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# Introduction to Household Water Treatment and Safe Storage (HWTS)

Technical Brief  
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# Technical Brief: Introduction to Household Water Treatment and Safe Storage (HWTS)

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*This document is part of a collection of resources for learning and training about household water treatment and safe storage (HWTS). To access CAWST’s other HWTS resources, visit [cawst.org/resources](http://cawst.org/resources).*

## 1 Introduction

Household water treatment and safe storage (HWTS) is an approach used by millions of people around the world to improve and protect their water quality. By treating water in the home and storing it safely, people can reduce their likelihood of getting sick from contaminated water.

Household practices often affect people's drinking water quality. Unhygienic behaviours, such as using dirty buckets to transport or store water, can make even water from safe sources unsafe to drink. Hygienic household behaviours, however, can act as important and effective barriers to risk. By using HWTS systems, people can remove or inactivate contaminants and help protect themselves from disease.

In this technical brief:

- We introduce and define HWTS.
- We describe how HWTS fits within a multi-barrier approach to safe drinking water.
- We discuss the benefits and limitations of HWTS.

Key words in this document are marked in a bold font. If you are reading this on a screen, you can go to the definition of key words by clicking on them while holding the Ctrl button. If you are reading a printed copy, please refer to Section 7: Definitions.

## 2 What is HWTS?

**Household water treatment and safe storage (HWTS)** is a general term for activities people can do to improve their drinking water quality at home. This usually includes treating and then safely storing drinking water. Sometimes HWTS is called managing water at the **point-of-use (POU)**. HWTS can include any of the following treatment and storage activities that take place at the point-of-use (for example in a home, business, or institution):



**Sedimentation:** A physical process used to reduce the **turbidity** of water. Sedimentation can be as simple as letting particles in water settle to the bottom of a bucket or tank. Sometimes people add **coagulants** to cause particles to clump together and settle more quickly.



**Filtration:** A physical process in which water passes through filter media such as sand, ceramic, cloth, or membrane. The pores of the filter media are big enough to allow water to pass through, but small enough to trap particles suspended in the water. People can use filtration after sedimentation to further reduce turbidity and remove **pathogens**. Examples of household water filters include biosand, ceramic, and membrane filters.



**Disinfection:** A physical or chemical process that inactivates or kills pathogens in water. Examples of household disinfection methods include chlorine, solar disinfection (SODIS), ultraviolet light, pasteurization, and boiling. Many of these methods will be more effective if turbidity has already been reduced by sedimentation or filtration. Flocculant-disinfectant products combine chemicals that make particles clump and settle out of water (sedimentation), and chemicals that inactivate pathogens in the water (disinfection).



**Safe Water Storage:** Keeping water in a clean storage container and handling it hygienically. Safe storage is particularly important to prevent recontamination after water treatment. The best safe storage container is clean, non-transparent, has a lid, and uses a tap or narrow opening to dispense water.

Engineers use the same water treatment steps (sedimentation, filtration, and disinfection) when designing larger systems for whole communities. In any treatment system—whether designed for a household or for an entire community—combining multiple steps can make water treatment more effective. When you use a combination of methods to prevent and reduce contamination of drinking water, you are adopting a **multi-barrier approach** (see Section 3).

HWTS is not new. For centuries, households have used a variety of methods for improving the quality of their drinking water. Promotion of HWTS has increased over the last two decades, as researchers and implementers have recognized how effectively HWTS can protect people from diarrhea. Based on 67 national surveys, an estimated 33% of households in low- and middle-income countries report treating their drinking water at home (Rosa & Clasen, 2010). Boiling water is the most widely practiced form of household water treatment (Rosa & Clasen, 2010). Most low-cost HWTS solutions are designed to remove or inactivate pathogens from human and animal feces. Some HWTS systems may also remove certain chemicals, such as arsenic or iron.

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### 3 What is the Multi-Barrier Approach to Safe Drinking Water?

All water supply systems have multiple points at which contaminants could enter the water and make it unsafe. Using a multi-barrier approach is the best way to make sure the water people drink is safe. The multi-barrier approach uses a combination of behaviours and technologies to:

- *Protect the water source* from contaminants—for example, by properly siting latrines, restricting animal access to the water source, and using safe waste disposal methods.
- *Transport the water safely* to the home and within the home—for example, by monitoring distribution networks, adding **residual disinfectants**, using clean containers with lids, and handling water safely every time it is transferred to a glass or another container.
- *Treat the water* to remove or inactivate contaminants—for example, by using centralized and/or household water treatment systems. Regardless of the scale of the

system, people may choose to apply multiple treatment barriers (sedimentation, filtration, and disinfection) based on the identified risks.

- *Store and handle the water safely* to prevent contamination before and after treatment—for example, by regularly monitoring and maintaining any water storage tanks, and by using a clean container with a lid and tap to store treated water.

People often focus on a specific technology for water treatment, without thinking about how they can add other barriers to increase their water safety. Using a multi-barrier approach is important because if one barrier fails, water can remain safe.

Think of HWTS as a system that combines multiple barriers to address identified risks. An appropriate combination of sedimentation, filtration, disinfection, and safe storage will make your HWTS system more effective. Combining HWTS with source protection and safe transportation adds extra barriers to risk. For more information about ways to protect the safety of drinking water, refer to *CAWST Technical Brief: The Multi-Barrier Approach to Safe Drinking Water*.

## 4 What are the Benefits of HWTS?

### 4.1 Improved Health

Interventions that improve drinking water quality, including HWTS, have proven health benefits. In 2015, a Cochrane Review summarized 55 studies that evaluated the health impacts of different water quality interventions (Clasen et al., 2015). This review found that HWTS significantly reduces diarrhea. Greater effects were found when the treatment method included safe storage, and when the method was used consistently to treat all water consumed by household members (Clasen et al., 2015).

The table below gives a summary of the effects found for different HWTS types. These results should not be used to compare different technologies, but taken together they show that HWTS is effective at reducing diarrhea.

**Table: Reduction in Diarrhea for Different HWTS Interventions**

HWTS Intervention Type	Reduction in Diarrhea
Chlorination	23%
Flocculation – Disinfection	31%
Ceramic Filters	61%
Biosand Filters	53%
Lifestraw Filters	31%
SODIS	38%

(Clasen et al., 2015)

Researchers have published similar findings in other reviews. For example:

- Wolf et al. (2014) concluded that household water treatment can significantly reduce diarrhea and is more effective when combined with safe storage.
- A review published by the WHO (2014) found that HWTS (boiling or filtration with safe storage) can reduce diarrheal disease by around 45%.

Most studies on the health impacts of HWTS have focused on diarrheal disease. Safe water, hygiene, and sanitation are also important for preventing other health problems such as intestinal parasites, undernutrition, and stunting. Few researchers have documented the impacts of HWTS in preventing these health issues. Similarly, few studies have measured indirect impacts of HWTS, such as increased school attendance and higher productivity.

### What Factors Lead to Greater Health Benefits from HWTS?

Clasen (2015) identified three factors that contribute to greater health benefits from HWTS:

1. The HWTS method must be effective in removing or inactivating pathogens.
2. People must use the HWTS method **correctly, consistently, and continually**. If people use HWTS inconsistently and drink unsafe water at work, school, or home, they are less likely to experience health benefits. Households should use their HWTS method on a continued basis through all seasons (see also Brown & Clasen, 2012).
3. The HWTS method must be accessible to vulnerable populations. Those with weaker immunity, such as young children, the elderly, and people living with HIV/AIDS, can benefit most from HWTS.

### **HWTS for People with Lower Immunity**

People with lower immunity to disease include children under the age of five, elderly people, pregnant women, and people living with HIV/AIDS. Safe water is very important for these groups because their immune systems are not as strong. They are more vulnerable to certain types of infections. HWTS can help them reduce the likelihood of getting sick from unsafe water.

For more information about the importance of safe water for people with lower immunity, refer to *CAWST Technical Brief: Reproductive, Maternal, Newborn and Child Health and the Importance of Safe Water, Sanitation and Hygiene*.



## **4.2 Individual Control**

Centralized water treatment systems and household water treatment systems both result in proven health benefits. However, many people who live in remote rural communities or dense peri-urban centres are unlikely to have reliable centralized treatment systems in the near future. Similarly, those displaced by conflict or natural disasters often relocate to camps or settlements without safely managed water supplies. HWTS gives these individuals and families control over their drinking water quality.

## **4.3 Rapid Implementation**

Many HWTS systems are small and portable, which means they can be distributed quickly to those who need them most. This is particularly useful in emergencies, where people need access to safe drinking water very quickly to prevent the spread of disease.

HWTS systems also offer an immediate solution for non-emergency settings where centralized water treatment is unavailable. Many rural, remote, and underserved communities do not have the funding or expertise to repair, upgrade, or build centralized treatment systems in the short term. In some cases, immediate implementation of HWTS is more realistic for these communities. Often, households or community groups can find, purchase, and begin using HWTS systems within a short time period.

## **4.4 Entry Point for WASH**

HWTS is a practical first step households can take to improve their WASH practices and their health. For example, in places where water is very turbid, households can clearly see the advantages of water filters as the appearance of their water improves. This may increase their eagerness to learn more about other WASH solutions.

*“In our experience, people without access to safe drinking water are not willing to hear about other WASH practices. They complain about the unsafe water they are using. But then, when you start teaching people about HWTS, they want to hear more about other WASH solutions. Safe water is a starting point because it is needed for other WASH practices such as food hygiene and personal hygiene.”*

Martha Gebeyehu, Manager of Ethiopia Kale Heywet Church Water Expertise and Training Center



## 5 What are the Limitations of HWTS?

### 5.1 HWTS does not Address Water Supply or Access

HWTS solutions are water quality interventions, not water access interventions. In some contexts, people do not have easy access to drinking water and must walk long distances to find water for their households. In these cases, water supply and water access must be addressed before—or alongside—household water treatment.

### 5.2 HWTS is not the Only Water Quality Solution

Adopting a multi-barrier approach involves addressing risks to water safety from the source to the user's glass. Barriers to risk often include, but should not be limited to, HWTS solutions. Additional measures should be taken to protect, transport, handle, and store water safely.

In some contexts, a centralized facility treats water and distributes it to people's homes. If this treatment system is reliable and effective, HWTS may not be necessary. HWTS is often helpful, however, if a centralized system is unreliable, unavailable, or provides water of inconsistent quality.

If households use HWTS systems because they do not have reliable centralized options, this should not reduce the responsibility of their government to continue expanding access to networked water supplies. However, in many communities it will be a very long time before safe, piped to-the-home water supplies are a reality. Even in many developed countries, remote communities are often not included in centralized treatment and distribution systems, and must rely on self-supply and point-of-use water treatment.

### 5.3 Not all HWTS Systems Can Remove all Contaminants

Different HWTS systems have different abilities to remove or inactivate contaminants.

The table below summarizes pathogen reduction values for various HWTS options. The values in the table do not account for potential recontamination that can occur after treatment due to poor storage and handling practices. As well, this table does not consider the effectiveness that can be achieved from combining appropriate barriers in the multi-barrier approach.



**Table: Pathogen Reduction for Different HWTS Options**

HWTS Process	Pathogen Group	Baseline Log Reduction Value (LRV)	Maximum Log Reduction Value (LRV)
Simple Sedimentation	Bacteria	0	0.5
	Viruses	0	0.5
	Protozoa	0	1
Flocculent – Disinfectant	Bacteria	7	9
	Viruses	2-4.5	6
	Protozoa	3	5
Ceramic Filter	Bacteria	2	6
	Viruses	0.5	4
	Protozoa	4	6
Membrane Filters (Microfiltration)	Bacteria	3	4
	Viruses	0	4
	Protozoa	2	6
Membrane Filters (Ultrafiltration, Nanofiltration, Reverse Osmosis)	Bacteria	2	6
	Viruses	3	6
	Protozoa	3	6
Biosand Filter (BSF)	Bacteria	1	3
	Viruses	0.5	2
	Protozoa	2	4
Solar Disinfection (SODIS)	Bacteria	3	5.5 +
	Viruses	2	4 +
	Protozoa	2	4 +
Free Chlorine Disinfection	Bacteria	3	6 +
	Viruses	3	6 +
	Protozoa (except Cryptosporidium)	3	5 +
Boiling	Bacteria	6	9 +
	Viruses	6	9 +
	Protozoa	6	9 +

(Sobsey, Stauber, Casanova, Brown, & Elliott, 2008; World Health Organization, 2017)

## What is “Log Reduction Value”?

Log reduction value (LRV) is a mathematical term used to show the relative number of pathogens removed or inactivated by a treatment method. For example, 1 LRV means the number of pathogens is 10 times smaller after treatment. LRV can be calculated by:

$$\text{LRV} = \log_{10}(\text{pre-treatment concentration}) - \log_{10}(\text{post-treatment concentration}).$$

LRV	Equivalent % Removal	Example
1	90%	A water sample with 100 CFU/mL before treatment has only 10 CFU/mL after treatment. The treatment removed 90% of pathogens, or achieved 1-log reduction.
2	99%	A sample with 100 CFU/mL before treatment has only 1 CFU/mL after treatment. The treatment removed 99% of pathogens, or achieved 2-log reduction.
3	99.9%	A sample with 1,000 CFU/mL before treatment has only 1 CFU/mL after treatment. The treatment removed 99.9% of pathogens, or achieved 3-log reduction.

CFU/mL = colony-forming units per milliliter. This is a unit for estimating the number of bacteria in a water sample.

In addition to pathogens, chemical contaminants can also be a major concern in certain water sources. Examples of chemical contaminants include nitrate, arsenic, fluoride, pharmaceuticals, and pesticides. Many HWTS technologies are designed to remove pathogens, but are less effective against chemical contaminants.

If your water source has one or more chemical contaminants at concentrations above the WHO guidelines or national standards, consider doing one of the following:

- Find and eliminate the source of the contaminant.
- Use another water source.
- Use a technology specifically designed to remove the chemical(s) of concern. Some specialized household water treatment systems can remove certain chemicals, such as arsenic or fluoride.

For more information about chemical contaminants and methods that can remove them from water, refer to *CAWST's Chemical Contaminant Fact Sheets*.

It is important to understand the types of contaminants that are most likely to affect your community, and to select an appropriate set of barriers for treatment and prevention. For more information about water quality parameters and the types of contaminants that can be removed by different HWTS options, refer to:

- *CAWST Technical Brief: Introduction to Drinking Water Quality for Household Water Treatment Implementers*.
- *CAWST HWTS Fact Sheets* and online HWTS Knowledge Base (<http://www.hwts.info>).

## 5.4 HWTS Relies on Households Taking Responsibility

While centralized treatment systems require only a few skilled technicians, HWTS systems require every household to have a basic understanding of system operation and maintenance. This means that household members will need training, follow-up, and ongoing support. Otherwise, they may not use the system properly or they may stop using it.



HWTS is unlikely to succeed in a community if most households are not motivated to adopt and sustain HWTS practices. However, when household members are motivated to use HWTS practices consistently, and when they have access to options that suit their needs and preferences, HWTS can lead to positive changes in their health and productivity.

Here are some ways you can make it easier for households to take responsibility for HWTS practices:

- Actively involve community members to select HWTS systems that are appropriate, easy to use, and locally available. Refer to *CAWST Technical Brief: Selecting HWTS Options*.

- Provide training and support. In addition to initial user training, you can help households by providing simple visual instructions, follow-up visits, and contact information for troubleshooting support.
- Be aware of the different motivators and barriers to correct and consistent use. Provide support to users and help them stay motivated. Refer to *CAWST's Behaviour Change Guide* for more information about addressing different behavioural determinants.
- Use a multi-barrier approach, including source protection, safe transportation, consistent HWTS use, and safe storage. If households forget to use their system or if the system fails, other barriers will still be in place to protect them from contaminants.

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## 6 Summary

Household water treatment and safe storage refers to activities people do to treat and store water at the point-of-use. HWTS options fit within one or more of the following categories:

- Sedimentation
- Filtration
- Disinfection
- Safe storage

HWTS methods are most effective within a multi-barrier approach, in which behaviours and technologies are combined to keep water safe—from the source to the user's glass.

When used correctly, consistently, and continually, HWTS has proven health benefits. HWTS gives households control over their water quality, can be implemented quickly, and can act as an entry point for other WASH improvements.

HWTS also has limitations. HWTS systems must be appropriate for the context they are used in, and households require support to use them correctly, consistently, and continually. HWTS systems cannot independently address all water access and water quality issues in a community. HWTS interventions should be combined with other measures to ensure that people have consistent access to safe drinking water.

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## 7 Definitions

**Coagulant:** Something (often a metal salt) added to water to cause suspended particles to clump together. Coagulants cause more particles to settle from water more quickly.

**Correct, consistent, continued use:** This refers to the three conditions required for HWTS to have the greatest health benefits. Health benefits are greatest when people use their HWTS systems to treat all of their drinking water all the time, and use the systems properly every time.

**Disinfection:** A process that inactivates or kills pathogens in water. It is the last step of the household water treatment process, after sedimentation and filtration.

**Filtration:** A physical process that involves passing water through filter media like sand, ceramic, cloth, or membrane. Filtration is commonly used after sedimentation to further reduce turbidity and remove pathogens. Water can pass through the pores of a filter, but particles are trapped by the filter media.

**Household Water Treatment and Safe Storage:** Activities by which household members treat and store water in their homes. Also called managing water at the point-of-use (POU).

**Multi-barrier approach:** Adding as many barriers (control measures) as possible to reduce the likelihood of drinking unsafe water. Each barrier incrementally reduces health risks.

**Pathogen:** An organism that causes disease.

**Point-of-Use (POU) water treatment:** Water treatment in the household or institution where the water will be used. Also called Household Water Treatment.

**Residual disinfectant:** A small amount of a chemical disinfectant (often from chlorination) that remains in water over time. Residual disinfectants help to protect against any pathogens that may contaminate the water after treatment.

**Safe water storage:** Keeping water safe from contamination while it is being stored. A safe storage container has a lid, a tap or narrow outlet to pour water, is not transparent, and is easy to clean.

**Sedimentation:** A physical water treatment process used to reduce turbidity of water. Sedimentation can be as simple as letting particles in water settle to the bottom of a bucket or tank. Sometimes coagulants are added to cause particles to clump together and settle more quickly.

**Turbidity:** The “cloudiness” or “dirtiness” of water. Turbidity is caused by suspended solids, such as sand, silt and clay, floating in water. Light reflects off these particles, which makes the water look cloudy or dirty. Turbidity is often measured in nephelometric turbidity units (NTU).

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## 8 Additional Resources

**CAWST HWTS Knowledge Base.** Available at [www.hwts.info](http://www.hwts.info).

- A knowledge base for point-of-use water treatment solutions, from technology options to implementation best practices.

**CAWST HWTS Education and Training Materials.** Available at <https://resources.cawst.org>.

- Technical briefs, lesson plans, presentations, posters, and other resources for learning and training about HWTS.

**World Health Organization: Publications and Documents Related to Household Water Treatment and Safe Storage.** Available at: [www.who.int/water\\_sanitation\\_health/water-quality/household/household-publications/en](http://www.who.int/water_sanitation_health/water-quality/household/household-publications/en).

- Resources related to national HWTS policies, the Scheme to Evaluate Household Water Treatment Technologies, water quality guidelines, water safety planning, and more.

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