Piloting Water Treatment Devices in conjunction with Jal Jeevan Mission

Evidence Action

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I. Background

Introduction

Evidence Action would like to thank a number of individuals and organizations that have been vital in building organizational understanding of the Indian water context, developing our pilot design, and formulating this proposal. Jal Jeevan Mission officials across the national and state levels have provided their time and expertise to include: Secretary Vini Mahajan, Additional Secretary and Mission Director Vikas Sheel, Director of Water Quality Ajay Kumar, Director Yogendra Kumar Singh, Dr. Mihir Kumar Purkait Professor-Indian Institute of Technology Guwahati, Section Officer Naveen Kumar among many others. Further engagement with the greater Non-governmental Organization (NGO) community and members of the Rural Water, Sanitation, and Hygiene (WASH) Partners' Forum include University of Chicago's Development Innovation Lab (DIL), Tata Trusts, WaterAid, and the Safe Water Network. Evidence Action looks forward to continuing these engagements and relationships through the proposed pilot and implementation.

Jal Jeevan Mission

The Government of India established the Jal Jeevan Mission (JJM) in 2019 with the intention of providing universal access to water by 2024. As of January 2023, 107,466,382 households, 56% of all households across all 28 states and eight union territories have tap water connections[1]. In addition to prioritizing provision of household taps, JJM has also prioritized ensuring appropriate drinking water quality through the household taps. As such, after undertaking rigorous evaluation, JJM has published a list of approved water treatment devices[2] that can be procured and installed by the state governments to best meet their underlying infrastructure needs. The devices on the JJM approved "technologies and best practices" list have been vetted by principal scientific advisers and designated committees and serve as recommendations to state-level departments of water when procuring water treatment devices.

Evidence Action Safe Water Background and India Programs

Evidence Action is a non-governmental organization operating in nine countries focused on delivering proven WASH and public health solutions. Evidence Action's flagship safe water program includes 27,000 dispenser and in-line chlorination devices enabling safe water access to 4.5 million people in Kenya, Uganda, and Malawi. Evidence Action is in the midst of expanding this safe water network to

[1] Jal Jeevan Mission - Har Ghar Jal, "Functional Household Tap Connection (FHTC) in every rural home" (2023).
[2] Department of Drinking Water and Sanitation, Ministry of Jal Shakti, "Approved Water Treatment Devices and Best Practices"

52,000 devices, enabling the organization to reach over 9 million people. In India, Evidence Action is represented by EAII Advisors Private Limited ("EAII") as its technical services provider under a Services Agreement, in terms of which EAII (on behalf of Evidence Action), provides technical assistance to 11 state governments' ministries of health, education, and women and child development to implement school- and anganwadi-based National Deworming Day and Iron and Folic Acid Supplementation to improve children's health, education, and long-term development. Evidence Action reaches nearly 200 million people every year through its deworming and Iron and Folic Acid supplementation programs. At its peak in 2019, Evidence Action supported state governments delivered 285 million deworming treatments to schoolchildren, a quarter of all deworming treatments accounted for worldwide. Through this strong government support and engagement, multiple Indian states are witnessing a sharp decline in their worm prevalence rate.

Evidence Action supports government partners across various dimensions:

- *Policy & Planning:* Help establish effective governance structures at the national, state, and community levels, and embed school-based health programs within relevant departments, policies, and budgets.
- *Resource planning:* Work closely with partner governments to help set performance targets, assist in creating operational plans, and support in developing budgets that enable the best use of domestic resources.
- *Procurement & supply chain management:* Support timely and accurate drug procurement, consistent and robust delivery systems, and efficient coordination between education and health officials.
- *Real-time monitoring & evaluation:* A world-class monitoring and evaluation function drives accountability and helps governments monitor progress, identify bottlenecks and challenges as they emerge, and make improvements in real time.
- *Training & capacity building:* Work at multiple levels of the system simultaneously, help governments design and coordinate an efficient multi-tier training cascade that is tailored to the local context.
- *Community sensitization:* Help governments develop locally appropriate campaigns that educate children and communities, leveraging social media and other digital platforms to increase awareness.

To enable this level of support, Evidence Action has 12 offices in India with approximately 100 full-time staff, as well as over 60 field staff and contractors.

Michael Kremer Meta-analysis and Findings

In March 2022, Nobel Laureate Michael Kremer and co-authors published a working paper entitled "Water Treatment and Child Mortality: A Meta-analysis and Cost-effectiveness Analysis." The team analyzed 15 randomized controlled trials (RCTs) using a novel methodology – beyond the published results of each RCT, they obtained additional data from qualifying studies' authors on under-five (U5) mortality. This enabled them to analyze the impact of water treatment on *child* survival, even if the original analyses focused on different cohorts. Of the 15 studies included in the main analysis, which included over 25,000 participants in total, twelve examined water chlorination, two examined water filtration, and one examined spring protection.

The authors included 15 RCTs that had data on child mortality in the meta-analysis. The paper concludes that water treatment reduces all-cause U5 mortality by around 25%. Using cost data from Evidence Action's Dispensers for Safe Water program, they estimate the program is 45 times more cost-effective than the WHO's "highly cost-effective" threshold. The paper states, "Our analysis suggests that water treatment is one of the most cost-effective health approaches available, and that policymakers aiming to improve child health should consider water treatment."

Michael Kremer served as the Gates Professor of Developing Societies at Harvard University until 2020. He is currently a University Professor in Economics and Public Policy at the University of Chicago, and the founding director of the Development Innovation Lab housed there. In 2019, he was jointly awarded the Nobel Memorial Prize in Economics, together with Esther Duflo and Abhijit Banerjee, "for their experimental approach to alleviating global poverty."

Academic Studies on Chlorine Decay and Recontamination

According to current academic research, Evidence Action believes it would be beneficial not only to enact water treatment at sites where no treatment is currently occurring, but also to add chlorine "top-up" along systems where water treatment is already taking place. Specifically, evidence suggests that large, centralized water treatment schemes are susceptible to chlorine decay and recontamination, and would benefit from chlorine "top-up" closer to household taps. Chlorine decay occurs due to various factors, including length of time treated water is stored, the quality of the water being treated, biofilm buildup in the pipe system, distance traveled by the treated water, etc. Recontamination occurs when already treated water is exposed to sources of contamination due to issues such as pipe breakages or negative pressure in pipes, which is a phenomenon in intermittent water systems. These occurrences allow water and other substances from the area around the pipes, which is not treated, to enter the pipes.

Below summarizes a number of academic studies demonstrating that chlorine decay and recontamination is a common issue.

In "Microbial water quality improvement associated with transitioning from intermittent to continuous water supply in Nagpur, India"[3], Bivins et al. find that in Nagpur, "Free chlorine residuals in 61.5% of samples from IWS (intermittent water supply) areas and 57.1% from the CWS (continuous water supply) area were below the 0.2 mg/L required by The Indian Standard for Drinking Water (BIS:10500)." The water in question was centrally treated with chlorine.

In "Comparing microbial water quality in an intermittent and continuous piped water supply"[4], Kumpel and Nelson find that in Hubli-Dharwad, India, only 39.9% of samples from the intermittent water supply network and 68.3% of samples from the continuous water supply network met the official guidelines for chlorine residual. Both the IWS and CWS networks centrally treat the distributed water.

In "Upgrading a Piped Water Supply from Intermittent to Continuous Delivery and Association with Waterborne Illness: A Matched Cohort Study in Urban India"[5], Ercumen et al. find that in a centrally treated intermittent water system in Hubli-Dharwad, India, 32% of tap water samples tested positive for E. coli, thus not meeting WHO drinking water quality guidelines.

In "A cross-sectional study of enteric disease risks associated with water quality and sanitation in Hyderabad City"[6], Mohanty et al. note that out of 49,494 water samples taken, over 5% had no residual chlorine, despite the fact that the water had been chlorinated centrally by the Hyderabad Metropolitan Water Supply and Sewerage Board. Still more water samples had residual chlorine present, but in amounts lower than the residual prescribed (0.2 ppm) in the water manual prepared by the Central Public

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[3] Bivins, Aaro; Lowry, Sarah et al. "Microbial water quality improvement associated with transitioning from intermittent to continuous water supply in Nagpur, India" (2021). Science Direct, Water Research.

[4] Kumpel E, Nelson KL. "Comparing microbial water quality in an intermittent and continuous piped water supply" (2013). Science Direct, Water Research.

[5] Ercumen A, Arnold BF, Kumpel E, Burt Z, Ray I, Nelson K, et al. "Upgrading a Piped Water Supply from Intermittent to Continuous Delivery and Association with Waterborne Illness: A Matched Cohort Study in Urban India" (2015). PLoS Med 12(10): e1001892. doi:10.1371/journal.

[6] J. C. Mohanty, T. E. Ford, J. J. Harrington and V. Lakshmipathy, "A cross-sectional study of enteric disease risks associated with water quality and sanitation in Hyderabad City" (2002). Journal of Water Supply: Research and Technology—AQUA.

Health Environmental Engineering Organization, Ministry of Urban Affairs, Government of India. In some areas of Hyderabad, the percentage of water samples with no residual chlorine was as high as 14% despite chlorination at the source. The authors note on chlorine decay, “Bacteriological examination (total and fecal coliforms), conducted by the HMWSSB of about 400 water samples per month at distribution sites where no residual chlorine is detected, shows that the treated water rapidly deteriorates in microbiological quality as it passes through the distribution system.”

II. Underlying Assessments

Technology Assessment

In building organizational understanding of “Made in India" water technologies and recognizing JJM’s priorities, Evidence Action started with an in-depth review of the JJM Approved Technologies and Best Practices List. Following the review, they hired an Indian water technical consultant to develop an appropriate market landscape and held continuous and ongoing discussions with designated JJM nodal officers, representatives at the National Environmental Engineering Research Institute (CSIR-NEERI), and partner organizations in the NGO WASH Partners Forum. Further the water treatment technologies reviewed included discussions with academics and industry experts on the applicability of fields of technologies to Evidence Action’s proposed pilot.

Shortlisted technology types included ultrafiltration, nanofiltration, silver ionization, and chlorination. While filtration and silver ionization are both JJM approved best practices and are promising at certain scale and situations, chlorine serves as the most applicable technology field when considering the water tank capacity, distance water travels, applicability across Total Dissolved Solid (TDS) ranges, residual chlorine benefit, and that MVS are already treated with chlorine.

Endorsed by JJM and the World Health Organization[7], chlorine has a number of benefits as a water treatment solution. Chlorine dosing devices are low cost, have low operational and maintenance requirements, can operate with or without electricity, and there are multiple “Made in India” devices on the market. Chlorine, or basic table salt in the case of electrochlorination, are widely available throughout India with significant supply chain diversity. Residual chlorine or free chlorine can maintain treatment efficacy for up to 72 hours post introduction. Further, given organizational experience employing

[7] World Health Organization, “Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda” (2022). Pg. 361-362.

chlorination-based solutions across Kenya, Uganda, and Malawi for over a decade, Evidence Action is uniquely poised to provide robust recommendations on chlorination to the Indian government.

This process culminated with in-depth interviews with nine Indian firms and suppliers to include Tiaano Water Sanitation, HiSafe Global, Adwyn Chemicals Private Limited, TechnoOrbital Advanced Materials, Senco India, Grundfos Pumps India, Initiative Engineering, Easol PurAll, and Absolute Water.

This proposal does not serve as an endorsement of only chlorine-based solutions or run opposed to JJM recommendations. Chlorine is simply a JJM and World Health Organization endorsed water treatment solution that is applicable across the size and scale of SVS and MVS.

Infrastructure Assessment

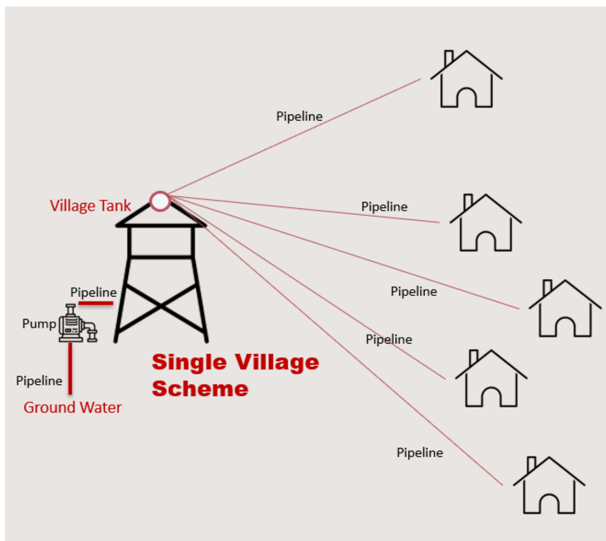
Simultaneous to technology assessment and to better understand major infrastructural aspects of SVS and MVS, Evidence Action secured the requisite approvals at the state level and leveraged existing staff to conduct a rapid survey of water tanks across multiple states. Survey questions were intended to understand tank structural considerations that would directly affect the selection of water treatment technologies such as tank capacity, tank materials, pipe materials and sizes, frequency of electricity, number of households served, etc.. Results were intended to be directional and serve as a snapshot of common types of water points. A total of 152 sites were surveyed across ten states[8] including 101 water tanks in SVS and 51 water tanks as part of MVS. Results of the infrastructure survey as well as discussions at multiple levels of government have informed the "Common Infrastructure Profiles" in the Assessment Findings.

Assessment Findings

Through multiple field visits, technology assessment, and the infrastructure assessment, Evidence Action identified the following trends and potential intervention points for the water treatment pilot. To note, recommendation for piloting does not include any endorsement of these companies or brands in particular, but the products are representative of the field of chlorination-based technologies. Potential intervention points include:

[8] Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh, Uttarakhand

Single Village Schemes (SVS): Are typically a groundwater-based system that is not treated via a centralized site. If treatment is occurring in SVS it is likely the result of a local government initiative or market-purchased bleaching powders by the local water committee. Depending on the area's water table and access to surface water, SVS is often the primary method for water access in some Indian states. 70% of the water points in Evidence Action's infrastructure survey were SVS and further desktop research suggests SVS may make up 50% of water points in Andhra Pradesh, 85% in Madhya Pradesh, and a similarly high concentration in Rajasthan due to a high dependence on groundwater.[9,10] Evidence Action will look to verify these numbers with state governments. Initial analysis captured the following Common Infrastructure Profile for village-level water infrastructure in SVS and village-level water infrastructure in MVS.



Single Village Scheme: Depicting the general layout of a single village scheme and the potential intervention point at the village-level water tank.

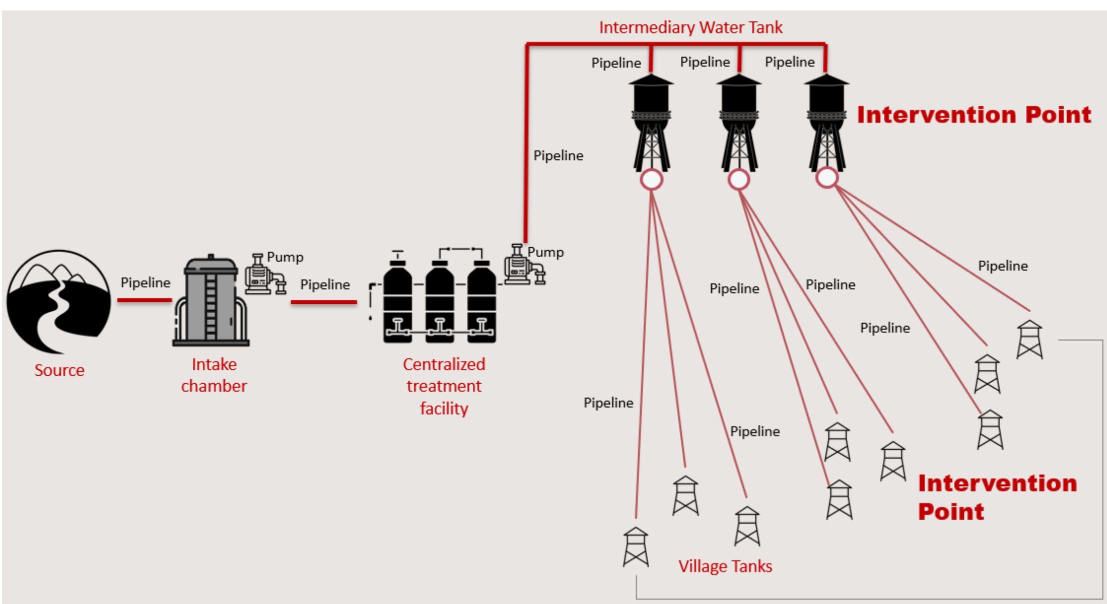
Single Village Scheme Village-Level Scheme "Common Infrastructure Profile"	
Tank Capacity	Average tank capacity 100,000 liters; median 50,000 liters; minimum recorded 1,000 liters, maximum 800,000 liters
Number of Households Served	Average households served 400; median 230; maximum 3,000

[9] Census of India 2011, HL-06: Households (excluding institutional households) by main source of drinking water and location

[10] Andhra Pradesh Water Resources Information & Management System, "Water Available in Andhra Pradesh as of Jan-5-2023", (2023)

Common Tank Material	70% concrete, 15% plastic, 3% metal, the remaining were indeterminate
Common Pipe Material	55% metal, 12% HDPE, 18% PVC, the remaining were indeterminate
Common Inlet Pipe Size	Average 129 millimeters; median 77 mm
Access to Electricity	47% had municipal power, 9% solar power, 18% other source; 24% had no electricity; the remaining were indeterminate
Most commonly administered by	80% of WPs surveyed administered by the government; the remaining largely administered primarily by the community

Multi-Village Scheme (MVS): A water treatment system serving multiple villages, typically a surface water source, constructed and run by JJM or another government agency and reaching tens to hundreds of thousands of people. There are two identified water treatment intervention points in MVS, Village-Level Water Tanks and Intermediary Water Tanks. There is a robust body of literature, outlined in the "Academic Studies on Chlorine Decay and Recontamination" section, showing that water recontamination occurs in intermittent water systems due to fluctuating water pressure and holes in pipes and that chlorine "top-up" is a best practice due to chlorine decay, pipe breakages, pipe leaks, chlorine demand over long distances, and biofilm buildup.



Multi-Village Scheme: Depicting the general layout of a multi-village scheme and the two potential intervention points, at the Intermediary Water Tank and the Village-level water tank.

Multi-Village Scheme Village & Intermediary Level "Common Infrastructure Profile"	
Tank Capacity	Average tank capacity 960,000 liters; median 320,000 liters; minimum recorded was 16,000 liters, maximum 8,000,000 liters
Number of Households Served	Average households served 3,700; median 1,000; maximum 35,000
Common Tank Material	80% concrete, 6% metal, the remaining were indeterminate
Common Pipe Material	76% metal, 4% HDPE; the remaining were indeterminate
Common Inlet Pipe Size	Average 265 millimeters; median 200mm
Access to Electricity	75% access to municipal power, 2% solar power, 2% other source; 17% had no electricity; the remaining were indeterminate
Most commonly administered by	>90% of WPs surveyed were administered by the government; the remaining were administered by private actors

III. Pilot Design

Under JJM's supervision and direction, Evidence Action proposes to conduct a pilot with the aim to test the performance of selected JJM approved water treatment technologies in the most common types of rural water tanks servicing single village schemes (SVS) and multi-village schemes (MVS). The proposed pilot will focus on establishing operational considerations that state governments can rely upon during their procurement and scale-up decisions. Post pilot recommendations will include an analysis of device performance and applicability across various factors such as tank capacity (20,000L, 40,000L, 100,000L, etc.), access to electricity, level of community engagement, population served, and others. Following the pilot, findings and recommendations will be provided to JJM and state departments of water for incorporation in policy, water treatment guidelines, procurement processes, and implementation.

With JJM leadership endorsement and approval, Evidence Action proposes installing selected chlorine-based water treatment directly on currently in-use water infrastructure as directed by state departments of water. The pilot would test the technologies' ability to provide safe water directly to the water infrastructures' population.

Objectives

The pilot aims to identify the following for each device tested:

- Installation Feasibility – Complexity and amount of effort and time required for the installation
- Operational Feasibility – Operating, refilling, and basic operator-level maintenance of the technology
- Efficacy – In terms of conducting the device's designated task, e.g. is the dosage correct and consistent
- Financial and Economic Implications – Understanding the full costs of installing and operating the device and costs per person served per year
- Scalability – Understanding the firms' ability to scale production and programmatic ability to replicate technologies across multiple infrastructures

Given that the proposed pilot is designed to measure operational findings in the short-term, this pilot will not be able to evaluate:

- Seriousness of operational and maintenance issues – Frequency and degree e.g. equipment breakdown due to the multi-year life cycle of some of the technologies
- Community buy-in – Long term community buy-in and commitment to operating and maintaining the device. Evidence Action will look to state-level government support to assess community engagement.

Locations

Evidence Action proposes conducting the pilot across three states as the most effective balance between diversification of infrastructure and governments versus the operational feasibility and cost of running the pilot. Current states are Andhra Pradesh, Madhya Pradesh, and Rajasthan. Evidence Action has conducted successful meetings with both the Andhra Pradesh and Madhya Pradesh governments and submitted state-level proposals and Memorandums of Understanding for final approval. Evidence Action will be meeting with the Rajasthan government in the next two weeks and anticipates proceeding with Rajasthan as the third state. Evidence Action will keep JJM informed of all updates regarding any states discussed here. These states were selected based upon public health criteria prioritized by the Michael Kremer meta-analysis to include under-5 all cause child mortality (rate), under-5 all cause child mortality (gross), enteric infection disability-adjusted life years (DALY), diarrheal DALYs, among others. Technologies would be piloted across five to six locations in each state to include SVS, MVS village level, and MVS intermediary level and bring the total number of pilot locations to 18 sites. Evidence Action requests support from the JJM state representatives and state departments of water to identify appropriate locations and facilitate access to the sites. Following recommendation submission to JJM and state departments of water, Evidence Action would be interested in expanding the program, scaling, and implementing across interested states.

Intervention

The results outlined in the infrastructure assessment and the capabilities of identified technologies informed Evidence Action's pilot design. The below proposed technologies would be installed directly on active water infrastructure.

Single Village Scheme Village-Level Water Tanks: These tanks are directly at the village level and have outlets or feed water to hundreds or thousands of household taps. Considering the results outlined in the infrastructure assessment and the capabilities of identified technologies, the following technologies are most applicable at **Single Village Scheme Village-Level Water Tanks**:

1. **Mechanically-based in-line liquid chlorine dosing pumps:** Provide a low cost, low operationally intensive, and low maintenance solution to chlorinate water at the village level. Different models operate with or without electricity providing flexibility depending on the available infrastructure. Mechanically-based in-line liquid chlorine dosing pumps are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Mechanically-based in-line liquid chlorine dosing pumps are on the market that are appropriate for water tank sizes from 1,000 liters to 1,000,000 liters or more and only the dosing rate and liquid chlorine tank would have to be adjusted. Example devices that will be included in the pilot are the HiSafe Global Chloritron (Website Link) (Link on JJM approved technologies List) and others sold by Adwyn Chemicals Private Limited (Website Link).
2. **Tablet-based passive in-line chlorination devices:** Provide a low cost, low operationally intensive, and low maintenance solution to dose dry chlorine tablets at the village level. Dry chlorine tablets are more stable and less volatile across climates, but are still easy to source across India. Tablet-based passive in-line chlorination devices do not require electricity and only dose chlorine when the water is flowing and passing over the tablet making these devices effective in intermittent water supplies. Tablet-based passive in-line chlorination devices are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Devices are on the market that are able to handle water tank sizes from 1,000 liters to

100,000 liters. Example devices that will be included in the pilot are the Easol PurAll 100 (Website Link) (Link on JJM approved technologies list).

Multi-Village Scheme Village-level water tanks: These tanks are directly at the village level and have outlets or feed water to hundreds of household taps. Chlorine-based interventions suitable for SVS would also be applicable for the MVS village level.

Considering the results outlined in the infrastructure assessment and the capabilities of identified technologies, the following technologies are most applicable at **Multi-Village Scheme Village-level water tanks**:

1. **Mechanically-based in-line liquid chlorine dosing pumps:** Provide a low cost, low operationally intensive, and low maintenance solution to chlorinate water at the village level. Different models operate with or without electricity providing flexibility depending on the available infrastructure. Mechanically-based in-line liquid chlorine dosing pumps are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Mechanically-based in-line liquid chlorine dosing pumps are on the market that are appropriate for water tank sizes from 1,000 liters to 1,000,000 liters or more and only the dosing rate and liquid chlorine tank would have to be adjusted. Example devices that will be included in the pilot are the HiSafe Global Chloritron (Website Link) (Link on JJM approved technologies List) and others sold by Adwyn Chemicals Private Limited (Website Link).
2. **Sensor-based in-line liquid chlorine dosing pumps:** Provide all of the benefits of a mechanically-based in-line liquid chlorine dosing pump, but also include sensors at the dosing pump inlet, outlet, or both to test the free chlorine concentration in the water. Based on the amount of chlorine in the water, the sensor-based in-line liquid chlorine dosing pump then adjusts the amount it doses accordingly. This can be beneficial to prevent underdosing or overdosing in a MVS when the water is already treated with chlorine at a centralized facility, but there is inconsistency in the amount of residual chlorine at the village level. Due to the inclusion of the sensor(s), sensor-based in-line liquid chlorine dosing pumps can be more expensive and have greater maintenance requirements, but still well within a cost effective threshold. The devices will all require electricity, are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Sensor-based in-line liquid chlorine dosing pumps are on the market that are appropriate for water tank sizes from 1,000 liters to 1,000,000 liters or more and only the dosing rate capacity and liquid chlorine tank would have to be adjusted. Example devices that will be included in the pilot are the Initiative Engineering (Website Link)

(Link on JJM approved technologies List) and others sold by Adwyn Chemicals Private Limited (Website Link).

3. **Tablet-based passive in-line chlorination devices:** Provide a low cost, low operationally intensive, and low maintenance solution to dose dry chlorine tablets at the village level. Dry chlorine tablets are more stable and less volatile across weather conditions, but still easy to source across India. Tablet-based passive in-line chlorination devices do not require electricity and only dose chlorine when the water is flowing and therefore passing over the tablet making these devices effective in intermittent water supplies. Tablet-based passive in-line chlorination devices are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Devices are on the market that are able to handle water tank sizes from 1,000 liters to 100,000 liters. Example devices that will be included in the pilot are the Easol PurAll 100 (Website Link) (Link on JJM approved technologies list).

Multi-Village Scheme Intermediary Water Tanks MVS typically have a centralized water intake and treatment point, from which water is piped to intermediary water tanks to build potential energy and then to village-level tanks. MVS can run dozens to hundreds of kilometers. Intermediary points within MVS feed water to tens of thousands of people, enabling a single water treatment device to have significant impact.

Considering the results outlined in the infrastructure assessment and the capabilities of identified technologies, the following technologies are most applicable at **Multi-Village Scheme Intermediary Water Tanks**:

1. **Electrochlorinators:** Electrochlorinators enable water treatment facilities to input a sodium chloride (NaCl) and water solution into the device and in as little as eight hours produce the required Sodium Hypochlorite (NaOCl). Electrochlorinator's tradeoff generally includes a higher upfront capital expenditure to purchase the device, but lower operating and supply chain costs due to only requiring standard salt. Depending on scale and use, an electrochlorinator may return its initial capital expenditure cost via reduced operating costs in as little as two years. The devices all require electricity, are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Electrochlorinators are on the market that are appropriate for water tank sizes up to 1,000,000 liters or more. Some electrochlorination devices include their own dosing pumps and chlorine storage tanks or if modularity or scaling is required can be outfitted with aftermarket pumps and tanks. Example devices that will be included in the

pilot are the Tiaano Chloro Sanitizer Electrochlorinator (Website Link) (Link on JJM approved technologies List)

2. **Sensor-based in-line liquid chlorine dosing pumps:** Provide all of the benefits of a mechanically-based in-line liquid chlorine dosing pump, but also include sensors at the dosing pump inlet, outlet, or both to test the free chlorine concentration in the water. Based on the amount of chlorine in the water, the sensor-based in-line liquid chlorine dosing pump then adjusts the amount it doses accordingly. This can be beneficial to prevent under-dosing or overdosing in a MVS when the water is already treated with chlorine at a centralized facility, but there is inconsistency in the amount of residual chlorine at the village level. Due to the inclusion of the sensor(s) sensor-based in-line liquid chlorine dosing pumps can be more expensive and have greater maintenance requirements, but still well within a cost effective threshold. The devices all require electricity, are able to operate on all non-metallic tanks, all material and size water tank inlet piping, and across a range of flow rates. Sensor-based in-line liquid chlorine dosing pumps are on the market that are appropriate for water tank sizes from 1,000 liters to 1,000,000 liters or more and only the dosing rate capacity and liquid chlorine tank would have to be adjusted. Example devices that will be included in the pilot are Initiative Engineering (Website Link) (Link on JJM approved technologies List) and others sold by Adwyn Chemicals Private Limited (Website Link).

Phasing of Recommendations

Due to the differences and inherent complexity in piloting each of the technologies and intervention points, Evidence Action envisions requiring different lengths of time to establish and capture results across SVS, MVS village level, and MVS intermediary water tanks. Evidence Action's number one priority is providing evidence-based and sound recommendations to governments and aims to ensure sufficient data has been collected before providing any policy recommendations.

Evidence Action will continue to engage with JJM state and national level officials as well as state departments of water throughout the pilot. Each phased recommendation will include a formal written report outlining the pilot results and meetings to discuss the findings.

Timeline

Evidence Action anticipates beginning device installation in early to mid-February 2023 with installations complete by mid-March 2023. Device operations would begin mid-March 2023. Due to the highlighted phasing of recommendations, Evidence Action anticipates providing recommendations to JJM and state departments of water on SVS technologies in August 2023, on MVS village-level technologies in

September 2023, and on MVS intermediary technologies by mid-April 2024. Evidence Action will keep JJM and state departments of water informed of any shifts to these timelines due to operational constraints and data collection.

Monitoring

A sound monitoring, learning, and evaluation plan is essential to providing a robust recommendation to government. This monitoring plan will undergo further expansion and refinement to ensure all appropriate information is accounted for, but to also provide the level of granularity necessary to capture the listed objectives. Generally, monitoring would occur in three phases, a baseline analysis pre-pilot, throughout pilot implementation, and post-analysis after the pilot for that intervention point has concluded. Throughout pilot implementation, devices and subsequent water systems would be monitored to track the objectives listed above. Additional monitoring devices would be installed on the water infrastructure to track some key performance indicators while others would be tracked via Evidence Action personnel, contracted information monitoring firms, or surveys. Data and information captured via this pilot will be solely at the discretion of JJM and state-level governments. This data will not be published or shared unless approved by JJM.

Key performance indicators would be broken down into three categories: installation metrics, operational metrics, and efficiency metrics. Key performance indicators are listed below:

Category of Metric	Key Performance Indicator	Measured by
Installation Metric	Time required for installation	Surveying/questioning contractors on hours required to fully install device
Installation Metric	Expertise required for installation	Surveying/questioning contractors on level of expertise needed: high-medium-low scale
Installation Metric	Complexity in installation	Identifying if any unique or hard to source items, expertise, or infrastructure is required for installation
Operational Metric	Refill rate	Recording # refilled required over pilot period; compare this with manufacturer information on devices’ chlorine capacity and dispensing rate

Operational Metric	Expertise required for normal operation	Surveying/questioning person(s) responsible for normal operation: high-medium-low scale
Operational Metric	Expertise required for preventative maintenance	Surveying/questioning person(s) responsible for normal operation: high-medium-low scale
Operational Metric	Ease of sourcing consumable material	Hours required to identify and place order for required materials from suitable vendor(s); days required for materials to arrive once order is placed; % of materials that arrive within target time window
Operational Metric	Ease of sourcing preventative maintenance parts	Hours required to identify and place order for required parts from suitable vendor(s); days required for parts to arrive once order is placed; % of parts that arrive within target time window
Operational Metric	Company's performance under warranty	Average response time to inquiries and repair requests
Operational Metric	Likelihood of corrective maintenance required	# incidents of corrective maintenance required during pilot
Operational Metric	If applicable, performance of device sensors	As applicable
Efficacy Metric	Dosing consistency	Random sampling of water being treated by device throughout pilot period, at consistent locations
Efficacy Metric	Dose reaching selected locations in water system (first house, mid-point, last house)	Random sampling of water being treated by device throughout pilot period at selected locations
Efficacy Metric	Dosing at appropriate levels	Random sampling of water being treated by device throughout pilot period, at consistent locations
Financial and Economic Metric	Device lifetime cost	Calculate and estimate full cost

		of device installation, operation, consumables, and removal
Financial and Economic Metric	Device cost effectiveness	Cost per person served per year
Financial and Economic Metric	Device personnel requirements and personnel costs per year	Staff requirements for normal operations including regional rates
Financial and Economic Metric	Device maintenance and repair costs per year	Personnel, materials, and consumables costs for preventative and corrective maintenance
Financial and Economic Metric	Device consumables costs per year	Chlorine or sodium chloride costs for normal operation
Scalability Metric	Firm's ability to scale	This will be captured outside of the direct confines of the pilot, but rather during engagement with suppliers and contractors

In order to consistently improve the efficiency of the proposed pilot and to withhold the spirit of an open and transparent partnership, Evidence Action would request for frequent consultations with the JJM leadership at the national and state level to share intermediate results to gather feedback and suggestions.

Government Support

Evidence Action views this pilot as a joint partnership effort with JJM and state-level governments. Due to the nature of the pilot, state and JJM and state-level government support would be required through pilot preparation, pilot implementation, and pilot transition. Critical non-financial support would include site identification, access to pilot sites, ability to install water treatment devices, facilitation and sensitization with local governments at the state level and below, ability to monitor and collect data from the pilot, and personnel support to observe and operate the equipment. Memorandums of Understanding will be signed with each pilot state government.

Evidence Action will contribute funding for the pilot portion of this proposal including all additional device and personnel costs. Evidence Action funding is intended to show proof of concept, display Evidence Action's commitment to the program, and establish relationships and trust with national and state-level government officials.

Post-pilot, Evidence Action aims to work with JJM and state departments of water to incorporate recommendations into policy, water treatment guidelines, procurement processes, and implementation.

IV. Proposal Request

Evidence Action hereby requests formal Jal Jeevan Mission approval to execute requests outlined in the proposal across three Indian states. Evidence Action further requests Jal Jeevan Mission's continued advice and engagement in pilot development, implementation, and facilitating state-level relationships and access.

Please direct any questions or comments to Parth Bahuguna at parth.bahuguna@evidenceaction.org and Michael Simpson michael.simpson@evidenceaction.org.

Signed,

Kanika Bahl
Chief Executive Officer
Evidence Action
kanika.bahl@evidenceaction.org