Learning about Community Water and Sanitation Action Plans

RiPPLE

SNV

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Research-inspired Policy and Practice Learning in Ethiopia and the Nile region (RiPPLE) is a 5-year Research Programme Consortium funded by UKaid from the Department for International Development) aiming to advance evidence-based learning on water supply and sanitation (WSS). The RiPPLE Consortium is led by the Overseas Development Institute (ODI), working with the College of Development Studies at Addis Ababa University; the Ethiopian Catholic Church Social and Development Coordination Office of Harar (ECC-SDCOH), International Water & Sanitation Centre (IRC), MetaMeta, and WaterAid-Ethiopia.

RiPPLE acknowledges the contributions, inputs, comments and support from: Jan Teun Visscher (team leader and main author), Marieke Adank, Josephine Tucker (authors module 4), Lenneke Knoop, John Butterworth, Tamene Chaka, Fantahun Getachew and Zemede A. Zewdie, Eva Ludi, Alan Nicol, Roger Calow and staff from the TVETC and the Water Bureau in Hawassa.

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Preface

Building government capacity at woreda level to support communities in planning, implementing and managing improved water supplies is central to the achievement of the Government of Ethiopia's Universal Action Plan (UAP). The plan requires both huge leaps in current levels of water and sanitation service provision by 2012 and ensuring the sustainability of existing services. To this end, the University of Addis Ababa, MetaMeta, SNV-Ethiopia, IRC and the Technical and Vocational Education and Training College (TVETC) in Hawassa have piloted an innovative approach to training woreda staff using Guided Distance Learning (GDL).

Key to the approach is that participants in the course obtain a set of training modules either as a document, on a CD Rom or through the internet (provided Internet access is feasible). These self learning modules comprise key information, specific field assignments with 'learning-by-doing' exercises and a question and answer section where participants can check their own progress.

The field assignments are developed in small groups of participants from the same or adjacent woredas will be shared with the course moderators and resource persons through the internet, normal mail and or face to face contact. Trainers will come to the place of work of the small groups of trainees and will go with them into the field to jointly review the main field assignments.

This approach to on-the-job Guided Distance Learning (GDL) programme was piloted in SNNPR at woreda level with trainers and trainees of 'sector' TVETC and resource persons from the water bureau. This initial work showed a demand to embed this approach in the regular TVETC training programme to enable them to focus more on practical, problem-based learning. Based on the positive results of the first course this broader course package was developed with the intention to role out the approach of *Guided Learning on Water and Sanitation (GLoWS)* in Ethiopia through all nine TVETCs concerned with water supply and sanitation training. A staged approach is adopted comprising the expansion and testing of the modules bringing in key experience from the ODI-led RiPPLE program, the training of trainers in the TVETC and resource persons from the Water Bureaus, initially in SNNPR, and thereafter in other areas of Ethiopia.

The development, expansion, revision and delivery of the GLoWS module will be led by MetaMeta with the ongoing support of the TVETC in Hawassa, the RiPPLE programme and the SNV.

This set of training modules was developed by a group of persons including: Jan Teun Visscher (team leader and main author), Marieke Adank, Josephine Tucker (authors module 4), Lenneke Knoop, John Butterworth, Tamene Chaka, Fantahun Getachew and Zemede A. Zewdie, Eva Ludi, Alan Nicol, Roger Calow and staff from the TVETC and the Water Bureau in Hawassa.

I General Introduction to the course

Waterborne and sanitation related diseases such as cholera, yellow fever, hepatitis, diarrhoea and typhoid claim the lives of hundreds of thousands of people in Ethiopia each year. In 2004 only 80 percent of the urban and 7 percent of the rural population had access to improved water supply systems (UNICEF/WHO, 2006), and many of these are facing important water quality problems. Considerable efforts are underway however to improve the situation, with the result that the number of improved systems is growing but monitoring and maintenance is not well developed.

Hence an urgent need exists to establish possible water pollution hazards and performance problems in rural water supply and sanitation systems which can have adverse health effects on consumers and mitigate these hazards where possible. Key water sector staff at Woreda level from government agencies and NGOs is in a very good position to help communities to ensure that their water and sanitation systems can be improved and sustained. To help sector staff in this role a practical training course has been established. This 120 hour course is being implemented in a distance learning mode over a period of two months. It comprises the following course modules:

1. ***Community water supply*** which introduces the participant in the complexity of water supply in small and medium size communities and presents an overview of systems that are applied in Ethiopia
2. ***Water quality risk management*** which introduces both chemical and microbial water quality assessment including sanitary inspections and suggests approaches to explore options to manage the related risks in the water cycle at community level
3. ***Water supply improvement*** showing a number of practical improvements to overcome problems in existing system
4. ***Sustainable multiple use water services*** introducing the concept of multiple use water services (MUS) and effect of seasonal influences on water use patterns to better assess and use existing water systems and exploring possibilities for district support.
5. ***Sanitation and hygiene*** focussing on options to avoid the transmission of sanitation and hygiene related diseases with emphasis on improving sanitation systems
6. ***Community water and sanitation action planning*** which introduces a community based approach to improving the water and sanitation situation bringing together the learning in the previous modules leading to the development of a structured plan.
7. ***Management and finance*** which will present a number of management tools suitable for community water supply and sanitation and possibilities to explore the financing of some interventions
8. ***Module: Example of a Community Water and Sanitation Action Plan***

At the end of the course participants will be able to:

- Assess the water supply and sanitation situation in a community, adopting a broad perspective including seasonal water fluctuations and multiple water use.
- Assist communities (water and sanitation committees) in establishing practical water and sanitation improvement plans at community level and to use these data to contribute to district level planning.

II How to go about the course

This training course has been established to help participants to acquaint themselves with water and sanitation problems that may be present in communities in their working area and to enable them to, jointly with community members, find possibilities to improve upon the situation. At the end of the course they will be able and have practiced with the development of community water and sanitation action plans including participatory situation analysis, assessment and management of relevant risks and planning and introduction of important improvements. They will also be able to embed these plans in the Woreda planning cycle.

The course follows an innovative approach of guided joint learning, where participants can access training modules, resource materials and resource persons, in different ways. The access may be through the internet, through CD Rom or through a paper based approach. Participants will learn in their work environment and have some face to face contact with fellow participants, course moderators and resource persons.

The course includes field assignments in which participants will work in small teams. These assignments will focus on communities close to the place where participants work and will require interaction with these communities. The advantage of this approach is that these communities can benefit from the course results and will get advice about possibilities to improve their water and sanitation situation.

Course structure and timing

Module	Activities	Timing of completion
Introduction meeting	**Collection of information Formation of teams of trainees Identification of trainer per team Establish contact arrangement with trainer**	**Start (one day meeting)**
Module 1	**Review module, meet with team, visit a water supply system[1] nearby and submit assignment**	**End of week 2**
Module 2	**Review module, meet with team, review a water supply system nearby and submit assignment (as an alternative you can submit the assignment together with assignment in module 3**	**End of week 4**
Module 3	**Review module, meet with team, visit a water supply system nearby and submit assignment, possibly together with assignment of module 2**	**End of week 6**
Module 4	**Review module, meet with team, submit assignment, possibly together with assignment of module 5**	**End of week 8**
Module 5	**Review module, meet with team, submit assignment, possibly together with assignment of modules 4 and 6**	**End of week 10**
Module 6	**Review module, meet with team, submit assignment, possibly together with assignment of module 5**	**End of week 12**
Module 7 and 8	**Review modules; visit a community with your team to make a detailed plan. This is likely to take two visits Submit your draft plan and arrange for visit of trainer and resource person**	**End of week 14, 15 or 16**
Final assignment	**Incorporate comments of trainer and resource person Submit assignment**	**End of week 17**
Group meeting	**Two day meeting of trainers and trainees**	**Week 18 or 19 End of course**
1. Instead of choosing a system in your own community you may also choose one in a community where you want to do the whole process including the development of the action plan. It is important however to ensure that you can easily reach the community with your small team of trainees		

Module 1 Community Water Supply

This module provides an introduction to community water supply and an overview of systems used in Ethiopia. At the end of this module the participant will have:

- *A better understanding of the dynamic character of community water supply, often comprising different water sources and technologies each involving possible health risks*
- *An overview of the main water supply technologies that are being used in Ethiopia*
- *Provided an overview of the water supply systems in their Woreda and made a drawing of the water supply system in a community of their choice*

1.1 Introduction

There are few issues that have greater impact on our lives than the management of water. Water is a basic requirement for human life; we need water to stay alive and maintain basic health and sanitation. We need it to grow our food, to maintain our industry and economy and to sustain our environment.

Access to safe water is a complex issue particularly in smaller communities. It is not a straightforward engineering problem. It is about people and much less about technology. Men, women and children may have different views about their water supply and its quality, and they, knowingly or unknowingly, interfere with their water supply systems.

"Everyone living in a specific place has access to some form of water supply"

This water supply may range from a polluted river or an open well to a piped water supply with house connections and treatment. Although some of these supplies may be unacceptable to outsiders, they may be well appreciated by the local user. People create their own 'world view' and have their own perception of their situation which is shaped by history. People living all their life in a polluted environment may be so accustomed to it that they do not appreciate possible health hazards. Children seeing that mothers handle faces of babies as if they are harmless are likely to adopt this behavior as well.

In many places we see that people continue to use traditional water sources even after handpumps have been installed for example because they do not like the taste of the handpump water or because they have to walk further, wait longer or have to pay and are not much concerned with concepts such as bacteriological quality.

"Never assume that people see potential health risks the way you see them"

In 2006 according to UNICEF/WHO (2007) 1.1 billion people in the world did not have access to improved water systems, which are systems with a higher likelihood that the water is not polluted (Table 1). Ethiopia was one of the countries with lowest coverage and particularly in rural areas where coverage was only 11% in 2004.

Table 1.1 Qualification of water supply technologies (WHO/UNICEF JMP 2000 p. 5)

Technologies considered "improved"	Technologies considered not "improved"
Household connection	Unprotected well
Public standpipe	Unprotected spring
Borehole	Vendor-provided water
Protected dug well	Bottled water[1]
Protected spring	Tanker truck provision of water
Rainwater collection	

[1] Not considered 'improved' because of potential limitations in water quantity, not the quality

Figure 1.1 Collecting water from a well in Ethiopia

It is important to realize however that even improved systems may provide water that is not safe for consumers. These systems may tap polluted ground or surface water sources that that may require some form of water treatment to make it safe to drink. Adding treatment however enhances the complexity of the system because trained staff is not always available, advisory support is usually lacking and chemical supplies are not reliable. But even if the water is safe at the point of collection, it may get contaminated if it is subsequently transported and stored. Hence thinking of safe water implies looking at the total water chain from the catchment area where the water starts its journey to the point of use and disposal (Figure 1.2).

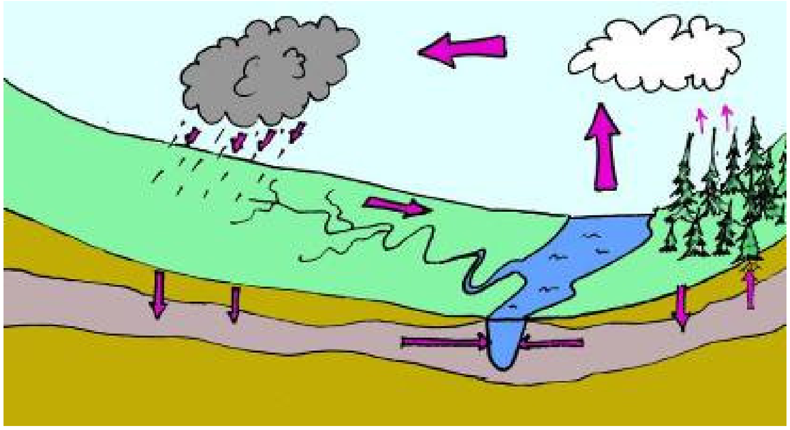

Figure 1.2 The water cycle

Different dimensions of community water supply

A community water supply system is not about technology alone. It is a much broader issue in which three dimensions can be distinguished (Figure 1.3).

- The community that uses the water
- The environment in which the community lives
- The technology that is used to transport the water and make it acceptable to use

These three dimensions are embedded in the political, legal and institutional framework of the country in which communities are situated. These dimensions are briefly described here, but more information can be found in Visscher (2006).

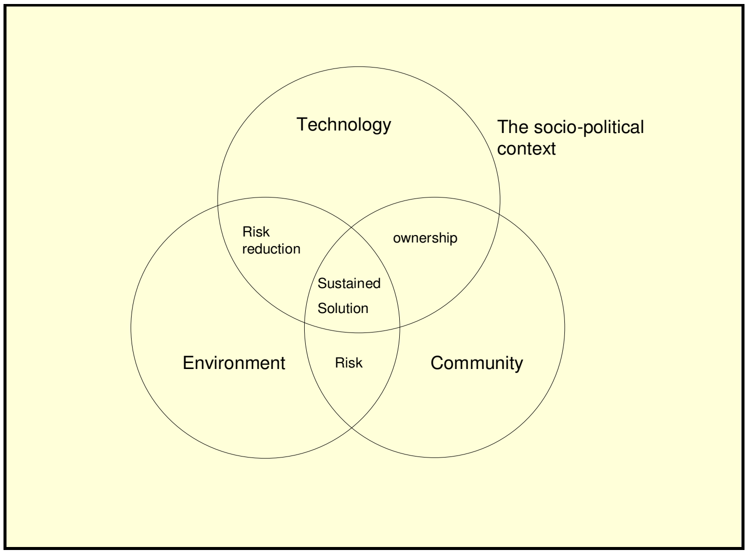

Figure 1.3 Conceptual framework for community water supply (Galvis et al., 1994)

The community comprises different groups of people usually with common and conflicting interests and ideas and different socio-economic and cultural backgrounds. The water supply system may be one such common interest, but can be a major source of conflict as well.

Long waiting lines at water points may lead to people jumping the queue leading to serious quarrels. Upstream users may leave too little water or may pollute the water for downstream users. Water vendors may be afraid to lose their income if new water systems are built etc.

Women often have interests different from those of men. Women may have to walk long distances to fetch water or may be buying it. Are they really heard when a new water supply is introduced in their community?

Figure 1.4 Ethiopia, queuing for water

The **environment** produces the water that the community can access. This dimension includes the available water resources, their pattern over the year and their level of pollution.

The interface between environment and community represents the risk the community has to overcome in relation to its water supply. This may include risk with a natural cause such as a high iron or fluoride content or climate change, but many risks are directly caused by people. People may pollute water in the catchment area by farming or cattle herding. They may construct latrines close to wells, touch water with hands that contain fecal material etc.

Figure 1.5 People and cattle can contaminate the water source

Technology is the combination of the water supply system and the knowledge to develop and sustain it. It involves the hardware, its management, the available external support as well as the role of the consumers and their level of adoption and ownership.

The interface between environment and technology represents the availability of knowledge and practical options to reduce the risk of drinking polluted water. Risk reduction may involve technical interventions but also issues such as change in agricultural practices and change in behaviour of users.

The interface between technology and community deals with the type of solutions the community wants; is willing and able to manage and sustain; and that match their technical, socio-economic and environmental conditions and capacities.

Figure 1.6 Collecting funds for the maintenance of community ponds;

The dynamics of water supply systems

A water supply system is not static. It changes over time because:

- The community may grow which my imply that systems need to be expanded, or it may shrink, implying that less users are available to share the cost and other burdens;
- The technology may gradually reduce in performance because of wear and tear if not properly maintained and managed. This may go unnoticed for some time and may make people to turn to other sources; Another problem may be that when a new system is built, people no longer maintain the traditional systems and then get into trouble if the new system breaks down.
- Users may adopt new habits that affect their water consumption. Introduction of new systems (water flush toilets, showers etc.) may increase water consumption whereas water saving devices may reduce consumption. Also communities may start to use water for productive use;
- The environment may change possibly affecting the availability and/or quality of the water. This may include lowering water tables because of over abstraction of water or climate change but also deterioration in water quality because of erosion, use of fertilizers and pesticides, or changes in groundwater composition.

The dynamics of a water supply system need to be recognized and taken into account to ensure long term sustainability of the system. This also stresses the need to ensure adequate monitoring to assess if the situation is changing.

Sustainable water supply

The main challenge is not to build or improve a water supply system, but to ensure that it is sustained over time. Too many systems have been built that do not operate at all. The non-functionality of rural water supply systems in Ethiopia may be as high as 35%. This is a sad situation because many people have given their best effort but to no avail.

To ensure longer term sustainability in rural water supply in Ethiopia a number of key issues need to be in place:

- Together the different water supply systems in a community need to cater for the needs of the population
- The systems need to be of sufficient quality which is not the case in quite some locations
- The community need to be able to sustain the systems financially and technically and needs to cope with their management often with limited means
- Adequate back-up needs to be available (preferably at district level) to ensure that potential problems (technical as well as organizational) can be solved within a short period of time. This includes support for capacity building to train new operators and water committee members.

1.2 Overview of water supply systems in Ethiopia

People may take the water they need from different types of water supply systems, and can only survive for a few days without it. Based on the type of source we can make a distinction between:

- Groundwater based systems,
- Surface water based systems, and
- Rainwater based systems

Important differences exist in the quality of surface water, ground water and rainwater. Rainwater is usually clean but may pick up impurities from the surface from which it is collected. Groundwater may comprise excess chemicals, but is usually free from harmful bacteria and viruses unless the water is polluted for example by nearby pit latrines or during abstraction and transport. Most surface water is contaminated with harmful bacteria and viruses and may also contain other contaminants such as herbicides, pesticides and excess chemicals. For more details see Smet and van Wijk (2002).

People may use different systems

It is often overlooked that people may use different water systems in parallel or at different times of the year and for different purposes. To help improve upon the local conditions it is therefore essential to get detailed insight in the water culture, the way in which people deal with water and the water sources and systems they use. Figure 1.7 gives an example of the water supply in a rural community.

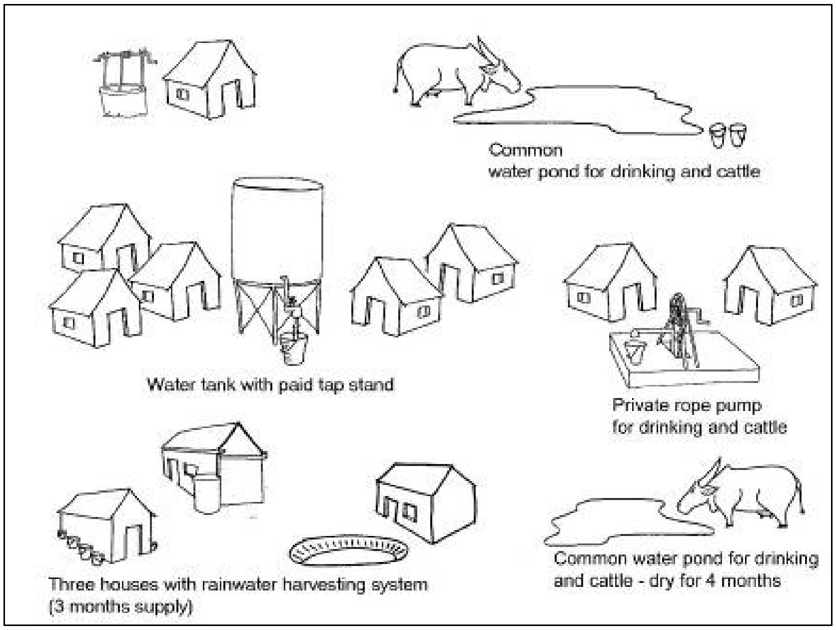

Figure 1.7 Example of a water supply system of a rural community

Table 2.1 Example description of a community water supply system

Type of source	% of users[1,2]	Access	Type of use	Comment
Tank with tapstand	60%	Public	Drinking and washing	Two periods of three hours per day; tariff. In dry season more users
Water pond 1	70%	Public	Drinking, washing, cattle, water vending	Two km distance, year round supply
Water pond 2	60%	Public	Drinking, washing and cattle	One km distance, 8 months supply
Rope pumps	10%	Private	Drinking, washing, gardening and cattle	One pump falls dry for three months
Rainwater tank	15%	Private	Drinking	Supply for some four months

1. The percentage refers to the approximate number of families that use this source.
2. If several sources run dry during part of the year the table needs a column for the wet and for the dry season

1.2.1 Groundwater based systems

In this group we can distinguish the following broad categories:

- Springs
- Shallow wells (unprotected or protected and with or without a lifting device)
- Deep wells with a hand or rope pump
- Deep wells with an engine driven pump and water tank
- Deep wells with distribution system (with or without treatment)

1.2.1.1 Springs

Springs can be found in different places often at slopes but sometimes also water may emerge under pressure at other places. In most cases this water will come from a confined water layer in the subsoil and therefore may be free from harmful bacteria and viruses. Spring protection (Figure 1.8) may make this water source even more valuable, but a lot of care is needed not to build up water pressure in the system you construct as this may result in the water finding another outlet leaving the spring without water.

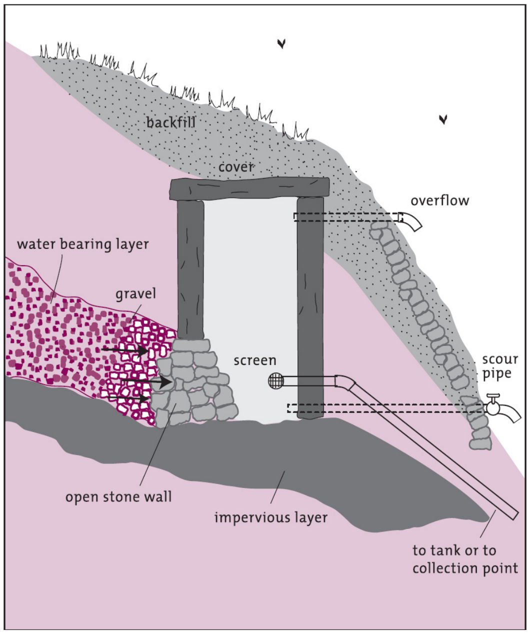

Figure 1.8 Spring capitation (WHO & IRC, 2003)

1.2.1.2 Shallow wells

Shallow wells are important water sources in rural areas and also in some urban areas. An important characteristic is that they usually tap water from a shallow aquifer which may be subject to seasonal fluctuation in water availability and to pollution from for example pit latrines. The systems may range from open dug wells to fully protected shallow boreholes.

Lined wells with a headwall (Figure 1.9) and properly sealed shallow boreholes are less prone to contamination by seepage of contaminated water around the well. Wells equipped with a rope and pulley system are less prone to pollution than wells were people use their own buckets. A pump (Figure 1.10) however is a safer solution as this minimizes the contact between the users and the water in the well. It has the disadvantage that when the pump is broken the water cannot be accessed. In dug wells a lockable manhole is therefore often included in the well cover for emergency use.

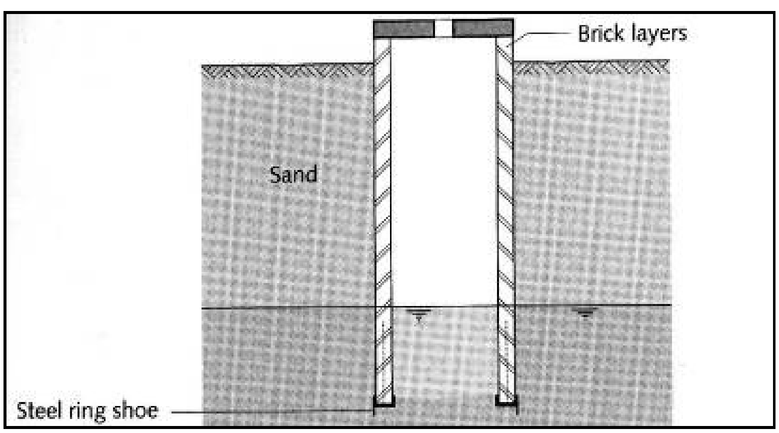

Figure 1.9 Lined dug well with brickwork (Source: IRC Small Community Water Supplies, 2002)

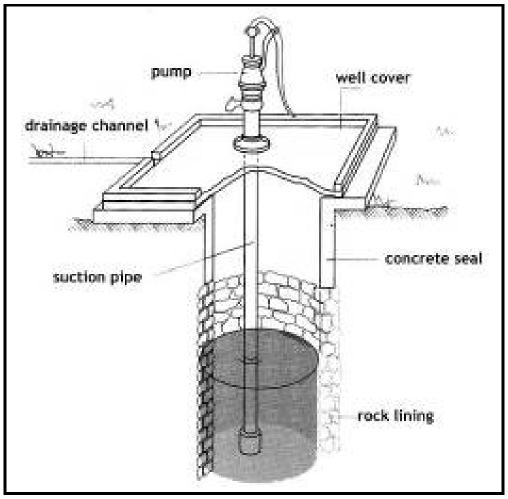

Figure 1.10 Lined well with hand pump (Source: IRC Small Community Water Supplies, 2002)

Different types of pumps can be used, but rarely this includes wind, solar, diesel or electrical pumps as the volume of water that can be abstracted from a shallow well is usually small.

1.2.1.3 Deep wells

An increasing number of deep wells are used in Ethiopia. They usually tap water from confined aquifers which is less prone to bacteriological contamination, but may contain too high concentration of chemicals such as fluoride.

Systems equipped with handpumps can be found in many places and if properly sealed can be quite safe in terms of bacteriological quality. Different types of pumps can be distinguished:

- Rope pump, in which the rope functions as a continuous chain with washers that lift the water from the well (Figure 1.13). A small risk of contamination exist because of relatively free access to the rope
- Suction pump, in which the cylinder is above ground. A risk of contamination exists because the pump may need to be filled with water to initiate pumping.
- Direct action pump, in which the cylinder is in the well (Figure 1.12). The plunger is directly connected to a handle at the surface. Very low risk of contamination if the pump is properly installed and maintained.
- Deep well piston pump with a handle or a wheel (Figure 1.15). It may also be animal or wind driven. The cylinder is in the well and the pump entails a very low risk of contamination if it is properly installed and maintained.

All these different types of pumps are used in Ethiopia. The trade marks include: India Mark II, Afridev, Rope pump, etc.

Unfortunately the quality of some of the locally produced pumps is very poor with a result of frequent breakdowns.

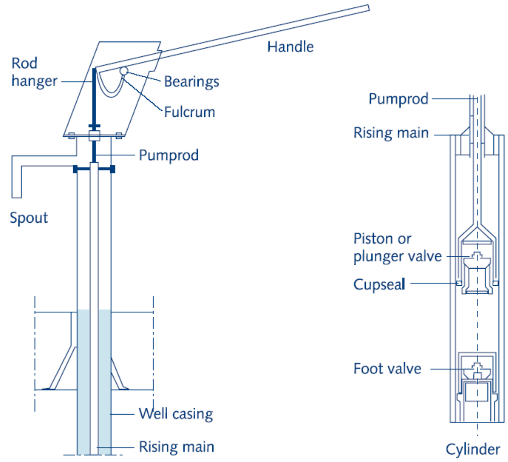

Figure 1.11 Well with rope pump)

Figure 1.12 Deep well pump (source: IRC

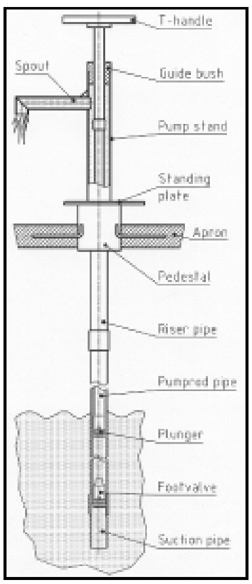

Figure 1.13
Direct action pump

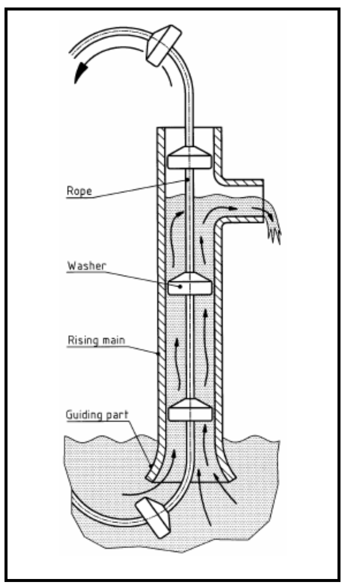

Figure 1.14
Rope pump

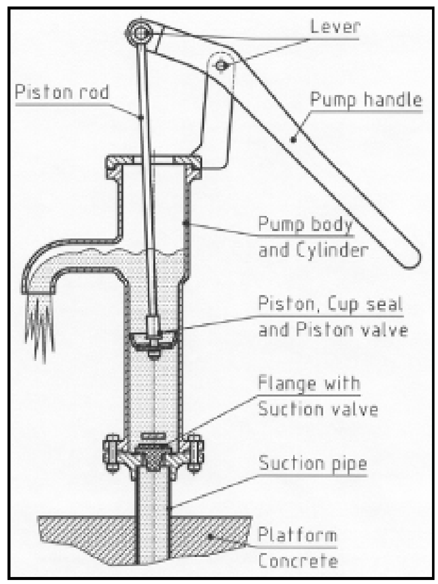

Figure 1.15
Suction pump

Figure 1.16 Different types of rope and pulley systems

Systems equipped with an engine driven pump and storage reservoir are common in Ethiopia. In some of these systems water can be collected against payment at tap stands connected to the reservoir others also include a distribution system and yard connections. In some cases these systems may include chlorination and water treatment particularly related to the removal of Fluoride but also of Iron and Manganese. Obviously adding house connections and water treatment makes the system more complex.

Figure 1.17 Deep well with tap stand

1.2.2 Surface water based systems

In this group the following type of systems exist in Ethiopia:

- Open sources (ponds, lakes, canals and rivers);
- Gravity water supply systems (with or without treatment)
- Pumped water supply systems (with or without treatment)

1.2.2.1 Open surface water sources

This type of system is still a very important water source for a large part of the population. The sources are often used for different purposes including drinking water, cattle and irrigation. Pollution levels can be considerable.

1.2.2.2 Gravity water supply systems

In hilly areas gravity water supply can be applied. Water may be captured from a spring, but more often the system uses a surface water source. In the latter case water treatment will be needed to make the water safe to drink. The number of water treatment systems in this type of supplies is still very limited in Ethiopia and therefore treatment systems will not be discussed in this module.

Figure 1.18 Water collection from an open source

1.2.2.3 Pumped water supply systems

The systems that pump water from surface water sources usually draw their water from contaminated sources. This implies that water treatment is required to make these sources safe to drink. Usually this involves some form of filtration and disinfection. As few of these systems are available in rural areas this is not discussed in this module

1.2.3 Rainwater based systems

In this group we can distinguish

- Direct collection in pots and pans
- Roof catchment systems
- Rain water ponds

Given the fact that most parts of Ethiopia receive no more than 3-4 months of rainfall per year, rainwater based systems are not likely to be the sole water supply option for a household or community. An exception may be the rain water ponds which may last longer. If rainwater is directly collected it is safe to drink unless the recipient is not clean or the water is contaminated by users. Water from roofs can be contaminated by bird or animal droppings.

Figure 1.19 Simple roof catchment and storage. Source: IRC.

1.3 Self Evaluation

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers (section 1.7). In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. Which technologies are considered improved?

A: Borehole, Protected dug well, Bottled water, Tanker truck provision
B: Household connection, public standpipe, protected dug well, rainwater collection
C: Household connection, public standpipe, vendor provided water

Q2. People with access to improved water technologies drink safe water

A: Yes
B: No
C: May not be the case

Q3. Once a water supply system is constructed we do no have to worry about whether it still meets the needs of the population.

A: Correct: Water supply systems are planned for long periods of time, 10 years or even 20 or 30 years, so they meet the demand of future populations
B: Correct: At least the first five to ten years we do not have to worry as the population will not grow that much.
C: Not correct: The population and their habits may change which may affect the water demand
D: Not correct: The people and the environment may change

Q4. A community water supply system is

A: A handpump
B: A piped water supply
C: A combination of rainwater harvesting and open wells
D: The combination of all possible water sources and technologies a community uses

Q5. Which of the following answers only includes groundwater based systems

A: Shallow wells, handpumps, ponds
B: Shallow wells, springs, dug wells, drilled wells,
C: Shallow wells, gravity piped water supply, drilled wells

Q6. Which of the following statements is correct?

A. Rainwater is always safe to drink
B. Ground water is safer than surface water
C. Groundwater may contain harmful bacteria

1.4 Assignment

In this section you will find the assignments related to this module. Preferably these assignments are done jointly with one or a few fellow participants.

1 Make a list of the type of water supply systems and water lifting devices that are being used in the Woreda were you live or work. Include the English names, the trade mark and the local names of the different system and pumps.

2 Make a drawing and description (see table 2) of the water supply of a community which you can visit relatively easily. This may also be (a part of) the community where you live. The overview should include the different types of water sources the community uses and the purpose for which they are being used.

3 Give an impression of the water quality of one but preferably two of the water sources the community uses: What do you think about the water quality and how do you come to this conclusion.

Copy the answers of your small group to questions 1, 2 and 3 and submit this to your trainer through your water desk or through another means of communication you have agreed upon with your trainer. If you can send your response by email, you may just send the table instead and not the drawing.

1.5 References

Galvis G.; Visscher, J.T. and Fernandez, B. (1994). Overcoming water quality limitations with the multi-barrier concept: a case study from Colombia. In : Slow sand filtration. (pp. 47-60). Denver, CO: American Water Works Association.

UNICEF/WHO, 2007. The state of the world's children. New York: UNICEF; Geneva: WHO

WHO/UNICEF JMP 2000. WHO/UNICEF Joint Monitoring Programme (2000). Global water supply and sanitation assessment 2000. Geneva: World Health Organization and New York: UNICEF.

1.6 Further reading

If you want to explore these issues in more detail you may wish to access a number of additional titles in the internet (or on your CDrom) including:

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1.7 Answers to self evaluation questions

Q1. Answer B. The other two answers include some technologies that are not considered as improved (Bottled water, Tanker truck provision, and Vendor-provided water)..

Q2. Answer C. The term improved water supply does not imply safe water as a considerable number of improved systems including handpumps and piped systems with house connections do not provide water of adequate quality. This may be because the source is polluted with chemical or bacteriological contaminants which is collected and supplied without treatment. In other cases treatment may fail. But also people may contaminate the water during collection, transport and storage.

Q3. Answers C and D are correct. The situation in a community and in the environment is not stable over time. Changes may occur that may reduce the water resources. Erosion may cause sources to reduce in flow or disappear. Also the community may grow thus requiring more water or shrink thus having fewer resources to maintain the system. The key message therefore is to stay alert and ensure that the system and possible changes in the community and the environment are properly monitored.

Q4. Answer D is the most generic answer. It is essential to realize that people may use different water sources in parallel or different members of the community use different sources. Hence the water supply system of the community involves all the available sources and technologies. Often the poorer sections in the community are at a disadvantage because they may use sources that entail a higher hazard or are farther away.

Q5. Answer B and depending on the local conditions answer C. Answer A includes ponds which are surface water sources. Answer C includes gravity piped systems which in many places take water from a surface water source but some take water from springs.

Q6. Answer C. Groundwater may indeed contain harmful bacteria stemming for example from nearby pit latrines. The first statement is not correct because rainwater may become contaminated during collection. In many circumstance the second statement will be correct, but there are also cases that groundwater is more polluted than surface water.

If you failed to provide several of the correct answers, then review this module again.

Module 2 Water Quality risk management

This module provides an introduction to water quality in community water supply. It discusses some key water quality parameters as well as sanitary surveys. At the end of this module the participant will have:

- *A better understanding of key water quality aspects and related hygiene risks*
- *Explored what main risks of contamination exist in water supply systems*
- *Undertaken a sanitary survey of a water supply system in a community of their choice.*

2.1 Introduction

Safe, adequate, accessible and reliable drinking water is essential for human health. A person needs, on average, a daily intake of water that ranges from 1.8 to more than 10 litres, depending on the conditions. Someone doing hard labour in the sun requires much more water than a person resting in the shade (Cairncross and Feachem, 1983).

Water can cause the person to become ill, as it may contain:

- Microbiological contamination that can lead to diseases such as diarrheas and dysenteries caused by bacteria, viruses or protozoa, enteric fevers and worm infestation.
- Chemical contamination causing diseases such as fluorosis and arsenic poisoning, as now reported from several countries.

The problem is that we cannot see most chemical and/or bacteriological contamination. As a result many people judge the water just by their senses (pleasant in taste, cool, free from visual contamination, free from odor) and others just take whatever they can get or are used to. In all of these cases however this water may cause disease if it contains contaminants.

In the world as a whole, approximately 10.8 billion cases of diarrhoea each year cause 1.7 million deaths, mostly among children under the age of five (Mathers et al., 2003; WHO, 2005). A considerable number of these cases can be attributed to poor sanitary conditions.

Intestinal worms which infect about 10% of the population of the developing world are also a problem. These can be controlled through better sanitation, hygiene and water supply. Intestinal parasitic infections can lead to malnutrition, anaemia, retarded growth and development, depending upon the severity of the infection.

Ensuring that people can drink water that is bacteriological and chemically safe and have sufficient water for their personal needs can reduce the suffering of many people

The water people obtain should be free of chemical substances and micro-organisms that can result in rejection or disease among users, or in deterioration of the water supply system and domestic utensils.

Clean water can be ensured by selecting water sources that are not contaminated or by removing contaminants by water treatment. Yet the provision of clean water may not be sufficient. Water from point water sources such as handpumps will be transported from the source to the point of storage at homes. This implies a considerable risk of contamination during transport and storage that depends on the "water culture" of the users.

As discussed in module 1, a household connection has a much lower risk of recontamination, but the water may be obtained from polluted sources and may not be properly treated. In many countries, service providers do not meet their legal obligation to supply safe water to the consumers. Many water supply systems both in urban and rural areas are operating intermittently and do not include adequate water treatment.

So we can conclude that water quality hazards may exist in all steps in the water chain from catchment to consumer. To assess these hazards the sanitary inspection or sanitary survey has been developed as will be explained in this module. This approach allows to establish the most important biological and chemical hazards related to the water supply and to identify control measures to reduce the risk that these hazards represent for consumers. It basically consists of a systematic assessment of the total water chain from catchment to consumer.

2.2 Key issues in water quality

2.2.1 Physical aspects

The physical aspects of drinking water (taste, odour and appearance, Table 2.1) need to be such that consumers do not reject the water.

Table 2.1 Ethiopian standards for the physical characteristics of drinking water

Characteristic	Maximum permissible level
Odour	Unobjectionable
Taste	Unobjectionable
Turbidity (NTU)[1]	5
Colour (TCU)[2]	15

1. **Turbidity** is the cloudiness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air
2. The **colour** of a water sample is caused by both dissolved and particulate material in water, and is measured in **Hazen Units** (HU). The colour of a water sample can be reported as:
   - Apparent color consisting of colour due to both dissolved and suspended components.
   - True color which represents the colour due to dissolved components only and is measured by filtering the water sample to remove all suspended material

2.2.2 Chemical water quality

There are few chemical components that produce an acute risk for users, except for situations where accidents occur in industry or through the spraying of pesticides and herbicides. In such cases, the water is often rejected by the consumers. Chemical pollution may, however, bring a chronic health risk associated with long periods of exposure, as can be seen from the incidence of arsenic or fluoride poisoning which may lead to dental fluorosis (Figure 2.2) or even more serious forms affecting the bone structure.

Figure 2.2 Dental fluorosis a sign of long term exposure to high concentration of fluoride

The few existing data show that water quality across Ethiopia is highly variable. It ranges from fresh waters in many of its rivers, springs and wells to more saline waters and waters with high concentrations of fluoride especially in the Rift zone. Areas with high nitrate concentrations are found in shallow groundwater and particularly in urban areas because of leaking septic tanks (BGS, 2001). Also iron and manganese may be a problem in different areas. The main approach to cope with chemical contamination is to try and find a better source, as the alternative of water treatment adds considerably to the cost and complexity of the water system.

2.2.3 Biological water quality

The contamination of a water source with excreta from people or animals introduces a great variety of bacteria, viruses, protozoa and worms (Figure 2.3). Insufficient protection of water sources, or inadequate treatment, handling and storage, thus puts the community at risk of contracting infectious diseases. An important problem is that the risk of bacteriological contamination may not be perceived by the community as the pollution is often not visible. Local people may value the taste and appearance of the water, but not its bacteriological quality unless they understand the risks.

Figure 2.3 Water can be polluted by people but also animals

The risks of microbial contamination are more significant in shallow aquifers, which may show important changes in quality in response to rainfall. Deeper aquifers tend to have better and more stable microbial quality.

Indicator bacteria
Measuring all pathogens potentially present in the water would be far too complex. It is therefore normal practice to use a test to detect just one group of 'indicator' bacteria, usually "faecal coliforms, mainly comprising Escherichia coli. They are a subgroup of the total coliform group and they occur entirely, or almost entirely, in faeces of people and warm-blooded animals" (Cairncross and Feachem, 1983). These bacteria are always excreted in large numbers by people and animals, irrespective whether they are healthy or sick".

Their presence in water is an indication of faecal contamination and thus a potential health risk as it may include excreta from people or animals with a disease. This is why they are called indicator bacteria. Measuring feacal coliforms requires a special field test kit with an incubator where a sample is being kept at a prescribed temperature for 48 hours after which the level of contamination can be established. An alternative is to transport the sample packed in ice to a laboratory where it should reach within 6 hours. Further information on how to carry out this type of test is not included in this manual as few test kits are available and functioning in rural Ethiopia. So we assume that anybody with access to such a test kit will receive a specific training.

Still it is relevant to underscore that often such tests by themselves have little value. Test results are only indicative as they relate to the specific moment in which the sample was taken. A sample taken just after a rainy day may give very different results from one taking in a dry period. To cope with this difficulty WHO has introduced the concept of sanitary inspections.

2.2.4 Sanitary Inspections

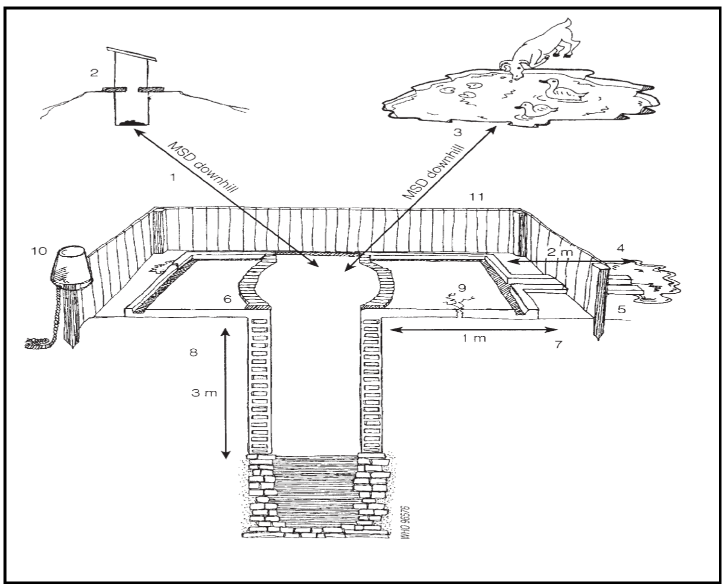
A sanitary inspection (sanitary survey) consists of a systematic review of possible hazards that may occur in the water supply chain (catchment area, water source, water supply system and water storage and use) (Lloyd, B. and Helmer, R. 1991). Preferably this is done by experienced sector staff, together with community members and staff from the local organization responsible for the management of the system. After some training, subsequent inspections can be carried out (several times per year) by the local organization without external specialist support.

The inspection aims at identifying all the hazards that are potential and actual causes of contamination of the water. It is concerned with the physical structure of the system, its operation, and external environmental factors (WHO 1997). It involves looking at all water sources and systems in a community (water catchment area, well, handpump, water intake, transmission main, treatment system, water storage, distribution network and water use) to identify possible risks for the users (WHO 1997).

The main steps involved in a sanitary inspection of a community water supply include:
1. Identification of all water sources and water systems in the community and their use
2. Exploring the water chain in each of the systems from the source to the water use. This implies making a brief sketch of each system looking at where the water is captured, how it is extracted (pump, well etc), how it is collected and stored.
3. Identification of the risk of contamination in each component of the chain (pollution of the source, infiltration through cracks in the well cover, contamination of water during transport etc.) by observation and discussions with users
4. Documenting this information (and exploring how to reduce risks)

Sanitary inspections will provide insight in the sources of contamination and risks involved. They are the basis to establish corrective actions in the system, the community, and community habits, to eliminate or reduce the hygiene risks.

Figure 2.4 shows an overview of the sanitary hazards in a shallow well. The possible hazards include:



- Possible sources of pollution (latrines, ponds or pools) close to the well. Harmful substances from these sources may travel underground to the well. The minimum safety distance (MSD) depends on local conditions including the type of subsoil and direction of groundwater flow.
- Problems with the well lining, headwall and cracks in the well cover
- Unhygienic handling and storage of the bucket

Figure 2.4 Potential pollution hazards in an open well with bucket (WHO, 1997)

Sanitary inspections and water quality analysis (2.2.5) are complementary activities that preferably are carried out at the same time. Whereas the sanitary inspection identifies potential risks, the water quality analysis establishes the level of contamination at the point and the time of sampling. The sanitary inspection is essential for the interpretation of the results of the water quality analysis and to prioritize remedial actions. The difficulty with water quality analysis is that it is just a snap shot and therefore may not at all be representative for the situation. Furthermore it may be quite difficult in many situations to find the necessary equipment and chemicals, whereas the sanitary inspection combined with users information is always feasible.

Climate conditions may have an important influence on water quality. Particularly in micro-catchments these changes can be of short duration and may be difficult to detect with occasional water quality testing. The sanitary inspection can be of great help in such case. Waste water discharge often is more critical in the dry season when less water is available. First rains after a dry spell can severely enhance the microbial and chemical contamination of a water source and increase turbidity levels.

The community is an important source of information. They know about changes in water quality during and over the years in terms of turbidity, colour and taste (salinity, iron). Also they may be able to give an indication of the incidence of water borne diseases in the community. Hence their information can help to confirm the findings of a sanitary inspection. One would expect a high incidence of diarrhea if the sanitary inspection shows that there are considerable sanitary risks from the source and/or inadequate hygiene habits.

Although there are numerous contaminants that can compromise drinking-water quality, not every hazard will require the same degree of attention. The risk associated with each hazard or hazardous event may be described by identifying the likelihood of occurrence (e.g., certain, possible, rare) and evaluating the severity of consequences if the hazard occurred (e.g., insignificant, major, catastrophic). The aim should be to distinguish between important and less important hazards or hazardous events.

A semi-quantitative scoring can be used relying to a significant extent on expert opinion to make judgments on the health risk posed by hazards or hazardous events. A "cut-off" point must be determined, above which all hazards will require immediate attention. On the other hand, there is little value in expending large amounts of effort to consider very small risks.

2.2.5 Water quality parameters

Ethiopia has comprehensive water standards that are based on the WHO guidelines. But the WHO (2005) suggests that these types of standards are too complex to adhere to in rural areas and municipalities with limitations in infrastructure. WHO (1997) presents a much less prescriptive approach, which combines the use of a few water quality parameters and the implementation of sanitary inspections.

The water quality parameters included in the minimum WHO approach to community water supply include:

- Turbidity
- E. coli counts (the indicator discussed in section 2.3)
- residual chlorine (if applied)
- pH (if chlorine is applied)

Even these very few parameters are still difficult to measure on a regular basis. Hence an approach may be to sample only regularly those systems that are susceptible to pollution and or are the water source for larger populations. For other schemes, the quality of water is monitored through sanitary surveys, and water quality testing is only carried out when pollution is suspected or an outbreak of water-borne disease is reported.

Another important aspect is to view the water quality in the context of local conditions. In an area where there are numerous other potential routes of disease transmission, the impact of less stringent water quality norms may be lower than in very clean environments.

2.3 Identification of water supply hazards

Managing hazards implies confronting situations that pose a level of threat to life, health, technologies or environment. Most hazards are dormant or potential, with only a theoretical risk of harm, however, once a hazard becomes 'active', it can cause harm. The risk involved in a hazard (and the management attention it merits) depends on the likelihood that it can become active and the seriousness of the damage it can cause.

To establish the risk involved in a hazardous event in a water supply we need to explore:

- The hazardous event
- The likelihood of its occurrence, and
- Its potential impact on water quality or quantity

Howard (2002) distinguishes three categories of factors that need to be explored:

- Hazard factors; Potential sources of feacal material or chemicals situated so that they may contaminate the water supply (e.g. a pit latrine or waste dump in relation to the water source).
- Pathway factors; Potential routes by which contamination may enter the water supply (e.g. eroded backfill areas of protected springs, cracks in well covers, or leaking pipes).
- Indirect factors; Factors that represent a lack of a control measure to prevent

contamination (and therefore increase the likelihood of a hazard or pathway developing). The absence of a fence, for example, will not lead directly to contamination, but may allow animals or humans to gain access to the source and create either a hazard (through defecation) or a pathway (through causing damage to the source or its immediate surroundings).

Assessing hazards and risks implies that the water supply chain needs to be reviewed very carefully while taking into account possible problems in the design, construction, operation and maintenance of all components in the water chain (catchment area, wells, pumps, pipes, storage vessels etc. These may all influence the type of hazardous events that may occur and the associated risk (in particular the likelihood of occurrence).
The sanitary inspection is the main tool to assess the risks, but it is not a one off activity as risks involved in hazardous events and pathways may vary during the year and change over time. For instance in rural areas microbial contamination may peak at the start of the rainy season but then rapidly diminish as the reserve of faecal material diminishes. Man made interventions in catchment areas may cause erosion and change of runoff patterns which may negatively affect springs in terms of quality and quantity.

The sanitary survey also needs to take into account problems caused by the technology and inadequate maintenance. This may for example result in lower production levels of pumps which may lead to longer waiting times at collection points. Users than may go to alternative (polluted) sources or buy water from vendors (forcing them spend more on water). As such problems may be the result of poor management and financing, also these aspects need to be explored as will be discussed in more detail in the other modules in this course.

2.4 Management of the risks in the water supply chain

Managing the risk of transmission of water related disease related to drinking water supply starts with looking at all the hazards that may occur in the supply chain from collection to use (Figure 2.5). The overview of hazards and the level of occurrence will provide insight where to focus our interventions.

Some of these interventions are very feasible to implement in existing systems, but some hazards need to be or can better be addressed at the design stage. This may include, for example, choosing a protected water source with good quality water, ensuring a sanitary seal at the top of a dug or drilled well, or including a very robust treatment system.

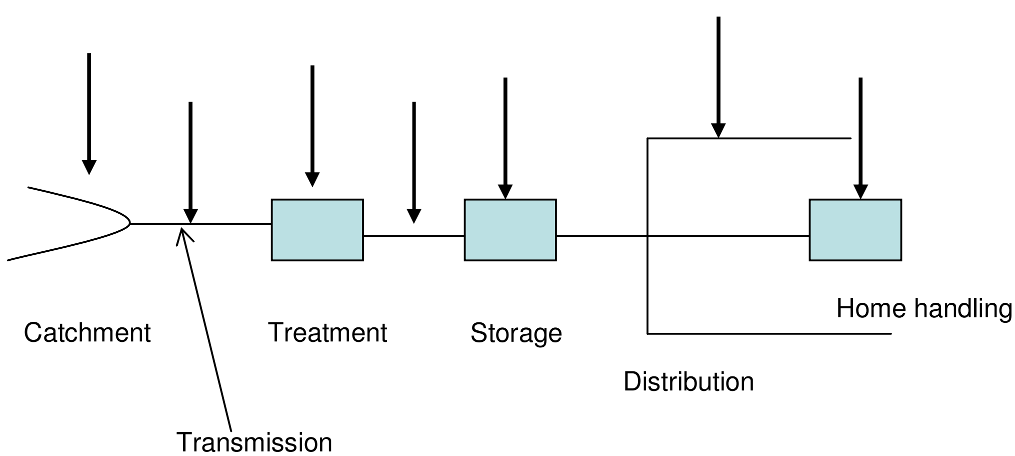


Figure 2.5 Examples of a water supply chain (arrows indicate potential risks)

2.4.1 Managing hazards related to water sources

Looking at managing hazards related to water sources implies posing a number of questions

- Where is the water coming from?
- What are the main microbial and chemical contamination hazards?

- What are the main pathways that exist for contamination to enter the source?
- Who are the main actors involved and in what way do they contribute to the risk?
- Can hazards and/or pathways be reduced or blocked?
- Is the technology in good shape and well maintained?
- Is the management properly functioning?

The answers to these questions are water source specific, but may be quite generic in similar communities in the same area. Once we know the answers it may be possible to take specific action to prevent or strongly reduce the risks. A number of possible actions for different water sources are presented in Tables 2.2 and 2.3. Additional information on some of the actions such as disinfection is presented in module 3.

Table 2.2 Action to prevent or reduce sanitary risks in existing groundwater sources

Hazard and pathway	Remedial action
Pollution of aquifer "upstream" of the water source by infiltration	Avoid or remove latrines, cattle ponds and pools close to the water collection point. The 'safe distance' needs to be assessed locally as it depends on the travel time of harmful bacteria or chemicals.
Changes in run-off patterns because of interventions in the catchment area	Regularly review catchment area to ensure adequate protection; avoid overgrazing, deforestation, spraying with chemicals etc.
Direct infiltration of polluted water in the source	• Ensure fencing of springs to avoid erosion of the protective cover (back fill). • Review system components (spring box, well cover etc.) for possible cracks and repair them • Ensure that safe water is used for possible priming of pumps • Avoid the use of unclean buckets in protected wells • Carry out repairs in a hygienic way and if possible disinfect afterwards • Disinfect the source if pollution has occurred (which may be shown by an outbreak of diarrhea)
Wells running dry and/or salt water intrusion	Avoid possible over-pumping of groundwater as this may cause a fall in the water table. In some areas it may also result in salt water intrusion. Another option to look into is to enhance recharge of the well for example by improvements in the catchment area or building of subsurface dams

Table 2.3 Action to prevent or reduce sanitary risks in existing surface water sources

Hazard and pathway	Remedial action
Pollution of water source "upstream" of the point of collection	Avoid or remove, waste water discharge, cattle grazing, human intervention and agricultural activities that may affect the water quality and water availability. Adequate water catchment protection is a good start to ensure good water quality, but almost always some form of treatment will be needed
Changes in run-off patterns because of interventions in the catchment area	Regularly review catchment area to ensure adequate protection; avoiding overgrazing, deforestation and inadequate land management. Construct bunds if erosion is increasing.
Direct infiltration of polluted water in the water intake and water transmission pipe	• Ensure fencing of the water intake. • Review system components (water intake and transmission pipe) for possible cracks and leakages and repair them • Close intake if water quality deteriorates (dead fish, bad smell, strange color etc.)

2.4.2 Managing hazards related to water treatment

Although few rural water supply systems in Ethiopia involve water treatment this some issues are mentioned here that need to be looked at if water treatment or disinfection is included. Key questions that need to be posed:

- Are the treatment processes (treatment barriers see Resource Note) adequate to produce a water that is attractive and low in sanitary risk;
- What are the main hazards that need to be addressed in terms of microbial and chemical contamination during the treatment process?
- What are the main pathways that exist for (re)contamination of the water during treatment and storage?
- Who are the main actors involved and in what way do they contribute to the risk?
- Can hazards and/or pathways be reduced or blocked

The answers to these questions are specific for each water treatment system, but may be quite generic in similar communities in the same area. Once we know the answers it may be possible to take specific action to prevent or strongly reduce the risks. A number of possible actions for different water sources are presented in Table 2.4. Additional information on some of the actions such as disinfection is presented in module 3.

Table 2.4 Action to prevent or reduce sanitary risks in water treatment and related storage

Hazard and pathway	Remedial action
Inefficiency of water treatment processes	• Monitor the treatment processes and take action when required indicator levels are not met • Ensure adequate operation and maintenance • Explore if the operator occasionally by-passes the water treatment system, explore why and try to solve the problem
Problems with overdosing chemicals in treatment	• Over dosing of chemicals such as alum sulphate or chlorine may not represent a direct health hazard, but it can be dangerous as people may reject the water and use polluted sources instead. Monitor as feasible and take immediate action if problems are encountered or users complain.
Ineffectiveness of disinfection process	• Monitor chlorine level at strategic locations. Review functioning of the equipment and chlorine dose if indicator levels are not met
Direct infiltration of polluted water in treated water or in the central storage tank	• Review system components (tanks, pipes, boxes and valves) for possible cracks or other damages and repair them • Ensure that safe water is used for possible priming of pumps and cleaning • Avoid the use of unclean equipment, boots etc. in O&M • Carry out repairs in a hygienic way and if possible disinfect afterwards • Disinfect the clean water pipes and storage tank if pollution has occurred (which may be shown by an outbreak of diarrhea)

2.4.3 Managing hazards related to water transport and distribution

In water transport and distribution we can distinguish three main situations:

- **A piped water supply system**, which is a convenient system that may entail some hazards primarily related to the intrusion of polluted (ground) water through leaks into the system or cross connections with pipes that contain polluted water
- **Manual transport by users** often in open containers with a considerable risk of contamination by hands and dirt.
- **Mechanized transport by water vendors** which in most countries is not well controlled. Risk involved may be considerable including

For each situation the main questions are the same

- Is the water of good quality when it enters the distribution system;
- What are the main hazards that need to be addressed in terms of microbial and chemical contamination during distribution?
- What are the main pathways that exist for (re)contamination of the water during distribution?
- Who are the main actors involved and in what way do they contribute to the risk?
- Can hazards and/or pathways be reduced or blocked

The answers to these questions will depend on the type of distribution and local conditions, but may be quite generic in similar communities in the same area. Once we know the answers it may be possible to take specific action to prevent or strongly reduce the risks. A number of possible actions for different water distribution options are presented in Tables 2.5 and 2.6. Additional information on some of the actions such as disinfection is presented in module 3.

Table 2.5 Action to prevent or reduce sanitary risks in piped water distribution

Hazard and pathway	Remedial action
Water pressure is not maintained during 24 hours	• Maintain continuous pressure on the pipes to avoid infiltration by improving efficient water use (leakage control and reduced consumption) to improve water pressure conditions • If 24 hours supply is not feasible test water quality at taps in strategic locations particularly after periods of low or no water pressure • Ensure water treatment at home
Pipes are buried and pass through water logged areas or close to waste drains	• Improve drainage and/or reinstall the pipes in areas that pose a risk • Test water quality at taps in strategic locations • Ensure water treatment at home if needed
Water is contaminated because of repairs of the distribution system	• Carry out repairs in a hygienic way and if possible disinfect afterwards • Inform users that the water supply will be interrupted for a given period (to allow them to store water) and tell them that they will need to treat the water at home (boiling) during the first day after the repair of the system.

Table 2.6 Action to prevent or reduce sanitary risks in water transport

Hazard and pathway	Remedial action
The water may be polluted at the point of collection; water vendors for example may collect water from polluted sources	• Explore where the water is being obtained • Test the water if possible • Encourage that water is only collected from 'safe water sources' • Inform the users that the water is polluted • Encourage water treatment at home
Water is contaminated by users during transport	• Explore how people handle the water • Introduce safer containers with less risk of pollution • Inform the users about the risks and show better ways of handling the water • Inform about water treatment at home for weaker family members
Water is contaminated by vendors during transport	• Explore how vendors handle the water and if feasible test the water • Introduce safer ways of handling the water to reduce the risk of pollution • Explore possibilities of disinfection of the water by vendors • Inform the users about the quality if the water of vendors • Inform about water treatment at home for weaker family members

2.4.4 Managing hazards related to water storage

Water storage is yet another aspect where water may be contaminated either because pollution can infiltrate in the storage tanks or containers or because the water is withdrawn in an unhygienic way.
Key questions that need to be posed include:

- What are the main hazards that need to be addressed in terms of microbial and chemical contamination during household storage?
- What are the main pathways that exist for (re)contamination of the water during storage?
- Who are the main actors involved and in what way do they contribute to the risk?
- Can hazards and/or pathways be reduced or blocked

The answers to these questions are specific for each type of storage. Once we know the answers it may be possible to advise the users about specific action they can take to prevent or strongly reduce the risks. A number of possible actions are presented in Table 2.7. Additional information on some of the actions such as disinfection is presented in module 3.

Table 2.7 Action to prevent or reduce sanitary risks in household water storage

Hazard and pathway	Remedial action
The water may be polluted prior to the storage	• Explore whether the water comes from a safe source and if the risk of recontamination in water transport is low (test if possible) • Encourage use of water with lower risk either by using water from safer sources and safer water transport or by water treatment at home
The storage container may be polluted before the water is stored	• Explore maintenance of the water container and encourage cleaning preferably with a disinfectant.
Pollution may enter the water in the storage because the storage is not properly closed or water is taken out in an unhygienic way	• Ensure that the water storage container can be properly closed to avoid that pollution (dust, flies, rodents) may enter • Encourage users to keep storage containers closed • Encourage users to draw water from the container either with a clean ladle but even better if the container has a tap.

2.4.5 Managing hazards related to household water treatment

In many situations it will not be feasible for people to obtain water with a low risk of contamination. This implies that many households still will need to ensure that they have access to safe water. Some are in the advantageous position that they can afford to buy bottled water, but this is often very expensive. For many other people the only feasible option then becomes to treat the water at home by boiling or by using other treatment processes to reduce the health risk involved.

Management of household water treatment may involve however a number of risks which will need to be reviewed. The main issue in household water treatment is about its effectives. This needs to be explored by looking at a number of generic questions:

- Is the treatment effective for the type of pollution that needs to be controlled
- Is the treatment process properly handled by users
- Is it necessary and affordable to apply treatment throughout the year
- Is water properly stored after treatment

These questions will generate insight in the local situation and possible remedial actions can be identified that needs to be shared with users. As actions may be quite divers, we have not included a table but refer to the information presented in module 3.

2.5 Self evaluation

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers (see section 2.9). In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. Is cold crystal clear water safe to drink?

A: Yes
B: No
C: May not be the case

Q2. Indicate which of the following statement is correct. (Several statements may be correct)

A: The physical characteristics of water include Odour, Taste and Smell
B: The physical characteristics of water include Odour, Taste, Smell, Turbidity and Colour
C: Important chemical contaminants in some Ethiopian water sources include fluoride and nitrates
D: Bacteriological contamination of water supplies is an important problem in Ethiopia

Q3. A sanitary inspection

A: Consists of a systematic review of all the hazards that are potential and actual causes of contamination of the supply.
B: Consists of a systematic review of all potential and actual causes of contamination in combination with water quality testing
C: Is carried out only once when the best water source is being identified for a community

Q4. A good sanitary survey only needs to be carried out once to clearly identify the risks involved in hazardous events and related pathways.

A: Yes
B: No

Q5. An experienced researcher may carry out a sanitary survey without asking information from the local community and water users.

A: Yes
B: No

Q6. Indicate which of the following statement is correct. (Several statements may be correct)

A: Changes in run-of patterns in a catchment area may imply changes in the sanitary risks
B: Low water pressure in pipes are an important hazard and may lead to transmission of water related diseases
C: Users may contaminate safe water during transport and storage
D: Water treatment at home is needed in a considerable number of communities in Ethiopia

2.6 Assignment

Make a brief report (2-3 pages) (including a drawing with all key components and their dimensions) and a sanitary inspection of a simple water supply system such as a rainwater tank, a handpump, a well or a spring. Include a brief description of all the water quality hazards you observe. Add if feasible some key data about the water quality if you have data available or have access to test equipment or people who have this type of equipment. (If you have to travel to the community then look at assignment 3.5 as well as you may combine the field work for the two assignments)

2.7 References

BGS, (2001). Groundwater Quality: Ethiopia, London: British Geological Survey

Cairncross, S. and Feachem, R.G. (1983). Environmental health engineering in the tropics: an introductory text. Chichester: John Wiley & Sons.

Howard, G. (2002). Urban water supply surveillance - a reference manual. WEDC/DFID, Loughborough University, UK.

Lloyd, B. and Helmer, R. (1991). Surveillance of drinking water quality in rural areas. Harlow: Longman.

WHO, 1997. Guidelines for drinking water quality. Volume 3 Surveillance and control of community supplies. Geneva: WHO. http://www.who.int/water_sanitation_health/dwq/gdwq2v1/en/index2.html

WHO (2005). Children's environmental health (CEH). Geneva: World Health Organization.

2.8 Further reading

If you want to explore these issues in more detail you may wish to access a number of additional titles in the internet (or on your cdRom) including:

- WHO, 1997. Guidelines for drinking water quality. Volume 3 Surveillance and control of community supplies. Geneva: WHO. (http://www.who.int/water_sanitation_health/dwq/gdwq2v1/en/index2.html)

- WHO (2008) *Guidelines for drinking-water quality: Training materials.* Geneva: WHO http://www.who.int/water_sanitation_health/dwq/dwqtraining/en/index.html

- Water Safety Plans, managing drinking water quality from catchment to consumer (2005) by Davidson, A., Howard, G., Stevens, M., Callan, P., Fewtrell, L., Deere, D. and Bartram, J., WHO. http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf

2.9 Answers to self evaluation questions

Q1. Answer C. The cold clear water may not be safe as chemical and bacteriological pollution may not be visible. So it will depend on the water source, possible hazards in the water supply system and in the handling and storage at home.

Q2. All answers need to be marked as they are all correct

Q3. Answer A. The sanitary inspection looks at the potential and actual causes of contamination of the supply and is complementary to water quality testing. It is not carried out once but on a regular basis as a monitoring tool.

Q4. Answer B. A sanitary survey is not a one off activity as risks involved in hazardous events and pathways may vary during the year and may change over time. Important differences may exist for example between the wet and the dry season. Also situations may change over time. Water tables may be falling because of over-pumping and water catchment areas may change because of overgrazing of cattle or deforestation. People may invade the area etc.

Q5. Answer B. Communication with the users and people living in the catchment area is an important part of a sanitary survey. They know about activities that take place in the area, which may be related to specific seasons. They know if the water sometimes becomes turbid. They know if they receive water intermittently or at low pressure etc.

Q6. All answers need to be marked as they are all correct

If you failed to provide several of the correct answers, then review this module again.

Module 3 Water supply improvements

This module introduces technical improvement options to overcome problems in water supply systems. Course participants will have their own experience and may know other solutions. Still the options presented here may encourage them to improve upon the solutions they know and if they have very interesting experience than they are requested to inform their trainer as it may be worthwhile to include the option in future trainings and/or on the resource web site. *At the end of this module the participant will have:*

- *An overview of different options to improve water supply systems together with community based organizations and community members*
- *Identified possible remedial actions in a water supply system of their choice (see 2.6) .*

3.1 Introduction

Water supply systems operated and maintained by local operators including small Community Based Organizations (CBOs) with limited specialist skills, (financial) resources, amounts of time, formal training and back-up support may have different types of problems. The water supply systems may be old and already incorporate many problems and operators may have very few tools and equipment to identify and rectify faults. In theory they may have support from external bodies (usually an arm of local or national Government) to provide support for problems beyond their capacity but in practice this is often not existing or is not timely and effective.

An important way to support these water operators is to help them develop a water and sanitation action plan to establish measures to improve the performance of the community water supply and sanitation situation. Part of this plan will concern the implementation of practical technical improvements looking at all steps from catchment to consumer. We can distinguish between different categories of problems including:

- Inadequate preventive and corrective maintenance
- Problems as a result of mistakes in the design and/or construction
- Water quality problems
- Water quantity problems

The key issue to problem solving is to get a good understanding of the problems together with the community who often are part of the problem and of the solution.

So the first step in any location is to carefully review the different water systems that are in use and explore their conditions. The steps involved include:

- Physical inspection of the system(s) to review the technical conditions. This includes an assessment of the performance of systems (see box 3.1)
- Discussion with the operator to explore the operation and maintenance routines. You can learn a lot from these discussions and you are likely to find for example that monitoring is not part of the routine and that breakdown maintenance is very frequent, with the big disadvantage that this cannot be planned and so repair may take time.
- Assessment of potential causes of breakdown and repair experience
- Assessment of the technical capacity at local level (and supervision of operators)
- Exploration of difficulties with sparepart supply
- Possible risk of pollution (sanitary inspection)

Box 3.1 Some tips to explore performance of systems

- In dug wells the main issue is often the variation in water level between seasons. If water tables fall over the years it is good to explore if other users draw water (irrigation)
- In case of handpumps it is essential to check the yield and ask if this varies (has reduced) as this may be an indication of wear in the cup seals; Furthermore it is necessary to count the strokes when pumping starts after a period of rest. If it takes several strokes the foot valve may have problems. You want to discuss these issues with the operator as these are useful management indicators.
- In pumped systems the operator may have a logbook with production figures and fuel consumption. If not you may be able to get some insight by measuring the time it takes to fill the reservoirs. Also you may be able to explore how much water they sell and how much they pump to get insight in the water that is being lost. You may also be able to get insight in the performance of piped systems by asking about pressure problems particularly in the tail ends.

It is important to take an action oriented approach from the beginning. The review of the systems will show a number of problems which sometimes may be very serious. It does not seem fair to just leave the community and write a report instead of already exploring possible 'emergency' improvements the water operator or community members can make. In high risk systems for example it can be considered to suggest as a minimum that water needs to be boiled, chlorinated or treated by solar disinfection at household level at least for children and elderly people.

3.2 Water quality improvement techniques

Water treatment may be needed to as much as possible reduce the potential risk involved in ground water or surface water supply. The level of treatment should maintain harmony with aspects such as: the type of risk existing in the water source and water supply system and the socio-economic conditions in the community. Five issues are essential to take into account.

- **Select and protect the best water source you can find**. Water catchment and water source protection is in fact the first step in water treatment as this will allow you to prevent harmful materials entering the water. This may include measures such as banning construction of latrines close to wells etc. Source selection may also be an option to avoid fluoride problems. It is well known that fluoride levels may vary considerably in water sources even if they are close to each other. Prioritizing the 'safest' source for drinking water then may be a feasible option to reduce the problem.
- **Make sure that possible treatment works.** If no experience exists with a specific treatment system first try it out or have it tried out carefully before you depend on it. Particularly explore the assurance that possible chemicals and spareparts are readily available.
- **Disinfection** requires that the water is already of reasonable quality and does not contain a lot of pathogenic micro-organisms or substances such as organic matter that can interfere with the disinfection process. The essence is to ensure that the water quality is sufficiently good (either by selecting a good water source or providing water treatment) that only a small and rather constant dose of disinfectant is needed to make the water safe to drink.
- **Avoid recontamination of the water**. Unfortunately recontamination of water after treatment is rather common either trough leaking pipes or inadequate collection transport and storage of the water.
- **Household water treatment** In many situations water treatment may not be included in the water supply, or water is being re-contaminated in the water chain prior to its use. In such situations household water treatment needs to be explored as the quickest option. Yet this puts an important challenge to individual households as household water treatment may add a number of routine activities to the daily chores.

3.2.1 Physical Disinfection

Disinfection means the destruction, or at least the complete inactivation, of harmful micro-organisms present in the water. At family level the two principal physical disinfection methods used are boiling of the water and solar disinfection. Ultraviolet radiation is gaining acceptance for community water supply because of the reliability of the components and the declining costs.

Boiling is highly effective as it destroys pathogenic micro-organisms such as viruses, bacteria, cercariae, cysts and ova. On the down side it may be expensive as it requires considerable fuel consumption. Also consumers may not like the taste of boiled water and it takes a long time for the water to cool. Yet particularly for vulnerable groups such as babies, and young children water boiling may prevent a lot of problems.

Solar disinfection (SODIS) (Figure 3.1) works on the principle of pasteurization to destroy pathogenic germs that may be present in the water. Heating water above 62.8°C for 30 minutes or 71.7°C for 15 seconds is sufficient to destroy waterborne bacteria, rotaviruses and enteroviruses in water. Cysts of Giardia lambia are inactivated after 10 minutes at 56°C.

Usually SODIS is performed by putting transparent bottles (plastic or glass) with water for several hours in the sunshine. It is a low cost appealing technique that is accepted by users without difficulty. The limitation is that several parameters may interfere with the safety of the water including environmental temperature; geographical latitude and altitude; season; number of hours of exposure; time of the day; clouds; temperature; type, volume and material of vessels containing the water; water turbidity and colour. Hence to be effective solar disinfection must be applied to relative clear water and the bottles need to be exposed to sunlight for six hours, for example on the roof of a house (or for 2 days if the sun is obscured by clouds). The water should be consumed directly from the bottle or transferred to a clean glass

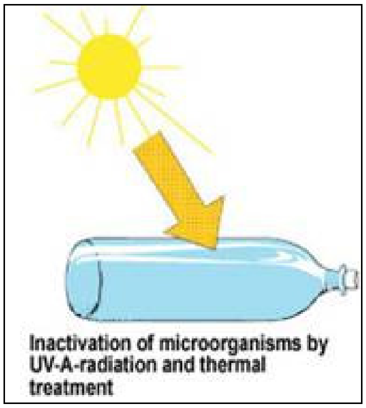


Figure 3.1 Solar disinfection SODIS (Source: www.sodis.ch)

3.2.2 Chemical disinfection

Several chemicals, acting as strong oxidants, can destroy micro-organisms including for example chlorine, ozone and iodine. Here we will focus on water disinfection by chlorination, which was massively introduced worldwide in the early 20th century in water treatment. Chlorine and chlorine related substances have a number of characteristics that are highly valuable including:

- A broad-spectrum germicidal potency
- A good persistent residue that can be easily measured and monitored in networks and after delivery to users.
- Simple dosing equipment including possibility to dose in small tablets
- Availability in many even remote locations
- Economic and cost effective.

Chlorination of drinking water is carried out in practice through the bubbling of chlorine gas through the water or by dissolving chlorine compounds in the water. At household level the approach is to add a tablet to a container of water. Chlorine is also used to disinfect wells by hanging a container with chlorine compounds in the water or by providing a single dose of powdered or liquid chlorine.

It is essential that the water that is being chlorinated is very low in turbidity and organic content. This is important as the chlorine may react with these impurities thus becoming less effective and requiring a higher chlorine dose. Turbidity may also imply that bacteria can be protected by hiding in flocculate material. In case of turbid water this first need to be treated by filtration for example to obtain good results.

3.3.3 Filtration

One option to improve the transparency of water and partly remove impurities is plain sedimentation. By adding chemicals this process can be further improved. Filtration however gives much better results. In the 18th century the first slow sand filter was build in the small city of Paisley in Schotland. A slow sand filter is a box with sand through which the water slowly passes. After some days a biological film is formed at the surface which comprises a lot of bacteria, protozoa’s, algae and other micro organism that contribute to oxidizing organic matter and to the removal of disease causing organisms.

Slow sand filtration

Slow Sand Filtration (SSF) is a very effective treatment process which is also used on small scale by filling perforated pots with sand and passing the water through this pot. This Domestic water filters (Figure 3.2) do reduce turbidity but have a limitation in that often the process is not continuous and therewith the removal efficiency for harmful organism is not guaranteed. So still some chlorine dosing, solar disinfection or boiling is needed particularly before giving it to young children.

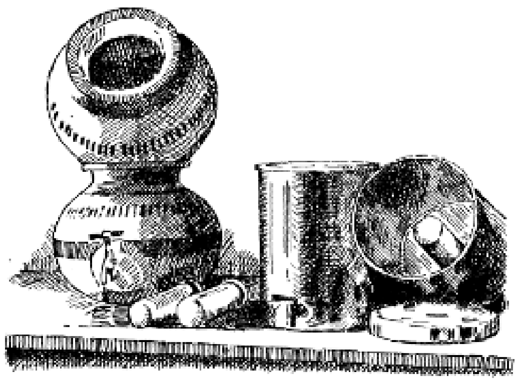


Figure 3.2 Domestic water filter

Rapid sand filtration

It is good to mention also the process of rapid sand filtration (RSF). This technology requires less space to produce large volumes of water. Yet it is less suitable for rural water supply as it requires chemicals and is less efficient in the removal of bacteria. RSF systems do remove a considerable quantity of micro-organisms, but not completely, still leaving a considerable risk of transmission of water borne diseases unless the water is properly disinfected after filtration.

Ceramic filter candles

Ceramic Filter Candles (Figure 3.3) are porous candles which are put in a container with water but also can operate under pressure. Different filter candles are being produced throughout the world, some using the latest techniques to provide a hollow porous ceramic which is fired at a temperature of over 1000°C. The most effective candles have an inner silver coating that kills bacteria that still may pass the candle. This coating however gradually dissolves and therefore the candle needs to be replaced (often after one year in normal use). The most advanced candles use a variety of specialist media to improve taste, odour and appearance as well as combat chemical and organic pollutants.

Figure 3.3 Modern filter candles

Locally made filter candles may also be available but may be less effective as they may have small (invisible) cracks which may enable some bacteria and viruses to pass through the filter. Hence a risk still remains that the water is not safe unless the silver coating is working and therefore, particularly in the case of locally made filters, still extra measures may be needed for babies and small children.

3.2.4 Fluoride removal

In this course fluoride removal techniques are not discussed as they apply only for specific areas in Ethiopia. It is important to however to realize that all techniques are rather difficult to sustain. On the other hand not all sources even within the same communities in fluoride infested areas have similar levels of fluoride. Therefore the first option is to try and select the water sources with lowest fluoride content and reserve these for drinking and cooking water, keeping those with high fluoride for other household chores. For those who face fluoride problems in their area we refer you to the study by Haimanot (2005).

3.3 Technical improvements

Technical problems may exist in water supply systems because of design and construction mistakes which were feasible should be traced back to the source (designer or contractor). Too often such mistakes are the result of insufficient review of the design. Also inadequate supervision is a main issue as it may allow contractors to use poor quality materials or to put in less cement and iron rods in the concrete. The problem is that this may very much reduce the life time and the performance of systems and enhance the suffering of the users.

Other problems may arise from poor maintenance and repairs particularly in older systems but also from an increasing number of users. In this section we will present a few experiences with this type of problems which sometimes can be overcome quite quickly at low cost whereas in other cases larger external interventions are needed.

3.3.1 Physical improvements in tanks, wells and springs

- **Repairing cracks** in tanks and wells often can be done quite quickly. It can help to reduce leakage and may reduce the risk of infiltration of contamination. If cracks in tanks are considerable you will need to check structure for problems. Sometimes a quick way to repair is to put chicken mesh wire with a cement coating of some three centimeters on the inside wall and floor.

- **Leaking overhead tanks** of other materials also need repairs as continuous leakage is costing a lot of resources in pumped systems. A way to calculate the leakage is to fill the tank, close the tap, and measure the fall of the water level over say a period of one to a few hours.

- **Deepening of wells** may be an option in some areas to chase falling water tables. Yet this needs a lot of care and first and foremost the cause of the problem needs to be assessed. If it results from over pumping for example for irrigation than this may need to be controlled also because irrigation is often very inefficient. Another problem is that deepening sometimes leads to connection with another aquifer which sometimes may be of lesser quality.

- **Installing a head wall and cover** may be a good way to reduce the risk of contamination. Yet in areas with a high percentage of broken pumps it is essential to keep a manhole (with a lock) as an emergency water supply when the pump breaks.

- **Spring protection** may also be a good option, but is another intervention that requires caution in order not to lose the spring. It is always essential to avoid that the free flow of water is blocked and pressure can built up in the collecting structure. This may result in the eye of the spring finding another outlet and your structure will become useless.

3.3.2 Improvements in distribution networks

Leakages in distribution networks may be extensive. Often this occurs at valves and meters.

There are several options to try to find the leakages even with simple means. When reaching an area you may explore the following:

- **Checking the water loss** (making a water balance) by comparing production and consumption. This involves assessing the water production per day by taking data from the bulk water meter. If no bulk water meter exists but a water tower you may get this information by asking for the pumping hours and by pumping for 10 or 15 minutes into the tower with all outlet valves closed to obtain the pump production per hour). The total then needs to be compared with the volume that is received by the users (either from the water meters or the sales). The difference is the non revenue water (leakage but maybe also illegal connections or meters with problems).

- **Reducing water loss** is a challenging task as leakages may not be so visible. Still a visual inspection of the network and taps can be useful including being alert on possible leaking taps, wet spots in the ground or differences in vegetation. Still this will not help you enough to find the leakages. A better option is to close all outlet taps and 'to listen to flowing water' by putting a metal stick through the ground to touch the pipes. This device you can call a 'local listening device' because when you put your ear to the metal bar you will hear water flow if there is considerable leakage. You follow the pipe downstream and repeat the listening and this may help you to detect leakages.

- **Exploring possible meter problems.** This can be done by comparing the payment by different water users or different stand posts. Differences may show up which can be the result of differences in water use (number of users etc.) but also may indicate meter problems. Than the out layers in the data can be checked. If you then find low consumption data but a large family or many users than you need to check the meter for example by tapping a few hundred or even 1000 liters of water and see what the meter indicates. You may ask one or more water vendors to help collect this water as they will have the recipients.

- **Low pressure at taps** may be an important problem that may be caused by leakage but also by many people with open taps at the same time or distribution systems with too small pipes. For standposts this may lead to long waiting lines. One option to tackle this problem is to install storage tanks at the tap points where water can accumulate during periods with low consumption. One added advantage is that the number of taps connected to this tanks can be increased thus allowing more people to get water at the same time. An added advantage is that when a risk of (re)contamination has been identified then it could be considered to put a disinfection device in these tanks.

- **Very high pressure at taps** may also be a problem as it will increase leakage. This problem is quit common in gravity piped systems and may require the installation of pressure break chambers or pipe reductors.

3.3.3 Improvement in pumps

Problems with pumps are common in many places as a result of design and construction failures, falling water tables but mostly because of poor monitoring and maintenance. You will need to explore the situation in detail with the operator to understand the problem asking among others about age, performance, repairs etc.

- **Problems with electrical pumps** may particularly relate to fluctuation in current which may cause burning of pumps. Performance may also be dropping of both electrical and fuel pumps because of wear and tear over the years. Lower production may also be caused by lowering water tables. Often you will need a pump specialist to establish the cause of the problem

- **Problems with handpumps** often relate to poor maintenance (or break down maintenance) whereas a simple monitoring of the pump production can give a good indication of the need to plan an intervention. Two main issues are to be assessed, the number of strokes it takes to make the water flow after a period of rest (leaking foot valve). If it takes three strokes than repair needs to be initiated and carried out within the next two weeks. The same applies if production starts to reduce considerably below the normal flow (leaking cup seals). Users may give a hand as they know how long it normally takes to fill their buckets. If it starts to take considerably longer then repair needs to be scheduled in next days.

- **Problems with rope pumps** may also be common and in a number of cases these are the result of the poor quality of materials that are being used. So the first step is to check the pumps to assess whether repair is realistic or whether it is better to find a more sturdy rope pump. If you have doubts it is important to seek technical advise from outside.

SNV has supported the development of a) Preventive Operation and Maintenance of Water Lifting Devices in the SNNPRS (Abate, B and Migbar Assefe, A., (eds.) 2009) which is useful to review. It includes information on trouble shooting of different types of pumps that can support the analysis of the problems at hand. An example is shown in Table 3.1.

Table 3.1 Trouble shooting for Indian mark II and Extra Deep Handpumps

Fault	**Cause**	**Remedy**
Pump handle works easily but no flow of water	Worn out cylinder leather cup washer	Overhaul the cylinder and replace the leather cup washer
	Valve seat worn out	Replace valve seat
	Connecting rod joint disconnected	Pull out the pump and join the connecting rod where ever necessary
	Pump cylinder cracked	Replace cylinder assembly
	Water level gone down below the cylinder assembly	Add more pipes and rods
Delayed flow or small flow	Leakage in cylinder check valve or upper valve	Overhaul cylinder Replace rubber seats
	Leather cup washer worn out	Overhaul the cylinder and replace leather cup washers
	Damaged rising main	Replace the damaged pipe or disconnect the affected rising main
Folding of chain during return stroke	Leather cup washer getting jammed inside the cylinder	Overhaul the cylinder and replace the leather cup washer
	Improper erection	Adjust the length of the last connecting rod suitably
Noise during operation	Stand assembly flange not leveled properly	Level the flange
	Bent connecting rod	Change the defective rod
	Hexagonal coupler welded offset	Change the defective rod
Shaky handle	Loose handle axle nut	Tighten handle axle nut
	Worn out ball bearing	Replace ball bearing
	Spacer damaged or short in length	Replace spacer
	Bearings loose in the bearing house	Replace the handle assembly

Source: Abate, B and Migbar Assefe, A., (eds.) (2009)

3.3.4 Improvement of household storage and treatment

The household is often a weak link the water chain as they may easily pollute the water during transport, storage and use. Hence the first action to take is to review the water habits and the risks involved. Is water transported and stored in close containers? Is it withdrawn from these containers in a hygienic way? You may then suggest improvements based on the risks you see and perhaps you can use more careful users to help others.

If the water from the source is not safe or recontamination cannot be avoided than it may be an option to introduce solar disinfection or at least advice to boil water for younger children.

3.4 Self evaluation

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers. In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. **An experienced water professional can assess the prevailing problems in a water supply system without asking information from the local community and water users.**

A: Yes
B: No

Q2. **Important water leakages may occur and can be detected by (indicate which answer is correct (multiple answers possible):**

1. Observing and repairing leaking taps;
2. Visual inspection of the area where the network is installed;
3. Making a water balance
4. Making a detailed inspection including the use of a 'local listening device'

Q3. **Indicate which of the following statement is correct**. (Several statements may be correct)

A: Low water production in a handpump may be caused by worn out washers
B: If water appears only after several strokes of the handle than the pump may have a leaking foot valve or a leaking pipe or cylinder
C: When the water appears only after several strokes than it is very likely that the water table has lowered

Q4. **In a water supply system it is important to (**several answers possible**):**

1. Prevent contamination of source waters even if you have water treatment;
2. Treat the water to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets;
3. Prevent re-contamination during distribution, storage and handling of drinking-water

A: Answers 1 and 3 are correct
B: Answer 2 is correct
C: All three answers are correct

Q5. **Household water treatment is not needed in systems with chlorination**

A: This is indeed not needed
B: This is still very much needed
C: This still may be needed

3.5 Assignment

Take your assignment of module 2.6 and explore possible remedial actions that can be taking to reduce or avoid the hazards that you have identified in the system that you have reviewed.

3.6 References and Further reading

Abate, B and Migbar Assefe, A., (eds.) (2009) Preventive Operation and Maintenance of Water Lifting Devices in the SNNPRS, a general guide line. Addis Ababa: SNV (Separately you will receive a summary report with main trouble shooting)

Bolt E., Fonseca C. (2001) *Keep It Working: a field manual to support community management of rural water supply.* IRC Technical Paper Series 36; IRC, the Netherlands
http://www.irc.nl/content/download/2602/27266/file/TP36_KeepItWorking.pdf

Brikke, F. and Bredero, M. (2003) Linking technology choice with operation and maintenance in the context of community water supply and sanitation. Geneva: WHO and Delft: IRC
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Smart Water Solutions http://www.irc.nl/page/28654

Visscher J.T. (2006) *Facilitating Community Water Supply, from technology transfer to multi stakeholder learning.* IRC, International Water and Sanitation Centre, the Netherlands http://www.irc.nl/content/download/25104/278851/file/TP46_FacilitatingCWS.pdf

WHO, 2008 Household Water Treatment and Safe Storage. Geneva: WHO http://www.who.int/household_water/en/index.html

3.7 Answers to self evaluation questions

Q1. Answer B. Communication with the users and people living in the catchment area and supply area is an important part of a sanitary survey. They know about activities that take place in the area, which may be related to specific seasons. They know if the water sometimes becomes turbid. They know if they receive water intermittently or at low pressure etc. If you did not have provide the correct answer, than also review Module 2.

Q2. All answers need to be marked. All four options can contribute to the reduction of water loss. The water balance will give you insight in the level of the water loss, the visual inspection may show some problem areas, the listening device will help you to find mayor leakages and dripping taps in fact may produce considerable leakage. Just as an experience put a bucket under a dripping tap and come back an hour later. If you did not mark all answers than better review module 3 again.

Q3. Answers A and B are correct: In fact most problems in handpumps occur because of normal wear and tear of cup seals and washers. Leaking pipes and cracked cylinders are less common, but indeed may occur. Answer C is not correct. A falling water table may cause a reduction in pump flow or the flow may stop entirely if the water level drops below the cylinder. It does however not cause a 'delayed' flow.

Q4. Answer C. All three answers are correct

Q5. Answer C. Even if the water supply system includes disinfection at the source this may not be fully effective to the point of use. So you will need to explore if a risk of recontamination exists. This risk may result from infiltration of impurities in for example pipes which may be common in systems that operate intermittently, but also from water carrying and home storage.

If you failed to provide several of the correct answers, then review this module again.

Module 4 Sustainable multiple use water services

This module introduces the concept of multiple use water services (MUS) and the effect of seasonal influences on water use patterns to better assess and use existing water systems and exploring possibilities for district support to be included in the community water and sanitation action plan. *At the end of this module the participant will have:*

- *A better understanding of the implications of multiple water use including seasonal influences*
- *Identified the livelihood zone(s) and the wealth groups in a community of their choice*
- *Prepare a seasonal calender*

4.1 Introduction

As mentioned in module 1, people may use water from different sources and to satisfy different needs. Multiple use water services (MUS) is an approach towards water services provision, which takes people's multiple water needs as a starting point for providing integrated services, moving beyond conventional sectoral barriers of domestic and productive sectors (Van Koppen et al, 2006)

Water services provision is the process of converting water resources (surface, groundwater, rainwater) into the delivery of a certain water service though hardware (infrastructure) and software (people to do the planning, design, implementation, operation, maintenance, rehabilitation etc of the infrastructure and the awareness raising, monitoring, capacity building etc). These services may vary in quantity, quality, accessibility and reliability over the year. They are often developed in projects (with a short lifespan), but water service provision does not end with the project, but needs to proceed over the years.

People in rural areas have **multiple needs for water**. They use water for a variety of uses. These include domestic uses, like drinking, cooking, washing and cleaning. They also may use it for watering animals, gardening, irrigation, processing of agricultural products and small-scale industrial activities, like beer brewing and brick making. These different uses of water bring different benefits. Domestic water use will mainly lead to an improved health situation with respect to water, sanitation and hygiene related disease, while productive use of water can result in direct economic benefits (income generation) and improved diet and greater food security (Moriarty et al 2004).

The figure below gives an example of multiple uses of water, from multiple sources, which bring multiple benefits.

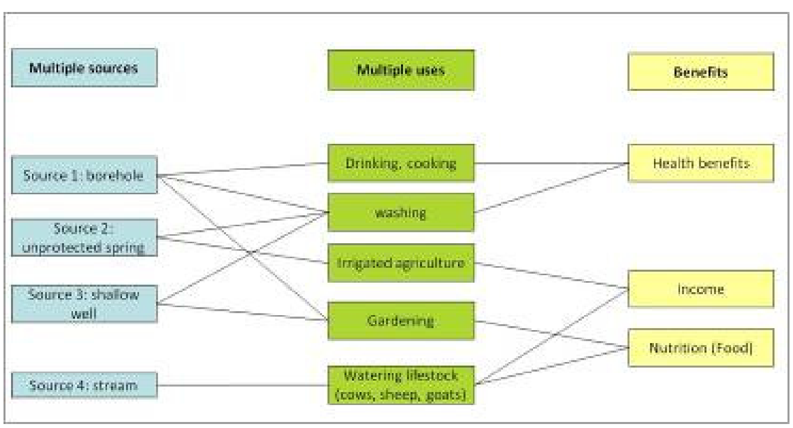

Figure 4.1 Multiple sources, multiple uses and multiple benefits at user level

Providing **integrated services** means not only focusing on water supply for domestic use, or on water for livestock or water for irrigation, but assessing what people need water for and addressing this in an integrated way.

Why multiple use services?

If people's multiple water needs are taken as a starting point, multiple use water services can be provided which will result in multiple benefits, rather than providing services that only bring one specific set of benefits, either health and time saving benefits from domestic water use, or economic benefits from productive uses.

Furthermore, taking into account the multiple needs people have for water can have a positive impact on sustainability of water systems. If water systems are designed for one specific use but used for multiple uses, the resulting extra pressure on services may cause conflict and premature system failure and breakdown. Taking the multiple uses into account in the design and management of the system will help prevent that. Adopting multiple water services can also positively impact the willingness of the users to operate and maintain the system, since it caters for their needs. People might be more willing to pay for water they can use for different uses, including productive uses.

Multiple use services:

- Take people's water needs as starting point
- Adopt a long term 'service delivery' approach, rather than just building systems
- Match water needs in a reasonable way and adopt fair use regulation

Woreda level staff should be able to make high quality equitable decisions to meet the demand within the available water system options, building on and strengthening existing hard and software, where appropriate. Woreda staff needs to be aware of the heterogeneity of communities and their multiple water needs and need to deal with this in a transparent and equitable way (Van Koppen 2009). In the next part we will have a more detailed look into how woreda staff can assess the current situation and what interventions can be done in order to better adapt multiple water services to people's multiple demands.

4.2 Situation analysis: participatory mapping of multiple uses of water

In order to ensure that communities have access to water services for their multiple uses, all year round, it is important to first understand what these uses are, and what water sources and infrastructure are available to meet them, and to understand the barriers people face in accessing these resources. This can be established by establishing a participatory assessment of the situation looking at the water sources and their use throughout the year.

Water Resources:

As we saw in module 1, there are 3 types of water resources:

- Ground water (where are they located, in which months are they available, and what is the quality of the water)
- Surface water (where are the sources of surface water, in which months are they available, and what is the quality of the water)
- Rainwater (what are the rainy periods and how strong is their fluctuation)

There can be seasonal variations in the availability and quality of water resources, for example:

- Water tables drop during the dry season
- Seasonal ponds and pools appear during the rainy season and disappear in the dry season.
- Rivers may be seasonal and dry up (or partly dry up) during the dry season.
- The discharge in rivers may reduce and may results in higher levels of contamination
- Boreholes may break down in the dry season because other sources of water have disappeared and they are therefore over-used.

These variations are part of normal seasonal cycles and are seen in a normal year, but they are often intensified by droughts.

Infrastructure:

As we saw in module 1, there is a variety of systems based on the above mentioned water resources. An overview is given in the box 4.1.

Box 4.1 Water supply systems (Recap from Module 1)

Ground water based:

- Springs
- Shallow wells (unprotected or protected and with or without a lifting device)
- Deep wells with a hand or rope pump
- Deep wells with an engine driven pump and water tank
- Deep wells with distribution system (with or without treatment)

Surface water based:

- Open sources (ponds, lakes, canals and rivers);
- Gravity water supply systems (with or without treatment)
- Pumped water supply systems (with or without treatment)

Rainwater based:

- Direct collection in pots and pans
- Roof catchment systems
- Rain water ponds

When regarding multiple use water services, usually the systems will need to be bigger as more water is needed and also some additional infrastructure may have to be built such as:

- Cattle troughs
- Irrigation infrastructure for example for drip irrigation
- Different type of lifting devices

Demand

Water demands of communities are likely to include:

Domestic use:

- Drinking and cooking
- Personal hygiene and sanitation
- Washing clothes and utensils

Productive use:

- Growing crops (find out what kinds of crops are irrigated, and try to estimate the area of irrigated land in the community)
- Livestock (find out what types of livestock the community keeps, and approximately how many livestock of different kinds are kept).
- Other activities such as brewing or brick-making (find out how many community members are doing this, and approximately how much water they use).

The minimum volume of water for **domestic use** is defined as 15 litres per person per day[1]:

- 5 litres per person in a household per day for drinking and cooking needs
- 6 litres per person per day for hygiene and sanitation needs plus
- 4 litres per person per day for laundry.

The volume of water needed for **productive uses,** will depend on the number and types of crops, livestock and other activities. The minimum volumes of water required by livestock in different seasons are given in the Table 4.1 below.

[1] Minimum requirements are based on SPHERE standards, which are the same as those used by the Ministry of Water Resources.

Water demand will vary over the year and will not be the same for everyone within the community. This requires careful analysis, planning and discussion of the distribution of the additional cost involved in multiple use systems.

Table 4.1. Daily Water Requirements for Livestock Across Seasons (voluntary intake)[2]

Daily Water Requirements – Livestock (Lpcd)	Wet seasons (23 - 27°C)	Cool dry seasons (15 – 21° C)	Hot dry seasons (27°C)
Camels	13	25	28
Lactating camels	17	30	33
Cattle	9	20	22
Lactating cows	13	26	29
Goats	2	4	4
Sheep	2	4	4
Horses & donkeys	5	16	18

Voluntary intake is the daily amount of water drunk by an animal assuming that fodder contains 70-75% moisture during the wet season and 10-20% moisture during the dry season. (Source Coulter, 2010)

Access:

Finally, it is important to assess *access* to water resources and infrastructure. Different people within the community may have different levels of access to water services. So we have to ask ourselves: Who uses which water for what? What are the barriers different people face for accessing water services?

These barriers can include:

- Physical barriers:
  - Long distances to water infrastructure
  - Physical difficulty of collecting water (e.g. the source is on a steep rocky slope)
  - Long time to collect water because the flow is very slow
  - Long queues for water
- Social and legal barriers
  - Source is on private land, and access is blocked by the landowner at certain times
  - Certain people are excluded from using water from certain water points
- Financial barriers
  - Water fees are too high for certain people or for certain uses
  - Lack of resources to collect and store water (e.g. lack of a donkey to collect water from a nearby community, lack of jerry cans etc)

[2] Voluntary intake is the daily amount of water drunk by an animal assuming that feed contains 70-75% moisture during the wet season and 10-20% moisture during the dry season.

Figure 4.2 Donkeys carrying several jerry cans of water

Access to water resources and water services are also subject to seasonal influences. For example:

- People may have to travel long distances to collect water in the dry season if the source near to their home dries up.
- People fetching water may face long queues in the dry season
- Landowners may prevent other households collecting water from springs or other sources on their land at certain times of year.

These **seasonal variations in access to water have impacts on livelihoods, food security and health,** which often also show seasonal patterns. For example:

- Use of seasonal pools and ponds, which are unprotected sources, for drinking is associated with peaks in diarrhoea occurrence.
- Long waiting times for water during the dry season use up household labour, preventing household members (especially women) from engaging in income-generating activities or devoting time to childcare.
- Livestock which do not receive adequate water during the long dry season produce less milk, which can affect the food security of pastoral households.

4.2.1 Assessment tools for multiple use water services

Tools that are helpful in assessing community level water resources, infrastructure, demand and access to water for multiple uses, include:

- Community water mapping
- Livelihood grouping
- Wealth ranking
- Seasonal calendar

Community mapping

Community mapping can be helpful to get a better insight in water resources, infrastructure, demand and access for water for multiple uses within the community. Community mapping can be done with different groups within the community, like different livelihood groups, different wealth groups and with men and women separately. This can give insight of the differences in water demand, access and use between the different groups.

Box 4.2 How to do community mapping

- Ask a number of people from the community (about 10) to participate in the exercise. Make sure the participants are a good representation of the communities (men / women, poor / less poor, people with livestock/ people without livestock, people who irrigate / people who do not irrigate)
- Tell people you would like to get more insight in their water system and that you would like to do this by asking them to draw a map of their communities and the water sources and systems, indicating houses, roads, farm land (irrigated or non irrigated), water sources and infrastructure, communal grounds, forests etc.
- Explain that you would like everyone to have an input in drawing the map.
- Explain the use of the material (flipcharts + markers in different colours, or locally available materials, like stones, twigs etc)
- Give people ample time and opportunity to draw the maps
- Explain the trends of going from the initial situation to the multiple use situation of the community.
- Discuss the results by asking the group to explain what they have drawn.
- Make notes of the discussion

The map will stay in the community. Make a sketch or a picture of the different stages of the map.

Livelihood grouping, making of livelihood zone profiles

Demand for and access to water for multiple uses may vary widely over different livelihood groups. Livelihood groups consist of people who are involved in similar activities to sustain their livelihoods, for example cow farmers or farmers mainly crowing a particular crop.

All woredas in Ethiopia have already been delineated into 'livelihood zones' by the early warning department and the Disaster Risk Management and Food Security Sector (DRMFSS). Livelihood zones are areas with similar agro-ecology, market access, and livelihood activities. Some woredas lie entirely within one livelihood zone, while others include several zones. For each livelihood zone, short profiles are available which include a 'seasonal calendar' showing seasonal (month by month) patterns of food availability, disease, and main farm and non-farm activities.

Wealth ranking

Just as for livelihood groups, wealth groups and their characteristics (in terms of what assets they generally have) have already been identified for socio-economic groups in all woredas and livelihood zones in Ethiopia through the DRMFSS's livelihoods baselines. The livelihood zone profiles describe the typical characteristics of better-off, middle, poor and very poor households in the zone. Woreda officials can use these wealth group breakdowns – found in the livelihood profiles for each livelihood zone and woreda – as a guide to help understand the different assets held by each wealth group and how these affect demand for and access to water. It may also be useful for selecting people to participate in participatory mapping exercises, like the participatory mapping, mentioned above.

Seasonal calendars

A useful way to bring together information on access to and use of water for multiple uses, is through a seasonal calendar. Woreda staff can collect data on seasonal water availability and access and link this to the seasonal calendar, to better understand how lack of access to adequate quantity and quality of water is affecting the livelihoods, food security and health of communities, and develop appropriate responses.

Box 4.3 How to make a seasonal calendar

To create a seasonal calendar of water sources, draw a table with a column for each month of the year. For each of the main water sources, add rows to represent different uses of the source (drinking, washing, irrigation, livestock and any others). Shade in the boxes to show in which months water is used for these different purposes. Then add a row to record the round trip time to collect water in each month.

Finally, ask the community which months are the peak months for diarrhoea (waterborne disease) and add this as a row to your table.

Table 4.2 An example of a seasonal calendar

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Source 1 (protected spring)	Collection time (hrs)	-	-	3	3	-	-	-	3	3	3.5	3.5	4
	Drinking & cooking												
	Washing & laundry												
	Irrigation												
	Livestock												
Source 2 (unprotected spring)	Collection time (hrs)	1.5	1.5	2	-	1.5	1.5	1.5	2	-	-	2	2
	Drinking & cooking												
	Washing & laundry												
	Irrigation												
	Livestock												
Diarrhoea	Peak months												

A seasonal calendar like this allows you to quickly see all the information about water sources and uses together, and to identify months when there are problems such as use of unprotected sources or long waiting times.

Seasonal calendars can also be used to link information on water sources and use with information on livelihoods, and to find connections between the two. The livelihood zone profiles referred to above (available from the DRMFSS) already include seasonal calendars of major livelihood activities. The Figure below is an example of a seasonal calendar from the livelihood zone "Sorghum Maize Chat", which is found in East Hararghe. This calendar shows:

- Months when there is a high labour demand for livelihood activities (e.g. crop planting and harvesting; livestock sales)
- Months when labour is hired out
- Months when food is scarce (the "hunger period")

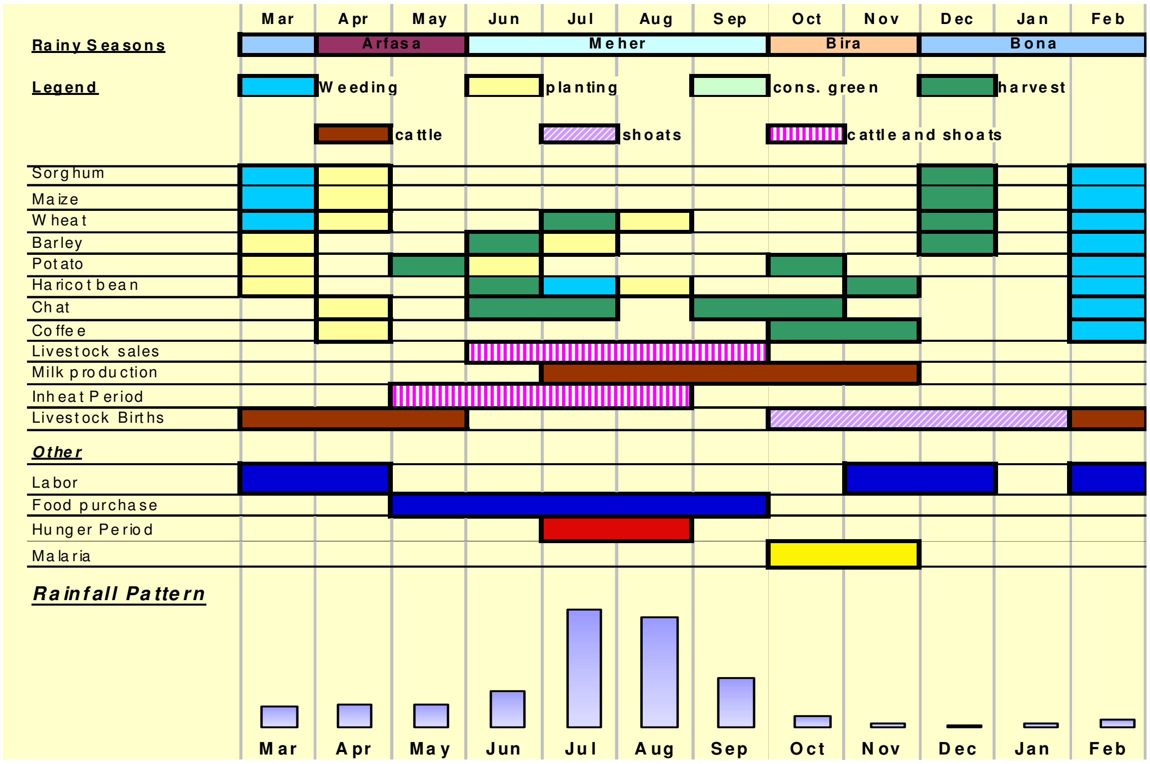

Figure 4.3 Seasonal Calendar from SMC [check] Livelihood Zone

You can compare the water seasonal calendar with the livelihoods seasonal calendar to identify:

(a) Months when high collecting times for water clash with peaks of livelihood activity creating a conflict over time and labour. (In this situation households may reduce water use or turn to more convenient but unprotected water sources, which have negative impacts on health.)

(b) Water sources which are associated with waterborne diseases.

(c) Periods of vulnerability where high labour demands, poor health and hunger coincide

4.3 Facilitating multiple use services

After having done a good participatory assessment of available water resources, infrastructure, demand and access related to multiple uses of water in the community, we can start thinking about what can be improved in order to better match the water services to people's multiple demand in a sustainable and equitable way.

In module 2, we have looked at options for improving water quality. In module 3, we have looked at options for technical improvements to overcome problems in water supply systems. The options mentioned in these modules can support multiple uses of water, by making more water available and by improving the quality of the water, so it can be used for different uses.

In addition, here we will look at some technical and institutional options for better matching supply to demand:

- Implementing and maintaining multiple use water systems, by
    - modifying existing single use systems to cater for multiple uses (e.g. adding lined canals to divert the overflow of a spring system supplying water for domestic use, to irrigated plots; adding a domestic water collection point to an irrigation system using spring water),
    - planning new systems that build in MUS from the beginning,
- Implementing and maintaining separate systems to address different water needs.

- Developing and supporting institutional arrangements for multiple use services

4.3.1 Systems for multiple use water services

Different types of systems provide different levels of potential for multiple water uses. In general we can differentiate between the following technological options:
- Household options
- Communal systems with single access point
- Communal distribution systems (Van Koppen 2009)

Within and between these technological options, there can be incremental steps going from single to more multiple use of water. Below we will give an overview of these options and what can be done to make them more suitable for providing multiple use water services.

Household options are (often) a result of self supply. These options include family wells and household level rainwater harvesting technologies. Family wells, or shallow wells, are generally used for domestic water use, but also for watering animals and gardening. Households often build these wells themselves, close to their house.

Whether or not a household option can be safely used for multiple uses, including drinking and cooking will depend on the water quality from the well. Water quality can be improved by improving the water source (e.g. by lining the well with cement), but also by applying household level water treatment (see 2.4.5: Managing hazards related to household water treatment).

The potential for multiple uses of household options can be improved by improvements in the water lifting potential, for example by equipping the shallow well with a simple pump, like a rope pump. When more water can be easily extracted from the source, this water can be used to irrigate more land, water more livestock etc.

In that way, household options can be used for providing water for different uses, including drinking, watering livestock and watering plants.

Communal point source systems include hand dug wells and boreholes with hand pumps and piped systems with scattered public standpipes. Communal point source systems generally have limited scope for multiple use services. Often the number of users is quit extensive making access to the service provided by communal point sources limited. Still boreholes with handpump and piped systems with scattered public standpipes can offer an opportunity for some communal productive uses, like communal gardens or communal livestock troughs. They are often used in combination with other sources for other uses.

In Ethiopia, gravity spring systems in mountainous areas often supply water for both domestic, as well as for other uses, like watering animals and irrigating small plots. Often, these springs are developed to supply either water for domestic use, or for irrigation. However, in reality people will often use the water for both. Run-off water will be used for irrigation and watering animals, in case of a water supply system. In case of an irrigation system, people will often fetch water from the storage reservoir. These multiple water uses can easily be facilitated by add-ons to the single use infrastructure, for example by adding a public standpost for domestic water use to an irrigation reservoir, or by adding small scale irrigation infrastructure (small lined canals) to guide the run-off water from a spring water supply system. The box below gives an example of this.

Box 4.4: Technological add-ons to facilitate multiple use of water: the case of Ido Jalala and Ifa Daba

In Ido Jalala, a community in Gorogutu Woreda, East Hararghe zone, Oromya Region, the Ethiopian NGO HCS capped a spring and installed a water point to improve the quality and the easiness in which the water can be collected and used for domestic use. Initially, the spring had been used for domestic water, as well as irrigation. Therefore, HCS decided to add an irrigation component to the system, with a night storage reservoir and lined canals, to improve the efficiency of water use.

In Ifa Daba, a community which can also be found in Gorogutu woreda, HSC capped a spring and diverted the water into an irrigation reservoir, from which lined irrigation canals divert water to irrigated plots. However, people collected water from the irrigation reservoir for domestic water as well. Collecting this water was not easy and quite time consuming (see picture). Therefore, HSC decided to add a water tap from which people could collect water for domestic use.

Figure 4.5 Woman collecting water from the irrigation reservoir in Ifa Daba

Communal distribution systems are piped systems with household connections and/or standpipes, bringing water closer to people. These systems supply water to taps closer to people's homes. This offers a good opportunity for multiple uses and to be complemented with 'add-ons', like drip irrigation to water home gardens in an efficient way, using domestic water from the piped network.

4.3.2 Multiple systems for multiple uses

Providing multiple use water services which respond to people's water needs does not mean that all uses of water have to be addressed through one single system. There may be multiple systems providing services for different uses. Rainwater harvesting for example is often done to complement water supply from other sources. This water can be used for domestic uses, but can also be used for productive uses. It should be taken into account in the planning of separate systems to address different needs. The main point is to take people's needs as a starting point and to provide financially sustainable equitable services that respond to those needs.

4.3.4 Institutional arrangements for multiple use services at community level

Systems providing multiple use water services can be managed by individual households (like in the case of household options), external agencies (like utilities or local government departments), or, most commonly, by communities themselves. Within the community, there can either be one single water committee, which is responsible for the system(s) providing water for multiple uses, or separate committees for different uses, for example a watsan committee for water supply for domestic use, and an irrigation committee for irrigation. This is mostly the case when there are separate branches or systems providing water services for different uses (Van Koppen 2009).

In addition to the management issues related to conventional water service delivery for single use (see module 7), it is particularity important for multiple use services to understand how community institutions shape the access levels for different groups within the community (Van Koppen 2009). As mentioned above, demand for multiple uses of water within communities differ over different groups within the community: man and women, different livelihood groups (e.g. livestock keepers and crop farmers) and different wealth groups. Not everyone will be able to benefit equally from improved water services. Managing and prioritising different water uses is very important. In case of multiple use services, there is thus a need for internal rules and regulations to ensure equitable distribution and priority setting. This often needs support from national, regional and woreda level.

4.4 Self evaluation

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers. In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. Which answer is the most correct answer? Multiple use water services are about

A. Addressing people's multiple needs for water through providing integrated services
B. Implementing systems that can both provide water for domestic uses, as well as for productive uses
C. Addressing people's multiple needs for water by implementing and maintaining different systems that provide either water for domestic uses, or water for productive uses

Q2. Which of the following systems has the least potential for multiple uses of water?

D. A piped system with 100 household connections and 4 communal stand posts
E. A household level shallow well
F. A community level hand dug well with a hand pump used by more than 500 households

Q3. What can be said about the following statements

- i) Multiple uses of water can be facilitated by adding a technological add-on to existing systems
- ii) Multiple uses of water can be facilitated by supporting community level institutional arrangements for prioritising water uses and conflict management

A. Statement i is correct, statement ii is not correct
B. Statement ii is correct, statement i is not correct
C. Both statements are correct
D. Both statements are not correct

Q4. Which is not an example of a livelihood group:

A. The best-off / wealthy people in the community
B. Day-labourers
C. Cattle-farmers

4.5 Assignment

1) Revisit the results of the assessment you have done about the water sources (water resources and water infrastructure) in model 1. Check whether you have included all sources for all uses of water.
2) Find out in which livelihood zone(s) the community lies. Find also out what are the characteristics of people in different wealth groups according to the livelihood zone profile.
3) Make a seasonal calendar based on the seasonal calendar from the livelihood zone profile.

4.6 References and further reading

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4.7 Answers to self evaluation questions

1-A: Multiple use water services go beyond implementing systems for multiple uses, or implementing different systems for different uses, but are about meeting people's demands by providing integrated services.

2-C: As mentioned in 4.3.1 "Communal point source systems generally have limited scope for multiple use services. Often the number of users is quit extensive making access to the service provided by communal point sources limited."

3-C: Multiple uses of water can indeed both be facilitated by adding a technological add-on to existing systems and/or by supporting community level institutional arrangements for prioritising water uses and conflict management

4-A: "The best-off / wealthy people in the community" is a wealth group, rather than a livelihood group. The fact that people in this group are wealthy does not say anything about the livelihood activities they are involved in.

If you failed to provide several of the correct answers, then review this module again.

Module 5 Sanitation and hygiene

This module reviews options to avoid the transmission of sanitation and hygiene related diseases with emphasis on improving sanitation systems. *At the end of this module the participant will have:*

- *A better understanding of the risk of the transmission of sanitation and hygiene related diseases*
- *Identified what key aspect to assess at community level*
- *Learned about some possible improvements.*

5.1 Introduction

Poor sanitary facilities, lack of hygiene and inadequate waste management are major public health problems. Although sanitation coverage increased still the levels are very low. In rural areas 8% uses improved latrines. 2% share latrines, 19% uses unimproved latrines and 71% practices open field defecation (WHO/UNICEF, 2010). This may explain why still highly infectious diseases such as diarrhea and cholera take a considerable human toll in Ethiopia. Diarrheal diseases kill some 2.2 million people each year, 85% from them are children under five.

Hence it is very important to help people understand the need to improve sanitary facilities and change risky hygiene behavior. The essence is to recognize that Water Sanitation and Hygiene (WASH) promotion need to go hand in hand. This includes the promotion of simple measures such as hand washing after defecation and before food consumption.

5.2 Cutting the transmission of infectious diseases

Faecal-oral contamination route
An infectious disease is transmitted from one person (or animal) to another person (or animal). All infectious diseases are caused by living micro-organisms that are classified as bacteria, viruses, protozoa and parasitic worms. Most of the harmful micro-organisms that are transmitted by men are found in the excreta of people carrying a disease. Once excreted these micro organisms can reach another person in different ways (Figure 5.1).

The figure shows that it is essential to break all the different transmission routes to effectively prevent the transmission of disease. It should be realized that this not only concerns micro-organisms from human faeces. Many wildlife species and domestic animals can potentially shed organisms pathogenic to humans.

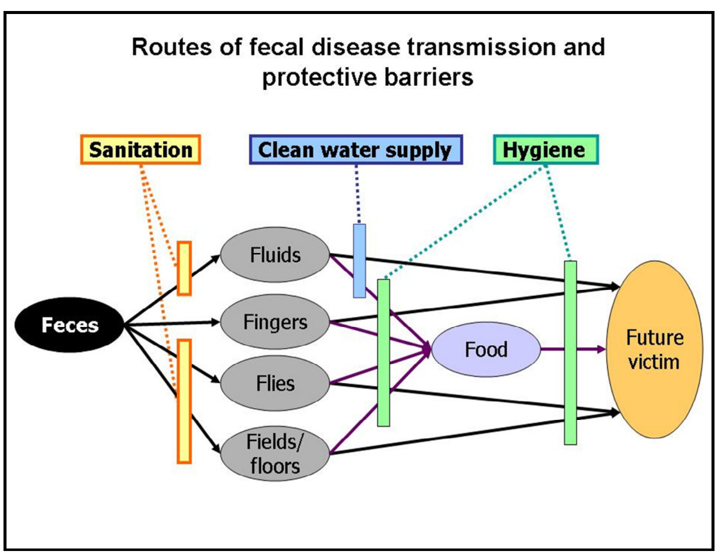

Figure 5.1 The F-diagram summarizing the feacal oral transmission routes (Source: Worldbank.org)

Figure 5.1 shows that a combination of adequate sanitation, good hygiene practices and safe water supply is needed. The 'primary barrier' is to isolate fecal matter from the environment through adequate isolation thus avoiding that it enters the environment. Here it is good to realize that in fact all community members have to adopt the use of safe excreta disposal to ensure effective reduction of the risk of contamination. Yet it is also needed to ensure proper 'secondary barriers' to protect against fecal material which is already in the environment. These barriers include good hygiene practices and particularly washing hands with soap.

Two main groups of sanitary facilities can be identified being on-site or of site facilities. In addition it is good to briefly clarify the concept of ecological sanitation.

5.2.1 On-site sanitation

This concerns facilities in which the excreta are disposed on-site such as dry pit latrines, ventilated improved pit latrines as well as poor flush latrines with a soak pit. These systems can be very effective provided that they are kept clean and properly avoid that flies can access the faces. Unfortunately many pit latrines are not properly build or kept and therewith in fact turn into a health hazard. But even if the on-site facility is well kept it still may imply a health risk if it is located close to shallow wells that are used for water supply.

5.2.2 Of-site systems

This concerns facilities that are discharging their content or part of their content outside the plot where they are built. This may include toilets with septic tanks or toilets connected to the sewer. The risk of transmission of harmful bacteria is present in many locations where the waste water is not being treated. So septic tanks need to discharge for example in a soil adsorption field to ensure that harmful bacteria are being trapped and if treatment of waste water cannot be guaranteed than the construction of sewer systems should be discouraged.

5.2.3 Ecological sanitation

Ecological sanitation (Ecosan) starts from the principle that human excreta are not a waste but a valuable input for agriculture, as nutrients and organic matter. Already before 500 BC the Chinese had a collection system of excreta which they transported to rural areas. This enabled intensive agricultural that sustained the most densely populated societies of that time. Human waste can supply nutrients needed for growing approximately 250 kg of cereals. The urine contains most of these nutrients.

Ecosan begins with the collection of excreta and urine in a container or pit. Afterwards waste is sanitized so pathogens die off. The product is a relatively safe soil conditioner (from faeces) and nutrients (mostly from urine), which assists crop production.

The main advantages of Ecosan are:

- Safe recovery of nutrients and organic material
- Minimising the risk of pathogens contaminating water.
- Stimulating soil fertility and use of organic matter
- Higher agricultural production.
- Lower water consumption in toilet practice mineral fertiliser.
- Stimulates a more interdisciplinary and holistic way of approaching sanitation (instead one of wasting of valuable resources).

The Ecosan concept has proven itself around the world in different climates and countries as widely diverging as Sweden, China, South Africa, the Philippines, Mexico and Bolivia. Some salient lessons from these experiences include:

- It is important to consider cultural and gender aspects
- It is important to not only look at the sanitation systems but also at the use (fertilizer) side
- Potential risks involved need to be assessed in the local situation

- The hygienic risk of urine is normally very low unless polluted with feces. The feces contain the harmful bacteria and viruses. These risks need to be well understood and controlled..
- The users need to properly manage their systems to prevent too much moisture (flies and odors)
- Separating urine and feces greatly improves the performance of sanitation systems
- Several projects failed because they did not provide adequate follow up

These lessons show that Ecosan needs considerable efforts in mobilization, information, but also adaptation to the local situation and culture. Success stories involve full participation of the users of sanitation systems and users of recyclates. Often also CBOs, government and NGOs will be important as stakeholder in implementing Ecosan systems. The first step is to explore current type of use of urine and feces and whether animal dung and or compost is used already.

A very important fact is that the urine contains most nutrients (60%P and 90%N) and has rarely a sanitary risk. This has led to the development of facilities that separate urine and faeces. The added advantage is that such systems have less odour problems (as these are mainly caused by the Nitrogen). Good experience exists with only reusing the urine, which just requires some dilution with water to be used as a fertilizer. Faeces require decomposing, a process taking at least 6 month, before they can be reused. So instead of reusing both it may be interesting to (initially) think of a hybrid form of only urine diversion. This is feasible even on a standard pit latrine with a sandplat, by just putting a pedestal with a diversion toilet and making a separate urinal.

5.3 Assessing sanitation and hygiene related risks

To assess the sanitation and hygiene related risk a 'sanitation' transect walk will be needed as well as discussions with the local health staff and as feasible with the community. The main aspects to observe and discuss at local level include:

- **Coverage** – being the number of households and schools that have sanitary facilities that are being used in a hygienic way. It is also important to look at availability of hand washing facilities close to the sanitary facilities;
- **Convenience** – relating to the easy access at required time and place; Latrines should be rather close to the houses as this will reduce the problems of using them in the night and will facilitate the training of young children (and the hygienic disposal of child faeces. In schools this is particularly important and when few systems are available it may be considered to stagger the breaks to ensure that fewer children need to use the facilities at the same time.
- **Quality** - to promote continued use, facilitate cleaning and ensure that flies cannot access the faeces and thereafter leave the latrines;
- **Cost** – is a crucial issue as many latrines just using local material (wood, mud) may not be easy to clean, but the poorer sections in a community may not be able to pay for example for a plastic latrine pan or for some cement. Hence in such cases it may have to be explored how to support the poorest families (often female headed households);
- **Capacity** to manage the facilities is an underrated issue. Even a pit latrine needs some management and at some point need to be emptied or relocated. In septic tanks it may be important to be careful with disinfectants to avoid interfering with the treatment process etc.;
- **Culture** – is important as it will dictate the habits and beliefs of users and this may for example not allow the application of human manure in agriculture etc.

In the 'sanitation' transect walk a systematic review is made of the sanitary situation to look for possible health hazards (Figure 5.2). Important aspects to take into account include:

- The general sanitation conditions (open field defecation, poor waste management etc.)
- Functioning, technical state, and management of latrines including approach to pit emptying
- Low-lying areas and areas with poor drainage including review of the functionality of drains and the organization of cleaning drains

Special attention should be given to potential hazards like:

- Visible presence of faecal material and flies
- Cleanliness of latrines (floors, pans etc.)
- Absence of materials to cover the pit opening (or fly screen in ventilated improved pit latrines. If no lid is available than at least material such as ash should be there to cover the feaces
- Absence of water and soap for hand-washing
- Inadequate handling of child faeces and presence of excreta around (behind) the facilities (particularly common in schools)
- Lack of water in water based system to flush excreta
- Unhygienic handling of garbage
- Unhygienic handling of wastewater

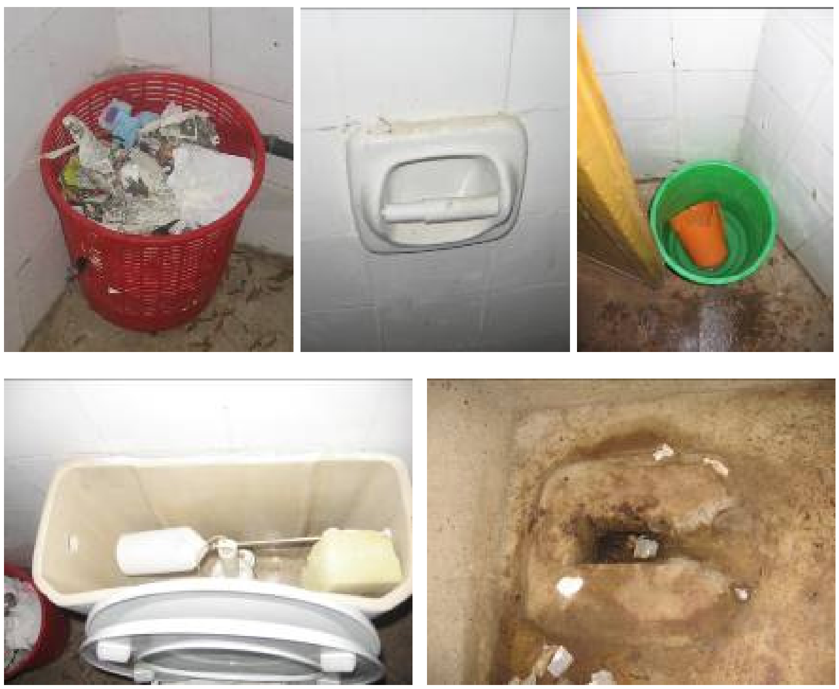

Figure 5.2 Some health hazards that you may find?

Making a brief report of the transect walk is essential (see Table 6.1 for a reporting model). The community is an important source of information. They know about changes in health situation of community members and may be able to give an indication of the incidence of water borne diseases in the community. Hence their information can help to confirm the findings of the transect walk. One would expect a high incidence of diarrhea if many risks are being identified.

Involving health staff and community members in the assessment is essential and may help them to better understand and "see" the risks. The problem with human nature is that daily routines make that people get accustomed to the situation and no longer 'see' possible risks.

It is also important to explore about earlier interventions. Different organizations may have already made an effort to support the community in improving their sanitation and hygiene situation. They may have trained community members or local health staff and may have had good or less good results. Learning from these earlier interventions is essential as it may show what worked and did not work and you may find 'champions' in the community that can take the lead on establishing change.

It is equally important to be critical as earlier approaches may have not worked out well partly because methodologies were not properly applied, systems not properly constructed and/or staff and users not properly informed and trained despite all good intentions.

Table 5.1 Report of the sanitary transect walk

Name of community	
Population size	
Official Health staff that can help to promote change	
Interviews (# of persons)	
Type of sanitary facilities	
Coverage (different systems)	
Convenience	
Quality	
Cost	
Operation & Maintenance	
Hygiene Culture (handwashing)	
Solid waste disposal	
Drainage	
Overall conclusion about the risks	
Earlier hygiene and sanitation interventions	
Key action points	

5.4 Promoting change

After having explored the situation with the community it is important to identify what needs to be done and how this can be done. Here you will need all the help you can get as creating change is complex and requires sustained inputs of locally based actors. It may be anticipated that you will require to stimulate sanitation improvements as well as to change hygiene behavior.

5.4.1 Changing sanitation practice

Simple technical improvements
It may well be that a large part of the population has already installed latrines or other sanitary facilities, but many of them may have considerable problems, may be dirty, attract flies and therewith are a health risk. Here you will need to find practical improvement options and the people that can implement them. This may include:

- Improving existing wooden toilets, by improving the drop hole, making it more easy to clean, putting a lid on it and suggest people to use ash to cover the feaces
- Replacing the wood with a sand plat (small concrete slab with a hole and putting a lid on it. Local masons may be able to help with this change.
- Changing the latrine into a water-locked toilet by putting a toilet pan on top of the whole. This you can only do if the soil is sufficiently stable and sufficient water is available to flush the pan
- Introduce urine separation either through putting a urine separating device, or as a minimum introduce urinals. This may be particularly useful at schools, and has the advantage that urine separation strongly reduces odor problems in latrines.

In addition you will have to win over the people that are still practicing open field defecation. Yet having already a number of people using latrines may be of considerable help to influence the others.

Massive intervention
You may also find that only very few latrines are being used and most people practice open field defecation. Then you will need quite an intensive approach. One option that is being applied in Ethiopia is ***community led total sanitation***. This approach is focused on the elimination of open defecation by adopting a "naming and shaming" approach while encouraging community members to lead the process to get a 100% open defecation free community. It involves awareness raising, problem analysis and planning, and in some cases includes showing different options for local sanitation solutions constructed and/or financed by the households themselves (see Box 5.1).

Box 5.1 The 10–step planning for the CLTS approach.

1. The community discusses the impacts of open defecation with external facilitation
2. Together they visit sites of open defecation
3. Community maps out areas of open defecation
4. Community works out how much human waste they produce
5. Community draws up an action plan to tackle the problem
6. Health and hygiene education sessions are carried out
7. Facilitator and community work on action plan
8. Construction of latrines (or other sanitation systems) begins
9. Latrines are now available to everyone and hygiene education continues:
10. The community is awarded 'open defecation free status' and a sign is erected.

(http://www.wateraid.org)

Interestingly, the CLTS approach emphasizes that often too much subsidy and donor money leads to adverse effects of for example donor pushed technologies for sanitation and discouragement of CLTS adaptors by rewarding neighbour communities for not having taken initiative to take action with generous investments in latrines. CLTS starts from the principle that no subsidy is needed for hardware, and only some money is needed to pay facilitators and make the process work. This may however not be entirely the case as some parts of sanitary facilities may not be available in the local market unless some support is being provided. So this implies that a good understanding of the local market is required when developing a sanitation and hygiene programme.

Furthermore the success story of CLTS is mixed as in quite some programs there is indeed a considerable number of latrines that are being established, but their quality may be quite insufficient. As a result they may turn into a health hazard closer to home than the area where open field defecation was practices. So good guidance is needed and special measures may be need for the poorest families.

5.4.2 Hygiene promotion

The risk on contamination will always exist when awareness lacks or when knowledge on how to avoid risks is absent. Therefore, health education and hygiene promotion is necessary. It is essential that people of all ages use (improved) toilets in the correct way and keep them clean. The disposal of children's feaces is as important as the disposal of adult's feaces.

Hygiene promotion in the sector is about creating awareness and change of risky behaviour in relation to water and sanitation. It is about helping people to understand the risk and find opportunities to develop new behaviours. Often people talk about WASH, being Water Sanitation and Hygiene promotion that need to go hand in hand. WASH programmes at schools are of critical importance as it can help to instill good sanitary behaviour in children at an age that they may be still in a better position to change. Furthermore school hygiene promotion can also stimulate the link between the school and the household where children can become agents of change.

Hygiene promotion is very important because more hygienic practice, such as hand washing after defecation and before food consumption, will reduce the transmission of germs, thus cutting the transmission cycles of disease. Improved water quality reduces childhood diarrhoea by 15-20% BUT better hygiene through hand washing and safe food handling reduces it by 35% AND safe disposal of children's faeces leads to a reduction of nearly 40% (Appleton et al, 2005).

Hygiene promotion can be applied at different levels. It can be used in promotion of safe use of water in the household, for changing sanitary practice of children in school, or for preventing open defecation in an entire community. The essence is that you cannot expect too many changes at the same time, so you need to focus on some key behavioral issues.

Perhaps the three most important issues to explore in terms of hygiene risk are hand washing, safe disposal of excreta (including feces of babies) and safe water handling and storage.

Promotion of hand washing has been tried successfully in different ways, but all more successful ones adopted longer term approaches. Weekly visits during a one year period of households in Pakistan had positive impacts on health indicators, while women group meetings in Thailand during a 9 months period had a measured and lasting impact on contamination of hands (Shordt, 2006)). In Zimbabwe local health-clubs were established, supported by the Health Ministry. Topics included sanitation, water and transmission of diseases and hand-washing (Appleton et al, 2005). Hand washing preferably is done with soap but ash is an alternative.

Safe excreta disposal and water care may require more efforts than hand washing as often it relates to some improvements in facilities which require materials, skills, training etc. What seems important is that interventions aim at change of risky practice and are designed with the community and/or target groups and adapted to the local situation. Ideally hygiene promotion will be most effective if it is combined with appropriate improvements to water and sanitation services (Appleton, et al., 2005).

This is also very important in schools and interestingly school hygiene promotion is more and more taking a "life skills based approach", in which children are not only learning new things but are directly applying their knowledge in practice. In a project in Somalia school children learned about hygiene behavior through role-play, coloring and group conversations. Not only did the project influence children's' behavior it also indirectly influenced behavior at the household level. Changes included hand washing, toilet use, tooth brushing and food handling (IRC, 2006).

The first step is to make an assessment of the local hygiene related risks at households and schools with members of the community. The second step is to make an inventory of existing experiences and practices in discussion with members of the community. From this a plan can be made how to stimulate better hygiene practices. Plans could include capacity building of community leaders, but also staff from NGOs local government if certain knowledge or methodological skills are not present at the moment.

5.4.3 Monitoring hygiene promotion

Monitoring hygiene promotion projects is difficult in case of general programs, but if linked to changing practice it becomes easy to define some key indicators, such as % of people practicing hand-washing, increase in hygienic latrine use or change in habits towards safe water storage. Monitoring needs to be set up with help of local 'eyes', such as a local health worker, local teacher or someone from the local community.

The philosophy is that scaling up can take place at low costs through community facilitators from early starters which help other villages in promoting the same approach. On the downside we see that several of these CLTS programmes have considerable problems in ensuring that latrines that are constructed are hygienically used and sustained. Hence also in CLTS a longer term support seems required, the level of which however will depend on local circumstances.

It is important to take into account that in hygiene promotion as well as in CLTS a gender sensitive approach needs to be taken including gender specific analysis and working with separate target groups women, men and children. Often changes in practices of hygiene, water use and sanitation have different implications for women and men. Access to resources (time, money, information, contacts) and capabilities (skills, training) is different for women and men. This influences who can do what when improving hygiene. Many exercises exist to help focus on the gender aspect. One example is mapping 24 hour activities of men and women as an eye opener to why it often is difficult for women and girls to take on extra hygiene tasks (Appleton et al, 2005).

5.4.4 What type of costs are involved

Costs for hygiene promotion and sanitation involve more than only the salaries and costs for training and transport and the local community paying for the latrines. It is important to have some money to support small community-designed projects. Costs for educational materials are low. For participatory exercises such as Rapid Appraisals and self surveys normally local materials are used, involving hardly any cost. Important costs can surge in case there is a need for program management support and capacity building and backstopping. Also setting up and initially supporting a monitoring system on local and regional scale can involve some costs. A very important issue is that often a pilot testing is needed to find out about the real cost.

Costs for school programs involve adapting the school curriculum, making training materials for teachers, actually training of teachers and make some arrangements for backstopping and monitoring of the program.

5.5 Self evaluation questions

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers. In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. Indicate which of the following statement is correct. (Several statements may be correct)

A: There are different transmission routes of water related diseases including transmission by hands, soil and flies.
B: Water supply is the most important transmission route of diarrhea.
C: Latrines can be a great support to reduce the risk in transmission of disease

A: Answers 1 and 3 are correct
B: Answer 2 is correct
C: All three answers are correct

Q2. On-site sanitation involves a higher health risk than off-site sanitation.

A: Yes
B: No

Q3. It is sufficient if

A: 50% of the population uses a sanitary facility
B 70% of the population uses a sanitary facility
A: 80% of the population uses a sanitary facility

A: Answers A is correct
B: Answer B is correct
C: Answer C is correct
D: None of the answers are correct

Q4. Promoting change in hygiene behavior implies

A: A sustained process that starts with the exploration of possible risks in the daily practice of the community
B: Carefully exploring the situation of the poorer sections in the community as these may have larger problems to change and may not be able to finance the necessary adjustments
C: Assessing which organizations have already worked in the area, with what type of approach and results and what possible champions can be identified

A: Answers 1 and 3 are correct
B: Answer 2 is correct
C: All three answers are correct

Q5. Hygiene promotion needs to

A: Be very comprehensive and address all hygiene risks
B: Needs to include children as a special group
C: include a gender perspective as the situation for men and women and boys and girls is very different

A: Answers 1 and 3 are correct
B: Answer 2 and 3 are correct
C: All three answers are correct

5.6 Assignment

Visit one or a few latrines preferably at least including one in a school. Make a brief drawing of the latrine(s) and write a short note (one page) on possible hygiene risks related to the latrine.

5.7 References and further reading

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- WHO, 2007. Combating water borne disease at the household level. The network to promote household water treatment and safe storage (http://www.who.int/household_water/advocacy/combating_disease.pdf)

5.8 Answers to the self evaluation questions

Q1. Answer A is correct. There are different transmission routes of water related diseases as shown in Figure 5.1. Latrines can indeed reduce the of disease transmission (including transmission of diarrhea and intestinal worms), but they need to be in good conditions to ensure that they do not change into a health hazard for example by allowing direct access of flies and not keeping them clean properly. Answer B is not correct as it will depend very much on the local conditions which transmission route is most important.

Q2. Answer B. is the correct answer as it will depend on the local conditions which type of system is most risky. If properly managed on-site systems can be very safe. Off-site systems have the disadvantage that they transport the faecal material to another location but often without treatment.

Q3. Answer D is the only correct answer. Even if a small part of the population continues with open field defecation, the spread of many diseases including diarrhea and intestinal worms will continue. Furthermore the answers do not indicate whether the people also have hand-washing facilities, which is an essential additional element to ensure safe hygiene behavior.

Q4. Answer C, as all three statements are correct. It is essential to start with a good assessment of risky behavior to identify which aspects to deal with first. Also special attention is needed for the poorer sections that may not be able to finance possible changes. And exploring who has been working in the area and with what results is very important.

Q5. Answer B. is correct. Involving children is crucial and looking from a gender perspective is indeed making a difference as men and women have different chores and responsibilities. The first statement is not correct as it is much more effective to focus on changing a few key behaviors

If you failed to provide several of the correct answers, then review this module again

Module 6 Management and finance

This module introduces a number of management issues related to community water supply and sanitation and possibilities to explore financing options. *At the end of this module the participant will have:*

- An overview of the management requirements of water supply systems
- *A better understanding of the importance of practical monitoring schedules*
- *Developed a management plan for a simple water supply system.*

6.1 Introduction

Management is perhaps one of the most neglected aspects particularly of rural water supply. It is very common that breakdown management is applied combined with the collection of a fee to meet operational cost. Sometimes water committees and operators obtain one-off training when systems are being installed with external support. A large number of water and sanitation systems however show substandard performance or are not working at all. Adequate financial management is another limitation which has a lot to do with lack of local understanding of cost issues. To change the situation it is essential that:

- Adequate management models are established for each type of system
- Management capacity is developed at community level
- Good repair capacity and spare parts can be accessed within reasonable distance
- Performance of water systems is actively monitored (to ensure sustained performance);
- Adequate local finance is obtained at least to meet recurrent cost and possible repairs

6.2 Management and organization

Different models exist to manage and maintain rural water supply systems including:

- Systems managed by a water committee which may hire some community members for revenue collection, tap attendance and some operation and maintenance tasks. Often they receive a small remuneration for these tasks. Local operators may be trained or just learn the work on the job from a predecessor (adopting possible mistakes that have crept in). The water committee may be elected and some regulations may apply concerning reporting to the community, duration of term, re-election, and gender balance. More advanced committees may even have a code of conduct. In some cases the water committee is an association where some or all families in the community have a membership.
- Systems managed by private individuals or small scale operators perhaps under an agreement with a water committee.
- Water vendors who manage their water supply chain. Having a strong interest to keep the chain working as they depend on it for their income.

A step wise approach is needed to improve the local situation. Steps include:

- ***Analyzing the local situation,*** including a description of the actors, their roles, relationships, capacities and their external links for example for spare part supply. Capacity indeed may be locally available because experience shows that even with the limited available means some operators (as a miracle) keep their systems working.
- ***Making management plans*** to match roles and realities implying that all management tasks are being established and discussed with the actors involved and where needed the existing system are being adjusted.
- ***Making clear rules of engagement and detailed work schedules*** to ensure that every body knows what needs to be achieved and whom to report to. This may also include the introduction of a code of conduct for staff and committee members to avoid possible issues such as corruption.
- ***Establishing a monitoring model for each system*** as this can help to ensure timely interventions and repairs
- ***Strengthening the local capacity*** as this may be one of the immediate needs in many locations. Often it may just be enough to sit with the persons involved at community level, listen to their problems and help them to make improvements. Often capacities to be strengthened may have to include some ideas about conflict management as one of the important problems in many systems.
- ***Provide support*** during a period in which system improvement is strived for.

6.2.1 Management plans

Management (and repair) plans are needed that describe actions to be taken during normal operation or incident conditions as well as the necessary upgrading and improvement steps. These plans also need to include the monitoring plans (see 6.3) and a specification of the required external support. Most local operators of community water supplies will require support to develop system-specific plans. Working with successive communities will help you to generate your own data base of system specific plans that will be very helpful as a resource for developing plans with future communities. Be aware however that these should not become blue prints that are forced upon communities and water committees. The process to develop the plan with them is very important to create the necessary buy-in and to ensure that local conditions and experience are properly taken into account.

The management plan needs to include:

- The organizational structure of the water provider including external support
- The main responsibilities of the key actors and reporting lines
- A description of the (financial) administration
- A description of the water supply system
- An overview of the normal operating procedures including monitoring
- A description of emergency operating procedures
- An overview of the main risk that have been identified and the remedial actions

6.2.2 Monitoring

Monitoring refers to collecting, organizing and using information about the actual situation and comparing it to a planned or expected situation. It usually also entails an issue of (pre-determined) action which needs to be undertaken if the data are outside a desired range. It should ensure that deviations from required performance are detected in a timely manner. In water supply this may relate to issues such as water quality, but also system performance in terms of electricity consumption, wearing of cup seals, water pressure in the system, but also users satisfaction.

Monitoring is an ongoing function that provides crucial information that we need to sustain the systems. In fact we monitor all the time although we may not be aware of it. For example, a bicycle rider will automatically check to see if the tires have enough air, if the brakes work, and so on. The rider collects this information by using his/her eyes, sometimes by feeling and sometimes by listening. If there is something wrong, then the rider either fixes the bicycle directly or asks someone else to repair it. Sometimes he or she does not wait until the bicycle actually breaks. As preventive maintenance, for example, different parts are oiled to avoid rusting (Shordt, 2005).

The issue of monitoring is crucial to enhance system performance, but is often treated badly. Operators are not provided with a simple monitoring model and simple monitoring tools nor are they held accountable for their actions. At best they receive a reporting form and not a tool that initiates and stimulates action. It appears as if reporting is more important than sustaining the water supply service at the desired level. Monitoring should support the technical, economical and managerial performance of a water supply system, a sanitation facility or a project or programme. It needs to have clear indicators that best can be established with the people involved (operator, project team etc.). It needs to spell out the actions to be taken if the desired level for specific indicators is not reached.

Box 6.1 Monitoring made easy and effective

For a handpump the performance can be measured in terms of the number of strokes it takes for the water to appear and the volume produced per minute at a fixed stroke speed. If it takes more than three strokes for the water to appear the foot-valve needs to be checked and possibly replaced or the pipe is leaking. If the volume produced per minute falls below a set standard the cup-seals need to be replaced. The operator measuring performance in this way sees a gradual reduction in volume and can predict when it will reach the minimum acceptable level, thus enabling him or her to plan the necessary repair, instead of waiting till the pumps breaks down. Similar indicators can be established for the performance of piped systems as well as for financial and managerial performance.

6.2.3 Developing a monitoring system

Monitoring systems need to be developed for every water system and need to spell out the items to be monitored (looking at the main issues that can go of track) and the action to be taken when something goes of track and who should take it (Table 6.1). The main issues to look at in water supply systems include:

- The technical performance including maintenance;
- Possible water quality risks
- Possible water quantity risks
- Users satisfaction
- Financial performance

Table 6.1 Model for monitoring of a handpump on a dug well

Key monitoring items	Desired Situation	Actions to take if conditions are not met
Pump performance	Check weekly	
Discharge of the pump (time to fill a bucket of 18 litres (same person stroke speed 40 per minute)	$a_1 < N < b_1$ sec.	Schedule the replacements of the cup-seals (inform the area mechanic that he needs to come within a week; (Check water level in well to ensure that it is not caused by falling water table)
Discharge of pump (number of strokes it takes to start the water flowing after a short rest)	$0 < N < 3$	Schedule the repair of the foot-valve (inform the area mechanic that he needs to come within a week
Technical condition (No major difficulties e.g. play in handle, loose bolts, corrosion etc.)	Pump ok	Do regular maintenance (greasing) and inform area mechanic in when problems
Water quality risk	Check weekly	
Sanitary inspection (no cracks or other possibility for water infiltration; no puddles around the well; or latrine construction nearby)	Sanitary inspection ok	Discuss action with water committee and repair cracks
Water quality (turbidity, color, smell, salt content);	No changes or big outbreak of diarrhea	Seek external advice from district to do water quality test and assess why the quality changes
Access of animals to pump site	No	Repair fence
Operator	Every 3 months	
Spare part stock is up to date?	Yes	Discuss first with operator and if no improvement discuss with committee
Reports timely on O&M problems	yes	Discuss with operator / then committee
Is satisfied with job and support received?	Yes	Discuss with operator / then committee
Keeps accounts of expenditures (and income unless this is collected by someone else)	Yes	Discuss with operator / then committee
Responds to user complaints	yes	Discuss with operator / then committee

Operators of small systems may not have the necessary equipment for water quality testing. They may have to rely on sanitary surveys in combination with feedback from their users on possible outbreaks of diarrhea. This underscores the necessity for occasional checks by a water surveillance agency.

The monitoring model provides a quick overview of the situation and shows key actions to be taken when the measured performance is not in line with the previously established guideline values. This model can also be used to establish the key parameters the operator needs to measure and the ones to register in order to have an indication of the long term performance of the system. It needs to be complemented by a reporting format and models that deal with other components of the system including the catchment area, the transmission main and the distribution network.

6.2.4 Capacity building

Part of the activities needed to improve the situation will require building capacity at the local level and providing back-up support. Important limitations may exist for example in tariff collection which in turn makes adequate operation and maintenance of the system difficult or impossible. A lot of illegal collections may exist among others because the village committee or the operators do not know how to best deal with this. Preventive maintenance requires skills and attitudes that may be lacking.

Hence it may be expected that capacity building will be a key component of the management plan to improve the situation. An interesting experience in this respect is the development of community training centres that is taking place in Colombia. These centres adopt the concept of peer training. Members of water committees and water operators train people from other communities with a little external support in issues they have learnt themselves. They use adult learning approaches and include practical on the job assignments which are well appreciated by trainees. The fact that they are peers and speak 'the same language' is an important asset as it helps to build trust and make trainees feel at ease.

6.2.5 Conflict management

Community water supply and sanitation is incorporating a lot of (potential) conflicts. Conflict may become visible if women jump the queue, resulting in shoving and clay water jugs being smashed. It may remain invisible, but deeply felt if, for example, a village chief's wife goes to the head of the queue or when certain wells are declared to be sacred, restricted to such uses as preparing traditional medicines rather than for general water supply. It may include friction along ethnic lines, for example, when different ethnic groups bring livestock to the watering station (MacMIllan 2001)

A (water/sanitation) conflict is "a social situation where one party tries to profit from a given situation or tries to solve its own water supply and sanitation problems in such a way that it negatively affects other parties".

Conflicts are normal and in fact may be having a great potential for growth if the negative energy can be transferred into joint action. So the challenge is not to avoid conflict but to manage it as conflict avoidance and neglect can worsen situation. Many conflicts can be dealt with in a positive way through negotiation and joint problem solving. A few key aspects include:

- All parties need to understand the conflict and gain insight in the (subjective) views of the other parties
- Dialogue as the basis for problem solving in which actors listen to each other
- Separating the people (emotions) from the problem, but dealing with both. This aspect may require the involvement of a mediator to facilitate the process. Actors need to learn how to jointly face the problem instead of each other
- Focus on interests instead of positions to open dialogue
- Can problems be turned into opportunities by the actors allowing benefits to be enlarged and better shared?
- Develop multiple solutions to choose from and insisting on using objective criteria, independent of the will of either side, to choose the solution.

6.3 Finance

Financing the development and repairs of water and sanitation systems is another undervalued aspect perhaps because many systems are constructed under short term projects and therewith are not likely to include repair costs. When such costs emerge the project often has already moved on. This problem can be overcome by a good financial plan which takes a number of key aspects into account:

- What are the costs involved in the development of the system, and who pays them? Even if the system is totally funded from outside still it is essential that the community knows and appreciates the cost. If a community contribution is requested than it is crucial to explore if this is feasible also for the poorer sections. If a poor family for example cannot afford to pay say a 5% contribution they may be left out and therewith

miss out on the subsidy the others get
- What are the recurrent costs directly related to the system and who will pay these (again looking at affordability. Are options available to accept in kind contribution?
- Who controls the 'books' and is this system accountable.
- There may be recurrent cost at a level above the community such as water quality testing or the provision of back-up support to communities which for example may be paid by the government or other actors. They do need to be paid however and may for example have to be included in a district plan.
- How to deal with new users in an affordable way (connection fees may be included in the monthly bill instead of as a one of payment)

6.3.1 Clarifying the cost picture

Development, management and possible repairs of water supply and sanitation systems may imply considerable cost. Thus it is essential to make a good overview of all the cost items and specify who will be meeting these costs. If a community cannot afford to pay the running cost of its water supply without a subsidy then the wrong system may have been put in place as this will make them totally dependent. So a 'rule of thumb' is that they at least can cover these costs and where needed possible repair cost as well. A one of subsidy for the development of a system is less problematic, but may in fact come with a process in which external actors take the decisions.

So before developing a system a clear overview of future cost is needed as well as a strategy how to meet these costs. The latter may be more difficult in a rural community without financing institutions, thus not having the option to open a saving account. Then it may be better not to take risks and just keep a minimum saving and invest this for example in spare parts (low risk of depreciation).

6.3.2 Who picks up the bill

Be creative in searching for solutions. It is not obvious that funding needs to come from the government or NGO's as that often may take a long time. Community members may be willing and able to support provided they understand what is at stake and will get a (quick) benefit. For example adding two extra taps to a water tank may cost a few USD, but may cut waiting lines considerably. Users or water vendors may therefore be very willing to meet these costs in return for spending less time in waiting every day.

For medium and long term larger interventions however government funding may be needed which then will need to be included in the district water plan.

6.3.3 Administration

Many communities already have some kind of administration which may be fairly simple (Table 6.2). The first step therefore is to explore with them their book keeping.

Table 6.2 Basic administration format

Income	Amount	Expenditures	Amount
Connection fees		Salaries	
Tariffs		Consumables (fuel etc.)	
Fines		Repairs	
Total		Total	

You may also need to develop a budget to finance adjustments to the system or to calculate the tariff. Again the first step is to see what exists and what needs improvement.

Finally you may want to check what kind of control mechanisms they have (to avoid corruption) and where they keep their profits, as the value of the latter may easily devaluate if they are not invested in issues such as spare parts.

6.4 Self evaluation

This is an individual evaluation of your understanding of the information presented in this module. Answer the (multiple choice) evaluation questions and check your own answers. In case your answers had many mistakes it is suggested that you review the module again before doing the assignment.

Q1. An adequate management model:

1. Requires a detailed analysis of the existing system and existing practices
2. Ensures that manuals with all technical specifications are available in the community
3. Includes appropriate monitoring formats for the tasks to be performed

A: Answers 1 and 3 are correct
B: Answer 2 is correct
C: All three answers are correct

Q2. A written report is the most important aspect of a monitoring system.

A: Yes
B: No

Q3. The most important reason to establish a good monitoring format for a water supply system is:

A: The need to have reliable data and a good performance record
B: The need to be able to review the performance of the system over time
C: The need to be able to manage the system

Q4. Indicate which of the following statement is correct. (Several statements may be correct)

A: In conflicts it is essential to explore the underlying interests with the parties instead of just looking at the positions
B: The role of the mediator is not to solve the problem but to help the actors to find solutions and try to come to an agreement
C: In capacity building of maintenance staff it is essential to understand the local situation and the experience of the participants
D: Community members may be good trainers

Q5. It is sufficient in rural areas if the community knows the tariff

A: Yes
B: No

6.5 Assignment

Establish a management plan for one type of water system (e.g. handpump, well with a rope pump, borehole with tank) which you have already described in one of your previous assignments. Include a monitoring format and make a brief overview of the cost items you need to include in the cost estimate to manage and maintain the system.

6.6 References and Further reading

Butterworth, J., Ducrot, R., Faysse, N. and S. Janakarajan (eds) (2007). Peri-Urban Water Conflicts. Supporting Dialogue and Negotiation. Delft, The Netherlands, IRC International Water and Sanitation Centre. http://www.irc.nl/page/38645

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Shordt, K. (2005); *Action Monitoring for Effectivenes: Improving water, hygiene and environmental sanitation programmes*, Part I; IRC International Water and Sanitation Centre, Delft, The Netherlands
http://www.irc.nl/content/download/23444/267722/file/Part_I.pdf

Shordt, K. (2005); *Action Monitoring for Effectivenes: Improving water, hygiene and environmental sanitation programmes*, Part II; IRC International Water and Sanitation Centre, Delft, The Netherlands
http://www.irc.nl/content/download/23445/267725/file/Part_II.pdf

Visscher, J.T. (2008) Conflict mediation in the water and sanitation sector: And how to reach solutions. IRC International Water and Sanitation Centre, The Hague, The Netherlands. http://www.irc.nl/page/46285

6.7 Answers to self evaluation questions

Q1. Answer A. An adequate management model requires that clear insight is obtained in existing systems and that a good overview is provided of all the tasks and responsibilities, but it is not necessary that all detailed specification of the different technologies are available locally as these will be only relevant for the technicians that will carry out repairs that go beyond the community capacity.

Q2. Answer B. In many locations reporting is strongly emphasized, but the main reason of a monitoring system is to generate action when needed. Recording of some data can be useful, but do not make this into a burden as many monitoring aspects do not need to be recorded. So the essence is to establish a monitoring system that clear shows which indicators need to be checked and depending on the results what action need to be taken.

Q3. Answer C. A good monitoring format that clearly describes the indicators to be monitored and the actions required if indicators do not fall into the prescribed levels is crucial to be able to adequately monitor the system. It may also be used for reporting and assessing the performance, but these are not the most important reason. A good monitoring format will help the operator to do his or her job and seek timely support when needed.

Q4. All answers are correct

Q5. Answer B is correct. Knowing the tariff in a rural community is essential but it is not enough. Tariffs or (upfront) contributions may felt to be high unless the community knows the full cost picture including the (often) subsidized investment. .

If you failed to provide several of the correct answers, then review this module again.

Module 7 Community Water and Sanitation Action Plans

This module introduces the key elements of a community based approach to improving the water and sanitation situation using the learning from the previous modules. It aims at developing a structured plan to reach practical improvements in the water systems from source to consumer and in introducing better sanitation and hygiene. An example plan is shown in Module 8, which includes a number of more generic activities that may be applicable in different communities. When gaining experience with the method, you will find that quite a few actions may be fairly similar for different communities. So once you have helped to develop a first plan, subsequent plans will be easier. *At the end of this module the participant will have:*

- *Developed a water and sanitation action plan which where feasible also will look at the possibility for multiple water use*

7.1 Introduction

Most water supply systems in rural Ethiopia are operated and maintained by local operators including small Community Based Organizations (CBOs) with limited specialist skills, (financial) resources, amounts of time and formal training. In their challenging task they receive support from the Woreda Water as well as the Health Desks. The development of a structured improvement plan fits very well into making this support more effective and where necessary linking the community water and sanitation action plans with the broader Woreda planning. The action plan (see special Module 8) needs to include the following main components:

- A comprehensive assessment of the water supply systems exploring the physical conditions, system performance, type of use, seasonal problems and the hygiene risks.
- A comprehensive assessment of the sanitation situation
- An description of the management performance of all water systems;
- A management plan describing actions to be taken (including a priority setting).
- A proposal for effective operational monitoring of the different to facilitate timely intervention in future
- A funding proposal indicating cost and potential resources

7.2 Steps to develop the water plan

To develop the water plan a number of steps can be envisaged:

- Establishment of a community based development team
- Comprehensive assessment of the water supply systems, their performance, the management and the (critical) hygiene risks
- Identification of short-, medium- and long-term corrective water actions
- Development of specific management and monitoring schedules for the different systems
- Reporting back to the community
- Implementation and evaluation

7.2.1 The team

It is essential to develop the plan under local leadership. This is challenging and initially may take more time, but only local leadership will ensure that sustained action can be established as already discussed in module 5. The starting question is therefore what type of organization already exists and in how far can these structures be used to manage and organize the plan. It is essential that the team has time, is active and representative. So even if you build on existing systems you need to check who can participate in the team, in what role or capacity and with what level of time inputs. A few of the most important aspects include:

- ***Local leaders*** need to be involved. Participants need to include some of the leaders that can make a difference in the community but at the same time you may need to ensure that also dynamic newcomers have a role to play

- ***Representation of relevant groups***. This includes looking at the composition of the community and making sure that relevant groups are represented. Attention is needed for gender representation as well as participation of both better off and poorer community sections. So involving the youth is an issue to carefully explore.
- ***Availability*** is often an overlooked issue as 'external as well as local interventions' often work around the same people. So can the individual team members spend the time needed to take up their roles? Also women or poorer groups may have already many chores and therefore may not be able to afford spending time unless some of their other chores are taken over. Here you can be creative, thinking for example about for example water collection with a donkey cart in return for working on the team, joint child care or some other compensation.
- ***Knowledge and experience*** embedded in team members will make it easier to move forward. So try to find a number of team members with experience. This may be experience in different fields including local technicians, health workers, teachers etc.
- ***Roles and realities*** implying that you need to look at the functioning of the group and you may occasionally explore changing some of the roles in the team to ensure that opportunities for growth are shared.
- ***A clear plan for the team with an agreed division of roles*** as people work much better if they understand what they need to do and how activities hang together. A range of activities may need to be established and this may require to establish even sub groups within the team dealing with different aspects of water and sanitation assessment and improvement
- ***Monitor progress*** as a regular activity of the team
- ***Establish training or peer-learning*** as part of the plan. Some team members may have experience they can share including by working in pairs, whereas new skills may also need to be learnt.

7.2.2 Comprehensive assessment

The comprehensive system assessment aims to determine whether the different water supply chains (up to the point of use) as a whole can deliver water of a quality that meets the requirements. It is much more than a brief report on a visit to a community. It includes as we have seen in module 2 the systematic and detailed assessment of the systems as a whole including technical performance, management and prioritization of hazards based on system conditions and water handling practice. It also explores multiples water use (module 5)

Not every hazard will require the same degree of attention as its priority will depend on the likelihood of occurrence (e.g., certain (3), possible (2), rare (1)) and the severity of consequences if the hazard occurs (e.g., insignificant (1), major (2), catastrophic (3)). The aim should be to distinguish between important and less important hazards or hazardous events. Simple scoring based on 'expert opinion about the risks' can be adopted by multiplying the occurrence score (1, 2 or 3) by the consequence score (1, 2 or 3) and looking at those with the highest scores as these may require immediate attention. Remember that there is little value in spending large amounts of effort to block small risks.

It is important to take an action oriented approach from the beginning. The review of the system will show a number of hazards which sometimes may be very serious. It does not seem fair to just leave the community and write a report instead of already exploring possible 'emergency' improvements the water operator or community members can take. In high risk systems for example it can be suggested as a minimum that water needs to be boiled, chlorinated or treated by solar disinfection at household level at least for children and elderly people.

The water system assessment as shown in module 2 and module 5 usually comprises:

- A sanitary inspection and if feasible/needed water quality analysis
- The review of the actors and their roles in system management
- The water handling practice of users

Results need to be documented as much as possible in bullet form. To help you in this task a comprehensive format has been established shown in module 8.

Community members are an important source of information and may reduce the need for water quality testing (which is often difficult as equipment and chemicals may not be readily available). An important limitation of water quality testing is that it only provides a snapshot of the situation and the sample may not be representative of conditions at other moments. This can be partly overcome by asking the water operator and/or community members about the situation.

They know about changes in water quality during and over the years in terms of turbidity, colour and taste (salinity, iron). Also they may be able to tell whether there are many children with diarrhea. Hence their information can help to confirm the findings of a sanitary inspection even without testing. Yet testing is necessary if you expect problems with chemical contaminants such as fluoride or arsenic.

7.2.3 Identification of actions

The comprehensive assessment including a review of management practices is the basis to establish corrective actions (Module 3) in the systems, the community, and community habits and to identify the external support requirements which will need to be embedded in the Woreda Water Plan. An example is presented in Module 8 where actions have been divided in:

- ***Short term actions***, often comprising activities the community can do themselves, and/or urgent repair jobs. This may include emergency actions such as the identification of safe sources, or the repair of one or more sources in such a way that safe drinking water can be obtained, whereas other sources can be used for other purposes. This will also have to include helping people to be more careful with water transport and water storage. It may also include simple repairs of cracks and improvement of preventive maintenance by community members. The key word is **organised collective action.** People can do a lot to improve upon their situation if they join hands, understand what they can do, how they and their children will benefit, and see some short-term results.
- ***Medium term actions*** which can be organized mostly with available means and within a few weeks or months. This can include some of the actions mentioned as short term when they are expected to take more time from community members, capacity building and perhaps external materials and therewith may need more planning and organization.
- ***Long term actions*** which will need a more comprehensive approach and more complex arrangements including involvement of external intervention teams

For each of the actions a description is needed of the:

- Problem
- Remedial action
- Leading actors who takes responsibility (and the team if applicable)

7.2.4 Establishing management, financing and monitoring systems

As explained in module 6 for each of the water systems in the community a management model and monitoring system needs to be developed as well as a financing system. This essential aspect is often overlooked in many systems. But with adequate monitoring management becomes much easier including the prediction of possible problems that would require external support. These management and maintenance schedules are not included in the example format that is provided in Module 8, but the schemas in module 7 can be used to develop them for each system.

7.2.5 Implementation and evaluation

The implementation of the action plans (see Module 8) needs to be monitored by the community team. This requires the development of a plan which clearly marks the activities and expected results over time. This will very much contribute to the practical implementation of the plans.

7.3 Steps to develop the sanitation plan

To develop the sanitation plan a number of steps can be envisaged:

- Establishment of a community based sanitation team
- Comprehensive assessment of the sanitation situation and related (critical) hygiene risks involving health workers were feasible
- Identification of short-, medium- and long-term corrective water actions
- Reporting back to the community
- Implementation and evaluation

7.3.1 The team

It is essential to develop the sanitation and hygiene plan under local leadership. This is challenging and initially may take more time, but only local leadership will ensure that sustained action can be established as already discussed in module 5. The starting question is therefore what type of organization already exists and in how far can these structures be used to manage and organize the plan. It is essential that the team has time, is active and representative. So even if you build on existing systems you need to check who can participate in the team, in what role or capacity and with what level of time inputs. Also you need to explore if it is best to combine the water team and the sanitation and hygiene team or go for separate teams that work together and share their plans. A few of the most important aspects include:

- ***Local leaders and local 'champions'*** need to be involved. Participants need to include some of the leaders that can make a difference in the community but at the same time you need to encourage the involvement of local champions, people already having adopted improved hygiene practices and for example having good facilities at home or in the school that are properly used and kept.
- ***Representation of relevant groups***. This includes looking at the composition of the community and making sure that relevant groups are represented. Attention is needed for gender representation as well as participation of both better off and poorer community sections. So involving the youth is an issue to carefully explore.
- ***Availability*** is often an overlooked issue as 'external as well as local interventions' often work around the same people. So can the individual team members indeed spend the time needed to take up their roles? Also women or poorer groups may have already many chores and therefore may not be able to afford spending time unless some of their other chores are taken over. Here you can be creative, thinking for example about for example water collection with a donkey cart in return for working on the team, joint child care or some other compensation.
- ***Knowledge and experience*** embedded in team members will make it easier to move forward. So try to find a number of team members with experience. This may be experience in different fields including local technicians, health workers, teachers etc.
- ***Roles and realities*** implying that you need to look at the functioning of the group and you may occasionally explore changing some of the roles in the team to ensure that opportunities for growth are shared.
- ***A clear plan for the team with an agreed division of roles*** as people work much better if they understand what they need to do and how activities hang together. A range of activities may need to be established and this may require to establish even sub groups within the team dealing with different aspects of water and sanitation assessment and improvement
- ***Monitor progress*** as a regular activity of the team
- ***Establish training or peer-learning*** as part of the plan. Some team members may have experience they can share including by working in pairs, whereas new skills may also need to be learnt.

7.3.2 Comprehensive assessment

The comprehensive system assessment aims to determine the hygiene risks that exist in sanitation as discussed in module 5. It includes the systematic and detailed analysis of the different sanitary facilities and the open field defecation sites as well as an exploration of possible risky hygiene behavior.

Not all hazards will be equally severe, so you will need to give priority to the most risky ones. Here it is essential to be very selective in order not to overload the team and the community. Schools may require special attention as they may in fact present considerable health risks for the children and can be a good place to start changing hygiene behavior.

It is important to take an action oriented approach from the beginning. The review of the sanitation systems will show a number of hazards which sometimes may be very serious. Some of these however may be quickly reduced by very simple means. Just putting a lid on a squat hole and putting some ash on feces in the latrine can greatly reduce the access of flies. So this type of 'emergency' improvements you can suggest already after having done the first transect walk. Also hand washing facilities can be established rather quickly by just hanging a small water bottle close to the latrine.

The sanitation assessment as shown in module 5 comprises:

- A review of the different sanitation systems
- An assessment of the hygiene practice of users
- Discussion with users about their perception of the situation and the way they manage the facilities (emptying problems) and for example child feces
- An inventory of local capacities to support sanitation and hygiene improvements

Results need to be documented as much as possible in bullet form. To help you in this task a comprehensive format has been established shown in module 8.

7.3.3 Identification of actions

The comprehensive assessment is the basis to establish corrective actions (Module 5) to improve the latrines in the houses and schools, encourage changes in risky hygiene habits and to identify possible external support requirements which will need to be embedded in the planning at Woreda level. An example is presented in Module 8 where actions have been divided in:

- ***Short term actions***, often comprising activities the community can do themselves, and/or urgent repair jobs. This may include emergency actions such as the promotion of putting a lid on latrines, hanging water bottles close to the latrines for hand washing etc.
- ***Medium term actions*** which can be organized mostly with available means and within a few weeks or months. This can include some of the actions mentioned as short term when they are expected to take more time from community members, capacity building and perhaps external materials and therewith may need more planning and organization.
- ***Long term actions*** which will need a more comprehensive approach and more complex arrangements including involvement of external intervention teams for example to help communities to initiate a total sanitation campaign.

For each of the actions a description is needed of the:

- Problem
- Remedial action
- Leading actors who takes responsibility (and the team if applicable)

7.2.4 Establishing management, financing and monitoring systems

As explained in module 6 for sanitation improvement a management model and monitoring system needs to be developed as well as a financing system in a similar way as for water systems. This essential aspect is often overlooked in many systems. But with adequate monitoring management becomes much easier including the prediction of possible problems that would require external support. These management and maintenance schedules are not included in the example format that is provided in Module 8, but the schemas in module 7 can be used to develop them for each system.

7.2.5 Implementation and evaluation

The implementation of the action plans (see Module 8) needs to be monitored by the community team. This requires the development of a plan which clearly marks the activities and expected results over time. This will very much contribute to the practical implementation of the plans.

Module 8 Example: CWS Action Plan of Wahira

This is an example format which is very comprehensive and includes many types of water systems (more than you will normally encounter). This implies that in most cases you will only need to follow part of the report. The other key issue is to write as much as possible in bullet points and not in long text as in essence a short report is needed.

8.1 Introduction

This report summarises the community water and sanitation action plan of Wahira (see Table 8.1). It was developed in April 2010 by a group of people from the community with external support (see Annex 8.1 for the participants). It looks at all the water sources and water supply systems and also at the sanitary situation.

This CWSA plan comprises five main components.

- The description of the water supply situation looking at all available water sources and existing (multiple) use
- The assessment of the risks involved in each of the water sources
- A review of the management of the different water systems
- A summary plan for improvement measures
- An assessment of the sanitary situation with suggestion for improvements

Table 8.1 General data from the community

Item	Data
Name of community	Wahira
Population size	2015
Main occupation (s)	Farming, cattle raising
Type of water supply systems	Piped supply, 2 handpumps, 1 traditional wells, 2 ponds
Water systems used for multiple use	Systems and type of use
Water coverage (% using improved water systems)[1]	80% (dry season) 60% (wet season)
Quality water supply	Systems are not well kept and all systems as well as water transport and storage involve hygiene risks
Sanitation coverage (% with improved facilities)[2]	40% (latrines) 60% open field
Quality sanitation systems (spot sample in few houses)[2]	Latrines are not very well kept and involve health risk (fly breeding) as openings are not covered
Health situation	According to health worker incidence of diarrhoea increases in wet season
1. Improved water systems according to WHO/UNICEF are: household connection, public standpipe, borehole, protected dug well, protected spring, Rainwater collection. In practice many of these systems do have water quality problems and some also water quantity problems **2.** This information is based on a brief visit to a few households and discussions with the water committee	

8.2 Water supply assessment

8.2.1 Situation analysis

This section summarizes the general water supply situation in the community. It looks at all water sources that are used (Table 8.2). The table also gives an estimate of the percentage of users that make use of a specific system based on discussions with the water committee and some users. A general finding was that particularly poorer community groups more often use unimproved systems for which they do not have to pay.

A schematic overview of the location of the different water systems is presented in Annex 2. For each of the type of systems a summary description and a risk assessment have been made that are presented in Annexes 3, 4, 5 and 6. The different systems fall under different management arrangements as will be presented in the next section.

Table 8.2 Overview of water supply systems

Type of system	Users[1] (%)	Water quantity	Water quality	Quality of systems
Piped water supply	65/45	Intermittent supply, but people are satisfied with quantity and pay 10 cents per 10 litre	Good taste, no chemical contamination, low risk of bacteriological contamination except during transport and storage	The system has considerable leakages. Some are visible. A further analysis is needed to check the distribution system
1 Handpump and 1 rope pump	15/15	Continuous functioning, people are satisfied with the service and pay	Good taste, chemical quality not known but seems not to pose a risk. One pump with very low risk of bacteriological contamination, the shallow well has a moderate risk	Both pumps need servicing as the water appears only after a few strokes. Also according to the users filling their buckets takes more time.
Traditional wells (2)	20/40	One of the wells strongly reduces in quantity in dry season	Good taste (according to population), very high risk of pollution	Superstructure of both wells shows cracks and people use their own tools to extract water
Pond (2)		Year round supply, but less in dry season. People use for washing, gardening and animals	High risk of bacteriological contamination but as it is said not to be used for drinking water this seems less problematic	The catchment area is showing signs of corrosion which may lead to siltation of the ponds
1. Coverage (% of users) in dry season / coverage in wet season				

8.2.2 Water supply management

The piped water supply (Table 8.3) has a water committee, a pump operator and plumber, an assistant operator and two paid standpost attendants who collect the users' contributions.

Table 8.3 Management of piped water supply system

Item	Description	Remark
Management	Water committee with 5 male members already in place for 5 yrs.	It is necessary to explore if gender interests are properly safeguarded and how the committee can become more balanced
Training	Administrative and technical training were provided during construction.	No refresher training is provided and no training was received on management issues and consumer relationship
Daily operation	Operator and an assistant are responsible for pump management, (small) repairs and new connections	Preventive maintenance absent; repairs and new connections don't meet quality standards. Supervision and backstopping lacks
Financing	Tariffs have been set to cover operation and maintenance cost. No funding is available for larger repairs	People pay for water from standposts With the aging of the system cost will increase and repairs are needed. This needs to be discussed with users and relevant authorities.
Tariff collection	Two standpost attendants collect the tariff from the users.	People pay 10 cents per ten litres but some can only afford 5 litres.
Conflict management	Conflicts exist between the water committee and standpost attendants and some users	Conflict management is not an issue that the water committee has learned and no trained external support is available either.
Spare part management	Few spares stored in community, thus high risk of long repair periods.	Invest user contributions in spare parts, also as their cost tends to increase with time
Maintenance	Typical breakdown instead of	Preventive maintenance is essential and often

	preventive maintenance is applied	less costly in the long run.
Back-up support	An area mechanic is supposed to give backstopping. Mayor repairs require input from regional office	Area mechanic only comes if called for repairs. Interventions are strictly technical; no support for management. Repairs may take weeks
Monitoring	Data of pump operation and fuel consumption and users contributions are registered.	Monitoring schedule is too limited and not properly used to support management of the system

Table 8.4 shows that the two handpumps are managed by a users committee which has been established with the help of an NGO but have no relation with the committee managing the piped supply. Local caretaker controls the pump but has no repair skills.

Table 8.4 Management of handpumps

Item	Description	Remark
Management	A community health committee with 3 male and 2 female members was established by an NGO 5 yrs ago.	It is necessary to explore the link between the water committee and the health committee as it is better to keep water supply in one hand
Training	Administrative and technical training were provided during construction.	No refresher training is provided and no training was received on management issues and consumer relationship
Daily operation	Pump caretaker looks after both pumps	Preventive maintenance is virtually absent. Supervision and backstopping is not sufficient.
Financing	Tariffs have been set to cover O%M cost. No funding is available for larger repairs	With the aging of the pumps maintenance cost may increase somewhat. This needs to be discussed with users and relevant authorities.
Tariff collection	Committee members collect the monthly tariff from the users.	Some poorer families have difficulty to pay the tariff
Conflict management	Sometimes conflicts arise among users jumping the queue	Conflict management is not an issue that the committee has learned and no trained external support is available either.
Spare part management	Very few spare parts are stored in the community	High risk of longer repair periods if no spares are available. Also cost of spares tend to increase over time, hence good to invest user contributions in spares
Maintenance	Breakdown maintenance is used (no preventive maintenance)	Preventive maintenance is essential and often less costly in the long run.
Back-up support	An area mechanic is supposed to give backstopping	In practice the area mechanic only comes if called for repairs (and usually only after several days). His support is strictly technical leaving a big gap of management support
Monitoring	No data are registered except for tariff collection.	Monitoring schedule is too limited and not used to support management of the system

Traditional ponds are managed by users directly following long term tradition (Table 8.5). When needed money is collected from users with better off families often paying more.

Table 8.5 Management of water ponds

Item	Description	Remark
Management	The ponds is not managed	
Financing	No cost are charged for using pond water	Because of high level of pollution indirect cost (health, loss of working days) may be high if water is used for consumption
Conflict management	Sometimes cattle owners push their way if water gets scarce	Conflict management is not dealt with
Maintenance	No maintenance is applied	Ponds are gradually deteriorating.
Monitoring	No data are registered	Gradual deterioration and volume reduction is not becoming visible through monitoring

8.3 Water supply improvement plan

This section presents a number of actions that need to be taken in the short, medium and long term. It is very clear that only a small part of the community has access to potable water and that urgent action is needed. Also the different systems are not performing well, are not adequately managed and lack adequate back up support. The required actions to improve upon the situation involve different actors and for each action a clear indication of the leading action will be needed.

8.3.1 Short term action

The short term actions (Table 8.6) aim at taking immediate steps that do not require mayor external intervention, reconstruction and considerable external resources. The focus is on doable actions within existing means.

Table 8.6 Short term action

Problem	Description	Remedial action	Actor
Access to potable water	Only one handpump provides potable water; piped water system is intermittent thus involving a health risk	Inform the community about: ▪ using handpump water for drinking ▪ disinfection at home ▪ solar disinfection in plastic bottles ▪ Initiate hygiene promotion activity	Health worker with water committee and health committee
Lack of chlorine	Chlorine can be used to disinfect water at home, in the well or in the piped supply	Explore the possibility to supply chlorine to disinfect the well with the rope pump and possibly for home treatment. The piped supply cannot be treated as contamination enters in the distribution system	Water technician in consultation with the health worker and the community
Lack of maintenance	Both preventive and some corrective maintenance are needed	Make a good overview of the necessary activities; explore with the operators and the committees what can be initiated and what requires additional resources (see table 4.2)	Operators and committees with support from water technician
Lack of monitoring	Good monitoring can very much enhance performance and is crucial to plan interventions	Develop and introduce a monitoring system	Water technician with water committee and health committee
Lack of coordination	The current piped water supply and the handpumps fall under responsibility of different committees which is not very effective and efficient	Initiate the discussion between the two committees to explore how best they can collaborate or possibly merge	Water technician or other external agent

8.3.2 Medium term action

Medium term action concerns issues that need relative quick intervention say in the next six months to one year, but which require more resources. It implies that more time is available to develop proper plans and explore possibilities to finance improvements. Table 8.7 shows a number of medium term actions. Several of these actions do require external support particularly from the water technician. This implies however that the water technician also needs to have a background in management issues. If not other external staff will be needed to facilitate or train (including perhaps peer training by water committee members or operators from other communities).

8.3.3 Long term action

The long term action (Table 8.8) concerns more structural interventions that require often the work of external agencies or considerable financial resources. The water technician is envisaged to either initiate this type of action or to direct the community (water committee) to relevant agencies and help them to take appropriate action using for example the water action plan to explain the situation to these agencies. This often will also include several actions that go beyond the community level requiring a more regional or even national approach

Table 8.7 Medium term action

Problem	Description	Remedial action	Actor
Contamination of piped water supply	The piped supply is contaminated because it is intermittent. Disinfection at the source therefore is not helpful and opting for continuous supply requires upgrading of the distribution network.	Explore the possibility to repair the distribution system and avoid or drain low lying areas. As an alternative it may be feasible to construct small storage tanks at the public standposts and introduce disinfection in these tanks.	Water technician and water bureau in collaboration with the water committee
Contamination of shallow well with rope pump	Possible contamination from two nearby latrines and cracks in the well structure.	Repair cracks and explore the possibility to relocate the latrines improve the well to avoid contamination	Water technician in consultation with watsan committee and community
Poor quality traditional wells	The traditional wells involve important risks of infiltration and contamination	Protect the traditional wells with a proper head wall, an extraction device and a fence. Disinfect the wells after repair	Water technician with water committee and possibly external funding
Lack of skills and knowledge of committees and operators	Maintenance and repair is not adequate and committees do not really manage	Initiate a training programme for both the operators and the (united) water committee	Water technician with other external authorities
Inadequate conflict mediation	Problems exist between the water committee and the pump attendants and several users	Assist the committee to better handle conflicts (training) and if needed initiate conflict mediation with support of the water technician, the health worker and/or external mediator	Water technician with other external authorities
Lack of financing	Part of the maintenance is not taken care of because of lack of funding	Explore possibilities to: ▪ Increase the tariff (perhaps with special tariff for the poorest households) ▪ Obtain external resources ▪ Quickly repair some of the leakages in the system to reduce pumping cost	Water technician with water committee

Table 8.8 Long term action

Problem	Description	Remedial action	Actor
Contamination of piped water supply	The piped supply is intermittent and has a high water loss.	Explore the possibility to: ▪ Repair the water supply system to reduce water loss (now 50%) ▪ Adopt 24 hour supply and disinfection, or as an alternative take measure to prevent intrusion of pollution (pipes avoiding poor drainage areas or construct above ground in these areas etc.	Water technician and water bureau in collaboration with the water committee
Environmental contamination	The inadequacy of the local sanitation practices result in a wide spread bacterial contamination which contributes to water contamination	Explore if the health workers or others are already actively promoting sanitation improvement, assess the effectiveness and if needed stimulate the initiation of a community sanitation programme	Water technician in collaboration with health worker and relevant external agency
Falling ground water table	Ground water table is falling possibly due to	Explore the situation in more detail and identify what corrective action	Water technician and water bureau

	over abstraction by nearby farmers	can be taken	with the water committee
Changes in operators and/or water committee	Operators and water committee members may change over time, which implies training of new people to ensure adequate management and maintenance	Explore where training can be obtained in the region or if this is not available initiate action to stimulate the development of this type of facility	Water technician with other external authorities

8.3.4 Time line

For each of the plans it is essential to make a good time line. In this section just one example is provided for the short term plan (Table 8.9). Furthermore it needs to be clear for all involved how much time is needed for the activities, what is the role of everyone involved and who is the activity leader.

Table 8.9 Time line for water supply improvements

Activity	Leader	Wk 1	Wk 2	Wk 3	Wk 4
Develop plan to inform about safe source and plan repair of two handpumps	Aaa	X			
Inform about the safe source	Aaa	xx			
Contact repair team and inform committee	Bbb	X			
Develop monitoring schedules	Ccc		X		
Apply monitoring schedules	Ddd		xx		
Review experience monitoring	Ccc			x	x
Etc.					

8.3.5 Budget and contributions

To ensure that activities can take place often a budget will be needed and community contributions may have to be arranged. The budget needs to include all cost related to the activities and a plan how to generate these resources through community contributions or in other ways.

8.4 Sanitation assessment

8.4.1 Situation analysis

This section summarizes the general sanitation situation in the community (Table 8.10). The table also gives an estimate of the percentage of users that make use of a specific system based on discussions with the water committee, the health worker and some users. A general finding was that a considerable hygiene risk exists that requires urgent action. It is interesting to note that even some of the better houses have very poor sanitation facilities clearly suggesting that sanitation is not a priority.

Table 8.10 Overview of sanitation system

Type of system	Users (%)	Quality of systems	Hygiene risk
Ventilated pit latrines	5	Most systems are not well maintained and present technical deficiencies.	A considerable risk exist in most of the systems, but some are kept very clean and have hand washing facilities (plastic bottles and soap)
Open pit latrines	35	All systems present problems as latrines are not covered and have direct fly access	A considerable hygiene risk exists; Pits are not covered and no ash is put on top of faeces.
Open field	60	In part of the community vegetation cover is nearby whereas in other areas people have to walk a distance	Considerable hygiene risk as part of the areas that are used can drain into the water sources. Particularly for women situation is difficult
School sanitation		Facilities are in poor condition and only used by part of the children and trainers; no hand washing facilities	High risk exists and situation is even more difficult for girls
Personal	30	Simple fenced areas exist for	Positive for personal hygiene and very

washing areas		personal hygiene in some of the compounds	low hygiene risk as no important drainage problems exist

8.4.2 Sanitation management

Maintenance of the facilities is done directly by the households with cleaning left entirely to women. Most facilities need some form of repair. The overall impression is that limited experience exists with good facilities. When pits fill up people may dig a new pit, but some also seem to abandon the latrine and go back to the field.

8.5 Sanitation and hygiene improvement plan

This section presents a number of actions that need to be taken in the short, medium and long term. It is very clear that only a limited part of the community has access to adequate sanitation facilities and that many of these are not in good conditions. The required actions to improve upon the situation involve different actors.

8.5.1 Short term action

The short term actions (Table 8.11) aim at taking immediate steps that do not require mayor external intervention, reconstruction and considerable external resources. The focus is on doable actions within existing means.

Table 8.11 Short term action

Problem	Description	Remedial action	Actor
Direct fly access to faces in latrines	Latrines are not covered and no ash is use to cover faces	Inform the community about: ▪ Need to put a lid on the latrine to block fly entrance ▪ Ash on the faces to block fly access	Health worker with health committee, health volunteers
Lack of handwashing facilities close to latrines	No water and soap are present close to latrines	Inform the community about: ▪ Need to wash hands after defecation ▪ Possibility to hang a water bottle (and soap) close to the latrine	Health worker with health committee health volunteers
Lack of maintenance of latrines in homes or schools	Latrines are not well cleaned thus presenting a hygiene risk	Explore the problem with the users, while discussing the risks involved and encourage improvements in cleaning	Health worker with health committee health volunteers School teachers
Presence of child faces close to the homes	Child faces not deposited in latrines or buried as they are considered harmless	Explore the problem with the parents, while discussing the risks involved as child feces may contain a lot of germs. Encourage improvement (deposit in latrines)	Health worker with health committee health volunteers
Feces behind school latrines	The number of school latrines may be too few or they may be dirty	Explore the problem with the teachers and encourage that latrines are kept clean and suggest adjusting breaks. Do not release all children at the same time as this will create crowded latrines	Health worker School teachers

8.5.2 Medium term action

Medium term action concerns issues that need relative quick intervention say in the next six months but which require more resources. It implies that more time is available to develop proper plans and explore possibilities to finance improvements. Table 8.12 shows a number of medium term actions. Several of these actions do require external support particularly from health staff.

8.5.3 Long term action

The long term action (Table 8.13) concerns more structural interventions that require often the work of external agencies or considerable financial resources. The health worker is envisaged to either initiate this type of action or to direct the community (health committee) to relevant agencies and help them to take appropriate action using for example the sanitation analysis and the sanitation and hygiene plan to explain the situation to these agencies. This often will also include several actions that go beyond the community level requiring a more regional or even national approach

Table 8.12 Medium term action

Problem	Description	Remedial action	Actor
Open field defecation	A relatively small part of the community practices open field defecation	Initiate a discussion about the risk of open field defecation and explore the reasons why some do still practice this. Analyze if they can change to latrines (have the means)	Health worker with health committee, health volunteers
Quality of latrines in insufficient	Latrines are of poor quality (free fly access, no slab, dirty)	Explore possibility to improve the latrines (improved wooden slab, concrete slab)	Health worker with health committee, health volunteers Local mason
Quality of school latrines is insufficient	Latrines are of poor quality (free fly access, no slab, dirty)	Explore possibilities to improve the facilities with community support, but often this may require some external support as well (see long term action)	Health worker with School teachers health committee, health volunteers Local mason
Hand washing facilities lacking in school	There are no facilities were children can wash their hands	Install facilities perhaps starting by just putting water containers (drums) preferably with a tap and soap (with community support)	Health worker with School teachers health committee, health volunteers Local plumber
Hand washing is not practiced	Many people do not wash their hands after defecation or before preparing meals	Initiate a hygiene promotion process with the community and the schools	Health worker with health committee, health volunteers School teachers

Table 8.13 Long term action

Problem	Description	Remedial action	Actor
Open field defecation	A relatively large part of the community practices open field defecation	Develop an intervention with external support such as community led total sanitation after doing an assessment of the existing latrines and the need to improve them	Health worker with Woreda Health Desk and district level organizations
No good quality materials are available for latrines	Existing latrines are of poor quality because there are no materials (concrete slabs etc,) in the market	Explore possibility to establish regional outlets or production of some latrine components	Health worker with Woreda Health Desk and district level organizations
Absence of school latrines and hand washing facilities	Schools have no latrines, urinal nor hand washing facilities	Explore possibilities to initiate a school improvement programme that includes the construction of latrines, urinals and hand washing facilities	Health worker with Woreda Health and Education Desk and district level organizations

8.5.4 Time line

For each of the plans it is essential to make a good time line. In this section just one example is provided for the short term plan (Table 8.14). Furthermore it needs to be clear for all involved how much time is needed for the activities, what is the role of everyone involved and who is the activity leader.

Table 8.14 Time line for the sanitation and hygiene improvements

Activity	Leader	Wk 1	Wk 2	Wk 3	Wk 4
Develop a plan to inform the community about the sanitary situation	Aaa	X			
Identify practical improvement measures	Aaa	xx			
Train a small intervention group	Bbb	X			
Inform the community about the situation and proposed ideas	Ccc		X		
Initiate improvement campaign			xx	xxxxx	xxxxx
Inform the school teachers	Ddd		xx		
Inform the school children	Ccc			x	x
Etc.					

8.5.5 Budget and contributions

To ensure that activities can take place often a budget will be needed and community contributions may have to be arranged. The budget needs to include all cost related to the activities and a plan how to generate these resources through community contributions or in other ways. In sanitation improvements most of the cost may need to be financed by the individual households, but it is very important to explore if the poorer households can indeed afford the minimum types of improvements that are needed

8 Annex 1 List of persons involved

The following persons were involved in the development of this report:

8 Annex 2 Overview of the water supply situation

Figure A.2.1 Schematic overview of the water supply systems (*Insert drawing developed together with water committee of community with an indication of the main water supply systems also showing main roads, piped network and estimated distances*).

8 Annex 3 Assessment of piped water supply

Item	Description	Remark
Pump	Electrical pump (2 yrs old) with generator (5 yrs old) Bulk water meter	Borehole not protected, preventive maintenance is lacking, repairs needed, water production and fuel consumption registered daily
Treatment	No treatment	Source has good water quality
Water storage	Two overhead tanks in community (1 km from well)	In good shape but never cleaned or flushed
Water distribution	2 km distribution network 5 yrs old, HDP pipe with 2 stand posts	Maintenance is insufficient. Pipes are exposed; stand posts are muddy and unclean. Water loss is estimated at 20%
Water transport and home storage	Water transport and storage is mostly done in closed plastic jerrycans	Safe way of transport but at filling point water may be contaminated by dirty plastic tubes
Water disposal	Waste water is not properly drained leading to puddles	This may lead to mosquito breeding, unpleasant smell and mud pools
Coverage	65% of the community use the piped system in the dry season and 45% in the wet season	People try to cut cost by using other sources when easily available or for certain activities like cloth washing
Continuity of system	Water supply is available 8 hours per day	People are satisfied with the 8 hours, but find waiting times (> 1 hour) too long
Continuity of source	Water table has fallen two meters in 5 years	It need to be explored with higher level authority what is the cause and whether this will affect long term sustainability
Quantity	Stand post users use on average 20 lpcd	Poor households take only 5 to 10 litres per day
Cost	People pay 10 cent per 10 litre of water	Cost family with standpost 30 Birr/m
Water culture	People like the taste of the water; very few treat it at home (boiling, disinfection)	People not fully aware of risk of (re) contamination of water
Quality[1]	Sanitary survey indicates that	Water should be considered a bacteriological

	water is safe at source, but some risk exists of infiltration through the well head; high risk of infiltration in distribution system because of intermittent supply and pipes crossing poorly drained areas	risk. Would be good to obtain confirmation from water quality test. Treatment/disinfection at source not an option as contamination is afterwards and is disperse. Distribution lines need to be repaired with special attention for poorly drained areas.
Overall assessment	The system requires better maintenance and needs upgrading to reduce water loss. The water involves a considerable hygiene risk and will require treatment as long as distribution system has not been repaired. This however is not useful at the source as contamination occurs in the distribution system. So disinfection may be considered at the standposts (would require extra storage tank) or at household level	
A schematic drawing of the system is shown below		

Figure A3.1 Schematic drawing of the water system *(Insert drawing of water system)*

8 Annex 4 Assessment of hand pumps

Item	Description	Remark
Pump 1.	India Mark 2 on a deep borehole (150 meters; static water level 20 m, 5 yrs old)	Borehole reasonably protected, preventive maintenance is lacking, foot valve and plunger seals need repair.
Pump 2	Rope pump on a dug well (16 m, static water level 5 m, 1 yr old)	Well is not sufficiently protected. Pump is in good working condition
Treatment	No treatment	A few people boil water at home for babies
Water transport and home storage	Jerrycans and open containers. Some use donkey for transport	Jerrycans are a safe way of transport. Few containers are closed with a lid.
Water disposal	Waste water is not properly drained at pumps leading to puddles	This may lead to mosquito breeding, unpleasant smell and does not positively influence good hygiene behaviour
Coverage	10% of the community use the handpump 1 and 5% handpump 2 both in the dry and wet season	Several people use also other water sources when easily available
Continuity	Water supply is available 8 hours per day. At other time pumps are locked	People are reasonably satisfied with the 8 hours. If pumps breakdown they may be out of service for several weeks
Quantity	On average people use some four jerrycans of 20 liter per family per day	Water use is on the low side and confirms the use of other sources
Cost	People pay 2 Birr/month per family	Income does not adequately cover O&M cost. For larger repairs they try to get support from outside
Water culture	People like the taste of the water; very few treat it at home (boiling, disinfection). One of the two pumps is not kept clean by users	
Quality[1]	Sanitary survey indicates that the deep well is reasonably protected but the water from the shallow well has a considerable sanitary risk because of infiltration possibilities of surface water and presence of nearby latrines	Water in the shallow well should be considered a bacteriological risk. Would be good to obtain confirmation from water quality test. Disinfection of the well may be an option in combination with the removal of potential sources of pollution.
Overall assessment	Both pumps require better maintenance and need repairs. The water in the deep well is reasonably safe, but the shallow well has a high sanitary risk which requires improvement (or household level treatment). In both cases home storage is needed and this is often done in containers that are not properly cleaned, hence also involving a considerable hygiene risk. This requires improved storage or household level treatment.	
1. A schematic drawing of both pumps and the related risks is shown in Annex 7		

Figure A4.1 Schematic drawing of the system *(Insert drawing of the water system)*

8 Annex 5 Assessment of traditional wells

Item	Description	Remark
System	Four open unlined traditional wells exist that are used by household, cattle and wildlife	Wells are not protected by a fence. People draw water with unclean bags
Treatment	No treatment	A few people boil water at home for babies
Water transport and home storage	Jerrycans and open containers. Some use donkey for transport	Jerrycans are a safe way of transport. Few containers are closed with a lid
Water disposal	Waste water is not properly drained leading to puddles	This may drain into the well and causes a muddy environment
Coverage	40% of the community use the wells in the wet season and 20% in the dry season	People try to cut cost by using well water instead of piped water supply.
Continuity	Water supply is available continuously in the wet season, but two wells dry up in the dry season	People are partly satisfied with the wells but don't like then to dry up
Quantity	On average people collect some three jerrycans of 20 liter per day for their family	On average people use some 12 lpcd, which is on the low side. Some however supplement with water from other sources and washing is done in the wet season at the pond
Cost	People do not pay	People have some cost (annual replacement of the bag and rope to collect the water) indirect cost as the ponds are at a distance of 20 minutes
Water culture	People like the taste of the water; very few treat water at home (boiling, disinfection)	
Quality[1]	Sanitary survey indicates that a huge sanitary risk exist in all four ponds	Water involves a high bacteriological risk. Treatment/disinfection of the wells is feasible provided they are first better protected
Overall assessment	The wells are contaminated hence the water involves a considerable hygiene risk and will require treatment. Treatment at household level can be an option (solar disinfection, chlorination, boiling). An alternative is to use safe drinking water from the deepwell pump or from the piped system (provided this is safe or is disinfected at the standpost (equipped with extra storage tank and disinfection).	
The four traditional wells are very similar and for that reason only a general description is made		