Safe Water for Western Honduras Technical Report

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"Water Mission has offered to help. Before Water Mission, no organizations supported us and we thank God that we found this organization. Today we reflect upon that we are going to have safe water. We understand with certainty that we are now going to maintain good health, which we have never seen before. So today indeed we celebrate this progress. Thanks to God and to the foundation that has worked with you – the one called Pentair." - Tablones (Male, Age 40)

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1. Executive Summary

Despite explicit recognition as a human right, 2 billion people still lack access to safely managed drinking water and basic handwashing facilities, and 3.5 billion lack access to safely managed sanitation services. The United Nations Sustainable Development Goals (SDGs) recognize the importance of an interdisciplinary approach to ending global poverty and other deprivations. The SDGs also aim to reach the poorest of the poor by combating inequalities within and amongst countries.[1] SDG Goal 6: Ensure availability and sustainable management of water and sanitation for all, further recognizes access to safely managed water and sanitation services as a 'prerequisite for the realization of other human rights.' [2]

Water Mission is a Christian engineering nonprofit that builds safe water solutions for people in developing countries, refugee camps, and disaster areas. In alignment with SDG 6, Water Mission focuses on access, affordability, and the sustainability of water and sanitation by using best-in-class technologies and interventions that support and strengthen the participation of local communities in improving water and sanitation management. In alignment with the United Nations' commitment to reach the poorest of the poor, Water Mission supports last-mile rural communities.

In partnership with the Pentair Foundation, Water Mission conducted a 5-year research study in the Lempira and Intibucá departments in Western Honduras to better understand the relationship between safe and sustainable water and sanitation interventions and holistic development outcomes. Material poverty is heavily concentrated in both Lempira and Intibucá.[3] Water Mission hypothesized that holistic WASH interventions would result in increased community well-being, improved management performance of WASH infrastructure, and improved WASH outcomes.

This study followed a longitudinal quantitative design whereby change was measured over time using the Routine Evaluation of Sustainability and Transformation (Restore) Survey tool. The Restore Survey is a validated survey instrument developed by Water Mission in 2016 to collect routine data on the outcomes and impact of WASH interventions. The Restore Survey is composed of 59 questions designed to measure changes in Infrastructure Management, Well-Being, and WASH Domains at the community level throughout a Water Mission project life-cycle. As such, the Restore Survey is administered to Water Mission communities four times: twice pre-intervention and twice post-intervention.

This study included 15 communities between July 2018 to April 2023. SurveyCTO (Doability, Inc.), a modern mobile data collection tool, was used to administer the Restore Survey 4,517 times. Once the study's data collection period was complete, descriptive statistics were tabulated using R (R Core Team), and the data were analyzed using a generalized linear mixed model.

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[1] "UNSDG: Leave No One Behind." UN Sustainable Development Group, 2023. https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind.

[2] Resolution A/RES/64/292. United Nations General Assembly, July 2010
General Comment No. 15. The right to water. UN Committee on Economic, Social and Cultural Rights, November 2002

[3] Robay, Monica, Britta Rude, and Kiyomi Cadena. Honduras Poverty Assessment: Toward a Path of Poverty Reduction and Inclusive Growth, February 2023. https://openknowledge.worldbank.org/server/api/core/bitstreams/d2e8818d-d44f-4721-ac5f-289698a29504/content.

The results of the generalized mixed model revealed significant differences in the WASH domain pre- and post-intervention while the overall Management and Well-Being domains showed no significant changes. All three WASH Factors scores: Handwashing, Sanitation, and Water Use improved pre- and post-intervention. While overall positive change was not detected for the Management Domain, the Water System factor did show statistically significant improvements from pre- to post-intervention. No significant change was detected for any of the four Well-Being factors.

These results demonstrate community-level change in domains directly related to Water Mission activities and interventions: the effective installation of sustainable and well-managed water systems and improved WASH knowledge and behaviors. However, these results do not support Water Mission's hypothesis that our intervention will lead to improved holistic development outcomes such as well-being (social, material, spiritual, and emotional) and management (human resources, financial, and leadership).

This study assessed Water Mission's interventions in the Lempira and Intibucá departments in Western Honduras' ability to impact overall development outcomes as a result of improved water and sanitation services. The results of this study contribute to existing literature on water, development, and well-being by looking beyond economic and physical health indicators.

In 2020, the study was interrupted by the impacts of the global COVID-19 pandemic. Nationally imposed lockdowns interrupted the data collection schedule and likely impacted the study's results regarding material, social, spiritual, and emotional well-being due to increased isolation, high levels of inflation, and a slowdown in trade and remittances.[4] Therefore, the study's results should be reviewed in the context of the global pandemic.

2. Introduction

2 billion people lack access to safely managed drinking water and basic handwashing facilities, and 3.5 billion people lack access to safely managed sanitation services.[5] Water Mission is a Christian engineering nonprofit that designs, builds, and implements best-in-class safe water, sanitation, and hygiene (WASH) solutions in partnership with local communities. Water Mission approaches the global water crisis with a focus on sustainability and equipping local communities with the skills and knowledge to manage their safe WASH projects long-term. Interventions include water quality testing and treatment, solar-powered decentralized piped water systems, technical training programs, capacity building, and systems strengthening activities. Through these programs, Water Mission aims to transform the lives of the people we serve beyond improved physical health and believes that access to safe and sustainable water systems can lead to improved development outcomes at the community level.

In 2006, Water Mission partnered with the Pentair Foundation to provide improved water and sanitation services in the district of Colón, Honduras. Project Safe Water Colón provided safe water and sanitation to more than 300,000 people, making it the largest scientifically documented water and sanitation project in Central America. In 2010, Water Mission and the Pentair Foundation engaged in research to measure the effect of Project Safe Water Colón on water related illnesses. The study's results showed a significant decrease in morbidity and amebic disease loads and a shift in attitudes concerning drinking untreated water.[6]

Subsequently, in 2018, the success of Project Safe Water Colón inspired Water Mission to expand projects to under-served regions in Honduras. The Safe WASH for Western Honduras program was designed to build on and

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[4] Robay, Monica, Britta Rude, and Kiyomi Cadena. Honduras Poverty Assessment: Toward a Path of Poverty Reduction and Inclusive Growth, February 2023. https://openknowledge.worldbank.org/server/api/core/bitstreams/d2e8818d-d44f-4721-ac5f-289698a29504/content.

[5] "Goal 6 | Department of Economic and Social Affairs." United Nations. Accessed August 15, 2023. https://sdgs.un.org/goals/goal6.

[6] Deal, Jeffery L, Sylvia Nazar, Ronald Delaney II, Micah Sorum, and Nicolaas Frans Gijsbert van Vliet. "A Multidimensional Measure of Diarrheal Disease Load Changes Resulting From Access to Improved Water Sources in Honduras." Translated by Thomas Leatherman. *Practicing Anthropology* 32, no. 1 (2010): 15–20.

replicate the outcomes of Project Safe Water Colón in Western Honduras over three years. This project focused on the Lempira and Intibucá departments in Western Honduras, where the estimated population of 554,000 experience some of the highest percentages of people living in extreme poverty in Honduras. Inequities in Lempira and Intibucá are apparent: Lempira has the lowest Human Development Index score (0.592) in Honduras, with 60% of the population in the lowest wealth quintile, and 35% of the population lacking access to improved sanitation. Intibucá is only slightly better with 53% of the population in the lowest wealth quintile, ranking Intibucá as the third poorest department in Honduras.

The Safe WASH for Western Honduras program provided an opportunity for Water Mission and the Pentair Foundation to continue research on the impact of safe water and sanitation projects at the community level. While Project Safe Water Colón research centered on health outcomes, Water Mission aimed to focus future research on the relationship between WASH Interventions and holistic development outcomes. More specifically, Water Mission set forth to investigate the relationship between strong and resilient water systems and improved social, emotional, and material well-being and community management and leadership capabilities.

Figure 1. A woman accesses safe water from a community kiosk in Camalote Campuca, Western Honduras.

2.1 Objectives

Between 2018 and 2023, Water Mission and the Pentair Foundation conducted research to assess the impact of safe water and sanitation on holistic development outcomes.[7] Through the Safe WASH for Western Honduras studied to answer the research question: **How is overall development impacted when "improved" water and sanitation are made safe and sustainable?**

Water Mission hypothesized that the Safe WASH for Western Honduras program would lead to increased human capabilities and holistic well-being. The results of this study can be used to evaluate the effectiveness of Water Mission's program model in Western Honduras to increase overall human flourishing. This research also contributes to the limited existing literature on the relationship between water, well-being, and community vitality beyond improved physical health, hygiene, and overall prosperity at the household level.[8]

[7] For this study, holistic development is defined as a multi-dimensional approach that considers living standards, good governance, psychological well-being, and community vitality as key development outcomes.

[8] Kulkami, Seema. "Gender, Water, and Well-Being." Essay. In *Globalization of Water Governance in South Asia*, edited by Vishal Narain, Chanda Gurung Goodrich, Jayati Chourey, and Anjal Prakash, 19–34. Abingdon: Routledge, 2019.

3. Research Methodology

3.1 Restore Background

The Restore Survey is a validated survey instrument developed by Water Mission in 2016 to collect routine data on the outcomes and impact of WASH projects. The survey was designed in SurveyCTO to be self-enumerated in low-literacy contexts. Community members use smartphones to independently complete the survey by listening to each question in their local language and responding using a Likert Scale composed of color-coded shapes (*see Figure 2*). The modified Likert Scale further ensures the tool's accessibility by allowing color-blind and illiterate individuals to self-enumerate the survey.

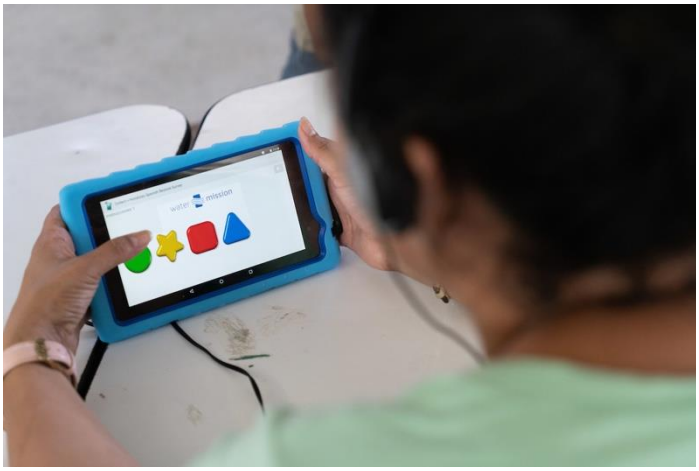


Figure 2. A woman participates in the Restore Survey in Western Honduras in 2018.

As a community-level evaluation tool, Water Mission prioritizes community access to survey results. Data from the survey are synched and aggregated offline and shared immediately with community leaders. Restore data undergoes a JENKS analysis to transform the data into the following scores: high (7-10), medium (3-7), and low (0-3). These results are visualized on PowerBI and distributed to community leaders, empowering them to reflect on community-level changes. Water Mission Community Development staff then present the results to the Safe Water Committee and other community leaders. After addressing concerns and identifying best practices for improvement, community leaders develop action plans through “community commitments.”

In alignment with Water Mission's hypothesis that well-managed water systems lead to improved physical, social, emotional, and material well-being, the Restore Survey captures indicators of project sustainability, WASH Behavior, and well-being at the community level. Therefore, this survey enables Water Mission to measure changes in hygiene behavior, household economy, and social factors related to water and sanitation interventions. These outcomes are categorized into three domains:

- **Management Skills:** the capacity of a community to maintain the technical and operational aspects of a project;
- **Community Well-Being:** factors that motivate a community to maintain the project due to positive impact experienced across four categories (spiritual, social, emotional, and material);
- **WASH Behaviors**: ensures uptake of healthy behaviors as a direct result of project activities.

Each domain is comprised of sub-categories referred to as “factors.” Table 1 features the factors contributing to each domain.

Table 1. Restore Domains by Factor

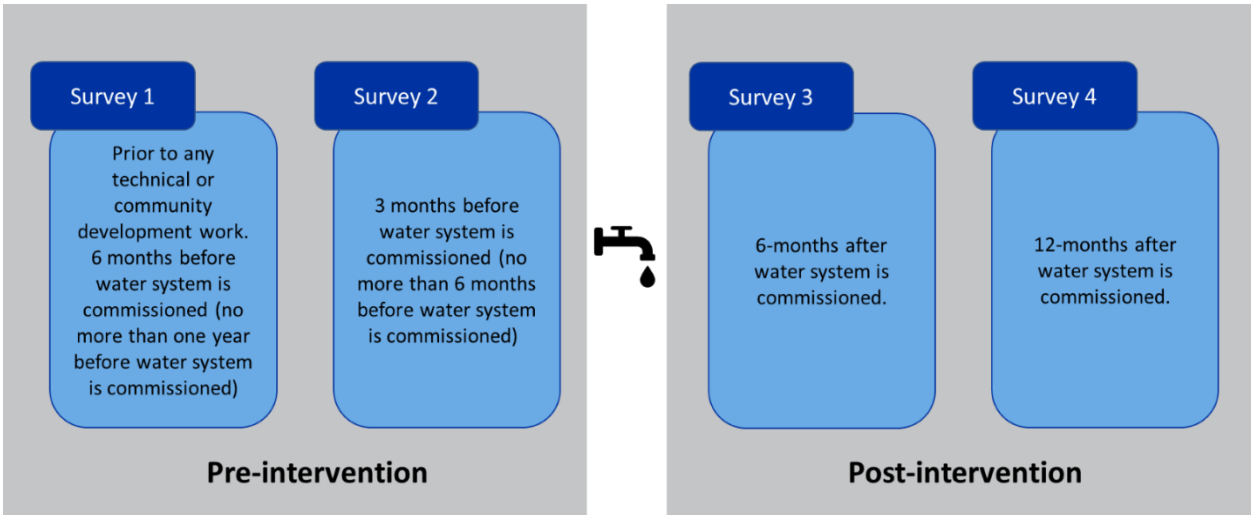
Domain	Factor	Factor Definition
WASH Behaviors	Water Use	Safety & quantity
	Sanitation	Knowledge & latrine use
	Handwashing	Key times, facilities, knowledge
Management Skills	Water System	Maintenance, repair, and water service
	Financial	Budgeting, saving, income generation, accounting & reporting
	Human Resource	Conflict resolution, productivity, hiring & retaining
	Leadership	Qualities, influence, community representation
Community Well-Being	Material	Financial and future expectations
	Social	Respect, trust, community participation
	Emotional	Personal, family & neighborhood
	Spiritual	Christianity, morality, religious cooperation

The Restore Survey contains four sections, a training statement, three instruction statements, four practice statements, and 59 Restore Survey statements covering the three domains and eleven factors.

After administering the Restore Survey, Water Mission analyzes the data and shares survey results with community leaders and members. Findings are printed and distributed to the meeting attendees, and the results are shared with a focus on areas of strengths (highest scores) and weaknesses (lowest scores). This is an opportunity for participants to discuss what changes they are seeing in their community and create action plans to improve on areas of weakness. This meeting is facilitated on the same day as data collection to ensure that results are decentralized and that the community benefits from participating in the survey.

To measure change, the Restore Survey was administered four separate times in each community. The first survey instance occurred before any community development activities took place, about 6-12 months before the water system was commissioned. Survey Instance 2 was administered 3 months before the water system was commissioned. Both Survey 1 and 2 were considered baseline datasets as they occurred pre-intervention. Survey instance 3 occurred 6 months after the new water system was commissioned, and Survey instance 4 occurred 12 months after the system was commissioned.

Figure 3: Timeline of Restore Survey Instances during the project life cycle.



3.2 Data Collection

3.2.1 Quantitative Data Collection

The Restore Survey was administered four separate times in communities between July 2018 and April 2023. *A priori* power analysis was conducted using Optimal Design Software to determine the minimum sample size and cluster sizes required to find significance with a desired level of power set at .80, an α-level at .05, an ICC at .15, and a moderate effect size of .25 (f).[9] Based on the analysis, it was determined that at least 32 households per village and 15 communities were required to ensure adequate power for the hierarchical linear model. By considering a 50% attrition rate, 64 people would be enrolled in each community. This sample and cluster size is adequate for binary and continuous dependent measures.

Water Mission selected communities to be considered for the study from the list of pending water projects within the study area. Community size and location were considered in site selection to ensure a mix of large and small communities and rural and near-road communities. Fifteen communities were recruited to the study in the summer of 2018 and another fifteen in March 2019. Of the 30 communities, fifteen declined to participate, leaving 15 communities to be included in the study (Table 2).

Table 2: Timeline of Restore Survey Administration

Project #	Community Name	Survey 1	Survey 2	Survey 3	Survey 4
00.359.19	Bo. Terrero (Intibucá, Intibucá - HN)	07/12/18	08/02/19	07/22/21	06/23/22
00.359.16	Aldea La Sorto (Intibucá, Intibucá - HN)	08/13/18	10/17/19	07/19/21	06/20/22
00.359.92	Bo. El Centro (Talgua, Lempira - HN)	09/10/18	05/15/19	06/16/21	08/15/22
00.379.88	Los Alpes (Jesus de Otoro, Intibucá - HN)	11/14/18	11/13/19	07/30/21	09/07/22
00.360.20	Suntul (Belén, Lempira - HN)	04/26/19	08/22/19	07/12/21	06/14/22
00.358.81	Guayaman (Jesus de Otoro, Intibucá - HN)	05/24/19	11/22/19	06/10/21	04/22/22
00.384.72	La Puerta (Belén, Lempira - HN)	06/14/19	10/23/19	05/13/21	10/11/22
00.359.73	Las Aradas (Masaguara, Intibucá - HN)	06/21/19	11/06/19	06/16/21	08/23/22
00.385.66	El Cacao (Intibucá, Intibucá - HN)	08/09/19	11/05/19	05/24/21	09/14/22
00.361.24	Camalote Campuca (Gracias, Lempira - HN)	08/25/19	10/09/20	05/21/21	11/15/22
00.387.03	Copantillo (Masaguara, Intibucá - HN)	10/13/19	12/05/19	06/03/21	01/10/23
00.386.26	Bo. Las Delicias (Intibucá, Intibucá - HN)	10/13/19	12/08/19	05/29/21	02/14/23
00.359.18	Taragual (La Iguala, Lempira - HN)	09/22/19	04/13/21	07/19/22	03/20/23
00.358.95	El Eden (San Rafael, Lempira - HN)	11/17/19	07/05/21	05/09/22	04/10/23
00.385.80	Tablones (La Iguala, Lempira - HN)	11/15/19	04/21/21	07/22/22	04/17/23

The Restore survey follows a longitudinal community cluster data collection strategy and therefore utilizes a stratified community sampling scheme. Table 3 outlines sampling targets set to promote the collection of representative data. To ensure proportional samples from each community, Water Mission staff worked with community leaders to identify a central location to administer the survey. In addition to a central meeting location,

[9] Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd Ed.). Hillsdale, NJ: Lawrence Erlbaum Associates; Raudenbush, S. W., & Liu, X. (2001). Effects of Study Duration, Frequency of Observation, and Sample Size on Power in Studies of Group Differences in Polynomial Change. Psychological Methods, 6(4), 387-401; Raudenbush, S. W., et al. (2011). Optimal Design Software for Multi-level and Longitudinal Research (Version 3.01) [Software]. Available from www.wtgrantfoundation.org.

community members completed a 'community mapping exercise' to assess if participants represented all neighborhoods in the community.

Figure 4. A woman participates in the "community mapping exercise" by marking the location of her household.

Table 3: Sampling Parameters

Demographic Descriptor	Parameter/Sample Size
Number of people	≥32 households ≥64 people
Gender	40/60% male/female
Age	18 – 24 years old: ≥ 10% 25 – 55 years old: ≥ 10% 55+ years old: ≥ 10%
Community Leadership Role	≥ 10%

3.2.2 Qualitative Data Collection

Respectively, qualitative data were collected in all 15 research communities four times over the implementation timeline of the program. Qualitative data were collected during post-survey community meetings, whereby 5-15 community leaders and members gathered to discuss the results of the survey. These meetings served as focus groups and centered on a series of open-ended questions relating to community strengths, weaknesses, and experiences. Participants were invited to share community stories and any potential changes they experienced or witnessed due to the WASH project. Water Mission staff recorded these stories utilizing a standard PDF form referred to as "Appendix 24."

4. IRB Status and Approval

This study was reviewed and approved by the IntegReview Institutional Review Board. In adherence with standard research ethics, informed consent was obtained from each study participant before they entered the study. Community members participating in the Restore Survey were prompted and required to give consent before starting the survey. Consent statements included:

1. I have been given information about the survey, and I understand that the survey is anonymous, and no one will know how I respond to the survey. I have had the opportunity to ask questions.

2. I grant Water Mission, its representative, and employees the right to take photographs of me and use the information I provide in my survey in connection with the project in my community.
3. I voluntarily agree to participate in the survey, and I understand that I am free to withdraw at any time.

Disagreement with any of the three consent statements resulted in the automatic termination of the survey and the redistribution of the smartphone to another community member.

Likewise, verbal consent was obtained from individuals participating in the community meetings. Participants were made aware of reporting procedures and were asked for consent before documenting shared stories and experiences. Participants were presented with two consent options:

1. Full Consent: Water Mission can share this story using my name, gender, age, and community position.
2. Anonymous (de-identify): Water Mission can share this story without disclosing any personal information.

5. Data Analysis

5.1 Quantitative Analysis

Data was exported from SurveyCTO (Doability, Inc.) and was analyzed using R (R Core Team). Descriptive statistics for each community were tabulated using R. Hierarchical models (generalized mixed models) were used to account for the nested nature of the data including participants repeated over time, and participants nested within communities repeated over several years. Specifically, due to the very left-skewed distribution on most outcome measures, reciprocal transformations were performed on the outcomes first, so the distributions were right-skewed which met the gamma distribution. Then, a series of generalized linear mixed models with gamma function using maximum likelihood were conducted to examine the overall domain and each item (i) between two baselines (survey 1 and survey 2) and (ii) between baseline and post-intervention.

5.2 Qualitative Analysis

Community stories documented on the "Appendix 24" report were entered into Excel for coding. The codebook was created using twenty randomly selected community stories. The codes were categorized into themes to assess how respondents interpreted the success of the Safe WASH program. The codebook was applied to analyzing each response to the entire sample of community stories. 48 reports were submitted, and 96 community stories were included in the analysis for the study.

6. Results

6.1 Quantitative Results: Participant Demographics

Table 4 shows the demographic distribution for gender and age across the entire sample at each survey instance. Across the entire sample, the demographics kept to the initial parameters for gender (between 40/60% split) and at least 10% in each age category. Community leaders made up 31.53% of the entire sample, therefore also meeting the sampling parameters (equal to or greater than 10%).

Table 4. Summary statistics of Restore participants.

	Survey Instance				Survey total
	1	2	3	4	
Total (n)	1,157	900	1,208	1,252	4,517
Men n (%)	609 (52.6%)	456 (50.7%)	549 (45.4%)	579 (46.2%)	2,193 (48.5%)
Women n (%)	548 (47.4%)	444 (49.3%)	659 (54.6%)	673 (53.8%)	2,324 (51.5%)
Under 25 n (%)	215 (18.6%)	164 (18.2%)	221 (18.3%)	190 (15.2%)	790 (17.5%)

25-55 n (%)	734 (63.4%)	571 (63.4%)	773 (64%)	887 (70.8%)	2965 (65.6%)
>55 n (%)	208 (18%)	165 (18.3%)	214 (17.7%)	175 (14%)	762 (16.9%)
Community Role	417 (36.04%)	303 (33.67%)	383 (31.71%)	321 (25.64%)	1424 (31.53%)

Table 5 shows the demographic distribution for National Wealth Quintiles across the entire sample at each survey instance. National Wealth Quintiles are determined by an Equity Tool (13-question questionnaire) that measures and compares the wealth of respondents to the national population. Each quintile represents 20% of the population, with Quintile 1 representing people among the poorest in the country and Quintile 5 representing the wealthiest in the country. This tool is embedded into the Restore Survey to determine if Water Mission is reaching the "poorest of the poor." Results verified that Lempira and Intibucá are amongst the poorest people in Honduras. Aggregating results across communities and instances showed a wealth distribution skewed toward the two most poor quintiles. More specifically, 54.02% of survey respondents scored on the lowest 2 quintiles.

Table 5. Summary statistics of Restore participants: National Wealth Quintiles

	National Wealth Quintile					Survey total
	1	2	3	4	5	
Total (n)	891 (19.73%)	1549 (34.29%)	1332 (29.49%)	626 (13.86%)	119 (2.63%)	4,517
Survey 1	310 (26.79%)	382 (33.02%)	314 (27.14%)	127 (10.98%)	24 (2.07%)	1,157
Survey 2	198 (22.00%)	333 (37.00%)	253 (28.11%)	94 (10.44%)	22 (2.44%)	900
Survey 3	207 (17.14%)	381 (31.54%)	401 (33.20%)	189 (15.65%)	30 (2.48%)	1,208
Survey 4	176 (14.06%)	453 (36.18%)	364 (29.07%)	216 (17.25%)	43 (3.43%)	1,252

6.2 Quantitative Results: Participant Demographics

The average number of people attending the Community Meeting was 42 (SD = 35) with a minimum attendance of 3 people and the largest meeting at 96 attendees. Table 6 summarizes the demographics of community members providing testimony through community stories.

Table 6. Summary statistics of community members providing testimony

Demographics		Total Number of Responses
Men n (%)	28 (29%)	96
Women n (%)	16 (17%)	
Anonymous n (%)	52 (54%)	

6.3 Pre- and Post-Intervention Difference

6.3.1 Summary

To establish a comprehensive baseline score, an analysis was conducted to compare the results of Survey 1 and Survey 2. All domains and factors were subject to this analysis. While results showed no statistically significant differences in the three domains: Management Skills, Community Well-Being, and WASH Behaviors, change was detected on the factor level regarding Human Resources and Sanitation. Between Survey 1 and Survey 2, the Human Resources (Management) score decreased while the Sanitation (WASH Behaviors) score increased. These results were used to configure a new baseline score henceforth referred to as the "Pre-intervention." Respectively, Survey 3 and Survey 4 are considered "Post-intervention 1" and" 'Post-Intervention 2" (see Table 7).

Next, the Pre-versus Post-Intervention differences were checked. The results of the generalized mixed model revealed significant differences in the WASH domain pre- and post-intervention while the overall Management and Well-Being Domains showed no significant changes. All three WASH Factors scores: Handwashing, Sanitation, and Water Use improved pre- and post-intervention. While overall positive change was not detected for the Management Domain, the Water System factor did show statistically significant improvements from pre- to post-intervention. No significant change was detected for any of the four Well-Being factors. Table 7 shows the range of Domain and Factor scores across the dataset pre- and post-intervention.

Table 7. Mean RESTORE scores (Standard Deviation) by survey instance, by domain then factor.

		Pre-intervention	Post-intervention 1	Post-intervention 2
WASH Behaviors	Overall	6.67 (1.29)	7.13 (1.33)	7.3 (1.4)
	Water Use	6.08 (2.04)	6.78 (1.85)	6.89 (1.96)
	Sanitation	6.5 (2.13)	7.05 (2.04)	7.18 (2.19)
	Handwashing	7.42 (1.74)	7.56 (1.79)	9.82 (1.85)
Management Skills	Overall	7.84 (1.4)	7.74 (1.4)	7.86 (1.37)
	Financial	*7.22 (1.58)*	*7.03 (1.59)*	7.09 (1.57)
	Human Resources	7.57 (1.79)	7.3 (1.79)	7.25 (1.88)
	Water System	8.31 (1.64)	8.63 (1.54)	8.84 (1.44)
	Leadership	8.25 (1.78)	8 (1.87)	8.24 (1.89)
Community Well-Being	Overall	7.5 (1.55)	7.43 (1.55)	7.47 (1.55)
	Material	6.67 (2.33)	6.7 (2.23)	6.71 (2.38)
	Social	8.07 (1.88)	7.87 (1.92)	7.99 (1.89)
	Emotional	7.75 (1.82)	7.66 (1.81)	7.69 (1.85)
	Spiritual	7.49 (2.05)	7.48 (2.08)	7.5 (2.15)

6.3.2 WASH Domain

The WASH Domain measures the uptake of healthy WASH behaviors categorized into three factors: Handwashing, Sanitation, and Water Use. Water Mission's project activities are designed to change these behaviors through education, sensitization, and hygiene construction activities. Alongside the installation of water systems, activities include the building of handwashing stations and latrines, and WASH promotions throughout the community.

Results indicate a statistically significant change in the overall WASH Domain between pre- and post-interventions. Table 8 shows the increase in the average WASH score domain from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2.

Table 8. Average WASH domain score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2

* p<0.05 vs Pre-intervention

Qualitative results corroborate these findings. Improved WASH Behaviors was cited most frequently as the greatest change in communities. Community members discussed how improved WASH behaviors have decreased water related illnesses in their communities such as diarrhea and stomachaches. For example, community members from Los Alpes, and Las Aradas shared how the consumption of safe water and proper handwashing techniques improved physical health in their communities:

> *"There have been many improvements. Now, almost the whole community uses safe water, illness like diarrhea in children have decreased, also with latrine most of the community have one and the most important they use them, it has been a positive change in the community." - Los Alpes (Female, age 42)*

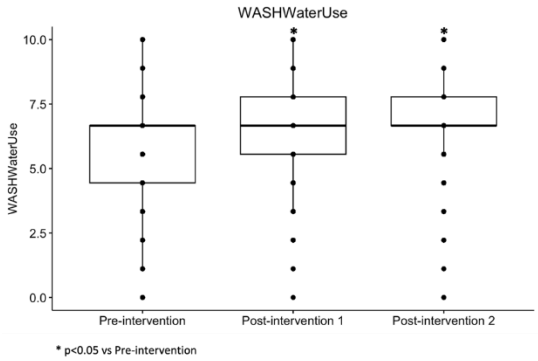
> *"The community has improved in health and education. Before we did not care about it, but now we work a lot in it. Illness like diarrhea has decreased, that was because we were drinking unsafe water, so we have improved a lot in those things." - Las Aradas (Male, age 52).*

These stories support results demonstrating that Water Mission's intervention is effective in changing attitudes and behaviors relating to water consumption, hygiene, and sanitation. Therefore, qualitative findings support results showing a statistically significant change in all three WASH Behaviors factors.

6.3.2.1 Water Use

Water Use significantly improved from baseline to both post-intervention surveys: Post-Intervention Survey 1 (β = -.092, p < .001) and Post-Intervention Survey 2 (β = -.092, p < .001). The above results indicate that shifts in water use behaviors were realized as early as 6 months into the project life cycle and can be considered short-term outcomes.

Table 9. Average Water Use Factor score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2



* p<0.05 vs Pre-intervention

Qualitative data contextualizes how the safe water project has improved the quality and quantity of water used in the community. For example, Taragual experienced challenges with water shortages and water borne illnesses prior to project implementation. A female community member shared:

> *"Our community suffered many years from water shortages, our children suffered from diarrhea and stomach illnesses, and we did not have many options to solve this complicated situation. We are very happy to have made the decision to work with you to find ways to improve the situation we had in our community."- Taragual (Female, Age 42).*

Alongside water shortages, available water was often polluted and unsafe for consumption. Community members in Camalote and Cañadas discussed water quality in their community's pre-intervention:

> *"We used to drink polluted water before. Today we are going to drink safe water which is really good for human consumption. And that is going to improve living conditions. I am thankful to Water Mission because you have given us a good water project which is fruitful not only for me but for our community and families." - Camalote (Male, Age 36)*

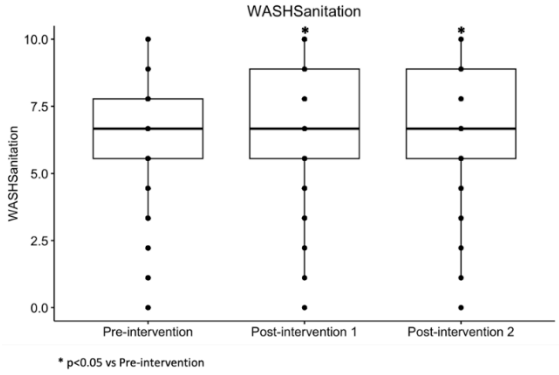
> *"Our community has suffered for years due to the quality of water that reaches our homes. The water was very cloudy and our children would get sick constantly." - Cañadas (Male, Age 37)*

These stories further support results of improved Water Use outcomes post-intervention and the effectiveness of Water Mission's programs on water quantity and safety. The importance of consuming safe drinking water is further highlighted through testimonies on improved physical health.

6.3.2.2 Sanitation

A statistically significant change was also detected at the factor level for sanitation during both post-intervention surveys: Post-Intervention Survey 1 (β = -.067, p < .001) and Post-Intervention Survey 2 (β = -.071, p < .001). The above results indicate that shifts in sanitation attitudes and behaviors were realized as early as 6 months into the project life cycle and can be considered short-term outcomes.

Table 10. Average Sanitation Factor score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2



Qualitative results support findings that communities experienced increased knowledge and latrine use from interventions. Increased knowledge of proper sanitation behavior and improved latrine facilities were cited frequently as a project benefit. Improved latrine facilities were well received throughout the community and reported to decrease the frequency of open defecation. For example, in El Eden, an anonymous source shared:

> *"Latrines have made a big difference in the cleanliness and hygiene in the community. One community member, who lives next to the stream, used to go to the river to relieve herself when she felt like it. Now that we have managed to get her a latrine, she is delighted and always uses it." - El Elden (Anonymous)*

In addition to decreased frequency of open defecation, WASH promotions empowered communities to improve cleanliness and hygiene standards throughout living areas. In Bo El Centro, community members shared:

> *"We have realized that our sanitation conditions are not as good as we thought and that we need to improve both in our homes and in our neighborhoods with good hygiene and sanitation practices." - Bo. El Centro (Male, Age 56)*

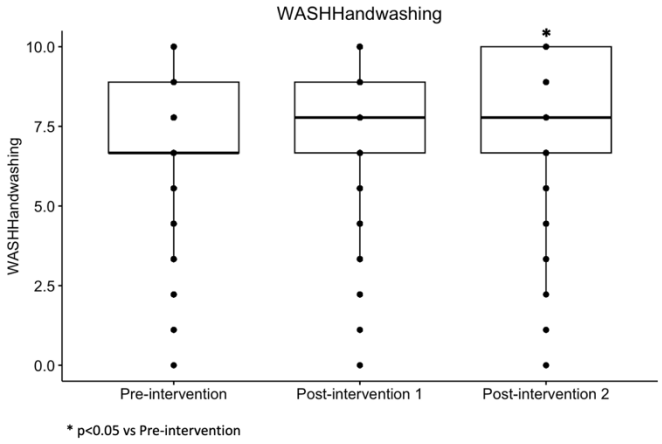
> *"We have a plan for solid waste treatment and to have better sanitation to improve the community." - Bo. Terrero (Male, Age 42)*

Stories related to sanitation highlight the effectiveness of Water Mission's intervention on proper sanitation practices, empowering communities to be active agents of change, and providing dignity through access to sanitation facilities and amenities. As such, both quantitative and qualitative results indicate that interventions improve the adequacy of resources and the level of knowledge related to proper sanitation.

6.3.2.3 Handwashing

Finally, a statistically significant change was also detected for the handwashing factor. However, this change was not detected until Post-Intervention Survey 2 (β = -.033, p < .001), which was administered 12 months after the project's commissioning. Therefore, results could indicate that increased knowledge and the presence of handwashing materials throughout communities are long-term community outcomes.

Table 11. Average Handwashing Factor score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2



In alignment with these findings, community members shared how the project improved handwashing knowledge and behaviors in their communities. Community members are motivated to apply new knowledge on handwashing because of the better health outcomes they experienced post-intervention. Community stories exemplifying changes in hygiene behaviors include:

> *"In the field of health, the community has improved in terms of hygiene and, therefore, the diseases that previously plagued them have been reduced. People are more motivated to keep their homes cleaner and to wash their hands"- Taragual (anonymous)*

> *"The project has been a great benefit because we have fewer illnesses like stomachache or diarrhea than before because people wash their hands in a right way and also they use safe water." - Cañadas (Male, 43)*

Community members further explain that they have seen the most change in hygiene behavior and health outcomes with their children. In Suntal, a community member and father explained:

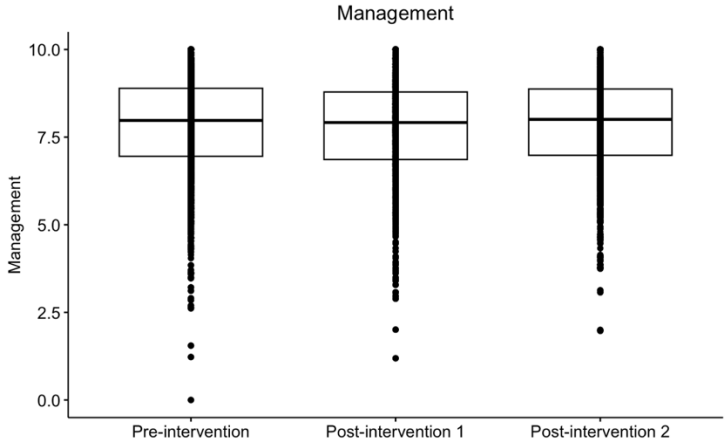
> *"All the information and workshops we have received from Water Mission has been very useful for us. We can now take better care of ourselves and our children by giving them safe water and teaching them how to wash their hands correctly. We have experienced a positive change in handwashing and tooth brushing, mostly with children – Suntal (Male, 45).*

Community stories support Restore Survey results showing a statistically significant change in the WASH domain and all three factors: Water Use, Sanitation, and Handwashing. Amongst these three factors, community members provide insight into how educational elements of the intervention, alongside the construction and improvement of facilities and amenities, were key in improving physical health outcomes in their respective communities.

6.3.3 Management Domain

The Management Domain measures a community's capacity to maintain the technical and operational aspects of a project. A statistically significant change was not detected in the overall Management Domain from baseline to Post-Intervention Survey 1 (β = -.008, p = .096) and Post-Intervention Survey 2 (β = -.005, p = .338). The Management Domain is categorized into four factors: Economic, Leadership, Human Resources, and Water Systems. While pre- and-post-intervention change was not detected at the Domain level, a statistically significant increase was detected at the factor level regarding Water Systems from baseline to post-intervention: Post-Intervention Survey 1 (β = -.031, p < .001) and Post-Intervention Survey 2 (β = -.053, p < .001). In contrast, Human Resource scores were significantly decreased from baseline to Post-Intervention Survey 1 (β = .027, p < .001) and Post-Intervention Survey (β = -.033, p < .001). Financial factor scores also significantly decreased at instance 3 (β = .018, p = .002). Likewise, Leadership scores significantly decreased at Post-Intervention Survey 1 from baseline (β = .026, p < .001).

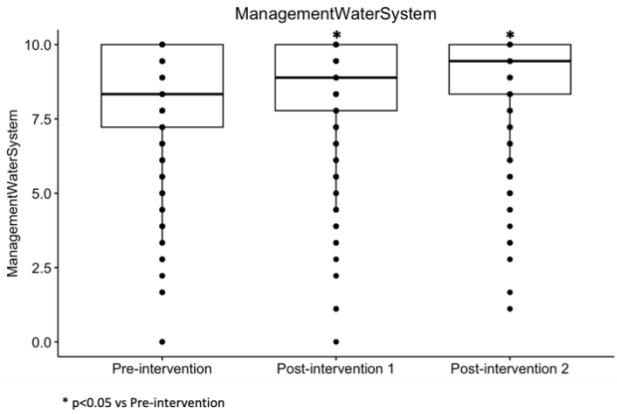
Table 12. Average Management Domain score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2



6.3.3.1 Water Systems

The Water System factor reflects the community's desire and ability to contribute to the success of the water project, to find spare parts, and to fix problems that might arise. A statistically significant change was detected in both post-intervention surveys: Post-Intervention Survey 1 and Post-Intervention Survey 2. These results highlight increased community ownership and capacity to maintain their water system as a short-term outcome.

Table 13. Average Water System Factor score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2

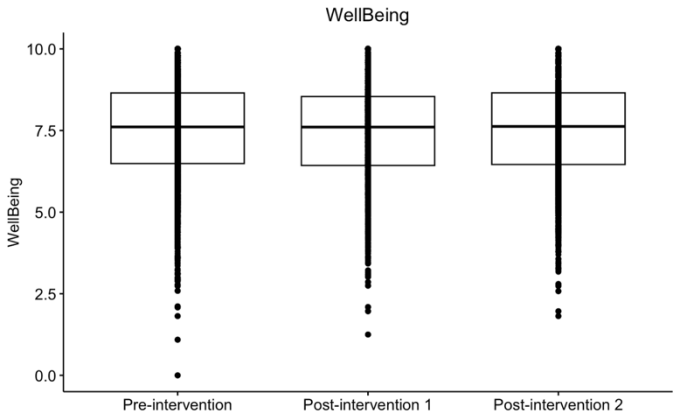


6.3.4 Well-Being Domain

The Well-Being Domain assesses change in the community's social, emotional, material, and spiritual health before and after experiencing safe water and sanitation solutions. A statistically significant change was not detected at the Domain level from baseline to Post-Intervention Survey 1 (β = .006, p = .257) and Post-Intervention Survey 2 (β = .001, p = .867).

The Well-Being Domain is categorized into four Factors: Spiritual, Material, Emotional, and Social. Results showed no change in Spiritual, Material, and Emotional Well-Being Factors (all p > .05). Statistically significant change was only detected for Social Well-Being, where scores significantly decreased at Post-Intervention Survey 1 compared to pre-intervention surveys (β = .018, p < .011).

Table 14. Average Well-Being Domain score from Pre-Intervention to Post-Intervention 1 and Post-Intervention 2



Despite unexpected quantitative results indicating that Water Mission's intervention does not necessarily lead to improved Well-Being outcomes, community stories showcase the connection between improved WASH Behaviors and Social and Emotional Wellbeing. Community members explained:

"Las Canadas is a huge community, and the safe water project has come to benefit every family here. The whole community is motivated and interested in drinking safe water – that is a social benefit." (Anonymous)

" Our health is improving because we are receiving safe water, and the latrine project has been a great benefit. Thank God for all the people who received a latrine. We are using them, and we are taking care of them. We want to inspire people to take care and improve their health."

These stories exemplify how the safe water project contributes to social cohesion in communities through the introduction of a shared goal and how self-sufficiency and dignity are obtained throughout the project. Qualitative

data provides limited evidence that there is a correlation between access to safe water well-being and further research is needed to better understand why Water Mission did not achieve the intended impact for this domain.

6.3.4.1 Material Well-Being

While no positive statistically significant change was detected for the Well-Being Domain, qualitative results indicate that interventions have at least some impact on material well-being. The Material Well-Being factor reflects the sufficiency of households' resources to meet their basic needs, including education and healthcare. Community stories indicate a decrease in expenditures related to healthcare and water. In Terrero and Bo El Centro, community members shared:

> *"The Water Mission water system has been a great benefit to the community because it is a safe water. We now have less sick people in the community and we do not spend money at the hospital. Also, the water is better and cheaper than the other water." - Terrero (Male, 46).*
>
> *"This project has been a great benefit to our community, especially in my house. I have seen that economically I now save more money than before since a bottle of commercial water costs around 25 Lempiras. Now with this project, we get safe water at a lower cost. Before I spent a lot of time in a health center because I was affected by the contaminated water and now my health is better." - Bo. El Centro (Female, Age 38)*
>
> *"We have experienced many positive changes in the quality of life of people in the community. Before we had a bad system of water and now thanks to Water Mission we have an excellent System of safe water. Money that people spent on health, they can now buy food or other things." - La Sorto Male 43*

Despite improved Material Well-Being being frequently cited amongst community stories, no statistically significant change was detected.

7. Discussion

Water Mission hypothesized that the impact of improved WASH Behaviors would extend beyond physical health and lead to improved community management, cohesion, and holistic well-being. Both quantitative and qualitative results confirm Water Mission's success in improving WASH Behaviors and developing sustainable water system management but fall short of demonstrating impact beyond activity level outcomes. Qualitative results also highlight a degree of positive change in terms of Material Well-Being, where community members highlighted how consuming project water and practicing healthy hygiene reduced household expenditures on healthcare and drinking water. In other words, all factors indicating a positive change directly correspond with Water Mission's activities. Therefore, results indicate that Water Mission does not seem to be having a statistically significant impact on holistic development.

There are several explanations for the failure to detect statistically significant changes in the Management and Well-Being Domains. First, it is important to note that both the Management and Well-Being Domains scored highly (7-10) pre-intervention. High baseline scores indicate that communities were operating at a high level before receiving Water Mission projects, leaving little room for major improvement. An additional explanation is that more than 12 months are required to see changes in these domains. Limited evidence of improved social cohesion provided through community stories could support this explanation. Finally, it is important to consider extraneous variables that could directly impact well-being, human flourishing, and community cohesion.

For example, the results of this study must be reviewed in the context of a global pandemic, which introduced overlapping challenges to communities across Honduras. Government-imposed lockdowns led to restricted labor

markets and increased rates of social isolation.[10] Woon et.al, 2021[11] determined that issues of confinement and disruption of routine economic and social activities lead to increased psychological disorders. Lara-Arévello et. al., 2023, suggests that one of the biggest impacts of the COVID-19 pandemic in Honduras was restricted food access, resulting in residents walking up to three hours for food in rural communities. Therefore, the socioeconomic consequences of the COVID-19 pandemic likely impacted measures related to well-being and the economy and should be considered an extraneous variable in this study.

This supposition is supported by comparing baseline data in communities that received an additional baseline survey during the COVID-19 pandemic. Recognizing COVID-19 as an extraneous variable, Water Mission attempted to minimize the impact of COVID-19 on the study by re-administering baseline Survey 1 in some communities. While the sample size of communities receiving an additional baseline survey was small and therefore unreliable, results showed that the Management Domain and Well-Being Domain scores decreased after the onset of the pandemic. Under the Management Domain, two factors specifically showed statistically significant decreases: Financial and Human Resources. Under the Well-Being Domain, the Social and Spiritual scores decreased. Therefore, it is important to consider that the results of this study were affected by the COVID-19 response in Western Honduras.

8. Limitations

There are a few limitations to consider when reviewing the results of the study. Midway through this longitudinal study, the COVID-19 pandemic took place which will have impacted the results in unquantifiable ways. The pandemic impacted project implementation and therefore survey administration, resulting in delays and additional time between Survey Instance 2 and Survey Instance 3.

Logistical complications also limited Water Mission's ability to adapt research to capture how COVID-19 impacted the study. While Water Mission tried to implement new COVID-19 baseline surveys, only two research communities completed updated pre-intervention surveys, therefore making the sample size inadequate to conclude from. Despite rapid adaptation from the research team, the timeline between lockdowns, project implementation, and country reopening failed to align with the updated research plan.

9. Conclusion

Around the world, billions of people still lack access to safe water and sanitation services. Water Mission believes in taking a comprehensive approach to combating the global water crisis and aims to build resilient and sustainable water and sanitation systems by investing in and empowering the people in the communities where we work. This research confirmed that Water Misson is working in under-served communities through a National Quintile analysis and assessed Water Mission's effectiveness at promoting holistic development outcomes through sustainable and well-managed water and sanitation systems. This is in alignment with the UN Sustainable Development Goals that focus on sustainability and reaching "the poorest of the poor."

Results indicate that Water Mission is effective at catalyzing change in knowledge and behaviors in domains and factors directly related to intervention activities. However, results do not corroborate Water Mission's hypothesis that access to safe water and sanitation services will lead to holistic development outcomes such as improved Well-Being and Management skills. Alongside demonstrating where Water Mission is having an impact, results

[10] Lara-Arévalo, Jonathan, Lucía Escobar-Burgos, E R H Moore, Roni Neff, and Marie L Spiker. "Covid-19, Climate Change, and Conflict in Honduras: A Food System Disruption Analysis." Global food security, June 2023. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10106828/#:~:text=Evidence%20suggests%20that%20the%20biggest,early%20months%20of%20the%20pandemic.

[11] Woon LS-C, Leong Bin Abdullah MFI, Sidi H, Mansor NS, Nik Jaafar NR. Depression, anxiety, and the COVID-19 pandemic: severity of symptoms and associated factors among university students after the end of the movement lockdown. *PLoS One*. (2021) 16: e0252481. doi: 10.1371/journal.pone.0252481, PMID: [PMC free article] [PubMed] [CrossRef] [Google Scholar]

provide insight into the time required to see change regarding different factors. For example, positive change was detected for Sanitation and Water Use 6 months post-intervention (Survey 3), while it required 12 months post-intervention to detect statistically significant change in handwashing. Understanding the time required to see change within a community helps Water Mission and other implementors set realistic short-term and long-term goals.

Finally, while the results failed to demonstrate a statistically significant change in the Well-Being and Management Domains, it is important to note alternative explanations aside from a failed hypothesis. First, it is important to consider that as long-term outcomes, changes in Well-Being and Management Skills might require more than 12 months to be realized. This explanation is supported by qualitative data relating to Social Well-Being that described how the safe water project united communities through a common goal. Secondly, external research suggests that the COVID-19 pandemic likely skewed the results of the study. Therefore, results confirm the effectiveness of Water Mission's interventions to achieve activity level outcomes, but more research is needed to better understand the relationship between the successful implementation of a safe water project and wide-spread improved Well-being and Management outcomes.