Healthy Schools

A Manual for Water, Sanitation & Hygiene for Elementary School Directors and PTA

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Contents

1 Introduction

This manual is a practical guide to hygiene (which includes toilet use and cleaning practices) and water supplies for elementary schools in Eritrea.

It is proven that children perform better in school when they have a healthy learning environment. If children drink clean water, and use toilets instead of open spaces they will reduce the spread of illness. Good school hygiene will also spread good hygiene practices to their homes and to the wider community.

Objectives

The objectives of this manual are to:

- raise awareness of the links between hygiene and health;
- provide information on how to improve toilet use and cleaning practices;
- provide information on how to improve existing school water supplies.

Who can use this manual?

This manual can be used by school directors or members of parent teacher associations (PTAs) to maintain water, sanitation and hygiene in the school.

Elementary schools in Eritrea and their physical environments vary greatly depending on their location. For this reason, we hope that the users of this manual are able to adapt this information to suit their own school environment.

How to use this book

This book can be used at parent teacher meetings or by school directors to increase awareness and generate discussion on the links between hygiene and health.

There are many actions that can be taken by directors, PTA and community members to improve hygiene and water supplies in schools.

The information can be used to motivate your school to make both behavioural and physical changes to improve school hygiene and water supplies.

While the path towards becoming a hygienic school is a challenging one, each step towards encouraging good hygiene habits in Eritrean students is a step closer to a healthy and educated community.

2 The links between hygiene and health

Hygiene, sanitation and water storage habits affect people's health. Dirty water results in sick people. Water is important for daily life, as we use it for most activities. It is also vital in the environment as it supports our animal and plant life, which in turn supports our livelihood.

Are students at your school often sick?

Health of children relies on:

- Use of toilets
- Washing themselves
- Water supplies

Common health problems that schools can prevent are:

- bacterial diseases (caused by bacteria) such as Shigella, Cholera, skin diseases and Trachoma;
- parasites (organisms that live in or off a person) such as Giardia, Dysentery and Amoebiasis; and
- viruses (non living diseases) such as the rotavirus and Hepatitis A.

  (Refer to the Glossary on page 59 for full definitions of these diseases and disease types and Appendix C for symptoms and signs of common hygiene related diseases).

Many of these above diseases cause diarrhoea.

Diarrhoea is a major cause of death, particularly in children under 5. In Eritrea, roughly 1,500 children per year die of water, sanitation and hygiene related diarrhoea. Handwashing with soap is known to be a significant factor in reducing diarrhoea.

Source: WHO Eritrea Health Update 2007

A healthier school will:

- reduce the number of children missing school due to illness
- improve students' concentration in class
- stop diseases spreading to other students and their families
- save money on medicine to cure diseases.

1.

Poor hygiene practices can lead to the spread of disease.

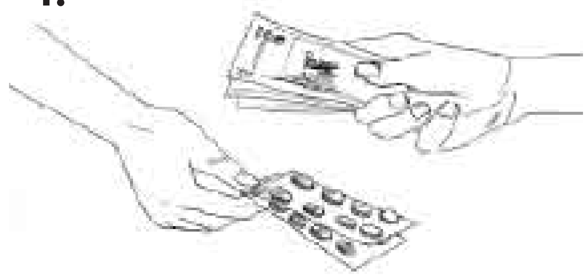
2.

Diseases can lead to serious illness.

3.

Illness can effect the whole family and lead to people missing school and being unable to work.

4.



Buying medicines can be costly for the family.

> *Much better to prevent disease than to provide the cure.*

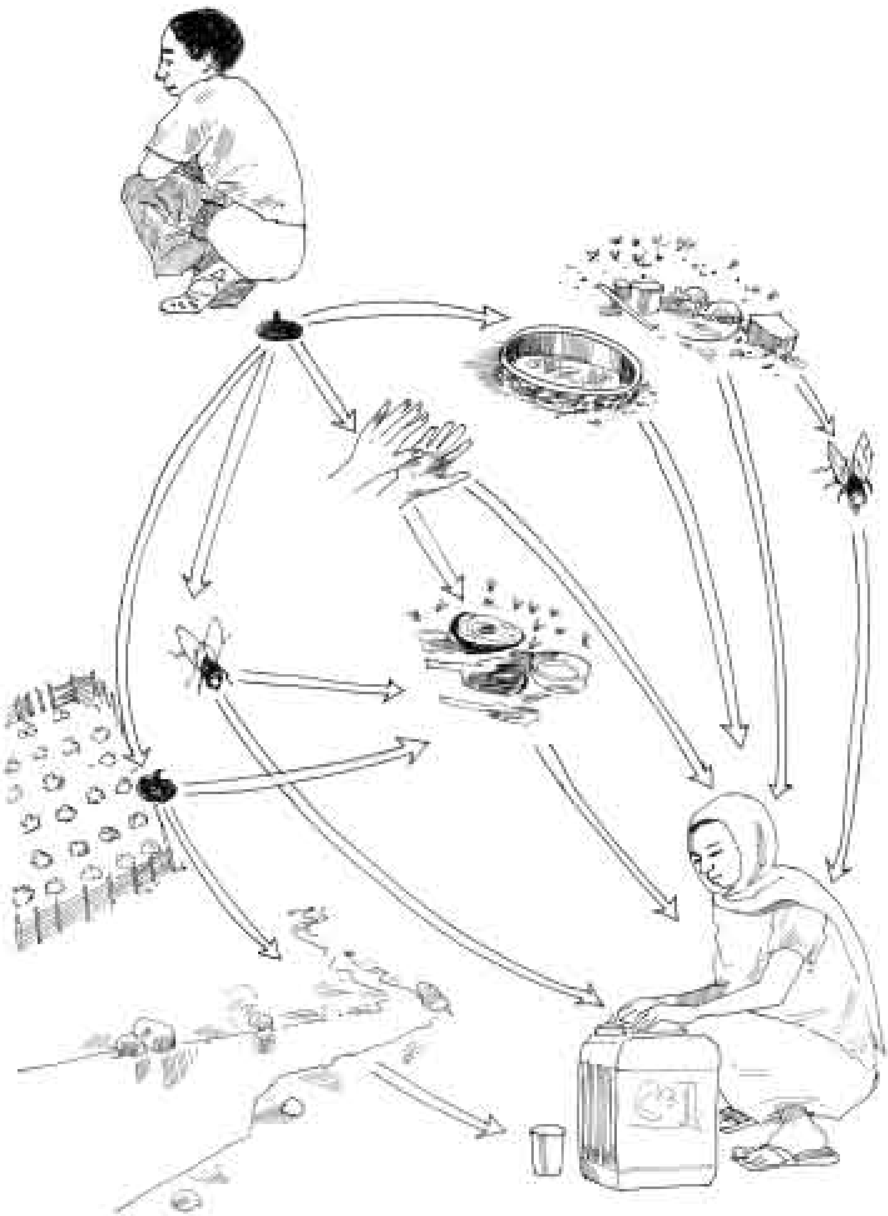
It is important to consider the costs of continuing the spread of hygiene related diseases, when considering the costs involved in improving the hygiene of your school.

Why do we get these diseases?

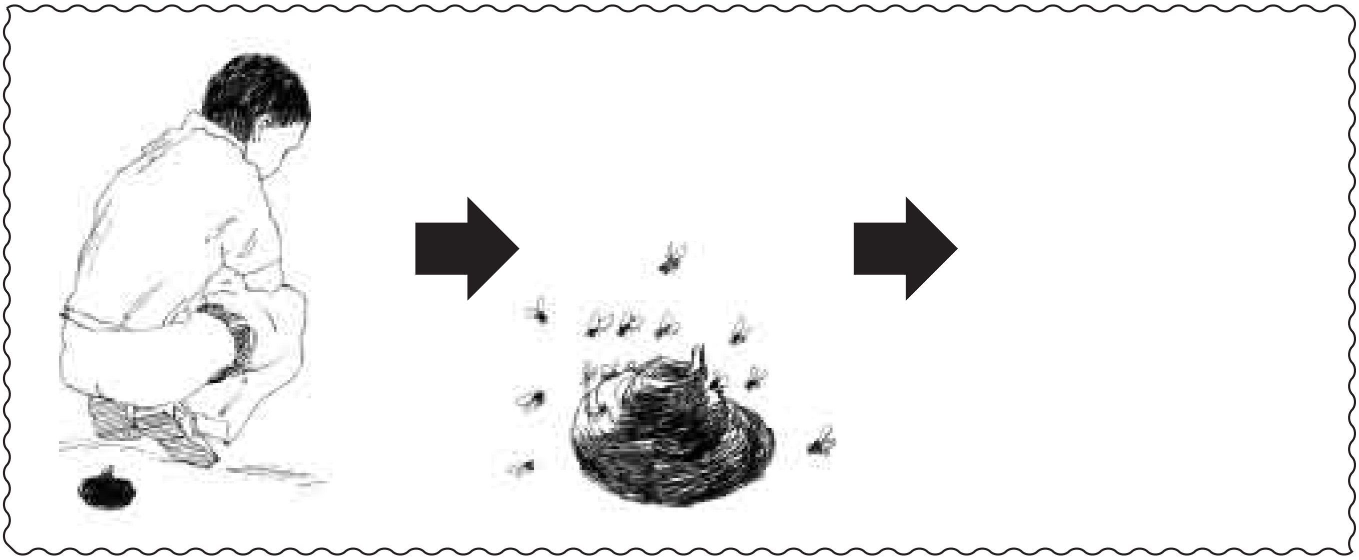
Reason number 1 - Not using toilets

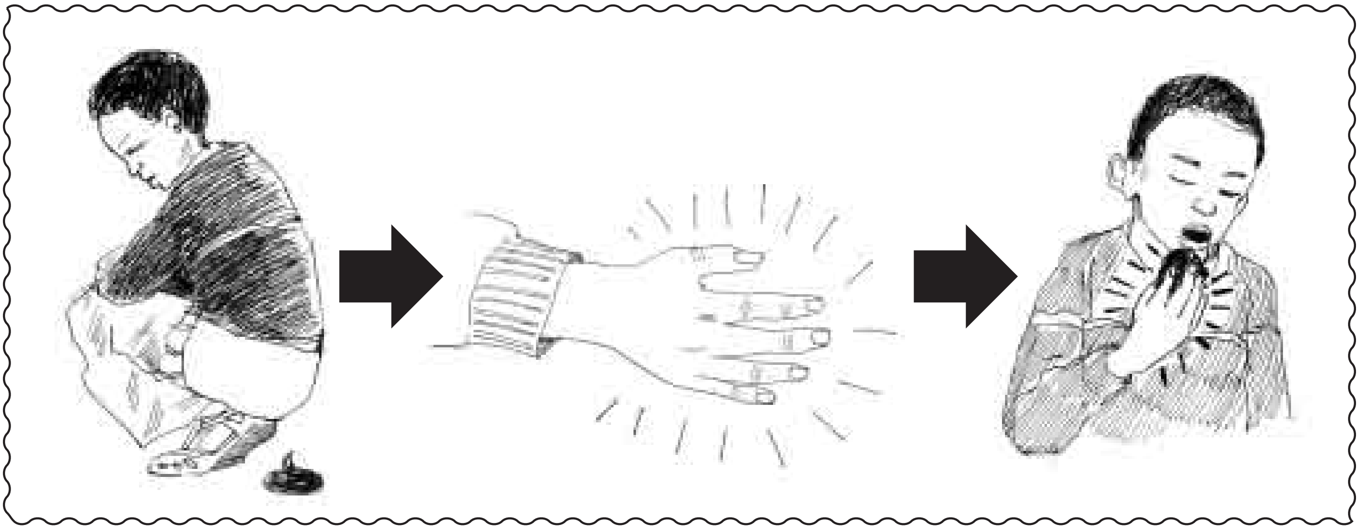
Around the world, not using toilets has been shown to be the number one cause of diarrhoea.

Leaving faeces uncovered, due to not using toilets, (open defecation), can lead to the spread of parasites, bacteria and viruses. As shown below, they are spread to human food or water supplies by insects, wind, animals or people.

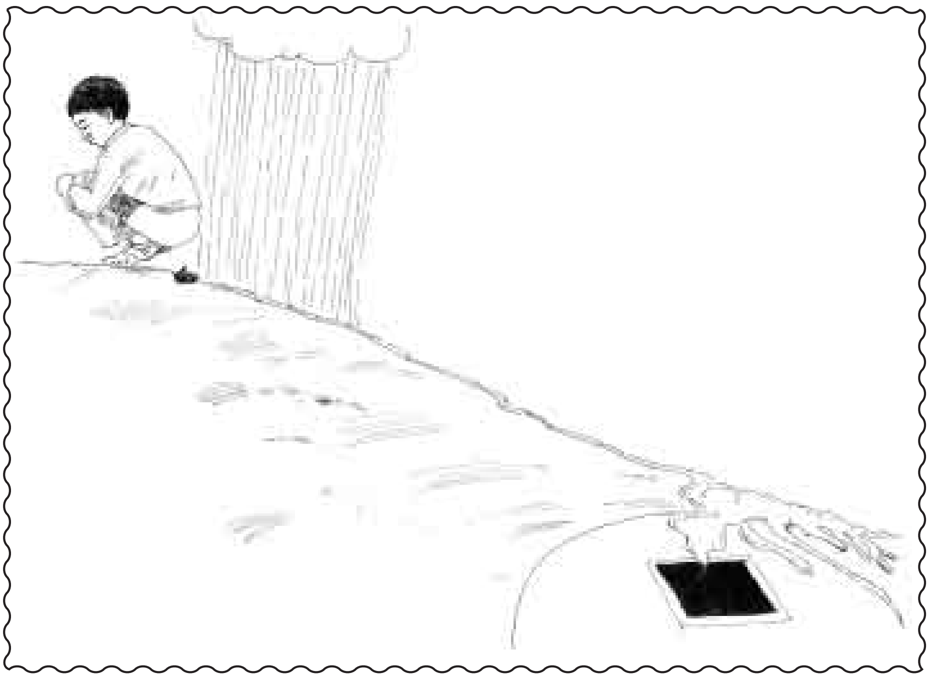


For example these are some ways that faeces can be spread:





During the rainy periods, faeces can also wash into local rivers and local groundwater and contaminate drinking supplies.



If having clean functioning toilets at your school is not yet possible, then the next best thing is for students to bury their waste afterwards or defecate in areas which are far away from water supplies.

Reason number 2 – Lack of hygiene practices

Another very important health issue is cleaning hands, particularly after going to the toilet. It is also important to keep our whole body clean.

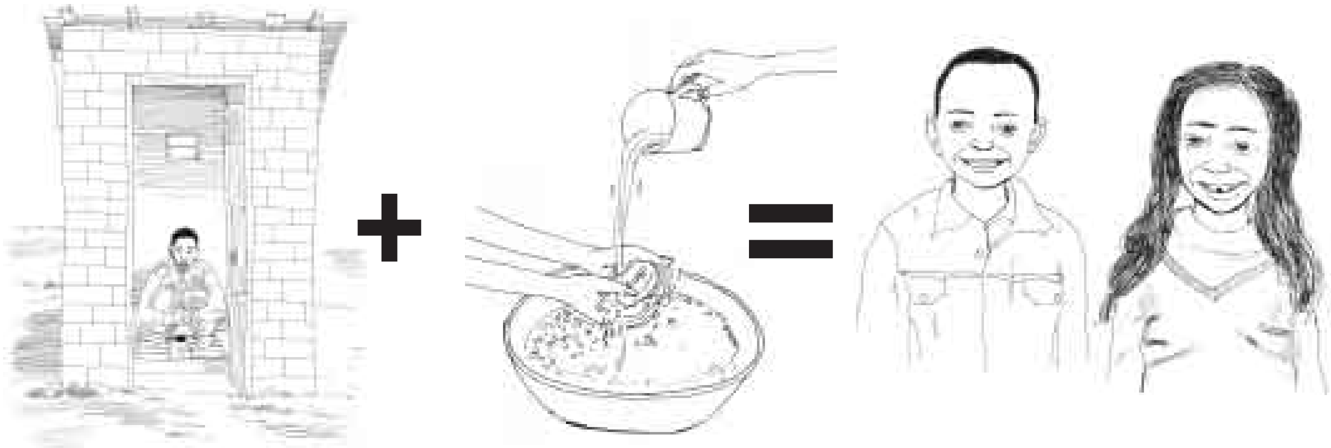
If your students don't wash their hands after going to the toilet, it is possible that they will swallow small amounts of faeces when they next eat.

Also, when these students come in contact with other students they might pass small amounts of faeces on to them. As shown below, even very small amounts of faeces can contain large numbers of viruses, bacteria and parasites.

One gram of faeces contains

- **10,000,000 Viruses**
- **1,000,000 Bacteria**
- **1,000 Parasite cysts**
- **100 Parasite eggs**

Many diseases, such as trachoma, can be caught through contact between children. Therefore hygiene in schools is particularly important for controlling diseases.



toilet use   handwashing   healthy children

Having a good supply of water at schools is important because without a water supply it is not possible to keep toilets clean or for students to wash their hands.

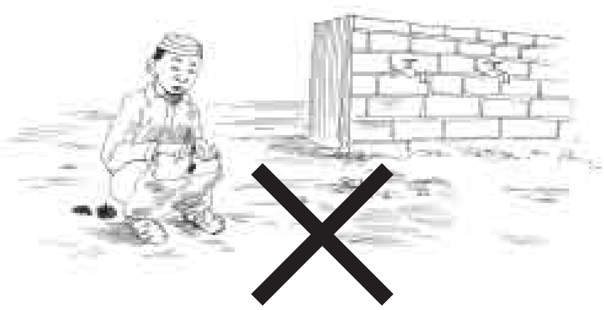
3 Actions to reduce disease in our schools

This section focuses on what changes you can make at your school to reduce hygiene related diseases.

The following four actions have been shown to have the greatest impact on reducing disease:

1. Increasing toilet use
2. Improving personal hygiene (especially face & handwashing) and hygienic food preparation
3. Providing enough good quality, clean water (for cleaning)

Information and suggestions for student activities aimed at improving cleaning and toilet use practices are included in the WASH Club Book.



Not using toilets is likely to contaminate the water supply

Using toilets will reduce contamination of the water supply

Action number 1 - Increasing toilet use

Using toilets

A community that uses toilets will improve the health of children and adults. Schools with clean toilets that the students use set a good example to the wider community.

Also, if students get into the habit of using toilets at school they will make sure to continue this behaviour throughout their life.

When students at your school use toilets the faeces are contained in the one location and therefore the organisms that cause disease, are less likely to be transported from the faeces to human food or to drinking supplies.

If older girls are menstruating they also need the benefit of private and clean toilet facilities.

Attendance of all children improves when they can use good sanitation facilities.

Toilet maintenance

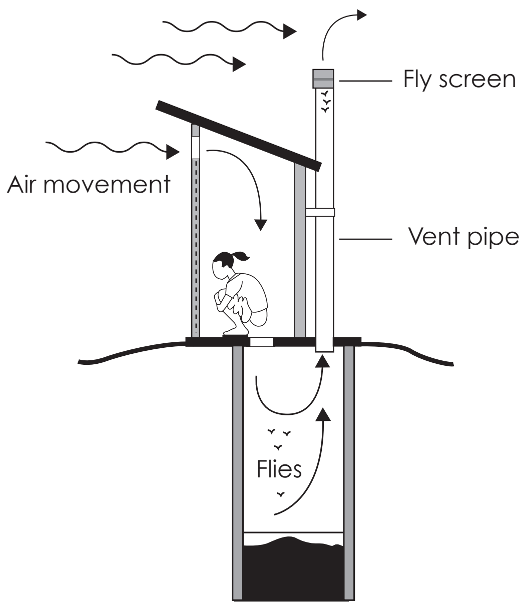
Toilets at your school need to be maintained and cleaned regularly so that they are working and free of disease. Students are more likely to use clean toilets.

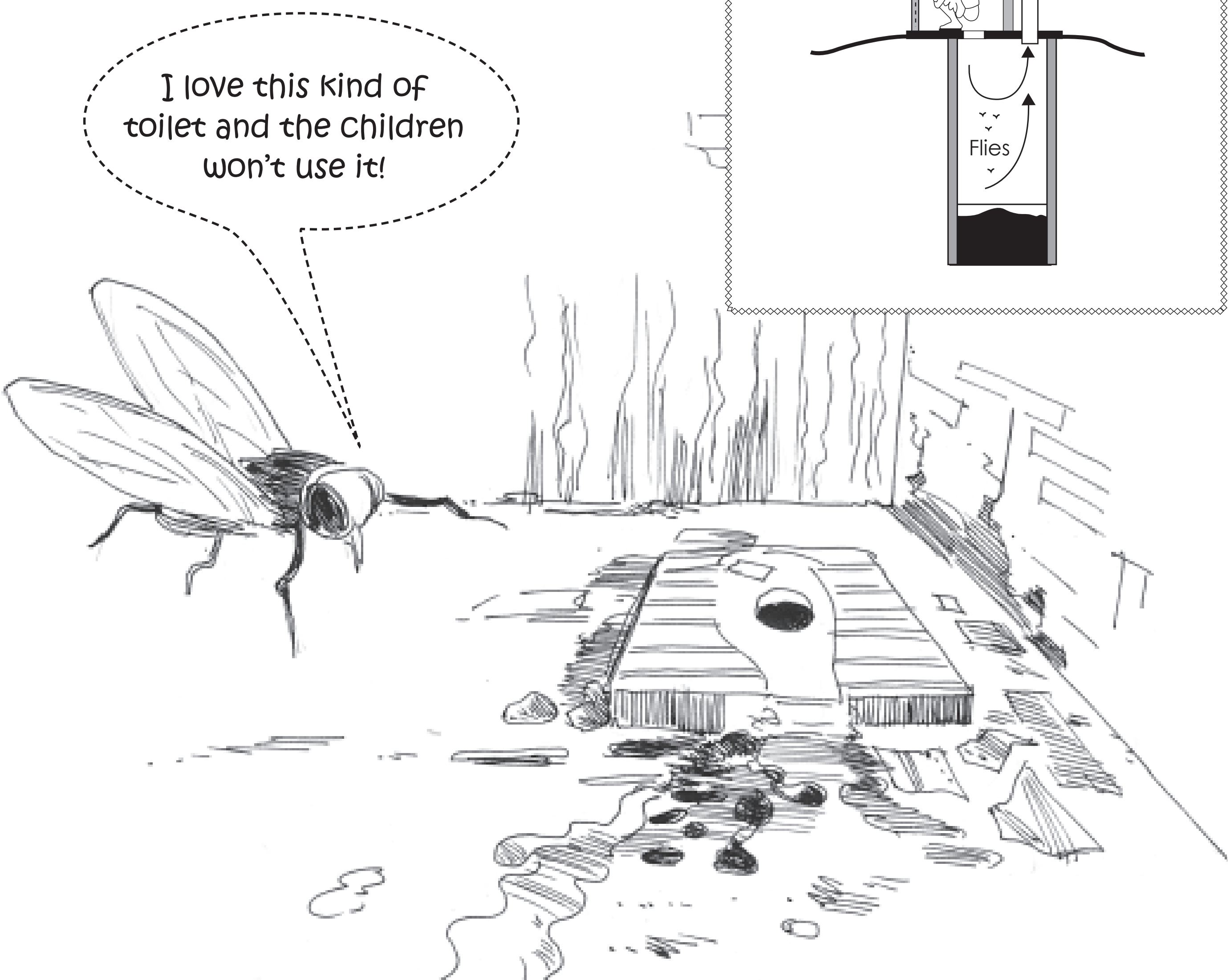
Students need to be taught how to use toilets properly (refer to the *WASH Activities Book* for ideas on how to promote correct toilet use).

Recommended numbers of toilets at schools are:

- girls: one toilet for 25 girls; and
- boys: one toilet for 100 boys.

In water scarce areas, we recommend pit toilets, as they only require small amounts of water for cleaning.





Toilets require cleaning and maintenance otherwise children will be less inclined to use them.

What can schools do if there are no toilets

Many communities have successfully designed and built toilets for themselves. They have designed toilets that are not expensive and which the community are able to build without elaborate equipment.

Ideally schools should become open defecation free areas. This involves more than simply building toilets. The whole school community, students, parents, teachers and PTA, needs to commit to eliminating open defecation. This involves confronting the problem of human waste and the way in which it is currently being dealt with. This is not an easy subject to bring up however teachers and parents are well aware of the health consequences of open defecation.

Bringing about a change like this will need active leadership from a key group of individuals in the school. This group might include teachers, particularly the Health Focal Person, the School Director and members of the PTA. They will need to gain the support of parents to confront the problem of open defecation at or near the school.

One way of gaining this support is for the key group to arrange for parents and students to look honestly at where open defecation is occurring. This can be done by a group walk around the school and surrounding areas looking at where students are defecating. Once people look at this problem honestly and openly, they are motivated to do something about it. Parents want the best for their children. Appealing to their pride in their sons and daughters and their desire to do the best thing for them is a good way to motivate them to help in constructing toilets.

Residents in the village of Adi-Mer-aei have built also their own toilets using locally sourced materials.

Once you have a motivated group of parents it is possible to begin planning the construction of toilets. If parents have sufficient funds, or are able to raise money, then toilets can be professionally constructed. If parents do not have funds, then low cost solutions need to be looked at. Some examples of low cost toilets built by communities are shown in these photos. These examples come from Adi Habteslus, the first village in Eritrea to become open defecation free and Glas, a village that is well on its way to becoming open defecation free. You will need to talk to local health officials to get advice on how deep the pits for your toilets should be.

Children need to be actively engaged in the process of planning and building toilets. They need to develop a sense of ownership and pride in the new toilets so that they are motivated to use them.

Building and using toilets at your school will not solve all the health problems caused by open defecation. As long as open defecation is happening in the community, there will still be problems. However the school can provide an example to the rest of the community and it can play an important part in raising children's awareness of the need to use toilets.

While your school is moving towards being free from open defecation, children should be encouraged to bury their waste using a spade or a rock. They should not defecate near a water source.

Action number 2 - Improving personal hygiene

Your school can improve personal hygiene by ensuring that children wash their hands, preferably with soap (if available) and using water from safe clean sources. This action is extremely important for preventing disease, particularly after going to the toilet. For this reason handwashing facilities, which need not be expensive, are essential in schools.

Good hygiene practices for students throughout the day are:

- **Before School** – wash hands/body before coming to school and wear clean clothing/footwear. Eliminate being a transmitter of bacteria, parasites and viruses originating from the home.
- **During School**
  - Toilet use, provision of adequate and clean water sources for washing.
  - School time, student to student interaction, play, organized sports, use of playgrounds and sports equipment.
- **After School** – Good practices should be maintained when travelling home and before meal time.

$$\underbrace{\text{Toilet use + hygiene}}_{\text{Water supply}} = \text{healthy students}$$

Washing with soap and water is best!

Washing with water is better than not washing at all.

Not washing the hands and face can lead to the spread of disease.

Handwashing

Many diseases including skin and eye diseases, such as Trachoma, can be prevented simply by washing hands, face and bodies. If children are encouraged to not rub eyes or other children's faces this will also reduce the spread of Trachoma and other facial diseases. They need to wash themselves at least once a day with clean water and soap to prevent diseases.

Illustrated below are some simple handwashing facilities that could be set up at a school. They are low cost and require minimal water.

Rubbing eyes with dirty hands can lead to Trachoma.

> *Handwashing with soap can reduce incidence of diarrhoea by 44%*
> *Unicef 2009*

Simple handwashing options

With a bowl

Dipper with a hole and soap

Recycled container

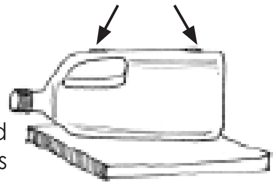
Soap on a rope

A plastic or fabric net around the soap, not only holds it, but also is abrasive which helps scrub the hands more effectively.

Two holes at the top of the bottle

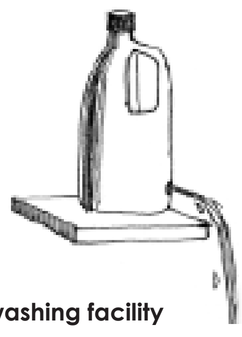
Tight fitting lid

Support of wood or bricks



1. Horizontal position

2. Vertical position



Plastic bottle as a handwashing facility

Source: http://www.schoolsanitation.org/BasicPrinciples/HandwashingFacilities.html

Handwashing facilities can be simple and inexpensive. This example uses an old bottle, tied with string and a toe release.

Action number 3 – Providing enough good quality water

Water quality is important not only for drinking but for cleaning hands and faces and in food preparation, toilet use and household cleaning.

If your school does not currently have a good supply of clean water, you might benefit from the sections titled 'The Importance of school water supplies' and 'Improving your school water supply' (page 20).

4 The importance of school water supplies

Water is linked to our health, general wellbeing and even to our ability to get an education and make a living.

Even in areas with limited freshwater, schools must provide clean water to maintain the general wellbeing of the students and staff.

Why is water required at your school?

Students and teachers at your school need access to clean water for:

- **Drinking**
- **Handwashing**: before eating and after defecating (in toilet or in the open).
- **Cleaning the toilets:** For this buckets (and detergent and disinfectant) are needed as well as brushes or brooms.

If there are flushing toilets at the school then water for flushing is required. In areas where water is extremely scarce, pit toilets that do not require flushing are recommended.

Water is also used in schools to clean the chalkboards and classrooms or settle dust.

Students can bring their own drinking water to school (in closed clean bottles).

Remind children not to drink from the same bottle but to use separate cups when sharing.

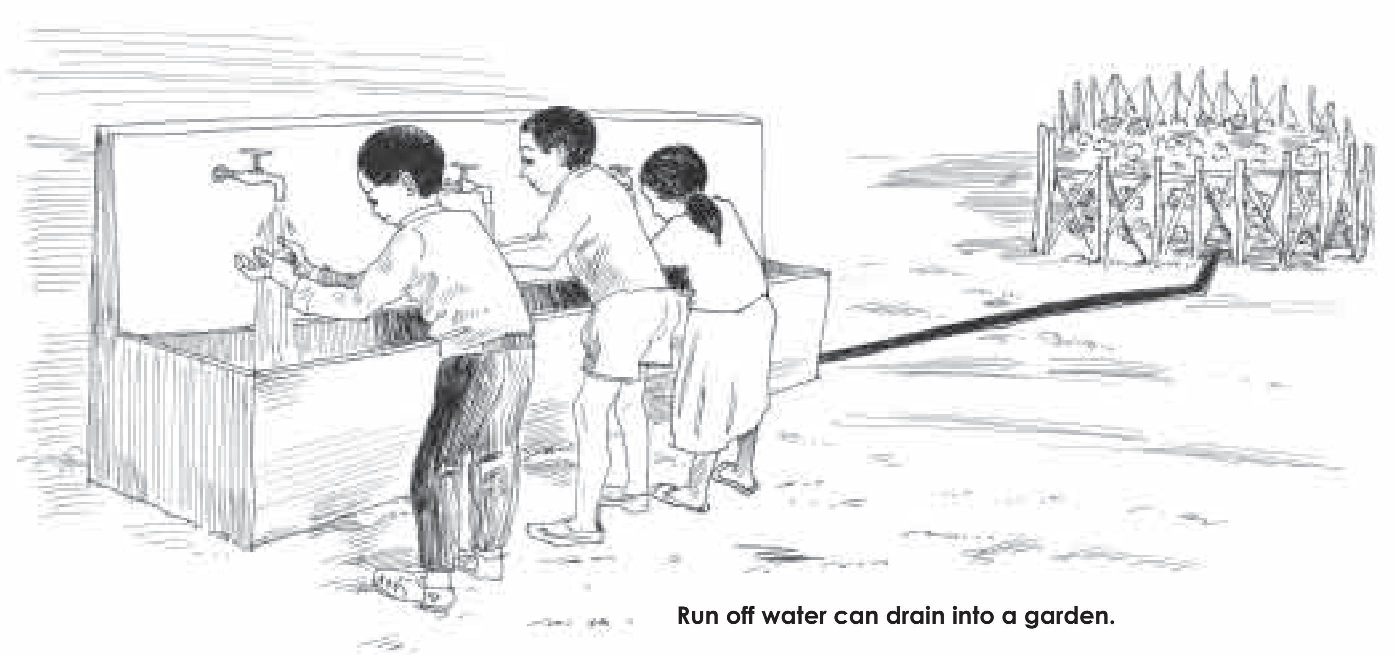
Waste water from washing hands and cleaning toilets at your school must be drained away from the water supply to avoid contamination.

Waste water can be used for school gardens by, for example, tipping waste water onto a garden using a bucket or by draining the water away.

Student with drinking water.

Students using waste water to water plants.

Students washing their hands over the plants to reuse water.



Run off water can drain into a garden.

5 Improving your school water supply

Questions to help you determine whether you need to improve your school's water supply

- Does the school already have access to enough water?
  (In this report we assume that 2 litres is required for each child for drinking and cleaning hands, while they are at school[1]
- Is the water clean enough for consumption and hygiene requirements?
- Does the water supply meet all needs all year round?
- Is the water source nearby and easy to access?
- Are repairs necessary to reinstate and/or improve water supply arrangements?
- Does the school need additional water for washing class rooms, watering plants?

- Is the school water supply system being maintained?
- Is there a piped water system?
- Is the water supply affordable?

If you answered 'no' to any of these questions then the following sections may help you improve the water supply situation at your school.

1 (http://wedc.lboro.ac.uk/WHO_Technical_Notes_for_Emergencies/09-Minimum_water_quantity_needed_for_domestic_use/09-Minimum_water_quantity_needed_for_domestic_use.php)

If your school does not have adequate clean water

If your school currently does not have a clean and reliable (usually available) or adequate water supply source then this section may help you provide an improved water supply to your school.

Surface water

What is Surface water?

Surface water includes water sources above the ground such as water in rivers, streams, man-made water storages, such as rainwater collected from roofs or in town reservoirs or natural ponds and lakes.

Types of surface water in Eritrea

Gash River Tesseney, downstream

Koferenko reservoir

Rivers

There are five large river basins in Eritrea, however only the Setit River has water flowing for most of the year. All the other river systems including the Gash River, only flow during the rainy season. They drain from the highland areas where there is not much vegetation (trees etc) and more rain. Heavy rains in the highlands can result in flash flooding in the low lands. This often results in soil erosion along the river banks, particularly in areas which have been highly deforested.

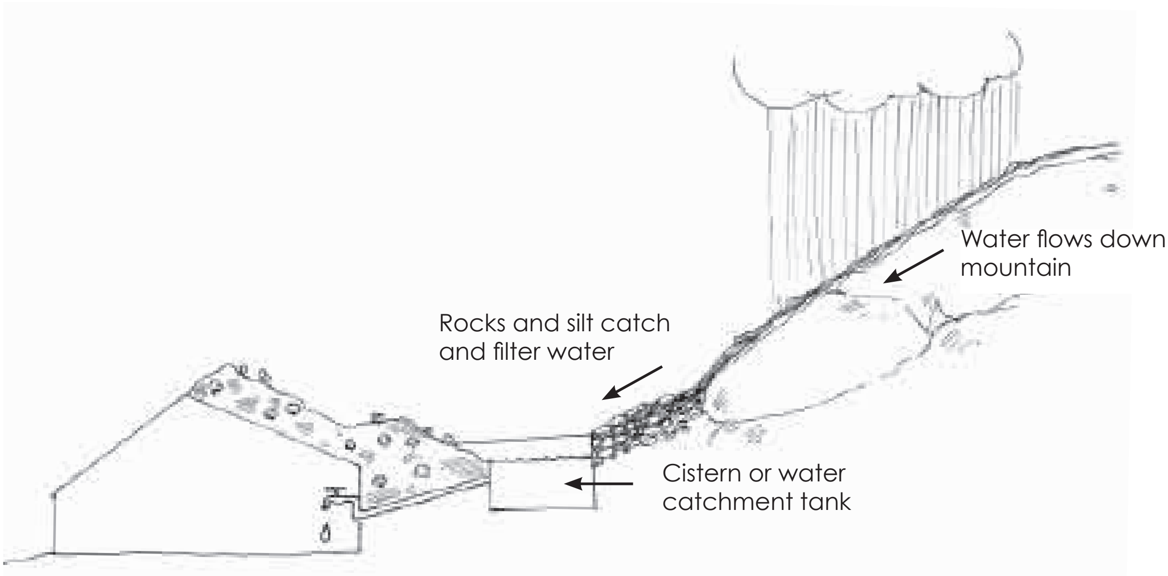
Reservoirs

There are no large natural lakes in Eritrea. However some reservoirs have been built to keep water for drinking supply or agriculture (mainly in parts of the eastern and western lowlands). The reservoirs often become full of sediment and silt (i.e. sand), sometimes within 10 years from when they were built.

Rainwater Harvesting

An important source of surface water is rainwater harvesting. Rainwater Harvesting is the collection and storage of rainwater from the ground or from manmade surfaces. Water collected from manmade surfaces, such as roofs, is usually good quality. Therefore it does not usually require treatment before drinking.

Water can also be collected from the ground. This water can be used for animals, irrigation or to refill aquifers in a process called groundwater recharge. If treated, it can also be used to provide drinking water.



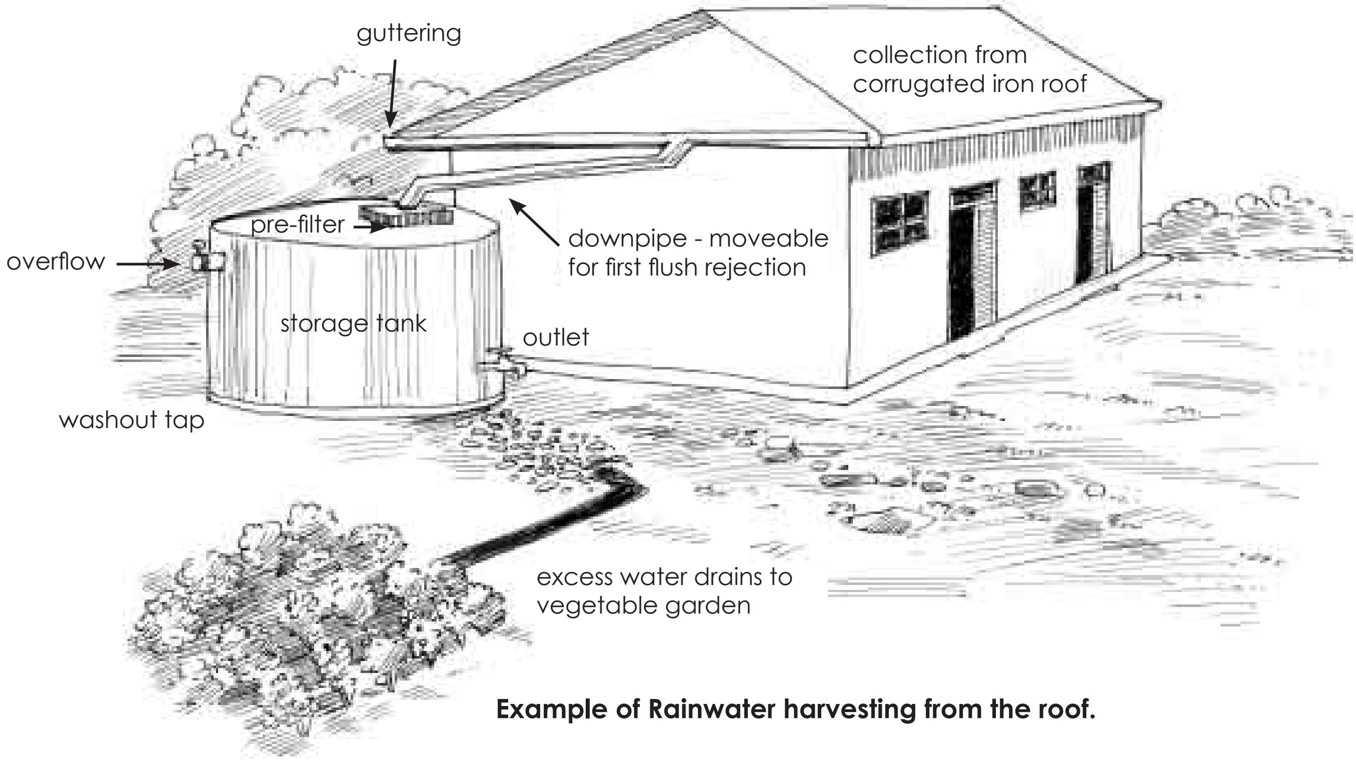
An example of rainwater harvesting from land by catching hillside run-off water.

Water can be collected from roofs in tanks, cisterns and other forms of storage.

Mogoraib Water Tank

Aklalet tank

Examples of types of water storage.

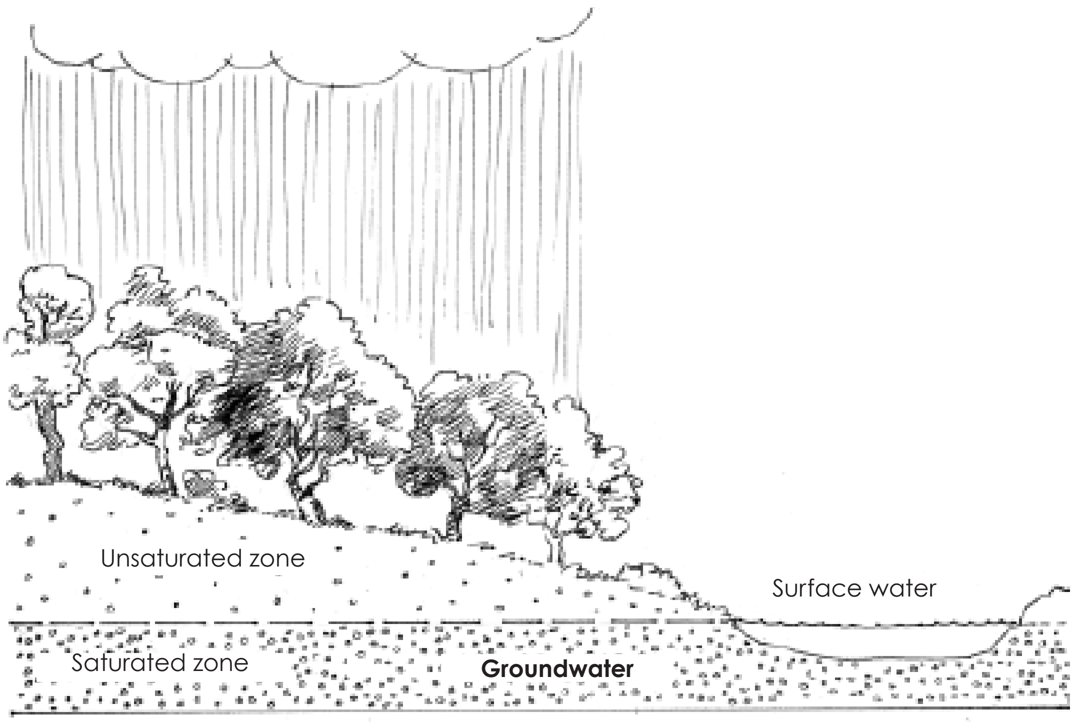


Example of Rainwater harvesting from the roof.

Ground water

What is ground water?

Groundwater is water that is found underground in the cracks and spaces in soil, sand and rock (for example gravel, sand, sandstone, or fractured rock, like limestone). Groundwater is stored in, and moves slowly through these cracks and spaces.



Groundwater fills the spaces between soil particles and fractured rock underground.

Choosing a water source

The following questions need to be asked when identifying and deciding how to source adequate quantiy and acceptable quality water for your school.

Rainfall harvesting	Surface water	Groundwater
Do you have high annual rainfall (more than 400mm) of rainfall? *(See rainfall map)*	**Is there a suitable surface water (river, creek or dam) source nearby?**	**Is there a good sustainable source of clean groundwater nearby?**
In areas of very high rainfall (above 400mm), it may be possible for rainwater harvesting to meet the school's water supply requirements and may even provide water for gardens. In areas where rainfall is above 200mm rainfall rainwater harvesting may be useful for supplementing existing supplies in wetter months or by providing a better quality water supply for drinking.	In highland and plateau regions perennial sources of surface water do exist – springs, creeks and streams. If a surface water source of suitable quality and quantity is available, then options to use this source for schools should be considered (i.e. a piped delivery system or implementing a schedule water carting). The capture and storage of surface water runoff could also provide a good reliable source of water (i.e. the construction of sand dams, rock dams).	(i.e. does your town have a safe and reliable groundwater supply or is it likely that good quality shallow groundwater exists within the grounds of the school?) If there is a good quality groundwater supply nearby which can be piped or delivered to the school at a reasonable cost then groundwater is likely to be a good option. If there is good quality shallow groundwater in the area, digging a well and extracting the water with a hand pump may be a good option.
YES	YES	YES
Consider: Rainfall harvesting	**Consider:** Surface water: • Delivery of / connection to available surface water supply • Construct surface water runoff capture systems, i.e. sand dam, rock dams	**Consider:** Groundwater through either: • delivery of / connection to town groundwater supply; or • establish a groundwater supply within the school.

Alternatively Consider a Combination of Water Supply Options

Rainfall harvesting, - collected from school roof and / or other town roof areas (administration centre, health clinic)

Groundwater – via delivery of / connection of groundwater supply to school or a groundwater supply within the school.

Surface water – via delivery of / connection to a surface water source.

Where groundwater is not available, is of poor quality or is expensive to pump or transport to the school, then the school may benefit from rainwater harvesting (in areas with good rainfall).

In areas where groundwater levels are currently declining, rainwater harvesting will also help reduce demand for groundwater and therefore enable groundwater levels to recover during wet periods.

Advantages and disadvantages of surface water versus rainwater harvesting versus groundwater

Aside from whether groundwater and good rainfall is available at your school, you should also consider and weigh up the advantages and disadvantages of using groundwater, surface water and rainfall harvest sources:

Advantages (good points) and disadvantages (bad points) of surface water, rainfall harvested and groundwater supply sources:

Rainwater harvesting

Advantages

- ✓ Clean water can be sourced from within the grounds of the school (no burden on sharing town potable water supply).
- ✓ Once set up, it is substantially less costly than most other options.
- ✓ Rainwater is generally a cleaner source of supply than other options – require little if any water quality treatment.

Disadvantages

- × Requires large roof areas for collecting water and adequate rainfall in order to meet demands.
- × Requires construction of pipes, storages for water collection. However these are easier and cheaper to maintain / repair than groundwater pumps.
- × Could be a less reliable (less usually available) water supply, especially in areas of low rainfall, i.e. supply may not be available all year round and during below average and drought periods.

Surface Water

Advantages

- ✓ Possible permanent supply of water available.
- ✓ Ability to design a gravity water delivery systems will eliminate pumping costs.
- ✓ Utilisation of rainfall runoff water.

Disadvantages

- × Water quality can vary considerably due to no or inadequate contamination source prevention, stock access to water sources (dams, reservoirs).
- × Some form of water treatment will be required – chlorination and /or filtration.
- × Will require construction of delivery mechanism – pipes , storages and possibly pumping systems.

Groundwater

Advantages

- ✓ Groundwater does not require a large water storage to be built.
- ✓ Groundwater is generally a more reliable (more often available) supply than rainwater harvesting during long dry or drought periods.
- ✓ No evaporation losses.

Disadvantages

- × When groundwater is deep below the surface, bores must be drilled and electric or diesel pumps used to extract the groundwater (expensive establishment and ongoing costs for operation and maintenance)
- × Groundwater levels may decline if what is being taken out is more than that recharged from rainfall.
- × If the pump breaks, repair or replacement can be costly (time without, sourcing parts and trained repair technicians).
- × Shallow local groundwater can be easily contaminated and once contaminated it's very difficult to treat.
- × If there is a pump at the school, there is a cost associated with pumping the water.
- × If the groundwater is being delivered from a town supply there are ongoing costs associated (water supply charges).

Water supply establishment and running costs (operation and maintenance) also need to be compared and will depend on:

- How much your school can afford? - Initial investment in water supply infrastructure.
- Whether your school is willing and able to undertake fundraising activities to provide additional funds for running costs? Water supply charges, operational and maintenance.
- What the cost is for getting water delivered to your school?

Appendix A provides some example costs to help you decide whether your school (community) can afford the key materials required to harvest rainwater or access groundwater.

The costs involved in making changes in the school to improve water supply are often high and most schools will be limited by low school revenues and capacity for school building facility donations from the school community. However, it is important to consider these costs in comparison to the costs to the wellbeing of the community with the persistent or continuing spread of hygiene related diseases.

Can you estimate the cost to the families of your students, which relate to the health problems?

Could you use this information to raise funds from your community for providing an improved supply of water at your school?

Creating your own dam for surface water

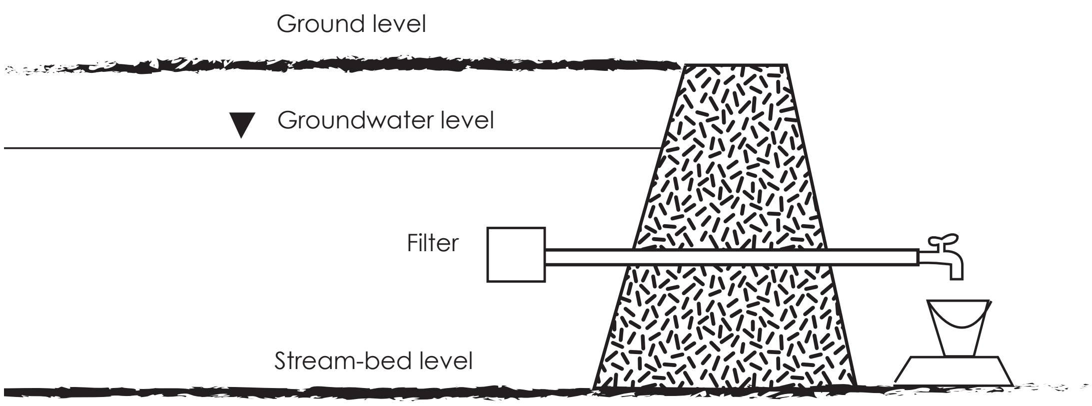
The next sections describe three different dams you can build to store surface water for your school and community: - sand storage, sub surface sand dams and rock catchment dams. These dams intercept the natural flow of groundwater.

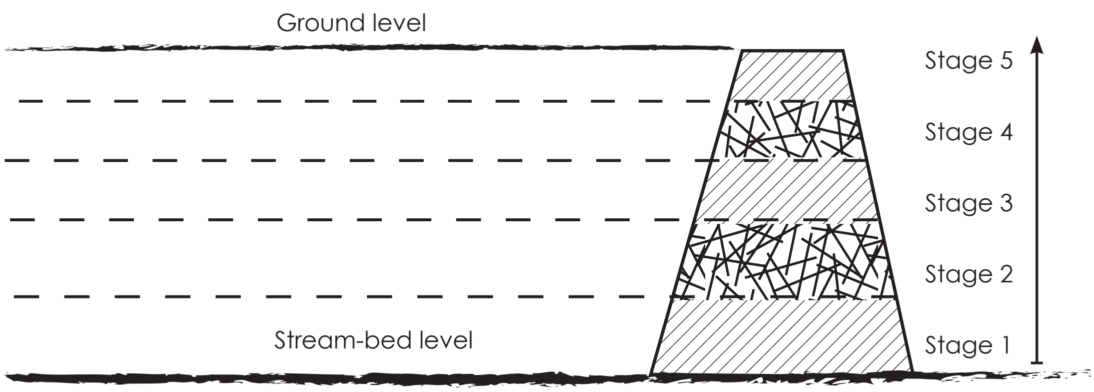
1. Sand Storage and sub-surface Dams

These dams may be used to retain and store water in ephemeral water courses. They are built across streams or valleys, ideally where rainwater from a large catchment area flows into a narrow passage. using waterproof materials such as compacted clay, concrete, stones or plastic sheets.

Sand storage dam

A sand storage dam is built above ground and contructed in layers to allow sand and gravel to accumulate during periods of high waterflow. Sand storage dams are built over a number of years, with the dam height gradually raised each year. Storage volumes are initially very low but will increase over the years as sediments are deposited and the dam wall is raised.





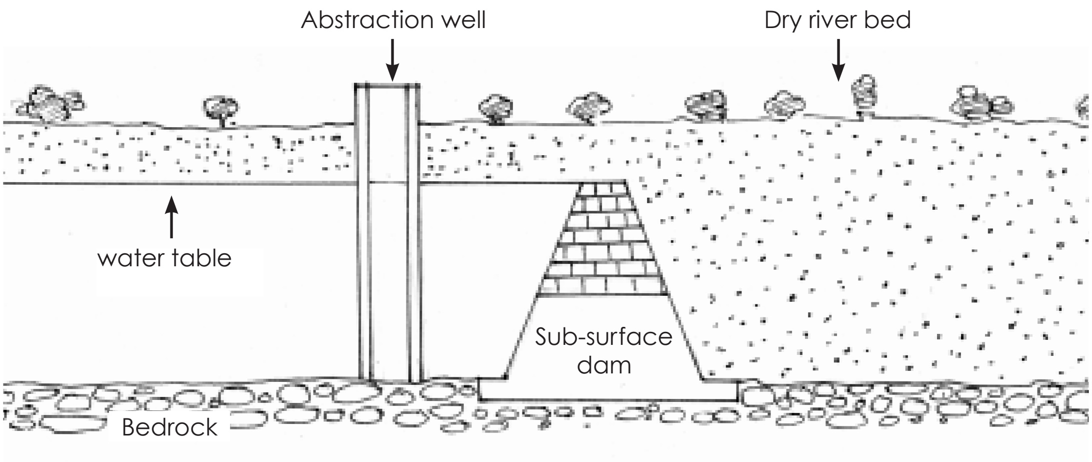
Stages of construction of a sand-storage dam

Source: http://www.rainwaterharvesting.org/methods/modern/gwdams.htm

Sub-surface Dams

A sub-surface dam is constructed below ground level and prevents the downstream passage of groundwater in the sand bed of ephemeral water courses. In the right conditions, a sub-surface dam can be constructed over a period of weeks. A good site for a sub-surface dam has the following features:

- A well defined valley
- A water course with intermittent flows
- Gentle slopes
- Sand or gravel river / stream beds.



2. Rock Catchment Dams

Impermeable bedrock surfaces found within the rocky top slopes or exposed rock outcrops in the lowlands of Eritrea often have natural hollows or valleys which can be turned into water reservoirs by building a dam. This can be a simple stone wall, constructed around the downstream end of hollows or valleys. Stone or mortar gutters may be built across the rock to channel runoff water into the dam.

The factors that need to be considered for the site of a rock catchment dam:

- Dams should be built at sites that can produce a relatively high depth to surface area ratio so as to minimize evaporation losses.
- Rock surfaces should not be fractured or cracked, which may cause the water to leak away to deeper zones or underneath the dam.
- Dam foundations must be of solid impermeable rock with no soil pockets or fracture lines.
- The dam should be in a convenient location for user groups.
- There should be no severe soil erosion in the catchment area.

Some of the design and construction considerations of a rock catchment dams are:

- A solid foundation, to avoid potential leaks.
- A sound dam construction, which if required, can be built in stages.
- An out-take, gravity pipe and water tap point should be constructed to abstract water downstream from the dam.
- The downstream side of the dam should be protected against erosion in case the dam overflows.
- The size of the dam and catchment area should be consistent with the available labour force.
- The shape of the reservoir created by the dam should minimize evaporation losses.
- Local construction materials should be relied on.
- Soil erosion should be absent in the catchment area or be easily controlled by simple soil conservation methods.
- The catchment area should be protected against pollution.

Rock Catchment Dam Kenya

Source: http://www.rainwater-toolkit.net/index.php?id=42

Roof rainwater harvesting

When considering whether rainwater harvesting is a good idea for your school you need to think about how roof rainwater harvesting compares with other water sources available in the community – from a cost and supply perspective. Groundwater supply is within the school or sourced from the local town water supply (either groundwater and / or surface water) are examined in section (on page 37).

This section will help you determine whether the setting up of a rainwater harvesting system is worthwhile, based how often and how much water it will provide. For example:

If you have very little rainfall (below 200 mm/yr, lots of students and a small roof, and can only afford to buy or make small water storage.

Rainwater may only provide supply for a couple of months.

If you are in an area with very high rainfall, you have a large roof, a smaller number of students and you can raise enough money to buy or make a large rainwater storage.

Rainwater may provide enough supply for not only drinking and cleaning but also for school garden / tree watering needs with!

It is important to note that all surfaces, which are being considered for rainfall collection, must be made of a nontoxic (safe) material (e.g. corrugated steel, tiles, concrete, fabric and plastic. Note that although rusty water may look and taste unpleasant it is not a health concern. Simple filtration methods (see page 49) can be used to reduce any water quality colour and / or taste issues due to the affects of rust water staining.

Steps for roof rainwater harvesting

Step 1
Calculate rainfall harvest potential for your school

Step 2
What is the total surface area that can collect rainfall?

Step 3
What is the maximum volume of rainfall the school roof could collect?

Step 4
What volume of water is needed at your school?

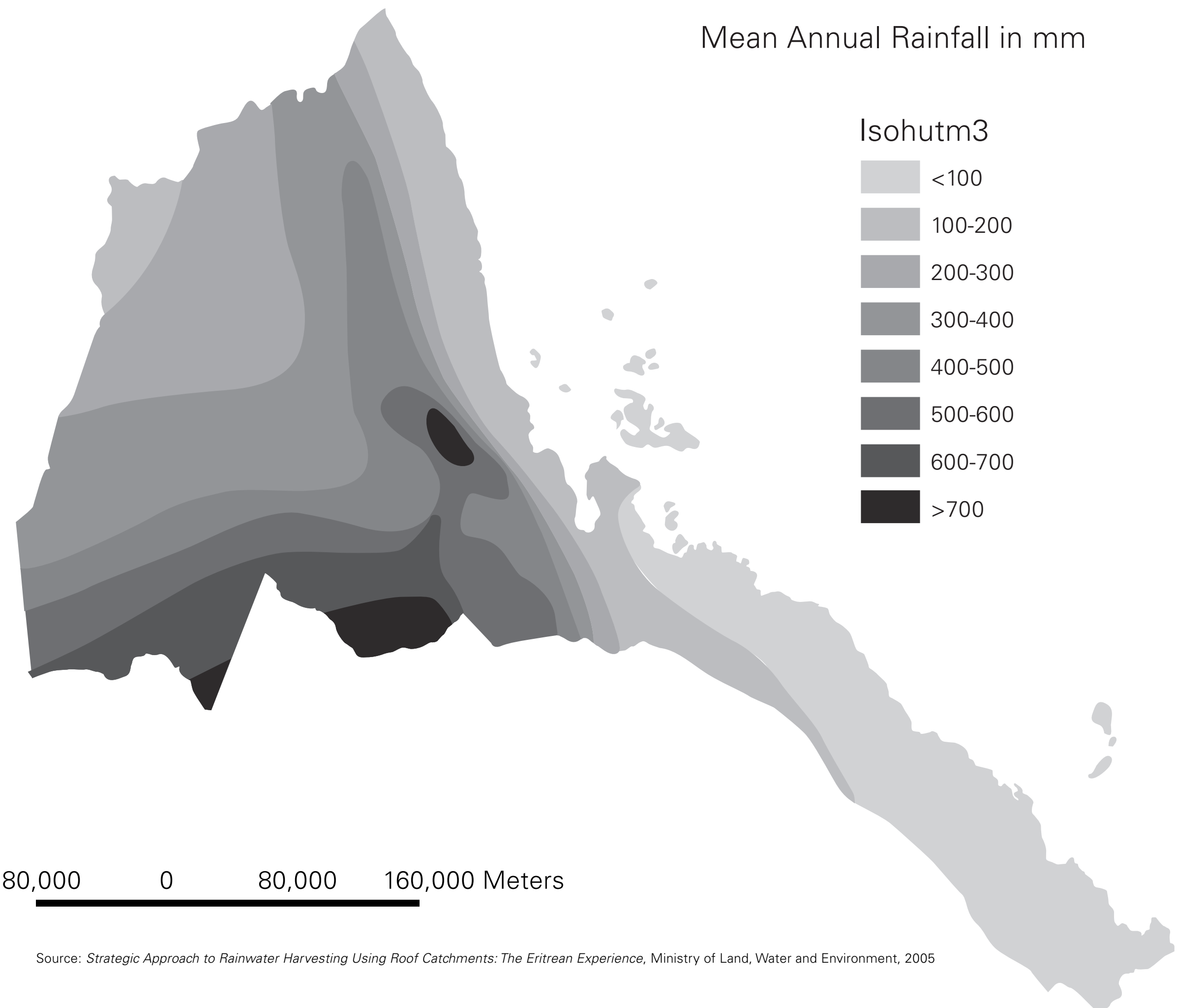
Step 5
What size of water storage will you need?

Steps to assist with decision making about installing rainwater harvesting. (Expanded version Appendix C on page 55).

TOP: A simple invention to collect precious water. BOTTOM: Gutters need to be maintained or water will be lost.

What is your school's rainfall harvest potential?

The annual rainfall distribution map for Eritrea below provides an indication of the potential for rainfall to be captured and used by your school. Many of the urban, peri-urban and regional area, that represents a significant portion of the Eritrean population, are located in areas where the annual rainfall ranges from 300 – 700 mm/yr. These areas all have the potential for roof rainfall harvesting to provide a substantial component of a school's water supply requirement.

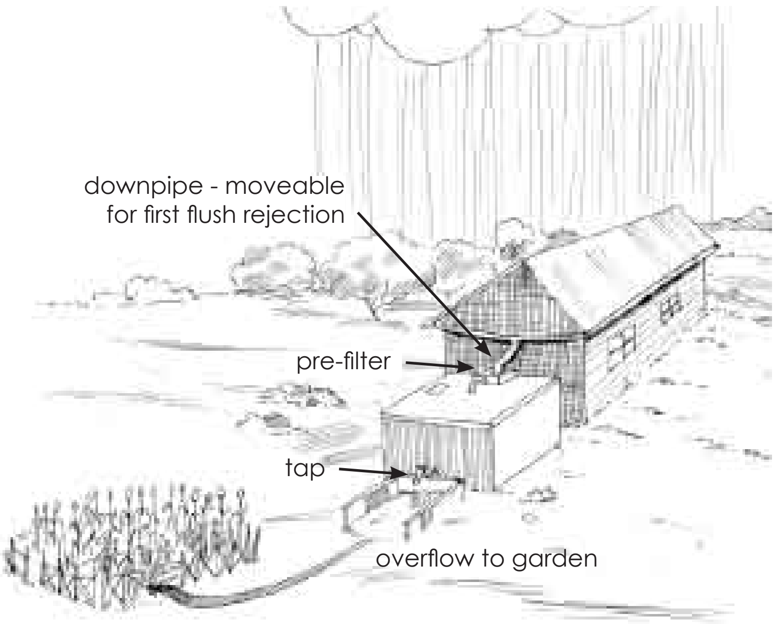


Source: *Strategic Approach to Rainwater Harvesting Using Roof Catchments: The Eritrean Experience*, Ministry of Land, Water and Environment, 2005

In contrast, the arid areas in the Northern and Southern Red Sea zobas are not suitable for schools to invest in roof rainwater harvesting as a viable alternative / supplement water supply source.

For the next steps in calculating the collection and storage required in your school, refer to Appendix C, on page 55.

Constructing a roof rainwater harvesting system



Good rooftop rainwater collection system

Rainwater systems are generally simple to construct and can often be made from local materials. There are a many ways to harvest rainwater.

Rainwater can be caught from the roof of your school using gutters and downpipes (made of local wood, galvanized iron or PVC). This water can be caught in one or more storage containers, which should be of a material which doesn't pollute the water supply (i.e. reinforced concrete, fiberglass or stainless steel).

Ideally there should be a way of bypassing collecting water from the first rains of the season (the first flush), which is generally of bad quality due to dust, rust, leaves, insects and bird droppings being washed of the roof.

Water storages

There are two categories of rainwater harvesting storages:

- surface or above-ground storages; most common for roof collection; and
- sub-surface or underground storages; common for ground catchment systems.

Ideally, your school's rainwater storage should include:

- A solid secure cover;
- A filter to remove large objects;
- An overflow pipe;
- A drain to enable it to be cleaned;
- An extraction system that does not contaminate the water; e.g., a tap or pump; and
- A drainage area beneath the access point to prevent spilled water from forming puddles near the storage.

It's also a good idea to have a sediment (silt and dust) trap, tipping bucket, or any other "first flush" removal mechanism.

First flush and screens

The first rains drain the dust, bird droppings, leaves etc. that lie on the roof of your school. If you can clean the roof surface before the first rains then you will not need a first flush system, however it is difficult to know when it will rain and it is easy to forget.

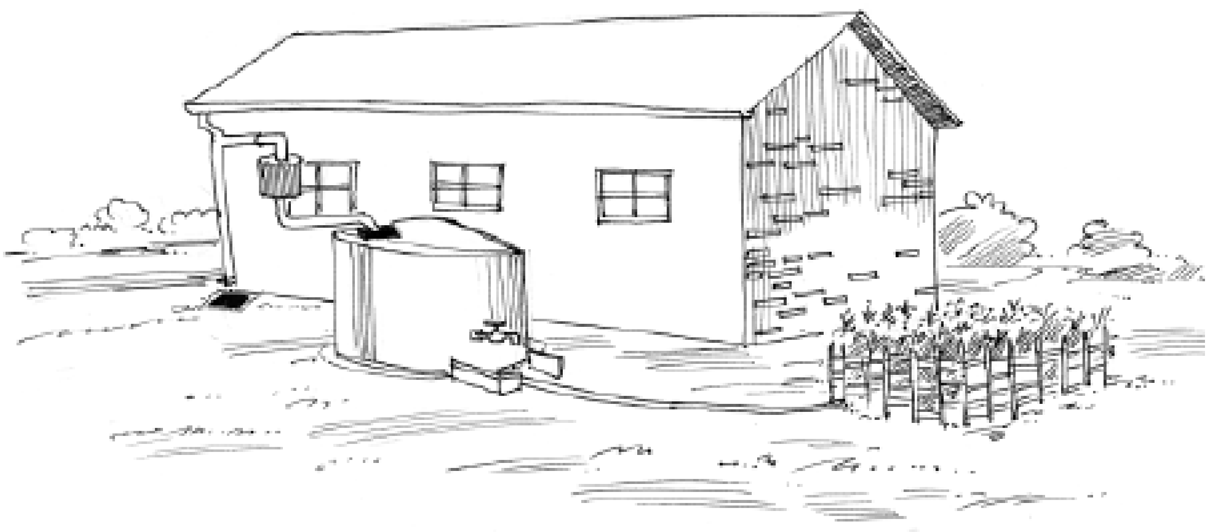
To prevent these pollutants from getting into the storage, the first rainwater of the season, which is the least clean, should not be collected.

There are many ways of not capturing this water. However a simple way is to move the down pipe (which normally carries water into the storage) away from the storage for the first rain of the year (depending on how long it takes the to clean the roof). So that it spills water onto the ground instead of into the storage. This method relies on someone being at the school and remembering to move the pipe at the start of the rainy season and then returning it to its original position once the roof has been cleaned by the rain.

Runoff from the land or harvested rainfall which often has large amounts of dust in it should be directed through a small filter consisting of gravel, sand and charcoal before entering the storage.

The storage reservoir is usually the most expensive part of the system so it's important to choose a material that will last a long time but won't leak or contaminate the water supply.

Materials for surface storages include metal, wood, plastic, fibreglass, brick, inter-locking blocks, compressed soil or rubble-stone blocks and concrete.



A large underground masonry cistern

A galvanised steel tank

A concrete storage

Storages should always be covered

Different types of rainwater storages:

Water kept at your school should be stored safely to avoid contamination. For example the storage should always be covered and kept clean. Using taps to get water from storages is better than using ropes and buckets, as it is less likely to cause contamination.

An underground cistern requires a way of lifting out water. Water may be taken from the storage using a pump or using a bucket and rope system, however this method is more likely to cause contamination.

For more information on how to avoid contamination see the section on Avoiding mosquitoes and general maintenance, page 37.

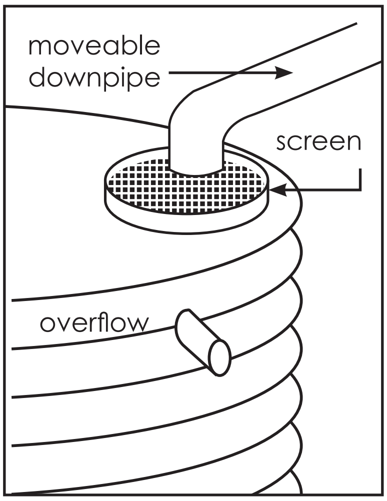
If your school cannot yet afford a large storage, it might be a good idea to consider smaller (and sometimes temporary) rainwater storages, which can provide water for handwashing during the wet season.

Gutters and downpipes

Common materials for gutters and downpipes are metal and plastic but cement-based products, bamboo and wood can also be used. With heavy rains, rainwater may shoot over a simple gutter, resulting in loses. Splash guards can prevent this from occurring.

Screens to retain larger debris such as leaves can be installed in the downpipe or at the storage inlet.

Rainwater collection in a barrel.



A screen to filter water and a moveable arm to allow the first water to be discarded.

Screen over a downpipe

Simple methods of water collection can be effective but cover water to avoid mosquito breeding.

The same concern applies to collection of rain runoff from a hard ground surface. Here the preparations before the first rains are easier and simple gravel-sand filters can be installed at the storage entrance.

Avoiding mosquitoes and general maintenance

Poorly designed or maintained roof rainwater harvesting systems may sometimes result in mosquito breeding. For example with storages that don't have screens or covers or gutters that do not drain water away properly. Gutters need to be cleaned and screens and covers checked regularly.

It's important that storages do not let in any light because mosquito larvae (worms) need light to survive and grow into adult mosquitoes. They also need nutrients and clean rainwater systems are low in nutrients.

Studies show that well-designed and maintained storages will not encourage mosquitoes. Rainwater harvesting systems are also only a small fraction of the available water for mosquito breeding sites and need to be considered as a part of a larger effort to mitigate mosquito breeding[1].

Other ways to maintain a rainwater harvesting system include:

- The storage should be checked and cleaned often. Cleaning should involve scrubbing of the inner walls and floors. Use of a chlorine solution is recommended for cleaning, followed by thorough rinsing. See page 50 for how to keep storages clean.

- Gutters and downpipes need to be periodically checked and cleaned carefully. Regular maintenance must also be carried out on any pumps, which may be used to lift water from the storage.
- Maintaining water quality at a level where health risks are minimized. In some systems this may involves chlorination of the supplies at frequent intervals.

Rust is difficult to avoid, however though rusty water may look and taste unpleasant it is not a health concern.

1 *Thomas, T.H. and Martinson, D.B. (2007). Roofwater Harvesting: A Handbook for Practitioners. Delft, The Netherlands, IRC International Water and Sanitation Centre. (Technical Paper Series; no. 49). 160 p.*

Groundwater supplies

Extraction of groundwater

Shallow wells with hand pumps or rope and buckets system are simple - low cost ways of accessing groundwater. However, the water should be tested first to check that it is safe to drink.

Deep boreholes with electrical or fuel powered pumps are very expensive to establish and operate, often making them economically unviable for school communities to implement. However, drilling shallow bores or constructing hand dug wells to access groundwater in or adjacent to the school grounds may be economic if groundwater levels are relatively shallow (< 15m). School able to establish such systems may also be able to offset costs by selling excess water to the town community.

Example of a hand dug well

The following are examples of how groundwater is extracted in Eritrea:

Hand Dug Wells

Mengula hand dug well.

Pumps can assist with extracting Ground Water

Different kinds of pumps are currently used in Eritrea to assist with extracting water from the ground which includes solar, electrical, diesel and hand powered pumps.

Examples of a hand pump, diesel pump and solar powered pump.

The main advantages and disadvantages of the various pumping methods are:

Method:	Main benefits:	Main disadvantages:	Depth and rate that you can get water:
Hand dug well + rope and bucket	Low cost Not dependent on fuel, electricity or complex technologies.	Easily contaminated.	Usually only suitable for shallow groundwater, i.e. less than 15m.
Hand dug well +hand pump	Provides unpolluted water. Less expensive than electric, diesel or solar pumps. Not dependent on fuel, electricity or complex technologies.	There are potential delays in obtaining spare parts. Valves can wear and can cause leaking. Rubber / leather values can be damaged from overuse.	15 to approximately 45 metres. Rate: 12 litres per minute
Electric pumps	Can pump uphill, at a faster rate and deeper than hand pumps.	Very expensive and has ongoing electricity costs. There are potential delays due to repairs / obtaining spare parts. Requires a reliable (usually available) electricity supply.	Up to 250 metres Rates of up to 10,000 litres / hour
Diesel pumps	Can pump uphill and at a faster rate and deeper than hand pumps. Quick and easy to install.	More expensive initial cost than hand pumps, with ongoing maintenance and diesel costs. Potential delays due to repairs / obtaining spare parts. Short life span.	Up to 250 metres Rates of up to 10,000 litres / hour
Solar powered pumps	Can pump uphill and at a faster rate and deeper than hand pumps. Does not involve ongoing electricity or fuel costs. Easy to install. Long life. Renewable energy.	There are potential delays due to repairs, which require skilled technicians. Very high initial cost. Don't work in cloudy periods.	Up to 250 metres Rates of up to 10,000 litres / hour
Supplied from pipeline to town groundwater supply	Low cost if town supply is only a short distance is uphill of school and or is provided by the government. Low maintenance	Depends largely on distance and position to town supply and capacity of the local government.	Rate: 0.2 to 0.4 litres / second per tap.

From Snel, Mariëlle, Ganguly, Sumita and Shordt, Kathleen (2002). School Sanitation and Hygiene Education – India: Resource Book. Delft, the Netherlands, IRC International Water and Sanitation Centre. (Technical Paper Series; no. 39). 268 p.

Options for getting water from the town groundwater supply

In some areas of Eritrea it is possible for water to be provided to schools from a town groundwater source via either:

- a pipeline from the town supply; or
- a truck, donkey or camel.

Water Trucking in Asmara

The relative estimated costs of the main materials required for these options are shown in *Appendix A – Examples of water supply materials.*

If your town supply is not available all year round it is a good idea to have an alternative 'back up' source of supply, for example a supply from rainwater harvesting.

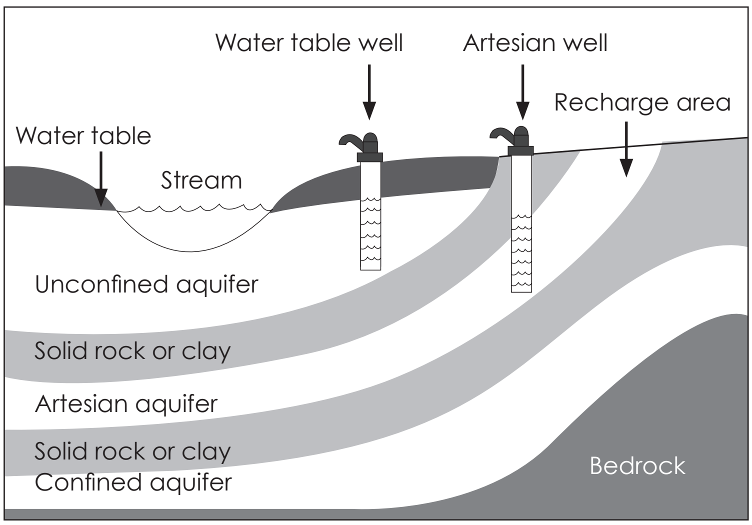
Minimising contamination of groundwater

Some groundwater reserves are more easily contaminated than others. How easily a groundwater source is contaminated depends largely on whether it is a confined or unconfined aquifer. Unconfined aquifers are not protected by a "seepage proof" layer and are often shallow. Therefore, if anything leaks or spills into the soil above the unconfined aquifer, it will seep into and contaminate the groundwater.

Aquifers

Unconfined aquifers are those into which water seeps into the aquifer from the ground surface directly above the aquifer (shown below). The unconfined aquifer is the water table or ground water that you find under river beds.

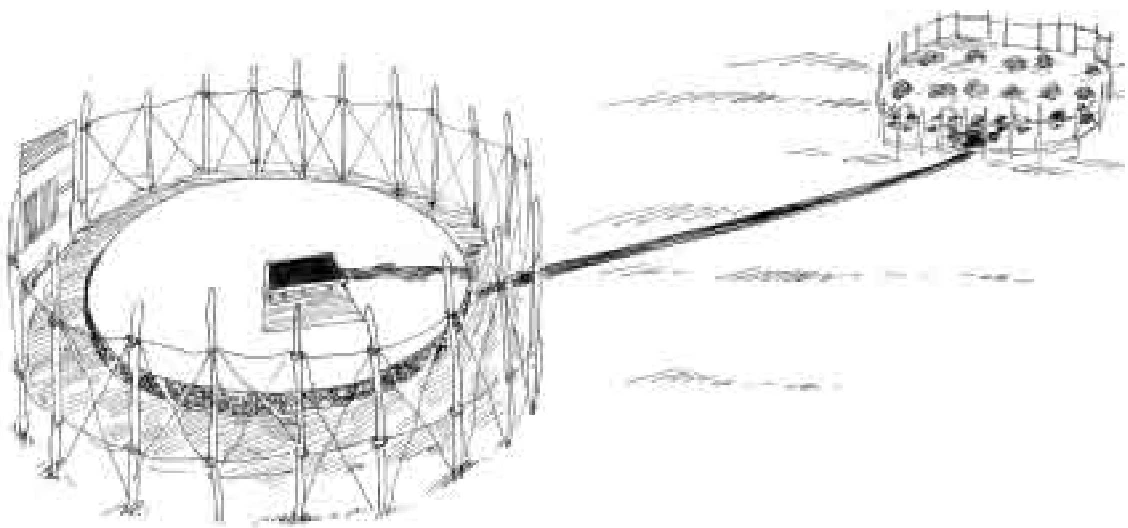
Confined aquifers are aquifers that are covered by a layer of dirt/rock layer, which stops water from seeping into the aquifer from the ground above. Water flows into these aquifers from further away (from where the protective layer doesn't exist).



Wells should be maintained and fenced to keep animals away. Animal faeces can leach into soil and contaminate wells.

How to avoid contamination of bucket wells

When using rope and bucket systems in schools, children must be very careful not to dirty the rope or bucket. The well should be covered and buckets should not be put on the ground. Animals and other sources of pollution should not be allowed close to or in the area upstream of the well. Efficient and groundwater source contamination free rope pumps are in common use throughout the world

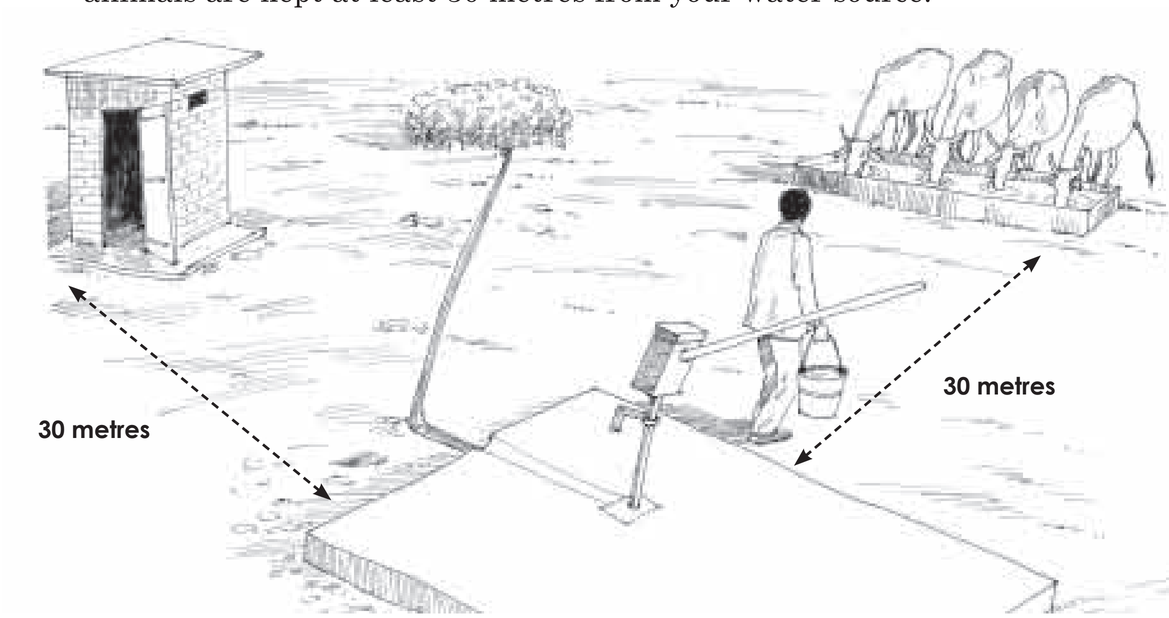


Run off from a well can be diverted for other uses, such as watering a small garden.

How to avoid contamination of hand pumps

Every handpump, must have an area of concrete (or another waterproof material) surrounding it to prevent pollution from seeping down the side of the casing and polluting the borehole water. This is also needed so that people drawing water do not have to walk through mud or stagnant water where they may pick up disease. Some good examples of how to minimise contamination process when accessing water at hand pumps are shown in the following figures:

Toilets should be at least 30 metres away from any water source and downstream of groundwater sources. Is is also important to make sure animals are kept at least 30 metres from your water source.



Animals and toilets should be kept at a minimum distance of 30 metres from a water source.

This water tank has a spill way. Excess water runs downhill into a section for livestock to drink from, away from the main water source.

6 Water treatment and keeping storages clean

Water Quality - The Hydrogen Sulphide (H_2S) Paper Strip Test

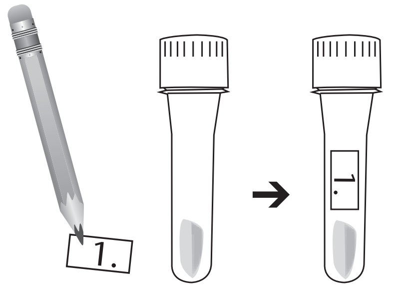
Use on rainwater from the roof of the school and your local drinking water supply.

The H_2S test is a simple test that will tell us if the water being tested is contaminated within three days (or less) depending on the amount of contamination. The test identifies if hydrogen sulphide (H_2S) is in the sample. H_2S is produced by faecal coliform bacteria. Faecal coliform is a type of bacteria that lives in the gut of humans and animals, if it is found in the water it means that harmful bacteria or viruses could be in the water. If the water being tested changes colour, this means that hydrogen sulphide is present, and also indicates the likely presence of bacterial contamination by faecal coliform in water. This also means that we need to take urgent action. The Hydrogen Sulphide- H_2S Paper Strip Test uses a paper strip to check for bacterial contamination in drinking water sources. The gas that coliform bacteria produces is called hydrogen sulphide (this is the gas that smells like rotten eggs). In order to check for the presence of coliform bacteria in water, a water sample is collected into the test bottle with the paper strip. Chemicals have been mixed into a solution and placed on the paper strip. The paper strip will react with the water sample by turning black if it comes into contact with hydrogen sulphide. If the water sample or paper-strip turns black, this indicates that hydrogen sulphide was produced. This means that it is likely that bacteria of faecal origin are present in the water- that is, the water has been contaminated with animal or human waste.

The advantages of the H_2S Paper Strip test are, that it is low-cost, does not require samples to be shipped or refrigerated, does not require a laboratory or expensive equipment, and most importantly, it is easy to understand and carry out in the field!

Read the information on the H_2S Paper Strip Test and then follow the instructions below.

How do we carry out the H_2S Paper Strip Test?

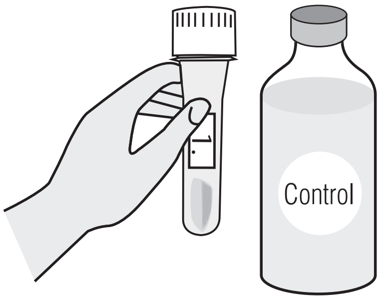


Step 1. Fill in the details

a. Fill in sample number and date on a sticker or sticker strip label and stick on the sample bottle.

b. Record your Sample number, date, time, location and description of the water sampled on the Result Record Sheet.

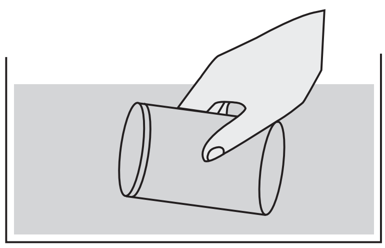
c. Record any other information e.g. turbidity, (how cloudy the water is), smell, source of pollution, faulty pump, etc.



Step 2: Collecting the Control

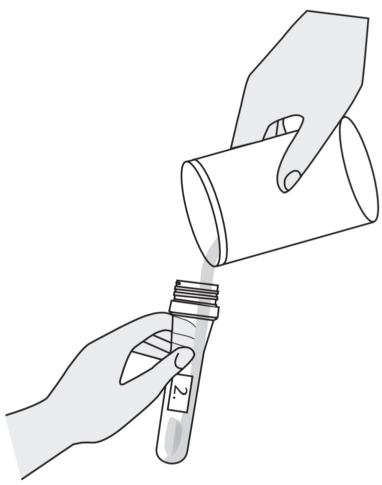
a. A control is used to compare the colour change in the test samples, and to ensure that the sample bottles are not contaminated before use. A control is a sample that you know for sure should not be contaminated. You need to collect the control only once for each monitoring programme.

b. Collect a sample of uncontaminated water e.g. distilled water, boiled water, bottled water, water treated with chlorine. This is to be used as the control. There may be a slight change in the colour of the sample to a pale yellow or light brown due to the colour change of the reagent. This is normal.



Step 3: Collecting the water sample:

Water from the roof



a. Collect water from the roof in the rainy season in a very clean container; make sure you don't collect rain water from the first week of the rainy season as this water is dirtier and is not normally collected for drinking;

b. Fill the test bottle carefully, this is because the test bottle will fill very quickly to the marked line and may overflow. If you do overfill the bottle, do not spill the water out and do not worry. Your result will still be valid.

c. Immediately close the sample bottle

d. You need to store the bottle in a dark place do not expose the bottles to direct sunlight. The suns rays can kill any bacteria.

Water from your town's drinking water supply

a. Before collecting the sample of drinking water, rinse the container several times.

b. Collect a sample of water from the container by filling the sample bottle up to the mark.

c. Close the sample bottle.

d. Place all the test samples in a dark place at room temperature.

e. Wash your hands!

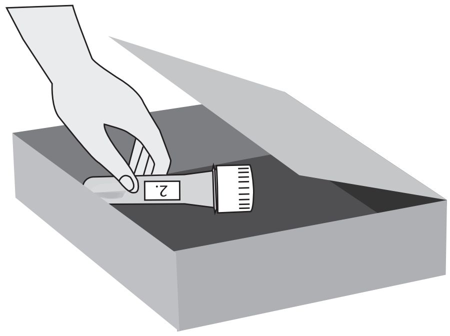
Step 4: Check your results

a. Check your test sample at the same time each day for 3 days for changes in colour.

b. Record the date and time for each observation on your recording sheet and your result for each day.

c. Compare the colour change with that of the control.

d. Use the H_2S Colour Code below to indicate the degree of contamination.



Step 5: What do your results mean?

Result Card H_2S Colour Code

(-) If there is no colour change this indicates that there is no hydrogen sulphide producing bacteria present.

(+) If the water has turned grey, there is a possibility that bacteria, is present in the water. Wait for a few days and check again.

(++) If the colour change is partially black then there is some amount of bacterial contamination in the drinking water. You may want to set up a regular monitoring programme and boil your drinking water!

(+++) If the paper strip and the water sample are noticeably black then there is a very high risk of bacterial contamination in the drinking water, therefore, it is not safe for drinking. Take action!

(+++) If there is a fast reaction—that is, the water solution and paper strip turns black overnight—that means that there is a high probability of bacteria present!

Water treatment

If your water supply is not fit for drinking without treating it first, then the following section will help you decide what treatment to use.

Boiling

Water can be treated by bringing it to the boiling point. Boil continuously for appoximately 1 – 5 minutes (3-5 minutes for the higher altitudes in Eritrea). However boiling might not be a good option for your school because:

- fuel is required (about 1 kilogram of wood is needed to boil one litre of water);
- water can be contaminated again when it has cooled.

Chlorine

If chlorine can be purchased in your area, then chlorination is a good option for treating water at your school. About 4 grams of active (available) chlorine are required for disinfecting one cubic metre (1000 litres) of water.

Step 1: preparing a stock solution of chlorine

One of the following products should be added to 1 litre of your water to obtain a 1% concentration of available chlorine:

Product: (percent concentration by weight of available chlorine)	Amount:
Calcium hypochlorite (70%)	15 g (I heaping tablespoon)
or Bleaching powder or chlorinated lime (30%)	30 g (2 heaping tablespoons)
or Sodium hypochlorite, supplied in liquid form (5%)	200 ml (I teacup)
or Sodium hypochlorite, supplied in liquid form (10%)	100 ml (I/2 teacup)
or Antiseptic solutions (bleach e.g. Javel, Milton) (I%)	Is itself a 1% stock solution

From WFP, UNESCO, WHO 1999. School Feeding Handbook. Rome, World Food Programme

Keep the stock solution in a cool place, in a closed container that does not let light in. As the stock solution becomes less effective with time, it should be used no later than one month after it has been prepared.

Step 2: using the stock solution to prepare safe water

To make sure it gets properly mixed, put the stock solution (in the amount

1. Excerpted from WFP, UNESCO, WHO 1999. School Feeding Handbook. Rome, World Food Programme.

shown below) into the container first and then add the water[1].

To purify this much water…	Use this much stock solution....
1 litre	0.6 ml or 3 drops
10 litres	6.0 ml or 30 drops
100 litres	60.0 ml or 4 tablespoons

From WFP, UNESCO, WHO 1999. School Feeding Handbook. Rome, World Food Programme

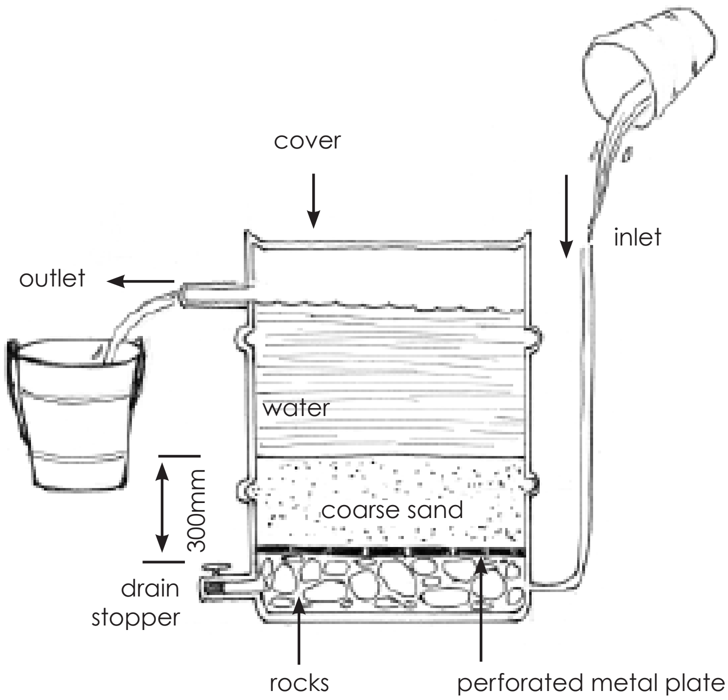
Filtration

If water sources are turbid (cloudy) and / or are of poor water quality, filtration methods are an effective way to improve water quality to make it fit for drinking. Filtration involves the removal suspended solids (e.g. silt, clay, mud) along with pathogens (all disease causing organisms).

There are various types of filters which not only reduce turbidity but also remove some diseases (e.g. bacteria, viruses).

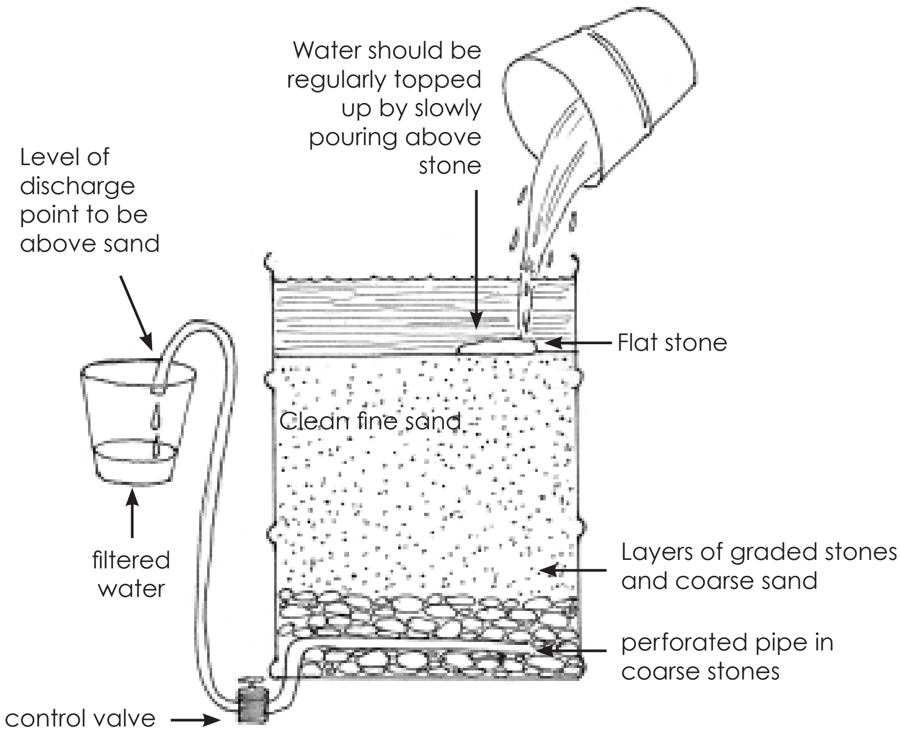
Homemade filters can be prepared as shown in the figures below illustrates packed drum filters. These filters use simple materials: a drum (e.g. an empty 200 litre oil drum), a pipe fitting, a tap, some gravel and sand. The slow sand filters are best suited for the removal of pathogens. If water sources are only turbid and water quality is relatively good, than the use of rapid sand filters can be used.

Suggestions are to use the following simple filtration systems:



A simple upward rapid flow sand filter

WATER AND ENVIRONMENTAL HEALTH AT LONDON AND LOUGHBOROUGH (WELL), Technical Brief 59: Household Water Treatment. http://www.lboro.ac.uk/well/



WATER AND ENVIRONMENTAL HEALTH AT LONDON AND LOUGHBOROUGH (WELL), Technical Brief 59: Household Water Treatment. http://www.lboro.ac.uk/well/

Keeping storages clean

If the water is stored at your school then it is very important to protect it from contamination. The containers used for storing water should be kept clean and rinsed regularly with boiling water or washed out with a bleach solution (one part liquid bleach to five parts of water).

After washing with a bleach solution, the surfaces should be rinsed with safe water. Cleaning and disinfecting (killing germs) of storages should be carried out at least once every six months. The containers should be provided with a tap and a cover to prevent insects, animals, dust and other possible contaminants from entering.

7 Appendices

Appendix A
Examples of water supply material costs

The following table provides a set of example costs for the most expensive components of the main school water supply options.

Please note that:

- these costs are for the materials only (unless stated otherwise); labour costs have not been included for all items due to their variability.
- Most of the costs are from 2006, as more recent costs were not available, and may have changed since.
- The reason why some of the prices are so high is due to many of the materials being imported from abroad. However if local materials can be used instead or if these materials are able to be manufactured in Eritrea, these costs will reduce. For example, the costs of the masonry reservoirs may, in time, reduce as more concrete is manufactured in Eritrea.

Your school should consider the overall costs of different options over long time period, such as 20 or 50 years. This way the ongoing costs (and savings) can be combined with the initial costs, to enable you to compare the total costs of the different options.

Table – Examples of water supply material costs

Materials: (excluding labour and ongoing costs)	Approx. Cost ($ US)	Approx. Cost (Nakfa)
Collapsible 1,500 litre plastic tank (= 7.5 fistos) (including taps) (4)	1,270(1)	19,110(1)
Collapsible 5,000 litre plastic tank (= 25 fistos) (including taps) (4)	1,450(1)	21,680(1)
Collapsible 10,000 litre Plastic Tank (= 50 fistos) (including taps) (4)	2,440(1)	36,650(1)
30,000 litre Plastic Tank (=150 fistos) (including taps) (4)	6,960(1)	104,390(1)
Underground masonry reservoir 60 m3 Capacity (3)	9,080(1)	136,200(1)
Above ground masonry reservoir 50 m3 capacity (3)	12,800(1)	192,000(1)
Borehole 50 meter depth (3)	9,200(1)	138,000(1)
Hand dug well 12 meter depth (3)	6,000(1)	90,000(1)
Water point at school (3)	2,360(1)	35,400(1)
Standard Tool kit for India Mark II Hand pump	120(1)	1,800(1)
India Mark II Hand pump (65mm) (up to 40m depth)	147(2)	2,205(2)
India Mark III Hand pump (65mm) (up to 40m depth)	166(2)	2,490(2)
Submersible Pump (Grundfos SP 17-13) 7.5 KW 3×380-415V 50HZ (45 – 75 m depth)	2,580 (1)	38,730(1)
Solar powered deep well hand pump (up to 45m)	5,000(1)	75,000(1)
Electric submersible pump, Flow rate 16m3/hr at 110m Head	3,500(1)	52,500(1)
Generator set 15kVA	5,540(1)	83,100(1)
Solar powered submersible pump, Flow rate 7.2m3/hr.	18,000(1)	270,000(1)
Elevated tank and stand (for storing groundwater)	2,000(1)	30,000(1)

– UNICEF 2006 material costs
– Water Resource Department, Ministry of Land and Environment, Eritrea Aug 2009
– Labour is estimated by UNICEF to be 70 % more than the cost of the materials i.e. × by 1.7
– These tanks can be ordered from UNICEF

Ongoing costs which may need to be considered include:

- water delivery costs (water is expensive),
- fuel or electricity,
- repairs and spare parts,
- water treatment.

Savings can include reductions in the amount spent on medicine, trucked water, or income earnt from selling excess water.

For example: the costs of trucking drinking water for 1 year, to a school with demands of 99,000 litres / day (i.e. 3 cups/d or 750ml/d for 500 students) is 69,300 N or $5,775 US. If children are bringing this same volume of water to school, which is being trucked to their homes, then their families will be paying for this same cost without the convenience of having the water available for the children at the school.

Appendix B

Symptoms (signs) of common hygiene related diseases:

Amoebiasis - range from mild diarrhoea to dysentery with blood and mucus in the stool.

Bilharzia - stomach pain, cough, diarrhoea, fever, tiredness, enlargement of both the liver and the spleen, genital sores.

Cholera - often mild or without symptoms, but sometimes it can be severe. Around one in 20 people with severe Cholera will have extreme watery diarrhoea, vomiting and leg cramps. Rapid loss of fluids leads to dehydration and shock. Without treatment, death can occur within hours. However most people do not become ill, even though the disease is present in their faeces for 7-14 days. In these cases it is difficult to distinguish it from other types of acute diarrhoea.

Dysentery - Diarrhoea containing mucus and blood.

Giardia - a small number of people get stomach cramps, explosive, watery diarrhoea, vomiting, bad smelling gas, and fever which may last for 3–4 days before going into a more serious phase. Most people slowly develop symptoms that return. Faeces become greasy and smelly but do not contain blood or pus. Watery diarrhoea may alternate with constipation. Upper stomach symptoms include nausea, becoming full quickly, bloating, egg-smelling gas, and acid indigestion, which may be become worse by eating.

Hepatitis A – in the early stages can be mistaken for the flu, but some people, especially children, show no symptoms at all. Symptoms typically appear 2 to 6 weeks, after infection. They can then return over the following 6-9 months and include fatigue, fever, abdominal pain, nausea, diarrhoea, appetite loss, depression, a yellowing of the skin or whites of the eyes, sharp pains in the right-upper quadrant of the abdomen, weight loss, Itching.

Rotavirus – ranges from stomach aches to severe diarrhoea and sometimes death through dehydration.

Shigella - diarrhoea, fever, nausea, vomiting, stomach cramps, flatulence, and constipation. Faeces may contain blood, mucus, or pus. In rare cases, young children may have seizures. Symptoms can take as long as a week to show up, but most often begin two to four days. Symptoms usually last for several days but can last for weeks.

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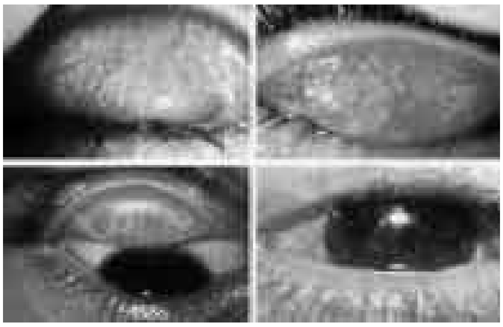


Trachoma - symptoms of conjunctivitis or irritation similar to "pink eye" (See photo). Can cause blindness if it is caught over and over again. Children may get white lumps in the under-surface of the upper eye lid. Follicles may also appear. Active trachoma will often be irritating and have a watery discharges. Further symptoms include: eye discharge, swollen eyelids (as shown), trichiasis (turned-in eyelashes), swelling of lymph nodes (in front of the ears), corneal scarring, and further ear, nose and throat complications

Children with signs of having the above illnesses should be given medical treatment as soon as possible.

Appendix C
Roof rainwater harvesting

This section will help you determine whether the setting up of a rainwater harvesting system is worthwhile, based how often and how much water it will provide. This section provides a set of calculations you can make to assess the water collection potential of rainwater harvesting.

What to do:

Step 1: Calculate rainfall harvest potential for your school

Step 2: What is the total surface area that can collect rainfall?

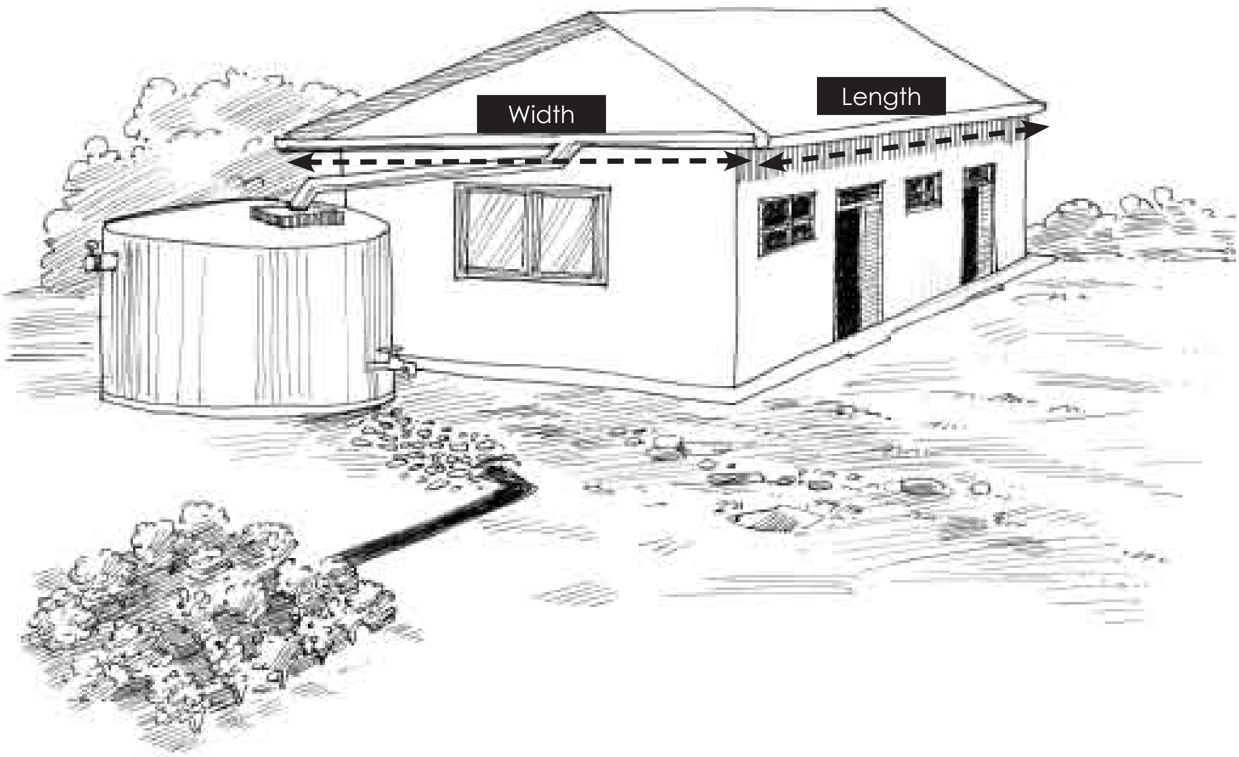
The total rainfall harvesting area (Area) of a number of rectangular blocks of classrooms is calculated as:

Area (m^2) = block width (m) × length (m) × no. blocks used to collect rain

(See diagram below, the slope of the roof doesn't affect the surface area where rain falls).

Example: If the school has two blocks of class rooms, which are both 10m wide and 28m long then:

Area = 10 × 28 × 2 = 560m^2



Harvesting area for school with only one block of classroom used to harvest rainwater

Step 3: What is the maximum volume of rainfall the school roof could collect?

Once the area of roof catchment has been determined and the average rainfall is known the maximum amount of rain that can be collected (in a year with average rainfall) can be calculated to be:

Rainfall collected (litres) = efficiency (%) x rainfall (mm) x roof Area (m^2)

The efficiency of rainwater collection depends on the materials used[1], the construction, maintenance and the total rainfall. A commonly used efficiency figure is 0.8 (i.e. 80 % efficiency). However, rainfall intensity should also be considered, as the capacity of roof rainwater harvesting systems may overflow during high intensity rainfall events, therefore further reducing the efficiency.

Example: If the average rainfall is 400mm/year and the roof area is 560m^2

Rainfall collected = 0.8 × 400 × 560

= 179,200 litres

Step 4 - What volume of water is needed at your school?

We will call this volume the demand. Assuming that the minimum volume required for a students to drink and to wash their hands with (including water for washing school toilets) is 2 litres/student/day then the total demand is:

Demand (litres/year) = no. students x 2 litres/day x no. school days/ year

Note that 2 litres is the same as 8 small cups of water (250ml each) and that children may need more than this in very hot and dry areas.

1 If cement tiles are used as roofing material, the year-round roof runoff coefficient is some 75%, while clay tiles collect usually less than 50% depending on the production method. Plastic and metal sheets do best with an efficiency of 80-90%.

If you would like extra water for watering gardens at your school and can afford to collect more and / or have larger water storage, the volume of water required to water a school garden / shade plants should be included into the total demand.

> *Example: If the maximum rain water collected was 179,200 litres/ year and the yearly demand is the same or greater than this, then you will need a water storage that can hold at least 179,200 litres.*

What if the maximum volume harvested is less than the annual water demand?

If the maximum volume of rainfall able to be harvested is less than the school's annual water demand then either:

- the harvesting area will need to be increased;
  and / or
- the demand will need to be reduced;
  and / or
- another source of supply will be required for the end of the dry season/s.

If the catchment area cannot be extended, one option you could take is to limit students to using approximately one litre per day. For example, asking them to bring water from home for drinking and only using the school water supply for handwashing (and for toilet cleaning), i.e. using only approximately one litre per day.

> *Example: If 500 students come to the school each day and they are at school for 6 days a week for 44 weeks a year, limiting demand to approximately 1 litre /day:*
>
> *Demand = 500 × 1 × (6 × 44) = 132,000 litres*
>
> *The demand can be supplied as it is now less than the total rainfall collected (179,200 litres/year)!*

Step 5 - What size water storage will you need?

If your yearly demand is the same or larger than the rainfall able to be collected:

Then you will need a storage container big enough to store all of the water collected over the whole year.

Example: If the maximum rain water collected was 179,200 litres/year and the yearly demand is the same or greater than this, then you will need a water storage that can hold at least 179,200 litres.

If your yearly demand is less than the rainfall able to be collected:

Then you will not need to collect all of the rainfall which falls on the school's roof. The storage only needs to be large enough to ensure that the required volume of water that can be collected by the storage will provide enough water in periods of no rainfall.

The simplest way to determine what size storage you need is to assume that, at the start of the wetter months, the storage is empty. If so, the size of your storage should be the same as the total volume of water required at the school over the longest period of no rainfall.

For example, if there is only one wet season and we assume that the storage is empty at the start of the wet season, then the volume of storage will need to be equal to the total rainwater demands over the dry season (which we will call Demand (dry)) i.e.:

Minimum storage volume = the total demand over the dry season = average demand / month × no. dry months.

If after any month the volume captured exceeds the volume of the storage then water will be lost to overflow.

Example: If the wet season is normally for half the year, all of the rainfall occurs in the wet season and the monthly demand is limited to 11,000 litres (1 litre / 500 children /day), then Demand (dry) = 11,000 litres × 6 months

= 66,000 litres
Minimum storage volume = 66,000 litres
Therefore the storage should be about 70,000 litres or 70 m^3.

1 litre = 1000 ml (millilitre) 1000 litres = 1 m3 (cubic meter)

Glossary

Amoebiasis - an infection or disease caused by amoebas (type of pathogen). Amoebiasis is usually transmitted through germs from faeces on hands touching anything that goes in the mouth.

Aquifer - An underground layer of porous stone, earth or gravel containing water.

Bacterial - Relating to or caused by bacteria.

Bilharzia - A disease caused by a parasite. Symptoms include: stomach pain, cough, diarrhoea, fever, fatigue, enlargement of some internal organs, genital sores.

Cholera - An infectious disease caused by eating food or drinking water contaminated with containing the bacteria. It causes diarrhoea, abdominal cramps, vomiting and dehydration.

Conjunctivitis - Inflammation of clear membrane that lines the inner surface of the eyelid and covers the front part of the eyeball. Often called pinkeye.

Constipation - long delayed or infrequent passage of dry hardened faeces.

Contamination - to introduce germs or dirt.

Corneal scarring - describes scarring of the curved, transparent covering on the front of the eye.

Defecating - is the final act of digestion by which solid, semisolid or liquid waste material (faeces) are eliminated from the digestive tract via the anus.

Diarrhoea - is the condition of having frequent loose or liquid bowel movements. Acute diarrhoea is a common cause of death in developing countries and the second most common cause of child deaths worldwide. The loss of fluids through diarrhoea can cause severe dehydration which is one cause of death in diarrhoea sufferers. Along with water, sufferers also lose dangerous amounts of important salts, electrolytes, and other nutrients.

Dysentery - is a disorder of the digestive system that results in severe diarrhoea containing mucus and blood in the faeces. If left untreated, dysentery can and usually will be fatal.

Faeces - is a waste product from a peoples/animal's digestive tracts expelled through the anus during defecation.

Follicle - A small cavity in the skin for example where hair grows.

Hepatitis A (formerly known as infectious hepatitis) is an acute infectious disease of the liver caused by the hepatitis A virus (HAV), which is most commonly transmitted via contaminated food or drinking water

Hygiene - refers to behaviour that maintains health and healthy living.

Mucus – a slippery and somewhat

sticky fluid secreted by the glands in mucous membranes. Mucus lubricates and protects the mucous membranes.

Parasites - An organism that lives on or in an organism of another species, known as the host. It gets nutrients from the host.

Polio - is a serious viral disease spread from person to person, through eating food or drinking water contaminated with faeces from an infected person.

Rotavirus is one of several viruses that cause infections commonly known as stomach flu, despite having no relation to influenza. It is the leading single cause of severe diarrhoea among young children. Rotavirus is transmitted by the faecal-oral route. Symptoms include severe diarrhoea and sometimes death through dehydration.

Seizures - a sudden attack, such as epilepsy.

Shigella - is a bacteria closely related to Escherichia coli and Salmonella. Shigella causes disease in primates, but not in other mammals. During infection, it typically causes dysentery.

Spleen - an organ in the lymphatic system, in the upper left part of the abdomen, that filters out harmful substances from the blood. The spleen also produces white blood cells, removes worn-out red blood cells from circulation, and maintains a reserve blood supply for the body.

Symptom - A sign of disorder or disease.

Trachoma - Eye infection transmitted from eye to eye by insects and through hand-to-eye contact. Trachoma is also spread by close contact between family members or among schoolchildren. Other causes include poor cleanliness due to lack of water. People in hot, dusty climates are at greater risk.

Typhoid - is an illness caused by a type of bacteria. It is transmitted by food or water contaminated with faeces from an infected person.

Viruses - Simple ultramicroscopic (20 to 300 nm in diameter) non-living particles that often cause disease.

Water table - The level, underground, below which the ground is saturated with water.

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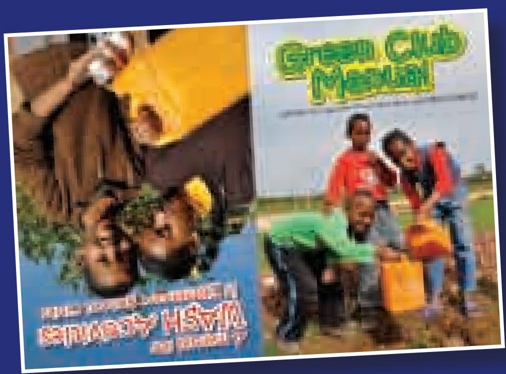
Overview of the Resources

The Environmental Education Curriculum Companions for elementary schools provide practical examples of how Environmental Education can be integrated across the subject areas of:

- English
- Science
- Social Studies



A manual has been developed to provide teachers with practical ideas for extra-curricular activities, including suggested activities for Green Clubs and Health Clubs.

A resource has also been developed to support the School Directors, School Staff and PTA about ways in which they can contribute to ensuring their school operates as a sustainable school environment.

There are additional resources provided in the Toolbox which includes posters, information cards and reference materials.