Chlorine Tablet Use for Household Water Treatment in Emergencies: Guidance for Tablet Selection

Chlorine Tablet Working Group, April 2019

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Chlorine Tablets in Emergencies

In emergencies, safe drinking water is a priority to prevent disease [1]. Chlorine is often used to treat drinking water, as it inactivates most bacteria and viruses that cause diarrheal disease and the remaining free chlorine residual (FCR) provides protection against recontamination in storage [2–4]. For effective treatment, water should be dosed with enough chlorine to ensure that FCR is maintained for the length of storage time in the household. At the same time, levels high enough to exceed taste and odor acceptability thresholds should be avoided [5].

FCR may be measured at the source, point of collection, or point of consumption. There are many international recommendations for FCR in drinking water, which can be summarized as:

- For emergencies with a normal or low risk of outbreaks water should maintain 0.2-0.5 mg/L FCR.
- For emergencies with a high risk of outbreaks water should maintain a 0.5-1 mg/L FCR [6–8].
- FCR should not exceed a maximum of 5.0 mg/L, per the World Health Organization.

However, these international recommendations do not specify the point at which the FCR is tested. Ideally, a residual of at least 0.2 mg/L should be maintained at the point of consumption until the last cup of water is consumed.

Fig 1. Chlorine tablets

Chlorine tablets (such as the sodium dichloroisocyanurate (NaDCC) Aquatabs®, Medentech Ltd.) are commonly distributed for household water chlorination in emergencies because they are widely available, cost-effective, easily transported, and simple to use (Fig 1) [2–4][2,8,9][2,7,8]. A recent systematic review found that actual use in chlorine tablet programs ranged from 1-87%, suggesting that chlorine tablets can be effective for water treatment in emergencies, but only if tablets are distributed and used properly [5]. This effectiveness often depends on context, and contextual factors found to affect chlorine tablet use were:

- **Knowledge**. Use was highest when tablets were distributed with household promotion and/or users had prior knowledge of water treatment.
- **Taste and Odor**. An aversion to the taste and odor of chlorine was reported as a barrier in nearly half the evaluations included in the review.
- **Appropriate Tablet Distribution**. In four evaluations, recipients did not have water storage containers appropriate for the tablets distributed, and in two context multiple chlorine doses were available and caused confusion regarding appropriate use (Fig 2).

Fig 2. Chlorine dosage difficulties (Nepal)

Doses

Chlorine tablets are produced in a range of sizes, designed to dose different volumes of water at different target, fixed dosages. We use "tablet size" in this document to refer to the active chlorine strength (in mg) of a tablet. For example, Aquatabs® are available in 10 different tablets, for 5 different volumes at 2 dosages ("emergency" fixed dose of 5 mg/L and "household" fixed dose of 2 mg/L) (Fig 3) [10]. It is recommended to double the dose if water is visibly turbid. The appropriate size chlorine tablet to distribute in each context depends on:

- Water quality (chlorine demand, turbidity, chemical properties)
- Recipient context (size of buckets in use, knowledge, preferences, water use)
- Taste and odor acceptability thresholds
- Local context (tablet availability, water distribution, outbreaks)

Litres	Emergency	Household Water
1 Litre	8.5mg	3.5mg
4-5 Litres	33mg	17mg
10 Litres	67mg	33mg
20-25 Litres	167mg	67mg
200-400 Litres	1.67gm	1.67gm

Fig 3. Aquatabs chlorine tablet doses

Dosing Confusion

Often, those factors are not appropriately considered and/or different tablets are distributed in an emergency. This can lead to confusion and mis-dosing by users who receive multiple sizes of tablets or tablets that are not appropriate for the size of their water storage containers. After the earthquake and subsequent cholera outbreak in Haiti in 2011, chlorine tablets labeled for different target dosages and for multiple volumes were available and often difficult to distinguish. The WASH Cluster in Haiti developed guidance for tablet selection that was implemented to solve this problem in Haiti (Box 1).

Box 1. Tablet Selection Guidance in Haiti

During the response to Hurricane Matthew in Haiti in 2016 there was an increase in the number of partners distributing chlorine tablets, and many tablets were in circulation (Fig 4, from the United States Centers for Disease Control and Prevention).

The existence of many tablets in circulation, including tablets that were not the right size for the volume of water stored in typical household containers, led to many cases of users incorrectly dosing their water.

Aquatabs® Tablets	
Strength	Color of Packet
8.5 mg	Yellow packet
17 mg	Green packet
33 mg	Green packet
67 mg	Blue packet
167 mg	Red packet

Fig 4. Aquatabs tablets available in Haiti

Because of the confusion over chlorine tablet doses, the WASH Cluster in Haiti produced a document to coordinate tablet distribution by partners [11].

The document includes guidelines that:

1) Prescribe the use of 33 mg chlorine tablets as appropriate to effectively treat water in a common container size at an acceptable dose during this emergency .
2) Dictate that blanket chlorine tablet distribution is only appropriate where monitoring systems are implemented post-distribution.
3) Require that implementing partners submit requests to distribute tablets that are reviewed and approved by the WASH Cluster before products can be delivered.

This tablet size and dosing confusion is not limited only to Haiti, as responders to emergencies in Yemen and Cox's Bazar, Bangladesh (among other places) have reported similar confusion. However, this case study from Haiti provides an example of how to implement context-specific guidance and alleviate confusion with systematic selection and coordination of tablet size for distribution [11].

Recommendations for Tablet Selection

To coordinate the choice of the appropriate chlorine tablet dose or to inform the best use of available doses for a particular emergency, it is necessary to assess four factors to choose a tablet that will result in an effective and acceptable chlorine residual:

- Water quality
- Recipient context
- Taste and odor thresholds
- Local context

The balance between these four factors may be different for each context in which chlorine tablets are distributed.

The goal of this document is to provide guidance on the assessment and interpretation of these parameters that influence tablet choice and the selection of specific size(s) of chlorine tablets which should (non-bindingly) be recommended for distribution in a particular emergency context.

Procedure for Tablet Selection

The procedure in this document is designed to guide emergency responders in selecting a tablet(s) that provides a dose of chlorine that effectively and appropriately treats water depending on the water quality recipient context, taste and odor acceptability thresholds, and local context in each emergency. **Ideally, when all these factors are considered the chosen tablet should dose water at 0.2-1.0 mg/L FCR for the duration of storage, while avoiding doses above the taste and odor rejection threshold starting at the beginning of the storage period.** To facilitate consistent use of appropriate doses and reduce confusion, responders need to base selection on a careful assessment of each context.

Please note that the scope of this document is limited to the selection and coordination of chlorine tablets. *This document is intended for use when it has already been determined that chlorine tablets are the most appropriate solution in an emergency and is not sufficient to guide all aspects of chlorine tablet programming.* While there are advantages to chlorine tablets and they are often appropriate in emergencies, other effective water supply or water treatment technologies may be a better choice and a separate process should be undertaken to make this determination. Please note that chlorine tablet distribution is not recommended as a long-term intervention. As this document is not a comprehensive guide to tablet distribution, further resources to guide successful programs (e.g. information on chlorine tablet promotion) are recommended in the bibliography (page 23).

This document will provide guidance on (Fig 5):

1) How to **ASSESS** key information necessary for decision making,
2) How to use this information to **SELECT** a tablet(s) appropriate for the emergency, and
3) What resources and key actors to engage for **DISTRIBUTION.**

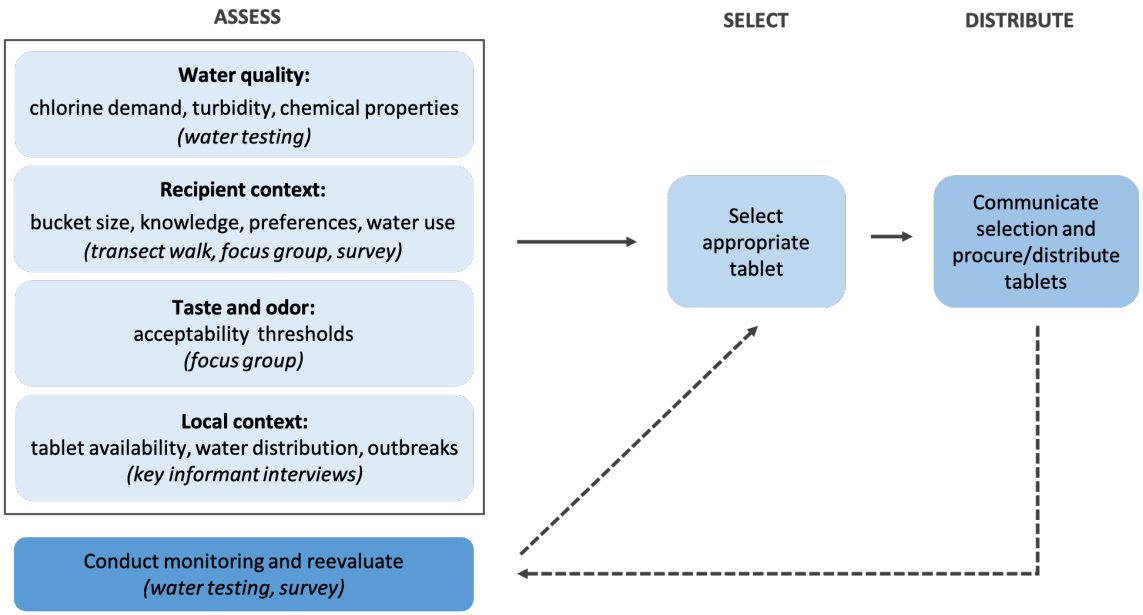


Fig 5. Flow Chart of Steps for Chlorine Tablet(s) Selection

Part 1: Assessing Key Information Necessary for Decision-Making

In order to make tablet recommendations, it is necessary to understand the water quality, recipient context, taste and odor thresholds, and local context in each emergency.

In this Part 1, the activities necessary to gather this information are summarized (Table 1.1), and in subsequent sections are more fully described. Please note full tools and worksheets for each activity are available in the annexes. The information provided by these activities are divided into primary and secondary parameters, which are used in stages to make a recommendation.

Required parameters are most critical to tablet selection and programming decision making and are highlighted in **bold**. When possible, all activities should be completed to provide the most accurate and detailed information to inform an appropriate tablet selection. However, if necessary due to constraints, a subset of activities can be completed to gather the required parameters.

After initial assessment and tablet selection, ongoing monitoring should be done to ensure that the tablet choice is achieving the intended result. This is described in section 1.3 (Table 1.2).

The selection process is presented in Part 2, after all activities are complete. During this process primary parameters are used to calculate an initial recommendation, and secondary parameters are considered to determine if the recommended dose should be shifted up or down.

Lastly, programs may find that the tools provided can be expanded to gather information that will influence other aspects of programming.

1.1 Summary of Data Collection Activities

Table 1 contains activities undertaken to inform the choice of chlorine tablet for an emergency. Items in bold are priorities, and should be completed to utilize this selection process. Please note that sample sizes recommended for each activity are an estimated sample size for a relatively homogenous population up to about 10,000 people. If the population is much larger, or if features of the water sources, practices, or physical environment vary widely, multiple assessments should be undertaken.

Table 1.1. Summary of activities needed to assess key information for decision making.

Activity	Tool	Sample Size	Description	Parameters
Recipient Context	**Transect Walk**	**1 walk**	**A rapid, systematic approach to observing water practices in a community**	**Primary** • **Water container/bucket size** • **Length of storage** **Secondary** • **Water sources** • **Water treatment** • **Local sanitary conditions**
	Focus Group or Survey	2-4 groups, ~10 participants per group 10-100 surveys	Focus group discussions, at least one group with men and one with women (held separately) Structured household surveys	Primary • Water container/bucket size • Length of storage Secondary • Water collection practices • Water storage practices • Water treatment practices
Water Quality	**Water Quality/Jar Testing**	**5 doses in triplicate (15 samples)**	**Water quality and jar testing to determine quality and chlorine demand of water**	**Primary** • **Chlorine demand** **Secondary** • **Turbidity** • **pH** • **Temperature** • Metals, chlorination byproducts, nitrates
Taste Testing	**Taste Testing**	**2-4 groups, ~10 participants per group**	**Blind test of varying chlorine concentrations in water, may be done in the focus groups or with local staff**	**Primary** • **Chlorine taste and odor acceptability thresholds**
Local Context	Key Informant Interview	3-5 respondents	Structured interview with emergency responders, local water or health officials, local leaders	Secondary • Water distribution practices • Use of chlorine tablets • Observation of water collection and management practices

1.2 Data Collection Activities

Each of the activities in Table 1 is described in more detail below.

Activity A. Water Quality: Jar Testing

This water quality data will provide the information necessary to determine the amount of chlorine necessary to ensure appropriate levels of FCR are maintained in the local water. Local source water quality is assessed by measuring:

Primary Parameters:

- Chlorine demand (jar testing)

Secondary Parameters:

- Turbidity
- pH

Jar testing for chlorine demand should be conducted using locally available tablets and observing residuals after varying lengths of storage in waters of typical influent quality. Tests should be done in triplicate for five doses of chlorine, over a 24 hour period. The average midday temperature and precipitation throughout the year should also be noted. The tools for water testing are included in Annex B.

If metals such as arsenic or iron are a known issue in the supply or clear water has very high chlorine demand, consider testing for metals. If there is concern about chlorine byproducts, testing should be conducted for trihalomethanes (THM). Information on testing is included in the Bibliography on page 23.

Activity B. Recipient Context: Transect Walk

Transect walks consist of a directed walk across a site, along with visits to key water. Local stakeholders guide the evaluator through the walk, which is used to map the drinking water assets in the area and record information on the most commonly observed practices and container sizes. Transect walks can be quickly completed to form a recommendation, but are not preferred because they do not yield all information necessary (e.g. water storage time in households). The recipient context is assessed by observing:

Primary Parameters:

- Water container/bucket size

Secondary Parameters:

- Water sources
- Water treatment options
- Local sanitary conditions

A tool for conducting transect walks is included in Annex C.

Activity C and D. Recipient Context: Focus Group/Survey

Information on practices, preferences, and beliefs of users is assessed using focus groups and/or surveys. Focus groups are preferred for their ease of implementation, but a survey may be used if it is the best option in a given context. Groups with men and women should be held separately, with at least one group of men and one of women. The recipient context is observed by including discussion about:

Primary Parameters:

- The sizes and materials of buckets used
- What the typical length of storage will be

Secondary Parameters:

- How users collect water
- What hygienic conditions are where water is stored
- The level of experience users have with chlorine tablets

Focus groups are also a good opportunity to understand ways to learn about rumors about chlorination. Tools for conducting focus groups are included in Annex D, and for surveys in Annex E.

Activity E. Recipient Context: Taste and Odor Testing

In taste and odor testing, participants complete blind tasting of water with different levels of FCR and provide feedback on taste and odor acceptability. A range of ages and backgrounds should be included in taste testing. Taste testing will be assessed by identifying:

Primary Parameters:

- Taste acceptability thresholds
- Odor acceptability thresholds

Taste tasting can be conducted with focus groups, or in some cases it may be appropriate to conduct testing with local staff. Tools for taste testing are included in Annex F.

Activity F. Local Context: Key Informant Interviews

The local context for tablet distribution is assessed using short key informant interviews (KII) with emergency responders, local authorities, local water/health governance, suppliers, and others who might engage with distribution or implementation of chlorine tablets. The local context will be assessed by asking interviewees about:

Secondary Parameters:

- Availability of chlorine tablets
- How products are used
- What response has been implemented in previous emergencies

Tools for KIIs are included in Annex G.

1.3 Monitoring and Reevaluation

Monitoring

Chlorine tablet use and FCR should be monitored in households regularly at the start of a tablet distribution program to confirm that the selected tablet(s) result in the appropriate target FCR when implemented by users. A short survey to be used for monitoring uses a subset of the questions used in the initial assessment survey. A sample monitoring survey tool is provided in Annex H.

Reevaluation

If an emergency lasts beyond several months, the context should be reevaluated to ensure that the selected tablet(s) is still appropriate. Reevaluation should be done both at regular intervals (e.g. every 6-12 months) or when there is a reason to believe conditions have changed. Examples include seasonal changes in temperature and precipitation, disease outbreaks, and changing social conditions.

Table 1.2. Summary of monitoring activities for chlorine tablet distribution.
Activities should be conducted frequently at the start of a chlorine tablet program to ensure that the dose(s) selected are used properly and result in the FCR intended.

Assess	Tool	Description	Parameters
Recipient context	Household Survey	1 page survey, administered to 10-100 households	• Water collection practices • Water storage practices • Container/bucket size • Container/bucket material • Length of storage • Water treatment practices • Measured FCR in stored water

Part 2: Using Information to Select a Tablet(s) Appropriate for the Emergency

2.1 Selection Process

After the assessment described in Part 1, these parameters can be used to guide the selection of a tablet(s) most appropriate for the context by filling out the Results Summary Worksheet (page 14) and following along the Tablet Choice Flow Chart (Page 16).

The goal is to select a tablet size that will dose water at the point of use such that a residual of at least 0.2 mg/L FCR is maintained in water with typical chlorine demand stored in the most commonly sized container until the last cup of water is consumed (represented by the typical length of storage), and such that the taste and odor of the water is acceptable to users.

In order to select the appropriate tablet, responders must first consider the primary parameters of container size, length of storage, and empirical chlorine demand (Fig 6). The dose that is optimal based on these parameters should then be adjusted up or down based on secondary parameters including turbidity, pH, presence of waterborne disease outbreaks, and taste and odor preferences. The choice(s) is then confirmed by discussion with local and international responders and local water and health ministries. In some cases, rights to distribute chlorine tablets should be granted by the local WASH Cluster, which can manage procurement.

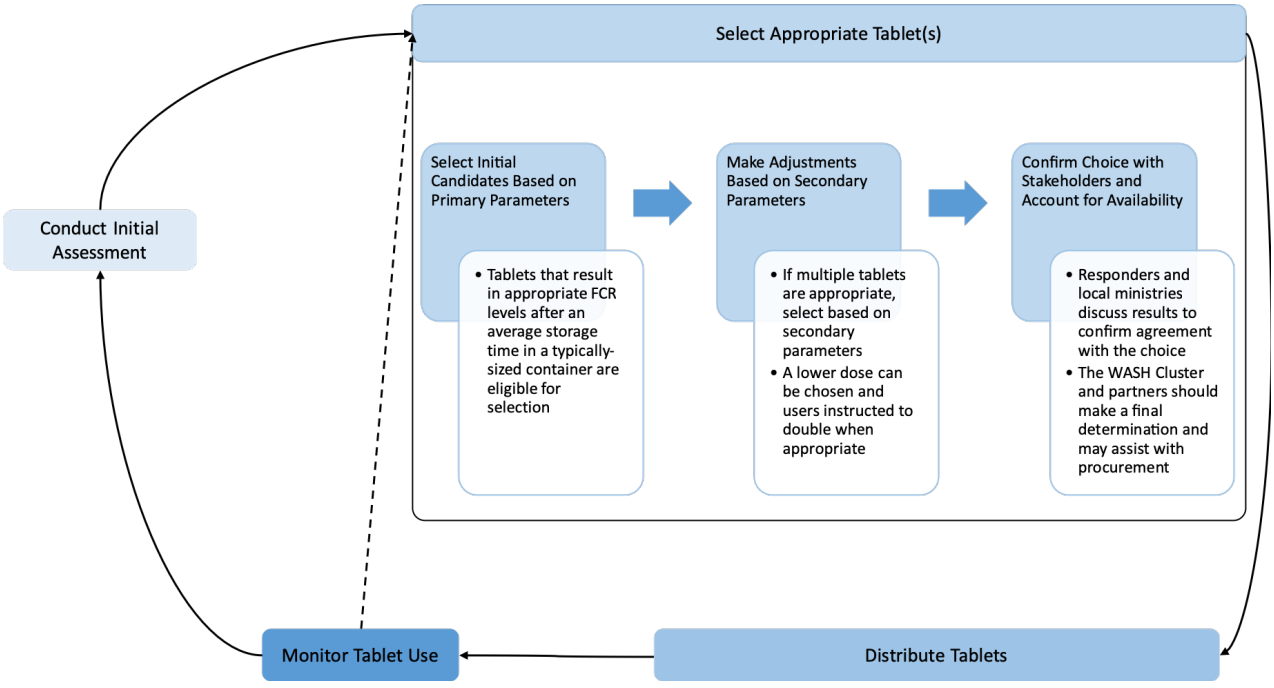


Fig 6. Summary of Chlorine Tablet Selection and Implementation

In order to synthesize this information and guide selection of the appropriate tablet, the following activities should be completed (using the tools on the following pages):

1) **Fill in the results summary worksheet (page 14).**
   This worksheet guides the summary of information on primary and secondary parameters that will influence the choice of a chlorine tablet. Filling out the worksheet will make the summary information on these parameters accessible in one place for analysis and discussion.

2) **Follow along with the tablet choice flow chart and identify one or more appropriate tablet choices (page 16).**
   This flow chart allows the users to interpret information from the summary worksheet to identify the most appropriate tablets for the primary parameters, and how this decision may be adjusted based on secondary parameters.

3) **Discuss this information at the WASH Cluster and make a final recommendation.**
   The final decision on tablet choice should be discussed and approved by the WASH Cluster and partners, with input from local and international response organizations that will distribute chlorine tablets and local WASH and Health Ministries, if applicable.

Please note that variation in conditions and user practices is expected, and the distribution of the appropriate tablet size should be accompanied by information that allows users to dose their water appropriately regardless of changing conditions.

2.2 Results Summary Worksheet

This worksheet is to be used to summarize parameters influencing chlorine tablet choice. This information can then be used to work through the Chlorine Tablet Selection Flow Chart to arrive at a recommended dose or doses to be used by all responders in an emergency.

Note: It is possible to complete this worksheet and selection process using only information from priority items in the assessment. Completing the full assessment is likely to yield more accurate information on which to base recommendations.

Primary Parameters	
What is/are the most common or most frequently observed container size(s)? *From transect walk, focus group, or survey*	1 L 4-5 L 10 L 20-25 L Other: _____ L
Length of storage (90th percentile) *From focus group or survey* 1. *Place responses in order from lowest to highest value* 2. *Calculate the 90th percentile rank using:* *Rank = 0.9*(# of answers + 1)* 3. *Choose the value at this rank #*	|___|___| hours *Use this number to evaluate FCR levels from jar testing*
Which doses of chlorine tablets resulted in FCR readings between 0.2 and 1.0 mg/L after |___|___|? *Use results from jar testing for the 90th percentile storage length time.*	17mg 33mg 67mg 167mg *Note: This value should be based on the test in which contact time was equal to or exceeded the storage time listed above. If the volume of containers used for testing was not the same as most commonly used container, multiply or divide to estimate what the residual in the appropriate container would be and use this value.*
For doses resulting in FCR in the target range, record the tablet size and FCR after the target storage length *From jar testing*	**Tablet Size** **FCR after |___|___| hrs** |___|___|.|___| mg |___|.|___| mg/L |___|___|.|___| mg |___|.|___| mg/L |___|___|.|___| mg |___|.|___| mg/L

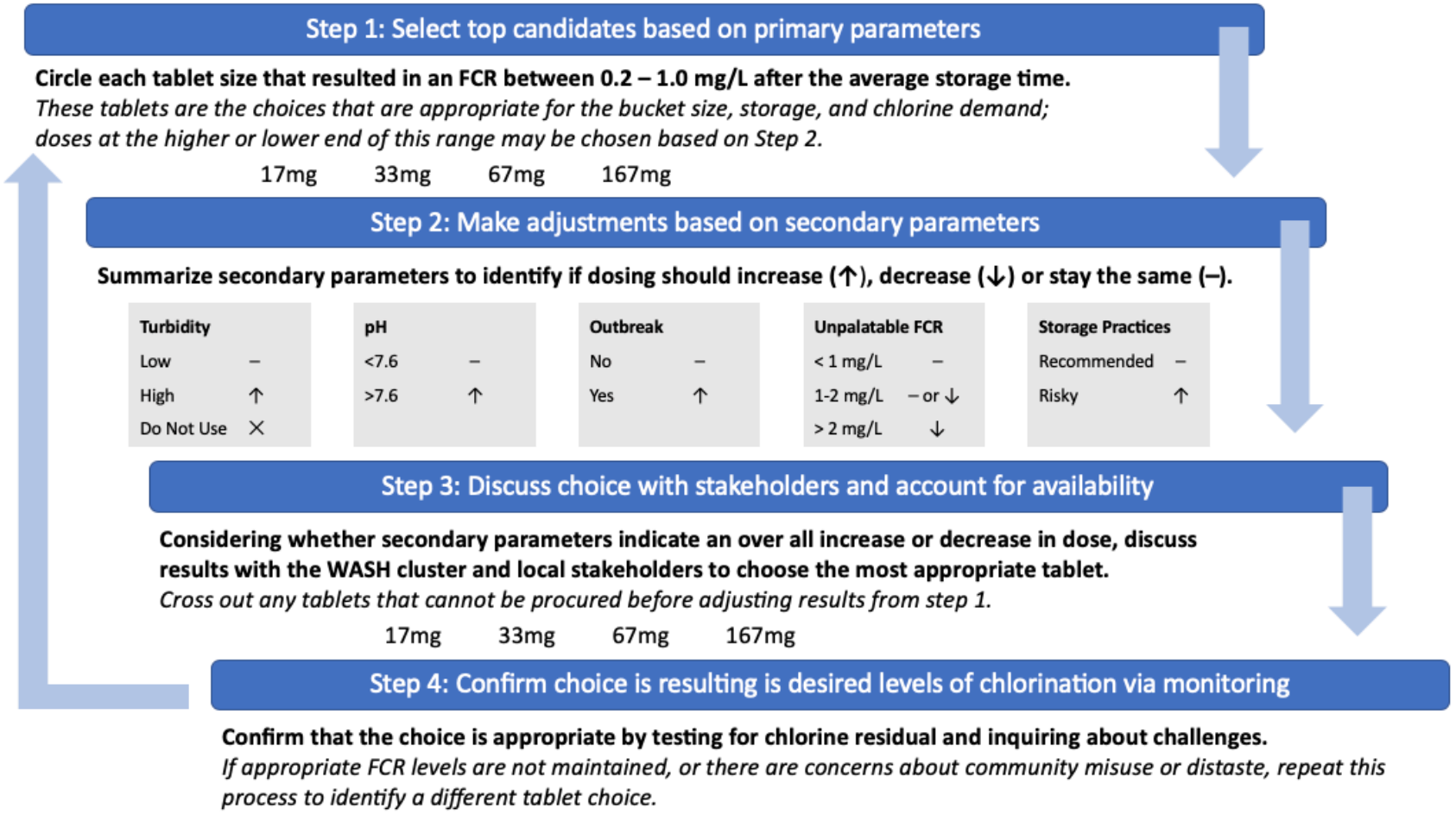
Secondary Parameters	
Average Turbidity (NTU)	|___|___|.|___| NTU
Average Level of Turbidity	Low (0-5 NTU) High (5-50 NTU) Do Not Chlorinate (>50 NTU) *Note: Water should be <5 NTU to be properly disinfected with chlorine. Consider a double dose of chlorine in water with high turbidity for short term emergencies.*
pH	|___|___|.|___|
Is there a waterborne outbreak in progress?	Yes No
What is the highest FCR at which <1/3 of local respondents reported disliking the taste and odor of the water?	|___|.|___| mg/L
Do respondents report risky water storage practices, e.g. using wide-mouth containers?	Yes No
Availability	
Which tablet sizes are currently available to responders in prepositioned stock?	[1] 8.5 mg emergency [2] 3.5 mg household [3] 33 mg emergency [4] 17 mg household [5] 67 mg emergency [6] 33 mg household [7] 167 mg emergency [8] 67 mg household [9] 1.67 g emergency [10] 1.67 g household
Which tablet sizes are currently available on the local market?	[1] 8.5 mg emergency [2] 3.5 mg household [3] 33 mg emergency [4] 17 mg household [5] 67 mg emergency [6] 33 mg household [7] 167 mg emergency [8] 67 mg household [9] 1.67 g emergency [10] 1.67 g household

Table 2.1 Reference Volume Ranges for Chlorine Tablets

These volumes represent typical ranges for each tablet, and are only a guideline.
"Emergency" tablets provide a double dose of chlorine compared to "household" tablets.

Emergency	**Household**
8.5 mg for 1L	3.5 mg for 1 L
33 g for 4-5 L	17 mg for 4-5 L
67 mg for 10 L	33 mg for 10 L
167 mg for 20-25 L	67 mg for 20-25 L
1.67 g for 200 – 400 L	1.67 g for 200 – 400

2.3 Tablet Choice Flow Chart



2.4 Special Considerations

While this document provides guidelines to help make an informed decision about the most appropriate chlorine tablet for household water treatment in a given emergency, sometimes there are cases that do not fit easily into this framework. This tool is meant to be a guide, recognizing that there are situations where these tools will need to be adapted or other parameters will need to be considered.

A number of situations may require either 1) special attention to promotion activities, or 2) the selection of more than one tablet. As is recommended above, when areas are particularly large or heterogenous the same tablet choice may not be appropriate throughout an emergency and multiple assessments should be undertaken. Some examples of situations where a deviation from the standard protocol might be required are:

Scenario	**Suggested Course of Action**
Multiple sizes of water storage containers are commonly used	• Recommend two tablets. • Engage in extra promotion to support use of the appropriate tablet with the appropriate container/source. • If different containers or water sources are used in different areas, considered distributing single tablets in different geographic areas.
Multiple water sources with varying water qualities are used for drinking	
Taste and odor rejection is high, but the need to chlorinate is also high	• Engage in extra promotion to encourage the use of chlorine despite distaste, engage with local civic and religious leaders to dispel myths about chlorine.
Water from different sources is being mixed	• Conduct additional jar testing to assess the impact of mixing. • Engage in extra promotion to support the use of appropriate tablets with appropriate water sources.
Storage times are very long, or highly variable	• Engage in extra promotion to encourage re-dosing of water or use in an appropriate time frame.

Part 3: Resources and Key Actors to Engage for Distribution

In order to complete this evaluation, it is necessary to consider timeline, staffing, budget, and communication/procurement. Below guidelines are provided on expectations for engaging these resources. These guidelines are based on the sample sizes suggested for each activity in the tools provided, which are intended for an assessment of a relatively homogenous population up to about 10,000 people. If the population is much larger, or if features of water sources, practices, or physical environment vary widely, multiple assessments should be undertaken and resources added accordingly.

3.1 Timeline and Staffing

Completing priority activities only should take 3-5 days, and completing all activities should take approximately 5-7 days. Please note that not all activities need to be completed (i.e. if focus groups are conducted, a survey may not be necessary), and that activities can occur simultaneously if staffing allows. Time required for training and execution will vary depending on the skill and training level of staff and sample size. Approximate timing for each of the activities is as follows:

Table 3.1 Timeline and Staffing

Activity	Staff Required	Training/Prep Time	Data Collection Time
Water quality	1-2	2-3 days 1 day organization 1 day collect materials 1 day training	1.5 days
Transect walk	1		0.5 days
Focus group	2-3		1 day
Survey	2-5		3 days
Taste Testing	1-2		1 day (may be within focus groups)
KII	1-2		1 days
Data Analysis	1		1-2 days

3.2 Budget

Items regularly included in the budget for these activities are staff salaries, equipment, and transportation. Costs can vary greatly depending on local staff salary expectations, ease of procurement of supplies, and need for and cost of travel. The following sketch budget provides an outline of the major expenses for each activity to help determine how to budget:

Table 3.2 Budget Considerations

Activity	Staffing Salaries	Equipment	Travel
Water quality/jar testing	1 person skilled in water quality testing experience, 1 additional person.	Water quality testing supplies, see Appendix A for full supplies.	Travel to or reimbursement for collection of water from sources.
Transect walk	1 person knowledgeable about WASH in emergencies, local leaders and experts.	Paper survey, pen or pencil, or electronic data collection device.	Travel across the transect may be on foot or by vehicle depending on the area to cover.
Focus group	1 person trained in facilitation 1-2 additional person(s).	Paper with guide and for notes, pen or pencil, recorder (optional).	Consider whether participants will need to be reimbursed for travel.
Survey	2-5 people trained in survey administration.	Paper survey, pen or pencil.	Enumerators travel to homes; consider how widely spaced homes are and what modes of transportation are used.
Key informant interviews	1 person knowledgeable about WASH in emergencies, local leaders and experts.	Paper with guide and for notes, pen or pencil, recorder (optional).	Staff may travel to participants, or participants may need to be reimbursed for travel.
Data Analysis	1 person knowledgeable about all data collection forms, proficient in database management, and able to do statistics.	Computer.	None.

3.3 Communication and Procurement

In order to use a given size of chlorine tablet in an emergency, the product needs to be available to responders. Availability of the optimal dose is considered during the process of choosing a tablet for this reason. When starting distribution of a chosen tablet, it is advisable to centralize the procurement logistics so that all organizations distributing tablets can access the proper dose. The local WASH Cluster or another working group serving a similar function should be the central point for all procurement requests.

Part 4: Field Trial Report

After this guidance was developed, a field test was conducted in partnership with Oxfam in Cox's Bazar, Bangladesh in Dec 2018. Cox's Bazar is host to camps with approximately 745,000 people who have fled violence against the Rohingya communities in Myanmar's Rakhine state since August 2017 [13]. Chlorine tablets had been distributed, although this had recently ended due to the planned installation of in-line chlorination devices on tube wells. The goal of this evaluation was to field test all chlorine tablet selection tools to ensure their usefulness, and to observe the changes such a process might recommend to current field practices. As this was a field test, we did not complete the final steps of ensuring availability and implementing and monitoring use of the final tablet choice.

Methods. In Cox's Bazar, we implemented all assessment tools, including: a transect walk, water quality and jar testing, household surveys, focus groups, taste and odor testing, and KIIs. After data was collected, the chlorine tablet selection worksheet was filled in and steps one and two of the selection process utilized. In step one, tablets resulting in empirically safe water were identified by considering: container size, length of storage, and empirical chlorine demand. All tablet sizes resulting in an acceptable FCR (0.2-1.0 mg/L) after the length of storage were considered eligible. In step two, other parameters that influence tablet appropriateness were considered, including: turbidity, pH, outbreak, and taste and odor rejection threshold. These secondary parameters were used to adjust the initial recommendation. A sample flow chart showing this process with results from Cox's Bazar is shown on page 20.

Results. During the transect walk, tube wells with hand pumps were identified as the primary water sources, and users were observed with 10-15 L aluminum and plastic containers. In surveys, respondents reported that water was consumed within 12 hours (90th percentile), and containers from 6-15 L were used, with 10 L most common. In focus groups, respondents described filling 8-10 L containers with drinking water 1-2 times per day. From the jar testing results, it was determined that 8.5 and 17 mg tablets resulted in an FCR between 0.2-1.0 mg/L FCR for the 90th percentile storage time of 12 hours (Fig 7). Thus, in step one the 8.5 and 17 mg tablets were selected as candidates.

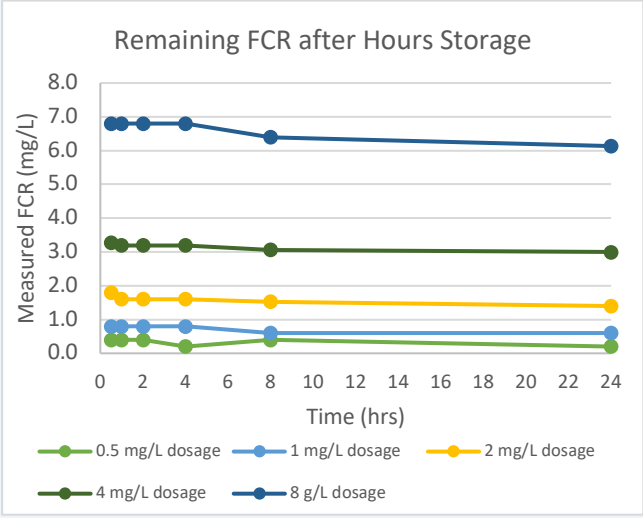


Fig 7. Jar testing results demonstrating remaining FCR after storage. *Green shaded area represents the target range FCR for drinking water (0.2-1.0 mg/L)*

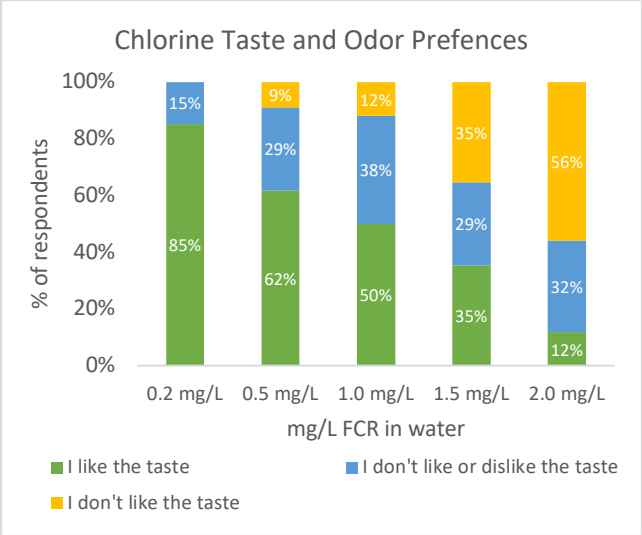


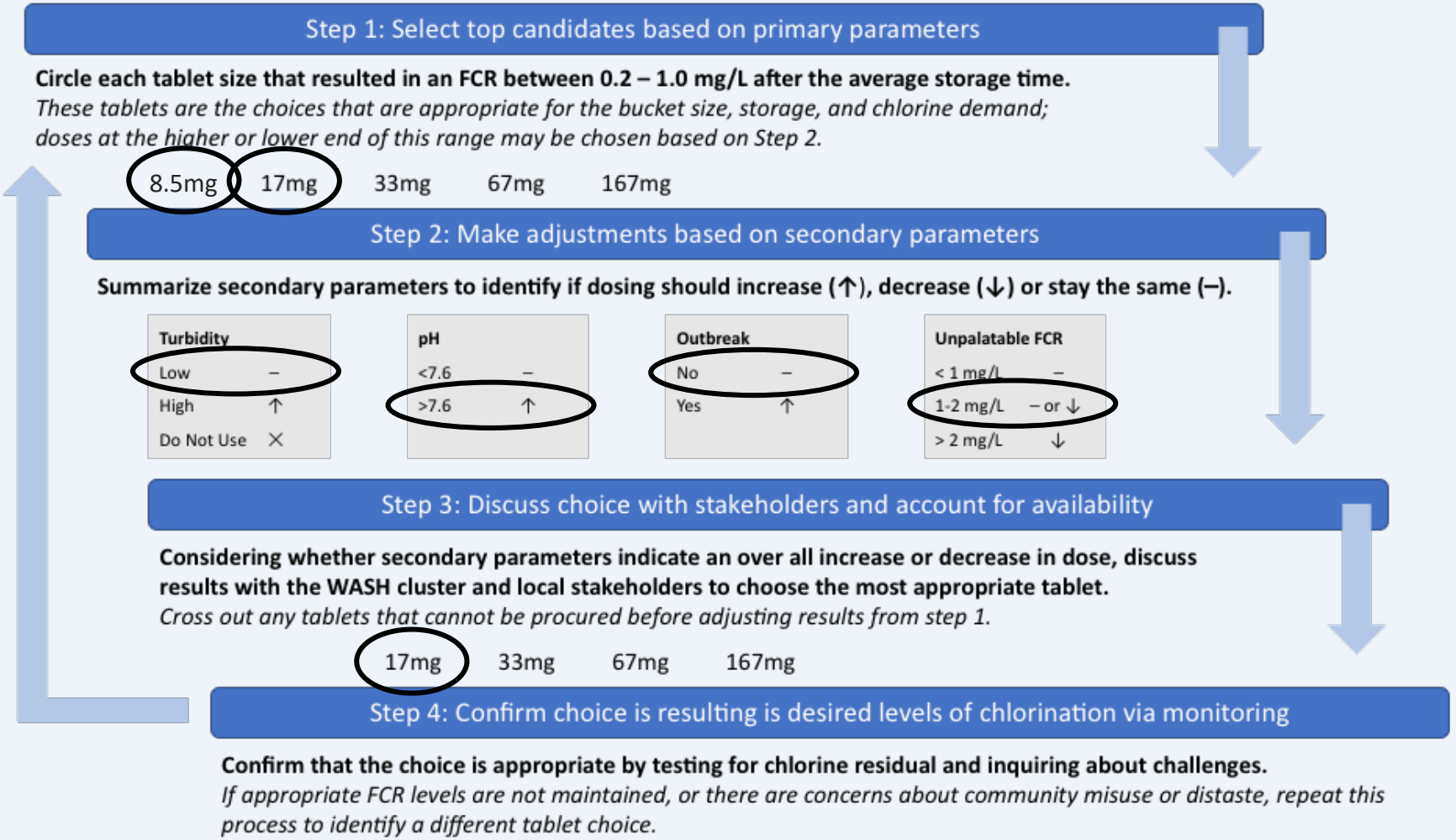
Fig 8. Chlorine taste and odor preferences in water with varying levels of FCR

In water testing, turbidity was low (2.5 NTU) and pH was high (7.7). Respondents did not express concerns with chlorine in surveys or focus groups, however in KIIs, Oxfam staff reported that chlorine rejection had been a major issue and acceptance increased after promotion efforts. The highest FCR at which <1/3 of the sample expressed disliking the taste and odor of the water was 1.0 mg/L FCR, and this was established as the taste and odor threshold (Fig 8). Thus, in step two the decision was made that the 17 mg tablet would be the best choice, as it maintains a higher FCR that is still under the taste and odor rejection threshold.

Conclusion and Recommendations. During this field test all chlorine tablet selection tools were used successfully, and the process resulted in a recommendation that differed from the tablet dose distributed in the camp. During the field test, researchers noted that the transect walk, water quality testing, survey, and KIIs were particularly easy to conduct. Jar testing was more difficult due to the space and time required to set up many buckets for testing. Focus groups and taste testing were also a challenge, because it took time to establish trust with respondents such that they were comfortable answering questions honestly and drinking provided water samples. However, all activities were conducted successfully in a period of four days of evaluation and one training day with four staff and one researcher.

The resulting recommendation, which suggests the use of a 17 mg tablet, was found to dose water with enough chlorine to disinfect and provide residual protection for the length of storage, while limiting taste and odor concerns. This recommendation differed from the tablet size that had been in use in the camp; choosing a lower tablet dose might have may have increased acceptability among users who had initially expressed concern about chlorine, facilitating correct and consistent use of water treatment. Thus, the chlorine tablet selection process provides a useful tool to identify tablets most likely to lead to effective use in an emergency. We recommend humanitarian response organizations consider 1) conducting a chlorine tablet selection process either at the start of an emergency to identify the most appropriate tablet for that context or during a protracted crisis to validate the current approach or identify needed changes, and 2) purchasing and pre-positioning a wider range of chlorine tablet dosages, to allow for use of the tablet identified by the selection process.

Tablet Choice Flow Chart – Results from Cox's Bazar



Conclusion

Chlorine tablets are often a good choice for water treatment in emergencies because they are widely available, cost-effective, easily transported, and simple to use. However, the availability of multiple tablet sizes in an emergency can result in users treating their water improperly, and some doses may be unpalatable to users. This document provides tools to assess water needs in an emergency and make a recommendation for the best chlorine tablet to avoid confusion and provide water that users will accept. This approach may also be used even when only one tablet size is available to inform use of that tablet. This includes activities that assess: 1) water quality, 2) recipient context, 3) taste and odor thresholds, and 4) local context, and the coordination of a recommendation based on these parameters.

This document serves as a guideline on which to base a recommendation and can be adapted based on the needs of a context keeping in mind the goal of providing a clear tablet choice to users that will produce water that is safe and acceptable for users in emergencies.

Please feel free to send comments on the use of these guidelines to Marlene Wolfe (marlene.wolfe@tufts.edu) and Daniele Lantagne (daniele.lantagne@tufts.edu).

Acknowledgements

Thank you to the members of the working group for making this document possible:

Alberto Acquistapace, Syed Yasir Ahmad, Imran Ali, Abu Aslam, Andy Bastable, Damien Blanc, Jason Brooks, Adrian Denyer, Kit Dyer, Tom Handzel, Peter Harvey, Anne-Lise Lavaur, Robin Lloyd, Kevin O'Callaghan, Melissa Opryszko, Alice Pieret, James Ray, Andrew Trevett, Claudio Valsangiacomo, Anil Dutt Vyas, Travis Yates

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Annexes

A. Further Resources

Given the focus of this guidance document on tablet selection, below are further resources on key aspects of program implementation which may be useful to increase the effectiveness of chlorine tablet programs.

Program Implementation and Best Practices

- The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response (Sphere)
- Guidelines on Drink-Water Quality, 4th edition (WHO)
- How much water is needed in emergencies (WHO, WEDC)
- Efficacy and effectiveness of water, sanitation, and hygiene interventions in emergencies in low- and middle-income countries: a systematic review (Yates et al 2018)
- Household Water and Safe Storage in Emergencies (IFRC)
- Household Water Treatment and Safe Storage (WHO)

Behavior Change

- Community Engagement in Cholera (UNICEF)
- Hygiene Promotion in Emergencies (WHO, WEDC)

Chlorination

- Chlorination (CDC)
- Free Chlorine Testing (CDC)
- Branz A, Levine M, Lehmann L, Bastable A, Ali SI, Kadir K, et al. Chlorination of drinking water in emergencies: a review of knowledge to develop recommendations for implementation and research needed. Waterlines 2017;36:4–39. doi:10.3362/1756-3488.2017.002.
- Wilhelm N, Kaufmann A, Blanton E, Lantagne D. Sodium hypochlorite dosage for household and emergency water treatment: updated recommendations. J Water Health 2018;16:112–25. doi:10.2166/wh.2017.012.

B. Water Quality and Chlorine Demand Testing

This protocol is intended to guide the testing of local water during emergency response to determine chlorine tablet dosages appropriate to treat water and maintain an acceptable free chlorine residual.

Water Quality Parameters

Testing of water quality parameters should be done in triplicate for samples from each water source in use, when possible taken at different times of day during which water is typically collected from. The number of total samples required will depend on the number of water distribution points in response areas. If conditions or source types vary between areas, jar testing in the next section should be done for each type of source. A data sheet is provided in the protocol to aid in recording of results.

Materials

- Containers for sampling water
- Glass (sometimes encased in plastic/rubber) or electronic thermometer
- pH strips or electronic pH meter
- Turbidimeter
- Data sheet
- Pens

Procedures

Sampling

A sample taken directly from the water source will be used to assess water quality.

1. Water should be collected from the water distribution point in the same manner as users collecting water for household use.
2. Containers of at least 1 liter should be filled with source water, to be used to test for temperature, pH, and turbidity.
3. Testing should be conducted immediately after water collection from the source.

Turbidity

Turbidity refers to the clarity of water. In emergencies, water will often have some suspended solids. High turbidity waters often have higher chlorine demand, which affects the amount of chlorine required to effectively treat water [8]. Turbidity can be quantified using a portable meter that scatters light through a sample and reports in nephelometric turbidity units (NTU),

or the relative level of turbidity can be assessed more imprecisely using a visual approach such as a turbidity tube. Because turbidity is a volatile parameter and is dependent on the amount of mixing or settling that has taken place prior to measurement, particular effort should be taken to measure turbidity immediately after a sample is taken.

1. Electronic turbidimeter
    a. Before use, calibrate the turbidimeter using standards with known NTU values according to the manufacturer's instructions. Meters that are not regularly calibrated will not provide accurate results.
    b. Remove the cap from an empty sampling vial. Rinse the vial with a portion of the sample; discard. Repeat for a total of three rinses.
    c. Replace the cap of the vial and wipe the sides with a soft cloth to remove any fingerprints.
    d. Without touching the glass sides of the vial, insert the vial into the turbidimeter.
    e. Close the lid and press "read."
    f. Record the turbidity in NTU to the level of precision provided by the meter.
2. Turbidity tube
    a. A turbidity tube consists of a tube with marked NTU levels along the edge and a black and white mark in the bottom – either a cross or checkerboard pattern. Please note that chlorine tubes are often not accurate, and if possible a turbidimeter is preferred.
    b. Position the tube so that you can look into the top and see the design in the bottom.
    c. Pour water slowly in the tube, allowing bubbles to clear and check regularly to view the design at the bottom.
    d. Once the design at the bottom of the tube can no longer be seen, check the NTU value marked on the scale on the side of the tube. This is the approximate turbidity of the water.
    e. Record the approximate turbidity.

<u>Temperature</u>

Temperature can affect the rate of degradation of chlorine – the warmer the conditions, the faster chlorine will break down.

1. Rinse the thermometer with some of the water sample; discard.
2. Immerse the thermometer at least 2 cm into the water sample.
3. Wait for the temperature reading to stabilize (at least 1 min).
4. Record the temperature to the nearest 0.1°C.

5. If the air temperature is much warmer than the water as it comes from the source, note the ambient temperatures and consider using the same procedures to record the temperature of household stored water after 12 hours.

pH

pH can affect the efficacy of chlorine in water – a pH above 8.0 will make disinfection less effective. pH can be confirmed using either pH indicator strips or an electronic meter. Indicator strips are less accurate than a meter, but are much less expensive and are very small, light, and easy to ship. Pocket-sized pH meters that operate using batteries are available for field use.

1. pH indicator paper/strips:
    a. Remove a single pH strip from the package.
    b. Dip the strip into the water sample, and wave back and forth in the water for 30 seconds.
    c. Remove strip from water and compare to color comparator chart (usually located on the pH strip packaging). Ensure that packaging has not been damaged such that colors have faded as this will change the accuracy of the test.
    d. Record the pH value that most closely matches the pH strip to the nearest integer.
2. Electronic pH meter
    a. Before use, calibrate the pH meter using standards with known pH values according to the manufacturer's instructions. Meters that are not regularly calibrated will not provide accurate results.
    b. Remove the cap of the electrode, which should contain a buffer solution for storage. Rinse the electrode in a portion of the sample; discard.
    c. Immerse the electrode in the sample at least 2 cm, ensuring that the electrode is also 2 cm away from the sides and bottom of the container.
    d. Turn on the meter. Wait for the pH reading to stabilize, and record the pH value to the level of precision provided by the meter.
    e. Wipe the electrode with a soft cloth and store in buffer. Always pack meters in padded carrying cases for transport.

Metals and Chlorine byproducts

This protocol does not include testing for metals or chlorine byproducts. However, testing for these parameters should be considered in the following cases:

Metals

- Consider testing for iron if chlorine demand is found to be high but water has low turbidity.
- Consider testing for arsenic if it is typically an issue in the region.
- Samples may be collected and delivered to a central/national lab for testing, if available.

Chlorine byproducts

- Although chlorinating drinking water has been shown to result in trihalomethanes that are below the WHO thresholds, consider testing if there is significant community concern about chlorine byproducts [14].
- New rapid-test kits are becoming available, or samples may be collected and delivered to a central/national lab for testing, if available.

Water Testing Data Sheet

Staff Name: _____ Date:_____

Sample Number	Water Source Name	Water Source Location	Water Source Type	Time	Turbidity	Temperature	pH
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Jar Testing (Chlorine Demand)

While turbidity, pH, and temperature all contribute to chlorine demand, the best way to assess true demand is by conducting jar testing to find the optimal dose of chlorine that maintains an appropriate FCR. Jar testing is performed by dosing a series of containers (buckets) filled with the source water of interest with a known dose of chlorine, and measuring the resulting free chlorine residual. The tablet can then be selected that provides the residual most appropriate and acceptable in the context, after considering additional factors such as storage time, level of outbreak risk, and taste and odor preferences.

Materials

- 15 water storage containers (10-20 L recommended)
- Secure space to store 15 containers for 24 hrs, accessible for sampling
- Chlorine tablets (typically 17 mg, 33 mg, and/or 67 mg)
- Electronic colorimeter, color comparator, or test strips to measure FCR
- Bottled clean, unchlorinated water to dilute target 8 mg/L samples
- Data sheet
- Pens

Procedures

1. Identify the appropriate number of chlorine tablets to add to achieve each of the five target FCR levels (0.5, 1, 2, 4, and 8 mg/L) based on the volume to test and tablets available, using Table A1 below as a guide.

Table A1. Chlorine Tablets per Volume Water

This table provides information on which tablets should be used for jar testing in two volumes of water. Choose one option per target FCR for the volume of water you are using. These instructions are based on the most common tablet sizes; other sizes may be used.

Target FCR	20 L Water	10 L Water
0.5 mg/L	One 17 mg tablet *OR* Half 33 mg tablet	Half 17 mg tablet
1 mg/L	One 33 mg tablet *OR* Half 67 mg tablet *OR* Two 17 mg tablets	One 17 mg tablet *OR* Half 33 mg tablet
2 mg/L	One 67 mg tablet *OR* Two 33 mg tablets *OR* Four 17 mg tablets	One 33 mg tablet *OR* Half 67 mg tablet *OR* Two 17 mg tablets
4 mg/L	Two 67 mg tablets *OR* Four 33 mg tablets *OR* Eight 17 mg tablets	One 67 mg tablet *OR* Two 33 mg tablets *OR* Four 17 mg tablets
8 mg/L	Four 67 mg tablets *OR* Eight 33 mg tablets *OR* Sixteen 17 mg tablets	Two 67 mg tablets *OR* Four 33 mg tablets *OR* Eight 17 mg tablets

2. Fill 15 large containers with water from the source in the same volume (usually either 10 L or 20 L). Ensure the containers are all filled with the same volume of water.
3. Dose each container with the appropriate chlorine tablets selected from Table A1. Stir or shake the container thoroughly for at least 30 sec and allow to sit for 30 min. Stagger chlorine dosing so that 5 minutes passes between the start time for each subsequent bucket, to allow time for taking measurements. Fig 7 shows a sample set up.

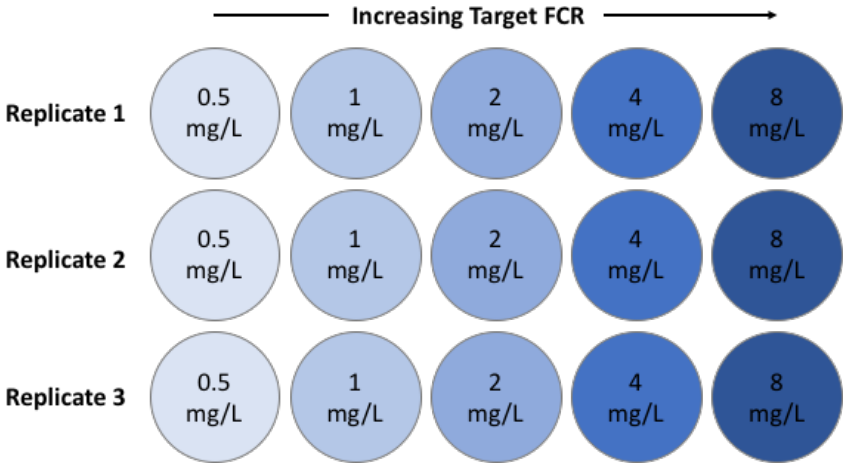


Fig 7. Sample arrangement of jar testing containers

4. After 30 minutes have passed, measure the FCR in each of the buckets. This can be done in several ways, with the color comparator or electronic colorimeter preferred [15]. Note that most methods will only measure chlorine up to 5 mg/L, and so the highest dose bucket should be diluted in clean, unchlorinated water to get an accurate result.
    a. Electronic colorimeter procedures
        i. In these procedures, a reagent is added to a small sample of water in a test vial and inserted in a pocket-sized device (battery powered). The colorimeter assesses the color of the sample and translates this into FCR.
        ii. Before use, calibrate the colorimeter using standards with known FCR values according to the manufacturer's instructions. Meters that are not regularly calibrated will not provide accurate results.
        iii. Collect a sample in the colorimeter vial. Add the appropriate reagent to measure FCR.
        iv. Tighten the lid on the vial and place in the colorimeter.

i. Close the lid and press “read.”
ii. Record the FCR to the level of precision provided by the meter.

b. Color comparator procedures (less accurate, but easy to use).
    i. Color comparator procedures usually involved two test tubes filled with the source water to be tested. A reagent is added to one of the tubes and color of the water is compared to a chart or wheel to determine the FCR.
    ii. Fill both of two tubes with the source water.
    iii. Add the reagent to one of the tubes and swirl to mix thoroughly.
    iv. Cap the tubes and place them in the color wheel or comparator kit.
    v. Adjust the color standards until the color behind the tube without the reagent matches the color of the tube with the reagent.
    vi. Record the FCR.

c. Test strip procedures (least accurate, very easy to use)
    i. Test strip procedures for chlorine are similar to pH and are based on the color change of the strip when immersed in water.
    ii. Dip the strip into the water sample, and wave back and forth in the water for the time indicated by the manufacturer.
    iii. Remove strip from water and compare to color comparator chart (usually located on the strip packaging). Ensure that packaging has not been damaged such that colors have faded as this will change the accuracy of the test.
    iv. Record the FCR.

5. Repeat all measurements at 1, 2, 4, 8, 12, and 24 hours after chlorine addition.
6. If the average storage time in households is known, measurements should be repeated one average storage length after chlorine addition if this is not captured in the pre-specified testing intervals.

Jar Testing Data Sheet

Staff Name: _____ Date:_____ L water in each container: |___|___|

			FCR Measurements							
Target FCR	**Container**	**Tablet (s) Added**	**30 min**	**1 hr**	**2 hrs**	**4 hrs**	**8 hrs**	**12 hr**	**24 hr**	**Avg. Storage |__|__| hrs**
0.5	**1**									
	2									
	3									
1	**4**									
	5									
	6									
2	**7**									
	8									
	9									

Staff Name: _____ Date:_____ L water in each container: |___|___|

			FCR Measurements							
Target FCR	**Container**	**Tablet (s) Added**	**30 min**	**1 hr**	**2 hrs**	**4 hrs**	**8 hrs**	**12 hr**	**24 hr**	**Avg. Storage |__|__| hrs**
4	**10**									
	11									
	12									
8	**13**									
	14									
	15									

C. Transect Walk

A transect walk is a tool used to rapidly identify key aspects of context that will influence programming. A small group of stakeholders should walk with the person conducting the transect walk to guide them and ensure that all relevant sites are viewed and put into proper context. The results of the transect walk should include: 1) a map of key drinking water features in the community; and, 2) data on the most commonly used water sources, management tools, and treatments observed.

Materials

- Transect walk data sheet
- Blank Paper
- Pens
- Clipboard

Stakeholders

Strive to include representatives of the community groups, leaders, and responding organizations in a group of 3-5 people accompanying the person conducting the transect walk.

Choosing a transect

Consult stakeholders to ensure that the path of the transect covers as much of the variation to be found in the local area as possible. The transect should be as much of a straight line as possible with marked start and end points, such that the walk can be repeated and results compared as conditions change.

Map

A sketch map produced during a transect walk should include:

- Water collection points
- Treatment points
- Distribution points for supplies such as buckets and chlorine tablets
- Main clusters of residences

Contextual Parameters

The following pieces of information should be gathered by observation during the transect walk if possible – this sample data sheet can be adapted to include further parameters relevant to each context.

Sample Transect Walk Data Sheet

Add a tick mark for each type of water collection point observed	_____ Borewell _____ Water vendor/truck _____ Shallow well _____ Private tap _____ Public tap _____ Water truck _____ Water tank _____ Protected spring _____ Unprotected spring _____ Lake/pond _____ River/stream _____ Dug well _____ Rainwater
Record the most common types/sizes of water storage containers seen	
Check each type of water treatment observed	|___| Boil |___| Filter |___| Liquid chlorine |___| Chlorine tablets |___| Solar disinfection |___| Other
Describe any water treatment distribution or sale observed	

D. Focus Group

Focus groups are a useful way to gather information on a particular topic without questions limited to just those on a survey. The facilitator will ask questions and generate conversation among the group – during this process issues can arise which responders may not have known to include in survey questions. Assembling a focus group also provides the opportunity to conduct taste and odor threshold testing.

Groups should consist of about 10 participants, and men and women should participate in separate groups. An effort should be made to include a range of ages, occupations, and life experiences in each group.

Introduce yourself to the group, and explain that there are no right or wrong answers to the questions asked and that you hope everyone will be very respectful of each other's experiences and contribute positively to the discussion. Remind the participants that you will not report to anyone what they said by name. Explain that the purpose of the group is to make sure that the water needs of their community are met during this crisis, and that there is some information that you need to know to make sure that the actions that responders take are the right ones to help the community.

As the conversation begins, allow space for the conversation to flow without too much interference, while also guiding participants towards the topics discussed below. The groups should last about 60 minutes. Assign someone who is not leading the group to take notes, and if possible record the session.

Materials:

- Voice recorder and batteries
- Focus Group guide
- Blank Paper
- Pens
- Clipboard

Guiding questions:

1. How many people are in your household? How many children under 5?
2. Where do you receive/collect your water for drinking? Has this changed since the start of the emergency?
3. Do you use water from this source for other purposes, or is there another source of water that you use? What is that source?

    a. Do you ever use water from that source for drinking, also?
4. What do you think of the water that you drink?
    a. How does it taste? Do you feel that it is safe? Is it convenient? Is there anything you especially like/don't like about the water?
5. Who collects the water for your household?
    a. What time of day is water collected for your household?
    b. What size and type of container do you collect water in?
    c. Is water transferred to a different container for storage for your household? What is the size and type of that container?
    d. How long does it usually take for your household to use all of this water?
6. Does anyone in your household do anything to make your water safer to drink?
    a. What is done?
7. Have you used chlorine tablets such as [name local products] before? Do you know what size/color the tablets are?
8. Have you used other chlorine products such as [name local products] before?
9. Do you think that chlorine is a good option to make water safe? What is good about it? What is bad about it?
10. Have you heard anyone in your community worrying about chlorine in water?
    a. What are they worried about happening what water has chlorine?
11. Do you think you can you taste when water has been treated with chlorine?
    a. Does it bother you, or do you like it, or maybe you don't really notice?
    b. Do you ever avoid or seek out drinking water because of the taste of chlorine?
12. Is there anything else you'd like to tell us?

If taste testing has not already been completed with another group or the information is due for an update, complete taste testing with focus group respondents.

When the focus group and any taste testing are complete, thank the respondents and remind them that their time has been very helpful to ensuring that you are able to help meet their need for clean water.

E. Household Survey

Household surveys are administered to adults, usually at their place of residence, and collect information using very structured questions with a largely pre-defined range of possible answers. This survey should be administered to approximately 10-100 households, depending on the size of the target population in the area for which a recommendation is being made. Respondents should 18 years of age or older; it is best to speak with the person in charge of water for the household, if possible.

Aim to survey a minimum of 1% of the population – e.g. at least 10 households for a population of 1,000, 50 for a population of 5,000, and 100 for a population of 10,000. Households may be selected by picking a systematic mechanism to visit households at regular interval. The simplest way to do this is to spin a pen or a bottle to choose a direction to proceed, and then visit every fifth or tenth household in that direction until there are no more and you are forced to again choose a random direction.

Before beginning the survey, introduce yourself to the respondent, and explain that there are no right or wrong answers to the questions asked. Remind the respondent that you will not report to anyone what they said by name. Explain that the purpose of the survey is to make sure that the water needs of their community are met during this crisis, and that there is some information that you need to know to make sure that the actions that responders take are the right ones to help the community.

Materials:

- Survey data sheet
- Clipboard
- Pen

Read script to respondent to obtain consent before beginning the survey.
Hello, my name is _____ and I am working with _____, an organization that is working to bring safe water to people in this community. We are doing work to understand how to provide people in this community with better options to make their water safe to drink. I am interested in your experiences – may I ask you some questions about your household and how you use water?

1. Number of people in household	|___|___|___|
2. Number of children under 5 in household	|___|___|
3. Where does your household receive/collect your drinking water?	[1] Private tap [2] Public tap [3] Water truck [4] Water tank [5] Protected spring [6] Unprotected spring [7] Dug well [8] Borewell [9] Rainwater [10] Other _____
4. Has this changed since the start of the emergency?	[1] Yes [2] No [3] DK
5. How long does it take to go to collect drinking water and return home?	|___|___|___| minutes
6. Is the water from this source used for other purposes in your household?	[1] Yes [2] No [3] DK
7. Is there another source of water used in your household?	[1] Yes [2] No → Skip to 10 [3] DK → Skip to 10
8. What is that source?	[1] Private tap [2] Public tap [3] Water truck [4]Water tank [5] Protected spring [6] Unprotected spring [7] Dug well [8] Borewell [9] Rainwater [10] Other _____
9. Do you ever use that source for drinking, also?	[1] Yes [2] No [3] DK
10. Do you like the taste of your drinking water?	[1] Yes [2] No [3] Neither yes or no
11. Why or why not?	
12. Do you feel that your drinking water is safe for your family?	[1] Yes [2] No [3] Neither yes or no
13. Why or why not?	
14. Is your drinking water convenient to access?	[1] Yes [2] No [3] Neither yes or no
15. Why or why not?	

16. What size is the container you collect water in?	|___|___| litres
17. What is the type of container that you use?	[1] Open bucket [2] Bucket with lid [3] Jerrican with small opening [4] Other _____
18. Is the water transferred to a different container for storage?	[1] Yes [2] No → Skip to 21 [3] DK → Skip to 21
19. What size is the container?	|___|___| litres
20. What type is the container?	[1] Open bucket [2] Bucket with lid [3] Jerrican with small opening [4] Other _____
21. How long does it usually take for your household to use a full container of water?	|___|___| hours
22. Does anyone in your household do anything to make your water safe to drink? If yes, what?	[1] Nothing [2] Boil [3] Filter [4] Liquid chlorine [5] Chlorine tablets [6] Solar disinfection [7] Other _____
23. Have you used chlorine tablets such as [local name] before?	[1] Yes [2] No → Skip to 26 [3] DK → Skip to 26
24. Do you know what type of tablet you used/can you show me the tablets your household uses?	[1] 8.5 mg (1 L emergency) [2] 3.5 mg (1 L HH) [3] 33 mg (4-5 L emergency) [4] 17 mg (4-5 L HH) [5] 67 mg (10 L emergency) [6] 33 mg (10 L HH) [7] 167 mg (20-25 L emergency) [8] 67 mg (20-25 L HH) [9] 1.67 g (200-400 L emergency) [10] 1.67 g (200-400 L HH) [11] DK
25. What brand of chlorine tablets?	
26. Has your household used other chlorine products such as [local name] before?	[1] Yes [2] No [3] DK
27. Have you heard rumors that chlorine in water is not good for you?	[1] Yes [2] No → Skip to 25 [3] DK → Skip to 31
28. What rumors have you heard?	

29. Have you heard anything good about chlorine?	[1] Yes [2] No → Skip to 25 [3] DK → Skip to 31
30. What rumors have you heard?	
31. Do you think that you can taste chlorine when it has been added to water?	[1] Yes [2] No → Skip to 33 [3] Neither yes or no → Skip to 33
32. What do you think of the taste?	[1] I like it [2] I don't like or dislike it [3] I dislike it Comments on taste: _____
33. Do you ever avoid drinking water because of the taste of chlorine?	[1] Yes [2] No [3] DK
34. Do you ever seek out drinking water because it has chlorine?	[1] Yes [2] No [3] DK

F. Taste and Odor Testing

Taste testing may be conducted with either a focus group of recipients or using a group of local staff (who are likely to have taste and odor preferences similar to those of the recipient population). Groups should consist of about 10 participants, and an effort should be made to include a range of ages and occupations in each group. Groups should be all male or all female, and at least one group should be conducted with men and one with women. Note that this activity requires establishing trust and a good rapport with participants, as they may be wary of being given something to taste.

Please note that bottled water is used for this test to ensure that although some samples have low-chlorine or no chlorine, water is safe to drink. Thus, taste may differ somewhat from the water source typically used by the community. Since chlorine demand will likely be higher in community source water, taste and odor rejection may take place at slightly lower dosages than results here indicate.

Introduce yourself to the group and explain that you will ask the participants to taste water that is safe to drink and give their preferences based on the taste and odor of the water. Remind them that there are no right or wrong preferences, and that this information will be used to make sure that safe water also tastes acceptable to people in this community.

Materials:

- 1 L bottles (6)
- Cups
- Chlorine tablets (17 or 33mg)
- Electronic colorimeter, color comparator, or test strips to measure FCR
- Taste and Odor data sheets and pens for each participant

Taste Testing

1. Using bottled water, prepare five bottles, containing different levels of FCR ranging from 0.2 mg/L to 2.0 mg/L (0.2, 0.5, 1.0, 1.5, 2.0 mg/L).
    a. Prepare a 1 L bottle of water with a high dose of chlorine, which will then be diluted to achieve each level of chlorine.
    b. Add one 17mg tablet OR half of one 33mg tablet to the 1L bottle to produce a solution of 10mg/L. Stir or shake for 30 seconds and allow to sit for 30 minutes before proceeding. Please note that other starting concentrations may be used, and volumes adjusted accordingly.
    c. Dilute the original bottle by adding the following volumes of the high-chlorine water and fresh water to each of 5 1L bottles:

Target FCR	Volume High-Chlorine Solution	Volume Fresh Water
0.2 mg/L	20 mL	980 mL
0.5 mg/L	50 mL	950 mL
1.0 mg/L	100 mL	900 mL
1.5 mg/L	150 mL	850 mL
2.0 mg/L	200 mL	800 mL

2. Use an electronic colorimeter, color comparator, or test strip to measure the FCR concentration in each bottle according to the instructions in the jar testing protocol to confirm the concentrations.
3. Label the bottles A-E in a random order. Do not label in order of ascending or descending chlorine level.
4. Provide the participants in the group with 5 cups, and pour a taste of each bottle of water.
5. Ask the participants to taste each cup in order from lowest chlorine concentration to highest, and privately mark on a sheet whether they like the taste of the water, whether the taste of the water is neither good nor bad, and whether they dislike the tastes of the water. After tasting each sample, the participant should rinse their mouth out with bottled water without any added chlorine.
    a. If any member of the group is illiterate and therefore not able to privately mark answers, the testing should all be conducted one on one in front of a staff member who will inquire about the participant's opinions after each taste. It is important that group members not hear the responses of the rest of this group, as this could influence their rating.
6. Once participants have tasted all the samples, they may return to any of the cups that they would like to taste again and reevaluate.

When the taste testing is complete, thank the respondents and remind them that their time has been very helpful to ensuring that you are able to help meet their need for clean water.

Sample Taste and Odor Data Sheet

	Check One			Comments
Cup	**I like the taste**	**I don't like or dislike the taste**	**I dislike the taste**	
A				
B				
C				
D				
E				

G. Key Informant Interviews

Key informant interviews are a useful way to gather information from an expert on a particular topic without questions limited to just those on a survey. The facilitator will ask questions and probe for further responses – during this process issues can arise which may not have been included in survey questions. Aim to conduct at least 3 interviews.

Likely key informants for interviews related to chlorine tablet selection include:

- Local leaders/governance
- Water ministry leaders
- Health ministry leaders
- Local vendors
- Local emergency responders
- International emergency responders

Introduce yourself and explain that there are no right or wrong answers to the questions and that you will not report to anyone what they said by name. Explain that the purpose of the interview is to make sure that you understand the full scope of water needs and availability during this crisis. As the conversation begins, allow space for the conversation to flow without too much interference, while also guiding the interviewee towards the topics discussed below. Not all questions are likely to be relevant for every interviewee – take time prior to the interview to select and prioritize the questions most likely to be relevant to the interviewee but remain open to all topics. Each interview should last about 30 minutes. Record the interview, if possible.

Materials:

- Voice recorder and batteries
- KII Guide
- Blank Paper
- Pens
- Clipboard

Guiding questions:

1. Where are users receiving/collecting water for drinking? Has this changed since the start of the emergency?
    a. If an existing municipal system is in use – do you have any records on the design, operation, or maintenance of the system that we can access? Is there another person we can speak to who has been responsible for the system?
2. Do users use water from this source for other purposes, or is there another source of water used for laundry, bathing, water for animals, etc? What is that source?
    a. Do you ever observe or hear of users using water from that source for drinking, also?
3. What are some of the primary complaints that you have heard about the water?
    a. Probe: some possibilities include objection to taste, inconvenience, limited quantity, high turbidity, concerns about safety.
4. Which containers are most commonly used/available for water collection?
    a. Is there a response organization distributing containers? What size/type?
    b. What size/type of containers are most available on the local market?
    c. Are there containers originally for other purposes that are typically being used for water collection? What size/type?
    d. Do households often use a container for storage that is different from the one that water is collected in? If so, what size/type?
5. Do people in this community typically do anything to make their water safer to drink?
    a. What types of water treatment have you heard of someone using in their home?
    b. Have you seen chlorine tablets such as [name local products] in previous work? Are they in use in this emergency?
        i. Were they distributed by an organization or sold at the market?
        ii. Do you know what size/color the tablets are?
    c. Have you used other chlorine products such as [name local products] before?
        i. Were they distributed by an organization or sold at the market?
6. What do people in this community think of chlorinated water? Do they perceive it as safe? Are there concerns or do people avoid it?
    a. Are there any rumors in the community about the addition of chlorine to water? What are they?
    b. Do people in this community seem to reject water that has been chlorinated because they do not like the taste or odor?
    c. If people avoid chlorinated water, what do you think it the main reason?
    d. Do people in this community seem to seek out water that has been chlorinated because of safety?
    e. Do people in this community like chlorine? Why?

H. Monitoring Survey

After a chlorine tablet size has been chosen and distributed, regular monitoring should be done to ensure that tablets are being used properly and that they result in the desired FCR after a given period of storage. As part of monitoring, household surveys are administered to an adult. Before beginning the survey, introduce yourself to the respondent, and explain that there are no right or wrong answers to the questions asked. Remind the respondent that you will not report to anyone what they said by name. Explain that the purpose of the survey is to make sure that the water needs of their community are met during this crisis, and that there is some information that you need to know to make sure that the actions that responders take are the right ones to help the community.

Read script to respondent to obtain consent before beginning the survey.
Hello, my name is _____ and I am working with _____, an organization that is working to bring safe water to people in this community. We are doing work to understand how to provide people in this community with better options to make their water safe to drink. I am interested in your experiences – may I ask you some questions about your household and how you use water?

Materials:

- Monitoring Survey
- Color comparator kit or chlorine test strips
- Clipboard
- Pens

1. Number of people in household	|___|___|___|
2. Number of children under 5 in household	|___|___|
3. Where do you receive/collect your drinking water?	[1] Private tap [2] Public tap [3] Water truck [4] Water tank [5] Protected spring [6] Unprotected spring [7] Dug well [8] Borewell [9] Rainwater [10] Other (specify) _____
4. How long does it take to go to collect drinking water and return home?	|___|___|___| minutes
5. Does anyone in your household do anything to make your water safe to drink? If yes, what?	[1] Nothing → end survey [2] Boil [3] Filter [4] Liquid chlorine [5] Chlorine tablets [6] Solar disinfection [7] Other (specify) _____
Ask questions 6-8 if respondent reports treating water with chlorine tablets	
6. Were these tablets distributed to you by [list of operating organizations]?	[1] Yes [2] No → Skip to 10 [3] DK → Skip to 10
7. If yes, do you know what type of tablet you used/can you show me the tablets your household uses?	[1] 8.5 mg (1 L emergency) [2] 3.5 mg (1 L HH) [3] 33 mg (4-5 L emergency) [4] 17 mg (4-5 L HH) [5] 67 mg (10 L emergency) [6] 33 mg (10 L HH) [7] 167 mg (20-25 L emergency) [8] 67 mg (20-25 L HH) [9] 1.67 g (200-400 L emergency) [10] 1.67 g (200-400 L HH) [11] DK
8. What brand of chlorine tablets did you receive?	
9. How many tablets did you receive?	|___|___|___| tablets
10. Do you like the taste of your treated drinking water?	[1] Yes [2] No [3] Neither yes or no
11. Do you feel that your treated drinking water is safe for your family?	[1] Yes [2] No [3] Neither yes or no
12. Can I take a small sample of some water that you have treated?	[1] Yes [2] No [3] None available
13. How long ago did you treat this water?	|____|____| hours
14. Observation: how large is the container?	|____|____| liters
15. Observation: what type is the container?	[1] Open bucket [2] Bucket with lid [3] Jerrican with small opening

16. Observation: measure free chlorine residual	|___|___|.|___|mg/L

I. Tablet Selection Worksheet

This worksheet is to be used to summarize parameters influencing chlorine tablet choice. This information can then be used to work through the Chlorine Tablet Selection Flow Chart to arrive at a recommended dose or doses to be used by all responders in an emergency.

Note: It is possible to complete this worksheet and selection process using only information from priority items in the assessment. Completing the full assessment is likely to yield more accurate information on which to base recommendations.

Primary Parameters	
What is/are the most common or most frequently observed container size(s)? *From transect walk, focus group, or survey*	1 L 4-5 L 10 L 20-25 L Other: _____ L
Length of storage (90th percentile) *From focus group or survey* 1. *Place responses in order from lowest to highest value* 2. *Calculate the 90th percentile rank using:* *Rank = 0.9*(# of answers + 1)* 3. *Choose the value at this rank #*	|___|___| hours *Use this number to evaluate FCR levels from jar testing*
Which doses of chlorine tablets resulted in FCR readings between 0.2 and 1.0 mg/L after |___|___|? *Use results from jar testing for the 90th percentile storage length time.*	17mg 33mg 67mg 167mg *Note: This value should be based on the test in which contact time was equal to or exceeded the storage time listed above. If the volume of containers used for testing was not the same as most commonly used container, multiply or divide to estimate what the residual in the appropriate container would be and use this value.*
For doses resulting in FCR in the target range, record the tablet size and FCR after the target storage length *From jar testing*	**Tablet Size** **FCR after |___|___| hrs** |___|___|.|___| mg |___|.|___| mg/L |___|___|.|___| mg |___|.|___| mg/L |___|___|.|___| mg |___|.|___| mg/L
Secondary Parameters	

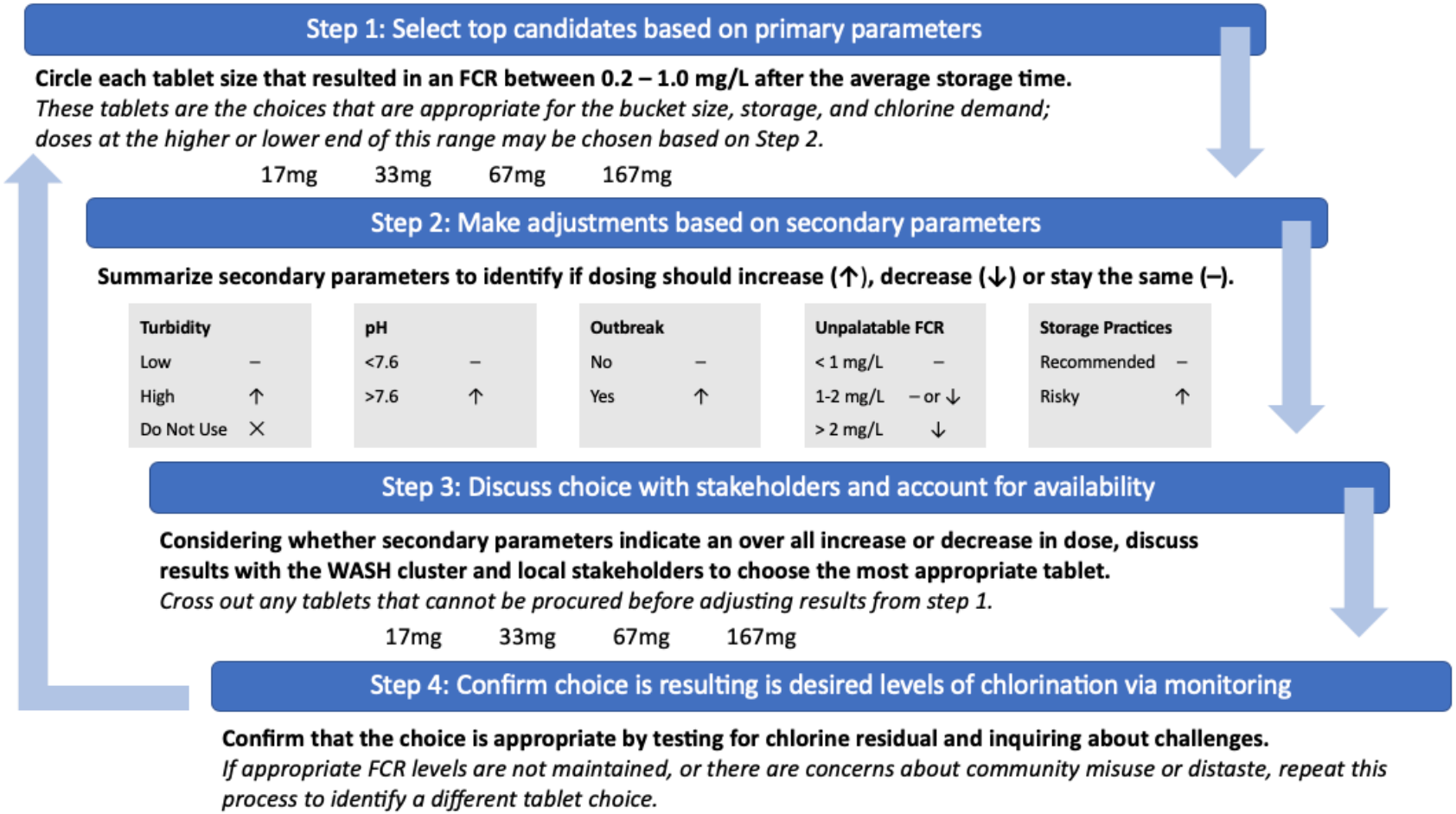
Average Turbidity (NTU)	|___|___|.|___| NTU
Average Level of Turbidity	Low (0-5 NTU) High (5-50 NTU) Do Not Chlorinate (>50 NTU) *Note: Water should be <5 NTU to be properly disinfected with chlorine. Consider a double dose of chlorine in water with high turbidity for short term emergencies.*
pH	|___|___|.|___|
Is there a waterborne outbreak in progress?	Yes No
What is the highest FCR at which <1/3 of local respondents reported disliking the taste and odor of the water?	|___|.|___| mg/L
Do respondents report risky water storage practices, e.g. using wide-mouth containers?	Yes No
Availability	
Which tablet sizes are currently available to responders in prepositioned stock?	[1] 8.5 mg emergency [2] 3.5 mg household [3] 33 mg emergency [4] 17 mg household [5] 67 mg emergency [6] 33 mg household [7] 167 mg emergency [8] 67 mg household [9] 1.67 g emergency [10] 1.67 g household
Which tablet sizes are currently available on the local market?	[1] 8.5 mg emergency [2] 3.5 mg household [3] 33 mg emergency [4] 17 mg household [5] 67 mg emergency [6] 33 mg household [7] 167 mg emergency [8] 67 mg household [9] 1.67 g emergency [10] 1.67 g household

Table 2.1 Reference Volume Ranges for Chlorine Tablets

These volumes represent typical ranges for each tablet, and are only a guideline. "Emergency" tablets provide a double dose of chlorine compared to" household".

Emergency	Household
8.5 mg for 1L	3.5 mg for 1 L
33 g for 4-5 L	17 mg for 4-5 L
67 mg for 10 L	33 mg for 10 L
167 mg for 20-25 L	67 mg for 20-25 L
1.67 g for 200 – 400 L	1.67 g for 200 – 400

J. Tablet Choice Flow Chart



K. Equipment List

Item	Activity/Activities	Quantity	Recommended Product
Sampling containers	Water Testing	~12	
Glass or electronic thermometer	Water Testing	1	
pH strips or meter	Water Testing	1 meter, 100 strips	
Turbidimeter	Water Testing	1	LaMotte 2020 Portable Turbidity Meter
Water Testing Data sheets	Water Testing	10	
Water Storage Containers (20L or 10L)	Jar Testing	15	
Chlorine tablets (17, 33, or 67 mg)	Jar Testing	~ 50	
Colorimeter OR Color Comparator Kit OR Chlorine Test Strips	Jar Testing, Taste and Odor	1	Hach Pocket Colorimeter II OR Hach Color Wheel 223102 AND Kit-specific reagents
Jar testing data sheet	Jar Testing	10	
Transect walk data sheet	Transect Walk	10	
Blank Paper	Transect Walk, Focus Group, KII	20	
Clipboard	Transect Walk, Focus Group, Household Survey, KII, Monitoring Survey	~5	
Pens	Transect Walk, Focus Group, Household Survey, Taste and Odor, KII, Monitoring Survey	~20	
Voice recorder	Focus Group, KII	1	
Recorder batteries	Focus Group, KII	~4	
Focus group Guide	Focus Group	10	
Survey Data Sheet	Household Survey	~100	
1L bottles	Taste and Odor	6	
17 or 33 mg chlorine tablets	Taste and Odor	10	

Cups	Taste and Odor	10-50	
Taste and Odor data sheets	Taste and Odor	10	
KII Guide	KII	10	
Monitoring survey data sheet	Monitoring Survey	~100	
Color comparator or chlorine test strips	Monitoring Survey	5 kits	Hach Color Wheel 223102 AND Kit-specific reagents