Mangrove Water
12/8/24

Concept Note:
Advancing the field of in-line chlorination through technology and resource development

Aim 1: Develop a comprehensive implementation guide for in-line chlorination

To increase access to safely managed drinking water, there is a need for professionalized, last-mile delivery of treated drinking water. Recently, we have observed increased demand from governments and other water service providers for technical guidance on how to implement in-line chlorination. However, limited documentation and technical guidance is available on how to effectively implement in-line chlorination given the diversity of drinking water infrastructure globally, and documentation is often limited to specific technologies. Guidance is needed to help governments and organizations assess if in-line chlorination is the most appropriate water treatment strategy for their existing water delivery infrastructure, choose compatible in-line chlorination devices, and develop optimized operation and refill protocols. As in-line chlorination is not widely implemented yet, very few organizations have this kind of technical capacity and expertise available in house. We aim to provide a guide for in-line chlorination implementation to remove the barriers to accessing this technical knowledge and support governments and organizations in their goal of providing safe drinking water.

We aim to create an implementation guide including the following components:

1. Infrastructure assessment guidance for implementers to determine if in-line chlorination is a good fit for their existing infrastructure
2. List of available in-line chlorination technologies and how to procure them
3. Recommended infrastructure and technology pairings under given constraints (i.e. flow rates, existing supply chain, operational needs, etc.)
4. Updated designs and building instructions for open-source chlorine tablet erosion dosers
5. Operation and maintenance guidance
6. Best practices for monitoring in-line chlorine doser performance (chlorine residual testing) and microbial water quality
7. Selected in-line chlorination case studies

We will publish this guide to our knowledge sharing platform to be hosted on the [Mangrove Water website](). We will also support dissemination of this guide to convening organizations in the global WASH field such as the USAID, The World Bank, Rural Water Supply Network, Global Water Center, and more. We anticipate, that equipped with this implementation guide, implementers will be prepared to determine first and foremost if in-line chlorination is the ideal drinking water treatment solution for their given context, second identify and install compatible in-line chlorination technologies, and third establish O&M and monitoring practices to support sustained access to chlorinated water.

<u>Timeline:</u>
Tasks 1,2,3,5, and 6 will be completed within 5 months (May 2025 if contract signed Jan 2025)
Tasks 4 and 7 will be completed within 12 months

[1] Cherukumilli K, Bain R, Chen Y, Pickering AJ. Estimating the Global Target Market for Passive Chlorination. Environ Sci Technol Lett. 2023;10: 105–110. doi:10.1021/acs.estlett.2c00781

Aim 2: Adapt the TuriTap to chlorinate water at manual handpumps

The TuriTap is a passive, in-line chlorination technology which doses chlorine into drinking water for disinfection without the need for electricity. The TuriTap was initially designed to operate in a range of drinking water sources at their point-of-collection, including water tanks and tap connections in community and institutional settings. An estimated 2.2 billion people currently use a drinking water source which is compatible with in-line chlorination[1], but there are no commercially available chlorination technologies for manual handpumps. We aim to develop a proof-of-concept prototype that would allow the TuriTap to operate at handpumps.

We will be launching sales of the first TuriTaps in Kenya in 2025. The current design can only be attached to tanks or pipes which have consistent flow rates between 5 to 60 liters per minute. Manual handpumps often generate low, variable flow rates which pulse with each stroke of the handle. Variable flow rates can inhibit the dosing control of other in-line chlorinators which require consistent flow rates through a bypass line to control dosing. However, we expect the fluid dynamics principle (the venturi effect) used by the TuriTap to dose chlorine to be able to effectively chlorinate intermittent flows through the device, resulting in more consistent dosing than other chlorinators.

We propose to develop a proof-of-concept prototype which allows for a TuriTap to attach to handpumps and chlorinate drinking water. We plan to do this over several phases:

1. *Rapid Prototyping and Testing* – In our existing laboratory at UC Berkeley, we will develop a working handpump testing setup to mimic real-world conditions. We will use design and prototyping resources available at UC Berkeley to build attachment models and rapidly test them on the handpump testing setup. If required, we will also explore options for regulating flow through the TuriTap by modifying the handpump outflow. Handpump attachment models will be evaluated based on their ease of installation, expected cost at scale, user operation, and TuriTap performance. The performance of the TuriTap will be evaluated by testing for free chlorine over varying flow rates and pumping conditions.

2. *Proof-of-Concept Prototype Refinement* – Following rapid prototyping, we will select 1-2 models for further evaluation. We will produce three validation prototypes created through standard machining practices (i.e. CNC machining, lathes, etc.) for lab and field testing. A production validation prototype can be considered an almost-complete manufacturable design to validate a specific functional form for mass manufacturing.

3. *Field Pilot in Kenya* – We will test the production validation prototypes under real field conditions in Kenya. We expect to install 2 prototypes at community water points in Kenya with an implementing partner who will monitor their performance over time. With our guidance, the implementing partner will identify community handpump water points, obtain permission for installation, install the TuriTap prototypes, service them (i.e. refills), and obtain user feedback through short surveys. We will monitor their performance over a 3-

month period and survey between 10-30 people on their experience with the prototype and perceptions of chlorinated water. We expect 3 months to provide enough time to learn of any failure points, monitor performance over time, and obtain feedback from users.

Completion of Aim 2 will produce a proof-of-concept prototype for attaching TuriTaps to handpumps, basic design models (i.e. computer-assisted designs and drawings) which can be used in the future development of a manufacturable design, and pilot data from Kenya on user feedback and TuriTap performance. We expect Aim 2 to be the first step in developing the TuriTap for handpumps before considering scaling up manufacturing.

Timeline for Aim 2
1 - Rapid Prototyping and Testing - 4 months
2 - Proof-of-Concept Prototype Refinement - 6 months
3 - Field Pilot in Kenya (including preparations) - 8 months
Total grant period: 18 months from time of contract signing

Ideally, we think Aim 2 should be a collaboration between UC Berkeley (where we have a current testing setup and prototyping resources), and Mangrove Water, which will be distributing the TuriTap and any accessories developed for the TuriTap. If possible, we would prefer two contracts, one to UC Berkeley and one to Mangrove Water.

Budget

Deliverable	Total Cost
Aim 1: ILC Implementation Guide	
Infrastructure assessment guidance for implementers to determine if in-line chlorination is the best solution	$5,000
List of evaluated in-line chlorination technologies and how to procure them	$8,000
Guidance on effective infrastructure and technology pairings under given constraints (i.e. flow regimes, supply chain, operational needs, etc.)	$8,000
Updated designs and models for open-source chlorine tablet dosers based on the original CTI-8 model	$24,000
General in-line chlorination operation and maintenance guidelines (not technology-specific)	$8,000
Best practices on water quality monitoring for performance assessment	$4,000
Selected in-line chlorination case studies	$20,000
Mangrove Subtotal for Aim 1	$77,000
Total Including Fiscal Sponsorship (15%) for **Aim 1**	**$88,550**
Aim 2: TuriTap Handpump Adaptation	
Mangrove Budget	
Rapid Prototyping and Testing - Inclusive of hours and materials for prototyping and testing through Mangrove. Additional time cost and materials estimates will be included in the Berkeley budget to cover assistants and use of lab facilities/resources.	$12,000
Proof-of-Concept Prototype Refinement - Inclusive of hours, designs for proof-of-concept prototype, and production of 2-3 production validation prototypes. Also includes estimates for validating performance in a lab setting before field pilot. Additional time cost estimates will be included through the Berkeley budget to cover assistant hours.	$20,000
Field Pilot in Kenya - Inclusive of Mangrove's time and travel costs	$42,000
Field Pilot in Kenya - Subcontract to implementing partner in Kenya to install, operate, and maintain the TuriTaps in two sites for 3 months. Includes data collection costs for gathering user feedback.	$60,000
Mangrove Subtotal for Aim 2	$134,000
Mangrove Total Including Fiscal Sponsorship (15%) for Aim 2	**$154,100**
Berkeley budget*	
Berkeley Total	$65,500
Total with 10% IDC	**$72,050**
Total budget for Aim 2	**$226,150**

*We need to get our Berkeley detailed budget approved by the University before we are able to share it. For now, we have included an estimate for the total including personnel time, supplies, use of prototyping facilities, and travel.