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EVALUATING WATER QUALITY ASSURANCE FUNDS IN GHANA:

BASELINE ASSESSMENT

October 2023

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ABOUT USAID/REAL-WATER:

USAID Rural Evidence and Learning for Water (REAL-Water) is a five-year partnership that develops and evaluates strategies for expanding access to safe, equitable, and sustainable rural water services. REAL-Water supports policymakers, development partners, and service providers to make strategic decisions and implement best practices for water management through implementation research. It also ensures coordination with USAID programs contributing to the water, sanitation, and hygiene (WASH) and water resources management (WRM) knowledge base, in alignment with the USAID Water for the World Implementation Research Agenda. For further information about this and other aspects of the project, as well as to access our knowledge products, please visit globalwaters.org/realwater.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

STUDY RATIONALE

In rural Africa, over two-thirds of the population is estimated to be exposed to contaminated drinking water. Monitoring water quality is essential to providing safe water and protecting public health, yet many rural water suppliers fail to conduct water quality tests regularly. Using an existing centralized laboratory for analysis might be a cost-effective option for expanding testing for many rural water suppliers, but these laboratories may be unwilling to work with rural suppliers due to non-payment risks. The Water Quality Assurance Fund is an innovative financial instrument developed to address these issues and encourage water quality monitoring in rural areas of Ghana and similar countries. A previous pilot within one district in Ghana showed promising results, but a larger, rigorous evaluation trial is needed to evaluate the impacts and quantify the cost-effectiveness of the Assurance Fund program.

ASSURANCE FUND INTERVENTION

The Water Quality Assurance Fund allows professional laboratories to expand regular water quality testing to small rural water suppliers without taking on additional financial risks that would otherwise deter them from working with these systems. It relies upon a third-party nongovernmental organization to guarantee payment to the laboratory if a rural water system is unable to pay for water testing services on time. Water systems can be withdrawn from the program if they default on payments multiple times.

The Assurance Fund implementation model also includes capacity-building and engagement components to increase knowledge related to test results: (1) monthly meetings to discuss test results, (2) technical assistance to improve chlorination at the request of water operators or local government authorities, (3) community engagement activities, and (4) online dashboards for visualizing water quality test data to foster accountability and competition among participating water systems.

STUDY DESIGN

This report summarizes baseline data collected before the launch of a two-year impact evaluation of the Assurance Fund implementation model. This evaluation consists of a randomized stepped-wedge trial, which allows measuring impacts rigorously while rolling out the intervention gradually. The evaluation involves 28 water systems in rural Ghana: 21 that were randomly assigned to one of three groups successively entering the Assurance Fund program at six-month intervals, and seven that were non-randomly assigned to the first group. At baseline, we measured the same indicators that we will measure subsequently over the course of the stepped-wedge trial: chlorine residual and *E. coli* in piped water (the primary outcome indicators for the trial), as well as water treatment practices, water quality knowledge of water system operators and local government officials, consumer awareness of and perceptions of water safety, and consumer willingness-to-pay for increased water treatment and testing.

DATA COLLECTION METHODS

We collected baseline data between December 2022 and February 2023 from 28 water systems, 560 residential customers (20 per water system), 48 focus group discussions with community members, 39 traditional authority interviews, and 20 district assembly member interviews. We primarily measured water system characteristics, community and household water practices, and water quality perceptions and knowledge. We also measured water quality for up to five standpipes per water system and household water quality from private taps or stored household water in a subset of households.

SUMMARY OF BASELINE FINDINGS AND IMPLICATIONS

The baseline results identified several areas of improvement in water safety management that may be addressed by the Water Quality Assurance Fund program:

- **WATER QUALITY KNOWLEDGE:** Water system operators and District Assembly members had some knowledge of sources of contamination, chlorination and what makes water safe, and regulations and standards related to water quality, but little knowledge about types of contaminants or pathogenic microorganisms. These findings suggest that monthly water quality testing and debrief meetings may improve water quality knowledge among water system operators and district authority members, and that this improved knowledge could lead to better water treatment, system management, and source protection practices.

- **WATER TREATMENT:** Water was inadequately chlorinated, with almost all water samples below recommended levels of at least 0.2 mg/L free chlorine residual (97% of water samples), providing insufficient treatment or protection against recontamination during transport and storage. Microbial water quality was sometimes good at the point of collection (60% of standpipes and 41% of private taps had no *E. coli* in 100-ml water samples), but almost always poor at the point of use (92% of stored household water samples were contaminated with *E. coli*). These findings indicate that access to monthly water quality test results and technical guidance on remedial actions may encourage water operators to improve their water treatment practices. We expect to see improvements in chlorine residual and reductions in *E. coli* at the point of collection from these activities.

- **COMMUNICATION AND CONSUMER PERCEPTIONS:** Community engagement by water providers was infrequent and rarely related to water quality. Regular community engagement activities, such as monthly radio programs, may improve community member's awareness of water quality testing, treatment practices, and water safety levels. These findings suggest that with adequate community engagement, water systems will be able to increase their tariffs to fund improvements in water safety management.

NEXT STEPS

Assurance Fund implementation began in the first group of study water systems in February 2023 and is ongoing. We are concurrently tracking implementation activities, water system payments, and any unexpected outcomes as part of a process evaluation. Data collection on impact indicators will take place every six months through early 2025.

INTRODUCTION

BACKGROUND

In rural Africa, over two-thirds of the population is estimated to be exposed to contaminated drinking water (UNICEF/WHO, 2022). Monitoring water quality is essential to providing safe water and protecting public health. Yet, many rural water suppliers fail to conduct water quality tests regularly. Since it can be expensive for rural water suppliers to hire and train specialized staff to conduct testing and to purchase testing equipment and supplies, using an existing centralized laboratory for analysis may be a more cost-effective option for expanding testing (Trimmer et al., 2023). However, existing laboratories may be unwilling to work with rural suppliers due to non-payment risks. The Water Quality Assurance Fund is an innovative financial instrument developed to address these issues and to support regular water quality monitoring in rural areas of Ghana and other similar settings.

HOW THE ASSURANCE FUND INTERVENTION WORKS

The Water Quality Assurance Fund allows existing professional laboratories to expand regular water quality testing to small rural water suppliers without taking on additional financial risks that would otherwise deter them from working with these systems (Figure 1). A third-party nongovernmental organization holds the Assurance Fund to guarantee payment to the laboratory if a rural water system is unable to pay for water testing services on time. It also provides payment if water is not flowing during a scheduled sampling visit. The Assurance Fund thus "assures" the laboratory that it will not suffer losses due to the non-payment of testing fees. The laboratory thereby gains revenue by opening another market for their services, while the rural water supplier gains a means to verify their drinking water safety with greater certainty and at a lower startup cost than establishing onsite laboratory capacity. The Assurance Fund can provide a cost-effective application of financial resources for water quality testing, because the Fund is only drawn down when water systems miss payments. The Assurance Fund implementation model includes a replenishment mechanism through water system reimbursements of delinquent fees. Local authorities enforce the water system reimbursements and associated fines (REAL-Water, 2023a; REAL-Water, 2023b).

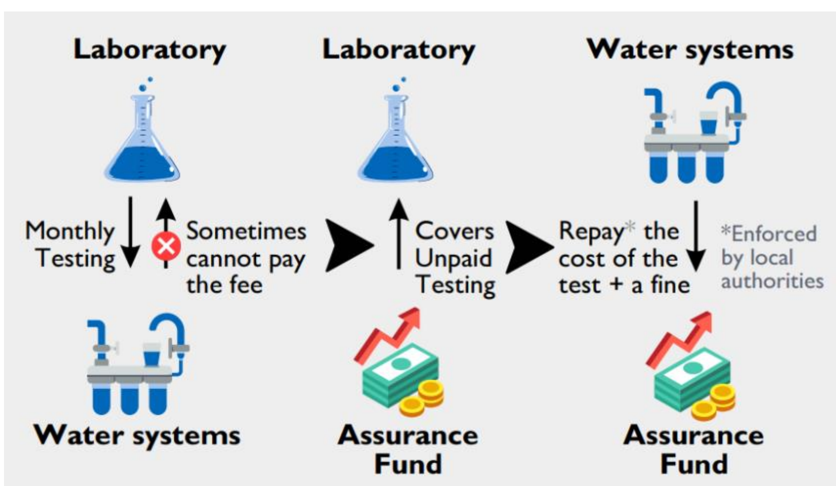

Figure 1. Water Quality Assurance Fund implementation model. The Assurance Fund provides an assurance to laboratories that they will be paid for water quality testing services provided to rural water systems.

The Assurance Fund implementation program also includes capacity-building and engagement components to increase water safety knowledge and to promote responses to the test results:

- Monthly meetings with water operators and local government authorities to discuss test results and water treatment;
- Technical assistance to improve chlorination at the request of water operators or local government authorities;
- Community engagement via the local radio or other mediums, and initial meetings with community members to inform them about the water quality testing program and to answer their questions; and
- Online dashboards for visualizing water quality test data to foster accountability and competition among participating water systems.

An initial pilot of the Assurance Fund implementation model in Ghana has led to water supplier improvements in testing frequency and water treatment (Press-Williams et al., 2021). However, this pilot only included water systems within one district in Ghana and was not designed to quantify the effects of the Assurance Fund intervention. The current impact evaluation is designed to measure these effects, and thereby answer two main questions:

1. How effectively can existing professional water quality laboratories expand their testing services to rural water supplies?
2. To what extent does water quality data trigger improvements in water treatment, consumer satisfaction, and sustainable water safety management practices?

OBJECTIVES

This report describes the baseline status of community-managed water systems in rural Ghana, prior to their enrollment in the Assurance Fund impact evaluation. We also discuss preliminary implications for water quality in rural, low-income settings, as the overall evaluation proceeds through 2025. This study has the following overall research objectives:

1. Evaluate the impact of monthly water quality data on system improvements in water treatment, consumer satisfaction, and sustainable water safety management practices.
2. Explore how effectively existing professional water quality laboratories can expand their water testing services to rural water supplies.

METHODS

STUDY DESIGN

We will evaluate the Assurance Fund program using a stepped-wedge randomized trial (Hemming et al., 2015), which will allow us to measure program effects through comparisons between intervention and control groups while rolling out the intervention gradually. The evaluation includes 28 water systems: 21 randomly assigned to one of three groups successively entering the Assurance Fund program at six-month intervals, and seven non-randomly assigned to the first group[1] (Figure 2).

Assurance Fund program implementation began in the first group of water systems in February 2023 and is currently ongoing. We are concurrently tracking implementation activities, water system payments, and any unexpected outcomes as part of a process evaluation. Data collection will take place every six months through early 2025.

Figure 2. Study design for Assurance Fund evaluation in Ghana with groups of water systems transitioning from control to intervention at different times.

Our primary outcome of interest is chlorine residual in water at the point of collection as a proxy measure of water treatment. Points of collection include public standpipes and private, household-level taps. Other priority outcome indicators include *E. coli* levels at the point of collection; water system operator knowledge related to water quality; and consumer awareness, satisfaction, and stated willingness-to-pay for treated and tested water. We will also collect qualitative data on stakeholders' perspectives regarding water safety and evaluate water quality (chlorine residual and *E. coli*) in household stored water.

This report presents the results of our baseline data collection efforts to understand the existing conditions in eligible water systems and communities prior to randomization and enrollment in the Assurance Fund program.

WATER SYSTEM SELECTION

We screened all public, community-managed water systems within the Ahafo (comprising 6 districts) and Bono (comprising 12 districts) regions of Ghana for inclusion in the Assurance Fund program evaluation. We selected these two regions because most of their water systems were located less than a two-hour

1 We assigned these seven systems to the first group due to early engagement with the district authorities and promises to provide the intervention as soon as possible. When the study is completed, we will evaluate all trial outcomes with and without the inclusion of this non-randomized group. Implementation began at these systems one month before Group 1 systems.

drive from the Ghana Water Company Limited laboratory that agreed to provide testing services for the evaluation. We first screened districts according to eligibility criteria, and then water systems.

Districts were eligible if they met the following criteria:

- They must have rural water systems managed by a community-based Water and Sanitation Management Team (WSMT) with District Assembly oversight less than a three-hour drive from the laboratory providing testing services (excluded six districts).
- They did not participate in a prior pilot of the Assurance Fund program in 2020-2022 (excluded one district).
- The District Assembly demonstrated interest and commitment to participating in the Assurance Fund program, including facilitating meetings between REAL-Water and the water systems and promoting the sharing of financial records by WSMTs.

The community-managed water systems among the selected districts were eligible if they met the following criteria:

- Piped water system or mechanized borehole under community-based management (i.e., we did not consider private water systems, those managed, or soon to be managed, by the national Community Water and Sanitation Agency, or those reliant on handpumps);
- Interest in the Assurance Fund program;
- No regular water quality testing;
- Good financial recordkeeping and willingness to share these records with REAL-Water; and
- Average monthly profits similar to or greater than the estimated monthly water quality testing expenses under the Assurance Fund.

Twenty-eight out of fifty-eight mechanized borehole and piped water systems in 10 districts (4 in Ahafo and 6 in Bono) qualified for enrollment in the Assurance Fund program. Most excluded water systems failed to meet the financial criterion.

WATER SYSTEM DESCRIPTION

The selected water systems comprised 23 piped schemes, primarily located in small towns with some urban characteristics, and five mechanized boreholes that were located in more remote rural farming communities. All are managed by WSMTs and their assets owned by District Assemblies. The piped water systems serve between 1,200-20,000 people (median: 6,230), and the mechanized boreholes serve between 240-2,000 people (median 1,760). All but one of the water systems is the main community water source. Standpipe tariffs average 18 pesewas (about 0.2 USD) per 18-liter bucket and private household connection tariffs average 6 GHS (about 0.5 USD) per cubic meter.

The average monthly profits of the piped systems are 130 USD compared to 72 USD for mechanized boreholes. Piped system WSMTs are generally well constituted with memberships of paid and unpaid members that follow local guidelines. Their records are audited periodically (internally by the District Assembly or externally). In contrast, none of the mechanized boreholes have well-constituted WSMTs that follow local guidelines. Their WSMTs typically comprise two to three volunteers and have limited accountability mechanisms.

BASELINE DATA COLLECTION

We collected baseline data from December 2022 to February 2023 (dry season). We interviewed operators of all 28 water systems, surveyed 20 residential customers per community, conducted focus group discussions with community members, interviewed the chief and queen mother of each community, and interviewed District Assembly members (Table 1).

We measured water quality for up to five public standpipes per community, and household water quality from private taps or stored household water in a subset of households for a total of 118 standpipe, 73 private tap, and 484 stored water samples. We used a Hach DR300 digital colorimeter to measure free and total chlorine, a Hach 2100Q Portable Turbidimeter to measure turbidity, and a digital Pocket Pro+ Multi 2 Tester to measure pH in the field. For *E. coli* analysis, we collected 100-ml water samples in sterile Whirl-pak bags containing sodium thiosulfate and processed these samples following procedures in the Multiple Indictor Cluster Survey Manual for Water Quality Testing (MICS, 2017). These procedures include identifying and counting *E. coli* on CompactDry media plates (manufactured by NISSUI Pharmaceutical Co. Ltd., Japan).

The Council of Scientific & Industrial Research (CSIR) ethical review board in Ghana approved our research protocol. We introduced the study and obtained informed consent from all participants before surveying or interviewing them.

TABLE 1. SUMMARY OF BASELINE DATA COLLECTED

DATA SOURCE	TARGET	DATA COLLECTED
Water systems (N=28)	System operator	System characteristics Treatment practices Revenue and financials Water quality knowledge
	5 standpipes per system*	Water quality (chlorine residual, *E. coli*, pH, turbidity)
Households (N=560)	20 households per water system†	Consumer awareness and perceptions Chlorine residual and *E. coli* in stored water (subset of households) and from private taps Willingness-to-pay for more consistent water treatment and testing
Focus group discussions with community members (N=48)	2 per community (1 with women, 1 with men)	Consumer awareness and perceptions
Traditional authority (N=39 interviews in 24 communities)	Chief Queen mother	Awareness and perceptions related to the water system and water quality testing Gendered perspectives
District Assembly (N=20 interviews in 10 districts)	Planning officer Water engineer	District commitment to water quality Water quality knowledge

* If there were less than five functional standpipes for the water system, we sampled all functional standpipes. When there were more than five functional standpipes per system, we divided standpipes into two groups of approximately equal size: (1) those close to a storage tank, and (2) those far from all storage tanks. We then randomly selected two standpipes to include from the first group and three standpipes from the second group.

† We systematically selected survey households using predetermined distances and directions from each selected standpipe to ensure good spatial coverage of respondents with respect to the piped network.

RESULTS

RESPONDENT CHARACTERISTICS

WATER SYSTEM OPERATORS. Almost all water system operators were male (93%) and 69% had completed secondary school or a higher level of education. Respondent's titles were typically water system operator or manager, with duties such as pumping/distributing water, treating water, conducting maintenance, and overseeing administrative or financial work. Over half (59%) had worked at the water system for five or more years. About half (52%) of water systems paid all their staff, while the remainder either fully relied on volunteer labor (26%) or had a mix of paid and unpaid staff (19%).

HOUSEHOLDS. Most household respondents were female (83%) and had completed primary or higher education (62%). Agriculture was the most common primary occupation (45%), followed by no employment (15%). Other respondents either worked in the private sector, for the government, or were students. Most households had a mobile phone (98%) and electricity (87%). Twenty percent of surveyed households had a private tap in their house or yard, four percent used a tap in a neighbor's yard, and the rest used a public standpipe.

TRADITIONAL AUTHORITY. The chief (i.e., male leader) and/or queen mother (i.e., female leader) were interviewed in 24 of the 28 communities. In the remaining four communities, there was either no traditional authority, conflicts among competing candidates, or traditional authorities were unavailable for an interview. We interviewed both the chief and the queen mother in 15 communities, only the chief in eight (often because the community did not have a queen mother), and only the queen mother in one.

DISTRICT ASSEMBLY. The district planning officer and an environmental health officer or water engineer were interviewed in each district. Most were male (80%) and half had worked in their positions for at least five years.

KEY FINDING 1: WATER SYSTEMS WERE NOT ADEQUATELY CHLORINATED.

CHLORINATION FREQUENCY

Water system chlorination was infrequent, if done at all (Table 2). Almost one-third of water systems (31%) never chlorinated, and those that did typically chlorinated monthly (35%) or quarterly (23%). This chlorination was usually done by manually adding chlorine powder or tablets to storage tanks. Although the appropriate frequency of chlorine addition can depend on a number of system-specific factors like tank size and source water quality, it would typically need to be at least once per week for water systems of this size using chlorine tablets. No water systems were chlorinating at this recommended frequency. About half of water systems (48%) had chlorination materials on site at the time of data collection. Additionally, none of the water systems performed any other types of water treatment.

TABLE 2. WATER SYSTEM CHLORINATION FREQUENCY	
FREQUENCY OF CHLORINATION	WATER SYSTEMS, N (%) N=27*
At least weekly	0
Every 2 weeks	2 (8%)
Monthly	9 (35%)
Quarterly	6 (23%)
Every 6 months	2 (8%)
Never	8 (31%)

* Data on chlorination practices is missing for one water system that was not asked this question.

CHLORINE RESIDUAL LEVELS

Almost all (97%) of the public standpipes and private household taps had residual-free chlorine levels below the recommended level of 0.2 mg/L (Figure 3) (GSA, 2021). Similarly, the vast majority (96%) also had free chlorine residuals less than 0.1 mg/L, which is often considered the lower limit for detectable chlorine due to potential false positives from other water constituents, such as manganese. Using a less conservative detection limit of 0.05 mg/L would have minimal impact on these results (with 83% of standpipe and 90% of private tap samples below 0.05 mg/L). This level of chlorination would not be sufficient to protect water from contamination during collection, transport, and household storage (WHO, 2022).

Residual free chlorine levels in household stored water were also low, with residuals of at least 0.1 mg/L only measured in 2% of samples. Few of these stored water samples (7%) had been mixed with another source of water.

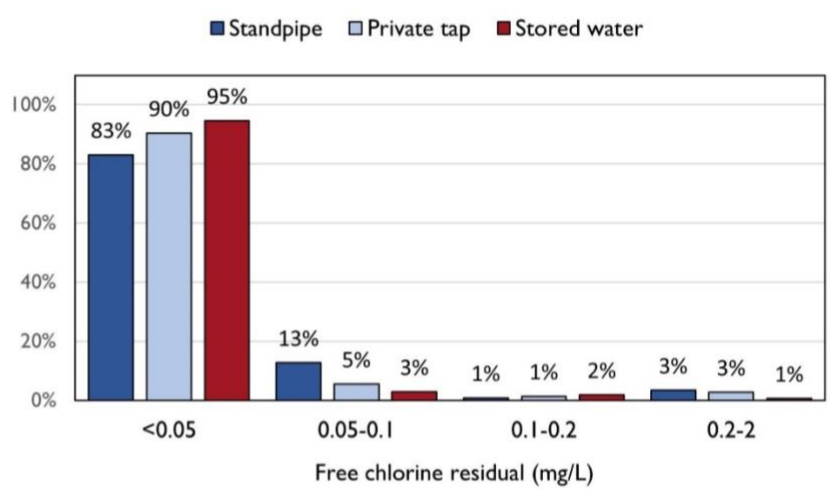

Figure 3. Free chlorine residual in standpipe (N = 118), private tap (N = 73), and household stored (N = 484) water samples. Almost all samples were below recommended minimum chlorine residual levels of 0.2 mg/L.

KEY FINDING 2: WATER OFTEN HAD MICROBIAL CONTAMINATION AT THE POINT OF COLLECTION AND ALMOST ALWAYS AT THE POINT OF USE.

Many standpipe (40%) and private tap (59%) water samples had detectable *E. coli* (Figure 4). The high prevalence of microbial contamination was likely due to inadequate disinfection, and is consistent with the poor chlorination practices reported above. Microbial contamination was even higher in household stored water, with the majority of samples having high or very high *E. coli* levels. Water quality thus deteriorated during water collection and storage, further demonstrating the importance of adequate chlorine residuals to protect against recontamination.

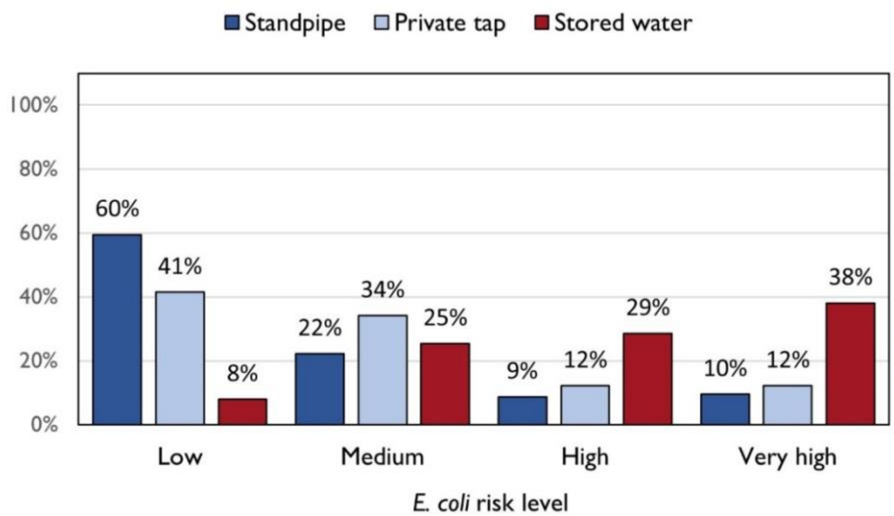

Figure 4. *E. coli* risk level in standpipe (N = 126), private tap (N = 82), and household stored (N = 63) water samples. Low risk corresponds to no colony forming units (CFU) per 100 ml sample, medium risk to 1-10 CFU per 100 ml, high to 10-100 CFU per 100 ml, and very high to >100 CFU per 100 ml. Microbial water quality was sometimes good at the point of collection with no *E. coli* detected, but almost always poor at the point of use.

KEY FINDING 3: WATER OPERATORS AND LOCAL GOVERNMENT OFFICIALS GENERALLY HAD LOW WATER QUALITY KNOWLEDGE.

Water quality knowledge was equally low among water system operators and local government officials. We assessed knowledge with 15 standardized interview questions related to water contamination, treatment, and water quality regulations. These included open-ended questions and true/false questions where we also assessed the respondent's justification for their selection. Out of 32 possible points, the median score was 10 (range: 4–18) among water system operators, 12 (range: 9–18) among district planning officers, and 12 (range: 8–16) among district water engineers or environmental health officers.

Knowledge levels varied across water quality topics (Figure 5). Respondents were most knowledgeable about sources of contamination, providing correct answers for about half of questions. Specifically, they were most aware of risks related to certain point sources of water contamination (e.g., latrines, mining activities, excess application of fertilizer or pesticides), answering an average of 70% or more of related true/false questions correctly. However, they often could not explain the different potential sources of contamination when open-ended questions were initially asked (less than 20% correct). Respondents also had some knowledge of chlorination and what makes water safe as well as water quality regulations and standards (around a third of correct answers), but little knowledge about types of contaminants or pathogenic microorganisms (less than 20% of correct answers). Better understanding of water quality topics could help improve water treatment, system management, and source protection.

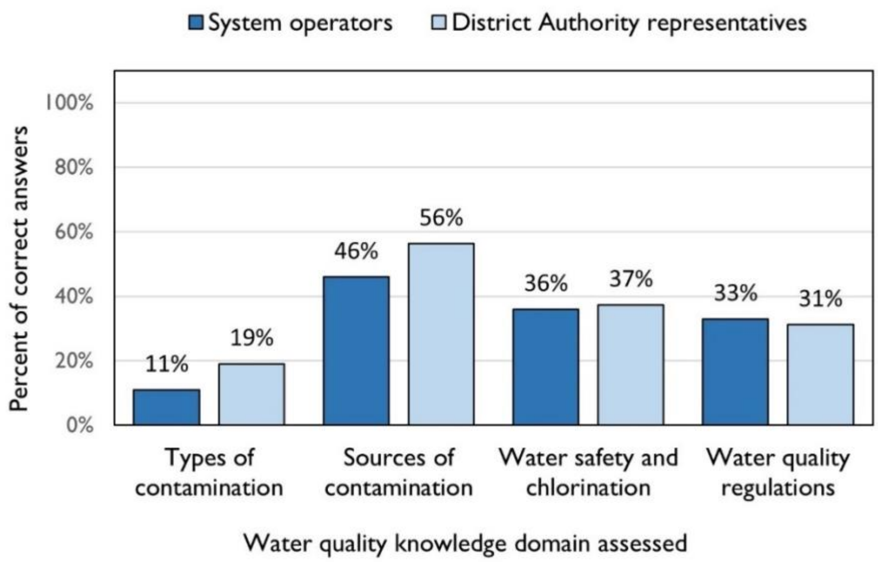

Figure 5. Water quality knowledge among water system operators and District Assembly representatives (including the planning officer and environmental health officer or water engineer for each district) based on 15 quiz questions. Knowledge was generally low across subject domains, but was the highest for sources of water contamination and lowest for types of water contamination.

KEY FINDING 4: MOST HOUSEHOLDS WERE AT LEAST SOMEWHAT SATISFIED WITH THE WATER, BUT MANY WERE WILLING TO PAY MORE FOR WATER THAT IS REGULARLY TREATED AND TESTED.

Most household survey respondents reported that the water system under investigation was their main source of drinking water (78%). The rest reported drinking sachet water (16%) or water from a borehole (6%). The most common reasons for choosing alternative sources of drinking water were perceptions that alternative sources were safer (51%), concerns with the smell and/or taste of water from the local system (38%), concerns with the color of water from the local system (12%), or a preference for the colder temperature of sachet water. Only a few households reported preferences for alternative water sources because they felt water from the system was too expensive (3%).

Almost all survey respondents were very satisfied (50%) or somewhat satisfied (41%) with the local water system. Only a few were somewhat dissatisfied (6%) or very dissatisfied (2%). Common reasons for dissatisfaction included taste, smell, unreliability, and cost. Some respondents (15%) also thought the water supplied by their local system was unsafe for health. About one-quarter of water systems had received a complaint from customers within the past month, often related to system functionality, payment, or water quality (typically about turbid water or chlorination-related changes to the color or other physical characteristics of the water).

Over half of households reported that they were willing to pay higher tariffs if water was regularly treated and tested (54% of standpipe users and 69% of households with private taps). The median stated increase in willingness-to-pay was a 20% addition to current tariffs. This would be 5 pesewas (about 0.004 USD) more per 20-liter bucket for standpipe users and 3-4 GHS (about 0.3 USD) more per month for those using private taps. Additionally, households who felt the water was unsafe were the most likely to report a higher willingness-to-pay.

KEY FINDING 5: WATER SYSTEM COMMUNICATION WITH CONSUMERS COULD BE IMPROVED.

Most water system managers did not communicate frequently with customers, and when they did, they largely shared information about breakdowns or service interruptions. Only one water system reported communicating with customers about water quality, and it was related to a specific illness outbreak within the community. Two water systems held quarterly community meetings to discuss water system operations, problems the community could help manage, or suggested improvements. A few other water systems only engaged with communities once per year when rendering accounts to explain how they used the water system revenue. Information-sharing methods included in-person community meetings, radio, or information center announcements (i.e., community loudspeakers).

Traditional authorities and households similarly reported infrequent communication from WSMTs. In some communities, the chief felt the water system had shared information with the community, but in the same communities the queen mother (who had more connection with women community members primarily responsible for water collection) was unaware of any information shared, suggesting dissemination may not have been inclusive. Most households (69%) reported not receiving any information from the WSMT about water safety. Those who did report WSMT engagement mostly indicated that they received information about storage tank cleanings. A few households reported receiving information about chlorination, water testing, or safe storage practices. A few chiefs indicated that they took it upon themselves to inform community members about water system issues and the importance of keeping their water points clean.

Consumer perceptions reflected the lack of adequate communication. Just over half (56%) of household survey respondents believed that water supplied by their community system was treated, with 17% believing it was not treated, and 27% not knowing if it was treated. The treatment practices they were aware of were mostly tank cleanings and occasional chlorination. They were mainly aware of these practices through changes in the taste or smell of their water, with some having heard about it from the WSMT, the community center, or the radio. Although data that we collected from water systems indicated that chlorination was sporadic at best (see Table 1), about half of the household respondents (48%) that believed their community water supplies were treated also thought current chlorination practices were sufficient to ensure that the water was always safe to drink, with 33% being unsure, and 18% disagreeing.

KEY FINDING 6: DISTRICT ASSEMBLIES THOUGHT WATER QUALITY WAS IMPORTANT, BUT FACED CHALLENGES IMPROVING IT.

Although it typically was not mentioned as a top priority of the district, all District Assembly representatives that we interviewed stated that drinking water quality was a key district priority related to water supply. Many felt that expanding water access and improving water quality were priorities that could not be separated from each other. Some felt quite strongly about these related priorities, describing the links between safe water, public health, and economic development within the district.

For instance, one respondent described: *Giving water to people if it is not wholesome that means you're still giving them diseases. And if a person is affected by any diseases that means you cannot be effective and be doing the daily activities that he's supposed to do. So, our topmost priority is to get them safe water so that the water that we're giving to them will not make them fall sick.* A few also recognized the importance of testing to ensure that water is safe. Others identified training of the WSMT members in water safety management as a priority related to water supply.

Insufficient funding was typically identified as a key barrier to improving water quality and testing. Many district representatives also noted challenges related to a lack of technical expertise regarding water treatment and water system improvements. Some also noted challenges in changing household behaviors on water source selection, chlorine acceptance, or water handling and storage practices. Review of districts' annual action plans and budgets confirmed that only one of the ten districts had budgeted for water quality management, and none shared records of implementing any activity related to water quality.

KEY FINDING 7: SOME BASELINE IMBALANCES EXIST BETWEEN STUDY ARMS THAT MUST BE ACCOUNTED FOR IN FUTURE ANALYSIS.

Due to the small number of water systems randomized for the study, not all important characteristics are balanced across study arms (Table 3). For example, water system standpipes in the first group had higher chlorine residual levels at baseline, and the third group had fewer water systems offering private connections. We will make sure to account for key baseline differences in the final evaluation analysis, and will describe analysis methods in a forthcoming pre-analysis plan.

TABLE 3. BASELINE CHARACTERISTICS AMONG STUDY ARMS

CHARACTERISTIC	STUDY ARM			
	GROUP 0	GROUP 1	GROUP 2	GROUP 3
Water systems, N	7	7	7	7
Water systems offering private taps, N (%)	7 (100%)	5 (71%)	5 (71%)	3 (43%)
Water system operator knowledge from assessment, mean score out of 32	8.3	9.4	12.4	11.3
Standpipes sampled, N	33	31	26	28
Free chlorine residual of at least 0.2 mg/L at standpipes, N (%)	0	4 (13%) *	0	0
Households surveyed, N	141	139	140	140
Respondent households which use target water system for drinking, N (%)	114 (81%)	115 (83%)	106 (76%)	104 (74%)

TABLE 3. BASELINE CHARACTERISTICS AMONG STUDY ARMS

CHARACTERISTIC	STUDY ARM			
	GROUP 0	GROUP 1	GROUP 2	GROUP 3
Household respondents very satisfied with target water system, N (%)	78 (55%)	68 (49%)	69 (49%)	67 (48%)

* All four standpipes are supplied by the same water system.

LOOKING TO THE FUTURE

Baseline results identified several areas of improvement in water safety management that we will measure as indicators of the Water Quality Assurance Fund program impact evaluation:

- **WATER QUALITY KNOWLEDGE:** Monthly water quality testing and debrief meetings may improve water quality knowledge among water system operators and District Assembly members. We hypothesize that better access to water quality data will lead to better water treatment, system management, and source protection practices.

- **WATER TREATMENT:** Technical guidance on remedial actions may support water operators to improve their water treatment practices. We hypothesize that better access to information and technical assistance will lead to improvements in chlorine residual levels and reductions in *E. coli* at the point of collection.

- **COMMUNICATION AND CONSUMER PERCEPTIONS:** Regular community engagement activities, such as monthly radio programs, may improve community members' awareness of water quality testing, treatment practices, and actual water safety levels. We hypothesize that with adequate community engagement, water systems may also be able to increase their tariffs to fund improvements in water safety management.

However, for the Assurance Fund program impact evaluation to demonstrate cost-effective benefits, district leaders must champion the related activities and act as driving forces to encourage water systems to pay testing fees on time, improve chlorination, and disseminate water safety information to communities. Despite widespread interest in improving water quality among district representatives, it is important to recognize that competing priorities and insufficient funds may detract from these objectives, and potentially, diminish the program impacts.

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