HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

MANUAL for the PARTICIPANT

World Health Organization
Western Pacific Region

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Household water treatment and safe storage (HWTS)

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MODULE 1

1.1 Background and objective of the module

The World Health Organization (WHO) estimates that improving water, sanitation and hygiene could prevent at least 9.1% of the global burden of disease and 6.3% of all deaths (Prüss-Üstün 2008). Diarrhoea represents a significant share of this burden, resulting in an estimated 4 billion cases and 1.9 million deaths each year of children under 5 years, or 19% of all such deaths in developing countries (Boschi-Pinto, Tomascovic and Shibuya 2008). Diarrhoeal disease also contributes to decreased food intake and nutrient absorption leading to malnutrition, reduced resistance to infection, and impaired physical growth and cognitive development (Baqui et al. 1993, Guerrant et al. 1999).

As of 2010, an estimated 780 million people worldwide lacked access to improved water sources (WHO/UNICEF 2012). Three quarters of these people live in rural areas where poverty is often most severe and where the cost and challenge of delivering safe water are greatest. Even improved water supplies, such as protected wells and communal stand posts, often fail to deliver safe drinking-water in settings with poor sanitation due to the infusion of faecal contamination (RADWQ 2006). Moreover, water that is microbiologically safe at the source or other point of distribution is subject to frequent and extensive faecal contamination during collection, transport and storage in the home (Wright, Gundry and Conroy 2004). Thus, the health benefits of safe drinking-water will remain elusive for vast populations for years to come.

Providing safe, reliable, piped-in water to every household is an essential goal, yielding optimal health gains while contributing to the targets for the United Nations Millennium Development Goals (MDGs) for poverty reduction, nutrition, childhood survival, school attendance, gender equity and environmental sustainability. While committed strongly to this goal, and to incremental improvements in water supplies wherever possible, WHO and others have called for targeted, interim approaches that will accelerate the heath gains associated with safe drinking-water for those whose water supplies are unsafe (Sobsey 2002). While careful not to encourage diversion of resources away from connected taps, public health officials have called for other approaches that will provide some of the health benefits of safe drinking-water while progress is being made in improving infrastructure (Mintz et al. 2001, WHO/UNICEF 2007).

One such alternative is household water treatment and safe storage (HWTS) (WHO 2007). In many settings, both rural and urban, populations have access to sufficient quantities of water, but that water is unsafe for consumption as a result of microbial or chemical contamination. This is increasingly true even for piped-in water, since supplies are rarely provided on a continuous basis, forcing householders to store more water in the home in ways subject to recontamination and leading to microbial infiltration of poorly maintained systems. Effective treatment at the household level—often using the same basic approaches of filtration, disinfection and assisted sedimentation, as characterized by conventional water treatment—can remove, kill or inactivate most microbial pathogens (Quick et al. 1996, Luby et al. 2001, Rangel et al. 2003, Souter et al. 2003). Moreover, by focusing at the point of use rather than the point of delivery, treating water at the household level minimizes the risk of recontamination that even improved water supplies can present (Wright, Gundry and Conroy 2004).

Despite the potential for HWTS as a targeted intervention for preventing diarrhoea and other waterborne diseases among vulnerable populations, the promise of the intervention has yet to be fully realized. This is due in part to suboptimal methods for treating water at the household level, but also to the need to reach the target population with affordable HWTS solutions and to secure their correct, consistent (exclusive) and sustained use. While many recent efforts have focused on improving and validating the microbiological performance of HWTS methods (WHO 2011), recent research has shown that the challenge of achieving coverage and uptake may be even more intractable (Arnold 2009, Mausezahl et al. 2009, Brown and Clasen 2012).

This module provides an introduction to HWTS. The module begins by reviewing some of the leading methods for treating water at the household level and the research on their microbiological performance. It then summarizes the evidence concerning the effectiveness and cost-effectiveness of HWTS to prevent diarrhoeal disease. The module ends by noting the major challenges in scaling up HWTS by achieving coverage and sustained uptake among populations that might benefit most from the intervention.

"There is increasing recognition that simple household-based approaches to ensuring drinking-water safety should be incorporated into country strategies to reduce waterborne disease." (WHO 2007)

1.2 What is household water treatment and safe storage?

Treating water and safely storing it in the home are commonly referred to as "household water treatment and safe storage" (HWTS) or treating water at the "point of use".

Although HWTS is not new, its recognition as a key strategy for improving public health is just emerging. For centuries, households have used a variety of methods for improving the appearance and taste of drinking-water. Even before germ theory was well established, successive generations were taught to boil water, expose it to the sun or store it in metal containers with biocide properties, all in an effort to make it safer to drink.

It is recognized that the best way to reduce the risks associated with drinking unsafe water is by using the multi-barrier approach. Each step in this approach, from source protection, through water treatment to safe storage, provides an incremental protection against unsafe drinking-water. The concept of the multi-barrier approach is also addressed as part of water safety plans, the principles of which can be applied at both community and household levels.

Both conventional community[1] and household systems follow the same basic water treatment process: sedimentation, filtration and disinfection (Fig. 1.2). A typical community-level system that relies on surface water, for example, may incorporate source protection (drawing water from a deep inlet away from shore), assisted sedimentation (using coagulants), filtration (rapid sand) and disinfection (with ozone and chlorine to minimize recontamination during distribution).

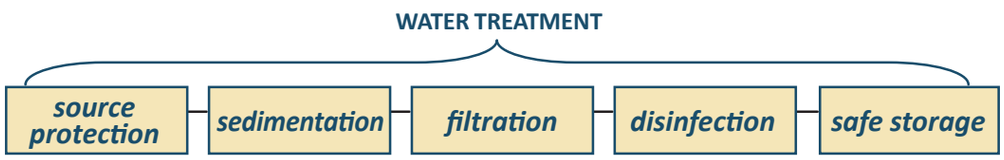


Figure 1.2 The multi-barrier approach

At the household level, a commercial gravity filter, for example, may also use a multi-barrier approach by combining filtration (carbon block or ceramics) with disinfection (chlorine); alternatively, a sachet product can combine a coagulant and disinfectant. In most cases, however, HWTS methods rely more heavily on a single approach, such as disinfection by boiling. Low-cost household options for each of the key water treatment steps will be discussed further in Module 2, including:

- sedimentation (settling, coagulation),
- filtration (biosand filters, ceramic filters, membrane filters),
- disinfection (chlorine, solar, ultraviolet, pasteurization, boiling).

1. Conventional water treatment consists of a combination of physical, chemical, and biological processes and operations to remove solids, organic matter and, sometimes, nutrients from water.

The fundamental difference between community systems and household water treatment is not the underlying mechanism for treating the water, but the point where such treatment is implemented. HWTS requires households to take responsibility for their own drinking-water safety by treating their water at home and preventing its recontamination. HWTS provides a tool for householders to take charge of their own water security.

At the same time, HWTS imposes an obligation on householders to treat their water consistently and not to consume untreated water. In some countries, particularly in parts of Asia, this is a cultural norm (Rosa and Clasen 2010). However, in settings where treating and safely storing water is not yet normative, its implementation requires fundamental changes in behaviour, much like hand washing with soap. While optimizing HWTS technology to make it easier and more attractive to use can help increase uptake, the behaviour change aspects of HWTS should not be overlooked, particularly given the need for consistent uptake.

1.3 Role of household water treatment and the MDGs

HWTS can help improve water quality at the point of consumption, especially when drinking-water sources are distant, unreliable or unsafe. However, HWTS should be viewed primarily as a stopgap measure only; it does not replace the obligation of a service provider to provide access to safe drinking-water. It is intended for people who have no access to improved drinking-water sources, for people with access to improved sources outside of their home or premises (i.e. when contamination can occur during transport and storage), for people with unreliable piped supplies who have to store water to bridge the gaps between deliveries, and for people in emergency situations (WHO/UNICEF 2012).

As part of MDGs, the United Nations expressed its commitment to reduce by half the proportion of people without “sustainable access to safe drinking-water” by 2015. Reaching this water target implies tackling not only water quality but also quantity and access (Clasen 2011). Progress towards meeting the MDG safe water target is tracked by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP).

Significant progress is being made, and the United Nations declared that the MDG water target was met in 2010—five years ahead of schedule. Nevertheless, the health benefits of safe drinking-water will likely remain out of reach for vast populations for years to come. First, JMP does not currently monitor water safety but only whether the source is improved or unimproved; many of the improved sources may not be microbiologically safe (WHO/UNICEF 2012). Second, JMP estimates that current trends will still leave more than 600 million people without improved water sources by 2015. Third, there is considerable geographic disparity among those with access to improved water supplies (Fig. 1.3).

As at 2010, the number of people in rural areas using an unimproved water source was still five times greater than in urban areas.

HWTS can contribute to global efforts to provide universal access to safe drinking-water. In many settings, both rural and urban, populations have *access* to sufficient *quantities* of water, but that water is unsafe as a result of microbiological or chemical contamination. This is increasingly true even for piped water. Supplies are rarely provided on a continuous basis, leading to faecal contamination of poorly maintained distribution systems and forcing households to store water in ways that can be easily recontaminated. For those who have access to sufficient quantities of water that requires treatment to remove pathogens, HWTS can make a direct contribution to the MDG water target (Clasen 2011).

It must be clear, however, that people relying on unimproved drinking-water sources who apply an appropriate household water treatment method are still not considered to have sustainable access to safe drinking-water. Doing so would absolve the providers of their responsibility to provide safe drinking-water and in effect transfer this responsibility to consumers (WHO/UNICEF 2012).

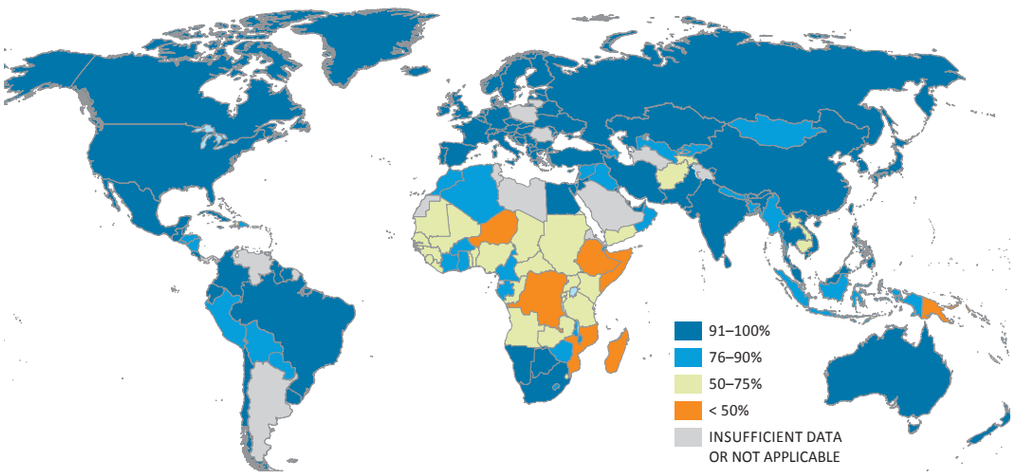


FIGURE 1.3 DRINKING-WATER COVERAGE IN 2010

Source: WHO/UNICEF Joint Monitoring Programme, 2012

HWTS has the potential to advance several health and development aims of the MDGs. As discussed below, there is evidence that the correct and consistent use of effective HWTS among those relying on contaminated water supplies can prevent diarrhoeal diseases, a major killer among young children (Fewtrell 2005, Clasen 2006, Arnold 2007, Waddington 2009). While there is evidence that the reported impact may be exaggerated, any protective effect will contribute to the MDG targets for reducing child mortality (MDG 4) and for combating major diseases (MDG 6). Because enteric infection interferes with normal absorption of nutrients, HWTS also has the potential for alleviating hunger (MDG 1). To the extent that preventing disease also reduces school absenteeism, HWTS can also contribute to the education goal (MDG 2) (Blanton et al. 2010).

1.4 Preventing diarrhoea

An increasing amount of evidence shows that HWTS can significantly reduce diarrhoeal disease. Diarrhoea is a leading cause of death and illness, killing an estimated 1.8 million people annually. Nearly 90% of diarrhoeal deaths are linked to unsafe drinking-water, poor sanitation and hygiene, and the majority of these are borne by children under the age of 5 years in developing countries (WHO 2008).

The belief that drinking-water quality is an important public policy focus is less controversial than it once was. Two decades ago, Esrey and colleagues reviewed the existing literature and concluded that initiatives that improved water quality were considerably less effective than initiatives focused on water quantity, water availability and sanitation (1985, 1991). Their conclusions have been cited widely in professional journals and practical guides, resulting in a prevailing belief that greater attention should be given to water supply and sanitation rather than to drinking-water quality. Equally entrenched became the belief that improving drinking-water quality would have relatively little impact on reducing diarrhoeal disease.

Recently, however, a growing body of evidence has suggested the need to reconsider this prevailing belief. Esrey's conclusions that water quality improvements could reduce diarrhoeal disease by only 15%–17%, critics pointed out, were based on studies involving interventions focused only at the point of distribution, such as protected wells and springs, ignoring the additional health gains to be found by ensuring water quality at the point of use, by treating water in the home, or by preventing recontamination during collection, transport and storage. Further analysis of the original review, in fact, suggests that only when the water supply is delivered at the home are health gains realized.

Three more recent systematic reviews of previously published studies also suggest that improvements in water quality make substantial contributions to preventing diarrhoeal disease (Fewtrell et al. 2005, Clasen et al. 2006, Waddington et al, 2009). Table 1.4 summarizes the results of these systematic reviews. They also suggest that HWTS may be more effective in preventing diarrhoea than interventions at the point of distribution. In the most recent of these reviews, Waddington and colleagues demonstrated that water quality interventions protected young children against diarrhoea if implemented at the point of use (relative risk 0.79, 95% CI: 0.63–0.98), but only marginally so if implemented at the point of distribution (relative risk 0.95, 95% CI:0.90–1.00).

From the household interventions, filtration was associated with the largest reductions in diarrhoeal disease. This could be because it also improves water aesthetics, which may increase its use in the home.

There is, however, increasing evidence that the results from HWTS may be exaggerated due to reportiang bias and the placebo effect (see box on page 8 for descriptions). Clasen and colleagues observed that while more than two dozen to studies of HWTS reported reductions in diarrhea, none of the four that attempted to blind the intervention with a

placebo found the effect of the treatment to be statistically significant (Clasen et al. 2006). The reporting bias found in HWTS also exists among hand washing and sanitation studies where it is even more difficult, if not impossible, to conduct blinded studies.

TABLE 1.4 REDUCTION IN DIARRHOEA FROM REVIEW OF STUDIES IMPLEMENTING WATER SUPPLY AND QUALITY IMPROVEMENTS

Intervention (improvement)	Fewtrell et al. 2005 RR (95% CI)	Clasen et al. 2006 RR (95% CI)	Waddington et al. 2009 RR (95% CI)
Water supply	0.75 (0.62–0.91) *[6 studies]*		0.98 (0.89–1.06) *[8 studies]*
Water quality	0.69 (0.53–0.89) *[6 studies]*	0.57 (0.46–0.70) *[38 studies]*	0.58 (0.50–0.67) *[31 studies]*
Source	0.89 (0.42–1.90) *[3 studies]*	0.73 (0.53–1.01) *[6 studies]*	0.79 (0.62–1.02) *[3 studies]*
Household	0.65 (0.48–0.88) *[12 studies]*	0.53 (0.39–0.73) *[32 studies]*	0.56 (0.45–0.65) *[28 studies]*
Chlorination		0.63 (0.52–0.75) *[16 studies]*	
Filtration		0.37 (0.28–0.49) *[6 studies]*	
Solar disinfection		0.69 (0.63–0.74) *[2 studies]*	
Flocculation/ disinfection		0.69 (0.58–0.82) *[6 studies]*	

See box on the next page for explanation of relative risk (RR) and confidence intervals (CI).

This and other evidence of the lack of successful strategies for adopting HWTS at scale has led some to conclude that efforts to scale up are premature (Schmidt and Cairncross 2009). Others note, however, that even if the results are exaggerated by reporting bias in open trials, HWTS still prevents diarrhoea. This is particularly true for those options whose sustainability can be maintained (Clasen et al. 2009, Hunter 2009).

In either case, there is still a need for further assessment of HWTS using blinded trials and objective outcomes—such as indicators of child growth—to determine their actual effect against diarrhoea (Clasen et al. 2006 and 2009). It should also be noted that the effect measured in any trial will depend on how significantly water is the main transmission route since there are other ways that people can get sick from diarrhoeal disease (e.g. eating contaminated food). This is important since diarrhoea can be transmitted by different pathogens using different pathways depending on the setting, season and other factors. Because of this, any trial, blinded or open, does not allow us to estimate reductions in diarrhoea that can be generalized across all settings and seasons. This is consistent with the large range of results reported in the analyses of these systematic reviews.

- **RELATIVE RISK (RR)**

The risk of an event (such as diarrhoea) in the group receiving the treatment or intervention, divided by the risk of the same event in the group not receiving the intervention (the control group). This is usually expressed as a decimal, though sometimes as a percentage.

For example, a relative risk of 0.79 (or 79%) indicates that the intervention reduced diarrhoea by 21% in the group receiving the intervention as opposed to the control group. A relative risk of 0.95 indicates a 5% reduction in diarrhoea among the group receiving the intervention.

- **CONFIDENCE INTERVAL (CI)**

Rather than simply stating an absolute value for relative risk, studies usually also give a confidence interval. The confidence interval provides us with a greater understanding of the range observed and therefore our best guess of the size of the true treatment effect that is plausible.

For example, a 95% confidence interval of 0.63–0.98 indicates that 95% of the time the reduction in diarrhoea is expected to be between 2% and 37%.

- **REPORTING BIAS**

The tendency to underreport unexpected or undesirable results. These unexpected or undesirable results are often seen as the result of other external factors and/or errors and not fully reported, while expected or desirable results are attributed to the intervention and fully reported even though these may be subject to the same external factors and/or sources of error.

For example, a study to reduce diarrhoea using filter *x* shows no improvement in diarrhoea. The study author decides this is due to a cholera outbreak and so does not publish the study. Filter *x* is studied again in another village and diarrhoea is reduced; the study is published even though there was a government campaign to promote hand washing at the same time.

- **PLACEBO EFFECT**

A well-known phenomenon where a person feels their condition has improved by a placebo (or sham) intervention even though it cannot be attributed to the intervention itself. The effect must therefore be due to the individual's belief in that intervention as opposed to the effectiveness of the intervention itself.

For example, a village is told that their water supply is being treated by chemical *x*. The manager of the system forgets to dose the system for the following week, but when the researcher returns, users report that the water tastes better and they have less diarrhoea.

- **BLINDED STUDY**

Blinded studies contain two groups of people, one receiving the intervention to be tested and another, the control group, receiving a placebo (a simulation with no benefits). The participants do not know whether they have received the real intervention or the placebo. This allows the researcher to avoid problems related to the placebo effect, as both groups will have the same perception.

1.5 TARGETING THE VULNERABLE

Household water treatment and safe storage can be quickly implemented and taken up by vulnerable populations. This includes the most vulnerable and hardest to reach, including those with:

- underdeveloped or impaired immune systems—children under 5, the elderly and people living with HIV/AIDS;
- interrupted water supplies due to natural disasters, such as flooding, or those displaced by war and conflicts; and
- high exposure to contaminated water—families relying on surface or unprotected water supplies, including those living in remote rural areas and urban slums.

In 2009, the United Nations Children's Fund (UNICEF) announced a seven-point strategy for the treatment and prevention of diarrhoea among children. It calls for the adoption of HWTS, in both development and emergency situations, to reduce the number of diarrhoea cases (UNICEF 2009).

Safe drinking-water is an immediate priority in most emergencies (Sphere Project 2004). When normal water supplies are interrupted or compromised due to natural disasters, complex emergencies or outbreaks, responders have often encouraged affected populations to boil or disinfect their drinking-water to ensure its microbiological integrity. Because of increased risk from waterborne disease, HWTS could potentially be an effective emergency response intervention in: (1) response to flooding events or natural disasters that lead to displacement; (2) complex emergency settings when relief cannot progress to development; and (3) response to outbreaks caused by untreated drinking-water, especially cholera outbreaks, which are currently increasing in severity and quantity throughout Africa (Lantagne and Clasen 2012). HWTS may also be especially effective during the initial phase of an emergency when responders cannot yet reach the affected population with longer-term solutions.

WHO recognized the contribution that HWTS can make among people living with HIV/AIDS. HWTS provides safe drinking-water for those on drug therapies and for preparing formula for mothers who are HIV positive and choose not to breastfeed to prevent transmission of HIV to their infant (WHO 2008).

For millions of poor households, daily water use varies temporally and seasonally due to changes in water quality and availability. Low pressure and irregularity of supply in a piped system mean that households in urban slums must seek a backup source, such as a shallow well. In rural villages, people might draw water from a protected well or public tap for part of the year but then are forced to fetch water from a river during the dry season. The use of water sources constantly varies according to factors ranging from water quality, proximity, price and reliability (United Nations Development Programme 2006).

Household water treatment allows people to use a wide array of water sources that may be more convenient and accessible, even though they are of poor quality, such as rivers, ponds, streams and canals. Treating water in the home allows people to adapt to the temporal and seasonal variations in their water supply.

In some cases, HWTS may be the only option for safe water provision. Remote and isolated rural homes, as well as homes in unplanned urban settlements, are among those that have little prospect of receiving piped water services.

Affordability has a significant influence on the use of water and selection of water sources. Households with the lowest levels of access to safe water supply frequently pay more for their water than do those connected to a piped water system. The high cost of water can force households to use alternative sources of water of poorer quality that pose a greater risk to their health. HWTS can be a low-cost option for these households to provide safe drinking-water, even if they are using contaminated sources.

To reach the vulnerable, drinking-water provision must meet some basic criteria—being simple, acceptable, affordable and sustainable, all of which are met by household water treatment. A variety of simple household treatment technologies and methods are available and many have been tested and successfully implemented in a variety of settings and for a diverse range of populations (Sobsey et al. 2008). Many of these technologies, which are presented in Module 2, are convenient and easy to use, minimizing the need for significant behaviour change in people's daily routines and habits.

1.6 Economic impact

Household water treatment is highly cost-effective compared to conventional water quality interventions. In addition to direct cost savings, there are health costs that can be avoided by both individuals and governments through the use of HWTS. When health-cost savings are included, implementing HWTS can actually result in net savings to the public sector.

As we have seen, HWTS can be effective in preventing diarrhoea. However, the degree to which it actually prevents disease also depends on the extent to which it is implemented among a vulnerable population. This, in turn, depends on the cost and cost-effectiveness of the intervention compared to alternative interventions.

With limited resources, particularly in developing countries, governments are forced to allocate health expenditure to a range of public health issues. Economic efficiency, by definition, requires that resources be directed to their most productive use. In the health

context, such efficiency implies more than just cost. Since the lowest-cost intervention is rarely the most effective, resource allocation depends on achieving the most health return for the investment.

Economic evaluation of potential options, therefore, relies on examining both the cost of the intervention and the gains achieved for that cost. Gains can be assessed using a cost–benefit analysis (CBA)—a comparison between the costs invested and the overall economic benefit gained from the intervention. Gains can also be calculated using a cost-effectiveness analysis (CEA)—a comparison between the costs invested and a social objective gained from the intervention, measured in its own units. For health interventions, a common unit of measurement is disability-adjusted life years (DALYs) averted as a result of the intervention.

Disability-adjusted life years (DALYs):

The sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability. One DALY can be thought of as one lost year of "healthy" life.

1.6.1 Cost-effectiveness of HWTS

In its *2002 World Health Report*, WHO compared the cost-effectiveness of various health interventions to help achieve the MDGs. The analysis included a variety of methods for achieving the water and sanitation targets, including HWTS. The report provides a compelling conclusion in favour of the cost-effectiveness of HWTS:

"The intervention, which is consistently the most cost-effective across regions and would be classified as very cost-effective in all areas where it was evaluated, was the provision of disinfection capacity at point of use. On purely cost-effectiveness grounds it would be the first choice where resources are scarce."

WHO also noted that adding basic low-technology water and sanitation measures to this option would also be either very cost-effective or cost-effective in most settings. It also concluded that implementing treated piped water supply and sewage, the ideal solution, could not be considered a cost-effective means of improving health in poor areas of the world. The report's conclusions regarding the cost-effectiveness of point-of-use disinfection were an important factor in pushing forward HWTS as a public health intervention.

Another analysis compared the cost-effectiveness of all leading HWTS options for which data on the health impact have been collected (Clasen et al. 2007). It used information from programme implementers to estimate the annual cost of the HWTS option per person covered and compared that with conventional improvements in water supplies. The analysis found that the annual cost of implementing HWTS varied from a low of US$ 0.63 per person (solar disinfection) to US$ 4.95 per person (combined flocculation/disinfection). This compares to an annual average US$ 2.61 per person for installing and maintaining

wells, boreholes and communal tap stands in Asia. Figure 1.6.1 provides details of the costs analysis and the range of costs found.

It is important to note that source water improvements do not guarantee safe water at the point of consumption, as microbial contamination can easily occur during collection, handling and storage. However, HWTS can improve the safety of drinking-water if a method that meets one of the three WHO performance levels is used correctly and consistently.

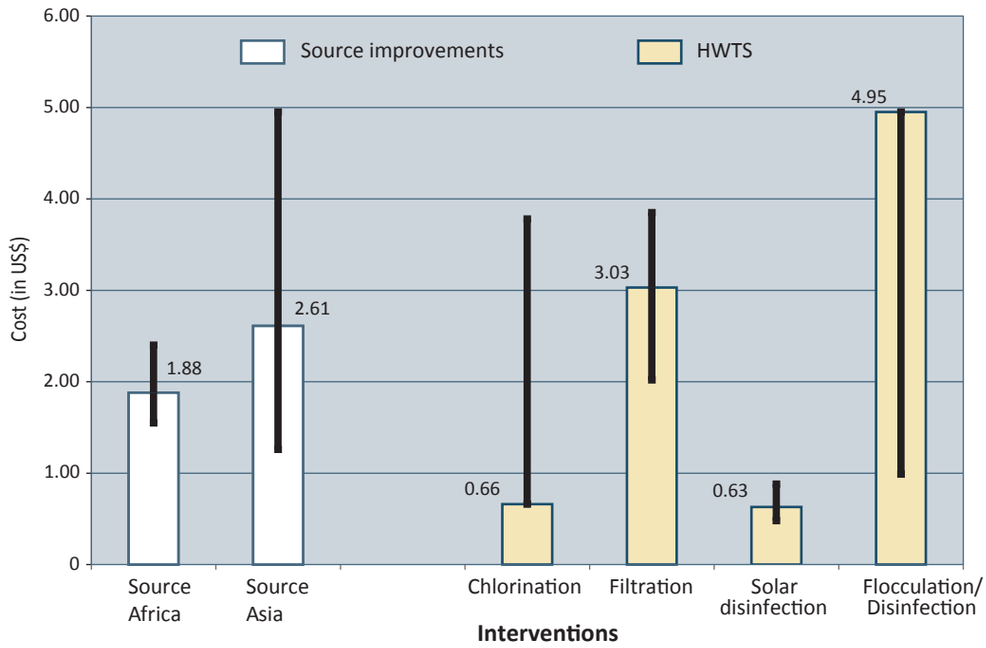


FIGURE 1.6.1 AVERAGE COST (PER PERSON PER YEAR) OF OPTIONS TO IMPROVE WATER QUALITY

Source: Clasen et al. 2007

The study also calculated the total cost of implementing these water quality interventions for those without access to improved water supplies in the WHO Western Pacific Region for 50% of the population. Table 1.6.1 presents the estimated cost savings that would be achieved from such coverage. It should be noted that these cost savings do not include the improvements in productivity that would also be generated. Significantly, an estimated 85% of these cost savings is realized by the government in the form of lower health care costs (Hutton et al. 2007). In some cases, such as household chlorination and solar disinfection, the cost savings actually exceed the cost of implementation. In other words, the saving made by the government would more than pay for the cost of HWTS implementation.

The analysis showed that the combination of lower cost and higher effectiveness means household chlorination is the most cost-effective intervention to prevent diarrhoea in the Western Pacific Region. It has a cost-effectiveness ratio of US$ 521 per DALY averted, less than half of the US$ 1077 for conventional source interventions. When health cost savings are included in the analysis, implementing HWTS actually results in net savings to the public sector (Clasen et al. 2007).

TABLE 1.6.1 COSTS OF ACHIEVING 50% COVERAGE OF WATER QUALITY INTERVENTIONS IN THE WHO WESTERN PACIFIC REGION

Countries in the Western Pacific Region	Intervention	Gross annual cost in US$ millions	Annual health cost offsets in US$ millions	Net annual cost in US$ millions
Cambodia, China, the Lao People's Democratic Republic, Malaysia, Mongolia, the Philippines, the Republic of Korea and Viet Nam, as well as the following Pacific island countries: Cook Islands, Fiji, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu.	Source	1079.9	340.97	739.0
	Household chlorination	452.9	773.71	– 320.8
	Household filtration	2079.3	1317.4	761.9
	Household solar disinfection	439.2	648.2	– 209.0
	Household flocculation/ disinfection	3397.0	648.2	2748.8

Source: Clasen et al. 2007

1.6.2 Cost–benefit of HWTS

A WHO-sponsored cost–benefit analysis also concluded that household chlorination was among the most beneficial of the various options for pursuing the MDG safe water targets. The method demonstrated high returns on every dollar invested, mainly through lower health-care costs but also increased productivity and school attendance (Hutton et al. 2007).

The impact of HWTS on school attendance was recently demonstrated in Kenya, where a school-based project that included hand-washing promotion and HWTS was associated with a 26% reduction in absence from school (Blanton et al. 2010).

In addition to these cost savings, there are health costs that can be averted by both individuals and governments through the use of HWTS. Direct benefits more than cover the costs of implementing most household water treatment interventions. This means that governments could reduce their overall expenditures by investing in HWTS and reaping the savings of reduced health-care expenses related to diarrhoeal disease (WHO 2008).

1.6.3 Willingness and ability to pay

While there is no fixed model to determine who covers the costs of HWTS implementation, in many cases, at least part of the cost is paid directly or indirectly by the household, an issue discussed in Module 3. Those who practise boiling—the most

widespread of HWTS methods—are already incurring costs in fuel and time. There is considerable evidence that people are willing and able to pay for some or all of the cost of HWTS products (Ashraf et al. 2006). This would aid the public sector and donors in providing funding, allowing them to focus on the poorest at the base of the economic pyramid.

Most evidence to date, however, suggests that few of those who might benefit most from effective HWTS interventions are willing and able to pay the full price for HWTS products. In a study in Bangladesh, Luoto and colleagues (2011) reported that the willingness of households to pay for filter and disinfection products was quite low on average (as measured by bids in an incentive-compatible, real-money auction), and only a modest few were willing to pay the actual or expected retail price for low-cost, chlorine-based products. This evidence suggests that HWTS interventions may have to be subsidized in order to reach the base of the economic pyramid where the risk of waterborne disease is actually greatest.

The private sector can contribute to coverage and uptake of HWTS interventions among those who are able to pay for them, allowing the public sector to target subsidies to those who cannot (Clasen 2009). It should be noted, however, that products that have been promoted commercially often also require public spending in order to promote basic health messages, awareness of the intervention, and continued and appropriate use.

1.7 Optimizing the potential of HWTS

To realize the full potential of HWTS, it is essential that it performs well, is affordable and cost-effective. It is also important to identify and implement successful approaches to increase the adoption of HWTS on a sustainable basis (WHO 2007) for those who need it most. HWTS must reach the most vulnerable populations at scale (coverage), and these populations need to use HWTS correctly and consistently over the long term (adoption). To date, there is mixed evidence on both of these fronts.

1.7.1 Achieving coverage

Using data from household surveys from 67 middle- and lower-income countries, Rosa and Clasen (2010) estimate that 33% of households—or more than 1.1 billion people—report treating their water in the home before drinking it. Recent estimates from China increased this figure by another 650 million people (Yang et al. 2012).

While at first glance this appears to be impressive, more than 20% of these households use practices that are unlikely to provide safe water, such as filtering their water

through a cloth or letting it stand and settle. The majority of the rest of the households reported boiling.

Evidence has shown, however, that boiling is actually practised less frequently and more inconsistently than the JMP household surveys reflect (Makutsa et al. 2001). Also, the practice of boiling is still largely regional and probably does not correspond with those at greatest risk of diarrhoea from using unimproved water supplies. For example, Sub-Saharan Africa is one of the regions most likely to rely on unsafe water with just 58% of its population having access to improved water sources. However, in 17 African countries, only 4.9% of the population reports boiling their drinking-water. This compares to 20.4% in Latin America and the Caribbean, 21.2% in South-East Asia, 34.8% in Central Europe and 68.3% in the Western Pacific Region. Rural populations are also specifically at risk and in 2006 represented 84% of the world's population using unimproved sources of drinking-water (WHO/UNICEF 2008). However, in all geographical regions, rural populations are less likely to boil their water (Rosa and Clasen 2010).

Studies show, too, that boiling, like other HWTS methods, is more than twice as likely to be practised in the richest 20% of households than in the poorest 20% (Rosa and Clasen 2010). Finally there is also evidence that children under 5 years of age, who are most vulnerable to diarrhoeal diseases, may not be benefiting from HWTS, even if it is practised by other members of the household (Rosa and Clasen 2010).

Another report commissioned by WHO (Clasen 2009) estimated that in 2007, the combined efforts of the HWTS products, excluding boiling and emergency situations, produced approximately 15.5 billion litres of treated water. This represents an average annual growth of 25.5% from the previous year when 12.2 billion litres were treated. Reported HWTS users also went up by over 25% to 18.8 million from a 2006 figure of 15.5 million. The largest single contribution to the figures was socially marketed chlorine solution, representing approximately 57% of the 18.8 million users in 2007. While social marketing is expressly targeted to low-income populations, there is evidence that these initiatives also result in uptake that favours urban and higher-income households (Freeman et al. 2009), much like HWTS practices generally.

It should be noted that these figures do not include boiling, which is estimated to be practised by 1.2 billion people. The figures also do not include emergency use of HWTS products, an important role for point-of-use water treatment, but one that does not normally contribute to the overall levels of coverage.

These figures are impressive, especially given that most of these HWTS programmes have been under way for less than 10 years and some less than five years. However, the results of HWTS, excluding boiling, are given a sobering perspective when compared with the 780 million people relying on unimproved water supplies and many more whose water is not consistently safe for drinking.

Recent efforts have been undertaken to combine the distribution of HWTS with other products, including high-efficiency cook stoves (Silk et al. 2012) or insecticide-treated bed nets to prevent malaria (Kahn et al. 2012). It may also be possible to support the distribution of HWTS products with funding provided through carbon-credit schemes.

1.7.2 Achieving adoption

Achieving the potential of HWTS depends not only on it being made available to the target population (coverage) but also on it being used correctly and consistently on a sustained basis (adoption). Like most health interventions, HWTS must actually reach the target population with safe, effective, appropriate and affordable solutions. This can be a daunting challenge, even for an intervention such as a vaccine. However, unlike vaccines, HWTS requires people to use it daily to provide maximum protection. Even occasionally, drinking untreated water may cancel out the potential health benefits of HWTS (Hunter et al. 2009, Brown and Clasen 2012).

Studies report a wide range of correct and consistent use among different HWTS interventions. A review by Arnold and Colford (2007) reported that in studies of chlorination, households had detectible chlorine levels in their treated water ranging from 36% to 100%. There is some evidence of higher uptake of chlorine from dispensers placed at water collection points (Kremer et al. 2011). There is also some evidence of longer-term uptake of ceramic and biosand filters (Clasen 2009). Procter & Gamble ultimately withdrew its PUR (flocculant/disinfectant) product from the market when it did not achieve the uptake it expected, reaching about 15% in the Philippines and only 5% in Guatemala (Hanson and Powell 2006).

It should also be noted that most of the evidence to date on uptake and adoption of HWTS comes from research-driven trials. These are typically undertaken in special settings with a population suffering from high levels of diarrhoeal disease believed to be attributable at least in part to poor drinking-water quality. They often involve intensive campaigns at the beginning of the study to ensure that households use the HWTS product, a level of effort that cannot always be duplicated in implementation programmes. These studies also typically involve continuous water testing and observation of health indicators. These frequent follow-up visits may themselves increase household use and again cannot always be replicated in programmes implemented by governments, nongovernmental organizations and entrepreneurs (Zwane et al. 2011).

Two recent assessments of programmes by nongovernmental organizations to introduce household water treatment (HWT) among vulnerable populations demonstrate the challenges of achieving adoption and the corresponding lack of any measurable health impact.

First, Arnold et al. (2009) assessed the uptake and health impact of a three-year programme by nongovernmental organizations in Guatemala to promote HWT, including boiling, solar water disinfection (SODIS) and chlorination, and hand washing with soap (HWWS). The six-month study compared 600 households in 30 villages (15 intervention and 15 control). They found no statistically meaningful difference in adoption of intervention and control households for HWT (9% vs. 3%) or HWWS. Consistent with the low levels of adoption, the investigators found no difference between intervention and control villages in child diarrhoea, respiratory infections or child growth.

Second, Mausezahl et al. (2009) used a trial in 22 rural communities in Bolivia to evaluate the effect of SODIS in reducing diarrhoea among children under the age of 5. A local nongovernmental organization conducted a standardized interactive SODIS promotion campaign in 11 villages targeting households, communities and primary schools. Despite this extensive promotion campaign, investigators found only 32% compliance with the intervention and no strong evidence for a reduction in diarrhoea among children.

Issues have been raised too concerning the sustainability of some common HWTS options themselves, due to affordability and the need to ensure continuous supplies of consumables and replacement parts (Sobsey et al. 2008).

Finally, there is evidence that the health impact of some HWTS interventions diminishes over time (Arnold et al. 2007, Waddington et al. 2009, Hunter et al. 2009). This is a problem that is common among public health interventions that require users to change their behaviour in return for health benefits. For example, recent evidence suggests that adoption of oral rehydration solution (ORS) is falling from levels achieved a generation ago (Bowen, unpublished data, 2006).

Despite similar concerns surrounding HWWS, however, there is evidence that it has been able to achieve sustained adoption in some settings (Waddington et al. 2009). Many promoters of HWTS have therefore begun to follow successful hygiene-promotion strategies, such as delivery in schools, where children become change agents for influencing behaviour at home (O'Reilly et al. 2008).

Achieving high levels of adoption will depend in part on meeting the needs and aspirations of the users (Clasen 2009). Recent research in Bangladesh and Kenya has attempted to identify consumer preferences for HWTS options (Albert, Luoto and Levine 2010, Luoto et al. 2011). Filters ranked higher than disinfection products in terms of user preference, but there were no overwhelming preferences for any product, and microbiological performance did not always correspond with preferences.

There is increasing research on behaviour change and communication as applied to HWTS (Figueroa and Kincaid 2010). Curiously, much of the behaviour change research on HWWS or other hygiene behaviours have not been applied to encourage adoption of HWTS.

1.8 Summary of key messages

- **Household water treatment and safe storage (HWTS) is an essential component of a global strategy to provide safe water to the 780 million people who currently live without it, and the millions more who suffer from contamination of their improved water sources.**
- **Research and implementation experience suggest that HWTS:**
  - **dramatically improves microbiological water quality;**
  - **can significantly reduce diarrhoeal disease if used correctly and consistently by a vulnerable population;**
  - **is highly cost-effective; and**
  - **can be quickly implemented and taken up by vulnerable populations.**
- **The Millennium Development Goals (MDGs) commit to reduce by half the proportion of people without sustainable access to safe drinking-water by 2015. While progress is being made, current trends will still leave hundreds of millions without access to improved water sources by the target date. HWTS can contribute to the MDG water target while advancing other health and development goals.**
- **Providing safe, reliable, piped-in water to every household is an essential goal. However, the resources needed to construct, operate and maintain a piped community water supply system are not always available. HWTS can provide the health benefits of safe drinking-water while progress is being made in improving water supply infrastructure.**
- **Piped water systems and HWTS should not be viewed in competition with one another; rather, they are complementary and both play a role in providing safe water and improving health. Resources should not be diverted from piped systems to support HWTS programmes.**
- **HWTS should be targeted to the most vulnerable populations, including those with:**
  - **underdeveloped or impaired immune systems—children under 5, the elderly and people living with HIV/AIDS;**
  - **interrupted water supplies due to natural disasters, such as flooding or those displaced by war and conflicts; and**
  - **high exposure to contaminated water—families relying on surface or unprotected water supplies, including those living in remote rural areas and urban slums.**
- **HWTS is highly cost-effective compared to conventional water supply interventions. In addition to cost savings, there are health costs that can be avoided by both individuals and governments through the use of HWTS. When health-care savings are included, governments could reduce their overall expenditure by investing in HWTS rather than treating diarrhoeal disease.**
- **To realize the full potential of HWTS, it is essential that technologies perform well and are affordable. However, it is equally important that they reach the most vulnerable populations at scale (coverage) and these populations use HWTS correctly and consistently over the long term (adoption).**

1.9 Resources

- **Akvopedia**
  Web site: www.akvo.org/wiki/index.php/Main_Page
  Akvopedia is an open resource on water and sanitation that anyone can edit. The goal of Akvopedia is to improve water and sanitation projects through knowledge exchange on smart and affordable technical solutions and effective approaches. The Water Portal contains explanations on various household water treatment technologies.

- **Centre for Affordable Water and Sanitation Technology (CAWST)**
  Web site: www.cawst.org
  CAWST is a Canadian non-profit organization focused on the principle that clean water changes lives. CAWST believes that the place to start is to teach people the skills they need to have safe water in their homes. CAWST transfers knowledge and skills to organizations and individuals in developing countries through education, training and consulting services. One of CAWST's core strategies is to make water knowledge common knowledge. This is achieved, in part, by developing and freely distributing education materials, with intent of increasing their availability to those who need it the most. CAWST provides free open content training manuals, posters, learning activities and HWTS fact sheets. These materials are provided to workshop participants and interested organizations upon request and are available online.

- **WHO/UNICEF International Network on Household Water Treatment and Safe Storage**
  Web site: www.who.int/household_water/network/en/index.html
  The purpose of the International Network on Household Water Treatment and Safe Storage (hereafter referred to as "the Network") is "to contribute to a significant reduction in waterborne and water-related vectorborne diseases, especially among vulnerable populations, by promoting household water treatment and safe storage as a key component of community-targeted environmental health programmes". (WHO/UNICEF 2011a). The Network was established in 2003 by WHO, and UNICEF joined WHO as a co-hosting agency in 2011. The Network is composed of more than 100 organizations, including international, governmental and nongovernmental, as well as private sector entities and academia, that subscribe to the above mission. The Network's four main areas are: policy/advocacy, research/knowledge management, implementation/scale up and monitoring and evaluation . The Network aims to increase effective implementation and achieve scale. This requires more rigorous monitoring and evaluation, and it is hoped that this document will facilitate meeting these goals.

- **International Water and Sanitation Centre (IRC)**
  Web site: www.irc.nl
  IRC bridges the knowledge gap and joint learning with partners for improved, low-cost water supply, sanitation and hygiene in developing countries. IRC offers public access to a bank of information and interactive tools. In addition to more than 100 documents on water and sanitation, they provide the Source Water and Sanitation News Service, the Source Bulletin, a digital library, InterWater Thesaurus, and a question and answer service.

- **Johns Hopkins Bloomberg School of Public Health, Center for Communication Programs**
  Web site: www.jhuccp.org/
  The Center advances the science and art of strategic communication to improve health and save lives. They are a recognized leader in the field of health communication, with extensive technical expertise and programme experience in social and behaviour change communication. Researchers have published documents on social, cultural and behavioral correlates on household water treatment.

- **London School of Hygiene and Tropical Medicine (LSHTM)** – Web site: www.lshtm.ac.uk
  The School's mission is to contribute to the improvement of health worldwide through the pursuit of excellence in research, postgraduate teaching and advanced training in national and international public health and tropical medicine, and through informing policy and practice in these areas. LSHTM conducts extensive academic research on household water treatment and safe storage in developing countries.

- **Massachusetts Institute of Technology (MIT)**
  Web site: http://web.mit.edu/watsan/tech_hwts.html
  This web site offers information on HWTS and technologies, global water mapping, the International HWTS Network, methods for water quality field testing, and open content courses on Water and Sanitation Infrastructure in Developing Countries.

- **Oxfam** – Web site: www.oxfam.org.uk/resources/learning/humanitarian/watsan.html
  Oxfam is a humanitarian organization that acts as a catalyst for overcoming poverty. To achieve the greatest impact, it works on three fronts: saving lives by responding swiftly to provide aid, support and protection during emergencies; developing programmes and solutions that empower people to work their way out of poverty; and campaigning to achieve lasting change. Oxfam has developed emergency manuals and guidelines, as well as technical briefing notes on public health engineering topics, including household water treatment and storage.

- **Swiss Agency for Development and Cooperation (SDC)**
  Web site: www.poverty.ch/safe-water.html
  SDC's 2008 document *Marketing Safe Water Systems* provides unique insights—from the varied perspectives of users, disseminators, producers and retailers—into the marketing challenges of point-of-use treatment devices. It discusses the 5 Ps of marketing: Product, Price, Place, Promotion and People. As well, the document puts forward a mix of marketing and social marketing strategies that can raise the dissemination of household water treatment systems to the levels required for achieving the Millennium Development Goals.

- **United Nations Children's Fund (UNICEF)** – Web site: www.unicef.org/wes/
  Web site: www.unicef.org/wes/files/Scaling_up_HWTS_Jan_25th_with_comments.pdf
  UNICEF works in more than 90 countries around the world to improve water supplies and sanitation facilities in schools and communities and to promote safe hygiene practices. In emergencies, UNICEF provides urgent relief to communities and nations threatened by disrupted water supplies and disease. Its 2008 publication *Promotion of Household Water*

Treatment and Safe Storage in UNICEF WASH Programmes summarizes some of the leading approaches for treating water in the home, provides evidence of their effectiveness and cost-effectiveness in development and emergency settings, and outlines how promotion of HWTS can be incorporated with UNICEF programmes.

- **United States Agency for International Development (USAID)**
  Web site: www.ehproject.org/
  The Hygiene Improvement Project was a six-year USAID-funded programme (2004–2010) that sought to reduce diarrhoeal diseases and improve child survival through the promotion of three key hygiene practices: hand washing with soap, safe faeces disposal, and safe storage and treatment of household drinking-water. The web site remains available to share the resources developed by the project, but will no longer be updated. USAID is the largest bilateral donor supporting HWTS. On its web site are resources and materials developed by implementers, as well as a comprehensive bibliography on point- of-use water disinfection at: www.ehproject.org/ehkm/pou_bib2.html. There is also a link to a Google group on household water treatment.

- **United States Centers for Disease Control and Prevention (CDC)**
  Web site: www.cdc.gov/safewater
  CDC promotes the safe water system (SWS)—a water quality intervention that employs simple, robust and inexpensive technologies appropriate for the developing world. The objective is to make water safe through disinfection and safe storage at the point of use. CDC provides various publications including the *Safe Water System Handbook* and fact sheets on their programmes and various household water treatment options.

- **Water and Sanitation Program (WSP)**
  Web site: www.wsp.org
  WSP is a multi-donor partnership administered by the World Bank. The goal is to help the poor gain sustained access to improved water supply and sanitation services. WSP works directly with client governments at the local and national level in 25 countries through regional offices in Africa, East and South Asia, Latin America and the Caribbean, and in Washington DC, WSP focuses on five topics: “financing the sector”, “rural water supply and sanitation”, “strategic communications”, “sanitation and hygiene”, and “urban water supply and sanitation”. WSP offers the *Access Newsletter* and news updates to subscribers.

- **World Health Organization (WHO)**
  Web site: www.who.int/household_water/en/
  WHO works on aspects of water, sanitation and hygiene where the health burden is high, where interventions could make a major difference and where the present state of knowledge is poor. WHO has produced several documents related to HWTS that are available online. As well, WHO manages a water, sanitation and health listserv to subscribers.

WATER CONTAMINATION AND HOUSEHOLD WATER TREATMENT AND SAFE STORAGE OPTIONS

MODULE 2

2.1 INTRODUCTION

In considering options for household water treatment and safe storage (HWTS), many people simply want to be told the "best" technology or method. Unfortunately, there is no easy formula that will answer this question since there are many factors to consider. These include treatment effectiveness, appropriateness, acceptability, affordability, accessibility, use and sustainability. Some of these criteria for selection are described further in this module.

To select the most appropriate HWTS option, implementers need to know about water quality, as well as how different HWTS options work and their effectiveness against different contaminants. This module presents the different biological, chemical and physical contaminants commonly found in unsafe water.

At the outset, it is useful to understand some of the terminology used in describing the diseases, transmission routes and interventions associated with the water sector. Water-related diseases are sometimes classified according to their disease transmission routes as waterborne (ingested in drinking water), water-washed (associated with inadequate supplies of water for proper personal hygiene), water-based (transmitted through an aquatic invertebrate host) or linked to a water-related vector (involving an insect vector breeding in or near water) (White et al. 1972). Most waterborne organisms that are harmful (pathogenic) to humans colonize the gut of humans and certain other mammals and are transmitted through the faecal–oral route. The transmission of common waterborne diseases can thus be interrupted by improvements in sanitation (excreta disposal), personal hygiene (especially hand washing) and microbiological water quality, while those that are water-washed are impacted by improvements in water supplies (quantity and access) for personal hygiene. Improving water supplies can also help prevent water-based diseases, such as schistosomiasis and dracunculiasis, by reducing the need to enter infected water bodies.

HWTS only addresses water quality. As a result, it only offers the potential to prevent waterborne diseases. Nevertheless, as discussed more fully below, this represents a substantial share of the disease burden associated with water, including diarrhoea and enteric fevers.

2.2 What is safe drinking-water?

As water moves through the water cycle, it naturally picks up and carries many things along its path. Water quality will naturally change from place to place, with the seasons, and with the kinds of medium (rocks, soil, etc.) through which it moves. Water quality is also impacted by naturally occurring contaminants, including animal excreta.

Water can also be polluted by human activities, such as open defecation, improper waste management, poor agricultural practices (e.g. use of fertilizers or pesticides near water sources) and chemical discharges. In developing countries, an estimated 75% of all industrial waste and up to 95% of sewage is discharged into surface waters without any treatment (Carty 1991).

Even though water may look clear, it does not necessarily mean that it is safe or otherwise suitable for us to drink. It is important to judge the quality of water by taking the following three aspects into consideration:

1. BIOLOGICAL: bacteria, viruses, protozoa and worms.

2. CHEMICAL: minerals, metals and other chemicals.

3. PHYSICAL: temperature, colour, smell, taste and turbidity.

Different household water treatment technologies remove different types of contaminants to different levels. Understanding the local water quality and contaminants will influence the selection of appropriate household water treatment options.

The main focus of household water treatment is on removing biological pathogens. This is because biological pathogens such as rotavirus present the most significant health risk. However, some household water treatment options can also remove chemicals and improve physical qualities of drinking-water.

MICROBIOLOGY VERSUS EPIDEMIOLOGY

MICROBIOLOGY – The study of organisms that are too small to be seen with the naked eye. The three main classes of microbes that cause disease in humans are bacteria, viruses and protozoa.

EPIDEMIOLOGY – The study of the causes, distribution and control of disease in populations. It focuses on groups rather than individuals. Epidemiology developed out of the search for causes of human disease in the 19th century. One of its main purposes is to identify populations at high risk for a given disease, so that the cause may be identified and preventive measures can be taken. Epidemiologists may use their understanding of microbiology when they are studying diseases.

2.2.1 Biological quality

Water naturally contains many living things. Most are harmless or even beneficial, but others can cause illness. Living things that cause disease are also known as biological pathogens. They are sometimes also known as microorganisms, microbes or germs, depending on the local language and country.

The three main classes of biological pathogens that are commonly waterborne and represent the chief threats to health are bacteria, viruses and protozoa. Poor water quality is associated with a variety of infectious diseases transmitted by helminths, protozoa, bacteria and viruses. Table 2.2.1.1 summarizes the most important of these diseases, their etiological agents and epidemiological significance. Further details are provided in this section and following sections. Some of these diseases also contribute to malnutrition, a separate cause of substantial morbidity and mortality that is not reflected in the direct burden of disease figures cited below (Black et al. 2003).

2.2.1.1 Biological disease agents and burden

The major threat from biological pathogens is diarrhoea (Table 2.2.1.1). Diarrhoeal diseases kill an estimated 1.9 million people each year (WHO 2005). Among infectious diseases, diarrhoea ranks as the third-leading cause of both mortality and morbidity, after respiratory infections and HIV/AIDS, placing it above tuberculosis and malaria. Young children are especially vulnerable, bearing 68% of the total burden of diarrhoeal disease (Bartram 2003). Among children under 5 years, diarrhoea accounts for 17% of all deaths (WHO/UNICEF 2009). For those infected with the human immunodeficiency virus (HIV) or who have developed acquired immunodeficiency syndrome (AIDS), diarrhoea can be prolonged, severe and life threatening. Diarrhoea is the passage of three or more loose or liquid stools per day, or more frequently than is normal for the individual. It is usually a symptom of gastrointestinal infection, which can be caused by a variety of bacterial, viral and parasitic organisms (WHO 2012). The clinical symptoms and course of the disease vary greatly with the patient's age, nutritional status and immunocompetence, and the etiological agent infecting the intestinal system and interfering with normal absorption. Most cases resolve within a week, though a small percentage continue for two weeks or more and are characterized as "persistent" diarrhoea. Dysentery is a diarrhoeal disease defined by the presence of blood in the liquid stools (Blaser et al. 1995). Though epidemic diarrhoea, such as cholera and shigellosis (bacillary dysentery), are well-known risks, particularly in emergency settings, their global health significance is small compared to endemic diarrhoea.

While enteric fevers such as typhoid and paratyphoid were leading causes of waterborne disease in previous centuries, morbidity and mortality diminished dramatically with the provision of disinfected safe water supplies and improved sanitary facilities (Cutler and Miller 2005). The etiological agents for typhoid and paratyphoid fevers are *Salmonella typhi* and *Salmonella paratyphoid*. A recent review estimates 21 million cases of typhoid annually, causing 216 000 deaths (Crump et al. 2004). The milder paratyphoid accounts for an additional 5 million cases each year.

TABLE 2.2.1.1 PRINCIPAL INFECTIOUS DISEASES, DISEASE AGENTS, TRANSMISSION ROUTES AND ANNUAL MORBIDITY AND MORTALITY RELATED TO POOR DRINKING-WATER

Disease	Etiological agent	Morbidity	Mortality
Diarrhoea (dysentery, cholera)	Viruses *Rotavirus* *Norovirus* Bacteria *E. coli* *Shigella* sp. *Salmonella* sp. *Vibrio* sp. *Campylobacter* sp. Protozoa *Giardia lambia* *Cryptosporidium parvum* *Emtamoeba histolytic*	4 billion (annual)	1.8 million
Hepatitis A	Hepatitis A virus	1.4 million	unknown
Hepatitis E	Hepatitis E virus	20 million	70 000
Dracunculiasis	Guinea worm	< 2000	
Typhoid and paratyphoid fever	*Salmonella* sp.	26 million	216 000

Source: adapted from Clasen and Sugden, 2009

2.2.1.2 Infective dose

The minimum number of pathogens needed to cause illness in a person is called the infective dose. The presence of a pathogen in water does not always mean that it will make someone ill. The infective dose is different depending on the type of pathogen. Generally, bacteria have a higher infective dose than viruses and protozoa. This means that with some bacteria, larger numbers need to be ingested to cause illness relative to other pathogens.

Infants, young children, the ill and the elderly generally have a lower infective dose than an average adult. This means that they are most at risk and more likely to die from water-related diseases.

TABLE 2.2.1.2 DOSE OF MICROORGANISMS NEEDED TO PRODUCE INFECTION IN HUMANS ID50[1]

Disease	Pathogen	Type of pathogen	Disease-producing dose
Shigellosis	*Shigella* sp.	Bacteria	10–1000
Typhoid fever	*Salmonella typhi*	Bacteria	100 000
Cholera	*Vibrio cholerae*	Bacteria	100 000 000

Source: adapted from Ryan et al., 2003

[1] Infective dose is the dose necessary to cause disease in 50% of the exposed individuals, hence ID50. These numbers should be viewed with caution and cannot be directly used to assess risk since they are often extrapolated from epidemiologic investigations, best estimates based on a limited database from outbreaks, worst case estimates or other complex variables (United States Food and Drug Administration).

2.2.1.3 Indicator organisms

Testing for every pathogen in water would be time-consuming, complicated and expensive. Alternatively, the presence or absence of certain bacterial indicator organisms is used to determine the safety of the water, especially since there are no routine testing techniques available for viruses and protozoa. Bacterial indicator tests have been found to be cheaper, easier to perform and yield faster results compared to direct pathogen testing.

There is no universal indicator to ensure that water is pathogen free, but there are several types of indicators, each with certain characteristics. Coliform bacteria are most commonly used as indicators because they exist in high ratios to pathogens, making them easier to detect in a water sample.

The WHO *Guidelines for Drinking-water Quality* (2011) recommend *Escherichia coli* (also commonly known as *E. coli*) and thermotolerant coliforms and indicators of faecal contamination for verification of water quality. Rather than setting single limit values of indicators, WHO recommends using a risk-based approach to managing water quality. Health-based targets are one component of this framework, along with adequate and properly managed systems and a system of independent surveillance. Refer to Sections 2 and 3 of the WHO *Guidelines for Drinking-water Quality* for more information. See Section 3.4 for further information about the guidelines.

2.2.2 Chemical quality

Most chemicals arising in drinking-water are of health concern only after extended exposure of years, rather than months. There are different ways that chemicals get into drinking-water. Some are found naturally in groundwater, such as arsenic, calcium, fluoride, magnesium and sulphur. Human activities such as agriculture and industry can also add chemicals such as nitrogen, phosphorous and pesticides to water. Many countries are experiencing a rise in industrial activity with limited compliance to environmental rules and regulations. As a result, water sources are increasingly becoming contaminated with industrial chemical waste.

Chemicals in drinking-water can adversely impact certain household water treatment (HWT) methods. For example, excess organics in water can cause premature exhaustion of adsorption media such as carbon. Organics and other chemicals can also increase chlorine demand or otherwise affect the performance of halogen disinfection.

Even though there are many chemicals that may occur in drinking-water, only a few—such as arsenic and excess fluoride—cause health effects on a large scale. Other chemicals, such as nitrates and nitrites, may also be an issue in certain situations (WHO 2006).

Some commercial water treatment technologies are available for small applications for the removal of chemical contaminants. For example, anion exchange using activated alumina or iron-containing products will effectively reduce excess fluoride concentrations. Bone char has also been used to reduce fluoride concentrations. Arsenic can be removed

by anion exchange processes similar to those employed for fluoride. Nitrates and nitrates, which are frequently present due to sewage contamination or agricultural runoff, are best managed by protecting the source water from contamination. They are difficult to remove, although disinfection will oxidize nitrite, the more toxic form, to nitrate (WHO 2011). Further information on important chemical contaminants can be found in the WHO *Guidelines for Drinking-water Quality* and associated chemical fact sheets. Please refer to the WHO Water, sanitation, hygiene and health web site for the latest fact sheets (http://www.who.int/mediacentre/factsheets/en/).

> ***The great majority of evident water-related health problems are the result of microbial (bacterial, viral, protozoan or other biological) contamination. Nevertheless, an appreciable number of serious health concerns may occur as a result of the chemical contamination of drinking-water. (WHO 2011)***

2.2.2.1 Arsenic

Arsenic can naturally occur in groundwater and some surface water. WHO considers arsenic to be a high priority for screening in drinking-water sources (WHO 2006).

High levels of arsenic can be found naturally in water from deep wells in more than 30 countries, including Bangladesh, Brazil, Cambodia, El Salvador, India, Indonesia, the Lao People's Democratic Republic, Mexico, Nepal, Nicaragua, and Viet Nam. In South Asia alone, an estimated 60 million to 100 million people are affected by unsafe levels of arsenic in their drinking-water. Bangladesh is the most severely affected, where 35 million to 60 million of its 130 million people are exposed to arsenic-contaminated water. It is possible that arsenic may be found in other locations as more extensive testing is done.

Arsenic is poisonous, so if people drink water or eat food contaminated with arsenic for several years, they develop chronic health problems called arsenicosis. According to the United Nations Development Programme (UNDP 2006), the projected human costs over the next 50 years include 300 000 deaths from cancer and 2.5 million cases of arsenic poisoning.

There is currently no effective cure for arsenic poisoning; however, the health effects may be reversed in the early stages by removing the exposure to arsenic. The only prevention is to drink water that has arsenic levels within the safe limit. There are different HWT technologies that are able to remove arsenic from drinking-water to safe levels.

2.2.2.2 Fluoride

Fluoride is also a naturally occurring chemical that may be found in groundwater and some surface water.

High levels of fluoride can be found naturally in many areas of the world including, Africa, the Eastern Mediterranean and southern Asia. The best-known area with naturally occurring elevated levels of fluoride extends from Turkey through Iraq, Iran, Afghanistan,

India, northern Thailand and China. It is possible that fluoride may be found in other locations as more extensive testing is done.

Small amounts of fluoride are generally good for people's teeth. But at higher amounts over time, it can damage people's teeth by changing colour and through pitting. Eventually, fluoride can build up in people's bones and cause crippling skeletal damage. Infants and young children are most at risk from high amounts of fluoride since their bodies are still growing and developing.

There is currently no effective cure for fluoride poisoning. The only prevention is to drink water that has safe levels of fluoride. There are emerging household water treatment technologies that are able to remove fluoride from drinking-water. More research is needed to find a simple, affordable and locally available technology that can be easily used by households.

2.2.2.3 Nitrate and nitrite

Nitrate and nitrite are naturally occurring chemicals in the environment. Nitrate is commonly used in fertilizers and for agriculture, and nitrite is used as a food preservative, especially in processed meat.

Nitrate in groundwater and surface water is normally low but can reach high levels if there is leaching or runoff from agricultural fertilizers or contamination from human and animal faeces (WHO 2006). High nitrate levels are often associated with higher levels of microbiological contamination since the nitrates may have come from faeces.

High levels of nitrate and nitrite in drinking-water can cause methaemoglobinaemia, commonly called "blue baby syndrome". This occurs in infants that are bottle fed with formula prepared with drinking-water. It causes them to have difficulty breathing and their skin turns blue from a lack of oxygen. It is a serious illness that can sometimes lead to death.

2.2.2.4 Iron

Iron can be naturally found in groundwater and some surface water (such as creeks, rivers and some shallow dug wells). There are areas of the world that have naturally high amounts of iron in groundwater. Iron can also be found in drinking-water that is passed through rusty steel or cast-iron pipes.

Drinking-water with high concentrations of iron will not make people sick. Iron, however, can turn water a red-orange colour, and it may cause people to avoid piped water and choose another, possibly contaminated, water source.

Iron is a nuisance — high levels can cause an objectionable colour and taste and can stain cooked food, fixtures and laundry. As well, some types of bacteria feed on iron and leave slimy red deposits that can clog water pipes.

2.2.2.5 Manganese

Manganese can be naturally found in groundwater and surface water, and it usually occurs with iron. However, human activities may also be responsible for manganese contamination in water in some areas. People need small amounts of manganese to keep healthy, and food is the major source for people. However, too little or too much manganese can cause adverse health effects.

Manganese causes similar issues as iron. High concentrations can turn water a black colour, which may cause people to avoid it and choose another, possibly contaminated, water source. It also causes an objectionable taste, stains pipes and fixtures and laundry, and forms a coating on water pipes. As well, some types of bacteria feed on manganese and leave black-brown deposits that can also clog pipes.

2.2.2.6 Total dissolved solids

Total dissolved solids (TDS) are made up of inorganic salts (mainly sodium chloride, calcium, magnesium and potassium) and small amounts of organic matter that are dissolved in water. TDS in drinking-water comes from natural sources, sewage, urban runoff and industrial wastewater. Some areas of the world have naturally high amounts of TDS in their drinking-water.

Water with very high or low levels of TDS is often called “hard” or “soft” water, respectively. Hard water received this name because it requires more soap to get a good lather and makes the water “hard” to work with. Soap is less effective with hard water due to its reaction to the magnesium and calcium; this leads to high use of soap for laundry and bathing. As well, hard water can leave a residue and cause scale to build up on cooking pots and water pipes. People generally prefer the taste of hard water due to the dissolved minerals; however, very high concentrations of TDS can cause a bitter or salty taste.

Soft water is usually preferred for laundry, bathing and cooking. However, water with extremely low TDS concentrations (e.g. rainwater) may be unacceptable because of its flat taste.

2.2.3 Physical quality

The physical characteristics of drinking-water are usually things that can be measured with our senses: turbidity, colour, taste, smell and temperature. For this reason, these are also called aesthetic characteristics. Objectionable physical characteristics in water may cause people to resort to other water supplies that are unsafe. In general, drinking-water is judged to have good physical qualities if it is clear, tastes good, has no smell and is cool.

Like chemicals, water physicals can adversely impact certain HWT methods. For example, high turbidity can cause premature clogging of mechanical filtration technologies, such as ceramics, or interfere with chlorine, solar or ultraviolet disinfection. In addition, low

or high pH (acidity/alkalinity) and very cold temperatures can impact the performance of chlorine disinfection.

2.2.3.1 Turbidity

Turbid water looks cloudy, dirty or muddy. Turbidity is caused by sand, silt and clay. Suspended precipitates of iron can be found floating in the water. Drinking turbid water will not make people ill by itself. However, viruses, parasites and some bacteria can sometimes attach to the suspended particles in water. This means that turbid water usually has more pathogens, so drinking it increases the chances of becoming ill.

It is also important to remember that clear water does not necessarily mean that it is free of pathogens and safe to drink.

High turbidity levels reduce the efficiency of some household water treatment technologies, such as chlorination, solar disinfection (SODIS) and ultraviolet disinfection. Sand in water can also wear out pipes, valves and pumps ahead of their time.

2.2.3.2 Colour

Coloured water will not make people ill. However, it may cause people to not use the coloured water and choose another, possibly contaminated, water source. The following explain some of the different colours that may be found in water:

- Vegetation such as leaves, bark and peat can cause dark brown or yellow colour.
- Sand, silt and clay usually cause brown or red colour.
- Iron can cause orange or brown colour that can stain laundry and plumbing fixtures and gives water a bad taste.
- Manganese can turn water black and cause the same problems as iron.
- Algae can make water look bright green or blue-green and some forms produce toxins which can be harmful.
- Bacteria growth can also turn water black. These bacteria can also cause illness.

2.2.3.3 Taste and smell

Most people like to drink water that tastes and smells good. A bad taste or smell may indicate some sort of contamination, especially when a change happens quickly. In most cases, an unpleasant taste or smell will not make people ill. However, it is next to impossible to convince people that water is safe to drink if it tastes or smells bad. The following explain some of the different tastes and smells that may occur in water:

- Algae and some bacteria may cause an unpleasant taste and smell.
- High level of sulphate (SO_4) may cause a bitter or medicinal taste.
- Some bacteria can convert sulfate (SO_4) to form hydrogen sulphide (H_2S), which has a rotten egg smell.
- Iron can combine with tea, coffee and other beverages to produce a harsh, unacceptable taste.

- Chlorine has a distinct taste and may be present in treated water.
- Salinity can be due to saline intrusion.
- Rainwater has less taste than groundwater or surface water.

2.2.3.4 Temperature

Most people like to drink cool water instead of warm water. The desirable temperature is between 4 °C and 10 °C (39 °F–50 °F); people generally do not like to drink water that has a temperature above 25 °C (77 °F). Some bacteria can grow in warm water and may cause the water to taste, smell and look bad over time.

2.2.4 Drinking-water quality guidelines and standards

WHO publishes the *Guidelines for Drinking-water Quality* (2011) to help ensure that people are drinking safe water around the world.

The implementation of the WHO *Guidelines for Drinking-water Quality* varies among countries. There is no single approach that is used worldwide. The guidelines are recommendations to work towards and they are not mandatory limits.

WHAT IS THE DIFFERENCE BETWEEN STANDARDS AND GUIDELINES?

STANDARD—A mandatory limit that must not be exceeded; standards often indicate a legal duty or obligation.

GUIDELINE—A recommended limit that should not be exceeded; guidelines are not intended to be standards of practice or indicate a legal duty or obligation, but in certain circumstances they could assist in evaluation and improvement.

Countries can take the WHO guidelines into consideration along with the local environmental, social, economic and cultural conditions. This may lead to countries developing their own national standards that are quite different from the WHO guidelines. For example, in 2007, Nepal developed national drinking-water standards in which total coliform should be zero at least 95% of the time.

2.2.5 Safe versus improved water

It is important to distinguish between “safe drinking-water” and “improved drinking-water sources”. Water is considered “safe” for drinking if it is free of pathogens. The Millennium Development Goal (MDG) water target is expressed in terms of sustainable access to “safe” drinking-water. WHO recommends regular monitoring and water safety plans to help ensure that drinking-water is safe.

The WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) assembles information from national household surveys to monitor the progress of water and sanitation initiatives. Its focus, however, is not only on water quality but also on water quantity and access—issues that are also important for human health. For this reason—and because resources do not allow for the large-scale monitoring of water quality directly—JMP reports not on "safe drinking-water" but on "improved drinking-water sources". Such improved sources are designed to offer protection against contamination, in particular faecal matter. Table 2.2.5 lists sources that are considered "improved" and those that are "unimproved".

Table 2.2.5 What are improved and unimproved drinking-water sources?

Improved sources	Unimproved sources
• Piped water into dwelling, yard or plot	• Unprotected dug well
• Public tap or standpipe	• Unprotected spring
• Tube well or borehole	• Vendor-provided water
• Protected dug well	• Tanker-truck water
• Protected spring	• Surface water (e.g. river, stream, dam, lake, pond, canal)
• Rainwater collection	• Bottled water[a]

Source: WHO/UNICEF, 2010

a. Bottled water is a source of improved drinking-water only when another improved source is also used for cooking and personal hygiene; where this information is not available, bottled water is classified on a case by case basis.

There is evidence that certain improved sources deliver safer drinking-water than unimproved sources. However, it cannot be assumed that "improved" water sources provide water that is "safe". Many people who have access to improved water are still, in fact, drinking contaminated water (WHO 2007). This contamination can occur at the source or within a piped distribution system. This is in addition to the risk of contamination of water during collection, transport and storage in the home (Wright 2004).

The MDG target for safe water is to reduce by half the proportion of people without sustainable access to "safe drinking-water". Statistics concerning the number of people who drink unsafe water worldwide, and consequently the progress in achieving the MDG targets, are approximate. The WHO/UNICEF JMP household surveys and censuses do not provide specific information on the quality of water. Assessing drinking-water quality through national health and demographic surveys is considered to be too costly and time-consuming to be practical. The WHO/UNICEF JMP relies, instead, on proxy indicators such as "improved" water sources to indicate water quality.

2.3 Methods of household water treatment

2.3.1 Water source protection

Before addressing methods of treating water at the household level, it is important to emphasize the need to use the best possible source of water. There are many ways in which pollution can threaten drinking-water quality at the source, or point of collection. These risks include the following:

- poor site selection,
- poor protection of the water source against pollution,
- poor structure design or construction,
- deterioration or damage to structures,
- lack of hygiene and sanitation knowledge and practice in the community.

Protecting the water source reduces or eliminates these risks and can lead to improved water quality and health. Actions that can be taken at the community level can include some of the following:

- regularly cleaning the area around the water source,
- moving latrines away from and downstream of water sources,
- building fences to prevent animals from getting into open water sources,
- lining wells to prevent surface water from contaminating groundwater,
- building proper drainage for wastewater around taps and wells,
- stabilizing springs against erosion and protection from surface run-off contamination,
- ensuring watershed use is non-polluting.

The use of water safety plans provides a systematic means to address drinking-water safety from catchment to consumer, and thus can be a useful instrument to determine when and where HWTS is most appropriate. Water safety plans are the most effective approach to ensure consistent supplies of safe drinking-water by requiring the identification, prioritization and management of risks to drinking-water safety before problems occur (Bartram et al. 2009, WHO 2012). It also requires regular monitoring of the control measures put in place and periodic review of the water safety plan to ensure that the control measures continue to work and the water safety plan as a whole is effective and remains up to date. Water safety planning draws on the principles and concepts of sanitary inspections, the multiple-barrier approach, and hazard assessment and critical control points (as used in the food industry) (WHO/IWA 2011). Water safety plans can be adapted to all water supply types, from point sources to large piped systems, in existing to new systems and in all socioeconomic settings.

2.3.2 Sedimentation

Sedimentation is a physical treatment process used to reduce the turbidity of the water. This could be as simple as letting the water settle for some time in a small container, such as a bucket or pail.

The sedimentation process can be accelerated or "assisted" by adding special chemicals or native plants, also known as coagulants, to the water. Coagulants help the sand, silt and clay join together and form larger clumps, making it easier for them to settle to the bottom of the container.

The common chemical coagulants used are aluminium sulphate (alum), poly-aluminium chloride (also known as PAC or liquid alum), alum potash and iron salts (ferric sulphate or ferric chloride). Native plants are also traditionally used in some countries, depending on the local availability, to help with sedimentation. For example, prickly pear cactus and moringa seeds have been used to help sediment water.

2.3.3 Filtration

Filtration is also commonly used to reduce turbidity and remove pathogens. Filtration is a physical process that involves passing water through filter media. Some filters are also designed to grow a biological layer that kills or inactivates pathogens and improves the removal efficiency.

Sand and ceramic are common filter media, although membranes and other media can also be used. Various types of filters are used by households around the world, including:

- biosand filters,
- ceramic pot filters,
- ceramic candle filters,
- membrane filters.

Other filters use media such as activated carbon that adsorb and hold contaminants like a sponge rather than mechanically remove them like a sieve. The capacity of these filters is used up once the adsorption sites become fully occupied.

2.3.4 Disinfection

Another approach to treating water in the home is to kill or inactivate pathogens through disinfection. The most common methods used by households around the world to disinfect their drinking-water are:

- chlorine disinfection,
- solar disinfection (SODIS),
- ultraviolet (UV) disinfection,
- boiling.

As noted above, when water has high levels of turbidity, pathogens "hide" behind the suspended particles and are difficult to kill using SODIS and UV disinfection. Reducing turbidity by sedimentation and filtration will improve the effectiveness of these disinfection methods. The effectiveness of chlorine disinfection is also impacted by pH, chlorine demand and temperature. The effectiveness of boiling is not impacted by the chemical or physical condition of the water.

Distillation is another method of using the sun's energy to treat drinking-water. It is the process of evaporating water into vapour, and then capturing and cooling the vapour so it condenses back into a liquid. Any contaminants in the water are left behind when the water is evaporated.

2.3.5 Safe water storage

Households do a lot of work to collect, transport and treat their drinking-water. Even after the water is treated, it should be handled and stored properly to keep it safe. If it is not stored safely, the treated water quality could become worse than the source water and may cause illness.

Recontamination of safe drinking-water is a significant issue. The risk of diarrhoea due to water contamination during household storage, first noted in the 1960s, has since been repeatedly observed by others (Wright, Gundry and Conroy 2004).

Distributing and using safe storage containers have shown substantial reductions in diarrhoeal disease (Roberts et al. 2001). Safe storage means keeping treated water away from sources of contamination and using a clean and covered container. It also means drawing water from the container using a tap or pouring it through a narrow opening in a way that will not cause contamination. The container should prevent hands from touching the water. There are many designs for water containers around the world. A safe water storage container should:

- have a strong and tightly sealing lid or cover,
- have a tap or narrow opening at the outlet for access,
- have a stable base so it does not tip over,
- be durable and strong,
- be easy to clean.

A good safe storage container should also have instructions on how to properly use and maintain it. Other safe water handling practices include:

- using a container for collecting and storing only untreated water,
- using a separate container for storing only treated water,
- regularly cleaning the storage container with soap,
- storing treated water off the ground,
- storing treated water away from animals,
- pouring treated water from the container instead of scooping the water out of it,
- using the water as soon as possible after it is treated, preferably on the same day.

Sometimes it is difficult for rural and poor households to find or buy good storage containers. The most important thing are to make sure that people do not put their hands into the water.

2.4 Technology selection

Decision-making and technology selection can take place at many levels, ranging from central governments to independent programme implementers to the individual households.

There is no one right way to make decisions, and they are often made pragmatically based on the information and resources available. Decision-making can take place informally and subconsciously by individuals, or it can be a formal process undertaken by the stakeholders.

2.4.1 What is the best technology?

Many people simply want to be told the "best" technology for household water treatment. Unfortunately, there is no easy formula that will answer this question since there are many factors to consider.

First of all, it is important to remember that household water treatment is a process and not just a single technology. It is not easy to know which combination of technologies is the most appropriate. Many measures have the potential to improve water quality, each with its advantages and limitations depending on the local circumstances. Different technologies have varying suitability under each situation.

The "best process" ought to be driven by a number of factors, including treatment effectiveness based on the source water quality and local contaminants, appropriateness, affordability, and acceptability for sustainable use by poor households.

Since the household water treatment process is dependent on so many different factors, there can be no standard solution. However, decision-making tools are available to help identify the HWTS process that is best suited for the local context.

The tools are participatory activities that encourage the involvement of different stakeholders in a group process. Participants can actively contribute to decision-making, rather than passively receiving information from outside experts, who may not have an understanding of the local issues.

Participatory activities are designed to build self-esteem and a sense of responsibility for one's decisions. Experience shows that when everyone contributes to the decision-making process, people feel more ownership of the problem and develop more appropriate

solutions for their situation. Participatory decision-making can empower communities to implement their own HWTS improvements.

2.4.2 Criteria influencing technology choice

There are several criteria that one should take into consideration when deciding which household water treatment technology is most suitable. Some of these include:

1. ***Effectiveness***—How well does the technology perform?
2. ***Appropriateness***—How well does the technology fit into people's daily lives?
3. ***Acceptability***—What will people think of the technology?
4. ***Cost***—What are the costs for the household?
5. ***Implementation***—What is required to get the technology into people's homes?

Each of these criteria is described in the following sections. Other criteria that are important to the stakeholders can also be added. For example, to the extent that the technology involves a product such as chlorine or filters that involve consumable components, sustainability must be considered.

2.4.2.1 Effectiveness

Effectiveness is the ability of the technology to provide sufficient water quality and quantity. There should be enough safe drinking-water for a household to meet its basic needs. Criteria that show the technology's effectiveness include the following:

- **Water quality**
  - Which microbiological, physical and chemical contaminants can be removed by the technology and how much?
- **Water quantity**
  - How much water can be provided every day?
  - Is it sufficient to meet the household's daily needs?
- **Local water source**
  - Will the technology be able to treat the specific microbiological, physical and chemical contaminants of the local water source?
  - Will it treat water from different sources to the same level?

For details on microbiological effectiveness, refer to WHO's *Evaluating household water treatment options: health-based targets and microbiological performance specifications* (2011).

2.4.2.2 Appropriateness

Some technologies will be more suitable than others depending on the needs and conditions of the community. Answering the following criteria can help to match a technology with a particular community:

- **Local availability**
  - Can the technology be manufactured in or near the community using local materials and labour?
  - Does the technology need imported spare parts or consumables?
  - Is it possible to buy spare parts or consumables locally?
  - Is the supply chain reliable?
- **Time**
  - How long does it take for a household to treat enough water to meet their daily needs?
  - Does it significantly add to the household's labour burden?
- **Operation and maintenance**
  - What are the household's responsibilities to operate and maintain the technology?
  - Is it easy and convenient for women and children to use the technology?
- **Lifespan**
  - How long will the technology last before it needs to be fixed or replaced?

2.4.2.3 Acceptability

People's opinion about the technology will affect its widespread adoption and consistent use. It is difficult for many people to accept a new technology until they personally experience the benefits. People's acceptance of a technology is affected by the following criteria:

- **Taste, smell and colour**
  - How will the treated water look, taste and smell?
  - Needs and motivations?
  - What benefits will the technology give to people?
  - Will it provide convenience, health improvement, social status, time or money savings?

2.4.2.4 Cost

Most HWTS options are not free. The following costs need to be considered:

- **Capital costs**
  - Initial purchase of a durable product.
  - Transportation.
- **Ongoing costs**
  - Continuing purchase of consumable products.
  - Operation and maintenance.
  - Potential repair and replacement parts
- **Willingness to pay and affordability**
  - Can households afford the full cost of the technology?
  - Are households willing to pay for capital costs?
  - Are households willing to pay for on-going operation and maintenance costs?

- How is technology impacted by household income fluctuations?
- Do durable or consumable items need to be subsidized?

- **Implementation costs**
  - Cost to run the programme (e.g. staff, office space).
  - Cost to raise awareness in the community.
  - Cost to educate people about how to use the technology.
  - Cost to provide ongoing support for households.

Successful cost recovery is an important part of the programme sustainability. Implementers need to consider how the costs can be recovered—whether from households, donors, government or others. It is important to figure out who is financially responsible for which costs, and over what period of time.

2.4.2.5 Implementation

There are several factors to consider about how the technology is implemented:

- How is the technology manufactured and distributed to the households?
- Are local manufacturing and repair skills and spare parts available? If not, can these be made available?
- How fast can the technology be implemented?
- What training will the household require to properly use the technology?
- Who will help a household if they have a problem or question?
- What monitoring is required for the technology?
- What additional support is needed?
- Do households perceive the technology to be of benefit to them?
- How well can the technology be integrated into current government programmes, especially those targeting vulnerable groups such as young children, people living with HIV/AIDs, and the malnourished?

2.5 Summary of key messages

The first priority is to ensure that drinking-water does not pose a significant health risk. Household water treatment and safe storage (HWTS) is one particular option within a broader water safety plan to make water safer to drink. HWTS is not a substitute for sustainable access to safe drinking-water, but it does provide an interim measure for removing pathogens from drinking-water, particularly where access to clean and safe water supplies is not available.

- **Different household water treatment technologies have varying levels of performance in removing the main classes of pathogens.**

- **Many chemicals may be found in drinking-water; however, only a few cause health effects on a large scale, such as arsenic and fluoride. Water quality testing of the source can help to identify mitigation and treatment options for particular chemicals.**

- **The implementation of the WHO Guidelines for Drinking-Water Quality varies among countries. There is no single approach, and the guidelines provide a framework for comprehensively addressing drinking-water quality through a risk-based approach.**

- **Safe water and improved water do not mean the same thing. Improved water source is a source that is, by nature of its construction or through active intervention, likely to be protected from outside contamination, particularly from faecal matter. It is assumed that certain sources are safer than others, but not all improved sources in actual fact provide safe drinking-water.**

- **Using the multi-barrier approach may be necessary to adequately reduce water contamination and protect health. Water safety plans use the concept of the multi-barrier approach, the principles of which can be applied at both community and household levels.**

- **People often focus on a particular HWTS option rather than considering the water treatment process as a whole.**

- **There is no "best" technology for HWTS. There are many criteria to consider in the local context, including treatment effectiveness for the water source, appropriateness, acceptability, affordability and implementation requirements.**

- **There is no one right way to make decisions about HWTS selection. They are often made pragmatically based on the information and resources available.**

- **Governments should take an active role in ensuring that available HWTS products meet minimum criteria for pathogen removal.**

- **Given that sustained operation of HWTS depends on a number of factors, it is often preferable to allow consumers a variety of options, for which performance is satisfactory. This provides households and implementers with the freedom to make their own decisions and to choose the options that best suit them.**

IMPLEMENTATION OF HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

MODULE 3

3.1 INTRODUCTION

The objective of this module is to illustrate the diversity of household water treatment and safe storage (HWTS) implementation strategies and explain the components shared by successful programmes. Understanding what it takes to implement a HWTS programme will help governments and other organizations promote and support best practices in their countries.

A review of the implementation programmes worldwide shows that there is no standard approach for successful HWTS implementation. There are a wide variety of organizations using different HWTS options and a diverse range of programmes, from emergency response to long-term development. While there is no one standard implementation model, many of the programmes do address the following key components, which make them more likely to succeed:

1. **Creating** demand for HWTS.
2. **Supplying** the required HWTS products and services to meet the demand.
3. **Monitoring** and continuous improvement of programme implementation.

An organization's ability to plan and implement these components is determined by its human capacity (people) and financing (money and other resources). Successful programmes understand and integrate these supporting components into their planning and implementation.

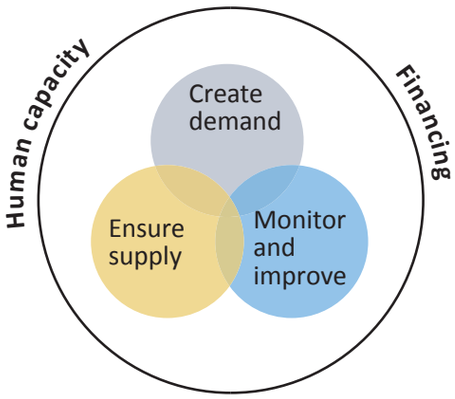


FIGURE 3.1 FRAMEWORK FOR HWTS IMPLEMENTATION

The following sections discuss each of these framework elements in more detail. Case studies are also used to illustrate the diversity of implementers and their approaches.

Implementation is the process of creating and following a plan to execute a HWTS programme. It also includes monitoring and evaluating the results of the programme.

3.2 Creating demand

Creating demand requires awareness and education to convince households of the need and benefits of HWTS so that it is desired and sought after. Creating demand also requires understanding the drivers for the use of HWTS, social norms and cultural habits. Demand exists when people need and want HWTS and have the opportunity and ability to practise it correctly and consistently. It is critical that households actually want and value HWTS; this helps ensure it will be used over the long term.

Ultimately all HWTS implementation programmes want to make a change—improving health by increasing the number of people who consistently drink safe water. For anything to change, people have to start acting differently, such as treating water in their homes. The challenge of changing people's behaviour, and subsequently creating demand for HWTS, is significant for implementers—requiring time, sustained investment and a range of strategies. Many successful implementers use the following steps to create demand for HWTS:

Plan	1. Identify a target population that would benefit from HWTS and spend time understanding the overall context. 2. Select an appropriate target population based on risk factors and practices. 3. Select a suitable and feasible HWTS option.
Initiate, pilot	4. Increase awareness of HWTS as a solution for safe water and educate people on the relationship between water and health. 5. Use demonstration projects to convince people of the benefits of HWTS and increase their self-efficacy. 6. Engage government agencies and/or community leaders to give credibility to HWTS.
Sustain, expand	7. Provide positive reinforcement to households so they continue using HWTS.

Each step is discussed in more detail in the following sections.

The piloting phase is especially important. Before scaling up, many organizations gain significant benefit from first implementing a small pilot project to establish processes, learn from experience, get household feedback, ensure quality of service, and demonstrate results and their capability to potential funders.

3.2.1 Identify and understand the target population

Implementers should identify a target population during their programme planning. Implementers should strategically focus on people who are most vulnerable from unsafe water, including those who:

- have low immune systems, such as children under the age of 5, the ill (including people living with HIV/AIDS) and the elderly;
- suffer from diarrhoeal diseases and other illnesses which can be prevented through water, hygiene and sanitation programmes;
- use surface water and shallow wells which are more likely to be contaminated by pathogens;
- live in areas susceptible to flooding, in areas of poor hygiene and sanitation, and in places experiencing conflict or other emergencies

Implementers should then spend the time necessary to gain a thorough understanding of the overall conditions of the target population and their knowledge, attitudes and practices relevant to water, sanitation and hygiene. Implementers can often find initial success by working with households likely to adopt HWTS and that have the organizational capacity for this. It is easier to start implementation in an area where people already have self-identified a need and motivation to adopt healthier behaviours.

3.2.2 Select HWTS options

Many organizations select only one HWTS option to implement. Often this approach is one favoured by the implementer or its funding organization and is selected in advance, with little input from the target community or assessment of the prevailing conditions.

Implementers should make their decision on the HWTS solution for the target population using the criteria presented in Module 2:

1. ***Effectiveness***—How well does the technology perform?
2. ***Appropriateness***—How well does the technology fit into people's daily lives?
3. ***Acceptability***—What will people think of the technology?
4. ***Cost***—What are the costs for the household?
5. ***Implementation***—What is required to get the technology into people's homes?

It is believed that demand can be increased by providing more HWTS options and allowing households to choose from a range of products at a number of price points (UNICEF 2009, Clasen 2009). Generally, the greater involvement households have in selecting their HWTS, the greater their understanding and motivation for using it.

People can, however, be easily overwhelmed if there are too many choices. Difficulty in making a decision may lead to people not taking any action at all and continuing to drink unsafe water. Households often need someone to help them make a decision by suggesting a good place to start. Some implementers help people decide what is most appropriate for their situation through education, training, communications and marketing.

3.2.3 Increase awareness and knowledge

Implementers need to increase awareness and knowledge to motivate people to take action. Promotional activities are used to create awareness and encourage people to learn more about the risks associated with unsafe drinking-water, how water becomes contaminated and the solutions for getting safe drinking-water. Education increases their knowledge of the relationship between water and health and the available HWTS options. Both are needed to motivate individuals to act differently and integrate HWTS into their daily routine. Promotion and education efforts must be specific for the target population.

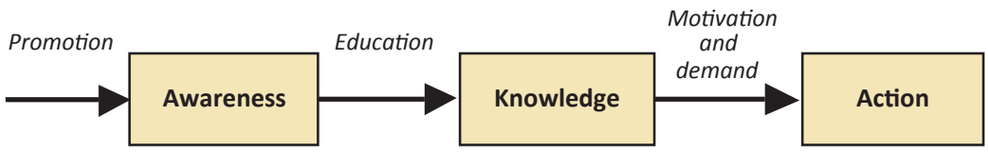


FIGURE 3.2.3 INCREASING AWARENESS AND KNOWLEDGE

3.2.3.1 Promotion to create awareness

Promotional activities are generally targeted at a wide range of individuals, with the understanding that those most interested will step forward. It lends itself to the use of mass media communication channels such as television, radio, newspaper, billboards and street dramas. Mass media campaigns usually focus on a few key messages for the general public, such as:

- "Dirty water can make you sick."
- "Clean water makes you healthy."
- "You can treat dirty water at home to get clean water."

Mass media can be very timely (e.g. raising awareness about cholera just before the rainy season) and can reach a large audience with limited human resources. However, mass media should be quickly followed by education to further motivate people to take action. Mass media alone is less effective for long-term change because it provides only one-way communication. As well, it may only reach selected audiences, such as wealthy households, who may be the only ones owning a television or radio.

3.2.3.2 Education to increase knowledge

People need to be educated about three issues in order to begin treating water in their homes:

1. Why use HWTS.
2. What to do to get HWTS.
3. How to use HWTS.

Community health promoters are critical to successful implementation by helping households learn about the need for safe water and HWTS. They are local people who are trusted and respected, giving credibility to HWTS, such as nurses, teachers, women's group leaders, community leaders and elders.

AN EDUCATION-FIRST APPROACH TO SAFE WATER—CERAMIC FILTERS, THIRST-AID, MYANMAR

Thirst-Aid's goal is to make knowledge of household water treatment as common as how to cook rice or fry an egg. It uses education and knowledge to inspire the drive for safe water to come from within the community before introducing HWTS.

The organization creates demand by using education and knowledge as investment capital. Its approach is based on the assumption that educated people do not willingly drink contaminated water—much less give it to their children.

Thirst-Aid provides the currency for community buy-in by issuing *Certificates of Knowledge* upon successful completion of its educational programme. These certificates serve as legal tender that can be later used for the purchase of HWTS.

(Bradner, personal communication, July 2010)

Studies show that people are more likely to treat water if they understand the relationship between water and health and have some knowledge of safe water practices (Kraemer and Mosler 2010, Brown et al. 2007). However many people around the world do not understand the relationship between water and health. Traditional norms, and beliefs that diarrhoea is not a disease or that it is caused by supernatural powers, are often mentioned by implementers as reasons for the lack of demand. Other implementers have found that people believe that since they have been drinking the water for a long time, they have immunity and do not need to treat it (Heri and Mosler 2008, Graf et al. 2008, Clasen 2009).

Choosing the most appropriate key messages and communication channels is essential for appealing to the beliefs and motivations of the target audience. For example, community health promoters may arrange for house-to-house visits and meetings with women's groups to reach mothers, while street theatre may be more effective in reaching fathers and youth.

Some argue that person-to-person communication is too resource intensive and not scalable and should therefore be limited to areas where the reach of mass media is unavailable (Parker 2009). However, many implementers report that group meetings and household visits done by community health promoters is the most successful strategy to educate people and support them to adopt HWTS. Acceptance, adoption and long-term use is more likely and, in addition, it helps create "word-of-mouth education" beyond the investment of the project—resulting in further potential scale-up.

USING APPROPRIATE COMMUNICATION CHANNELS—CHLORINE, AFGHANISTAN

In Afghanistan, men primarily learn about safe water though mass media channels such as television and radio. Women, however, generally learn about chlorine products through friends, neighbours and other person-to-person interactions. Given that men often control a family's finances and that women usually prepare the household's water, targeting both genders is critical for programme success.

3.2.4 Use demonstration projects

Seeing is believing. A demonstration project allows people to see and experience the benefits of HWTS for themselves. Doing a small demonstration project at the beginning of a programme is a good strategy for implementers. It helps to generate interest and create demand before the programme is scaled up.

SEEING IS BELIEVING—BIOSAND FILTERS, HAITI

Implementers have reported that when people observe the benefits their neighbours have with HWTS, they want the same thing for themselves.

A study by Moser et al. (2005) showed that people who saw others using solar water disinfection (SODIS) were more likely to use the technology themselves, thus leading to an overall higher percentage of SODIS use.

Clean Water for Haiti initially placed biosand filters in schools, health centres, churches and the homes of community leaders to demonstrate the technology. People were able to see for themselves that the filtered water was better, and that there were improvements in people's health. The success of the demonstration helped convince people to adopt filters. To date more than 10 000 households have had biosand filter installed, and demand outstrips the organization's ability to supply the filters.

(Dow Baker et al. 2008)

The best locations to set up a demonstration are generally public and community institutions, such as schools and health clinics. These locations highlight leadership from those in authority and give credibility to the programme. It is also a way for implementers to gain access to some of the most vulnerable populations—young children and those suffering from illness.

In a school situation, the effectiveness of HWTS can be demonstrated, and teachers can also receive training in safe drinking-water, sanitation, hygiene and HWTS to share with their students. Once youth have knowledge about the importance of safe drinking-water and the solutions available, they pass the messages on to their parents and encourage action at home.

Similarly, demonstrations in health clinics can be coupled with education for health workers, who pass the information on to their patients and clients. Outreach through clinics directly reaches the children under 5 years of age, who experience the highest rates of illness and death from diarrhoea, and mothers who are concerned about their family's health and looking for solutions.

HWTS options are usually given to schools and clinics at no cost. Letters of agreement or contracts have been used successfully to ensure that they agree to the proper operation and maintenance of the HWTS products. Some programmes also provide free HWTS for teachers and health workers to use at home.

EDUCATING COMMUNITIES THROUGH SCHOOLS AND HEALTH CLINICS—CHLORINE, KENYA

CARE-Kenya implemented a school-based safe water and hygiene intervention in rural schools. Schools were provided with safe water storage containers, WaterGuard (chlorine) and hand-washing stations. The programme was evaluated to assess its impact on students' knowledge and on parents' adoption of safe water and hygiene practices in the home. The approach showed promise for passing on messages from student to parent to promote water and hygiene interventions at home (O'Reilly et al. 2008).

In another study, nurses in a maternal and child health clinic were trained in chlorination using WaterGuard and proper hand washing. They were asked to communicate this information to their clients. Interviews with clients immediately following the training found that 76% reported being taught both chlorination and hand washing during their clinic visit.

(Parker et al. 2006)

3.2.5 Engage government agencies

Acknowledgement and support from government are required to help increase demand over time. Endorsements from government agencies give credibility to HWTS and implementers.

Implementers should be proactive and take steps to engage all levels of government—local, regional and national. HWTS can cross a range of sectors (such as health, water and sanitation, rural development, and education), so officials from each of these areas should be involved. Engaging government officials can be accomplished by educating them about the benefits of HWTS and showing how it can leverage their own efforts in providing services (Clasen 2009).

In Nepal, the government is very active in HWTS promotion. It coordinates the development of HWTS promotion materials and messaging with implementing organizations. The government of the Lao People's Democratic Republic also works closely with implementers to promote various HWTS options, including boiling, chlorine, SODIS and biosand filters. Nepal also provides training through its government extension system and is involved in the joint production of education materials with implementers (SODIS 2010).

A number of governments (including Cambodia, Indonesia, Nepal and the Philippines) have also drafted HWTS guidelines to encourage implementation and endorse product quality.

3.2.6 Provide positive reinforcement

Positive reinforcement is critical after HWTS has been introduced in the home. People need encouragement and support as they learn to incorporate HWTS into their daily routines. They often have questions or need to be reminded how to properly use and maintain their HWTS product.

One of the greatest challenges for implementers is to follow up with households in a timely manner to monitor and reinforce the use of HWTS. Many implementers have successfully used community health promoters to reinforce key messages and practices. Community health promoters visit with households and organize group activities to help people treat their water, provide troubleshooting, and answer questions.

NEED FOR CONTINUOUS REINFORCEMENT—SODIS, BOLIVIA

A study of SODIS in Bolivia observed that altering existing habits and developing new ones is a difficult and long process. It recommended regular monitoring and follow-up with new users over a long period of time to support and reinforce using SODIS.

(Moser et al. 2005)

3.3 Supplying requires products and services

Households need both HWTS products and support services to ensure proper and consistent use over the long term. This requires significantly more effort on the service component or "software" than has traditionally been the case in the water and sanitation sector.

Implementers must work towards supplying both high-quality products and services to create demand and then meet that demand. Many organizations choose to do a small pilot project to establish their processes, learn from experience, and ensure quality control of products and services before scaling up their programme.

While there are successful stories of large-scale supply of household water treatment (HWT) products, many organizations rely on localized supply. Supply chains which use locally available resources, supply routes, fabrication and people (for labour, education and follow-up) are often used as they can:

- Create local knowledge and skills that empower beneficiaries to meet their own needs.
- Aid demand creation and sustainable supply.
- Allow more gradual expansion, since implementation can be limited to a predefined area.
- Reach areas that are difficult to access via existing commercial means.

3.3.1 Products

Several HWTS methods have been proven to significantly improve drinking-water quality in the laboratory and in field trials in developing countries (Clasen et al. 2007, WHO 2011b). These HWTS methods include filtration, chemical disinfection, disinfection with heat (boiling and pasteurization) and flocculation/disinfection. In addition, a combination of these methods may be used to increase the efficacy of treatment. A summary of microbial removal performance and the advantages and limitations of each method is provided in Table 3.3.1a (see pages 52–53). In addition to those listed, safe water storage containers are critical products that households should also have.

HWTS options can also be divided into consumable and durable products, each requiring different implementation strategies to make them affordable and available (Table 3.3.1b).

TABLE 3.3.1b COMPARISON OF CONSUMABLE AND DURABLE HWTS PRODUCTS

Consumable products	Durable products
• Need to be constantly replenished • Have little to no capital costs, but regular recurrent costs • Should be self-sustaining without subsidies • Implementation (distribution and marketing) is similar to commercial products • Lend themselves to private-sector implementation	• One-time or infrequent purchase • Have relatively high capital costs but lower recurrent costs • Initial capital costs may be subsidized • Implementation is similar to community development or infrastructure programmes • Lend themselves to implementation by non-governmental organizations and governments

Consumable products, such as alum or chlorine, need to be replenished on a regular and continuing basis (e.g. weekly or monthly). As such, they have recurrent costs but generally no capital costs. Durable products are an occasional or one-time purchase (e.g. ceramic filter elements need to be replaced every one to two years; biosand filters can last a lifetime). They have a relatively higher capital cost than consumable products and minimal recurrent costs.

Boiling fits into its own category. Most households already have all they need to boil their water—a cooking pot and fuel. As a result, boiling is the one HWT method that can be immediately taken up and used without setting up a supply chain for consumables

Table 3.3.1 a Summary of microbial removal performance, advantages and limitations

METHOD	Removal performance (log removal)[a]	ADVANTAGES	LIMITATIONS
Filtration (ceramic)	• Bacteria: 2–6 • Protozoa: 4–6 • Viruses: 1–4	– Simple to use – Visual improvement in treated water – Possibility of local production benefits economy – One-time capital cost	– Lack of residual protection presents potential for recontamination (although products increasingly address this through attached safe storage containers) – Variability in quality of locally produced filters – Filter breakage requires reliable supply chain – Need to regularly clean filters and receptacles – Low flow rate of 1–3 litres per hour (slower in turbid waters) – Potential user taste objections
Filtration (slow sand filtration, i.e. biosand)	• Bacteria: 1–3 • Protozoa: 2–4 • Viruses: 0.5–2	– High flow rate (~ 20 litres per hour) – Simple to use – Visual improvement in treated water – Production from locally available materials – Longer life – One-time capital cost	– Lack of residual protection presents potential for recontamination – Difficulty in producing and transporting heavy concrete and plastic (45–160 kg) filter housing and sand – Need for periodic cleaning and difficulty in assessing when cleaning is needed
Filtration microfiltration [MF], ultrafiltration [UF], nanofiltration [NF], reverse osmosis [Ro])	• Bacteria: 2 MF; 3 UF, NF or RO –4 MF; 6 UF, NF or RO • Protozoa: 2 MF; 3 UF, NF or RO –6 MF, UF, NF or RO • Viruses: 0 MF; 3 UF, NF or RO –4 MF; 6 UF, NF or RO	– Visual improvement in treated water – Potential longer life if spare parts are accessible – One-time capital cost	– Lack of residual protection presents potential for recontamination (although methods increasingly address this through attached safe storage containers) – Need for multiple steps to use the product, requires additional user support – Requires reliable supply chain for spare parts

METHOD	Removal performance (log removal)[a]	ADVANTAGES	LIMITATIONS
Combined flocculant/ disinfectant powders	• Bacteria: 7–9 • Protozoa: 3–5 • Viruses: 4.5–6	– Reduction of some heavy metals (e.g. arsenic) and pesticides – Residual protection against recontamination – Visual improvement in treated water – Small sachets are easily transported due to size, non-hazardous classification, long shelf life	– Need for multiple steps to use the product, requires additional user support – Requires reliable supply chain – Most appropriate in areas with high turbidity – Higher relative cost per litre treated
Thermal (boiling and pasteurization)	• Bacteria: 6–9+ • Protozoa: 6–9+ • Viruses: 6–9+	– Existing presence in many households of materials needed to boil water – Sociocultural acceptance of boiling for water treatment in many cultures	– Lack of residual protection presents potential for recontamination – Potential for burn injuries and increased risk of respiratory infections from indoor stoves or fires – Potentially high cost of carbon-based fuel source (with concurrent deforestation risk) and the opportunity cost of collecting fuel – Potential user taste objections
Solar disinfection (solar disinfection + thermal effect)	• Bacteria: 3–5+ • Protozoa: 2–4+ • Viruses: 2–4+	– Simple to use – No cost to the user after obtaining the plastic bottles – Minimal change in taste of the water – Minimal likelihood of recontamination because of safe storage	– Need for pretreatment (filtration or flocculation) of waters of higher turbidity – Volume to treat dependent on availability of clean, intact plastic bottles – Lack of visual improvement in water aesthetics to reinforce benefits of treatment – Relatively longer time to treat water and variability depending on sun intensity (12–48 hours)
Chlorination	• Bacteria: 3–6 • Protozoa: 3–5 (non-*Cryptosporidium*) • Protozoa: 0–1 (*Cryptosporidium*) • Viruses: 3–6	– Residual protection against recontamination – Simple to use – Possibility of local production benefits economy – Low cost	– Lower removals in turbid waters – Potential user taste and odour objections – Requires reliable supply chain – Necessity of ensuring quality control of product – Misunderstanding about the effects of chlorination by-products

[a] The range of removals represents baseline (i.e. in the field by a relatively unskilled operator) to maximum documented removals. Removal may also be expressed in terms of per cent reduction: 90% = 1 log, 99% = 2 log, 99.9% = 3 log, 99.99% = 4 log, 99.999% = 5 log, 99.9999% = 6 log, etc.

or durables. Perhaps for this reason, boiling is by far the most common means of treating water at the household level; an estimated 1.6 billion people report that they usually drink boiled water (Rosa and Clasen 2010).

Moreover, boiling is the only HWT method that is fully effective against all waterborne pathogens in all types of water conditions. Boiling can be expensive compared to other options, and boiled water must be stored safely to prevent recontamination. Nevertheless, boiling is the benchmark against which other methods are measured and should therefore always be considered among HWT options.

THE SUCCESS OF BOILING

Boiling is the predominant method of HWT with 21% of low- and middle-income households reporting the practice. Boiling is almost universal in Mongolia (95.1%), Viet Nam (91%) and Indonesia (90.6%), and also quite high in Timor-Leste (73.4%), Cambodia (60.1%) and the Lao People's Democratic Republic (62.7%). In some countries, the success of boiling is due to governments recommending it as part of their overall health or hygiene campaigns. As well, many governments have trained health and community workers to promote the practice in villages and communities.

(Clasen 2009, Rosa and Clasen 2010)

3.3.1.1 Affordability

Both capital and recurrent costs need to be affordable. Many programmes are targeted to poor populations because they often derive the most benefit from HWTS. Consequently, both the initial capital cost and the ongoing recurrent costs need to be affordable to the poor, especially those who live on US$ 1 to US$ 2 a day.

It is generally agreed that for programmes to be sustainable, recurrent costs should not be subsidized. Households need to be able to afford the full cost of purchasing consumable products on a continuous and long-term basis. In the case of durable products, people should be able to pay for the recurrent costs associated with replacement parts and the ongoing operation and maintenance.

Subsidies for the capital cost of durable products, and in some cases consumable products, may be required to reach the poorest households. The high up-front purchase cost of durable products, such as a biosand filter, often makes it impossible for the poorest of households to afford. Similar to other infrastructure projects, some form of cost sharing is usually required.

Several different types of schemes have emerged to enable the poor to contribute to the capital costs. Householders often contribute in kind by providing voluntary labour for construction or transport, or by providing local materials. Households may also be offered the option of paying smaller amounts in installments, rather than having to pay the full cost all at once.

Microfinance institutions can also have a useful role in financing the capital cost of durable HWTS products (Freeman et al. 2012). Pilot microfinance projects in India have reported nearly 100% repayment on loans by lower-income populations for the purchase of filters that are usually only affordable to middle-income households. Safe water saves money from reduced illness and increased productivity, making it easier to repay loans over time. Even with this success, current access to small loans for non-income-generating products, such as HWTS, is limited. It will be important for implementers who wish to use microfinancing to educate these institutions on the benefits of HWTS (International Finance Corporation 2009).

HOUSEHOLD INVESTMENT IN HWTS—BIOSAND FILTERS, CAMBODIA

Biosand filters are subsidized by Clear Cambodia to support those who are unable to purchase them at full cost. Households pay a nominal amount and contribute labour to help construct and transport their filters home. As such, people have made a personal investment and Clear Cambodia has experienced a high adoption rate with over 67 000 biosand filters implemented in the country.

(Heng, personal communication, July 2010)

3.3.1.2 Availability

With the exception of boiling, a supply chain is needed to ensure that HWTS products are available to respond to the demand. As part of the supply chain, implementers need to consider how the product is going to be manufactured, packaged, distributed and priced (cost recovery and financing are discussed further in Section 4). The complexity of the supply chain depends on many factors, including:

- type of HWTS product (i.e. durable or consumable),
- availability of local materials and labour,
- strength and level of engagement of the private sector,
- transportation,
- shelf life,
- quality assurance,
- scale and capacity of the programme.

Consumable products require an uninterrupted and long-term supply chain. Product shelf-life and quality assurance are critical factors to consider when manufacturing and distributing consumable products. For example, consumable products that have a short shelf-life, such as chlorine solution, are best made by local manufacturers and distributed through small networks. Whereas products with a long shelf-life, such as NaDCC tablets, lend themselves to international manufacture and global distribution.

Durable HWTS products are usually more appropriate for local manufacture. Both biosand filters and ceramic filters can be built using locally available materials. They have

established production processes that allow them to be built to consistent standards in diverse communities with lower costs than imported filters. Also, these products are difficult to transport over long distances due to weight or fragility, so it is better to manufacture them as close as possible to the end users.

A variety of roles are needed to implement a supply chain. Manufacturing and distribution may be carried out within one organization or across multiple organizations. The implementing organization first needs to decide which parts of the supply chain it is going to manage itself and which can be handled by another organization or the private sector. We will consider manufacturing and distribution separately in the following sections.

a. Manufacturing

Implementers who do the manufacturing and distribution themselves have more control over the product's quality as they control the entire process from production to introduction to the household. It may, however, require them to have special skills and training, and an increased financial and human resource base.

Implementers who do their own manufacturing need to decide if they want to have centralized or decentralized production. For example, Resource Development International-Cambodia (RDI) uses a centralized factory to construct ceramic filters and then distributes them across the country. Alternatively, Clear Cambodia uses a decentralized model to build biosand filters. They have travelling teams that transport the filter molds and tools to a temporary work site in the village. The team spends several weeks there until the demand has been satisfied before moving on to the next village.

If the implementer decides to purchase HWTS products from another organization or the private sector, then the decision is one of whether to use local or imported products from national or international companies. While there are successful stories of large-scale imported supply, many organizations rely on a local supply of HWTS products.

Supply chains that use locally available resources, supply routes, fabrication and people (for labour, education and follow-up) are often used since they can:

- build local knowledge and skills that empower beneficiaries to meet their own needs,
- create jobs and support the local economy,
- allow for more gradual scale-up, since implementation can be limited to a predefined area,
- reach areas that are difficult to access via existing commercial means.

Leveraging the resources of local entrepreneurs or other organizations has many benefits. However, some implementers have found that working with local entrepreneurs was difficult and time consuming in the early stages of implementation. But in the end they report that it is essential for programme sustainability and cost-effectiveness.

Reputable regional and international manufacturers have the advantage of high-quality control standards and product manufacturing consistency. However, HWTS products that depend on international supply chains might be subject to importation taxes and storage and handling fees, potentially resulting in delays and additional expenses. Even with

outsourcing to the private sector, experience has shown that implementers might still need to be involved in the product development, sourcing of raw material suppliers, product registration, product testing and ensuring quality control (POUZN Project 2007, Ngai 2010).

b. Distribution

There are also many strategies used by implementing organizations for distributing HWTS products. Depending on the strength of the private sector, some implementers choose to distribute their products through traditional commercial outlets, such as retail shops and pharmacies. Others use nontraditional outlets to sell HWTS products, such as through community volunteers and mobile sales teams. In some programmes, households must purchase their HWTS product directly from the factory or implementing organization. Distribution strategies should also consider the implications of the location of supplies. In urban areas where population density is high, shorter distances between customers can be leveraged for increased efficiency. When serving rural families, a different distribution model, for example through health systems or health workers, might be required.

PARTNERSHIPS IN MANUFACTURING AND DISTRIBUTION—CHLORINE, INDONESIA

Aman Tirta, Safe Water Systems (SWS), a five-year project funded by the United States Agency for International Development (USAID), aimed to ensure widespread access in Indonesia to an affordable chlorine solution (Air RahMat) for low-income families with children less than 5 years old. Led by Johns Hopkins University, in partnership with the Ministry of Health, CARE International Indonesia, PT Tanshia Consumer Products and Ultra Salur, the project used a public-private partnership (PPP) model to create the first fully sustainable commercial model for SWS.

The PPP combined commercial manufacturing and distribution of Air RahMat by PT Tanshia with community participation and media promotion to create demand. The project negotiated and supported extensive distribution of Air RahMat through traditional channels (e.g. stores and kiosks), as well as nontraditional retail outlets (e.g. community-based organizations, microcredit organizations and community volunteers).

(Johns Hopkins University 2009)

3.3.2 Services

Implementers need to set up a system to support households for the proper and consistent use of HWTS over the long term. Households need a contact point for follow-up service, purchase of replacement parts and queries.

Ceramic water filters are not a passive resource; they require ongoing management and maintenance by users. Therefore, like computers, after- sales support is essential for ongoing and appropriate use of ceramic water filters. (Hagan et al. 2009)

Organizations need to identify the level of service required and how it will be financed as part of the programme to ensure that service is available. Delivering long-term services, even after the implementation programme may have ended, requires engagement with the community, often through community health promoters, local institutions (e.g. health clinics) and government agencies.

For consumable products that are sold commercially, the private sector has incentive to provide follow-up support to households, ensuring that they are satisfied and will purchase the product again. However, businesses that sell durable products that are a one-time purchase and much less likely to be replaced, have little incentive to provide support to households since it will cut into their profit margins.

3.4 Monitoring and continuous improvement

Monitoring is essential for ongoing improvement of the implementation of programmes. It helps to create a feedback loop within a programme. It is particularly important for measuring the impact and success of a programme, especially if an organization wants to scale up its activities.

WHO/UNICEF TOOLKIT FOR MONITORING AND EVALUATING HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

The toolkit is an important global resource for monitoring and evaluation. It includes 20 indicators to assess correct and consistent use of household water treatment and safe storage, along with a "decision tree" to guide in the selection of indicators. The toolkit also provides samples surveys, examples from the field, information on water-quality sampling and resources for additional information. Download the toolkit at: http://www.who.int/household_water/resources/toolkit_monitoring_evaluating/en/index.html

The key to successful monitoring is to keep it simple and within the means of the organization. The tendency for many implementers is to collect too much data, which is overwhelming and often not of practical use. It is ideal to use a small set of indicators that can be collected without becoming an additional burden to the programme.

The extent of monitoring will vary depending on the implementer's capacity and nature of its activities. There is no specific formula for implementers to follow, however programmes often monitor the following elements:

- management,
- product quality,
- distribution systems,

- household education,
- performance and use of the HWTS option,
- impact.

Good monitoring systems share the following characteristics:

- have a clearly defined purpose,
- collect specific information on a small but well-defined set of indicators,
- fully integrated into the programme activities,
- simple and within the means of the organization,
- analysed on a regular schedule to determine lessons learnt,
- focused on factors within complete control of the programme,
- results in programme modifications and improvements, based on lessons learnt and information collected.

3.4.1 What should be monitored

There are two broad categories of monitoring that can be used during implementation: process monitoring and impact monitoring.

Process monitoring looks at the processes that contribute to the functioning of the programme. These include production, quality control, distribution, financial control, use of materials and programme management. Process monitoring helps implementers to answer the question: "Are we doing things right?" Depending on the implementation approach, there are many different process indicators that could be used to monitor the programme. A few indicators to consider include:

- number of products manufactured,
- number of products distributed,
- cost per product,
- number of people trained (e.g. promoters, technicians and staff),
- number of education materials distributed,
- number of household visits conducted.

Impact monitoring looks at the impact of the programme on the target population and can look at the following: number of people with improved water as a result of HWTS implementation; proper and consistent use of HWTS; effectiveness of HWTS; adequacy of promotion and education efforts; and usefulness of training and education material. Impact monitoring helps implementers answer the question: "Are we doing the right things?" A few impact indicators to consider include:

- percentage of products meeting basic operating parameters,
- percentage of products still in use after a given time period,
- percentage of products being used correctly after a given time period,
- user perception of the products' benefits and limitations,
- number of people with access to safe water,
- number of people using the products,

- proportion of time that people, especially the most vulnerable, are drinking non-treated water,
- extent to which the HWTS intervention improves drinking-water (requires tests of microbiological water quality),
- proportion of people experiencing health benefits, such as reduced diarrhoea.

Module 4 provides further information about assessing the impact of HWTS.

3.4.2 Who should be involved

Process monitoring is usually internal to an organization and carried out by staff through record-keeping, spot checks, and regular reviews and appraisals.

Impact monitoring is usually initially done by the implementer and then should be transitioned to an activity done by the local community to ensure that it continues beyond the length of the programme. Community health promoters are an excellent mechanism to monitor behaviour change and encourage proper and consistent use of HWTS. In most instances, local government is also better placed than implementers to ensure long-term monitoring and support.

In addition, project evaluations are a form of impact monitoring, and normally include a review of the process monitoring to ensure that it is sufficient and being done correctly and consistently. Project evaluations are often done by people not involved in the process monitoring in order to reduce the potential for overlooking problems.

3.5 Human capacities required for implementation

Developing people's knowledge and skills is part of building the overall organizational capacity required for implementation. A capacity-building process with competency validation can be used to increase both individual and organizational capacity. The ultimate objective of HWTS programmes should be to build the capability of local populations to meet their own needs.

A variety of roles are needed to implement HWTS programmes (Fig. 3.5). The following roles may be carried out within one organization or more commonly across multiple organizations:

- programme implementers: Individuals or organizations that plan and implement a HWTS programme;

- community health promoters: raise awareness and educate households about the need for safe water and HWTS solutions;
- product manufacturers: construct and distribute the HWTS product;
- trainers: provide training and consulting to support implementers;
- other stakeholders: donors, government, universities and education institutions.

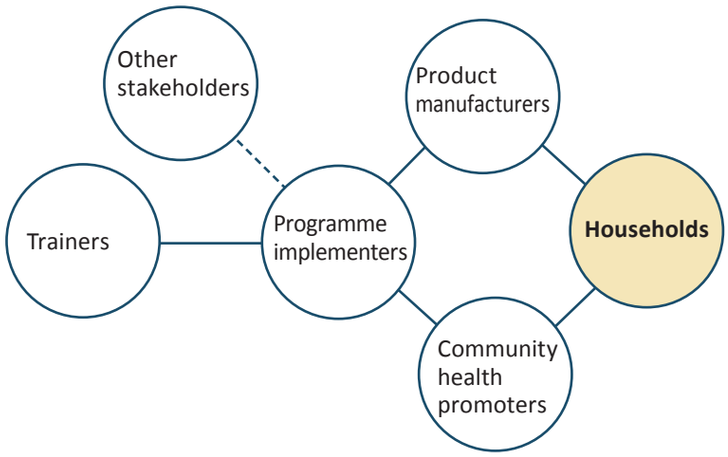


FIGURE 3.5 ROLES REQUIRED FOR HWTS PROGRAMME IMPLEMENTATION

Smooth transfer of knowledge from one role to another is vital and occurs best when:

- all stakeholders contribute to defining the programme goals and objectives;
- all stakeholders agree on and understand their roles and responsibilities;
- the needs of each stakeholder are understood by others (e.g. information, resources and support);
- communication channels remain continually open;
- formal and informal systems and tools are in place to aid knowledge transfer;
- communication and knowledge transfer occurs in both directions;
- plans and tools are available for building competency and capacity.

3.5.1 Programme implementers

There is no standard type of programme implementer. A review of HWTS programmes globally highlights the diversity of implementers, profiled in Table 3.5.1. However, successful implementers do share common characteristics, such as excellent planning, management, organizational and communication skills.

TABLE 3.5.1 CHARACTERISTICS OF IMPLEMENTING ORGANIZATIONS

Type of organization	Characteristics
Indigenous nongovernmental organizations	• Initiated and managed in-country by local people • Have strong relationships with the target population • Build local ownership and capacity to solve own problems • Often have simpler processes to implement projects • Can react quickly to lessons learnt and make changes • May need external support with technical expertise and institutional capacity-building • May depend on external funding support
International and multinational nongovernmental organizations	• From developed countries that initiate programmes, often in partnership with an in-country organization • Range from small international to large multinational organizations • Often have good access to funding • Have enormous technical expertise and are often well connected to the latest research • Knowledge and capacity often remain with foreign experts, needs to be transferred to the local community
United Nations agencies	• UNICEF is the main agency implementing programmes and supporting governments with HWTS in various countries • WHO supports research and establishes guidelines on effective HWTS; together with UNHABITAT, it assists governments in establishing or improving HWTS programming • Sometimes have access to funding • Have enormous technical expertise and often well connected to the latest research • Bureaucracy may limit implementation and delay planned activities
Government	• May be local, regional or national levels responsible for health, rural development, water or environment • Lends political will to change • Gives credibility to HWTS and leads to higher acceptance by households • Can support implementation by incorporating HWTS in public health and education programmes, may also be a source of funding • Bureaucracy may limit formal cooperation with other organizations and delay implementation of planned activities
Private sector	• May be local entrepreneurs or national and international companies • Has the expertise, incentive and resources to manufacture, distribute and promote HWTS products • In many cases, able to provide long-term financial and institutional sustainability to HWTS programmes • Market-driven, full cost-recovery models used by private sector are not likely to reach the poorest of the poor

3.5.2 Community health promoters

Community health promoters can be especially helpful for the successful implementation of most HWTS programmes. Their main role is to facilitate the learning process and help others improve their water, hygiene and sanitation practices through community activities and household visits.

Community health promoters usually report to the implementer. They can either be paid or act as volunteers, and may spend their whole day or only a few hours a week on the job. Depending on the organization, there may be additional responsibilities that are assigned, such as performing monitoring activities.

Almost anyone with the following capacities can become a community health promoter:

- is trusted and respected by the community,
- speaks the local language,
- understands the local culture,
- communicates effectively and listens to others,
- demonstrates good water, hygiene and sanitation practices within their household,
- is committed to addressing water, hygiene and sanitation needs in their community.

Community health promoters do not necessarily have to be experts in water, hygiene and sanitation. This is knowledge that they can learn through training. It is more important for them to have the capacity to learn new skills and communicate.

3.5.3 Trainers

Training and expert support are often required to build human capacity for the different implementation roles. On-the-ground assistance can be a significant factor that contributes to successful programmes. For many people, training helps build their knowledge and skills, and gain confidence, to meet the numerous challenges that must be overcome on a regular basis.

"Interaction with high-level experts from different organizations can be difficult as we feel we are lacking in knowledge and expertise to be able to talk at the same level, despite the fact that we have constructed and installed many filters which are operating properly and supplying people with safe water. We need additional professional training and support," reports Koshish, a biosand filter implementer in Pakistan.

(Dow Baker et al. 2008)

Any training needs to be practical and help address the real challenges that implementers face. Often implementers focus on technology training and on theory, which is usually not enough. Depending on their human capacity, organizations may also need to learn how to plan, implement and monitor their programmes.

External training organizations can provide professional training, consulting services and networking to implementers through highly skilled advisers and volunteers. Experienced in-country organizations can also act as local trainers and are capable of training other community organizations in the various roles required to implement HWTS programmes.

TECHNICAL TRAINING AND EDUCATION ORGANIZATIONS

CAWST, the Centre for Affordable Water and Sanitation Technology, based in Canada, provides technical training and consulting services on HWTS to implementing organizations around the world. CAWST starts with education and training to build local capacity. It delivers training that is customized for the different implementation roles. After training, CAWST provides ongoing support to help organizations with programme development overcome barriers to implementation and make connections with other implementers.

The Swiss Federal Institute of Aquatic Science and Technology (Eawag), based in Switzerland, provides technical assistance, support and education programmes to nongovernmental organizations and governments in developing countries. It focuses on the worldwide promotion and implementation of solar water disinfection (SODIS) programmes.

3.5.4 Other stakeholders

It is important for implementers to work with and create effective relationships with other stakeholders. There are many different types of stakeholders that play a role at various times.

- **Donors** include local and international individuals, community organizations, foundations and government agencies. Implementing organizations need long-term, consistent funding to ensure that their activities can be executed without disruption. Implementers have a role to play in educating donors who may not be familiar with HWTS and implementation best practices. It is helpful for donors to understand why and what they are funding when they are reviewing and approving proposals, providing advice, and conducting programme evaluations.
- **Government** has the mandate for providing safe water and can benefit from HWTS implementation programmes. Some governments have drafted national HWTS guidelines. Support and endorsement from government give credibility to HWTS and implementers. Government may be a source of funding and can provide in-kind resources to support implementers, such as workspace or transportation.
- **Universities and educational institutes** provide research that can build the case for HWTS as an intervention worthy of support by policy-makers and donors (Clasen 2009). Universities and other institutes can conduct research on technology development and programme implementation. Universities can also help implementers conduct programme evaluations.

3.5.5 Use a capacity-building and competency validation process

Competency is a knowledge, skill or attitude that is a standardized requirement for somebody to properly perform a specific job or role. A list of competencies can be created by implementers for each role within their organization, such as trainer, product manufacturer or community health promoter.

Validation is the process of checking people's knowledge, skills and attitudes to confirm that they are competent in their role. Validators can be from within the implementing organization or from external training organizations.

Implementers may use a capacity-building and competency validation process for several reasons:

- provides an opportunity and framework by which individuals and organizations can improve their knowledge, skills and attitude with respect to a specific process or task;
- brings credibility to the organization by giving justifiable confidence in its capacity to provide high-quality products and service;
- allows the implementer to pursue opportunities for financing or funding since they can demonstrate the quality of their products and services; and
- distinguishes those who are trained and provide a good product and service from those who do not.

Implementers need to ensure that time and resources are available to support individuals in improving existing capacities and developing new ones. A needs assessment can be conducted to help organizations identify gaps in people's competencies and create a plan to address the gaps and build their capacity.

There is no standard way to build capacity. Often people participate in training, and later apprentice with qualified staff or external experts to gradually take on more responsibility as they build their confidence, knowledge and skills. Building capacity and competencies takes more than just a one-time training event. It is important to provide ongoing coaching and mentoring to provide feedback and support as people develop and practise their new skills.

EXAMPLE COMPETENCIES FOR COMMUNITY HEALTH PROMOTERS

A community health promoter should be able to:

- describe his or her role as a community health promoter,
- identify local water and sanitation issues in the community,
- describe water-related disease transmission routes,
- describe the multi-barrier approach to safe water,
- demonstrate active listening and effective questioning skills,
- demonstrate how to facilitate participatory learning activities,
- demonstrate how to properly use and maintain various HWTS options,
- demonstrate how to effectively conduct a household visit.

3.6 Programme financing

Implementers need consistent and long-term funding to ensure that all of their programme activities are executed without disruption. Adequate financing is essential to ensure that implementation efforts are sustained and that they can be scaled up. Given the numbers of independent organizations operating at different levels, the success of scaling up HWTS will rely on providing varying amounts of funding to numerous implementers, including the often-neglected smaller organizations.

The costs of implementation are highly programme specific. At a minimum, the following costs should be considered:

- programme planning and administration,
- promotion and education activities,
- product manufacturing and distribution,
- monitoring and evaluation.

Implementers often need a combination of funding sources to cover their expenses. It is important to figure out who is financially responsible for each cost and over what time period. Financing also depends on the organization's legal structure (e.g. for profit, nongovernmental organization status) and its implementation strategy (e.g. subsidized products, retail sales). Potential funding sources may include:

- local and international donors,
- implementing organization,
- earned revenue from households,
- government partnerships.

The key for implementers to obtain funding is to know whom to ask for support, to clearly state the reasons why the financial support is needed and to explain how it will lead to more effective HWTS programmes. Typically, funding begins with small costs to start a demonstration project, with larger amounts made available based on the results and plans.

While there are no fixed models for financing, there are several lessons that have been learnt through HWT implementation.

- Raising awareness, education and capacity-building for HWTS are almost always a public sector activity, and highly subsidized.
- Users need to pay for their own long-term operation and maintenance, whereas initial capital costs can—and in some cases should—be subsidized.
- Durable products often need to be subsidized to enable access by the poorest.
- Households need to invest in HWTS at some level, whether in kind or small financial contributions.

These lessons will be discussed further in the following sections.

3.6.1 Programme planning and administration

Programme planning and administration need adequate attention and funding to increase the chances of implementation success. Those who fail to plan, plan to fail.

Many implementers underestimate the time and financial resources required to make comprehensive plans, and thus fail to seek or allocate sufficient resources to planning activities. As a consequence, many essential elements of planning are bypassed, and the overall programme design becomes fragmented. The different components (e.g. creating demand, supplying products and services and monitoring) are not thoroughly considered, and coordination and communications with stakeholders are weak. The end result is often ineffective or unsuccessful HWTS implementation.

Funding for programme planning and administration is commonly provided by donors or from within the implementing organization. The level of funding is dependent on many factors, such as the organization's internal financial and institutional capacity, the knowledge of and commitment to HWTS among donors, and the perceived reputation of the implementing organization.

3.6.2 Promotion and education activities

In many cases, implementers have found the cost of promotion and education activities (i.e. software) to be far greater than the cost of manufacturing the HWTS product (i.e. hardware).

As discussed previously, creating demand through behaviour change is a long and demanding process. To create real and lasting change in the perception and practice of HWTS, it is important to have a long-term investment of human and financial resources required for promotion and education.

Raising awareness, education and capacity-building for HWTS are almost always a public sector activity, and highly subsidized. These expenses widespread acceptance and donor funding and government partnerships to generate widespread acceptance and adoption of HWTS. For example, the social marketing strategy used by Population Services International (PSI) is designed to recover the cost of product manufacture and distribution, but not the promotion costs, which are covered by donor funding from USAID.

3.6.3 Product manufacturing and distribution

For most of the HWTS options, there are capital and recurrent costs associated with manufacturing, distribution, operation and maintenance. Consumable products need to be replenished on a regular basis and therefore have ongoing recurrent costs; they generally have no capital costs. Durable products have capital costs and minimal recurrent costs.

The relationship between what the households are expected to pay and the actual production and distribution costs can be divided into the following four categories:

- ***Fully subsidized as a public good:*** Households receive the HWTS product without paying any money.
- ***Subsidized with partial cost recovery:*** Households pay for a portion of the HWTS product cost.
- ***Full cost recovery:*** Households pay for the full cost of the HWTS product.
- ***Full cost recovery with profit:*** Households pay for the full cost of the HWTS product plus an additional cost allowing it to be sold on a commercial basis.

It is generally agreed and widely accepted that for programmes to be sustainable, households should pay the full cost of consumable products and recurrent costs.

However, some form of cost sharing is usually required to make the capital cost of durable products accessible to the poor. Durable products are often partially subsidized so that households contribute a small portion of the product cost, whether it is monetary or in kind. It is important to consider both the ability and the willingness of the households to pay. Implementers have also set different prices for the technology depending on the wealth of the household in the community. This way, higher-income households pay more and cross-subsidize the costs for lower-income families. Research has shown that the poor will pay, but payment needs to be flexible to their situation.

Implementers must engage donors to provide the necessary funding to cover the product subsidies given to households.

MOVING FROM SUBSIDIES TO FULL COST RECOVERY—CERAMIC FILTERS, CAMBODIA

International Development Enterprises Cambodia (IDE) and Resource Development International–Cambodia (RDI) have been manufacturing and distributing ceramic pot filters in Cambodia since 2001 and 2003, respectively. Their production is evolving from implementation subsidized by nongovernmental organizations to market-based, full cost-recovery programmes. The ceramic filters are accessible to all but the very poorest households.

IDE has four regional distributors covering 131 retailers in 19 provinces, operating on a full cost-recovery basis. They ended subsidized distribution of filters in 2005. IDE sells about 22 000 filters each year at full cost (US$ 7.50 to US$ 9.50)—about half to nongovernmental organization partners and the other half through retailers.

RDI is able to sell about 23 000 filters a year at full cost (US$ 8.00) through direct sales to users, local contract vendors and sales to nongovernmental organizations and government agencies. A relatively small number of filters are also distributed at subsidized cost to villages in a programme led by nongovernmental organizations. The subsidies are targeted to the poorest households, as determined by a means assessment, and the costs vary from US$ 1 to US$ 7.

(Brown et al. 2007)

3.6.4 Monitoring and evaluation

Monitoring and follow-up visits are essential to support people as they learn to incorporate HWTS into their daily routines. This helps to ensure proper and consistent use of HWTS over the long term.

The cost of monitoring and follow-up is not limited to household visits. Other expenses such as water quality testing, technical troubleshooting and reinforcement education and training, as well as programme evaluation, are important and should be considered as well.

There are many funding options for monitoring and evaluation activities. In some cases, donors support monitoring during the programme period, after which the funding must come from other sources. Local government institutions and/or community health promoters are often encouraged to conduct monitoring and follow-up well beyond the programme period, so the costs are essentially shifted over to their agencies or organizations. In other cases, the cost of monitoring and follow-up is incorporated into the overall product cost to be recovered at the time of sale. Occasionally, some implementers may charge a service fee to households for monitoring, troubleshooting and technical repair services.

3.7 Implementation of case studies

A review of HWTS programmes highlights the diversity of implementers and the wide range of strategies they use to create their own unique approaches to implementation.

Even within the same country, there is an assortment of implementers, situational contexts and strategies. This level of complexity makes it difficult to simplify implementation into typical approaches. However, social and commercial marketing are two approaches that are emerging and being used by a variety of implementers. In particular, the case studies highlight the strategies used by the implementer to address the following:

- creating demand for HWTS,
- supplying HWTS products and services,
- monitoring and continuous improvement,
- building human capacity,
- programme financing.

SOCIAL MARKETING—SAFE WATER SYSTEMS, POPULATION SERVICES INTERNATIONAL (PSI)

PSI is the largest social marketing nongovernmental organization in the world and seeks to engage private sector resources and marketing techniques to encourage healthy behaviour. Since 1998, PSI has been involved in the implementation of safe water programmes, and currently works in 30 developing countries, including Afghanistan, India, Myanmar, Nepal and Viet Nam. It promotes chlorine solution, chlorine tablets and a combined flocculation/disinfection product, in addition to safe storage and improved hygiene.

PSI designs a marketing strategy, including development of a brand name and logo, for the supply of the chlorine product and services it promotes, which includes ensuring products are available at affordable prices to consumers in convenient locations. PSI works through a variety of distribution channels, including wholesale and retail commercial and public sector networks, and generates demand through promotion and education activities using mass media, point-of-sale materials, street theatre and interpersonal communication.

PSI recovers some or all of the production costs, while trying to make sure that products reach the consumer at an affordable price. Donor funding, primarily from USAID and the United Kingdom Department for International Development (DFID), is usually required to pay for the promotion and education activities.

(POUZN 2007, Clasen 2009, PSI 2011)

3.8 SUMMARY OF KEY MESSAGES

- **There is no standard approach for getting HWTS into people's homes. There are a variety of organizations implementing different HWTS options in different ways. Sometimes a combination of approaches may be needed to ensure coverage and uptake. This level of complexity makes it difficult to simplify implementation into typical approaches.**

- **Implementers should address three key components to make it more likely for HWTS programme to succeed:**

  1. **Creating demand for HWTS.**
  2. **Supplying the required HWTS products and services to meet the demand.**
  3. **Monitoring and continuous improvement of programme implementation.**

- **The organization's ability to plan and implement the key components is determined by its human capacity (people) and financing (money and other resources).**

- **Awareness and education are needed to create demand and convince households of the need and benefits of HWTS. The following steps can be used to create demand:**
  1. **Identify a target population that could benefit from HWTS and gain a detailed understanding of their situation.**
  2. **Select appropriate and feasible HWTS options that reflect the specific context.**
  3. **Increase awareness of HWTS as a solution for getting safe water, and educate people on the relationship between water and health.**
  4. **Use demonstration projects to convince people of the benefits of HWTS.**
  5. **Engage government agencies to participate in programming and underscore the benefits of HWTS.**
  6. **Provide positive reinforcement to households so they continue using HWTS.**
- **Households need both products and support services to ensure the proper and consistent use of HWTS over the long term.**
- **HWTS options can be divided into consumable and durable products. Consumable products require an uninterrupted and long-term supply chain, and their recurrent costs should not be subsidized. For durable products, the capital cost may require partial subsidies to make it affordable.**
- **Boiling should always be considered as an option since it is effective and does not require establishment of a supply chain (except, perhaps, for safe storage).**
- **The key to successful monitoring is to keep it simple and within the means of the organization.**
- **Developing individual people's knowledge and skills is part of building the overall organizational capacity required for implementation. A competency building and validation process can be used to increase both individual and organizational capacity.**
- **A variety of roles are needed to implement HWTS programmes, including programme implementers, community health promoters, trainers and other stakeholders.**
- **Implementers need consistent and long-term funding to ensure their programme activities are executed without disruption. Costs are highly programme specific and implementers often need a combination of funding sources to cover their expenses.**

ASSESSING THE IMPACT OF HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

MODULE 4

4.1 Introduction

The success of household water treatment and safe storage (HWTS) can only be determined if its impact can be assessed. This module aims to highlight the challenges of measuring HWTS impact and suggest ways in which HWTS might realistically be measured by governments. It also provides some examples to help governments in developing a plan for assessing the impact of HWTS programmes in their countries.

4.2 Approaches to assessing impact of HWTS

There are three main approaches to assess the impact of HWTS. They are:

1. Using previous studies as evidence.
2. Direct impact assessments focusing on health improvements.
3. Indirect impact assessments focusing on coverage, performance and adoption.

Each of these approaches is described in the following sections.

4.2.1 Learning from previous studies

There are a large and growing number of health impact studies that provide guidance on the potential health impact of HWTS under various conditions. These previous studies can be used by governments and programme implementers as evidence to assess the impact of various HWTS options.

Before undertaking any type of programme assessment, it is important to review the existing literature and determine what gaps, if any, should be explored. More than

45 controlled trials of HWTS have been conducted through 2011 and dozens of other observational studies of HWTS have been published. In addition, there is also a large, though sometimes difficult to access, amount of unpublished literature on HWTS contained in reports from governments and programme implementers, and in graduate student dissertations and theses, etc.

There is a tendency for government officials to dismiss studies conducted in other countries, regardless of their quality, and to consider as relevant only studies conducted within their own country. This should be avoided. In some cases national laws and regulations require government officials to confirm the safety and performance claims made for products imported or sold in the country, including HWTS. Even so, it is unnecessary and usually a waste of resources to require such approvals to be based on local evaluations in the field. Such local evaluations should only be considered if there is strong evidence to doubt the relevance or reliability of studies performed elsewhere.

4.2.2 Direct impact assessment

The purpose of any health intervention is to prevent disease. As such, any assessment of the impact should ultimately be focused on health. As HWTS is designed to prevent waterborne disease, especially diarrhoea, an evaluation of HWTS programmes should ideally assess reduction in diarrhoeal disease. This is especially true among those populations at highest risk of death and serious health problems associated with diarrhoea. Alternative ways to measure diarrhoeal disease have also been used by some researchers, such as anthropometrics (assessments of human growth, for example height and weight). Given that malnutrition is both an outcome and a risk factor associated with diarrhoea, growth measurements in children that indicate malnutrition and diarrhoea can be a useful and more objective means of assessing the health impact of HWTS.

A rigorous assessment of the direct health impact of HWTS is exceedingly difficult, time-consuming and costly. Studies to assess the direct impact on health also present major challenges in terms of design, analysis and interpretation. As a result, these studies should not be undertaken without extensive involvement of experienced epidemiologists. Assurances of the time, funding and other resources necessary to conduct them should also be provided. Furthermore, such studies should seek to address gaps in the evidence, which requires a thorough understanding of the research that has already been conducted and remaining unanswered questions.

If a direct health impact assessment is undertaken, it is essential that the study be blinded or that the outcomes be objective (e.g. biomarkers of diarrhoeal disease) in order to prevent reporting bias. Recent studies have shown that relying on reported diarrhoea alone in open (non-blinded) study designs is subject to courtesy bias that tend to exaggerate the effectiveness of the intervention (Schmidt and Cairncross 2009).

Direct health assessments usually take the form of epidemiological studies. Since these studies take many forms, they use a variety of names of which the reader should

be aware. These include "observational" studies (e.g. ecological studies, cross-sectional studies, case-control studies, cohort studies) and experimental or "intervention" studies (e.g. controlled trials).

These terms are presented here so you will be able to identify them if you come across them, but they are not described in detail as they are out of the scope of this module.

Trial or intervention study—A study that involves the implementation of an intervention (e.g. giving a population household filters). The results of the intervention are then compared to data gathered without the intervention (e.g. before intervention compared to after intervention, or the intervention group compared to the control group).

Observational study—Where the effect of a particular product or condition (e.g. a household filter) is studied. This involves studying a population that already has the product or condition rather than that intervention being provided by the researcher. Again, the data are compared to a population without the intervention.

4.2.3 Indirect impact assessment

Instead of assessing the direct impact of HWTS, an indirect approach can be followed. This involves investigating the impact using easier-to-measure intermediate outcomes, ones that will directly contribute to improvements in health.

As discussed in Module 1, research has shown that HWTS offers the greatest potential for improved health when certain conditions are satisfied. These conditions can be grouped into three general categories:

- ***Coverage***—Ensuring that the HWTS is targeting the appropriate population.
- ***Performance***—Ensuring that the method used is safe and microbiologically effective.
- ***Adoption***—Ensuring correct, consistent and sustained use.

By focusing on measuring these three general conditions, an indirect assessment of the health benefit of HWTS can be made.

4.2.3.1 Coverage among target population

HWTS should target populations that are at greatest risk of waterborne disease. As discussed in Module 1, these include those with:

- increased vulnerability due to undeveloped or impaired immune systems,
- high exposure to microbiologically contaminated water.

The two groups with underdeveloped or impaired immune systems that receive the greatest focus are children under 5 years and people living with HIV/AIDS. Others whose immunity is compromised due to malnutrition, other diseases or aging are also at greater risk and may also be a focus. Successfully targeting these vulnerable populations requires an assessment of the access these groups have to HWTS.

High exposure to microbiologically contaminated water is greatest among populations:

- affected by conflicts and natural disasters who are displaced or whose normal water supplies are interrupted, overwhelmed or unavailable, forcing reliance on surface or other unprotected and untreated water supplies;
- affected by outbreaks of waterborne diseases, such as cholera or dysentery;
- with water supplies of poor or unreliable microbiological quality.

Emergency situations are usually of limited scope and duration. Identifying the affected population in these cases is usually easier than providing them with an effective solution. The role of HWTS in emergency response, and assessing the impact of HWTS under such conditions, presents special issues that are beyond the scope of this training module.

Of the three populations listed above, the largest potential impact for HWTS is among those who are able to meet their basic needs for water quantity and access (20 litres/person/day and 30 minutes round trip, according to WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation), but who rely on sources that are not safe or are recontaminated during collection, storage and use in the home. This includes "unimproved" sources, such as lakes, rivers and other surface sources, and unprotected wells and springs. As discussed in Module 1, there is, however, evidence to suggest that even "improved" sources often have poor microbiological quality, and that water that is safe at the point of collection can be recontaminated due to poor hygiene practices and unsafe storage in the home. Targeting HWTS to this population requires an assessment of the population's exposure to faecally contaminated water.

4.2.3.2 Microbiological performance of HWTS

The contribution of HWTS to improved health will depend on how effectively it works to remove pathogens. Since different HWTS options have a range of effectiveness against different pathogens, there is a need to assess their actual effectiveness.

Sobsey (2002) has described dozens of HWTS options and summarized the evidence concerning their microbiological performance both under controlled, optimal circumstances and as actually practised by households. Module 2 also provides guidance on selecting appropriate HWTS options under different conditions.

In some cases, particularly with new HWTS options or those being used in unusual conditions, it may also be necessary to undertake some microbiological testing of HWTS options to confirm their effectiveness in the field.

4.2.3.3 Adoption

Optimal impact of HWTS requires that the target population adopt and use HWTS both correctly and consistently over the long term. Research has shown that even occasional use of untreated water can completely undermine the potential health impact of safe

drinking-water (Hunter 2009). In a model developed by Brown and Clasen (2012), much of the benefit was lost if even 5% of the water consumed was untreated; there was no benefit whatsoever for those drinking 20% untreated water. Thus, the goal for HWTS interventions must be for the target population to consume treated water exclusively.

While use over the long term requires sustainable access to acceptable and affordable products and services, access alone is not sufficient to ensure correct and consistent use. As such, it is essential to assess actual and correct use by households.

It may, therefore, also be useful to assess to what extent products and services are available and affordable.

4.3 Using indicators

Fully evaluating even the indirect measures of HWTS impact requires collecting large amounts of complex data. Just one aspect, measuring microbiological water quality, for example, requires testing water samples for a wide variety of pathogens, including bacteria, viruses and protozoa. In order to make assessment easier, it is possible to develop sets of "indicators" that serve as substitutes for the many outcomes of interest to HWTS programmes, such as water quality and actual use.

Some indicators are highly developed and there is agreement on their validity. When measuring water quality, for example, it has been shown that the main contaminants of water that cause diarrhoea come from faeces. Extensive testing has demonstrated that the amount of *Escherichia coli* (*E. coli*), or thermotolerant coliforms (TTC), in water indicates the level of faecal contamination. As such, a common indicator of water quality is the faecal contamination of drinking-water measured using *E. coli* or TTC. Numbers are reported as the number of colony-forming units (CFU) of *E. coli* or TTC per 100 ml of water.

Also, where chlorine disinfectants are used, an effective indicator of actual use is the presence of residual chlorine in the water the household uses for drinking. Where the residual chlorine level is sufficient and turbidity (suspended solids) is low, this may also indicate the absence of pathogens.

As mentioned in Module 3, in 2012, WHO and UNICEF published harmonized global indicators for monitoring and evaluating HWTS. These indicators build upon previous efforts among HWTS stakeholders and are grouped according to the following themes: reported and observed use; correct and consistent use and storage; knowledge and behaviour; other environmental health interventions; and water quality. The indicators are highlighted in Table 4.3. For more details, refer to the toolkit.

TABLE 4.3 CORE HWTS INDICATORS

Core indicators	Characteristics
Reported and observed use	1. Self-reports of treating drinking-water 2. Observation of drinking-water treatment method/technology 3. Self-reports of safely storing water 4. Observation of safely stored drinking-water
Correct, consistent use and storage	5. Knowledge of correct use 6. Demonstration of correct use 7. Demonstration of safe water extraction 8. Frequency of non-use by most vulnerable 9. Consistent treating of drinking-water with HWTS 10. Use of improved drinking-water source
Knowledge and behaviour	11. Knowledge of at least one proven HWTS technology 12. Received messaging and/or training on HWTS 13. Access to HWTS products 14. Personal norm for drinking treated water 15. Confidence in improving the quality of their drinking-water 16. Community support in treating drinking-water
Other environmental health interventions	17. Knowledge of other environmental health interventions 18. Use of other household environmental health interventions
Water quality	19. Households effectively using HWTS method to improve quality of household drinking-water ("effective use") 20. Households with free chlorine residual in drinking-water

4.4 ASSESSING IMPACT BASED ON COVERAGE, PERFORMANCE AND ADOPTION

Based on need, financial resources, human capacity and time required, it is more realistic for government to assess the impact of HWTS using an indirect approach that measures coverage, performance and adoption. The following sections describe this approach in more detail.

4.4.1 Coverage among the target population

Cross-sectional surveys, conducted with the same population before and after HWTS is implemented, are perhaps the most common way of assessing the difference in HWTS coverage over time. Ecological studies and the gathering and analysis of data collected for other purposes, such as demographic and health surveys and maternal, infant and child surveys, can also be used to assess coverage changes. Longitudinal studies, following a population over a period of time, are another option too.

While it is important to measure the increase in HWTS coverage generally, it is also essential to calculate how much the programme has increased coverage among vulnerable populations. This can be done by adding questions to cross-sectional surveys, which identify these vulnerable groups, or by extracting this data from existing studies. Questions should allow for identification of children under 5 years, the elderly, people living with HIV/AIDS and those with other long-term health conditions.

There are two options to assess the increase in coverage among those relying on faecally contaminated water supplies. First, water quality can be measured directly using a faecal indicator such as *E. coli* or TTC. If the microbiological performance of HWTS is being assessed based on water quality, samples of source water and treated water may have already been collected and analysed by the programme implementer. The data for source water could then also be used to assess coverage.

The second option is to rely on classification of water sources as “improved” and “unimproved” as done by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP). While improved water supplies are not necessarily free of faecal contamination, they are likely to be less highly contaminated. Questions can be added to cross-sectional surveys to characterize the water supplies of the target population as either improved or unimproved.

Once data have been collected, the increased coverage among each population group can be reported. Increases in coverage among those with undeveloped or impaired immune systems and those relying on unimproved water supplies would suggest greater overall impact due to effective targeting.

4.4.2 Microbiological performance of HWTS

The best way of evaluating the performance of HWTS is to take samples of the drinking-water at the source and in the household after HWTS use.

Water quality testing should be completed using a method that quantifies the level of faecal contamination. The most common methods are membrane filtration or most-probable-number methods, which report the number of *E. coli* or TTC CFU per 100 ml. For details on the precise methods, reference should be made to existing literature and

manufacturer's instructions. While presence–absence methods have occasionally been used, they are not recommended for HWTS since it is possible for technologies to achieve high rates of pathogen removal but still show presence of contamination both before and after use.

If equipment and supplies are available to quantify the extent of faecal contamination in water samples, then the effectiveness of the intervention can be calculated and reported in two ways:

- the average improvement in water quality associated with the intervention; and/or
- a comparison of the distribution of samples faecal contamination for source versus household water.

The average improvement in water quality associated with the intervention is usually expressed in terms of percentage reduction of *E. coli* or TTC or in terms of a "log reduction value", as in Table 4.4.2.1. If samples are collected at different times, the average of the source and household samples can be compared for each round of sampling. Table 4.4.2.1 shows how these data can be presented based on results from an assessment of water treatment options by Hörman et al. (2004).

Table 4.4.2.1 Capacities of different water treatment options

Device	Log reduction values						
	Coliforms	*E. Coli*	Clostridia	Turbidity	Microcystin	*C. parvum* oocysts	F-Rn A phages
Survival straw	0.5	0.5	0.7	0.2	0.1	+	+
Katadyn combi	> 6.9	> 6.9	> 1.8	1.1	0.2	– (< 5.1)	+ (2.7)
Katodyn pocket	> 6.9	> 6.9	> 1.8	1.1	0.2	– (< 5.1)	+ (3.3)
Katodyn survivor	4.2	4.2	> 1.8	1.6	2.5	– (< 5.1)	– (> 5.8)
MiniWorks	6.9	> 6.9	> 1.8	1.3	0.3	+	+
Water workall	> 6.9	> 6.9	> 1.8	1.6	0.3	– (< 5.1)	+ (5.0)
n erox filter	> 6.9	> 6.9	> 1.8	1	0.1	Not tested	+ (5.8)
Safe water in-line hydration filter	> 6.9	> 6.9	0.3	0.04	0.3	+	+
WalkAbout microfilter	3.6	> 6.9	1.8	1.4	0.1	Not tested	+

Source: adapted from Hörman et al., 2004

It is also useful to compare the distribution faecal contamination for source water versus household water. It is common to classify samples according to log categories: 0 (i.e. conforming to WHO quality standards), 1–10, 11–100 and 101–1000 CFU per 100 ml. Figure 4.4.2 shows an example of how this distribution was reported in a study assessing the effectiveness of boiling in Viet Nam.

LOG_{10} REDUCTION VALUES (LRVs)

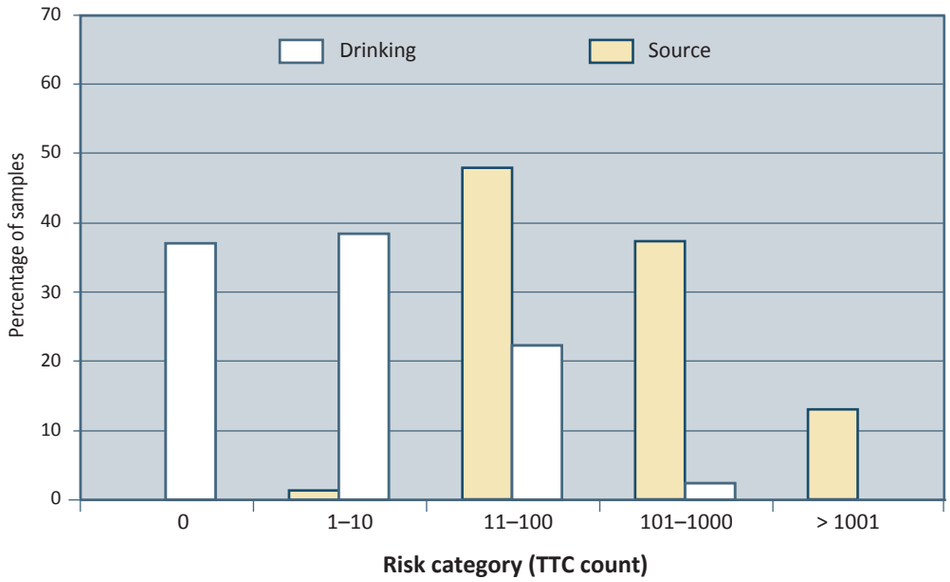
The microbiological performance of HWTS is often presented as a "log reduction value". Since contamination from pathogens found in water tends to follows a skewed distribution, LRVs are considered by the scientific community as a better way of representing contamination.

LRVs are calculated from $\log_{10}$ concentrations of pathogens observed in untreated water divided by the $\log_{10}$ concentrations of pathogens observed in treated water using the following formula:

$LRV = \log_{10}(C_{untreated}/C_{treated})$ where *C = concentration of the pathogen in the water*

Log_{10} reduction values relate to % reductions as follows:

- 1 $\log_{10}$ reduction = 90% reduction
- 2 $\log_{10}$ reduction = 99%, reduction
- 3 $\log_{10}$ reduction = 99.9% reduction
- 4 $\log_{10}$ reduction = 99.99% reduction, and so on…



Source: Clasen, 2008

FIGURE 4.4.2 PERCENTAGE OF WATER SAMPLES BY RISK CATEGORY

If resources are limited, an alternative method for assessing HWTS options is by categorizing them based on their potential effectiveness. This is the approach used by the JMP. In 2005, the JMP recommended that questions on household water treatment (HWT) be added to the household surveys used to assess drinking-water coverage. For this purpose, the JMP classified boiling, chlorination, filtration and solar disinfection as "adequate" methods. Filtering water through a cloth or letting it stand and settle were deemed "inadequate". However, caution is recommended in using this approach as recent research suggests that self-reported practices on HWTS exaggerate the prevalence and consistency of the practice (Rosa and Clasen 2012).

More recently, as seen in Module 1, WHO has developed a classification system based on the level of protection offered by various HWT options (WHO 2011). The three classifications—highly protective, protective and interim—are shown in Table 4.4.2.2.

TABLE 4.4.2.2 HEALTH-BASED PERFORMANCE TARGETS FOR HOUSEHOLD WATER TREATMENT

Target	LRV for bacteria	LRV fo viruses	LRV for protozoa
Highly protective	≥ 4 (≥ 99.99%)	≥ 5 (≥ 99.999%)	≥ 4 (≥ 99.99%)
Protective	≥ 2 (≥ 99%)	≥ 3 (≥ 99.9%)	≥ 2 (≥ 99%)
Interim	Achieves "protective" target for two classes of pathogens and results in health gains.		

Source: WHO, 2011

To use this approach, programme implementers need to add questions to their surveys or other data collection tools to determine which methods are regularly practised by households. The impact of HWTS can then be reported by comparing the level of use of methods in different categories before and after the intervention or between intervention and control groups.

Regardless of the approach used in assessing the performance of the HWTS method, certain limitations should be remembered. First, apart from boiling, many of the most common HWTS options are not effective against all waterborne pathogens. It is well known, for example, that important disease-causing organisms, such as *Cryptosporidium oocysts* and *Giardia* cysts are resistant to chlorine disinfection. Most filtration media that operate using gravity are very ineffective against viruses. These technologies must therefore be used with other treatment methods in order to remove or kill all waterborne pathogens (e.g. bacteria, viruses, protozoa) and give full protection. This multi-barrier approach is discussed in more detail in Module 2.

Second, the microbiological performance of many common HWTS options can be adversely impacted by variability in the source water quality. This is something that households may not be able to control or even assess.

The most important variable is the level of contamination of the source water. Only boiling and a few commercial HWTS products have been shown to remove sufficient levels of pathogens to meet the highest performance criteria under WHO recommendations on the performance of HWT. Most HWTS options, such as biosand and ceramic filters, achieve lower reductions in pathogens (1–2 log or 90%–99% reduction). Where water is highly contaminated, as it is in many settings, these products may greatly reduce the quantity of pathogens, but still leave the water with infective doses, as explained in Module 2. In addition, the performance of some methods, such as chlorine, is affected by water temperature, pH and excess turbidity or dissolved organics (Sobsey 2002). Filter performance can also be impacted by turbidity and certain chemical contaminants.

4.4.3 Adoption by the target population

The adoption of HWTS requires several factors, including access (e.g. availability, affordability, equity and sustainability) and use (e.g. correct, consistent and sustained use).

4.4.3.1 Access

AVAILABILITY

The main question concerning HWTS access is that of availability; do households have access to the products and services required to effectively practise HWTS? In terms of products, it is useful to have households actually show the product used for treating water in the home (e.g. boiling equipment or filter) and not simply rely on their reported use. For products that require replacement parts such as ceramic filters, the availability of replacement parts should also be confirmed. Where consumable products are used, such as chlorine or flocculants-disinfectants, their availability in the marketplace needs to be confirmed. It is also important to ascertain how frequently the products are purchased to ensure they do not expire. This can be assessed by cross-sectional surveys and market surveys.

AFFORDABILITY

Affordability also plays a key role in access to HWTS methods. Affordability is an interaction of cost and ability to pay. Both of these elements can be complex to assess.

Cost can be assessed in economic or financial terms, from the perspective of a society, household or person, from a gross or net (of savings) basis, and with respect to capital (upfront) and recurring costs. In terms of impact assessment of HWTS, cost usually focuses on financial costs and should include the cost of the product itself (durables and consumables), the services needed to support the product and programme costs. It is also important to determine which of these costs are borne by the household and which are covered by external subsidies. A survey of suppliers will help to assess these costs, as would including cost questions in surveys of households in cross-sectional studies.

Ability to pay, which differs from willingness to pay, is a function not only of available resources, but also actual cash on hand, cash flow, competing priorities at different times, distribution of payments, etc. Information on the economic characteristics of the population can be collected using cross-sectional surveys or other data collection tools. It should be noted that the most vulnerable populations are likely to have different economic characteristics as compared to the rest of the population. Ensuring HWTS is affordable to these populations will require collecting data to identify these populations.

Once both cost and ability to pay have been determined, they can be compared to assess the affordability of HWTS options for different economic and social groups.

EQUITY OF ACCESS

While the low-income and rural populations suffer more from diarrhoea and other waterborne diseases, access to some HWTS options is higher among urban, higher-income, better-educated populations (Olembo et al. 2004, Rheingans and Dreibelbis 2007). It is important to assess the equity of access in order to ensure that the most vulnerable are benefitting from HWTS.

To assess equity of access it is valuable to investigate how access and use of HWTS options vary based on socioeconomic criteria, location, age and other population characteristics. Information on population characteristics can be collected using surveys or other data collection tools and should be correlated with HWTS options to investigate equity of access.

SUSTAINABILITY

In the context of the Millennium Development Goal (MDG) water target, the idea of sustainability has the following two meanings:

- The intervention provides a long-term solution to the target population, which concerns not only the robustness of the intervention but also its long-term use as described below.
- The intervention provides environmental sustainability, which concerns the impact of the intervention beyond the actual user—on the household, neighbourhood, community, society and environment.

Unfortunately, the MDG water target provides little guidance on either aspect of sustainability. In terms of HWTS, the key test for sustainability in terms of its ability to provide a long-term solution is its consistent long-term use as described below.

4.4.3.2 Use

Ensuring the quality of water from HWTS requires some daily or other routine effort—and often some expenditure—on the part of households. This is in addition to the normal effort to actually collect the water. As noted above, research has suggested that the health benefits of interventions to improve water quality may be significantly reduced if the target population is even occasionally exposed to unsafe drinking-water by failing

to practise the intervention (Hunter et al. 2009, Brown and Clasen 2012). To gain the full benefit of HWTS, households must therefore use it correctly, consistently and exclusively, not just when they consider themselves at greater risk.

Consideration must first be given to the definitions of correct and consistent use and to the option. Chlorination, for example, may be defined in terms of treating water with a sufficient dose of chlorine and maintaining a minimum chlorine residual for up to 24 hours after treatment. In such cases, use can be confirmed using a common and inexpensive test for residual chlorine. For boiling, filtration and safe storage, a more valid indicator of use compared to self-reported practices may be defined in terms of the presence of the necessary product in the household and a correct demonstration of how to use the product.

Where possible, correct use should be confirmed by taking samples from water reportedly treated using HWTS, and comparing its faecal contamination with the source water. This data may already be collected for assessing the microbiological performance of the HWTS method as described above. If resources do not permit water quality testing, it may be useful to observe how households actually practise their chosen HWTS option to determine correct use. Conducting such observations without influencing the manner in which the household actually practises the method is difficult, and the observation itself can affect the results.

Consistent use should be assessed primarily by following a population over time (longitudinal studies). By doing so, it may be possible to determine consistent use by repeated measurements of correct use. An alternative for consumable products, such as chlorine, may be to count the number of used packages since the last visit. Some assessments also use separate questions about use in the previous 48 hours, week and month to obtain information on use patterns over time.

For assessing long-term use, it is important to conduct longer-term follow-up studies, from one to five years following the intervention, to determine whether the population actually continues to practise HWTS on a sustained basis.

4.5 Designing an impact assessment for a HWTS programme

An impact assessment for HWTS should be carefully planned in advance with appropriate experts and then carried out in accordance with a written protocol. The protocol will provide the background for the study, state clearly the questions or hypotheses being explored, provide the basis for calculating the required sample size and address issues concerning ethics. The protocol will also give details of the methodology to collect, analyse and report on the data.

4.5.1 Sampling

The size of the population on which the impact assessment will be carried out is likely to be too large to cost-effectively 'test' each individual. As such, it is common for a sample to be collected. The aim of a sample is to:

- find a smaller population that is representative (generalizable to) the study population,
- allow us to say the information from the sampled population is similar to that of the study population.

The principal steps to be taken in selecting an appropriate sample are:

- defining the study population,
- determining a representative sample size,
- selecting a sampling method.

The following section gives guidance on acceptable sample sizes and discusses different sampling methods

4.5.2 Determining the sample size

The following guidelines can help determine the sample size required for large and small projects.

- *Small projects (fewer than 100 households)*

The sample size depends on the purpose the assessment.

– For a trend analysis, 10%–20% of households can be used as the sample size. If resources are available, it would be good to test all the households in a small project.
– For a statistical analysis, a minimum of 30 units is needed for sampling. For example, 30 children at a school, 30 filters in the village or 30 households in the community.

- *Large projects (more than 100 households)*

Geographical location and socioeconomic status should be considered during the sample selection. Before determining the sample size, the area should be divided into different geographical areas, such as highland, lowland or coastal areas, to get an accurate representation. Households should also be classified based on socioeconomic status, such as high-, medium- or low-income. In general, 5%–10% of the total households can be taken as a sample from each geographical area and each socioeconomic group.

4.5.3 Choosing a sampling method

Basically there are two types of sampling methods:

1. **Probability sampling:** every unit of the population has an equal chance (probability) of being selected in the sample.
2. **Non-probability sampling:** does not use random selection.

4.5.3.1 Probability sampling methods

- ***Simple random sampling***

In this method, every unit of the population has an equal chance of being selected in the sample. A sample unit can be drawn either by using a random numbers table or by drawing a unit from the list of the total population. In this context, total population means the group of people, items or units under the study or research. We can use different methods to randomly select the participants, such as drawing names or numbers from a hat, or using a computerized random number generator (www.random.org).

For example, your sample size is 50 from a total population of 200 households. Write the name of each household on a separate piece of paper and put the pieces of paper into a container. Randomly select 50 names from the container.

- ***Systematic sampling***

In this method, a sample unit can be taken at particular intervals. The interval can be calculated by dividing the total number of units in the population by the number of units to be selected (sample size). The following is an example of systematic sampling:

Your sample size is 100 households from a total population of 1000 households; 1000 divided by 100 = 10 households. From a list of the 1000 households, begin at a random household on the list, and select every 10th household to be sampled

- ***Cluster sampling***

In this method, the population is divided into clusters or groups, and some of these are then chosen by simple random sampling or by an alternative method. It is a good method to use for large projects. Samples taken from households of the same street or households with the same tribe are an example of cluster sampling. The population is divided into clusters.

For example, an organization wishes to find out the effectiveness of a technology in the project area. It would be too costly and take too long to survey every household in the project. Instead, 50 households are randomly selected from all households using a local pond as their water source. These households are considered a cluster sampling.

- ***Stratified random sampling***

Stratified sampling methods are generally used when the population is heterogeneous. To choose a stratified random sample, divide the population into groups of individuals that are similar in some way that is important to the response.

For example, if you were interested in assessing the rate of technology adoption in terms of social status, select samples through stratified random sampling. In this context, the total population can be stratified by their economic status such as low income, medium income and high income.

4.5.3.2 Non-probability sampling methods

Non-probability sampling does not use random selection. In this method, generalization of the findings is not possible because the sample is not representative of population.

- ***Convenience sampling***

Convenience sampling does not produce a representative sample of the population because people or items are only selected for a sample if they can be accessed easily and conveniently.

For example, the sample may include the first 10 people meeting in a temple or the first row of people in a meeting.

- ***Purposive sampling***

A purposive sample is one in which an evaluator tries to create a representative sample without actually sampling at random. One of the most common uses of purposive sampling is in selecting a group of geographical areas to represent a larger area.

For example, it is not feasible to do a house-to-house survey covering the whole country. Due to financial constraints only a small number of towns and cities can be sampled; therefore, you might choose these in a purposive way.

- ***Quota sampling***

Quota sampling is a type of stratified sampling in which selection within the strata is non-random.

For example, you have a small project of 100 biosand filters and want to assess their effectiveness after two years. Your quota for the sample is 10%. Therefore, you only need to sample 10 filters to meet this quota since 10% of 100 (sample size) = 10 filters

- ***Snowball sampling***

This method is often used when an evaluator is trying to reach populations that are inaccessible or hard to find. The evaluator has certain criteria that must be met to be considered as a sample.

4.6 SUMMARY OF KEY MESSAGES

- **There are three main approaches to assess the impact of HWTS:**
  1. **Using previous studies as evidence.**
  2. **Direct health assessments focusing on health improvements.**
  3. **Indirect impact assessments focusing on coverage, performance and adoption.**

- **A rigorous assessment of the direct health impact of an intervention is exceedingly difficult, time-consuming and costly. Studies to assess the direct impact on health should not be undertaken without extensive involvement of experienced epidemiologists and without having the time, funding and other resources necessary to conduct them.**

- **There is a large amount literature that documents the impact of different HWTS option in many different circumstances, which can be used to assess impact.**

- **New local evaluations should only be considered if there is strong evidence to doubt the relevance or reliability of studies performed elsewhere.**

- **Impact of HWTS is greatest when targeted towards vulnerable populations, such as those with:**
  - **increased vulnerability due to undeveloped or impaired immune systems,**
  - **high exposure to microbiologically contaminated water.**

- **Indirect assessment of the health benefit of HWTS should be made by focusing on the three general conditions critical to achieving the greatest potential impact of HWTS:**
  1. ***COVERAGE*—Ensuring that HWTS is targeting the appropriate population**
  2. ***PERFORMANCE*—Ensuring that the method used is safe and microbiologically effective**
  3. ***ADOPTION*—Ensuring correct, consistent and exclusive use**

- **In order to make assessments easier, it is possible to use "indicators" that serve as substitutes for the many outcomes of interest to HWTS programmes, such as water quality and actual use. WHO and UNICEF recommend using the global indicators provided in the monitoring and evaluation toolkit.**

- **An impact assessment for HWTS should be carefully planned in advance and then undertaken in accordance with a written protocol.**

THE ROLE OF GOVERNMENT IN HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

5.1 The need for governmental participation

Government has an essential role and significant responsibilities in optimizing the impact of household water treatment and safe storage (HWTS). The following are examples of areas where government can play a specific role:

1. Making itself aware of the research on HWTS and the contribution it can make to improve health and well-being of its people.
2. Assessing the existing water situation to determine whether populations could benefit from HWTS.
3. Developing policies on how HWTS should be related to other health and development priorities.
4. Developing a plan for piloting, assessing and scaling up HWTS on a sustainable basis, with the involvement of all stakeholders. The plan should be based on a set of guiding principles that reflect national priorities and the overall goal of improving health.
5. Assisting, regulating, coordinating, monitoring and evaluating the efforts of all those involved in HWTS. This includes not only the activities of government, but also nongovernmental organizations and the private sector, to ensure all activities are consistent with the principles and priorities of the national HWTS policy.
6. Allocating funding and other resources so that the HWTS policy and strategic plan can be successfully implemented. This includes a coordinated, non-branded communication strategy designed to increase the adoption and correct use of HWTS. It also includes providing the funding necessary to ensure access to effective HWTS options by remote populations and those unable to pay the full or partial costs.
7. Building capacity to support the successful implementation of safe and effective HWTS options at the national, regional, district and local levels. Since appropriate solutions depend on specific local conditions, a range of options should be presented so that the most suitable technology choices can be made.
8. Supporting local universities and research institutions in conducting research on innovative HWTS solutions for local populations.

5.2 Evaluating HWTS in the context of public health priorities

Before developing a national strategy and action plan for HWTS, the role and potential contribution of HWTS must first be evaluated within the context of the country. This should be done taking into account existing conditions and other public health priorities. The evaluation should provide all the information necessary to determine whether and under what circumstances HWTS should be pursued.

5.2.1 Understanding the limits of HWTS

It should be understood that HWTS has limitations. HWTS is mainly designed to improve water quality; HWTS does not generally improve quantity and access to water, except in unique circumstances where it makes nearby surface water safe and available for drinking. HWTS should not, therefore, be treated as an alternative to reliable, well-managed and safe piped-in water supplies or other water source improvements. HWTS should also not divert resources away from long-term government efforts to provide sustainable access to safe drinking-water in accordance with the Millennium Development Goal (MDG) water target.

It is also important to note that most HWTS interventions mainly improve microbiological water quality, and some do not remove all types of pathogens. Certain protozoa cysts, such as *Cryptosporidium*, are resistant to chlorine, and many household filters are not effective in removing viruses. In addition, while some HWTS options can reduce levels of arsenic, fluoride and other chemicals, few well-tested options exist and even fewer have been implemented on a wide scale.

Finally, in order for HWTS to be effective in preventing disease, it must be used correctly, consistently and exclusively, especially among vulnerable groups. This requires not only that HWTS is introduced in a way that ensures uptake, but also that solutions are accessible, affordable, acceptable and sustainable. Much of the current research concerning HWTS is addressing these issues. Government should evaluate HWTS options not only on the basis of their microbiological efficacy, but also on these other factors critical to the success of their implementation. Further information on HWTS options and criteria for evaluation is presented in Module 2.

5.2.2 Targeting HWTS

HWTS can make significant contributions to health by improving water quality and preventing recontamination in the home. This is especially true if it targets vulnerable populations that could benefit most from the intervention. Governments also need to

consider under what circumstance HWTS would be most applicable. HWTS, combined with improved hygiene, may be most appropriate for those:

- affected by conflicts and natural disasters who are displaced or whose normal water supplies are interrupted, overwhelmed or unavailable, forcing reliance on surface or other unprotected and untreated supplies;
- affected by outbreaks of waterborne diseases, such as cholera or dysentery; and
- who have sufficient quantities and access to water on a year-round basis, but it is of poor or unreliable microbiological quality.

These first two circumstances involve emergencies or other situations that usually cover limited populations for a limited period of time. Even if an emergency continues, HWTS may be most effective in the early stages of the emergency response, being eventually replaced by other solutions that address not only water quality but also quantity and access (e.g. transporting large quantities of treated water to tanks and bladders or treating large quantities of water on site and providing local distribution). Emergency preparedness is an essential role of government, and an HWTS component (e.g. stockpiling chlorine tablets) should be considered as an important part of response plans.

As discussed in Module 4, the third circumstance above provides the largest potential opportunity for HWTS, among those who are able to meet their basic needs for water quantity and access but whose water sources are not safe. This includes those people using sources that are "unimproved" (e.g. lakes, rivers and other surface sources; unprotected wells and springs). "Improved" sources are also often of poor microbiological quality, and water that is safe at the point of collection can be recontaminated due to poor hygiene practices and unsafe storage in the home. A large segment of the population in many countries could, therefore, potentially benefit from HWTS.

Consideration should also be given to how HWTS might benefit other specific vulnerable groups, including children less than 5 years of age, people living with HIV/AIDS, the malnourished and others with undeveloped or impaired immune systems.

5.2.3 Gathering information

Government officials have an important role in gathering, analysing and interpreting relevant information to determine what role, if any, HWTS should play in government strategies to promote safe water and prevent waterborne disease. The following are sources of information that should be consulted.

NATIONAL STRATEGY AND ACTION PLANS. National strategy and action plans establish governmental priorities on health, rural development, water and sanitation, etc. They determine how funding, staffing and other resources are to be allocated. They should be examined to determine whether HWTS is consistent with and may help achieve existing government priorities.

NATIONAL HEALTH AND WATER COVERAGE STATISTICS. National health statistics should also be examined to determine how significantly diarrhoea and other waterborne diseases contribute to overall levels of disease. The levels of access to improved water supplies and current use of HWTS should also be reviewed. Possible sources of these data include the World Health Organization Global Health Observatory, Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and the World Bank's Living Standard Measurement Study (LSMS) databases. As well as helping to determine the priority given to HWTS, these data may help identify specific areas and vulnerable populations that would benefit most from HWTS.

RESEARCH AND REPORTS. Government officials should also undertake a review of relevant research, pilot programmes, programme assessments and reports that provide information on the effectiveness, uptake and sustainability of HWTS and other water quality interventions, especially those conducted in the country. This will both help to assess the priority given to HWTS and allow government to learn lessons from previous experiences.

SURVEY OF HWTS ACTIVITIES AND PARTICIPATING STAKEHOLDERS. A survey should also be undertaken to determine what HWTS activities have been carried out in the country, not only by the public sector but also by international organizations, nongovernmental organizations, community-based organizations and private companies. Various sources can help identify stakeholders, including those listed in the resources section of Module 1.

5.3 Establishing a national strategy and action plan for HWTS

If government decides to take an active role in HWTS, then the next step is to develop an initiative. This may take the form of a policy, a national strategy or an action plan. This section describes a proven approach that government could use in developing such an initiative.

5.3.1 Stakeholder workshop

Depending on the setting, developing an HWTS strategy may be done exclusively by government or with the participation of all stakeholders. If it is done exclusively by government, consideration should at least be given to involving regional, district and local officials who will play an important role in implementing the strategy. It is highly recommended, however, that all stakeholders involved in HWTS implementation contribute to development of the strategy.

Regardless of who will actually develop the strategy, there is value in ensuring that it reflects the experience and lessons learnt from others involved in HWTS. In a growing number of countries, this has been accomplished by organizing a national workshop on HWTS.

These workshops often include participation by ministries such as health, water and rural development that are able to describe the current situation of water, sanitation and public health in the country. If funds are available, international experts can be invited to present the latest research on HWTS, and other governments with prior experience in developing HWTS strategies can summarize their approach and recommendations. It is also essential to hear from those actively involved in promoting or implementing HWTS in the country including governmental officials, international organizations, nongovernmental organizations, community-based organizations and the private sector. They should be encouraged to present a candid assessment of the successes and challenges they have faced and the lessons learnt. Above all, each of the participants should be asked to give specific recommendations on the role of government in supporting HWTS in the country.

5.3.2 Developing a purpose and a goal

The first step is to define a purpose for the strategy. Since the main objective of any HWTS activity is to improve health, the purpose should focus on reducing disease. It should also stress the need to target HWTS to populations that could benefit the most. Finally, it is important for the HWTS strategy to be placed in the context of existing government priorities. This may be done by quoting or referring to other relevant policies and national priorities.

It is also important to set an overall goal of the strategy. It should be specific, measurable, objective, realistic and time limited. It should also be aligned with the purpose for the strategy, i.e. while the goal may be stated in terms of coverage, like the MDG water target, it should also focus on the impact on disease.

It may also be useful to add specific objectives to the purpose and goal. The process of defining objectives can help clarify the aim of the strategy and how success would be defined. This will make it easier to implement the strategy and resulting actions later.

5.3.3 Guiding principles

Developing guiding principles on which the strategy will be based can help to keep it focused on its purpose and goal. Among other things, these guiding principles may include the following:

- An acknowledgement that since the objective of HWTS is improving health, all elements of the strategy will be evaluated on the basis of its contribution to health.

- An acknowledgment of government's responsibility to ensure the safety and effectiveness of HWTS options promoted in the country, particularly because users alone may not be able to judge the microbiological performance of the HWTS options.
- An expression of the role of government in facilitating demand for HWTS, pursuing a demand–response approach, and subsidizing products for certain targeted populations.
- An expression of government's role in prioritizing HWTS initiatives, regulating HWTS products, securing necessary support and monitoring progress.
- A statement recognizing the need for correct, consistent use of HWTS over the long term.
- An acknowledgement of the role of HWTS in response to emergencies and outbreaks and need for government to ensure that the strategy addresses this need.
- An acknowledgement of the need for the HWTS strategy to be based on evidence, experience and lessons learnt, and to support high-quality and relevant local research.
- A confirmation that safe drinking-water is necessary but cannot alone ensure human health. As such, HWTS initiatives are part of a comprehensive strategy to ensure access to adequate quantities of safe water, good personal hygiene practices and environmental sanitation.
- An acknowledgement of the role of local manufacturers and vendors in developing HWTS options that are sustainable and based on local context.
- Recognizing the role of local universities and research institutions in conducting research in HWTS options and furthering public health agenda.

5.3.4 Developing national strategies and action plans

Once the purpose, goal and guiding principles have been established, general strategies and specific actions to achieve them can be developed. Once again, this should be done wherever possible with the involvement of all stakeholders.

Two general approaches have been used to develop these strategies and actions:

1. **Action-focused approach.**
2. **Strategy-focused approach.**

The action-focused approach begins by developing a list of actions that should be completed. This is done by first brainstorming and then organizing these ideas into categories. These categories can then be converted into specific strategies. To help with the process and ensure actions at all levels, workshop participants are asked to group themselves by occupation and develop actions based on their roles as policy-makers, technical experts, researchers, implementers, product manufacturers and sellers, etc. The result might be a set of action items that fall into the following categories:

1. **Government policy, regulation and planning:**
   a. policy,
   b. regulatory matters,
   c. leadership, advocacy and administration.
2. **Create demand by increasing understanding and awareness of HWTS.**
3. **Coordination among HWTS implementers.**
4. **Improve access to HTWS by vulnerable populations.**
5. **Promote research, monitoring and evaluation.**

The strategy-focused approach begins by developing the basic strategies, and then focusing on the specific action items. This approach may be more difficult in a workshop setting, and may require additional efforts after the brainstorming sessions to bring the ideas together in a cohesive strategy. Nevertheless, because it is focused on strategy, it may yield a more comprehensive plan. Appendix 1 contains an example of a strategy developed in the United Republic of Tanzania using this approach. The major strategies that were developed include the following:

1. Position effective HWTS as a policy priority.
2. Review and enhance the regulatory framework for HWTS.
3. Build institutional capacity to support HWTS.
4. Improve coordination of efforts to promote HWTS.
5. Encourage the development, testing, manufacture and introduction of effective HWTS technologies and delivery strategies in the country.
6. Increase understanding of the need for HWTS.
7. Use information, education and communication (IEC) to build awareness of and demand for effective HWTS.
8. Take steps to improve the use of HWTS in emergency response.
9. Undertake relevant, practical and rigorous research to improve the targeting, performance, delivery and adoption of HWTS.
10. Secure necessary financial support for implementation of the national action plan for HWTS.

5.4 Implementing the national strategy and action plan for HWTS

Once the HWTS strategy and action plan have been clearly defined, the hard part begins: putting them into action. If implementation has been considered at every step of strategy development, then it will be easier to put the plan into action. Other key factors that play an important role in achieving the purpose and goals of the strategy are discussed in the following sections.

5.4.1 Securing political support and necessary resources

Throughout this module, we have emphasized the need to place the HWTS strategy and action plan in the context of the existing water situation, local waterborne diseases, and policies and national priorities. We also have emphasized the need to ensure that the strategy is targeted at populations at greatest risk. All of these steps are intended to help secure political support for the strategy, which is required for success.

While political support is necessary, support alone is not sufficient for the HWTS strategy to be effective; it must be accompanied by funding and other resources. While nongovernmental organizations and the private sector may have funding to implement their own programmes, the role of government in supporting HWTS cannot be undertaken without some commitment of government funding, staffing and mobilization of resources.

5.4.2 Building awareness, capacity and commitment at lower levels of government

Much of this module has focused on government at the national level, where policy is usually developed and translated into strategies and action plans. However, HWTS is a household-level intervention and unlike large infrastructure projects, HWTS must be driven at the district and local levels. This means building awareness, capacity and commitment at these levels, as well as providing necessary support, ensuring proper programme delivery and demanding accountability.

5.4.3 Coordinating and leading HWTS efforts

Effective implementation of HWTS involves a variety of ministries, agencies, authorities and research institutions within government, as well as the participation of nongovernmental organizations and the private sector. Government has an important role in bringing together and coordinating the efforts of all these stakeholders. This not only requires that government support HWTS initiatives but also helps ensure they are accountable by regulating and monitoring their safety and effectiveness and encouraging implementers to target populations at highest risk.

At the national level, it is helpful to engage all appropriate ministries to develop a coordinated strategy for HWTS. This may include the ministries of health, water, development, education, agriculture, rural affairs, urban affairs, etc. At the same time, a single ministry, such a health or water, must take the lead in order to move the plan forward. If an inter-ministry committee or other body exists to coordinate drinking-water policy, its mandate can perhaps be expanded to include HWTS. If not, the ministries should establish a task force or other coordinating body to oversee implementation of the HWTS strategy and action plan. This body should also invite participation from representatives of all stakeholders.

5.4.4 Monitoring progress and making adjustments

Finally, government has a role in monitoring progress in the implementation of its HWTS strategy. This may require establishing new indicators and monitoring systems to collect reliable data on coverage and impact. It may also mean improving laboratory and field services and the development of new tools to assess the safety and efficacy of HWTS products and to ensure correct, consistent and sustained use. Once again, these resources should be provided strategically in order to ensure that populations at greatest risk of waterborne disease receive highest priority.

5.5 Case study: United Republic of Tanzania

Diarrhoeal diseases are the fourth-largest killer of children under 5 years of age in the United Republic of Tanzania. The country also suffers from cholera and other outbreaks of waterborne disease; flooding is also common. Despite significant progress increasing the coverage of improved water supplies, 45% of the rural population still relies on surface water and other unprotected sources. While HWTS matched with government priorities, and various nongovernmental organizations and private companies were promoting the practice, there was no specific strategy for promoting effective HWTS in the country, and no budget or other resources allocated to its development.

After reviewing various options for developing a strategy, representatives from different ministries formed a working group to organize an international conference on household water management for waterborne disease control in February 2009. The conference was part of the annual international/regional forums of the International Network to promote Household Water Treatment and Safe Storage; it followed similar conferences in Ethiopia, Ghana, Indonesia, Kenya, the Lao People's Democratic Republic, the Philippines and Viet Nam, each of which resulted in development of a national strategy or action plan

for HWTS. The conference was organized by the Government of the United Republic of Tanzania and supported by WHO, UNICEF and PSI. The opening of the conference was officiated by the Minister for Health and Social Welfare and was closed by the Permanent Secretary, Tanzanian Ministry of Water and Irrigation. A total of 108 participants, 86 from Tanzania mainland and Zanzibar, and 22 from Canada, the Congo, Ethiopia, Kenya, Liberia, Norway, the United Kingdom of Great Britain and Northern Ireland and the United States of America attended.

The conference discussed the link between HWTS and the control of waterborne diseases and was the first in a series of international conferences to explore the role of HWTS and cholera control. The four main objectives of the conference were:

1. **to learn from international experiences,**
2. **strengthen national initiatives on expanding HWTS,**
3. **develop and strengthen national and international partnerships,**
4. **share experience and document the different programmes taking place within and outside the country.**

The conference provided an opportunity for high-ranking officials from the Tanzanian Ministry of Health and Social Welfare, as well as the Ministry of Water and Irrigation, to express their strong support for the development and expansion of HWTS in the United Republic of Tanzania. The conference included presentations of scientific information, field experiences and recommendations, discussions, as well as demonstrations of HWTS technologies with high potential to improve water quality and reduce diarrhoea. It emphasized the importance of strengthening collaboration through the International Network to Promote Household Water Treatment and Safe Storage.

A framework for a National Action Plan on HWTS was developed to guide the country towards development of national plans and strategies to scale up HWTS (see Appendix 1). The framework was built on the foundations proposed from a national workshop and recognized the larger context of water, hygiene and sanitation policy. Agreement on main steps to be taken was reached by the United Republic of Tanzania following the conference to guide scaling up HWTS. These steps are summarized below:

The following action items were agreed upon and adopted as a way forward:

1. The United Republic of Tanzania should define the scope and meaning of household water treatment and safe storage (HWTS) or the proposed household safe water management for purposes of waterborne diseases control, setting clear definitions and boundaries. The scope of HWTS defined under the national policy/strategy should be focused to address cholera and diarrhoea disease prevention and control.

2. Household water treatment and safe storage should be based in the Ministry of Health and Social Welfare in order to maintain its intended goal to contribute to waterborne disease

reduction. The MOHSW should therefore establish a steering mechanism to propagate the establishment and development of HWTS services in the United Republic of Tanzania.

3. A subcommittee on HWTS was recommended to be formed to operate under the National Steering Committee on Water and Sanitation. HWTS activities should not be developed as part of a stand-alone strategy but should be established from within the existing hygiene and sanitation framework as well as the existing diarrhoea control framework by the Directorate of Preventive Services.

4. Terms of reference and institutional arrangements for HWTS should be drafted for approval as soon as possible.

5. The Government of the United Republic of Tanzania and other stakeholders should work together to develop a comprehensive country plan for scaling up HWTS services that would allow effective service provision and address the need to provide for most vulnerable groups and the poor.

6. The proposed national policy/strategy should identify and define the roles and responsibilities of the two key ministries; the Ministry of Health and Social Welfare and the Ministry of Water and Irrigation, and other sector ministries.

7. The Ministry of Water and Irrigation should incorporate HWTS plans in its national water supply plans, and make HWTS a standing agenda in small-scale water development projects.

8. The Ministry of Health and Social Welfare should spearhead the development of an effective mechanism to coordinate stakeholders, such as establishment of a country-level network or nationally recognizable periodic forum, e.g. annual forum.

9. The United Republic of Tanzania should review its structures in order to provide for necessary policy, economic and social atmosphere for sustainability of interventions. These include economic incentives.

10. The Government of the United Republic of Tanzania should strengthen its coordination mechanism to effectively strengthen links between the government and international partners, between Tanzania mainland and Zanzibar, and between government ministries.

11. The United Republic of Tanzania needs to establish standards and conducive HWTS product registration procedures for quality control and maintenance of necessary public health and safety requirements.

12. Research capacity should be strengthened by focusing research from evidence of effectiveness to ways in which HWTS can be scaled up and achieve more impact on diarrhoea.

13. The Government of the United Republic of Tanzania should commit itself to funding for HWTS among essential health interventions as well as complementary water quality improvement services.

14. The International Network to Promote HWTS will serve as the coordinating entity to ensure that Tanzania will benefit from the latest advances, implementation experiences, regulatory and policy development, as well as good practices from other countries. Furthermore the Network will act to ensure that the international community learns and benefits from the experiences and expertise of the United Republic of Tanzania.

15. To this end, the Tanzanian Ministry of Health and Social Welfare should appoint a person to the link the Ministry with the global Network.

The report on the conference concludes with a number of recommendations:

1. **The MOHSW** should take the necessary steps to develop a National Action Plan and Strategy and engage other stakeholders into actions on HWTS as promptly as possible.
2. **The MOHSW** should make use of the established link with the international community to strengthen international partnership and mobilize resources to drive forward the HWTS agenda.
3. **Government, partners and stakeholders** should allocate the much-needed funds to support initiation and implementation of sustainable HWTS projects in order to realize substantial impact on waterborne diseases.
4. **The United Republic of Tanzania** should strengthen the evidence-base foundation from initial stages of HWTS programme implementation through monitoring and evaluation, and should develop appropriate standards to guide the implementation process towards the goal.
5. **The United Republic of Tanzania** should develop and strengthen an appropriate country-level coordination and networking mechanism in order to join forces and optimize plans and actions of stakeholders.

Following the 2009 workshop, the United Republic of Tanzania was involved in a second workshop that was held in Uganda and included government officials, implementers, researchers and manufacturers from five East Africa countries (Ethiopia, Kenya, Rwanda, the United Republic of Tanzania, and Uganda) as well as international stakeholders. The workshop was facilitated by WHO and UNICEF, with support from the Ugandan Government (WHO/UNICEF 2012). At this workshop, the United Republic of Tanzania further developed and refined its National Action Plan and exchanged ideas and approaches with neighbouring countries with similar diarrhoeal disease and drinking-water quality challenges. In August 2012, the Government of the United Republic of Tanzania formally adopted the Action Plan and is now working with partners to implement the activities outlined in the plan.

5.6 SUMMARY OF KEY MESSAGES

- **Government has an essential role and significant responsibilities in optimizing the impact of HWTS.**
- **Developing a national strategy and action plan for HWTS should be undertaken factoring into account existing conditions and other public health priorities in the country.**
- **Government should target areas and populations where HWTS will be most applicable and successful.**
- **HWTS should not divert resources away from long-term government efforts to provide sustainable access to safe drinking-water, including piped water supply.**
- **There is value in ensuring that a national strategy and action plan for HWTS reflect the experience and lessons learnt from others. In several countries, this has been accomplished by organizing a national workshop on HWTS to bring the stakeholders together.**
- **If implementation has been considered at every step of strategy development, then it will greatly help in putting the plan into action.**
- **Effective implementation of HWTS involves a variety of ministries, agencies, authorities and research institutions within government, as well as the participation of nongovernmental organizations and the private sector. Government has an important role in bringing together and coordinating the efforts of all these stakeholders.**
- **Government has a role in monitoring progress in the implementation of its HWTS strategy as well as coordinating efforts to ensure it meets its goals.**

THE UNITED REPUBLIC OF TANZANIA,
MINISTRY OF HEALTH AND SOCIAL WELFARE

COMPREHENSIVE COUNTRY PLAN FOR SCALING UP HOUSEHOLD WATER TREATMENT AND SAFE STORAGE, 2011–2016

DRAFT 1

Prepared by

Ministry of Health and Social Welfare

Preventive Department

Environmental Health and Sanitation Section

September, 2011

APPENDIX

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Recommendations of the international conference on household safe water management for waterborne diseases control, 4–6 February 2009, bagamoyo, tanzania as adopted from conference report.

I. Foreword

Consumption of unsafe water continues to underlay diarrhea diseases burden in developing countries. Four (4) billion people suffer from diarrhea and 2.2 millions die every year for causes related to consumption of unsafe water and poor sanitation worldwide. About 1.7 million diarrhea cases occurs every year in Tanzania alone mostly affecting children under the age of five years. Inspite of many efforts to improve access to safe water supply, about 47% of rural and at least 20% of urban Tanzania populations live without the access to safe water[1]. Given the underlying poor sanitation and hygiene situation and low access to safe water, communities stand a great risk of contracting waterborne diseases.

Household Water Treatment and Safe Storage (HWTS) are widely being described as biologically effective and economically efficient approaches to control diarrhea diseases. Treating water at point of use ensures that water is safe before consumption regardless of the sources, thus ensure family or community protection against diarrhea. In addressing the need to reduce diarrhea incidences and the present challenges of access to safe water, the Ministry of Health and Social Welfare (MoHSW), has developed a Comprehensive Country Plan for Scaling up Household Water Treatment and Safe Storage to be implemented at National, Regional and District Levels.

It is the expectation of the Government that, this document will be used by all stakeholders for the promotion of HWTS in the country and lead to significant reduction of diarrheal disease burden.

Dr Deo Mtasiwa

Chief Medical Officer

[1] United Republic of Tanzania, National Bureau of Statistics, Household Budget Survey, 2000–2001

II. Acknowledgement

The Comprehensive Country Plan for Scaling up Household Water Treatment and Safe Storage is a result of combined efforts of the Ministry of Health and Social Welfare (MoHSW) and other stakeholders. The Ministry of Health and Social Welfare acknowledges with great appreciation the valuable support of UNICEF and WHO, who met the financial costs of the initial preparation and finalization of this document.

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The Ministry is grateful for their effort and wishes to thank them for a job well done.

Dr Donnan Mbando

Director, Preventive Services

Ministry of Health and Social Welfare

III. Acronyms

BCC	Behavioral Change Communication
CCHP	Comprehensive Council Health Plan
CSOs	Civil Society Organisations
DHO	District Health Officer
DWST	District Water Supply and Sanitation Team
EHU	Environmental Health Unit
FP	Focal Person
HWTS	Household Water Treatment and Safe Storage
IEC	Information Education Communication
M&E	Monitoring and Evaluation
MDAs	Ministries, Departments and Agencies
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania
MUHAS	Muhimbili University of Health and Allied Sciences
NAWAPO	National Water Policy
NGO	Non- Governmental Organization
NSCSH	National Steering Committee on Sanitation and Hygiene
NSHC	National Sanitation and Hygiene Committee
NSHP	National School Health Programme
NTCSSH	National Technical Committee on School Sanitation and Hygiene
NWSDP	National Water Sector Development Program
PMO-RALG	Prime Minister's Office Regional Administration and local Government
PS	Permanent Secretary
RAS	Regional Administrative Secretary
RWST	Regional Water Supply and Sanitation Team
ToR	Terms of Reference
UN	United Nations
UNICEF	United Nation Children Fund
VC	Village Committee
WASH	Water Sanitation and Hygiene
WHO	World Health Organization

IV. Definition of terms

- ***HOUSEHOLD WATER TREATMENT*** is the application of means (physical or chemical methods) to render water safe for drinking or other domestic uses at point of use, particularly in households.

- ***SAFE STORAGE*** means the use of protective vessel to keep treated water free from contamination or recontamination.

- ***HOUSEHOLD WATER TREATMENT AND SAFE STORAGE*** is the combination of water treatment, safe storage, hygiene, and sanitation measures applied at point of water use for disease prevention and health improvement purposes.

- ***WATER SAFETY AT POINT OF USE*** in this context refers to treatment and safe storage actions applied at point of use but may include other aspects of water safety management for public health protection.

- ***WATER QUALITY*** refers to microbial water content and its relation to water borne disease transmission. Notwithstanding the fact that, HWTS may lead to significant improvement in physical and chemical quality of treated water.

- ***SAFETY*** means being free from hazard. In this context hazard will refer to microbial hazards associated with drinking water, poor hygiene, and sanitation.

- ***POINT OF USE*** means at a place where water is being consumed. It includes households, public institutions (schools, markets, prisons etc), and emergency or disaster camps.

- ***FOCAL PERSON*** is an official person responsible to coordinate HWTS activities in a given locality or jurisdiction and provide information to the appropriate authorities

V. Executive summary

Diarrhoea is a leading cause of morbidity in Tanzania. At least 1.7million diarrhoea patients attend healthcare facilities. Diarrhoea accounts for 5%(16% from WHO) annual deaths among children below the age of 5year and also contributes to the deaths of population above 5 years . In rural areas,every year within six month 86% of households experience diarrhoea episode(s) Refference/look for current data. High prevalence of diarrhoea (and other waterborne diseases) is attributed to low access to safe water, poor sanitation, and hygiene conditions in rural and urban areas. This public health risk remains particular important as populations continue to drink water that is contaminated at source, or in the process of collection, transportation, and unsafe storage. Addressing water safety gap at household level therefore, is critical for the prevention of waterborne diseases.

The Ministry of Health and Social Welfare (MOHSW) has adopted Household Water Treatment and Safe Storage (HWTS) among strategic approaches to diarrhoea prevention. HWTS interventions are geared at bringing significant improvements in drinking water safety and subsequently reduce the burden of waterborne diseases. Notwithstanding the fact that HWTS methods are effective in reducing diarrhoea, a substantial level of adoption and appropriate use of HWTS methods complimentary to hygiene and sanitation improvements are necessary for reduction of diarrhoea diseases.

The Comprehensive Country Plan for Scaling up Household Water Treatment and Safe Storage (CCPS-HWTS) is the country level framework for implementation of HWTS actions. , the CCPS-HWTS establishes an institutional framework for operation of HWTS activities and mechanism for coordination of stakeholders with a goal of leveraging the use of HWTS among households. The CCPS puts into action the deliberations of the "International Conference on Household Safe Water Management for Waterborne Diseases Control" Bagomoyo February 4th–6th 2009, and recommendations of follow up "National Survey on Household Water Treatment and Safe Storage" conducted in June 2009. These high level technical recommendations were translated into the following key areas under the CCPS – HWTS objectives;

- Creation of enabling environment for the implementation of HWTS,
- Increase awareness on the role of HWTS for human health and wellbeing,
- Strengthening coordination among HWTS stakeholders,
- Mobilizing resources for effective implementation of HWTS activities, and
- Establishment of monitoring and evaluation for HWTS projects.

The CCPS defines the national targets for HWTS and subsequently translates the main objectives into workable actions that are planned to take place between 2011 and 5015.

1. INTRODUCTION

1.1. Background

Diarrhoea continues to increase the burden of morbidity and mortality globally. It kills an estimated 2.5 million people each year, the majority being children under 5 years. An estimated 4 billion diarrhoea cases that occur annually account for 5.7% of the global burden of disease and place diarrheal disease as the third highest cause of morbidity and sixth highest cause of mortality. Low access to safe water and poor sanitation conditions prevailing in most households poses risks of increasing disease transmission. Consumption of unsafe water is responsible for transmission of a number of diseases including diarrhea, typhoid fever, cholera, dysentery, poliomyelitis, and intestinal worms. However, keeping water safe minimizes the risk of pathogen transmission through drinking water. (give the background of Tanzania more than global)

Large proportions of populations in developing countries remain inadequately supplied with safe water. Similarly, those drawing water from safe sources may consume it unsafe as a result of contamination after drawing. Consumption of unsafe water accounts for 1.7million global deaths due to diarrhoeal diseases. About 99% [reference] of deaths occur in developing countries, predominantly affecting children (90%). Diarrheal diseases are an important cause of malnutrition, leading to impaired physical growth and cognitive development, reduced resistance to infection, and potentially long-term gastrointestinal disorders by inhibiting normal consumption of foods and adsorption of nutrients.

Improving access to safe water and assurance of safety at point of use has significant benefits in reducing disease occurrence. Access to water supply alone reduces diarrhoea morbidity by 25% while treatment of water at point of use reduces 50% of diarrhoea morbidity. However, a substantial proportion of rural and urban populations are likely to remain without access to improved water supplies within the foreseeable future (why? substantiate). This service gap signifies the need for employing affordable low cost practical technologies to enable individuals and households treat and maintain safety of water at point of use, of which Household Water Treatment and Safe Storage is most ideal.

1.2. Situational analysis

Tanzania bears a high burden of waterborne diseases. About 86% of rural households experience diarrhoea incidence every six months (MOHSW 2010[2]), and 1.7million diarrhoea victims attend healthcare facilities in a year. Diarhoea diseases remain number 4 major cause of admissions among under-five and above-five years age groups: Children under-five years have been the most affected with diarrhoea in which it causes 5% of deaths. Diarrhoea diseases kill more children than any disease in Tanzania after Malaria, Anaemia, and Pneumonia(MOHSW 2008[3]).

In recent decades Tanzania experienced rising cholera outbreaks which spread in regions including the city of Dar Es Salaam[4]. As many as 69,855 cholera cases have been reported in less than10 years time (between 1998 and 2006) leading to loss of 2,045 lives.While contaminated water, poor sanitation, and hygiene have frequently been indicated as the means of disease transmission, measures

2 Ministry of Health and Social Welfare, Report of the National Survey on Household Water Treatment and Safe Storage, June 2009 (correct to match with the above)

3 Ministry of Health and Social Welfare, Annual Health Statistical Abstract; 2008.

4 Ministry of Water and Irrigation, Water Quality and health aspects; http://www.maji.go.tz/modules/documents/index.php? (access on September 29, 2008).

to prevent and control the disease have been hampered by the prevailing shortage of safe water and unsound sanitation infrastructure.

Access to safe water for Tanzania is still low ranging from 11.4% population in Lindi to 74.1% in Kilimanjaro regions. About forty seven percent (46.5%) of people in rural areas and 27% in urban, do not have access to safe water yet[5]. Eighty three percent of national population use onsite excreta disposal facilities, of which more than half (53%) do not meet minimum requirements for disease prevention.

The current deficit in water supply services, sanitation and hygiene infrastructure continue to leave many Tanzanians at risk of diarrhoeal diseases including cholera outbreaks and resources remain inadequate to meet community needs for safe water within short and medium terms. There is therefore a compelling need to adopt practical short term approaches, complementary to larger scale community safe water supply interventions, in addressing safe water requirements of the underserved populations. Low cost HWTS options remain practicable solution for timely and equitable water safety for households from health and economic points of view.

In realization of the HWTS potential to reduce waterborne diseases, the MOHSW found it beneficial to adopt low cost safe water technologies in the prevention and control of waterborne diseases with focus on the poor and vulnerable. HWTS interventions are intended to compliment current measures used in prevention and control of waterborne diseases, which include sanitation improvement, hygiene promotion, and provision of water supply services to rural and urban communities.

To effect of HWTS interventions, the MOHSW in collaboration with the Ministry of Water and Irrigation and other national and international stakeholders initiated a national process for scaling up HWTS, from June 2008. The Ministry has since coordinate national and international stakeholders who worked together towards realization of the goal of safe water to all for health gains. These efforts led to the holding of the "international conference on household safe water management for waterborne disease control, Bagamoyo" in February 2009 and a National Survey on HWTS in June 2009. Both activities were performed with substantial support and close collaboration with UNICEF and WHO.

A national Survey on HWTS was conducted to determine diarrhoea experiences among rural households and assess involvement of various stakeholders in the prevention and control of the disease through improving water safety at household level. The purpose of the survey was to provide realistic view of the situation in Tanzania in order to guide the Government on how to put into action the recommendations from stakeholders' forums. The survey revealed a number of important facts including; a wide gap in access to safe water among rural households, where 75% of enrolled households obtained water from unsafe sources. It was also shown that 50% of the households employed some measures to improve water safety at home, which indicated low level of HWTS practices. It was also learned that households that used unsafe water had higher risk (2.7 times) of experiencing diarrhoea compared to those that used safe water sources.

Furthermore the survey showed that three factors namely presence of promotional activities, relative affordability of HWTS options (measured as ability to pay for HWTS methods), households' perception of safety of the water they used, and distance of household from water source. However, the study found that there were very few non-governmental stakeholders that were involved in promoting HWTS and that there was no government programs that supported households' adoption of HWTS at local government levels. These findings brought a considerable level of understanding and a guide to the key that would be necessary for HWTS programs at the current stage. Recommendation of the national survey (Annex II) and the way-forward of the Bagamoyo conference (Annex III) formed the basis for development of this action plan. (revisit the paragraph and simplify by indicating the variation of promotional activities and where there is NGOs and where there is not).

5 United Republic of Tanzania, National Bureau of Statistics, Household Budget Survey, 2000/01

GAPS

HWTS is implemented by a number of stakeholders yet they are not well coordinated There is weakness in coordination of stakeholders.

2. CCPS-HWTS CONTRIBUTION TO NATIONAL DEVELOPMENT VISION AND STRATEGIES

The CCPS-HWTS addresses the Tanzania development vision 2025. It facilitates attainment of quality livelihood target through improving access to quality health care services. The CCPS puts into action objectives of the leading policy in the health sector. The CCPS is structured to operate within the framework of the national development strategies and policies in the following areas:

2.1. Contribution to National Strategy for Growth and Reduction of Poverty (NSGRP)/MKUKUTA II

The CCPS address the second cluster, Goal 3 and 4 of the NSGRP 2011-2016 which deals with "Quality of life and social well being, which focuses on how to deliver quality social services in education, survival, health and nutrition, clean and safe water, sanitation,

decent shelter and a safe and sustainable environment to reaching more of the targeted poor." the CCPS will address the mentioned goals through promoting human health and preventing diseases. It will contribute to the specific NSGRP areas under cluster II;

Addressing Infant and Child Health and Nutrition: Where by household water treatment and safe storage is geared at reducing diarrhoea and other water borne diseases thus contributing to the reduction of under five mortality and improving well-being of children and the nation at large.

Addressing Sanitation and Hygiene: The HWTS mechanism emphasizes on the reduction of diarrhoea and cholera episodes by enhancing prevention and control measures in communities. The overall goal of the HWTS interventions is to increase wellbeing of those without access to safe water by rendering it safe at point of use (households) and advocate for provision of safe water to the underserved communities, and vulnerable groups.

2.2. Contribution to the National Health Policy

CCPS-HWTS will contribute to improvement of public health through reduction of waterborne diseases. HWTS interventions will enable poor households access safe water at point of use without regarding their source. These interventions will lead to improvement of water quality at homes and promote healthy behaviours, hence improve health of the vulnerable and poor, as well as increasing wellbeing of people.

2.3. Implementation of the Health Sector Strategic Plan III (HSSP III)

Having its focus on prevention and control of water borne diseases the CCPS will specifically address strategy 8 of the HSSP III. This Strategy address the prevention and control of communicable and non communicable diseases; including diarrhoea, cholera, other water born diseases, and opportunistic

infections. These and other priority diseases are important CCPScauses of morbidity and mortality with potential for life threatening outbreaks. As part of diarrhoea prevention, HWTS will link with sanitation, hygiene, and hand washing strategies, which will strengthen comprehensive environmental health approach to diarrhoea control. HWTS will also be intergrated with other complementary infection control programs like Maternal and Child Health, emergency preparedness and response, and home based treatment and care services.

This CCPS will facilitate participation of private providers on HWTS services hence strengthening public private partnership for health in accordance to Strategy 6 of the HSSP. Together with the government, private for profit and not-for-profit organizations and civil societies have been participating in varieties of activities to promote HWTS for health benefits. Within the framework of this CCPS, operations of private stakeholders will be enhanced through improvement of stakeholders coordination at all levels.

2.4. Implementation of the National Environmental Health, Hygiene, and Sanitation Strategy (NEHHSAS)

The NEHHSAS recognizes access to clean and safe water among key environmental indicators of health, as it attributes a number of infectious diseases (including diarrhoea, dysentery, cholera, and worm infection) to use of unsafe water. Strategic Objective 3 of the NEHHSAS provides for the need to empower communities to make informed decisions and take actions to improve their environment for better health. It includes the provision of information and use of affordable technologies to improve environment for better health.

NEHHSAS targets at having food borne, waterborne, and airborne diseases reduced by 50% of the levels present in 2008. In this regard, the CCPS-HWTS will employ appropriate technologies and promotional strategies to help households improve water at point of use thereby reducing the diarrhoea prevalence.

2.5. Contribution to Millennium Development Goals (MDG)

By rendering water safe before consumption HWTS partly contributes to the MDG No. 7 which targets at “halving the proportion of people without access to safe water by 2015”. Nevertheless achieving “universal access” to safe water remains an important long-term goal. HWTS complements to UN agenda on water supply that declares 2005 to 2015.

2.6. “Water for Life” - the international Decade for Action and setting of the world agenda on a greater focus on water- related issues. Scope of the CCPS-HWTS

The CCPS encompasses HWTS interventions in both rural and urban areas. It integrates HWTS operations of governmental and nongovernmental stakeholders including Non-Governmental Organizations (NGO), Commercial companies, Civil Societies, individuals, and groups within Tanzania national borders. It concerns application of measures to gain safety of water at households or communal points of use (such as in schools, markets, or disaster gatherings) in relation to control waterborne diseases. HWTS will be concerned with efforts to increase access to safe water but only limited to promotion and advocacy and not actual provision of safe water supply services. This CCPS will be operational for a period of 5 years between 2011 and 5016.

1. Rationale

Diarrhoea kills many children and causes suffering to significant percent of young and adult population. Safe water, an important media for the disease control is not accessible to most in need. There is a compelling need to take concerted actions and employ HWTS in the control of water born diseases to safeguard health of populations, particularly the poor and vulnerable. While it is effective and cost effective to promote HWTS for health gains, appropriate water treatment methods are currently under utilized and the present infrastructure is inadequate to promote them.

At this juncture it has been important that a national plan of action is formed in order to transform HWTS into a practical water safety solution that will bring health gains to people who needs it. CCPS-HWTS provides an appropriate framework for implementation of HWTS and suitable mechanism for coordination of actors. The CCPS is a tool for mobilization of resources, and enhancing utilization of best scientific knowledge and affordable technologies to bring the health benefits of HWTS to people. As a planning tool the CCPS puts together missions of many stakeholders into a common framework that will help to objectively define and address common targets.

2. Vision, mission, goal and objectives

2.1. Vision

To have communities accessing clean and safe drinking water at household level

2.2. Mission

To ensure availability and use of effective and affordable Household Water Treatment and Safe storage options to all Tanzanian households, taking into account the vulnerable and poor

2.3. Goal

To increase by 20% the usage of acceptable Household Water Treatment and Safe Storage methods in households by 2016

2.4. Objectives

2.4.1. Broad Objective

To empower people to manage their drinking water in households so as to prevent and control diarrhoea and other waterborne diseases.

2.4.2. Specific Objectives

Specifically, the CCPS for HWTS aims to:

1. Establish support system for HWTS interventions by 2016
2. Strengthen coordination amongst key actors and stakeholders on HWTS by 2016
3. Increase access to acceptable HWTS methods and technologies.
4. Create awareness on HWTS to decision makers, partners, and communities by 2016
5. Mobilize resources for the implementation of HWTS by 2016
6. Monitor and evaluate HWTS interventions by 2016

3. Strategies to achieve implementation and scaling up

3.1. To establish support system for HWTS interventions by 2016

Introduce incentives to HWTS products in order to create sustainable supply of affordable HWTS products to vulnerable and poor, based on medical grounds.

Develop guidelines, standards, and catalogues for delivery of acceptable HWTS services

Build capacity of implementers from both public and private sectors in the provision of HWTS services and their application in diseases control

Develop system for quality control of methods and technologies, promotion and feedback mechanisms for HWTS in regions and councils

3.2. To strengthen coordination among key actors and stakeholders on HWTS by 2016

Establish and operationalize technical working group on HWTS under the National Steering Committee on Water and Sanitation in order to streamline HWTS agenda into national environmental health priorities

Designate HWTS focal persons at national, regional, and council levels.

Integrate HWTS services into existing complementary interventions including IMCI, home based treatment and care for HIV/AIDS, emergency preparedness, sanitation, hand-washing, hygiene and school health programs.

Establish and launch national stakeholder forum for HWTS in Tanzania.

3.3. Increase availability of acceptable and easy to apply HWTS methods and technologies, and advocate for increased access to potable water in households

Procurement of demonstration HWTS equipment at national regional and LGA levels, schools and hospitals.

Increase production capacity of selected HWTS products through development of factories and distribution mechanisms.

Develop and adopt acceptable designs for HWTS equipment for rural and urban settings

Liaise with responsible authorities to ensure availability of reliable potable water supplies in households

3.4. Create awareness on HWTS to decision makers, partners and community by 2013

Define suitable approaches for promotion of HWTS to be used by all actors on HWTS and an advocacy plan for decision makers.

Develop effective messages to advocate for community behavior change towards assuring safe water by treating and prevent diarrhoea and other water borne diseases.

Conduct national level communication and information campaign for behaviour change towards drinking safe water and prevent water borne diseases.

3.5. To mobilize resources for the implementation of HWTS by 2016

Mainstream HWTS into government priorities and plans for funding and support

Advocate for investment and entrepreneurship in HWTS products and services by increasing private sector participation, partners support, and creation of community income generation activities

Mobilize funding for specific intervention project and human resource development on HWTS as part of WASH programs.

3.6. To monitor and evaluate HWTS interventions by 2016

Establish performance evaluation and registration of HWTS product and technologies for use in health interventions

Integrate HWTS monitoring into joint supervision and monitoring programs and provide feedback in appropriate decision making levels

Conduct systematic evaluation of HWTS performance in CCPS implementation areas.

4. Activity implementation matrix for CCPS

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)
SPECIFIC OBJECTIVES 1–6
See TABLE on following pages

4.1. Stages for CCPS implementation

Much as we look toward reaching at scale in the adoption and sustaining use of HWTS in communities, and achieve reduction of diarrhoea incidences; the CCPS is at the same time expected to build foundation for operation of Water Safety at Point of Use initiatives from very beginning. Operation of the CCPS is therefore set to follow important steps hereby described as implementation stages.

The CCPS will be implemented in three main stages, which are;

4.1.1. Introduce plans to stakeholders

This will involve mobilizing stakeholders that are operating on the ground and sensitization of potential others through sharing of the CCPS document, explaining the Government intentions, and opportunities offered within the CCPS framework. Partners and stakeholders will be explained the HWTS potential to reduce diarrhoea and contribute to overall health improvement as well as unveiling means by which they can participate/contribute.

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)

Main activities		No.	Detailed activities	2011	2012	2013	2014	2015	2016	Responsible Authority	Perfomance Indicators	Cost estimation in Tsh.
SPECIFIC OBJECTIVE 1: To establish support system for promotion and delivery of HWTS by 2016												
1.1	Introduce incentives to HWTS products in order to create sustainable supply of affordable HWTS products to vulnerable and poor, based on medical grounds	1.1.1	Establish HWTS products as tax free items based on health grounds by liasing with responsible authorities							MOHSW, MOFEA, DPs	Tax exemption classification/ agreement	400,000
		1.1.2	Institute subsidy schimes to approved products to be used by vulnerable and poorest populations.							MOHSW, MOFEA, DPs	Presence of subsidised programs for HWTS	
			Process for inclussion of HWTS products in MSD procurement and distribution list							MOHSW	List of items under MSD procurement/ distribution list	
1.2	Develop guidelines, standards, and catalogues for delivery of acceptable HWTS services	1.2.1	Develop and disseminate national guidelines on HWTS							MOHSW, PMORALG, MOW	National Guidelines available and disseminated	200,000,000
		1.2.2	Develop standards for delivery of HWTS services							MOHSW, PMORALG, MOW, GCLA. TBS and TFDA	Standards for HWTS available and disseminated	200,000,000
		1.2.3	Develop and disseminate national catalogue of HWTS equipment and materials							MOHSW, PMORALG, MOW,	Catalogue for HWTS available and disseminated	100,000,000
		1.2.4	Develop and disseminate standard operating procedures (Refer WHO guideline) for HWTS services in emergency and disaster situations							MOHSW, PMORALG, MOW	SOPs available and disseminated	80,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)

Main activities		No.	Detailed activities	2011	2012	2013	2014	2015	2016	Responsible Authority	Perfomance Indicators	Cost estimation in Tsh.
1.3	Build capacity of implementers from both public and private sectors in the provision of HWTS services and their application in diseases control	1.3.1	Train National facilitators on HWTS							MOHSW, MOW, MOEVT, PMORALG Learning institutions	No. of facilitators trained	120,000,000
		1.3.2	Conduct training to HWTS government implementors at regional, and district levels.							MOHSW, MOW, MOEVT, PMORALG Learning institutions	No. of governmental implementors trained	260,000,000
		1.3.3	Conduct training to implementors from non governmental organization and priviate partners on HWTS promotion and service delivery							MOHSW, MOW, MOEVT, PMORALG Learning institutions	No. of non governmental implementors trained	80,000,000
		1.3.4	Equip the LGAs with working facilities i.e transport means, allowances, working documents, stationery, etc.							MOHSW, MOW, MOEVT, PMORALG, Partners	No. of equipment/ facilities provided	300,000,000
1.4	Develop system for quality control of methods and technologies, promotion and feedback mechanisms for HWTS in regions and councils	1.4.1	Establish performance standards for HWTS products based on health and operational requirements.							MOHSW, MOW, MOEVT, learning and research institutions		120,000,000
		1.4.2	Prepare procedures, protocols, and SOPs for HWTS products certification							MOHSW, MOW, MOEVT, learning and research institutions		80,000,000
		1.4.3	Designate a reference laboratory for HWTS products							MOHSW, MOW, MOEVT, learning and research institutions		2,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)												
Main activities		**No.**	**Detailed activities**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Responsible Authority**	**Perfomance Indicators**	**Cost estimation in Tsh.**
		1.4.4	Establish task team for HWTS products quality control							MOHSW, MOW, MOEVT, learning and research institutions		200,000
	Subtotal 1:											**1,542,600,000**
SPECIFIC OBJECTIVE 2: To strengthen coordination amongst key actors and stakeholders on HWTS by 2016												
2.1	Establish and operationalize technical working group on HWTS under the National Steering Committee on Water and Sanitation in order to streamline HWTS agenda into national environmental health priorities	2.1.1	Incorporate HWTS into the existing National steering committee for sanitation and hygiene (Establish subcommittee for HWTS)							MOHSW PMORALG, MOWI	• National Technical committee formed • Revised TOR of the National Technical Committee for HWTS • Members nominated and TOR developed • Minutes of national technical committee meetings	80,000,000
		2.1.2	Establish and organize a national stakeholders forum for HWTS in Tanzania							National Focal Person	• TOR for the national stakeholders forum formed • Minutes of the stakeholders forum	100,000,000
2.2	Designate HWTS focal persons at national, regional, and council levels.	2.2.1	Nominate national, regional and district focal person.							MOHSW, PMORALG, MOWI, MOEVT	Focal person appointed	6,000,000
2.3	Integrate HWTS services into existing complementary interventions including IMCI, home based treatment and care for HIV/AIDS, emergency preparedness, sanitation, hand-washing, hygiene and school health programs.	2.3.1	Incorporate HWTS modules into training guides for related interventions, namely IMCI, Home Based Care with HIV/AIDS, and Emergency response.							MOHSW, PMORALG, MOWI, MOEVT	Presence of training modules for corsscuting or complementary training sessions No. of traning manuals incorporating HWTS	80,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)													
Main activities		**No.**	**Detailed activities**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Responsible Authority**	**Perfomance Indicators**	**Cost estimation in Tsh.**
		2.3.2	Lobby for incoporation of HWTS in related field based project and national guidelines								No. of complementary interventions adopting HWTS methods and messages	20,000,000
2.4	Establish and launch national stakeholder forum for HWTS in Tanzania.	2.4.1	Designate a host institution and management team for HWTS stakeholders forum							MOHSW and MOW	• Name of Host institution • TOR for HWTS forum in place • List of forum management team members	15,000,000
		2.4.2	Develop calenda and themes for annual forum							Forum Management	• Calender for HWTS forum • Reporting structure for HWTS forum	15,000,000
	Subtotal 2:											**316,000,000**
SPECIFIC OBJECTIVE 3: Increase access to acceptable HWTS methods and technologies												
3.1	Procurement of demonstration HWTS equipment at national regional and LGA levels, schools and hospitals.	3.1.1	Mobilize resources for support in procurement of HWTS materials for emergency							VPO, MOHSW, MOW, MOEVT, PMO-RALG, RED CROSS, NGOs	• List of HWTS materials for emergencies • Agreement to support provision of HWTS for emergency	12,000,000
3.2	Increase production capacity of selected HWTS products through development of factories and distribution mechanisms.	3.2.1	Educate factory owners and interpreneur on the marketing potential for HWTS products in rural and urban settings							HWTS coordinator, NGOs	No. of interpreneurs educated	40,000,000
3.3	Develop and adopt acceptable designs for HWTS equipment for rural and urban settings	3.3.1	Conduct research on acceptable (relevant and affordable) HWTS equipment designs							MOHSW, MOW, MOEVT, Accadeimic and research institutions	No. of research studies conducted with reccomendations	2,000,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)												
Main activities		**No.**	**Detailed activities**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Responsible Authority**	**Perfomance Indicators**	**Cost estimation in Tsh.**
		3.3.2	Conduct demonstrations and advocate for production of acceptable designs for HWTS equipment							Forum Management, accademic institution, NGOs	Innovations demonstrated	300,000,000
3.4	Liaise with responsible authorities to ensure availability of reliable potable water supplies in households	3.4.1	Team up to solicit finds for improvement of water quality in HWTS projects locations throghout Tanzania							MOW, MOHSW, MOEVT, PMORALG, NGOs, LGAs	No. of funded community water improvements projects in HWTS areas	
	Subtotal 3:											**2,352,000,000**
SPECIFIC OBJECTIVE 4: Create awareness on HWTS to decision makers, partners and community by 2016												
4.1	Define suitable approaches for promotion of HWTS to be used by all actors on HWTS and an advocacy plan for decision makers.	4.1.1	Document acceptable methods and framework for promotion of HWTS in Tanzania							MOHSW, MOW	Documentation on HWTS promotion in place	30,000,000
		4.1.2	Disseminate HWTS promotional package to all actors							MOW, MOHSW, MOEVT, PMORALG	No. of orientation sessions conducted on HWTS promotion	90,000,000
4.2	Develop effective messages to advocate for community behavior change towards assuring safe water by treating and prevent diarrhoea and other water borne diseases.	4.2.1	Educate the public on the use of HWTS for health gains (IEC/BCC)							MOHSW, PMORALG,MOWI	• No. of sensitization campaigns conducted • No. of households practicing HWTS	600,000,000
		4.2.2	Develop IEC/BCC materials on HWTS							MOHSW PMORALG, MOW, LEARNING INSTITUTIONS	IEC/BCC materials developed	100,000,000
4.3	Conduct national level communication and information campaign for behaviour change towards drinking safe water and prevent water borne diseases.	4.3.1	Advocate for prioritization of HWTS as part of WASH among decision makers							MOHSW, PMORALG,MOWI, LEARNING INSTITUTIONS	No. of advocacy sessions conducted	100,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)												
Main activities		**No.**	**Detailed activities**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Responsible Authority**	**Perfomance Indicators**	**Cost estimation in Tsh.**
		4.3.2	Conduct events/road shows/ open meetings/campaign and educate the public							All stakeholders	Number of public events done	250,000,000
	Subtotal 4:											**1,170,000,000**
SPECIFIC OBJECTIVE 5: To mobilize resources for the implementation of HWTS by 2016												
5.1	Mainstream HWTS into government priorities and plans for funding and support	5.1.1	Request/communicate with LGAs to include HWTS budget in the CCHP budget, and other relevant council plans							MOHSW, MOW, MOEVT, PMORALG	Number of LGAs incorporated HWTS activities in their plans	200,000,000
5.2	Advocate for investment and entrepreneurship in HWTS products and services by increasing private sector participation, partners support, and creation of community income generation activities	5.2.1	Inniciate partnerships for investment in HWTS production by working together with financial institutions and private sector.							HWTS coordinator, NGOs,	Agreements reached in partnership for investment	800,000,000
5.3	Mobilize funding for specific intervention project and human resource development on HWTS as part of WASH programs.	5.3.1	Develop proposals for specific HWTS projects as part of CCPS implemenation							All stakeholders	No of proposals developed	60,000,000
		5.3.2	Solicit support for national HWTS programs, and specific projects proposed in line with the current CCPS							All stakeholders	Number of proposals submited for funding	60,000,000
	Subtotal 5:											**1,120,000,000**
SPECIFIC OBJECTIVE 6: To monitor HWTS activities and evaluate the impact of implementation of HWTS plan by 2016												
6.1	Establish performance evaluation and registration of HWTS product and technologies for use in health interventions	6.1.1	Establish mechanism for HWTS products registration and certification							Key stakeholders led by MOHSW	Evaluation report showing progress against identified indicators	150,000,000

MATRICES FOR THE SCALE UP PLAN (BY SPECIFIC OBJECTIVES)

Main activities		No.	Detailed activities	2011	2012	2013	2014	2015	2016	Responsible Authority	Perfomance Indicators	Cost estimation in Tsh.
		6.1.2	Conduct field inspection of HWTS products being promoted in Tanzania for quality control.									200,000,000
6.3	Conduct systematic evaluation of program/project peformance	6.3.1	Conduct periodic country/or specific area project/program performance evaluation (i.e. annual evaluation of national plans implementation)							MOHSW, PMORALG,MOW, GCLA, LEARNING INSTITUTIONS	Meeting reports	300,000,000
		6.3.2	Conduct impact evaluation of HWTS interventions on related diseases in CCPS focus areas							MOHSW, MOW, LEARNING AND RESEARCH INSTITUTIONS	• No. of surveys conducted • Survey Reports	400,000,000
		6.3.3	Establish surveillance system for waterborne diseases							MOHSW, NIMR	Surveillance tools in place and operating	100,000,000
		6.3.4	Conduct household level water quality assessment							MOHSW, MOW, NIMR, MUHAS	Specific assessment results	100,000,000
6.4	Develop performance indicators, supervision tools for monitoring NAP implementation	6.4.1	Develop HWTS program performance criteria based on CCPS targets							MOHSW, MOW	HWTS evaluation criteria in place	50,000,000
		6.4.2	Develop and distribute HWTS program evaluation tools for self and external evaluation							MOHSW, MOW, PMORALG	Number of offices received stakeholders received performance criteria guide	50,000,000
6.5	Integrate HWTS monitoring into joint supervision and monitoring programs and provide feedback in appropriate decision making levels	6.5.1	Incorporate HWTS program performance criteria into the Joint Monitoring critieria for inclussion in the monitoring programs.							MOHSW, MOW, PMORALG, MOEVT	Updated Joint Monitoring program incorporating HWTS componenents	6,000,000
	Subtotal 6:											**1,356,000,000**
	TOTAL COST ESTIMATE											**7,856,600,000**

4.1.2. Solicit support and commitment for implementation

Having discussed and agreed on the scope and options for collaboration in HWTS, partners and stakeholders will be requested to either take part in implementation or commit to support HWTS collective interventions. Agreements and commitments reached should be recorded for follow-up and implementation.

4.1.3. Implementation, follow-up and feedback

The final stage in CCPS implementation is to make sure that steering and coordination mechanisms are operating, actions are jointly supervised, feedback is provided, and that interventions address agreed plans and targets. Evaluation mechanisms will be instituted to make sure that HWTS actions leads to intended health impact. Operationalize supervisory machineries and periodic forum for planning and reporting

5. Guiding principles

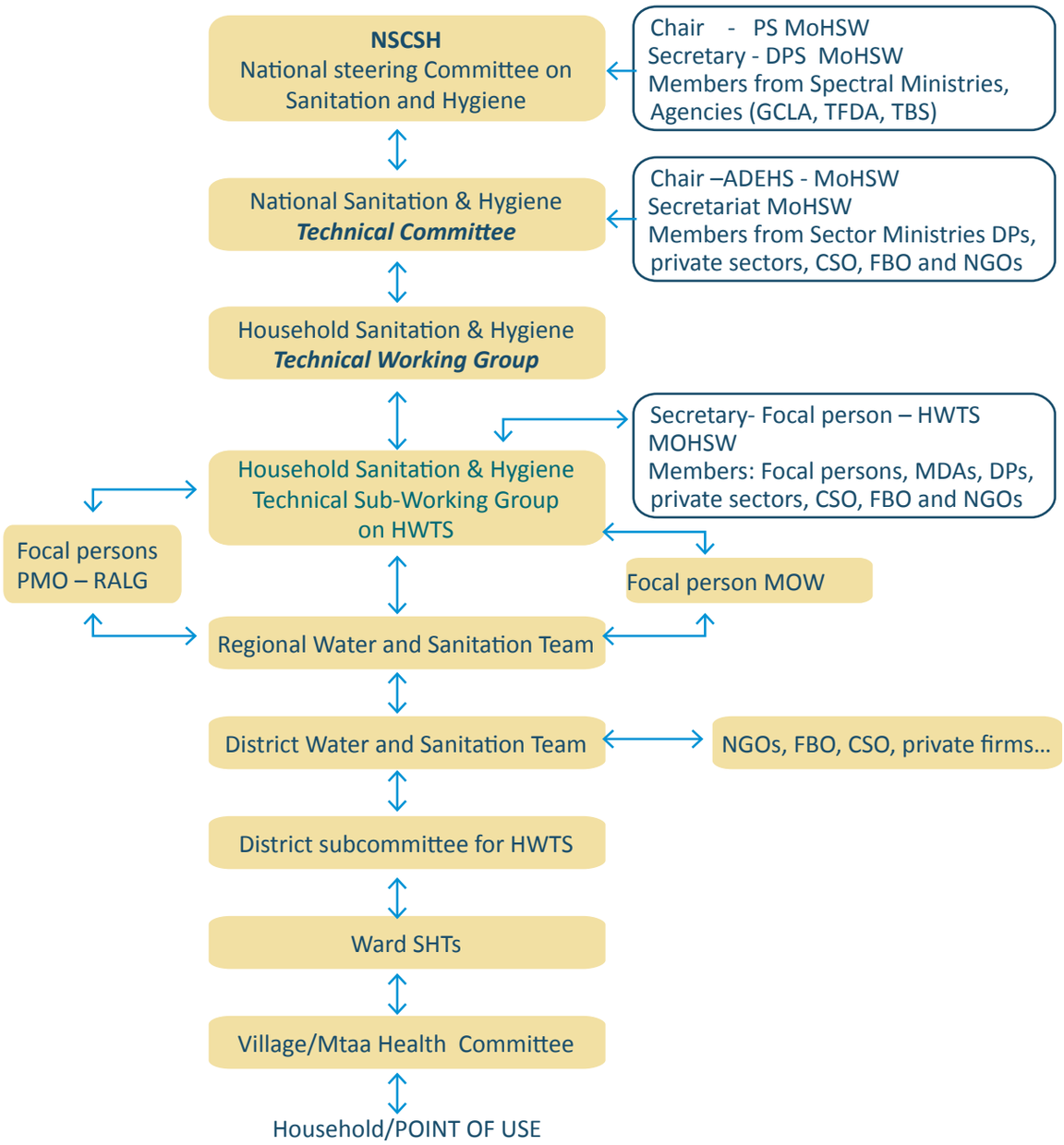
The actions taken under the Comprehensive Country Plan for Scaling up (CCPS) - HWTS will be governed by the following principles:

1. Health is the primary driver of all HWTS initiatives undertaken within the framework of the CCPS-HWTS. Any programme or project involving HWTS will be considered and evaluated on the basis of its contribution to health.
2. HWTS interventions at municipal/district/town councils should be coordinated by a Health Officer who will also be a member of the District Water and Sanitation Team (DWST)
3. HWTS products and technologies should be introduced in Tanzania only after they have been proved to be safe and effective and comply with governmental laws and regulations.
4. HWTS initiatives should follow a demand-response approach, with users deciding from a range of proven methods, products and technologies in consistency with national strategies, guidelines and target programmes.
5. Government has a special role in prioritizing HWTS initiatives, regulating HWTS products, securing necessary support, and monitoring progress. Other stakeholders should be encouraged to participate in providing effective HWTS solutions.
6. For government and civil society initiatives, culturally-appropriate information, education and communication (IEC) programmes can help guide user understanding. Commercially-marketed products for HWTS should be accompanied by accurate claims so that informed consumers can judge their performance capabilities, and use them safely and correctly.
7. Government and civil society initiatives should be accompanied by appropriate information, education and communication programmes to guide households to make informed choices that will result to better HWTS practices.
8. HWTS can be an effective intervention for containing outbreaks of waterborne diseases such as cholera. Assessment of HWTS solutions should be done in responding to such outbreaks to prepare standard operating procedures for their deployment and conduct necessary training and stockpiling of supplies before the onset of the emergency.

9. Safe drinking water is a necessary but not sufficient condition to human health. HWTS initiatives should be undertaken as part of a comprehensive strategy to ensure access to adequate quantities of water, good personal hygiene practices, and environmental sanitation.

10. Government should keep an inventory of initiatives going on HWTS and register them for continous follw up.

6. Organization structure for implementation of HWTS at point of use



7. Roles and responsibilities

7.1. The National Steering Committee for Sanitation and Hygiene (NSCSH)

The NSCSH is the country level overseer of HWTS interventions; it is responsible for final scrutiny of policy guidelines and standard operating procedures for the final approval. The National coordinator for WSPU will be a Co-opted member of the NSCSH.

7.2. National Sanitation & Hygiene Technical Committee

National technical committee for sanitation and hygiene comprise of representatives from The National Steering Committee and other relevant institution such as: - NEMC, GCLA, TFDA, TBS, NGOs, CBO, FBOs, and other co-opted members as it may deem necessary. Its responsibilities are to provide technical support and advice to National Steering Committee, identify areas of research in collaboration with other institutions and advise accordingly, prepare terms of reference for sanitation and hygiene research protocols, liaise and give feedback to members of National Steering Committee, and identify training opportunities in collaboration with other institutions. National focal person for HWTS will be a full member of this committee.

7.3. Household Sanitation & Hygiene Technical Working Group

Household sanitation and hygiene working group has been established under the National Hygiene and Sanitation Steering Committee. This working group coordinates the key technical responsibilities and contributions through NHSSC.

The technical working group planned to carry out duties and responsibilities to ensure all stakeholders are well informed on household sanitation and hygiene for the control of diarrhoeal diseases.

7.4. The Sub working group on Water Safety at Point of use (SWG-WSPU)

The SWG-WSPU will have full responsibilities and will be responsible for drafting and prepare guidelines, strategies, standard operating procedures, monitoring, supervision and evaluation of WSPU intervention. In this committee the National Coordinator for WSPU will be a secretary. Focal persons at PMORALG and MOW will permanent members of this technical working group.

The sub working group can make proposals for funding the implementation of HWTS activities for approval of the HHS&HWG. Such proposals will seek financing from the UNICEF, WA and other sources.

7.5. Monitoring and evaluation of the HWTS

Monitoring and evaluation should be carried out quarterly focusing on outputs of the implemented activities. The output should be based on deliverable of the planned activities and the specified time. The (M&E) will be carried out to measure progress towards the achievement of the intended goals of the CCPS among the stakeholders and community at large.

7.6. The National focal person for WSPU at MoHSW

Responsibilities

i. Be an overall coordinator of WSPU at National level

ii. Link with international community on issues of WSPU

iii. Compile annual and progressive report on implementation of WSPU

iv. Prepare technical working group meetings according to the schedule

v. Disseminate or share information on WSPU with the public

vi. Conduct monitoring and evaluation of WSPU programme

vii. Recommend mechanism for selecting and coordination of HWTS at various levels of implementation

7.7. Focal person for WSPU at PM0RALG

Responsibilities

- Liaise with national coordinator on all issues of WSPU
- Collaborate with national coordinator in compilation of regional report and provide feedback to regions/ districts on agreed issues in the Technical committee meeting
- Facilitate planning at regional and district level

7.8. Focal person for WSPU at MOW

- Liaise with national coordinator on all issues of WSPU
- Collaborate with national coordinator in compilation of national report on HWTS
- Facilitate planning and action on source water access and quality improvement

7.9. Regional Water and Sanitation Team

Responsibilities

i. Coordinate implementation of WSPU at regional level

ii. Interpret national guidelines and standard to user friendly for implementation

iii. Compile regional report on WSPU and submitting to national Coordinator at MoHSW with a copy to PMORALG focal person

iv. Conduct supportive supervision and provide technical support to all districts in the region

v. Dissemination of WSPU information to the public and provide feedback to Districts Focal Person on directives given by National coordinator and PMORALG focal person

7.10. District Water and Sanitation Teams (DWSTs)

Responsibilities

i. Set priorities on WSPU issues to be addressed at district level;

ii. Prepare plan of action for implementation of WSPU activities

iii. Conduct advocacy activities on WSPU

iv. Oversee the overall implementation of WSPU activities

v. Ensure that each participating sector has incorporated in its plan activities on WSPU

7.11. District subcommittee for HWTS

District subcommittee for HWTS will have full responsibilities and will be responsible to ensure HWTS activities are implemented as per guidelines, strategies, standard operating procedures. The subcommittee will have a responsibility to carryout monitoring, supervision and evaluation of WSPU intervention at district level. In this committee the District focal person for WSPU will be a secretary.

7.12. Ward Sanitation and Hygiene Team (Ward SHT)

- Promote water treatment methods recommended by the district
- Set village priorities on WSPU issues to be addressed at ward and village level;
- Prepare plan of action for implementation of WSPU activities

7.13. Village/Mtaa Health Committee

- Conduct awareness and mobilization meetings on WSPU
- Oversee performance and usability of proposed WSPU technologies
- Ensure that each household has proper and use properly WSPU facility

7.14. Water User Groups

i. Decide on water treatment and safe storage method

ii. Treat water before consumption

iii. Comply with WSPU guidelines and regulations

iv. Provide feedback to village/mtaa water and sanitation teams on advantage and challenges on selected method for treatment of water at point of use

v. Ensure personal hygiene and proper handling practice.

8. Annex 1: Conference Recommendations/Way Forward

Recommendations of the International Conference on Household Safe Water Management for Waterborne Diseases Control, 4–6 February 2009, Bagamoyo, Tanzania as adopted from Conference Report.

1. Tanzania should define the scope and meaning of Household Water Treatment and Safe Storage in its national context; setting clear definitions and boundaries. The scope of HWTS defined under the national policy/strategy should be focused on addressing the prevention of diarrhoeal diseases and cholera in particular.

2. Household Water Treatment and Safe Storage should be lead by the Ministry of Health and Social Welfare in order to maintain its intended goal to contribute to waterborne disease reduction. The MOHSW should therefore establish a steering mechanism to propagate the establishment and development of HWTS services in Tanzania.

3. A subcommittee on HWTS should be formed to operate under the National Steering Committee on Water and Sanitation. HWTS activities should not develop as a stand alone strategy but be established from within the existing hygiene and sanitation framework as well as in the existing diarrhoeal control framework, and be developed from Directorate of Preventive Services.

4. Terms of reference and institutional arrangements for HWTS should be drafted for approval as soon as possible.

5. The Government of Tanzania and other stakeholders should work together to develop a comprehensive country plan for scaling up HWTS services which would allow effective service provision and address the need to provide for most vulnerable groups and the poor.

6. The proposed national policy/strategy should identify the two key ministries; the Ministry of Health and Social Welfare and the Ministry of Water and Irrigation, and other sector Ministries with clear definition of roles and responsibilities each.

7. The Ministry of Water and Irrigation should incorporate HWTS plans in its national water supply plans, and make HWTS a standing agenda in small scale water development projects.

8. The Ministry of Health and Social Welfare should spearhead the development of an effective mechanism to coordinate stakeholders by establishing a country-level network or nationally recognizable periodic forum e.g. national annual forum on HWTS.

9. The Government of Tanzania should review its structures in order to provide for necessary policy, economic and social atmosphere for sustainability of interventions: These include economic incentives.

10. The Government of Tanzania should strengthen its coordination mechanism to effectively link it with international partners, strengthen link between Tanzania Mainland and Zanzibar, and between Government Ministries.

11. Tanzania needs to establish standards and conducive HWTS product registration procedure for quality control and maintenance of necessary public health and safety requirements.

12. Research capacity should be strengthened with refocusing of research direction more from evidence of effectiveness to ways in which HWTS can be scaled up and achieve more impact on diarrhoea.

13. The Government of Tanzania should commit itself to funding for HWTS among essential health interventions as well as complementary water quality improvement services.

14. The International Network to Promote HWTS will serve as the coordinating entity to ensure that Tanzania will benefit from the latest advances, implementation experiences, regulatory and policy development, as well as good practices from other countries. Furthermore the Network will act to ensure that the international community learns and benefits from the experiences and expertise of Tanzania.

15. To this end the Ministry of Health and Social Welfare Tanzania should appoint a person to link the Ministry with the global Network to Promote Household Water Treatment and Safe Storage.