	House 27 EWB Tank	yellow	no	0	12	21	
1/6/2015	22	House 27 First Flush	yellow	flouresce	0	22	22	
1/6/2015	23	House 27 First Flush	yellow	no	0	24	23	
1/6/2015	24	House 27 First Flush	yellow	no	0	18	24	
1/6/2015	25	House 30 Gov't Tank	yellow	no	0	28	25	
1/6/2015	26	House 30 Gov't Tank	yellow	no	0	23	26	
1/6/2015	27	House 30 Gov't Tank	yellow	no	0	31	27	
1/6/2015	28	House 30 Concrete Tank	yellow	flouresce	1	40	28	
1/6/2015	29	House 30 Concrete Tank	yellow	flouresce	0	29	29	
1/6/2015	30	House 30 Concrete Tank	yellow	flouresce	0	30	30	
1/6/2015	31	Alfonso EWB Tank	yellow	no	0	7	31	
1/6/2015	32	Alfonso EWB Tank	yellow	no	0	4	32	
1/6/2015	33	Alfonso EWB Tank	yellow	no	0	NR	33	
1/6/2015	34	Alfonso First Flush	yellow	no	0	6	34	Where first flush leads not recorded
1/6/2015	35	Alfonso First Flush	yellow	no	0	16	35	Where first flush leads not recorded
1/6/2015	36	Alfonso First Flush	yellow	no	0	9	36	Where first flush leads not recorded
1/6/2015	37	Alfonso Concrete Tank	yellow	no	0	18	37	
1/6/2015	38	Alfonso Concrete Tank	yellow	no	0	38	38	
1/6/2015	39	Alfonso Concrete Tank	yellow	no	0	49	39	
1/6/2015	40	Finca	yellow	flouresce	1	65	40	
1/6/2015	41	Finca	yellow	flouresce	1	60	41	
1/6/2015	42	Finca	yellow	flouresce	0	81	42	
1/6/2015	43	Midwife EWB Tank	yellow	no	0	8	43	
1/6/2015	44	Midwife EWB Tank	yellow	no	0	8	44	
1/6/2015	45	Midwife EWB Tank	yellow	no	0	7	45	
1/6/2015	46	Midwife EWB First Flush	yellow	flouresce	0	27	46	
1/6/2015	47	Midwife EWB First Flush	yellow	no	0	25	47	
1/6/2015	48	Midwife EWB First Flush	yellow	no	0	20	48	
1/6/2015	49	Midwife Gov't Tank	yellow	no	0	10	49	
1/6/2015	50	Midwife Gov't Tank	clear	no	0	6	50	
1/6/2015	51	Midwife Gov't Tank	clear	no	0	8	51	
1/6/2015	52	Midwife Gov't First Flush	yellow	no	0	19	52	The major red colonies were counted. TMC for minor colonies
1/6/2015	53	Midwife Gov't First Flush	clear	no	0	20	53	The major red colonies were counted. TMC for minor colonies. One count illegible (red colonies).
1/6/2015	54	Midwife Gov't First Flush	clear	no	1	23	54	The major red colonies were counted. TMC for minor colonies
1/6/2015	55	Miguel EWB Tank	yellow	no	0	12	55	
1/6/2015	56	Miguel EWB Tank	yellow	no	0	13	56	
1/6/2015	57	Miguel EWB Tank	yellow	no	0	10	57	
1/6/2015	58	Miguel Gov't Tank	clear	no	0	12	58	
1/6/2015	59	Miguel Gov't Tank	clear	no	0	16	59	
1/6/2015	60	Miguel Gov't Tank	clear	no	0	8	60	
1/6/2015	61	Miguel Gov't First Flush	clear	no	0	0	61	
1/6/2015	62	Miguel Gov't First Flush	clear	no	0	0	62	
1/6/2015	63	Miguel Gov't First Flush	clear	no	0	NR	63	
1/6/2015	64	Ricardo EWB Tank	yellow	no	0	40	64	2 counts illegible (red colonies)
1/6/2015	65	Ricardo EWB Tank	yellow	no	0	67	65	2 counts illegible (red colonies)
1/6/2015	66	Ricardo EWB Tank	yellow	no	0	120	66	2 counts illegible (red colonies)
1/6/2015	67	Ricardo First Flush	yellow	no	0	6	67	Where first flush leads to was not recorded
1/6/2015	68	Ricardo First Flush	yellow	no	0	10	68	Where first flush leads to was not recorded
1/6/2015	69	Ricardo First Flush	yellow	no	0	15	69	Where first flush leads to was not recorded
1/6/2015	70	Ricardo Gov't Tank	yellow	no	0	28	70	
1/6/2015	71	Ricardo Gov't Tank	yellow	no	0	23	71	
1/6/2015	72	Ricardo Gov't Tank	yellow	no	0	32	66	
1/6/2015	73	Willy's Gov't Tank	yellow	flouresce	0	37	73	
1/6/2015	74	Willy's Gov't Tank	yellow	no	0	12	74	1 count illegible (red colonies)
1/6/2015	75	Willy's Gov't Tank	yellow	no	0	36	75	

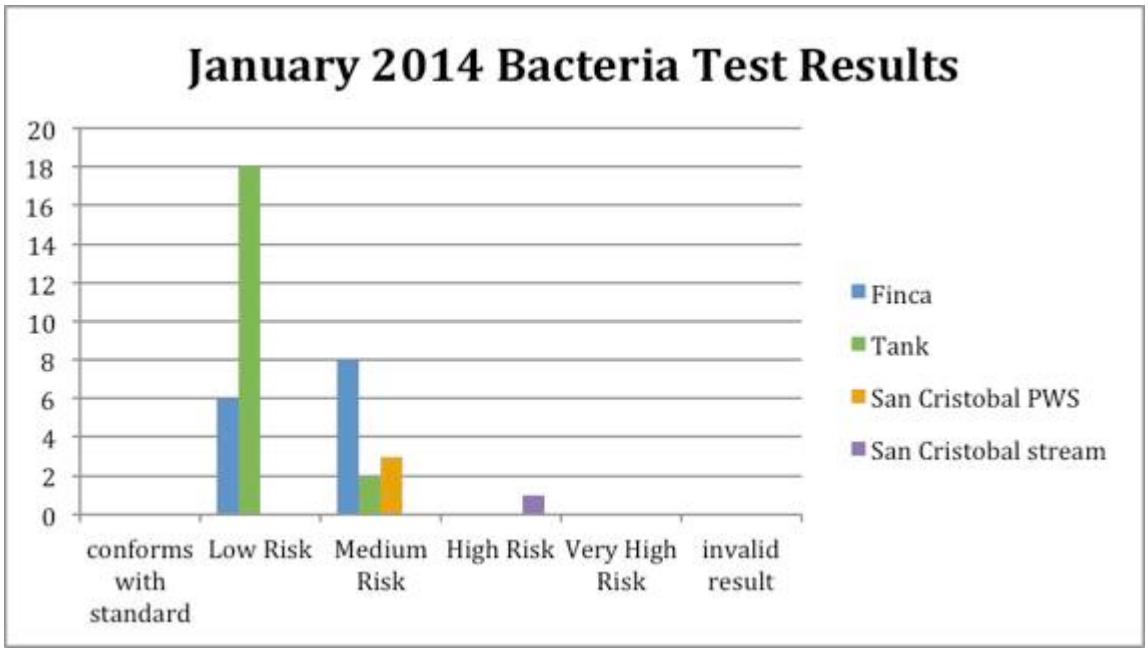
8.0 Appendix H: Water Quality Graphs



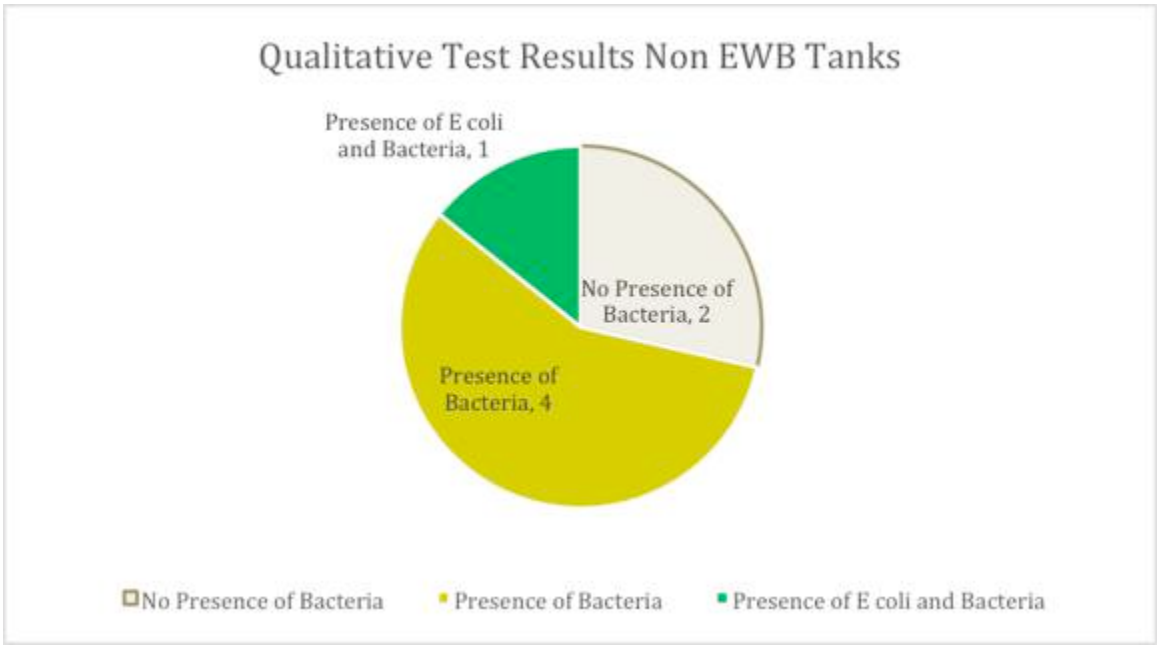
Graph 1: This Graph shows the distribution of the risk levels associated with the amount of bacteria found in the water sources tested in January 2015 according to Health Organization's Guidelines for Drinking Water Quality (2nd Edition).



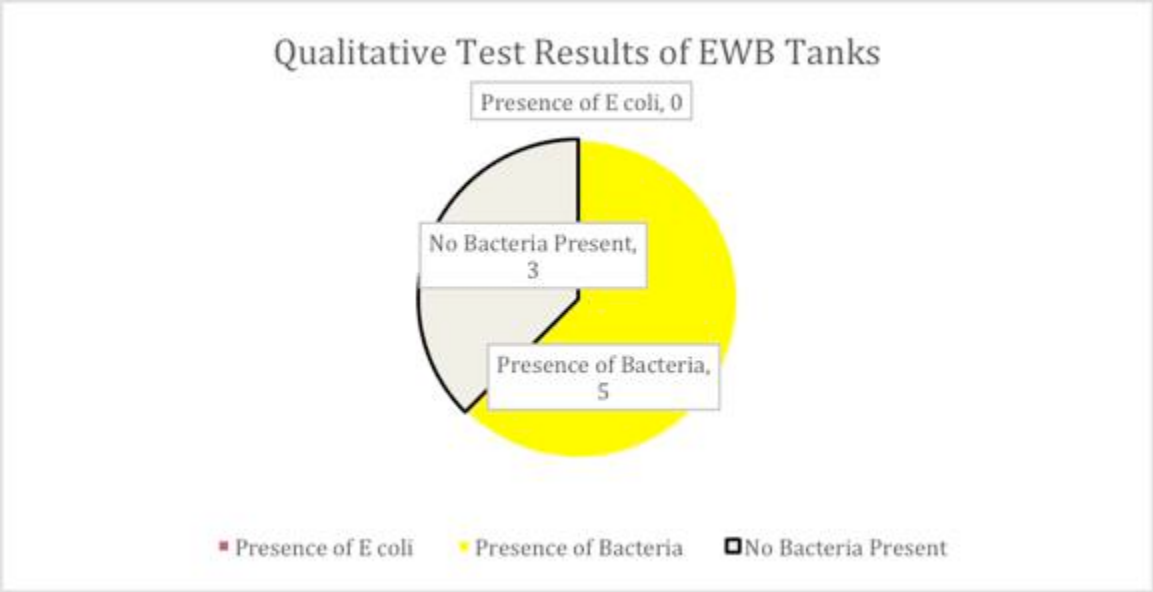
Graph 2: This graph shows the risk levels divided up into more specific units and showing which parts of the system were showing up under each risk level.



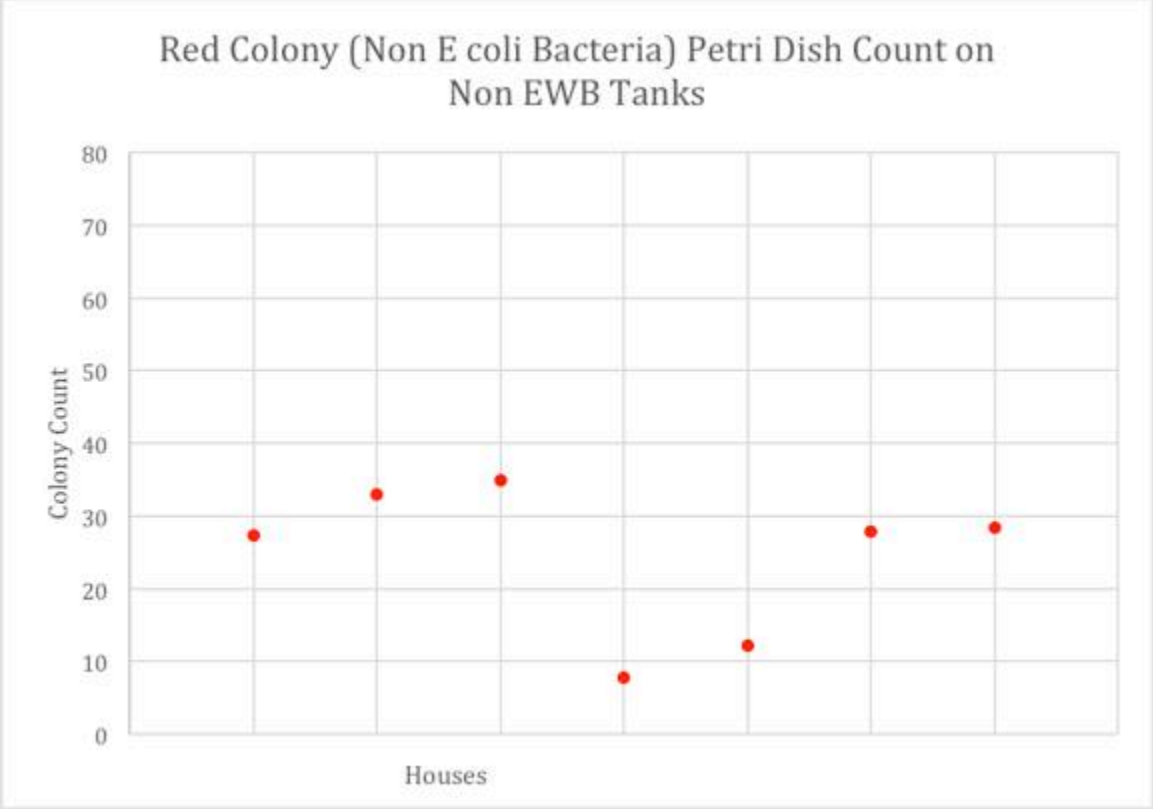
Graph 3: This is a graph from the January 2014 water quality tests to be used to compare to Graph 2 with the data from January 2015.



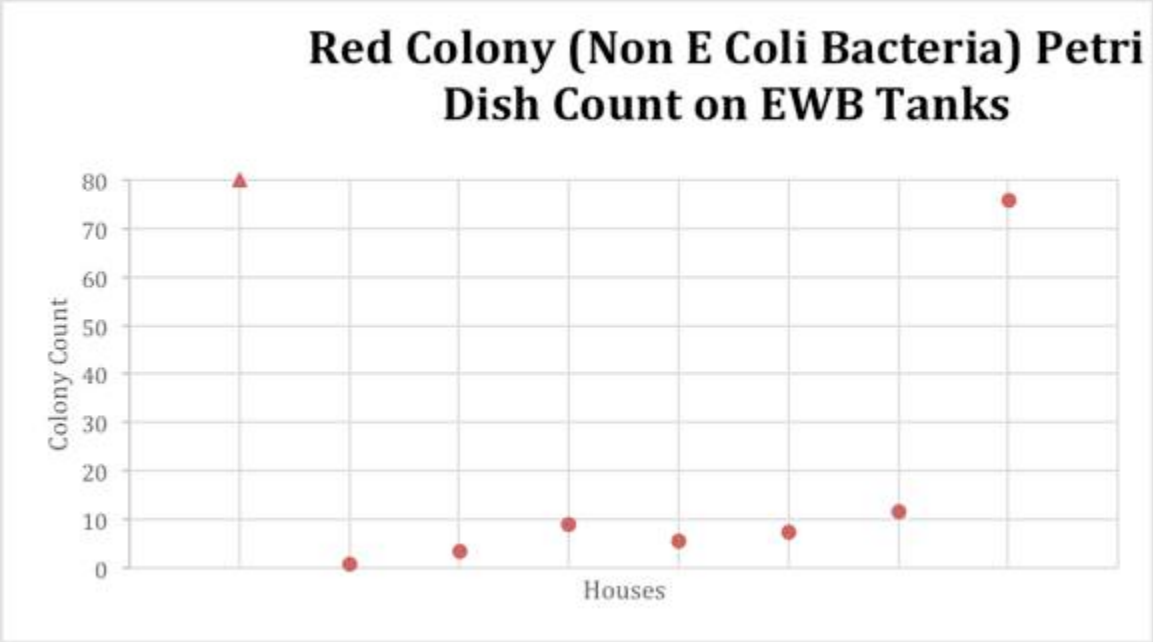
Graph 4: This graph breaks down the presence of bacteria in each of the non-EWB-USA WPI systems and the finca.



Graph 5: This graph shows the bacteria count for the EWB-USA WPI implemented systems.



Graph 6: This graph visually represents the bacteria counts for each of the non-EWB-USA WPI systems.



Graph 7: This graph visually represents the bacteria counts for each of the EWB-USA WPI systems.

9.0 Appendix I: Water Quality (WQ) Planned Testing Locations

Table 4: Record table for Colilert and Petrifilm WQ test results

EWB-USA WPI May 2015 Assessment Water Quality Information Colilert E. Coli PML

Date	Number	Location	Yellow/Clear	Fluoresce	Blue Colonies	Red Colonies
	1	Finca				
	2	Finca				
	3	Finca				
	4	House 1 EWB Tank				
	5	House 1 EWB Tank				
	6	House 1 EWB Tank				
	7	House 1 EWB First Flush				
	8	House 1 EWB First Flush				
	9	House 1 EWB First Flush				
	10	House 5 EWB Tank				
	11	House 5 EWB Tank				
	12	House 5 EWB Tank				
	13	House 5 EWB First Flush				
	14	House 5 EWB First Flush				
	15	House 5 EWB First Flush				
	16	House 6 Government Tank				
	17	House 6 Government Tank				
	18	House 6 Government Tank				
	19	House 6 Government First Flush				
	20	House 6 Government First Flush				
	21	House 6 Government First Flush				
	22	House 8 EWB Tank				
	23	House 8 EWB Tank				
	24	House 8 EWB Tank				
	25	House 8 EWB First Flush				
	26	House 8 EWB First Flush				
	27	House 8 EWB First Flush				
	28	House 9 EWB Tank				
	29	House 9 EWB Tank				
	30	House 9 EWB Tank				
	31	House 9 EWB First Flush				
	32	House 9 EWB First Flush				
	33	House 9 EWB First Flush				
	34	House 9 Gov't Tank				
	35	House 9 Gov't Tank				
	36	House 9 Gov't Tank				
	37	House 9 Gov't First Flush				
	38	House 9 Gov't First Flush				
	39	House 9 Gov't First Flush				
	40	Houes 12 Concrete Tank				
	41	Houes 12 Concrete Tank				
	42	Houes 12 Concrete Tank				
	43	House 16 EWB Tank				
	44	House 16 EWB Tank				

Table 5: Water quality test record sheet continued

EWB-USA WPI May 2015 Assessment Water Quality Information Colilert E. Coli PML

	45	House 16 EWB Tank				
	46	House 16 EWB First Flush				
	47	House 16 EWB First Flush				
	48	House 16 EWB First Flush				
	49	House 18 EWB Tank				
	50	House 18 EWB Tank				
	51	House 18 EWB Tank				
	52	House 18 EWB First Flush				
	53	House 18 EWB First Flush				
	54	House 18 EWB First Flush				
	55	House 21 EWB Tank				
	56	House 21 EWB Tank				
	57	House 21 EWB Tank				
	58	House 21 Gov't Tank				
	59	House 21 Gov't Tank				
	60	House 21 Gov't Tank				
	61	House 21 Gov't First Flush				
	62	House 21 Gov't First Flush				
	63	House 21 Gov't First Flush				
	64	House 23a Government Tank				
	65	House 23a Government Tank				
	66	House 23a Government Tank				
	67	House 23a Government First Flush				
	68	House 23a Government First Flush				
	69	House 23a Government First Flush				
	70	House 26 EWB Tank				
	71	House 26 EWB Tank				
	72	House 26 EWB Tank				
	73	House 26 First Flush				
	74	House 26 First Flush				
	75	House 26 First Flush				
	76	House 27 EWB Tank				
	77	House 27 EWB Tank				
	78	House 27 EWB Tank				
	79	House 27 First Flush				
	80	House 27 First Flush				
	81	House 27 First Flush				
	82	House 28 EWB Tank				
	83	House 28 EWB Tank				
	84	House 28 EWB Tank				
	85	House 28 First Flush				
	86	House 28 First Flush				
	87	House 28 First Flush				
	88	House 28 Concrete Tank				
	89	House 28 Concrete Tank				
	90	House 28 Concrete Tank				
	91	House 29 EWB Tank				

Table 6: Water quality test record table continued

EWB-USA WPI May 2015 Assessment Water Quality Information Colilert E. Coli PML

	92	House 29 EWB Tank				
	93	House 29 EWB Tank				
	94	House 29 First Flush				
	95	House 29 First Flush				
	96	House 29 First Flush				
	97	House 29 Gov't Tank				
	98	House 29 Gov't Tank				
	99	House 29 Gov't Tank				
	100	House 30 Gov't Tank				
	101	House 30 Gov't Tank				
	102	House 30 Gov't Tank				
	103	House 30 Concrete Tank				
	104	House 30 Concrete Tank				
	105	House 30 Concrete Tank				
	106	House 32 Government Tank				
	107	House 32 Government Tank				
	108	House 32 Government Tank				
	109	House 32 Government First Flush				
	110	House 32 Government First Flush				
	111	House 32 Government First Flush				

Table 7: Record table for inorganic WQ tests at the finca

Inorganic Contaminant Data

Parameter	Sample - House 9	Sample - Finca
Total Chlorine (mg/L)		
Free Chlorine (mg/L)		
Chlorine (mg/L)		
pH (standard units)		
Total Alkalinity (mg/L)		
Total Hardness (mg/L)		
Nitrates/Nitrites (mg/L)		
Iron (mg/L)		
Sulfates (mg/L)		
Copper (mg/L)		
Lead (mg/L)		
Pestacides (mg/L)		

10.0 Appendix J: Materials remaining in the Community Inventory

	Item	Amount	Measurement
2" PVC	PVC de 2 pulgadas	9	6 m
		1	.22 m
		1	4 m
		1	3.6 m
1.5" PVC	PVC de 1.5 pulgadas	1	3.5 m
		3	6 m
		1	4 m
1.25" PVC	PVC de 1.25 pulgadas	1	.282 m
		1	6 m
		1	5.5 m
3" PVC	PVC de 3 pulgados	1	2.6 m
4" PVC	PVC de 4 pulgados	1	.26 m
Rebar	Hierro	11	6 m
PVC glue	Pegamento PVC	3	all open
Concrete Tool	Herramiento Concreto	7	
Wire Clipper	Cortadores	2	
Pliers	Alicates	3	
Coarse Thread Drywall Screw Box	Tornillo Rosca Ancha para Panel de yeso	1	box
Silicon Tube	Tubo de Silicon	1	
Can of Spray Paint	Pintura en Spray	1	
Pedazos de Lija	Sandpaper	2	
Teflon Tape	Teflon	2	
Saw	Serrucho	3	
Hammers	Martillos	2	
Hand Saw	Serrucho (de mano)	4	
Brushes	Cepillos	1	
Wheel Barrow	Carretilla	4	
Levels	Niveles	4	
Bulk Heads	Roscas por Rotoplas 1.25"	2	
Male Adaptor (2")	Adaptadores Macho de 2 pulgadas	1	
Male Adaptor (1.5")	Adaptadores Macho de 1.5 pulgadas	14	
Female Adaptors	Adaptadores Hembra	7	
2" Elbows	Codo de 2 pulgadas	33	
1.5" Elbows	Codo de 1.5 pulgadas	15	
4" Elbow	Codo 4"	1	
3" Elbow	Codo 3"	1	
1.5" Cap	Tapon Macho 1.5" con Roscas	4	
2" PVC Union	Union 2"	9	
1.5" PVC Union	Union 1.5"	10	
2" PVC Union	Union 2"	9	
3" PVC Union	Union 3"	6	
2" Tee	Tee PVC 2"	6	
1.5" Tee	Tee PVC 1.5"	2	
2 - 1.5 Reducer	Reductor 2" x 1.5"	2	
3 - 1.5 Reducer	Reductor 3" x 1.5"	2	
1.5" 45 elbow	Codo PVC 1.5" x 45 deg	7	
2" 45 elbow	Codo PVC 2" x 45 deg	1	

Figure 97: This is page 1 of the inventory of the materials remaining in the community after the past implementations.

1.25 45 elbow	Codo PVC 1.25" x 45 deg	2
Gutter Unions	Tapaderas PVC Para Canal Colonial	4
Downspouts	Canal Debajada 2"	2
Gutter Clips	Clips	3 pair

Figure 98: This is page 2 of the materials inventory.

