Water Harvesting and Conservation

Volume 2 Part 2: Facilitation and Assessment Guide for the Technical Manual

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WHC Technical Manual

Phila Mejane
"Desolation from climate change"

Facilitation and Assessment Guide

Contents

1. Introduction

This WHC Facilitation and Assessment Guide (FAG) forms part of the WHC Comprehensive Learning Package. The FAG is designed as a guide for educators at any learning institution who present the **WHC Technical Course** to students. In the Technical Course, students are **equipped with the technical knowledge and skills** needed to help resource-poor farmers select and implement suitable and productive rainwater harvesting systems.

In the second part of the course (the Facilitation component), students are taught a **participatory approach to group facilitation** which follows an **action learning cycle** and is in line with current thinking around the role of facilitators and the facilitation process, particularly in relation to community development, where the role of the facilitator is to guide groups through interactive and participatory learning processes. ***It is therefore essential that you, as the educator, facilitate both parts of this course in a participatory manner and provide students with ongoing opportunities to experience action learning (i.e. learning through experience and critical reflection of that experience).***

The course itself, and the guidelines and suggestions provided in this FAG, have been designed to help you do this. For example, many learning activities have been included which provide students with the opportunity to experience new things and then critically reflect on and learn from these experiences. At the same time, you as an educator must also ensure that you demonstrate strong facilitation skills when presenting the course.

The content of this FAG includes:

1. A suggested course structure.
2. Lesson guidelines and suggestions for educators.
3. Activity guidelines.
4. "Test Yourself" questions and answers.
5. Assessment guidelines and rubrics.
6. Worksheet and handouts.
7. Additional tools for educators.

2. Suggested Course Structure

The way in which this course is presented will vary between learning institutions, particularly in relation to how time is allocated (e.g. the number of lessons that are presented over a course or module, the length of each lesson, the amount of student-facilitator contact time that takes place, the time allocated to group work, individual work and self-study, etc.).

The course structure presented in this section is structured around 20 lessons, each of which should include an ***average*** of 2.5 hours of student-facilitator contact time. Many lessons, however, require the allocation of ***additional*** time for group or individual work, longer activities, practicals and/or assessments. The course structure will thus need to be adapted to meet the requirements of your learning institution, as well as your own facilitation and presentation plans.

The main focus of this course is water harvesting and conservation (WHC), so it is important that sufficient time is allocated to the ***last chapter of the Technical Manual*** (Chapter 7: WHC Methods). This chapter contains practical activities which require a lot of time input from students, who are required to plan and implement a range of WHC methods at various sites (e.g. in home gardens or on farming sites which are linked to your learning institution). It is ideal for the class to have one main worksite where all of the activities can be done (see Section 3 for more information regarding the site/s).

SUGGESTED COURSE STRUCTURE

Lesson	Chapter	Content to Cover
Lesson 1	Chapter 1: Introduction to WHC	• Ch. 1 (all)
Lesson 2	Chapter 2: Water in the World	• Ch. 2 (all)
Lesson 3	Chapter 3: Systems	• Ch. 3 (all)
Lesson 4	Chapter 4: Water in the Landscape	• Ch. 4 (all) *This may need to be an extended lesson to have enough time for all of the activities. Note, however, that the 4 hours assigned to Activity 7 is for completion of the entire activity (including written observations of the terrarium over the period of a week), and Activity 8 can be assigned for homework.*
Lesson 5	Chapter 5: Soil	• Ch. 5, Section 1-8 *This may need to be an extended lesson in order to have enough time for all of the activities.*

Lesson 6	Chapter 5: Soil	• Ch. 5, Section 9-11 *Additional time will be needed for Activity 16: Soil Profile.*
Lesson 7	Chapter 6: WHC Planning	• Ch. 6 (all)
Lesson 8	Chapter 6: WHC Planning	• Ch. 6 (all)
Lesson 9	Chapter 7: WHC Methods	• Ch. 7, Section 1 & 3 (Trench Beds)
Lesson 10	Chapter 7: WHC Methods	• Ch. 7, Section 2 & Section 4 (Diversion Furrows and Mulching)
Lesson 11	Chapter 7: WHC Methods	• Ch. 7, Section 5 (Stone Bunds)
Lesson 12	Chapter 7: WHC Methods	• Ch. 7, Section 6 (Tied Ridges)
Lesson 13	Chapter 7: WHC Methods	• Ch. 7, Section 7 (Swales)
Lesson 14	Chapter 7: WHC Methods	• Ch. 7, Section 8 (Terraces)
Lesson 15	Chapter 7: WHC Methods	• Ch. 7, Section 9 (Fertility Pits)
Lesson 16	Chapter 7: WHC Methods	• Ch. 7, Section 10 (Greywater Harvesting) • Ch. 7, Section 11 (Roofwater Harvesting)
Lesson 17	Chapter 7: WHC Methods	• Ch. 7, Section 11 (Roofwater Harvesting)
Lesson 18	Chapter 7: WHC Methods	• Ch. 7, Section 12-14 (Ploegvore, Dome Water Harvesting and Saaidamme)
Lesson 19	Chapter 7: WHC Methods	• Open lesson
Lesson 20	Chapter 7: WHC Methods	• Open lesson

NOTE: Lessons 19 and 20 have been left as "open" lessons, which means that they can be placed *anywhere* in the course structure (e.g. between Lesson 4 and Lesson 5). The open lessons can be used for any purpose, for example to cover, revise or practice more complex content, or to conduct longer activities, site visits, practicals, or assessments.

3. Lesson Guidelines and Suggestions

This section contains some basic guidelines, ideas and/or suggestions for each lesson in the course structure provided in Section 2. Please note that following these guidelines is ***optional***, and that you are free to structure and present the course in a different manner if you prefer. What is important is that all of the content is covered in a logical and sequential order, and that you present (i.e. facilitate) the course in a participatory manner.

It is important to read through the Activity Guidelines (Section 4 of this guide) when preparing your lessons so that you fully understand what each activity involves and can plan your lesson time accordingly.

Please note that some of the site visits presented in these lesson guidelines are *suggestions only* and do not form part of the course requirements. While you are encouraged to conduct as many of these *additional* excursions as you can, you will also need to weigh up their benefits versus their limitations (e.g. time and financial implications).

The selection of a practical site (or sites) for the **compulsory implementation of selected WHC methods** (see Chapter 7, Activities 20-24) needs to be done with careful consideration, as students will need to spend a lot of time at the site/s over the duration of this course. The main factors which should be taken into account include:

1. Distance to the site from the learning institution, and what this distance means in terms of transport time, transport cost and other practicalities (e.g. vehicle and driver availability).

2. The suitability of the site in relation to the methods which need to be implemented. This includes:
   - suitability for growing vegetables (**or** a site with an established vegetable garden to which WHC methods can be added);
   - some flat land *and* an area with a degree of slope;
   - the availability of implements such as spades, picks, forks, wheelbarrows, etc. (it is ideal if implements can be stored at the site, rather than transported there each time);
   - the availability of natural resources such as mulch, rocks and stones, seedlings, etc.
   - shade (e.g. under a tree, a tent, a shed or any covered area); and
   - shelter which can be used in the event of rain (e.g. a tent, shed or covered area).

The ideal site would be a farming site that adjoins and is linked to your learning institution.

3.1 Lesson 1

Content to cover:

- Chapter 1 (all)

Materials needed:

- DVD: ***Scoping Study on Indigenours Water Harvesting and Conservation Practices (Water Research Commission)***
- TV and DVD player

1. Provide a brief overview of the course.

2. Provide a brief overview of the lesson.

3. Show the DVD ***Scoping Study on Indigenours Water Harvesting and Conservation Practices (Water Research Commission).*** Stop the DVD in various places, discuss what has been shown and make sure that students understand the content. [**Note**: Throughout the course you can show and discuss relevant sections of the DVD again, as this will help increase the students' understanding of WHC and various WHC methods.]

4. Facilitate a discussion on the words ***harvesting*** and ***conservation*** and make sure that students understand what both terms mean. Then, ask the following questions: What is *water harvesting and conservation*? Is the concept of WHC new to you? Do you know anybody who practices WHC? How do they do this? Why do some people harvest and conserve water?(some of these questions are from **Activity 1**).

5. **Activity 1: Group Discussion** (refer to Section 4 for activity guidelines). You can tell students to omit number 3 of the activity if these questions have already been discussed as a class.

6. If time permits, let students read about Phiri Maseko in class, ***or*** outline the case study verbally and then discuss Phiri's farm and WHC system in relation to the 8 WHC principles.

7. **Optional Activity: Field Trip**
   Arrange a visit to a site where WHC is practiced. Explore and discuss the WHC system in detail.

3.2 Lesson 2

Content to cover:

- Chapter 2 (all)

Materials needed:

- glasses (3 per group)
- 1 litre bottles or containers (1 per group plus an additional one)
- water
- measuring jug
- eyedropper

- climatic maps and/or maps showing rainfall data for an area or different areas (optional but recommended)

1. Revise lesson 1.

2. Provide a brief overview of this lesson.

3. **Important**: Much of the information in Chapter 2 is *contextual*. In other words, it is background information which is interesting and relevant to the topic of water but not directly relevant to the main focus of this course, and as such it does not have to be covered for assessment purposes. You can go over the contextual information in class if time permits, but it is more important to focus on the information and activities which are directly relevant to the course.

4. Go through Section 1 (Introduction).

5. Before doing **Activity 2**, divide the class into small groups. Give **each group** 3 glasses and a 1-litre container filled with water. Tell groups that the litre of water represents all of the water that exists in the world (salt, fresh, and drinking). Groups must then discuss and estimate how much of each type there is, and divide their litre of water between the three glasses accordingly (one glass for salt water, one for fresh water, and one for the amount of drinking water that they estimate is available to us).

6. **Activity 2: A drop in the bucket** (refer to Section 4 for activity guidelines).

7. Get students to brainstorm reasons for the global water crisis ***or*** begin a list on newsprint and add to it as the lesson progresses. Discuss each reason briefly.

8. Section 3-3.3 is contextual information and does not have to be covered in class or learned for assessment purposes. You can, however, go through these sections briefly if time permits.

9. Go over Section 4.1.

10. **Activity 3: Map Work** (refer to Section 4 for activity guidelines).

11. **Activity 4: Rainfall Information** (refer to Section 4 for activity guidelines).

12. Sections 4.2-4.7 is contextual information and does not have to be covered in class or learned for assessment purposes. You can, however, go through these sections briefly if time permits.

13. **Activity 5: Group Discussion** (refer to Section 4 for activity guidelines).

3.3 Lesson 3

Content to cover:

- Chapter 3 (all)

1. Revise Lesson 2.

2. Provide a brief overview of this lesson.

3. Revise the meaning of the word ***system***, which was introduced in Lesson 1, Activity 1 and go over the introduction. Get students to brainstorm other types of systems which are familiar to them.

4. Introduce and discuss the term ***ecosystem*** and briefly look at the 6 core principles of ecology which encapsulate the characteristics of living, open systems (i.e. networks, nested systems, cycles, flows, development and dynamic balance).

5. Go over Section 2.1 and then examine an ecosystem in the area (e.g. in the grounds of the learning institution. Help students to identify different components of the ecosystem. See if you can identify any links in the food chain/s of the ecosystem you examine (e.g. look for insects, spiders, birds, etc. and talk about what might eat what).

6. Section 2.2 is contextual information and does not have to be covered in class or learned for assessment purposes. It would be useful, however, to go through these sections in class if time permits,

7. Discuss the term ***biodiversity*** and how biodiversity is used as a measure of the health of an ecosystem.

8. Brainstorm and briefly discuss things which can threaten or disturb ecosystems (students can read the detail in Section 2.3 for homework).

9. Discuss ***farm systems*** and different types of ***farm resources*** (Section 3).

10. **Optional Activity: Field Trip**
    Arrange a field visit to a local farm of any size, and let students examine the farm system in depth.

11. Introduce and discuss the concept of ***sustainability*** and look at the four processes which, if they are functioning properly, indicate a sustainable system in which soil and water is naturally conserved (i.e. energy flow, nutrient cycling, the water cycle and ecosystem dynamic.

12. Examine the Integrated Systems Approach and LEISA as two farming approaches which apply the principles of sustainable farming.

13. Assign Activity 6 for homework, or give students time to work on it in pairs or small groups.

14. Read through **Activity 7: Make your own terrarium** with students, as they will be doing this activity during lesson 4. You need to decide ahead of time whether students will do this activity alone, in pairs or in small groups; if they are going to work in pairs or groups, let them pair or group up now. If ***you*** are going to provide some of the materials for this activity, make sure that students know exactly what you will be providing and what they must bring to class, and give them a few minutes to decide who will bring what.

3.4 Lesson 4

Content to cover:

- Chapter 4

Materials needed:

- DVD: ***Water is Life: A South African Journey (WRC)***
- TV and DVD player
- copies of **Handout 2: Water Pollution** (1 copy / student)
- overhead transparency (Figure 4.5) and overhead projector
- a large, clear plastic container (e.g. an empty 2 ℓ or 5 ℓ plastic bottle)
- a marker and scissors
- soil, sand and pebbles
- compost
- seeds and small plants
- two sponges of the same size
- a clear plastic container
- a watering can ***or*** a plastic container with small holes in the bottom
- water

This may need to be an extended lesson to have enough time for all of the activities. Note, however, that the 4 hours assigned to Activity 7 is for completion of the entire activity (including written observations of the terrarium over the period of a week), and Activity 8 can be assigned for homework.

1. Revise Lesson 3.

2. Provide a brief overview of this lesson.

3. If you assigned Activity 6 for homework, go over the answers in class or take in their assignment reports for assessment.

4. Show the DVD ***Water is Life: A South African Journey***. Stop the DVD in various places, discuss what has been shown and make sure that students understand its content.

5. **Activity 7: Make your own terrarium** (refer to Section 4 for activity guidelines).

6. Introduce and discuss **water catchments** (Section 2). Take the class outside, examine at least one nearby building and discuss it in relation to water catchments. Identify high and low points of the building and the land surrounding it, and try to determine where water will flow when it rains. Look at nearby features and discuss how they might impact on water flow. Talk about water catchments and what you have just examined in relation to Principles 1 and 2 of WHC.

7. **Activity 8: Water Catchments** (refer to Section 4 for activity guidelines). *Assign this activity for homework. Provide students with any additional instructions you may have.*

8. Work through Sections 3 (Surface Water) and 4 (Wetlands).

9. **Optional Activity: Field Trip**
   Arrange a field visit to a nearby wetland. Explore and examine it carefully, making sure that no damage is done to the area.

10. Work through Section 5 (Groundwater).

11. **Activity 9: Group activity** (refer to Section 4 for activity guidelines).

12. Give each student a copy of **Handout 2: Water Pollution** and examine it briefly. Students can read through the handout at home. (Note: the information is contextual and ***not*** for assessment purposes).

13. **Activity 10: Pollution** (refer to Section 4 for activity guidelines).

3.5 Lesson 5

Content to cover:

- Chapter 5, Section 1-8

Materials needed:

- sponge and plastic tub with water
- empty plastic container with narrow opening (e.g. dishwashing liquid container)
- magnifying glasses (a few)
- 3 samples of soil aggregates (refer to Technical Manual, Section 6: Soil Structure)
- 3 buckets/packets of soil, each from a different place (ideally sand, silt and clay)
- glass bottles for a bottle test (one bottle per group) and water
- newspaper or sheets of plastic (to protect working surfaces from soil)
- broom and dustpan
- small handspades (or other objects to assist with digging small holes in hard soil)

- **Worksheet 1: Soil Textural Triangle** (see 12 below – 1 copy per student)

This may need to be an extended lesson to have enough time for all of the activities, particularly if you do Worksheet 2 with your class.

1. Revise Lesson 4.

2. Provide a brief overview of this lesson.

3. Work through Section 1 (Introduction) and briefly discuss the role that soil plays to slow, spread and infiltrate the flow of water (WHC principle 4).

4. Discuss the five factors involved in soil formation (Section 2). Divide students into groups and give each group a piece of newspaper, a handful of soil and a magnifying glass. Let each group examine their sample with the magnifying glass and write down what they observe (e.g. insects, organic matter, debris, etc.). Groups can share their observations with the rest of the class.

5. Work through Section 3 (Soil Composition) and the beginning of Section 4 (Soil and Water).

6. **Activity 11: Experiment A** (refer to Section 4 for activity guidelines).

7. Continue working through Section 4. Make sure students understand how plants growing in soil link the water in soil to the atmosphere (i.e. the Soil-Plant-Atmosphere-Continuum).

8. **Activity 12: Experiment B** (refer to Section 4 for activity guidelines).

9. **Activity 13: Experiment C** (refer to Section 4 for activity guidelines).

10. Work through Section 5 (Soil Texture).

11. **Activity 14: Experiment D** (refer to Section 4 for activity guidelines).

12. If your students have relatively good mathematical and conceptual skills, you can hand out **Worksheet 1: Soil Textural Triangle**. Work through the information together and let students do the Activity (Textural Triangle).

13. Talk about **compaction** and what happens when it occurs.

14. Work through Section 6 (Soil Structure). If time permits, take students outdoors and let them examine the soil in a few different places. Help them to identify the structure of the soil in each place. Discuss how certain soil structures can lead to erosion, and which structures are conducive for planting.

15. **Activity 15: Group Activity** (refer to Section 4 for activity guidelines).

16. Work through Section 7 (Soil Horizons) and Section 8 (Soil Depth and Rooting Depth).

3.6 Lesson 6

Content to cover:

- Chapter 5, Section 9- 11

Materials needed:

- spades and picks (at least one of each per group)
- soil pH test kits (available from nurseries/garden centres/hardware shops)
- soil samples for pH tests

*Additional time will be needed for **Activity 16: Soil Profile**.*

1. Revise Lesson 5.

2. Provide a brief overview of this lesson.

3. Go over Section 9 (Soil Profile) and discuss reasons *why* a person might want to dig a soil pit and examine the soil profile / How can the information obtained be useful? *Possible reasons:* to see the depth of topsoil that is available for plant growth; to observe the plant rooting depth; to identify any hard horizons; to investigate if there is a shallow water table, etc.).
4. **Activity 16: Soil Profile** (refer to Section 4 for Activity guidelines). This activity can also be done at the end of the lesson because it involves going to a site where soil pits – which are fairly large – can be dug.

5. Work through Section 10 (Soil Fertility). Note: you do not need to spend a long time on the information presented in this section as it is contextual and not for assessment purposes. It is, however, necessary to know how to conduct a soil pH test (see Activity 17 below).

6. **Activity 17: Conduct a Soil pH Test** (refer to Section 4 for Activity guidelines).

7. Work through Section 11 (Soil Erosion).

8. If time permits, let students walk around outside and see if they can identify any places where soil erosion has taken place. Discuss the *type* of erosion which has occurred, and try to identify *reasons* for the erosion.

3.7 Lesson 7

Content to cover:

- Chapter 6 (all)

Materials needed (*PER GROUP*):

- protractors
- 2 x 2 m long poles (e.g. droppers)
- 1 x 1.2 m pole
- wire or strong cord to connect the poles (about 2 m) ***or*** hammer and nails
- light cord or string to attach the weight (1 m)
- weight (e.g. a glass bottle or stone)
- 2 x long poles which are exactly the same height (1.5 m or 2 m)
- string or fishing line to tie between the poles (about 11 m)
- a knife (to cut a notch in the poles)
- a line level (used by builders and available in hardware stores)

Other materials needed:

- 6 short sticks (about 15 cm long)

Although none of the items listed above is particularly expensive (and some – such as knives and empty glass bottles – do not need to be bought), you will need to have budget allocated in order to acquire them as they are needed to make A-frames and line levels, both of which are essential for this course.

1. Revise Lesson 6.

2. Provide a brief overview of this lesson.

3. Begin the lesson by asking the following questions:

(i) What do plants need in order to grow?
(ii) What do you need to take into consideration when deciding on a site for a vegetable garden?

Write down any answers given and discuss them in relation to Chapter 6, Sections 1-4.

4. Take students outside and help them work out the aspect of different sites in the area, using Method 1 (see Section 4.1). Select two different places where you can use Method 2, clear the ground and put the first two sticks in the ground. You will need to return to these later in order to complete the exercise (i.e. later you will need to put the third stick in the ground, mark out the "sunline" and use thi s to work out the aspect of the sites).

5. Work through Section 4.2 (Slope). Students who are not mathematically inclined are likely to need a fair amount of assistance when going through this section. Divide students into groups and let them practice measuring angles with a protractor. Explain that they will be making two measuring instruments (i.e. A-frames and line levels) which they can use to measure the percentage of a slope.

6. Discuss elevation and contour lines (Section 4.3). Explain that the measuring instruments they will be making can also be used to mark out contour lines.

7. Briefly work through Section 7 (Organic Material) and Section 8 (Easy Measurements).

8. Introduce A-frames and line levels and explain once again what they can be used for (i.e. to measure the percentage of a slope, and to mark out contours).

9. Divide the students into small groups and get each group to construct and calibrate an A-frame by following the instructions in Section 5 of their manuals (this is step 1 & and step 2 of Activity 18). Provide assistance only if/when necessary.

10. Get each group to construct a line level by following the instructions in Section 6 of their manuals (this is step 1 of Activity 19). Provide assistance only if/when necessary.

11. Store the completed items in a safe place so that they can be used during the next lesson. Groups will need to mark their items so that they are easily identifiable.

3.8 Lesson 8

Content to cover:

- Chapter 6 (Activity 18 & Activity 19)

Materials needed:

- hammers
- rulers/tape measures
- pegs/stakes/rocks or large stones

1. Revise Lesson 7.

2. Provide a brief overview of this lesson.

3. Arrange a site visit so that students can complete Activities 18 and 19, unless they can be done on the grounds of the learning institution.

4. **Activity 18: A-Frames** (refer to Section 4 for activity guidelines).

5. **Activity 19: Line Levels** (refer to Section 4 for activity guidelines).

3.9 Lesson 9

Content to cover:

- Chapter 7, Section 1 (Intro) & Section 3 (Trench beds)

Materials needed:

- Student guidelines/instructions for their activity reports (Activity 20) – refer to Section 4.7 for details).

1. Revise Lesson 8.

2. Provide a brief overview of this lesson.

3. Arrange to visit a farm or garden which has trench beds. Examine the beds carefully, and ask the gardener or farmer to explain how s/he constructed them, and why. Encourage students to ask further questions about the trench beds, as well as about any other farming or WHC methods which are used on the site. You can also use the opportunity to let students examine the farm or garden *system* as a whole.

4. Read through **Activity 20** with students. Let them form their groups. Discuss the activity generally and hand out ***your*** guidelines/instructions for their activity reports (see Section 4.7 for details pertaining to these guidelines).

5. Discuss and emphasise the importance of **planning** for this activity (as well as for all of the other activities in this chapter). Refer to Section 4.7 for things that groups need to consider when planning, and give groups time to begin their planning process in class.

   Inform students that they will learn about diversion furrows and mulching (both of which form part of Activity 20) before they begin the activity. In the meantime, they can read through the relevant sections in their manuals (Sections 2 and 4) to assist with their planning (e.g. to see if there are any additional tools or materials they will need).

3.10 Lesson 10

Content to cover:

- Chapter 7, Section 2 & Section 4 (Diversion furrows and Mulching)

Materials needed:

- Students must bring all of the materials they need for Activity 20 (Trench Beds).

This lesson will probably need to be extended and students will need to be on site for Activity 20.

1. Revise Lesson 9.

2. Provide a brief overview of this lesson.

3. Work through Section 2 (Diversion Furrows) and Section 4 (Mulching).

4. **Activity 20: Trench Beds** (refer to Section 4 for activity guidelines).

   Completion of this activity is possible if groups are well-planned and well-organised, and if the ground is not too hard for digging. When constructing their beds, let students refer to their manuals as much as possible and only provide advise or input if it is absolutely necessary.

3.11 Lesson 11

Content to cover:

- Chapter 7, Section 5 (Stone bunds)

Materials needed:

- Materials for Activity 21 (Stone Bunds). If students are going to make models of stone bunds instead, make sure that all of the materials are ready (see Section 4.7 for guidelines on making models as an alternative Activity 21),

This lesson will probably need to be extended and students will need to be on site for Activity 21, ***unless*** you choose for them to make models instead (in which case the activity might be able to be done at the learning institution).

1. Revise Lesson 10.

2. Provide a brief overview of this lesson.

3. Work through Section 5: Stone Bunds.

4. **Activity 21: Stone Bunds** (refer to Section 4 for activity guidelines).

3.12 Lesson 12

Content to cover:

- Chapter 7, Section 6 (Tied ridges)

Materials needed:

- large flat boxes (cardboard / cat litter boxes) filled with clayey soil (1/group)
- small forks and spoons (i.e. cutlery) to dig and "rake" with
- watering can/s
- mulch (chopped very fine if necessary)

1. Revise Lesson 11.

2. Provide a brief overview of this lesson.

3. Work through Section 6 (Tied Ridges).

4. Divide students into groups and let them construct models of tied ridges in the soil, using the materials listed above and following the instructions in their manuals. Provide assistance only

if/when necessary. Once the models have been made, you can conduct an experiment with students to see where and how water flows when it rains (use a watering can to simulate rainfall).

OR

5. Arrange a site visit to a farm or garden which has tied ridges (if there are any in your area). Encourage students to ask the farmer questions about the method as well as about any other WHC methods which are used on the farm. You can also use the opportunity to let students examine the farm system as a whole.

3.13 Lesson 13

Content to cover:

- Chapter 7, Section 7 (Swales)

Materials needed:

- Materials for Activity 22 (Tied Ridges ***or*** Swales)

This lesson will probably need to be extended and students will need to be on site for Activity 22.

1. Revise Lesson 12.

2. Provide a brief overview of this lesson.

3. Work through Section 7 (Swales).

4. Arrange a site visit to a farm or garden which has swales. Examine the swales carefully, and ask the gardener or farmer to explain how s/he constructed them, and why. Encourage students to ask further questions about the swales, as well as about any other farming or WHC methods which are used on the site. You can also use the opportunity to let students examine the farm or garden *system* as a whole.

5. **Activity 22: Tied Ridges and Swales** (refer to Section 4 for activity guidelines).

3.14 Lesson 14

Content to cover:

- Chapter 7, Section 8 (Terraces)

Materials needed:

- hand spade/s and hand fork/s (gardening tools)
- stones of various sizes, preferably flat or angular in shape (for modelling terraces)
- small A-frame made with small sticks and string) which has been calibrated.
- string and markers (stones or sticks)
- watering can

1. Revise Lesson 13.

2. Provide a brief overview of this lesson.

3. Work through Section 8 (Terraces)

4. Help students to construct a model of terraces (either in a box but preferably on a relatively steep slope somewhere outside). Use the materials listed above and follow the instructions given in the Technical Manual. *Don't worry too much about getting the terrace measurements exactly to scale – the main aim of making the model is for students to learnthe different steps involved in constructing terraces.*

   Once the model has been made, you can conduct an experiment to see where and how water will flow when it rains (use a watering can to simulate rainfall). If erosion occurs when the rainfall is "heavy", fix the soil and implement erosion protection measures, then repeat the experiment to see if the the measures you have implemented help prevent erosion.

OR

5. Arrange a visit to various sites which have terraces. Examine the terraces carefully, see if there are any erosion protection measures in place, and ask the gardener or farmer to explain how s/he constructed them, and why. Encourage students to ask further questions about the terraces, as well as about any other farming or WHC methods which are used on the site.

3.15 Lesson 15

Content to cover:

- Chapter 7, Section 9 (Fertility Pits)

Materials needed:

- Materials for Activity 23 (Fertility Pits)

This lesson will probably need to be extended and students will need to be on site for Activity 23.

1. Revise Lesson 14.

2. Provide a brief overview of this lesson.

3. Work through Section 9 (Fertlity Pits).

4. Arrange a site visit to a farm or garden with a fertility pit. Examine the fertility pit carefully, and ask the gardener or farmer to explain how s/he constructed them, and why. Encourage students to ask further questions about the pits, as well as about any other farming or WHC methods which are used on the site. You can also use the opportunity to let students examine the farm or garden *system* as a whole.

5. **Activity 23: Fertility Pit** (refer to Section 4 for activity guidelines).

3.16 Lesson 16

Content to cover:

- Chapter 7, Section 10 (Greywater Harvesting) & Section 11 (Roofwater Harvesting)

Materials needed:

- soil pH test kit and a few different soil samples (if students have not yet conducted soil pH tests)

1. Revise Lesson 15.

2. Provide a brief overview of this lesson.

3. Let students share and discuss what they know about greywater harvesting.

4. Work through Section 10 (Greywater Harvesting).

5. If you did not conduct soil pH tests earlier in the course, conduct a few now.

6. Work through Section 11 (Roofwater Harvesting) until the subheading **Calculating roof runoff volumes**. Also work through the last section titled **RECOMMENDATIONS FOR IMPROVED ROOFWATER HARVESTING SYSTEMS**.

   If your students do not have strong mathematical skills, you can tell them that the remainder of Section 11 is contextual and not for assessment purposes. In other words, they do not have to know how to calculate roof runoff volumes and the appropriate storage space required.

7. Go outside and examine a range of roofs in the area. Identify the roof material and the gutter type. See how many roofwater storage tanks you can find within a specific radius.

3.17 Lesson 17

Content to cover:

- Chapter 7, Section 11 (Roofwater harvesting) ***OR*** revision lesson

Materials needed:

- scientific calculator/s (for advanced classes)

1. Revise Lesson 16.

2. Provide a brief overview of this lesson.

3. Revision lesson. This lesson can be used to complete any activities which are unfinished or to revise any sections which students have found difficult or which have been rushed.

OR

4. If your students have reasonably strong mathematical skills, work through the remainder of Section 11 (Roofwater Harvesting). Make sure that students understand the various calculations involved, and give them a chance to practice different calculations. You can use the following "Maths Tutorial" to assist with this:

MATHS TUTORIAL: CALCULATING ROOFWATER RUNOFF

1. Understand rationale

1.1 Why measure rainfall runoff?

2. Input from facilitator

2.1 Explain that 1 mm of rain falling on 1 m^2 equals 1 litre of water.

3. Calculations

If the above is true, then:

3.1 If 10 mm falls on 1 m^2, how many litres will that be?

3.2 If 50 mm falls on 1 m^2, how many litres will that be?

3.3 If 100 mm falls on 1 m^2, how many litres will that be?, etc.

Get students to do a few calculations, varying the m^2, for example: How many litres if 100 mm falls on 22 m^2, 50 m^2, 100 m^2, etc.

4. Input from facilitator

4.1 Ask how you would calculate expected rainfall on one roof over one year.

4.2 Explain the concept of the "plan area of a roof".

4.3 Explain formula: rainwater runoff (litres) = roof surface area x annual rainfall (mm)

4.4 Discuss: What about loss due to splash, evaporation, absorption, etc.?

4.5 Explain runoff coefficient and then add coefficient factor to calculation to get:

rainwater runoff (litres) = roof surface area (m^2) x annual rainfall (mm) x runoff coefficient

4.6 Explain that if you multiply by a number bigger than 1 you get a higher number, whereas if you want to calculate in a loss, then the number should be less than one which is why the runoff coefficient is always less than one.

5. Calculation

5.1 Provide some examples for students to practice.

5. Provide individual assistance to any students who struggle with this part of the section (some will be more proficient at maths than others). Assign **Activity 24: Roofwater Harvesting** for homework.

3.18 Lesson 18

Content to cover:

- Chapter 7, Sections 12-14 (Ploegvore, Dome Water Harvesting & Saaidamme)

1. Revise Lesson 17.

2. Provide a brief overview of this lesson.

3. Work through Sections 12 (Ploegvore), 13 (Dome Water Harvesting) and 14 (Saaidamme). These three methods are practiced on a large scale, so students do not need to know how to apply them individually. They do, however, need to understand their underlying principles and what the application of each one entails.

3.19 Lesson 19

Content to cover:

- Optional

This is an open lesson which you can use at any point in the course, and to cover any content you choose.

3.20 Lesson 20

Content to cover:

- Optional

This is an open lesson which you can use at any point in the course, and to cover any content you choose.

4. Activity Guidelines

Before you conduct an activity it is strongly recommended that you read through the activity guidelines presented in this section.

Note that many of the activities can be used for formative or summative assessment purposes. Assessment can be conducted formally or informally and assessment rubrics can be used for either type of assessment, although other methods of assessing students can also be used. Five assessment rubrics are included at the end of this manual. The rubrics can be used as is, or they can be adapted to suit your assessment needs and preferences.

Please note that while some activities are important and are indicated as such in this guide, many are optional – you can try to do them all, or you can select those which you think are most useful or appropriate for your particular group of students.

4.1 Chapter 1, Activity 1

activity 1

Group Discussion

1. Read and discuss each definition of water harvesting. Make sure that you understand all of the words used, particularly those which are found in all three definitions.

2. Discuss the definition of water conservation. Brainstorm and list other ways of conserving water (a) inside the home, and (b) outdoors.

3. Discuss the following: Is the concept of WHC new to you? Do you know anybody who practices WHC? How do they do this?

4. What does the word **system** mean? / What is a system? What do you think the term ***farm system*** refers to? How about the terms ***water harvesting and conservation system*** and ***roofwater catchment system***?

Time: 30 minutes

Divide the students into groups (4-6 students per group). Groups can be asked to share the main points of their discussion with the rest of the class.

1. Students must understand the terminology used in the definitions. Some important words and their definitions are:

runoff – the water from rain, snowmelt or irrigation that flows over the land surface and is not absorbed into the ground.[1]

catchment – the area drained by a river or body of water[2]; any discrete area draining into a common system;[3] a structure, such as a basin or reservoir, used for collecting or draining water.[4]

concentration – to direct or draw toward a common center.[5]

entrap (entrapment) – to capture, snare, trap.[6]

watershed – a ridge of high land dividing two areas that are drained by different river systems.[7]

supplemental – something added to complete a thing, make up for a deficiency, or extend or strengthen the whole.[8]

diverting (divert) – to turn aside from a course or direction.[9]

2. Students should discuss water conservation in relation to **protecting** water resources, **developing** water resources and efficiently **managing** water resources (i.e. what do these things mean, and what might they involve?).

Some ways to conserve water inside the home:

- Turn off the tap while brushing your teeth / washing your face, etc.
- Put a brick in the toilet tank to displace water (this decreases the amount of water used per flush).
- Wash dishes by hand.
- Don't rinse dishes under running water.
- Use as little dishwashing detergent as possible so that less rinsing is required.
- Don't defrost food with running water.
- Clean vegetables in a tub of water (not under running water). Re-use this water afterwards.

Some ways to conserve water outdoors:

- Wash your car (or your pet dog) on the grass so that the water serves two purposes.
- Harvest rainwater for home and garden use.
- Set sprinklers so that the water falls in the correct places.
- Water plants only when necessary.
- Avoid watering plants when it's hot and/or windy.

3. Students should try to come up with a few concrete examples of how people practice water harvesting and conservation. If necessary, ask further questions to facilitate this discussion.

4. You may have to discuss these questions as a class. To help students understand the concept of a system, you can begin by asking questions such as: What is a *computer system*? What is a *stereo system*? What do we mean when we talk about our *digestive system*? The answers to these should help them to understand the following definition of a system:

   A <u>system</u> is a group of interacting and interdependent elements which together form a complex whole.

   The concepts of a ***farm system*** and a ***WHC system*** should be more easily understood once you have examined Phiri Maseko's story.

4.2 Chapter 2, Activities 2-5

activity 2

A drop in the bucket[2]

You will need:

- a 1 ℓ container
- a measuring jug
- three glasses
- an eyedropper
- water

Step 1: Fill the 1 ℓ container with water. This represents the total amount of water on earth (salt and fresh).

Step 2: Pour 30 ml of this water into a glass. This represents all of the *fresh* water on earth – about 3% of the total.

Step 3: Pour 6 ml of the fresh water into a second glass. This represents all of the fresh water on earth which is *not frozen* – about 0.6% of the total. Of this, only about 1.5 ml is surface water; the rest is stored underground in the form of ground-water.

Step 4: Take an eyedropper, remove a single drop of water from the second glass and drop it into the third glass. This represents our clean, fresh water which is available for use (i.e. not polluted, trapped in soil, too far below the ground, etc.) – about 0.003% of the total water on earth.

It is important to note that the fresh water which is available to us, as represented by the single drop, is actually a large volume of water on a global scale (billions of litres).

Time: 30 minutes

For this activity you will need to bring the items listed to class. Follow the steps closely, estimating the measurements if necessary (1 teaspoon is approximately 5 ml). After the demonstration, pose the following questions to students to facilitate a discussion about fresh water availability:

1. What did the demonstration teach you?
2. Did you learn anything new?
3. Did anything surprise you?

Note: You will need to set aside additional time for this activity if students are not familiar with the concepts *volume* and *percentage*. If necessary, discuss and/or explain each concept in turn so that the activity is meaningful to students (refer to Handout 1 in Section 8 of this FAG for assistance with this).

activity 3

Map Work

Answer the following by referring to Figures 2.1, 2.2 & 2.3:

1. What is the mean annual rainfall for the area where you grew up?
2. During what season does rain mainly fall in this area?
3. What is the mean annual rainfall in the most northern part of SA?
4. During what season does rain mainly fall along the west coast of SA?

Does the information from the maps match your own experience of rainfall in the area where you grew up, and in other areas where you have lived? Share and discuss your answers with a friend.

Time: 40 minutes

Students who are not familiar with reading maps will need a fair amount of assistance with this activity. Students can refer to Figure 2.1 (Map showing major cities and roads in South Africa) to help them identify the area/s where they grew up. You can go over this map with the class and explain the key, pointing out different towns, cities, roads and rivers (ideally, make an overhead transparency of tthis or another, similar map of South Africa).

Answers to questions 1 and 2 will vary according to the areas where students grew up. Make sure that students have understood and interpreted the information on the maps correctly. If necessary, check each student's answers or work through an example with the class.

1. answers will vary
2. answers will vary
3. 300-400 mm
4. Winter

activity 4

Rainfall Information

You have decided to start a vegetable garden at home, and need to find out which plants will grow well in your area. To do this, you need to find out the following information:

1) Your area's average rainfall.
2) Your area's rainfall seasonality (i.e. the months of the year that it rains, and the month/s with the most rain).
3) Your area's average minimum and maximum temperatures (in winter and in summer).

As a class, brainstorm and discuss the different ways in which you could find this information about your area.

Time: 20 minutes

Facilitate this brainstorm and discussion with students systematically by going through each different type of information that is required, one at a time.

Possible answers:

1)	**Average rainfall**	-	websites (e.g. SA Weather Bureau)
		-	rainfall maps
		-	talk to local people (e.g. farmers & extension officers)
2)	**Rainfall seasonality**	-	websites (e.g. SA Weather Bureau)
		-	rainfall maps
		-	talk to local people (e.g. farmers & extension officers)
		-	observation / own experience
3)	**Average temp**	-	websites (e.g. SA Weather Bureau)
		-	climatic maps
		-	talk to local people (e.g. farmers & extension officers
		-	observation / own experience

Discuss the usefulness and importance of *observation*, as this is the first principle of WHC ("Begin with long and thoughtful observation" – see Chapter 1, Section 2 of the Student Manual). **Discuss observation in relation to this principle**, and get students to brainstorm other things they can observe which would be helpful in starting their gardens. For example, they can observe the movement of the sun (to see where the best position for their garden will be), they can observe what other people are growing in the same area, they can observe where water runs off when it rains, etc.

activity 5

Group Discussion

Discuss the following in small groups:

1. Which people/groups of people in South Africa still lack access to adequate water supplies and sanitation? Why is this so?
2. In what ways does a lack of access to water impact on these people/groups of people in their daily lives?
3. To whom could you speak about water-related issues in your area, and how could you go about doing this?

Write down the key points of your discussion and share them with the rest of the class.

Time: 20 minutes

Divide students into groups of 4-6 and give them time to discuss the questions and formulate their answers. Allow time for group feedback and a final discussion. Summarise in writing any key points which are made.

1. People living in rural areas / poor people / people living in informal settlements and townships / any relevant group

   Many rural areas are isolated so infrastructure is expensive and difficult to provide / there is a supply backlog which is still being addressed / any relevant answer

2. People have to spend a lot of time collecting water by hand each day / hygiene may be compromised (as less water is available for bathing, washing hands, washing food, etc.) / water supplies can become contaminated, resulting in water-related diseases / any relevant answer.

3. People can speak to agricultural extension officers, ward councillors, officials from the Department of Water Affairs, or someone at the local municipality. They would probably have to contact the person telephonically and set up an appointment to meet with them in person.

4.3 Chapter 3, Activity 6

activity 6

Analyse a Farm System

Study the illustration of Thembisa's farm and complete the following in relation to her farm system:

1. What farm resources does Thembisa have available to her? Identify all those which you can see from the illustration, and list them under the following headings: natural, physical, human, social and financial.

2. What other resources might be available to Thembisa, even though they are not shown in the illustration? List each resource under its appropriate heading.

3. Identify and list 5 system inputs, 5 outputs, and 5 processes which take place within the system.

4. Explain in detail how you think this farm system has impacted on its ecosystem.

5. What sub-systems can you identify within this farm system?

6. Do you think that Thembisa's farm system is sustainable? Explain your answer in detail.

Time: 2 hours

If you choose to use this activity for assessment purposes you will need to tell students exactly how marks will be allocated. You will also need to give clear instructions as to how you want answers to be presented.

1. Farm resources which can be identified from the picture:

NATURAL	PHYSICAL	FINANCIAL	HUMAN	SOCIAL
land soil water (pond) climate biodiversity slope (for WHC) plants animals	farmhouse shed chicken house water tanks tools / equipment fence roofing	-	labour knowledge skills health (assumed)	-

2. Other resources which might be available:

NATURAL	PHYSICAL	FINANCIAL	HUMAN	SOCIAL
access to common resources (e.g. grazing land) water (river, rainwater)	vehicle/s roads machinery fuel electricity feed (for animals)	cash savings loans government support credit union stokvel	beliefs	community groups organizations kinship culture traditions

3. System inputs, outputs and processes:

INPUTS	PROCESSES	OUTPUTS
energy (solar) planting sowing weeding harvesting seeds water labour money organic inputs (e.g. manure, compost) fertilizer pollinators (insects)	photosynthesis germination digestion reproduction evaporation evapotranspiration infiltration plant growth decomposition pollination	crop yield / vegetables animal products (e.g. eggs, milk, meat) manure money energy (in the form of crop/ animal products being removed from the farm) water (e.g. groundwater recharge) compost

4. Answers will vary. Points which can be made include:

- reduced runoff in some areas (e.g. from stone walls and vegetated areas)
- increased runoff in some areas (e.g. from buildings)
- concentration of water in crop area
- destruction of natural grassland / vegetation / forest (depending on the landscape prior to the farm)
- increased methane production (from animals)
- increased or decreased biodiversity (depending on the landscape prior to the farm)
- increased compaction along pathways and roads

5. Sub-systems include:

- water harvesting and conservation system
- pond system
- fertility pit
- plant production system
- animal production system (chickens, goats)
- family system
- household system
- any other identified sub-system

6. Answers will vary, and must be explained in detail.

For example:

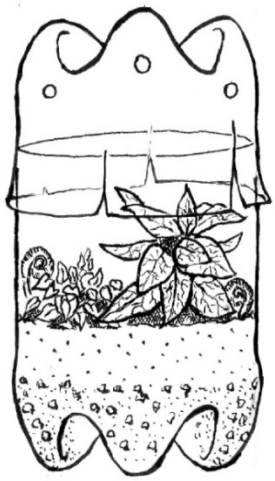
Yes, the system seems to be sustainable for the following reasons:

- Different farm elements have been integrated into a production system which appears appropriate for the environment.
- A water-harvesting and conservation system is in place to ensure an ongoing water supply. The system includes stone bunds, trench beds, diversion furrows, roofwater harvesting (gutters and tanks), a pond and a fertility pit.
- Various measures have been taken to prevent soil erosion and conserve the soil (e.g. there is lots of vegetation, there is a windbreak of trees, the stone bunds on the slope will break the water flow).
- Measures have also been taken to keep the soil fertile (i.e. the fertility pit and trench beds are designed to develop and maintain fertile soil; goats and chickens provide manure which contains potassium and nitrogen, both of which are important for soil fertility).
- Any reasonable answer.

4.4 Chapter 4, Activities 7-10

activity 7

Make your own terrarium



A ***terrarium*** is a small enclosure in which selected living plants are grown. To make your own terrarium, you will need the following:

- a large clear plastic container (e.g. a 2 ℓ coldrink bottle) with a lid or cap
- a marker and scissors
- soil and compost
- pebbles/small stones and sand
- seeds and small plants

To make the terrarium:

1. Draw a line around the bottle about 16 cm from the bottom. (*Tip:* Rest the marker on top of an upside down cup and rotate the 2 ℓ bottle against the tip to make a straight line.)
2. Make a small hole in the plastic and cut along the line with a pair of scissors.
3. Put the stones and sand at the bottom of the bottle (about 5 cm deep).
4. Put the soil and compost on top of the stones (till about 2 fingers from the top).
5. Plant your seeds/small plants. Plant 6-10 seeds to start; as they grow, you can pluck out some of the weaker ones and leave 2 or 3 of the best ones.
6. Water the terrarium. The soil should be moist but not soaked.
7. Put the top onto the base so that the top is on the outside (see picture). If you have trouble fitting it on, cut a small slit into the top so that it will squeeze on more easily.

Once the plants have germinated, make sure they get sunlight but do not leave the terrarium in direct sunlight for the whole day as it will get too hot. Pay attention to the soil also. It should look moist but not soaked or too dry. Beads of water should form on the top inside edge, and these will drip down the sides and continue to water the soil. If the soil is too wet, take the top off and leave the terrarium uncovered for a day or two.

Instructions:

1. Examine your terrarium daily for at least one week. Every day, write down your answers to the following questions: What is happening? What has changed? Why do you think these changes have taken place?
2. Write down any other interesting observations you make during the week.
3. Draw a diagram which illustrates how the terrarium replicates the water cycle.

Time: 4 hours

Students can complete this activity individually, in pairs or in small groups, ***as long as each person has access to the terrarium every day for a week***. It is suggested that you first demonstrate how to make a terrarium; for this you will need to bring the necessary materials to class. You can also give students time to make their terrariums in class. If you have the budget, you can provide most of the materials yourself (e.g. bring a bag of compost, a bag of soil and a bag of pebbles, some seeds and seedlings, etc.) while students can supply their own containers (although it is recommended that you bring some extra containers for students who forget to bring their own).

Students can be asked to write a report on this activity, which can then be used for assessment purposes. The report should include daily, detailed observations of the terrarium (see Instruction 1), any other observations which were made over the week (Instruction 2) and a diagram illustrating how the terrarium replicates the water cycle (Instruction 3). You can add further instructions or adapt the activity if you choose (for example, you can ask students to bring their terrariums to class). Assessment can be done holistically, using (or adapting) one of the rubrics provided in Section 7, or marks can be assigned. Make sure that you tell students exactly how you will assess their work before they begin the assignment.

This activity has been included in the Formal Assessment Schedule for this course.
If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.

activity 8

Water Catchments

Carefully examine the piece of land on which you live and complete the following:

1. Identify the high and low points of the land.
2. Note all features on it (buildings and other structures, paving, concrete, trees, flower beds, vegetation, etc.).
3. Draw a plan of the land as close to scale as possible. Include all of its features (see Figure 4.2 for an example).
4. Think about what happens when it rains. Where does the water come from and where does it run to? Is there any place where it accumulates? Use arrows to show how water flows over the land when it rains heavily.
5. Think about the piece of land in relation to the land around it. Are there any features in the surrounding landscape which influence how water flows over your land? Where does the water which flows onto your land come from? Where does it go to when it runs off the land?

Share and discuss your plan with a partner.

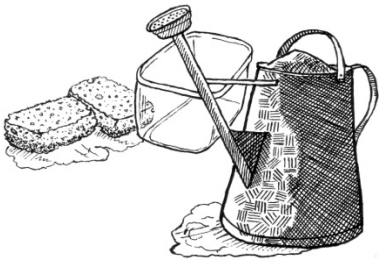
Time: 2 hours

It is suggested that you complete this activity as a class before assigning it to individuals. Select an accessible piece of land – such as a section of the college grounds – and help students examine and map it. Discuss each of the questions and help students formulate their own answers. Although students might not know what happens to rainwater (i.e. where it runs, accumulates and flows), you can help them examine the land and its features carefully so that they can predict what is likely to happen. If you have the opportunity to observe the land during a rainfall event, do so.

This activity has been included in the Formal Assessment Schedule for this course.
If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.

activity 9

Group Activity



You will need:

- two sponges of the same size
- a clear plastic container
- a watering can or a plastic container with small holes in the bottom
- water

Instructions: Place the sponges in the plastic container, one on top of the other. Pour water onto the top sponge (to simulate rain) and keep pouring slowly until the bottom sponge is full. Take note of what happens and in small groups, discuss what the experiment demonstrates and what each item used represents.

Time: 30 minutes

Let students do this activity as a class, or give them time to do it in small groups. If you plan to demonstrate the activity, make sure that you have the materials needed and practice it first on your own. It will work best if the sponges fit snugly (but not tightly) into the plastic container.

What will happen: The water will flow through the top sponge into the bottom one. If you stop adding water, the top sponge will eventually dry up. This demonstrates how water flows through the ground; the bottom sponge represents the saturated zone, while the top sponge represents the unsaturated zone, and the base of the container is the confining layer.

activity 10

Pollution

Refer to Figure 4.5 and complete the following:

1. Identify the various water users within the catchment.
2. Identify and list possible pollutants of the **surface water**. Discuss the specific impact that each pollutant could have on the environment (people, plants, animals, water cycle, etc.).
3. Identify and list possible pollutants of the **ground water**. Discuss the specific impact that each pollutant could have on the environment (people, plants, animals, water cycle, etc.).
4. List two specific actions that could be taken to control ground or surface water contamination.

Time: 30 minutes

It is recommended that you do this activity with the class. You can make an overhead transparency of Figure 4.5 (Groundwater contamination) so that it is easy to look at and discuss together.

1. Agriculture (farmers), industry (factories), domestic (rural/peri-urban).

2. Examples of possible surface water pollutants (refer to Table 4.1):

   - **Oil and grease** – harmful to fish and other wildlife
   - **Fixed particles in suspension** – can cause sedimentation and oxygen depletion in river
   - **Organic wastes** – can cause oxygen depletion in river
   - **Chemical residues** – toxic to aquatic life, plants, animals and humans
   - **Insecticides and pesticides** – toxic to bacteria and aquatic life

3. Examples of possible ground water pollutants:

   - **Detergents** – possibly toxic
   - **Pathogens and parasites** – can spread diseases

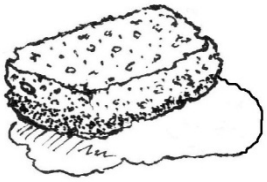
4. Examples of actions:

   - Imposing stricter control measures over factory emissions.
   - Stopping crop spraying from the air (which can contaminate surface water).
   - Ensuring that water pumps and pit latrines are situated further apart (to decrease the chance of pathogens and parasites contaminating the drinking water).
   - Any reasonable action.

4.5 Chapter 5, Activities 11-17

activity 11

Soil Experiment A



The way that soil acts is similar to that of a sponge. Take a sponge, place it under water and allow it to soak up as much water as possible. At this point, the sponge is at **saturation** point. Now, support the sponge with both hands and lift it carefully out of the water. When the sponge stops draining, it is at **field capacity**. Finally, squeeze the sponge until no more water comes out. The sponge is now at **permanent wilting point**, and the water which you squeezed out is the **water holding capacity** of the sponge.

Time: 10 minutes

It is recommended that you bring some extra sponges and containers (plastic tubs or bowls) to class so that students can do this experiment in small groups, with each one having a turn to hold the sponge. For the experiment to be meaningful, students *must* understand what each term means (i.e. saturation, field capacity, permanent wilting point and water holding capacity).

activity 12

Soil Experiment B

To visualise the suction exerted by cell walls, take an empty elastic plastic container with a fairly narrow opening, such as an empty dishwashing liquid container, and compress (squeeze) it a bit. Place the opening of the compressed container into water and watch how water is sucked into the container.

Time: 5 minutes

Demonstrate the suction by squeezing the container, holding it in water and letting go. Make sure that all of the students can see the demonstration.

activity 13

Soil Experiment C

Collect at least three different samples of soil aggregates. Examine each sample carefully and try to identify which class of structure it belongs to (refer to Table 5.3).

One by one, immerse each sample partially in water and see whether it slakes (falls apart). If an aggregate does not slake it can be called water stable, but if it slakes it is not.

Time: 20 minutes

If you have enough soil, let students do this experiment in small groups. You will probably need to help students identify the soil structure correctly. Also, make sure that samples are only immersed *partically* in the water. To avoid mess, put down plastic or newspaper to protect surfaces from water and soil spills (or work outdoors).

Soil Experiment D

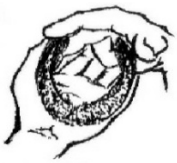
You can estimate how much sand, silt and clay is in a soil by how it feels. Take a handful of soil, wet it and roll it into a ball between your hands. Then roll this ball into a sausage. Refer to the table which follows to identify what type of soil it is. Conduct this experiment with soil from three different places and compare the results.

Very sandy (0-5% clay)
Soil looks very sandy and feels rough. It cannot be rolled into a sausage.

Sandy (5-10% clay)
Soil looks quite sandy and feels rough. It can be rolled into a sausage, but it cannot bend.

Sandy loam (10-15% clay)
Soil looks half sandy and half smooth, and feels rough. It can be rolled into a sausage and can bend a little.

Loam or silt loam (15-35% clay)
Soil looks mostly smooth. It feels a little sandy, quite smooth but not sticky. It can be rolled into a sausage which can bend about half way around.



Clay loam or sandy clay (35-55% clay)
Soil looks mostly smooth. It feels a little sandy, quite smooth and sticky. It can be rolled into a sausage which can bend more than half way around.

Clay (more than 55%)
Soil looks smooth, and feels smooth and sticky. It can be rolled into a sausage which can bend into a circle.

Time: 30 minutes

This activity should be completed **individually** so that each student has a chance to feel different soil textures and can learn to identify different soil types. Soil samples can be brought to class, or you can take students on an outing to source and study different soils. If you bring samples to class, ensure that (a) you bring enough for the entire class to experiment with, and (b) you bring three different soil types (or more if possible).

To avoid mess, put down newspaper or plastic to protect surfaces from water and soil spills, or work outdoors. Before students begin the experiment, let them examine each sample with magnifying glasses and discuss what they observe.

activity 15

Group Activity

Find an area where foot traffic has worn a bare path. Dig a small, shallow hole in the path, and another one next to the path. Examine the holes and the soil from each hole carefully, and try to identify the soil structure of each. Are there any differences in structure between the soil on the path and the soil next to the path? Discuss as a group and then share your findings with the rest of the class.

Time: 20 minutes

Let students complete this activity during class time (they can look for footpaths on the grounds of the learning institution); inform them that any holes which are dug ***must be filled in afterwards***. If the soil is very hard, students may need a hard or sharp object to dig with (such as a small handspade).

Students are likely to find that the soil from the footpath has a platy structure, which is typical of compacted soils.

activity 16

Soil Profile

In pairs or small groups, dig a soil pit which is 1 metre deep and wide enough to get into to observe the soil horizons. Complete the following in writing:

1. How deep is the topsoil (the soil in the A horizon)?
2. Is there any root growth in the soil? Describe.
3. Is there an E horizon? How deep is it?
4. Are there any impermeable layers between the topsoil and subsoil (soil in the B horizon and lower)? Describe what they look and feel like.
5. What is the texture of the topsoil? Of the subsoil?
6. Describe the structure of the topsoil and the subsoil.
7. Give an opinion of the ability of the topsoil to support plant growth, and provide reasons for this opinion.
8. Explain what you think will happen to water which lands on this soil. Give reasons for your answer.

Think of a creative way to present your findings to the rest of the class. *(Ideas: take photographs, draw a diagram, collect soil samples, prepare a poster presentation)*

Time: 4 hours

To dig a soil pit and examine the soil profile, groups will need a **spade** and a **ruler or tape measure**. (You can also refer them to Chapter 6, Section 8 of their manuals – Easy Measurements – in which case they can measure their pits using their spades only.) Students also need writing materials and any other optional items they plan to use (e.g. a camera or containers for soil samples; many cell phones have cameras on them and soil can be collected in empty coldrink bottles or packets).

Make sure that students have permission to dig their soil pits on the site that is selected. It is recommended that you let groups complete this activity at the same time so that the work of digging is shared and the number of pits dug is limited, and so that you can oversee and assist groups if necessary. *Ideally, get groups to dig their pits at different levels on a slope so that they can compare the soil profiles which emerge.*

It is also recommended that you talk through the following with students before they begin the activity:

- Reasons *why* a person might want to dig a soil pit and examine the soil profile (i.e. how can the information obtained be useful?). *Possible reasons:* to see the amount of topsoil that is available for planting; to take soil samples; to examine the soil profile of a planned building site, etc.

- How the position of the soil pit in relation to the slope will play a role in the amount of topsoil likely to be found (the lower the pit, the deeper the topsoil is likely to be).

This activity has been included in the Formal Assessment Schedule for this course.
If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.

activity 17

Conduct a Soil pH Test

In pairs or small groups, conduct a soil pH test on a sample of soil. To do this, use a simple soil pH test kit, which can be obtained from nurseries, garden centres or hardware stores. These tests usually consist of a test tube, some testing solution, a colour chart, and instructions for conducting the test. Follow the instructions carefully and interpret the result using the colour chart provided. Then, complete the following in writing:

1. Did you find the soil pH test kit easy to use? Give reasons for your answer.
2. Do you think that plants will grow well in this soil? Why or why not?
3. List five plants which you could grow in this type of soil (refer to Table 5.5).

Share your test results and answers to the above questions with the rest of the class.

Time: 1 hour

You will need to buy soil pH test kits (1 for each group) for this activity. Students can do this activity on site, or in the grounds of the learning institution. Ideally, they should test the pH of a few different soil samples.

This activity has been included in the Formal Assessment Schedule for this course.
If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.

4.6 Chapter 6, Activities 18-19

activity 18

Working with an A-frame

Follow the instructions provided in this section of the WHC manual to do the following:

1. Construct and calibrate an A-frame.
2. Use a line level (also called a spirit level) to see if the A-frame has been calibrated correctly.
3. Use the A-frame to measure the percentage of three different slopes (any slopes in the area).
4. Use the A-frame to mark out two contour lines on a slope.

Before you begin, list the materials you need and decide how to obtain them.

Time: 4 hours

Students **must** complete this activity, and every student should get a chance to use an A-frame. You will need to select a site with a slope of any degree (as long as it isn't completely flat) so that students can experiment with their A-frames and mark out contour lines.

The materials needed (if they are not supplied by yourself/the learning institution) are:

- 2 x 2 m long poles
- 1 x 1.2 m pole
- saw (to cut the poles – if necessary)
- wire or strong cord to connect the poles (about 2 m) ***or*** a hammer and nails
- light cord or string (1 m)
- weight (e.g. stone or bottle)
- a spirit/line level (used by builders and obtainable at hardware stores)
- sticks/stones (for marking out the contour lines)

To see if the A-frame has been calibrated correctly, position the A-frame so that it is level (i.e. the string must line up with the permanent mark on the crossbar which indicates the level position). Place the spirit level (also called a "line level") on the cross-bar and look at the position of the bubble – if it is in the center of the tube between the two lines, then the A-frame is level and has been calibrated correctly.

When measuring the percentage of the slopes and marking out contour lines, let students follow the instructions provided in their manuals (Sections 4.2 and 4.3). Provide assistance only if/when

necessary. Students will need to use their A-frames later in the course when they design and implement various WHC methods in the field, so the A-frames should be stored in a safe place.

<u>This activity has been included in the Formal Assessment Schedule for this course.</u>
<u>If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.</u>

activity 19

Working with a Line Level

Follow the instructions provided in this section of the WHC manual to do the following:

1. Construct a line level.
2. Use the line level to measure the percentage of three different slopes (any slopes in the area).
4. Use the line level to mark out two contour lines on a slope.

Before you begin, list the materials you need and decide how to obtain them.

Time: 4 hours

Students **must** complete this activity, and every student should get a chance to use a line level. You will need to select a site with a slope of any degree (as long as it isn't completely flat) so that students can experiment with their line levels and mark out contour lines.

The materials needed (if they are not supplied by yourself/the learning institution) are:

- 2 X long poles which are exactly the same height (1.5 m or 2 m)
- string or fishing line to tie between the poles (about 11 metres)
- a knife (to cut a notch in the poles)
- a spirit/line level (used by builders and obtainable at hardware stores)

When measuring the percentage of the slopes and marking out contour lines, let students follow the instructions provided in their manuals (Sections 4.2 and 4.3). Provide assistance only if/when necessary. Students will need to use their line levels later in the course when they design and implement various WHC methods in the field, so the line levels should be stored in a safe place.

4.7 Chapter 7, Activities 20-24

The activities in this chapter are designed to give students practical experience at planning, designing and implementing selected WHC methods. Each activity can be used for assessment purposes. Suggestions for assessment are provided for each activity, although you may choose to assess students in any way you deem appropriate.

activity 20

Trench Beds

In small groups (4-6 members), complete the following:

1. Construct a trench bed (1 m x 3 m in size).
2. Cover the trench bed with a layer of mulch.
3. Dig a diversion furrow which leads into the trench bed.
4. Plant a variety of seeds or seedlings in the trench bed.
5. Tend to the trench bed as the plants grow.
6. Compile an activity report, as per your lecturer's instructions.

Completing this activity successfully will involve, amongst other things:

- Selecting a site for the construction of the trench bed and diversion furrow. Groups must have permission to use the site for this purpose. The site must be accessible and the garden area must be secured from animals.
- Compiling a list of all the materials required, deciding how each item will be obtained, and ensuring that the appropriate materials are available when they are needed.
- Developing an appropriate and realistic timeframe for the activity and allocating the time required to complete each step.
- Planning each step in detail and assigning specific tasks to each group member.
- Performing the allocated tasks, working together to ensure that each step is completed successfully and on time.

Your lecturer will provide you with further instructions for this activity and for the group report.

Time: 30 hours

For this activity, students need to work in small groups of 4-6 members per group. You can allow students to form their own groups, or you can assign them to groups. It is important that students understand that the term "completing the activity successfully" means that they have followed the activity instructions carefully, that they have attempted to implement the WHC methods to

the best of their ability, and that they have learned from their experience, regardless of whether or not the trench bed was a "success" (i.e. what is important is to learn from the process regardless of whether or not vegetables are produced). Groups should be reminded that the activity is ***not a competition*** between groups. Instead, they should focus on planning the activity carefully so that they complete it successfully.

Students will need to have access to a site where they can construct their trench beds, such as a home garden or a project site which is linked to the learning institution. Students will also need specific tools and materials for the activity, such as spades, picks, string, pegs, mulch and seeds/seedlings. Ideally, tools and materials should *not* have to be bought. If necessary, help students source the required tools (e.g. spades and picks can be borrowed from friends or family members, and you may be able to get seeds from people with vegetable gardens).

If possible, allocate class time for groups to discuss the activity and develop their activity plans. Make sure that each group understands the activity requirements and that students engage together in a constructive manner. **It is particularly important that all further instructions for the activity provided by yourself are clear and are fully understood by group members. It would be best to provide all further instructions in writing, especially in relation to their activity reports.**

There may be additional information which students must acquire in order to complete the activity, particularly in relation to the seeds/seedlings which they should select for planting (the types of which will depend on the area and the time of year when the planting takes place). This information can be obtained in various ways, for example:

- Students who have experience in gardening can share their knowledge with the rest of the class.
- Students can be required to research the information for themselves by talking to farmers or gardeners, by looking at gardening manuals, by conducting online research, etc.
- Students can be provided with the required information.

Activity reports

It is recommended that each group is required to compile one main activity report, which can include:

- A description, map and/or plan of their selected site, and a written description as to how and why the particular site was selected.
- A materials list, including a brief description as to how – or from where – each item was obtained.
- Their activity timeframe and a brief report on how successful the group was in adhering to the timeframe, including reasons for any diversion from the plan.
- A task list, including a short report as to how and why each group member was assigned specific tasks.
- A report on the process as a whole, including challenges, problems encountered and how these were addressed, difficulties, successes and what the group learned from the process.
- A report on the WHC methods which were planned and implemented, including: details pertaining to the construction of the trench bed and diversion furrow (how they were

sited, how easy or difficult they were to construct and reasons for this, etc.); an evaluation of their effectiveness as WHC methods (e.g. how well they captured and conserved water when – or if – it rained, etc.); mulching (what mulch was used, how it was obtained, how effective it was as a WHC method); planting (which plants were chosen and why, how and when they were planted, how well they grew, etc.); tending the trench bed (how and what was done to maintain the trench bed garden and how effective this approach was).
- The final outcomes of the experience (a summary of what they learned, what they did right, what they could or should have done differently and why, etc.).

Each group member can also be required to hand in an individual report about their experience, including:

- A reflection on their experience as a member of their group.
- Specific challenges they faced and how these were addressed.
- Positive experiences they had (e.g. things which they particularly enjoyed doing and the reasons why; what they learned about WHC; and how they can and/or will use this knowledge in the future, etc.).

It is important that students are given detailed and specific instructions pertaining to the expected length of their reports, report presentation, report assessment, and due dates.

Other suggestions:

- Arrange for the class to visit and examine each trench bed. This can be done at any time during the course of the activity, depending on what you choose to focus on and/or explore during the visit.
- Ask students to bring any vegetables they have grown to class. Encourage students to share and/or swop vegetables with other groups.
- Arrange a class party to which students can bring dishes which are made from – or which include – some of the vegetables they have grown.

<u>This activity has been included in the Formal Assessment Schedule for this course.</u>
<u>If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.</u>

activity 21

Stone Bunds

Complete the following in groups of 6-10.

1. Construct two stone bunds, each of which is at least 10 metres long.
2. Maintain the bunds for at least two months.
3. Compile an activity report, as per your lecturer's instructions.

Completing this activity successfully will involve, amongst other things:

- Selecting an appropriate site for the construction of the stone bunds. Groups must have permission to use the site for this purpose.
- Compiling a list of the materials required, deciding how each item will be obtained, and ensuring that the materials are available when they are needed.
- Developing an appropriate and realistic timeframe for the activity and allocating the time required to complete it.
- Planning the activity in detail and assigning tasks to each group member.
- Performing the allocated tasks, working together to ensure that the activity is completed successfully and on time.

Your lecturer will provide you with further instructions for this activity and for the group report.

Time: 12 hours

Students will need to have access to a site where they can construct their stone bunds, such as a project site which is linked to your learning institution. If students are unable to find a site where there are enough stones, the bunds can be made shorter or only one can be constructed, or the activity can be completed as a class instead of in groups.

Students will need to use their A-frames or line levels to mark off the contour lines for the stone bunds. They will also need spades, stones, and a wheelbarrow (which is not essential if the groups are large and there are lots of stones available).

Make sure that each group understands the activity requirements and that students engage together in a constructive manner. It is particularly important that all further instructions for the activity provided by yourself are **clear** and are **fully understood** by group members.

Activity 21 – ALTERNATIVE OPTION

If it is impractical for students to do Activity 21 as it stands (e.g. there are not enough rocks on the practical site to construct the bunds), you can let groups make models of stone bunds instead.

Ideally, miniature stone bunds can be constructed on reasonably steep slopes somewhere outside, either at the prac site or someone on the grounds of the learning institution. You may even want to mark out different "sites" (e.g. 1 m^2 blocks marked out with string).

You will need to give detailed instructions as to how you want groups to make their models (e.g. indicate the size and length of the bunds and how many they must make). Groups can even make miniature A-frames (e.g. using chopsticks and string) to mark out the contours.

Once the models have been made, you can conduct an experiment with students to see where and how water flows when it rains (use a watering can to simulate rainfall).

Activity reports

For this activity it is recommended that each student compiles an activity report, which can include:

- A description, map and/or plan of the selected site, and a written description as to how and/or why the particular site was selected.
- A report on the process as a whole, including challenges, problems encountered and how these were addressed, what the group and individual learned from the process, and what could be done differently in future.
- A reflection on their experience as a member of their group.
- Positive experiences (e.g. things which they particularly enjoyed doing and the reasons why; what they learned about the method; how they can and/or will use this knowledge in the future, etc.).

It is important that students are given detailed and specific instructions pertaining to the expected length of their reports, report presentation, report assessment, and due dates. The reports can be due soon after the bunds have been constructed (i.e. it is not necessary to include maintenance of the bunds in the reports, although it is important that students check the bunds at least twice – particularly after heavy rainfall – to replace any stones which have become dislodged).

activity 22

Tied Ridges and Swales

Complete this activity in small groups (4-6 members).

Select a site which is at least 6 metres long and 6 metres wide and:

1. Construct tied ridges on this site and plant with maize or vegetables.

   OR

   Construct two swales and plant with permanent and seasonal crops.

   NB: Ensure that the soils, slope and rainfall are suitable for tied ridges if you decide on that option.

2. Maintain the tied ridges or swales for one growing season (3-4 months).
3. Compile an activity report, as per your lecturer's instructions.

Completing this activity successfully will involve, amongst other things:

- Selecting an appropriate site. Groups must have permission to use the site, and the site must be secured from livestock.
- Compiling a list of the materials required, deciding how each item will be obtained, and ensuring that the materials are available when they are needed.
- Developing an appropriate and realistic timeframe for the activity and allocating the time required to complete it.
- Planning the activity in detail and assigning tasks to each group member.
- Performing the allocated tasks, working together to ensure that the activity is completed successfully and on time.

Your lecturer will provide you with further instructions for this activity and for the group report.

Time: 18 hours

It is important that students understand that "completing the activity successfully" means that they have followed the activity instructions carefully, that they have attempted to implement the WHC method to the best of their ability, and that they have learned from their experience, regardless of whether the method was a "success".

Students will need to have access to a 6 m x 6 m site where they can construct their tied ridges or swales, such as a home garden or project sites which are linked to your learning institution. Students will also need specific tools and materials for the activity, such as A-frames or line levels,

spades, string, pegs, mulch, and seeds/seedlings. Ideally, tools and materials should *not* have to be bought. If necessary, help students source the required tools.

If possible, allocate class time for groups to discuss the activity and develop their activity plans. Make sure that each group understands the activity requirements and that students engage together in a constructive manner. It is particularly important that all further instructions for the activity provided by yourself are **clear** and are **fully understood** by group members. It would be best to provide any further instructions in writing.

There may be additional information which students must acquire in order to complete the activity, particularly in relation to the seeds/seedlings which they should select for planting (the types of which will depend on the area and the time of year when the planting takes place). This information can be obtained in various ways, for example:

- Students who have experience in gardening can share their knowledge with the rest of the class.
- Students can be required to research the information for themselves by talking to farmers or gardeners, by looking at gardening manuals, by conducting online research, etc.
- Students can be provided with the required information.

Activity reports

It is recommended that each group is required to compile one main activity report, which can include:

- A description, map and/or plan of their selected site, and a written description as to how and why the particular site was selected.
- A materials list, including a brief description as to how – or from where – each item was obtained.
- Their activity timeframe and a brief report on how successful the group was in adhering to the timeframe, including reasons for any diversion from the plan.
- A task list, including a short report as to how and why each group member was assigned specific tasks.
- A report on the process as a whole, including challenges, problems encountered and how these were addressed, difficulties, successes and what the group learned from the process.
- A report on the WHC method which was planned and implemented, including: details pertaining to the construction of the tied ridgesswales (how they were sited, how easy or difficult they were to construct and reasons for this, etc.); an evaluation of their effectiveness as WHC methods (e.g. how well they captured and conserved water when – or if – it rained, etc.); planting (which plants were chosen and why, how and when they were planted, how well they grew, etc.); tending the tied ridges/swales (how and what was done to maintain them, and how effective this approach was).
- The final outcomes of the experience (a summary of what they learned, what they did right, what they could or should have done differently and why, etc.).

Each group member can also be required to hand in an individual report about their experience, including:

- A reflection on their experience as a member of their group.
- Specific challenges they faced and how these were addressed.
- Positive experiences they had (e.g. things which they particularly enjoyed doing and the reasons why; what they learned about WHC; and how they can and/or will use this knowledge in the future, etc.).

It is important that students are given detailed and specific instructions pertaining to the expected length of their reports, report presentation, report assessment, and due dates.

Other suggestions:

- Arrange for the class to visit and examine each site. This can be done at any time during the course of the activity, depending on what you choose to focus on and/or explore during the visit.
- Ask students to bring any vegetables they have grown to class. Encourage students to share and/or swop vegetables with other groups.
- Arrange a class party to which students can bring dishes which are made from – or which include – some of the vegetables they have grown.

This activity has been included in the Formal Assessment Schedule for this course.
If you plan to follow this schedule, please refer to Section 6 for Assessment Guidelines.

activity 23

Fertility Pit

Complete this activity in groups of 8-10.

1. Dig a fertility pit, fill it with organic matter and plant trees (e.g. bananas and paw-paws) and plants around the rim.
2. Dig a diversion furrow to direct excess runoff from the surrounding area into the pit.
3. Collect and add any organic matter to the pit over the time period specificed by your lecturer.
4. Compile an activity report, as per your lecturer's instructions.

Completing this activity successfully will involve, amongst other things:

- Selecting an appropriate site. Groups must have permission to use the site.
- Compiling a list of the materials required, deciding how each item will be obtained, and ensuring that the materials are available when needed.
- Developing an appropriate and realistic timeframe for the activity and allocating the time required to complete it.
- Planning the activity in detail and assigning tasks to each group member.
- Performing the allocated tasks, working together to ensure that the activity is completed successfully and on time.

Your lecturer will provide you with further instructions for this activity and for the group report.

Time: 15 hours

It is important that students understand that "completing the activity successfully" means that they have followed the activity instructions carefully, that they have attempted to implement the WHC method to the best of their ability, and that they have learned from their experience, regardless of whether the method was a "success".

Students will need to have access to a site where they can dig the fertility pits, such as a home garden, or project sites which are linked to your learning institution. Students will also need spades, organic material, seeds/seedlings and plants (e.g. banana suckers). Ideally, tools and plants should *not* have to be bought.

If possible, allocate class time for groups to discuss the activity and develop their activity plans. Make sure that each group understands the activity requirements and that students engage together in a constructive manner. It is particularly important that all further instructions for the activity provided by yourself are **clear** and are **fully understood** by group members. It would be best to provide any further instructions in writing. Make sure that you specify a time period over which students must add compost to the pits.

There may be additional information which students must acquire in order to complete the activity, particularly in relation to the seeds/seedlings which they should select for planting (the types of which will depend on the area and the time of year when the planting takes place).

Activity reports

For this activity it is recommended that each compiles an activity report, which can include:

- A description, map and/or plan of the selected site, and a written description as to how and/or why the particular site was selected.
- A report on the process as a whole, including challenges, problems encountered and how these were addressed, what the group and individual learned from the process, and what could be done differently in future.
- A reflection on their experience as a member of their group.
- Positive experiences (e.g. things which they particularly enjoyed doing and the reasons why; what they learned about the method; how they can and/or will use this knowledge in the future, etc.).

It is important that students are given detailed and specific instructions pertaining to the expected length of their reports, report presentation, report assessment, and due dates.

Other suggestions:

- Arrange for the class to visit and examine each fertility pit. This can be done at any time during the course of the activity, depending on what you choose to focus on and/or explore during the visit.
- Ask students to bring any vegetables/herbs which have grown to class. Encourage students to share and/or swop vegetables with other groups.
- Arrange a class party to which students can bring dishes which are made from – or which include – some of the vegetables they have grown.

activity 24

Roofwater Harvesting

This activity must be completed individually or in pairs.

Select a building to which you have access, such as a house, a school, a clinic, an outhouse, or an informal dwelling. The roof of the building must be made from one of the following materials: galvanised iron sheets, tiles, cement, or thatch. Examine the roof and the building carefully, and complete the following in writing:

1. Name the material from which the roof is made.
2. Draw a plan area of the roof, and annotate it with the roof dimensions.
3. Use the roof dimensions to calculate the roof surface area. Show all of your calculations.
4. Identify and name the type of gutter which is on the roof (if any). State whether this guttering is the most suitable type to use on the building, and explain why or why not.
5. If there is no gutter on the building, name the guttering which you think would be most suitable to use and explain why.
6. Calculate the total annual roof runoff volume for the building. Show all of your calculations (these can be presented in a table) and present the rainfall data you used. Name the source of this data, and explain how you obtained it.

Your lecturer will provide you with further instructions for this activity and for your written report.

Time: 2 hours

This activity should only be assigned to classes where students have relatively strong mathematical skills.

If you use the activity for assessment purposes, students must be told how marks will be allocated/assessment will take place, and how their work must be presented. You may also assign additional tasks or change the activity instructions. For example, you can specify that students choose a **dwelling** (and not a school, clinic or outhouse) and then also calculate the **household demand** and the **storage requirements** for the building (it is suggested that calculating a garden demand is omitted).

5. Test Yourself Questions and Model Answers

The "Test Yourself" questions at the end of each chapter have been included to encourage students to engage fully with the content of the manual, and to express their understanding of the content in their own words and style. There are different ways in which you can use these questions. For example:

1. At the beginning of the course you can encourage students to work through the questions on their own after each chapter has been completed, as a way of revising and/or testing their understanding and retention of the chapter content. You can give students who choose to do this a copy of the model answers (provided in this section) so that they can assess their own work (self-assessment).

2. You can assign the questions to students for homework, or to be done in class if time permits, and use peer-review as the means of assessment (i.e. let students pair up and assess their partners' answers).

3. You can let students spend time in class working on selected questions, either alone or in pairs. You can also add questions of your own, or adapt the existing questions in any way you feel useful.

If the questions are used for revision purposes they can be answered in an open-book manner. In other words, students can refer back to the chapter content and then answer the questions ***in their own words***. Even though this might not always be easy – especially for students working in a second or third language – it should at least be attempted. It is particularly important that students understand *why* they should answer questions in their own words (e.g. to reflect a real understanding of the content, to help them practice putting ideas and concepts into their own words, to develop their language skills, and to avoid plagiarism). ***It is particularly important that you spend time discussing the concept of plagiarism*** with students, as well as the serious consequences of plagiarising, especially in a formal academic context. If possible, spend some time in class getting students to practice rephrasing different pieces of text from the manual into their own words. You can first practice as a class, then let students attempt it on their own.

The model answers presented in this section are provided as an *assessment guide* only. Many questions require that the students ***explain*** or ***discuss*** certain terms, concepts or processes. Although the answers provided in this manual are often presented in point form to highlight key points, the students' answers should be ***descriptive*** or ***explanatory*** unless otherwise specified.

5.1 Chapter 1

1.	**List the eight principles of water harvesting and conservation and explain why each one is important. (16)**

Principle	Why it is important
1. Begin with long and thoughtful observation. (✓)	This will help you develop an understanding of a specific context in relation to rain and water flow / it is important to understand your site (piece of land) before implementing water-harvesting methods or a system. (✓ for any relevant point)
2. Start at the top of your watershed and work your way down. (✓)	The water will infiltrate more evenly into the soil throughout the landscape (not just at the bottom); water harvested higher up can be moved around a site more easily than water harvested lower down; many smaller water-harvesting methods or structures can be used, each managing a smaller volume of water; the volume of runoff you will have to deal with at any one time will be less, making it easier to manage and control. (✓ for any relevant point)
3. Start small and simple. (✓)	It's easier, less expensive, and gives you a chance to see what works and what doesn't. (✓ for any relevant point)
4. Slow, spread and infiltrate the flow of water. (✓)	Slowing water down and spreading it down reduces erosion, while infiltrating it into the soil maximises the amount of water available for plant growth. (✓ for any relevant point)
5. Always plan an overflow route, and manage that overflow as a resource. (✓)	Overflow routes reduce or eliminate erosion (which can occur after heavy rainfall events); they also ensure that all excess water is used instead of being lost as runoff. (✓ for any relevant point)
6. Create a living sponge. (✓)	This maximises the ability of water to infiltrate the soil. (✓)
7. Do more than just harvest water. (✓)	Developing an effective farming system enables one to maximise mutually beneficial relationships within that system. (✓)
8. Continually reassess your system. (✓)	This enables you to identify things which work and things which don't work, so that any necessary changes, adjustments or developments can be made. (✓)

2.	**Provide a definition for each of the following terms: *rainwater harvesting* and *water conservation*.**	**(4)**

Rainwater harvesting (✓✓ for any one of the following):

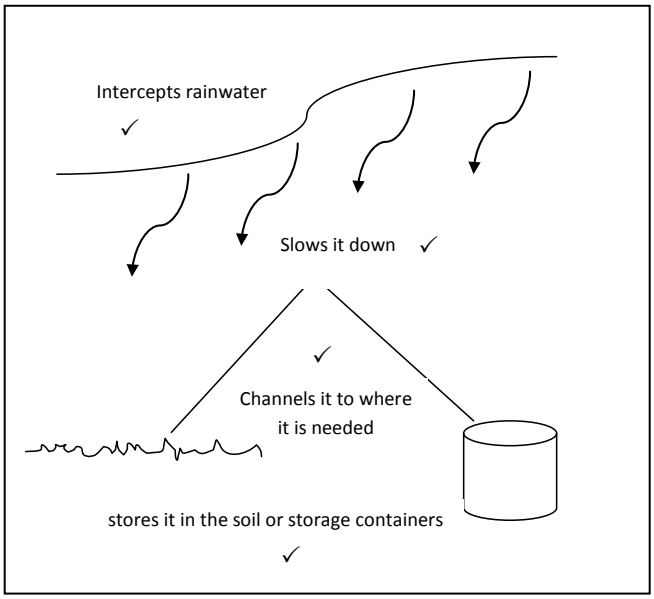
- "...the concentration and entrapment of rainwater runoff from a catchment".
- "...the process of concentrating rainfall as runoff from a larger catchment area to be used in a smaller target area".[12]
- "...the collection and/or concentration of runoff water for productive purposes."
- Any other acceptable definition (with a reference to the source).

Water conservation (✓✓ for any one of the following):

- "The protection, development, and efficient management of water resources for beneficial purposes."
- Any other acceptable definition (with a reference to the source).

3.	**Draw a simple diagram which illustrates the process of water harvesting and conservation.**	**(5)**

Any diagram which illustrates the process, for example:



✓ for diagram

4.	**List five benefits of WHC, particularly for rural households.**	**(5)**

Any five of the following: (✓ for each point)

- WHC can improve their food security.
- WHC can improve their income levels.

- WHC can improve their standard of living.
- WHC helps conserve the soil.
- WHC reduces soil erosion.
- WHC systems are low-cost, simple to construct, and require little maintenance.
- Women and children spend less time collecting water from other sources.
- Households can become water-independent.
- Any other benefit.

5.2 Chapter 2

1.	**One of the main reasons for our water crisis is the growing world population. List and discuss five other reasons for the global water crisis.**	**(15)**

Distribution and availability (✓) + (✓✓ for any point listed below)
- the world's freshwater supply is unevenly distributed across the planet
- many water sources (e.g. rivers and lakes) cross national boundaries and are shared by several countries, each with its own laws and beliefs about water use and ownership
- rainfall patterns, droughts, floods, and inappropriate veld and water management impact on the availability and supply of water

Climate change (✓) + (✓✓ for any point listed below)
- weather and rainfall patterns have become less predictable and there are more droughts and floods than there used to be, both of which reduce the ability of soil to hold water – this means that more water is needed for irrigation

Virtual water (✓) + (✓✓ for any point listed below)
- water is needed to grow, manufacture and package most of the products we eat, drink, wear and use in our everyday lives, and as consumer demand for food and for new products increases, so does the amount of water needed to produce such goods

Human activities (✓) + (✓✓ for any point listed below)
- canals, dams and levees obstruct natural water flow and can change the quantity and the quality of water downstream (e.g. increased pollution and sediment load)
- poor drainage and irrigation practices have resulted in the water-logging and salination of about 10% of the world's irrigated lands
- increased paving in towns and cities leads to increased runoff (rainwater running off into drains or storm sewers, rather than soaking into the ground and replenishing water tables)
- people pour household chemicals and pollutants down their drains, substances which contaminate our fresh water supply and are harmful to many other species
- about 60% of the water extracted for human use is wasted through evaporation, leaks, inefficient appliances and human carelessness

Pollution (✓) + (✓✓ for any point listed below)
- large amounts of human waste are disposed of in water courses

- large amounts of industrial waste is dumped untreated into waters, polluting the usable water supply
- fertilizers, pesticides, agricultural run-off, chemicals, poisons and infectious pathogens pollute water supplies

2. List the three Constitutional principles on which the review of South African water law was based after the elections of 1994. (3)

efficiency (✓) sustainability (✓) and equity (✓)

3. Name three water-related policies that are relevant to homestead agriculture, and explain the relevance of each one. (9)

Any three of the following:

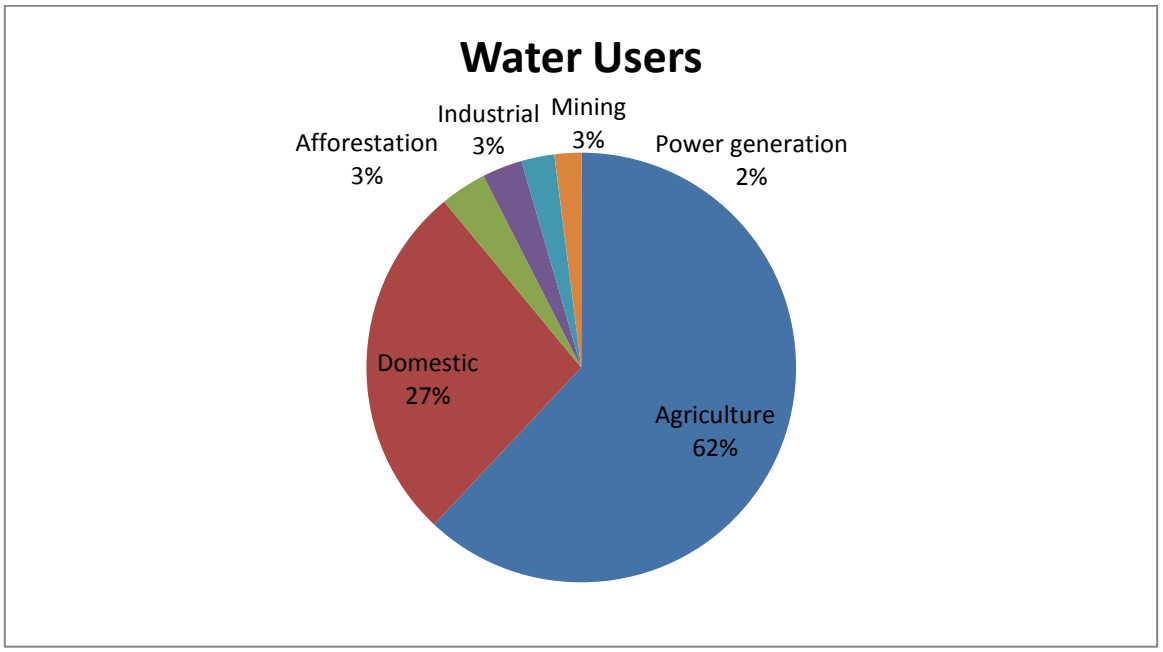
Policy (✓ for any 3 headings below)	Relevance (✓✓ for any reasonable explanation of its relevance)
Entitlement to water use Section 4.1 and Schedule 1 of the National Water Act (Act 36 of 1998)	A person may use, freely and without the need for licensing, water in or from a water resource (e.g. a river or stream) for various purposes including reasonable domestic use, gardening and animal watering.
The Reserve Sections 16 to 18 of the National Water Act (Act 36 of 1998)	The National Water Act (NWA) formally **reserves** a portion of water (i.e. a specific quantity and quality of water) from all significant water resources. The reserve consists of two parts – a basic human needs (BHN) reserve and an ecological reserve. The basic human needs reserve "provides for the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene."[15] Current policy sets the water for BHN at 25 litres per person per day, but there is strong advocacy to increase this amount, especially to enable economic activity in poor households.
Free basic water	In 2001 the government made a policy decision that municipalities must provide every household with 6 kilolitres (6 000 litres) of water per month, free of charge. This works out at 25 litres per person per day for a family of eight, and 40 litres per person per day for a family of five.
Financial support for resource poor farmers Sections 61 and 62 of the National Water Act (Act 36 of 1998)	DWAF will provide financial support to resource-poor farmers in terms of section 61 of the NWA. This includes a subsidy for household training in intensive home food production and rainwater harvesting, as well as for water storage infrastructure in the homestead yard (e.g. tanks).

4.	**Based on DWAF's licensing and regulatory requirements, rainwater harvesting within a homestead farming system falls under Schedule One Use. Explain what this means. (4)**

This means that ***no registration is required to practice rainwater harvesting*** (✓✓) because there is little or no risk of a negative impact (✓✓).

5.	**Draw a pie chart which shows South Africa's current water users and the current percentage of water allocated to each user group. (8)**

Example: (✓✓ for pie chart, ✓ for each user group presented accurately)



6.	**List four attitudes towards water which need to change if water is to be managed better, and explain why each attitude change is necessary. (8)**

Some examples:

Attitude	Attitude change (✓ for each attitude change)	Reason (✓✓ for each reason given)
There will always be water.	Water is a limited resource.	People are more likely to conserve water if they understand that the supply is limited.
It's fine to waste water, there's lots of it.	Water is valuable and should not be wasted.	People need to stop wasting water.

The government must supply me with water.	I can harvest water and have my own supply.	People need to take responsibility for themselves, and understand that they can choose to become water-independent.
It's just water.	Water is essential for life.	Water will be valued and appreciated more.
Any relevant answer	Any relevant answer	Any relevant answer

5.3 Chapter 3

1.	**Provide definitions for the following terms:**	**(6)**

1.1 **System** – a group of interacting and interdependent elements which together form a complex whole. (✓✓)

1.2 **Open system** – systems where energy and matter flow freely within the system as well as between the system and its environment ***OR*** systems which maintain themselves through constant interaction and exchange with their environment. (✓✓)

1.3 **Ecosystem** – a community of organisms functioning together and interacting with the physical environment (soil, air, water) through a flow of energy and a cycling of materials. (✓✓)

2.	**Every ecosystem has a biotic and an abiotic component. Explain in detail the difference between these two components.**	**(8)**

The **abiotic component** of an ecosystem is the non-living, environmental component, (✓✓) consisting of various chemical factors (✓) such as water salinity, and the level of water and air in the soil, and various physical factors (✓) such as sunlight, temperature, wind and rain.

The **biotic component** is the living component (✓✓) consisting of organisms which are classified either as producers or consumers (✓) depending on how they get their food. (✓) Producers, which are mainly plants, manufacture their own food, while consumers are organisms which feed on producers either directly (such as herbivores) or indirectly (such as carnivores).

3.	**Explain the difference between a food chain and a food web.**	**(4)**

A **food chain** shows a single path of eating relationships in an ecosystem (✓✓) while a **food web** shows the multiple feeding paths which connect different plants and animals in an ecosystem. (✓✓)

4.	**Name the two main processes of an ecosystem.**	**(2)**

Energy flow (✓) and nutrient cycling (✓)

5.	**Ecosystems can be threatened or disturbed by various things. Name four and explain why each presents a threat to ecosystems.**	**(8)**

Any four of the following: (✓✓ each)

- **Pollution** – pollutants in the soil, water or air disturb the natural balance of an ecosystem and affect organisms in various ways (e.g. water pollution can cause fish to suffocate and die).
- **Introduction of exotic (non-native) species** – the introduction of species which are not indigenous can endanger the system's biodiversity.
- **Destruction of habitat** – converting natural land and sea areas for other uses (e.g. golf courses) leads to a loss of species and a resulting decrease in biodiversity.
- **Exploitation of plant and animal species** – exploiting a particular plant or animal can threaten its viability as a species. The loss of a species impacts on an ecosystem's food web.
- **Desertification** – overgrazing, woodcutting and water-diversion leads to increased wind and water erosion, impacts on biodiversity, and can cause the land to lose its productive capacity.
- **Global warming** – global warming is causing the earth to get hotter and the ice in the Arctic circles to melt; these changes in temperature impact directly on ecosystems.
- **Farming** – the practice of farming changes the composition and functioning of the ecosystem/s in which the farm exists.

6.	**Explain what sustainable farming aims to do, and what doing this involves.**	**(8)**

Sustainable farming aims to integrate different farm elements into a production system (✓✓) that is appropriate for the environment, the people and the economic condition of the farm (✓✓) thus enabling the farm to meet current needs without compromising future needs. (✓✓)

Sustainable farming involves creating a farm which imitates a natural system (✓✓) **OR** creating a farm landscape which mimics or copies as closely as possible the complexity of a healthy ecosystem.

7.	**Name the four ecosystem processes that are at work on any farm and discuss two of them in detail.**	**(12)**

The four ecosystem processes are ***energy flow***, ***nutrient cycling***, the ***water cycle*** and the ***ecosystem dynamic***. (✓ for each process named)

Any ***two*** must be discussed in detail. (✓✓✓✓ for any two discussed in sufficient detail)

Energy flow – Energy enters the system when plants capture sunlight using the process of photosynthesis, and use it for growth. This energy then flows through the system as animals eat the plants, and as microorganisms decompose dead plants and animals. At every transfer point in the food chain some energy is lost as heat, as well as through movement and as solid waste. The amount of solar energy that is captured by plants determines the amount of energy that will flow through the farm system. Farmers can increase the amount of sunlight that is captured by maximizing the leaf area available for photosynthesis. Farmers can also ensure that the stored solar energy is cycled efficiently through the food chain.

Nutrient Cycling – The nutrients needed for plant and animal growth are continuously recycled as they move from the soil through the crops and animals and then back to the soil. In nature, these nutrients are recycled with very little waste and with no need for fertilizer, so when a nutrient cycle on a farm is well-functioning there is no need for the farmer to use fertilizer or to bring in animal feed from outside of the farm. Conditions and practices which inhibit the natural nutrient cycle and thus reduce a farm's sustainability include soil erosion, nutrient leaching, and the depletion of organic matter. Practices which enhance the nutrient cycle include feeding livestock on the farm, managing manure and crop residues carefully, reducing the loss of nutrients through leaching, and preventing soil erosion.

The Water Cycle – A water cycle is effective when water enters the soil quickly, the soil has the capacity to store large amounts of water, and there is no soil erosion. Sustainable farm systems aim to get as much water as possible into the soil during each rainfall. Rainwater harvesting helps with this process, as do any practices which maintain or increase levels of ground cover and soil organic matter, such as mulching, adding compost or manure to the soil, and growing high-residue crops.

Ecosystem Dynamic – A healthy ecosystem dynamic is indicated by a high level of diversity within a system. The term diversity refers to:

- the presence of many different plant and animal species
- genetic diversity within each species
- a wide-ranging age structure in each population
- spatial diversity (the vertical and horizontal locations of components in the system, e.g. the number of horizontal levels on a farm, and the spatial patterns of plants and other organisms).

Diversity within a system provides it with greater stability, makes it more resistant to change, and increases its ability to recover from disturbances. Practices which increase diversity include crop rotation, cover cropping, planting hedgerows and buffers, and increasing the amount of organic matter in the soil by applying compost and incorporating plant residues into the soil.

8.	**Briefly outline two farming approaches which apply the principles of sustainable farming.** **(8)**

The Integrated Systems Approach (✓ + ✓✓✓ for any three points listed)

- This approach is based on the view that whatever is being grown now was once part of a completely natural process, and grew without any human help.
- The aim of this approach is to recreate and integrate into the farm the beneficial connections and natural processes that support productivity.
- The approach thus helps reduce inputs from outside of the farm and contributes positively to the ecosystem dynamic of the farm system.

Low-External-Input and Sustainable Agriculture (LEISA) (✓ + ✓✓✓ for any three points listed)

- The LEISA approach to agriculture aims to ensure sufficient food production within the limits of the natural environment.
- LEISA builds on natural biological and ecological processes in order to maintain or enhance ecosystem functions.
- The approach combines the knowledge and experiences of traditional agriculture with new scientific understandings of biological and ecological processes, and aims to ensure that agricultural production is environmentally sound, benefitting both rural communities and the environment.
- LEISA uses technologies such as soil and water conservation, integrated plant nutrient systems, agroforestry, integrated pest management, intercropping, crop-livestock integration, and microclimate management.
- The approach aims to secure sustainable increases in agricultural production, while enhancing biodiversity and ensuring the sustainable use of natural resources.

5.4 Chapter 4

1.	**Name the three different forms which water can take as it passes through the water cycle.** **(3)**

solid (✓) liquid (✓) and gas/vapour (✓)

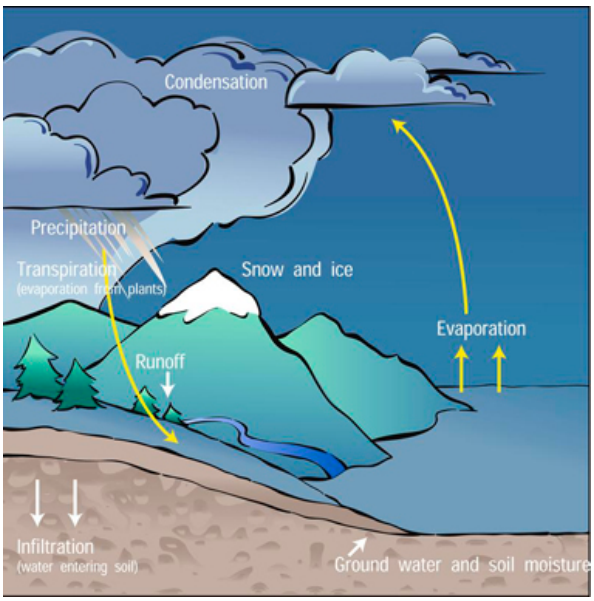
2.	**Name four different processes which cause water to change its form, and briefly explain each one.** **(8)**

Evaporation (✓) – the process by which water changes from a liquid into a gas. (✓)
Evapotranspiration (✓) – when the heat of the sun draws water from plants and soil. (✓)
Sublimation (✓) – the process by which water changes from a solid directly into a gas. (✓)
Condensation (✓) – when water vapour in the air cools down and changes into water droplets. (✓)

3.	Draw a diagram which illustrates the process of the water cycle.	(10)

Any diagram which accurately illustrates the water cycle is acceptable. For example:

(Mark allocation – use own discretion)



4.	Provide definitions for the following terms:	(10)

Water catchment – an elevated area of land down which water drains to a particular endpoint. (✓✓)

Surface water – water that is open to the atmosphere, including springs, streams, wetlands, rivers, dams, lakes and the ocean. (✓✓)

Wetland – an area of land where the soil is permanently or seasonally saturated with water, which can be salt, fresh or brackish. (✓✓)

Groundwater – water which infiltrates into the ground, saturating pores or cracks in the soil and rocks. (✓✓)

Aquifer – moderately- to highly-permeable rocks which carry water underground. (✓✓)

5.	Discuss the importance of wetlands in relation to water flow, and list four human activities which change the hydrologic conditions of a wetland.	(10)

Wetlands are important in relation to water flow because (✓✓ for any one of the following):

- They act as natural sponges which trap and slowly release surface water, rain, snowmelt, groundwater and flood waters.

- Wetland vegetation slows the speed of flood waters, distributing it more slowly over the floodplain and thus reducing erosion.
- Wetlands which are in or downstream of urban areas counteract the greatly increased rate and volume of surface water runoff from pavements and buildings.

Human activities which can change the hydrologic conditions of a wetland include (any four of the following, ✓ each):

- depositing fill material for development
- draining (for development, farming, mosquito control, etc.)
- dredging and channelling streams (for development, flood control, etc.)
- diking and damming to form ponds and lakes
- diverting water flow to or from wetlands
- creating impermeable surfaces in the watershed

6.	**Name three ways in which groundwater can become polluted.**	**(3)**

(✓ per point)

- seepage from broken sewage pipes and leaking pit latrines
- fertilizers and factory waste containing nitrates can seep into the soil or be washed into rivers and streams
- poorly designed water points (places where people get their water from a tap or pump) are often surrounded by stagnant, dirty water which seeps back into and contaminates the groundwater

7.	**List four specific water pollutants found in South Africa.**	**(8)**

Any four of the following (✓✓ each):

- colourants
- fixed particles in suspension
- oil and grease
- organic wastes
- insecticides and pesticides
- trace metals
- chemical residues
- acids (mineral and organic)
- alkalis
- nitrogen and phosphorus
- thermal pollution
- detergents
- pathogens and parasites
- salts
- radio-activity

5.5 Chapter 5

1. There are five factors involved in the formation of soil. Name them. (5)

(✓ each):

- parent material
- climate
- organisms
- topography
- time

2. Name the two solid components of soil. (2)

Mineral particles/matter (✓) and organic materials (✓)

3. Explain the importance of soil pores. (3)

Pores allow for the movement of water, air and nutrients (✓✓) within the soil system (✓).

4. Name and briefly describe the three soil separates. (6)

Sand particles – these particle are visible to the naked eye, are rough, and have sharp edges. (✓✓)

Silt particles – these particles can be seen with a microscope. They are smooth and powdery when dry, and smooth but not sticky when wet. (✓✓)

Clay p articles – these particles are so minute that they can only be seen with an electron microscope. They are smooth when dry, and sticky when wet. (✓✓)

5. List three harmful practices which break down the structure of a soil, and explain why each practice is harmful. (6)

Any three of the following: (✓✓ each)

- ***Watering too much*** – soil organisms and plants get choked because they lack air.
- ***Watering too often*** – soil organisms and plants get choked because they lack air.
- ***Adding chemical products*** (e.g. pesticides and fertilizers) – causes unnecessary poisoning of the soil.
- ***Heating of the soil surface*** (e.g. through fire or prolonged sunlight) – causes the ground to dry up, and kills micro-organisms.

6. Explain what a soil profile is and how one can be obtained. (3)

A soil profile is a cross-section through the soil (✓) which shows its horizons (✓). A soil profile can be obtained by digging a soil pit (✓).

7. Explain the terms *infiltration*, *drainage*, and *permeability*. (3)

Infiltration – the rate at which water enters the soil surface (measured in mm/hour). (✓)
Drainage – the ability of the soil as a whole to drain excess water. (✓)
Permeability – the rate at which water and air can penetrate or pass through a layer of soil. (✓)

8. List four properties of fertile soil. (4)

Any four of the following (✓ each):

- It is rich in the nutrients necessary for basic plant nutrition
- It contains sufficient minerals (or trace elements) for plant nutrition
- It contains organic matter which improves the soil structure and soil moisture retention
- It has a soil pH of between 6.0 and 7.0
- It is well-drained
- It has a *range of* micro-organisms which support plant growth
- It usually has a large amount of topsoil

9. Nutrients in the soil come from different sources. Name three of these sources. (3)

Any three of the following (✓ each):

- the weathering of soil minerals
- the decomposition of plant residues and animal remains
- the application of manures and composts
- nitrogen-fixation by legumes (e.g. beans and peas)
- the deposition of nutrient-rich sediment from erosion and flooding

10. Name the three most important nutrients for soil fertility. (3)

Nitrogen (✓) phosphorus (✓) and potassium (✓)

11. Complete the following table: (8)

Source	Nutrient/s
comfrey	potassium ✓
sheep manure	nitrogen ✓
urine	phosphorus ✓
legumes	nitrogen ✓
chicken manure	nitrogen and potassium ✓
bone-meal	phosphorus ✓
wood ash	potassium ✓
bones	phosphorus ✓

12. Explain why repeated soil erosion reduces soil fertility. (3)

Repeated soil erosion:

- removes the topsoil that is rich in nutrients and organic matter (✓)
- reduces the depth of soil available for plant roots and for storing water (✓)
- reduces water infiltration into the soil, which increases runoff (✓)

13. List five factors which impact on the amount of soil erosion that takes place in a particular area. (5)

Any five of the following (✓ each):

- The speed of the agent
- The frequency of the agent
- The slope of the land
- The type of soil
- Fire
- Compaction

14. Discuss the role of vegetation in helping to control the movement of water both in and over the ground. (8)

Any four of the following (✓✓ each):

- Vegetation slows down runoff, allowing more water to soak into the ground.
- Vegetation and plant debris breaks the force of raindrops on the soil.
- Dead vegetation increases the organic content of the soil, increasing its ability to absorb water.
- Plant roots hold the soil in place.
- Plants in wetlands and on river banks slow down water flow, and their roots bind the soil.
- Soil with no plants or protective vegetation is vulnerable to water erosion.

15.	**Name four measures which can be taken to prevent soil erosion.**	**(4)**

Any four of the following (✓ each):

- introducing vegetation or other types of ground cover (such as mulch)
- contour ploughing
- planting windbreaks
- leaving grass strips between ploughed land
- avoiding overgrazing
- breaking water flow (e.g. with logs, stone packs, old tyres)
- avoiding surface compaction

5.6 Chapter 6

1.	**The term *topography* refers to three physio-geographic characteristics of the land. Name and explain each one.**	**(9)**

elevation (✓) – the height of the land above sea level (✓✓)
aspect (✓) – the direction which a site or slope faces (✓✓)
slope (✓) – the angle it forms with the plane of the horizon (✓✓)

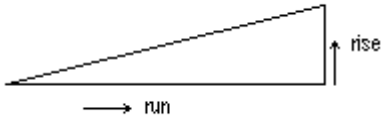
2.	**The slope of the land is the angle it forms with the plane of the horizon. Explain the three ways in which slope can be expressed.**	**(9)**

Slope can be expressed as a **proportion** (✓)which is the ratio of a slope's horizontal distance to its vertical distance. (✓✓) For example, a 1:4 slope rises a vertical distance of one unit for every four units it extends horizontally.

Slope can be expressed in **degrees** (✓) which is a measurement used to represent the angle of a slope. (✓✓) Degrees can be measured with a protractor or with survey instruments.

Slope can be expressed as a **percentage** (✓) which is calculated using the formula (✓✓ for the formula):

$$\text{Slope} = \frac{\text{rise}}{\text{run}} \times 100$$



3.	**Explain what an A-frame is and what it can be used for.**	**(3)**

An A-frame is a levelling device (✓) which can be used to measure the percentage of a slope (✓) and to mark out contour lines along a slope or hillside (✓).

4.	**List 8 organic materials commonly used for mulching, and 8 organic materials commonly used to make compost.**	**(8)**

Common **mulching** materials (any eight, ✓ each):

- compost
- animal manure
- tree bark
- wood chips
- straw
- dry grass and leaves
- seaweed
- paper products
- natural fibres
- sticks and branches

Common **compost** materials (any eight, ✓ each):

- fruit and vegetable scraps
- egg shells
- bones
- feathers
- hair
- paper products
- wood chips
- tree bark
- straw
- ash
- seaweed
- animal manure
- garden waste
- coffee grounds
- mielie cobs and stalks
- weeds
- natural fibres

5.	**Discuss six different factors which are important to consider when selecting a site for growing vegetables.**	**(12)**

Any six of the following (✓✓ each):

Accessibility
The site must be close enough to visit regularly; it should also be accessible with a vehicle, cart or wheelbarrow.

Security
The site must be secure from animals and theft.

Wind
The site should be protected as much as possible from wind, as too much wind – as well as certain types of wind – can damage the plants.

Water
There needs to be a water supply close enough to be easily accessible, to allow for additional irrigation when it is hot and dry, and during times of low rainfall or drought.

Soil
The soil should be as healthy as possible; it must be deep enough to grow vegetables in (at least 60 cm), and it should not be too rocky.

Aspect
Plants need to receive at least 5 hours of sunlight a day, so the site should get maximum sunshine all day long.

Slope
Flat sites are are easy to work on, and soil erosion and water loss is minimised.

5.7 Chapter 7

1.	**Explain the purpose of diversion furrows.**	**(3)**

A diversion furrow directs rainwater runoff (✓) from gullies, grasslands or hard surfaces such as paths or roads (✓) to a cropped area or to a storage tank (✓).

2. List six WHC methods which can be implemented in any type of soil. (6)

Any six of the following (✓ each)

- diversion furrows
- trench beds
- mulching
- stone bunds
- swales
- terraces
- fertility pits
- ploegvore

3. Explain the role of mulch in conserving water, and list four other advantages of using mulch. (6)

Mulching conserves water by increasing infiltration and reducing evaporation. (✓✓)

Any four of the following advantages (✓ each)

- Mulch protects the soil from erosion
- Mulch reduces compaction from the impact of heavy rains
- Mulch helps maintain a more even soil temperature
- Mulch helps prevent weed growth
- Mulch provides organic matter to the soil which improves root growth, increases water infiltration and improves the water-holding capacity of the soil
- The organic matter provided by mulch is also a source of plant nutrients and provides an ideal environment for earthworms and other beneficial organisms

4. Briefly outline the process involved in constructing a trench bed. (16)

(✓✓ per step in correct order)

Step 1: A place which is suitable for growing vegetables is selected and the ground is cleared of any rocks, bushes and grass.

Step 2: The trench bed is marked out using sticks and string.

Step 3: The topsoil is dug out to a depth of about 30 cm and placed to one side. The subsoil is then dug out until the trench is 1 metre deep. The subsoil is placed in a separate pile to the topsoil.

Step 4: The ground at the bottom of the trench is loosened and a layer of coarse organic material is placed at the bottom and covered with about 10 cm of subsoil. The layers are mixed together and watered.

Step 5: Alternate layers of organic material and subsoil are added until the trench is full. Each layer is watered.

Step 6: The topsoil is placed on top of the trench. Compost or manure is added to the topsoil and mixed in, and the bed is flattened using a rake or piece of wood.

Step 7: The bed is covered with a layer of mulch and left for a week or two before planting.

Step 8: Diversion furrows are dug from hard surfaces (e.g. paths and roads) to the trench bed so that the trench received runoff when it rains.

5. Name the WHC method which leads to the formation of natural terraces. (1)

Stone bunds (✓)

6. Explain what a terrace is and list four advantages of creating terraces. (6)

A terrace is a level strip of soil built along the contour of a slope and supported by an earth or stone bund. (✓✓)

Advantages of using terraces (any four, ✓ each):

- terraces create flat planting areas
- terraces stabilize slopes which would otherwise be too steep for crop production
- terraces slow down runoff
- terraces increase the infiltration of water into the soil
- terraces help control soil erosion

7. Explain how tied ridges increase the water that is available to plants. (2)

Terraces increase the water that is available to plants by collecting rainfall from an unplanted sloping basin and catching it with a furrow and ridge. (✓✓) Plants are placed on either side of the furrow where the water infiltrates.

8. Define the term *swale* and explain why swales should be used with caution in areas with high rainfall. (4)

A ***swale*** is an earth bank constructed along the contour with a furrow on the up-slope side. (✓✓)

Swales should be used with caution in areas with high rainfall (1200 mm or more) because waterlogging can occur. (✓✓)

9. Briefly outline the process involved in creating a fertility pit. (10)

(✓✓ per step in correct order):

Step 1: A site is chosen for the pit and a circle about 2 metres is diameter is marked and dug out to a metre deep. The soil which is removed is placed around the edge of the pit.

Step 2: The soil around the edge of the pit is shaped to form a ridge or mound. If the pit is on a slope, diversion furrows are dug to direct runoff into the pit.

Step 3: The pit is filled with organic material, with the most coarse materials at the bottom.

Step 4: Trees and plants are planted around the rim of the mound.

Step 5: The pit is used as a compost heap.

10. Define the term *greywater harvesting*. (2)

Greywater harvesting is the practice of directing greywater (all non-toilet wastewater produced in a household (✓) such as the water used for bathing, wathing, cleaning, cooking and rinsing) to the root zone of the soil (✓).

11. Explain why greywater does not need extensive chemical treatment before it can be used for irrigation. (2)

Greywater does not need extensive chemical treatment before it can be used as irrigation water because it goes through a natural purification process (✓) as it passes through the biologically active region of the soil/percolates through a healthy topsoil (✓).

12. Explain why greywater from the kitchen is the least desirable water to recycle. (4)

Greywater from the kitchen is the least desirable water to recycle because:

- the large amount of organic matter that is introduced into the water when food is prepared and dishes are washed is a significant source of contamination (✓✓)
- the oils and greases which dishwashing water usually contain have a negative impact on the soil because they accumulate, which affects the ability of the soil to absorb water. (✓✓)

13. List four guidelines and two precautions pertaining to the use of greywater. (6)

Guidelines (any four, ✓ each):

- Use greywater as soon after it is created as possible.
- Collect greywater in buckets and carry it to where it will be used.
- Apply the greywater directly onto the soil, around plants whose edible parts grow above the ground.
- Do not allow greywater to come into direct contact with the edible parts of food crops.
- Add mulch to areas where greywater is used to speed up the natural decomposition of waste residues.
- Alternate between applying greywater and freshwater to the soil to help leach out soil contaminants such as sodium.

Precautions (any two, ✓ each):

- Never drink greywater.
- Do not store greywater for more than a day, as micro-organisms will grow and reproduce in it, making it septic.
- Do not use greywater in areas prone to waterlogging.

14. Name the WHC method which is particularly effective for rehabilitating degraded soils, and explain why this method is effective. (4)

Ploegvore (✓). The method is effective because numerous small, well-formed pits are created in the soil (✓) which collect rainwater runoff, seed, sediment and plant litter (✓) and provide a relatively sheltered microclimate in which seed and seedlings can grow (✓).

15. Explain the difference between harvesting water from rock domes and harvesting water in Saaidamme. (8)

Harvesting water from rock domes involves intercepting and directing rainwater runoff from the rock dome directly to a field or reservoir, using a low diversion wall around the base of the dome to collect and channel the water. (✓✓✓✓)

Harvesting water in saaidamme involves diverting floodwater from non-permanent rivers into a series of flat basins which are used for cropping. The basins are completely surrounded by low earth walls. Diverted water is channelled into the fields and completely submerges the land for 1 to 3 days, where it fully saturates the soil. Water is released from the saturated field to the next field needing water through small stone spillways or larger steel sluice-gates. (✓✓✓✓)

16. Explain the term *runoff coefficient* as used in relation to roofwater harvesting. (2)

A **runoff co-efficient** is used to calculate the amount of the rainfall that will run off a roof and the amount which will be lost to evaporation and absorption. (✓✓) The higher the runoff co-efficient for the roof, the more water can be collected from it.

6. Assessment Guidelines

Formative and summative assessments can be developed and structured according to:

- the requirements and preferences of your learning institution;
- your own assessment preferences; or
- the assessment framework presented below, which can be used as is or adapted to suit your own assessment preferences.

Assessment Framework – WHC Technical Module

Class Mark	50%
Portfolio	50%
Total Mark – WHC Technical Module	**100**

Class Mark (50% of Total Mark for WHC Technical Module)			
Assessment Type	**Content**	**Due Date**	**% of Class Mark**
1. Class Test	Chapters 1-4		20%
2. Group activity and presentation of findings.	Activity 16: Soil Profile		20%
3. Group activity and individual report.	Activity 20: Trench Beds		20%
4. Group activity and individual report	Activity 22: Swales		20%
5. Class Test	Chapters 5-7		20%
			100% (Total Class Mark)

Guidelines for Class Mark

1. Class Test

Set a class test (30-50 marks) based on the content of Chapters 1-4. Make sure that you do not set any questions based on contextual information, as this information is not for assessment purposes.

2. Group Activity and Presentation of Findings – Activity 16: Soil Profile

You can assess the group task and presentation in the following way:

i. **Individual participation in the group activity** (use Assessment Rubric 5: Individual participation in a task/activity).

Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity. For example, you can show students a copy of Assessment Rubric 5, or you can develop a handout outlining more detailed assessment criteria if you prefer.

You will also need to have copies of Rubric 5 (one for each student) with you on site when the class does Activity 16 so that you can easily assess the participation of each student.

ii. **Group presentation** (use Assessment Rubric 1, 2 ***or*** 3).

Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity and preparing for their presentations. For example, you can show students a copy of the Assessment Rubric you plan to use, or you can develop a handout outlining more detailed assessment criteria if you prefer.

You will also need to have copies of the Assessment Rubric you plan to use (one for each group) with you when students do their presentations.

Mark allocation for group task and presentations (Activity 16):

Individual participation	10
Group presentation	10
TOTAL	**20**

3. Group Activity and Individual Report – Activity 20: Trench Beds

Detailed guidelines for activity reports (group and individual reports) are provided in Section 4.7 of this manual. You can use a combination of any/all of the following to assess this activity:

i. **Individual participation in the group activity** (use Assessment Rubric 5: Individual participation in a task/activity).

   Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity. For example, you can show students a copy of Assessment Rubric 5, or you can develop a handout outlining more detailed assessment criteria if you prefer.

   You will also need to have copies of Rubric 5 (one for each student) with you on site when the class does Activity 20 so that you can easily assess the participation of each student.

ii. **Group activity and report** (use Assessment Rubric 1 ***or*** 2).

   Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity. For example, you can show students a copy of Assessment Rubric 1 or 2, or you can develop a handout outlining more detailed assessment criteria if you prefer.

   You will also need to have copies of Rubric 1 or 2 (one for each student) with you on site when the class does Activity 20 so that you can easily assess the group activity.

iii. **Individual report** (develop your own assessment criteria and/or a marking schedule)

   Make sure that you provide students with the assessment criteria you will be using *before* they begin writing their reports.

4. Group Activity and Individual Report – Activity 22: Swales

Detailed guidelines for activity reports (group and individual reports) are provided in Section 4.7 of this manual. You can use a combination of any/all of the following to assess this activity:

i. **Individual participation in the group activity** (use Assessment Rubric 5: Individual participation in a task/activity).

   Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity. For example, you can show students a copy of Assessment Rubric 5, or you can develop a handout outlining more detailed assessment criteria if you prefer.

You will also need to have copies of Rubric 5 (one for each student) with you on site when the class does Activity 22 so that you can easily assess the participation of each student.

ii. **Group activity and report** (use Assessment Rubric 1 ***or*** 2).

Make sure that you provide students with the assessment criteria you will be using *before* they begin the activity. For example, you can show students a copy of Assessment Rubric 1 or 2, or you can develop a handout outlining more detailed assessment criteria if you prefer.

You will also need to have copies of Rubric 1 or 2 (one for each student) with you on site when the class does Activity 22 so that you can easily assess the group activity.

iii. **Individual report**

Develop your own assessment criteria and/or a marking schedule for the individual reports. Make sure that you provide students with clear guidelines and specific assessment criteria for their reports, as well as guidelines for the report presentation.

5. Class Test

Set a class test (30-50 marks) based on the content of Chapters 5-7. Make sure that you do not set any questions based on contextual information, as this information is not for assessment purposes.

Portfolio (50% of Total Mark for WHC Technical Module)			
Assessment Type	**Content**	**Due Date**	**% of Portfolio Mark**
1. Presentation of portfolio	Portfolio presentation		5%
2. Written report on activity.	Activity 7: Make your own terrarium		20%
3. Written report on individual activity.	Activity 8: Water Catchments		20%
4. Written report on group activity.	Activity 17: Conduct a soil pH test		15%
5. Written report on group activity.	Activity 18: A-frames		20%
6. Critical analysis and self-reflection	Course Reflection		20%
	Portfolio Submission Date		
			100% (Total Portfolio Mark)

Guidelines for Portfolio

1. Presentation

Assess the presentation of the portfolio using the following criteria:

Cover page: name, number, module name, facilitator name, title of document. **(5)**

Contents page: Sections of the portfolio are listed in the correct order, with page numbers next to each section. **(7)**

Overall presentation: The portfolio is neat and logically ordered, each section has a clear heading, and pages are numbered correctly (with numbers corresponding to the contents page). **(8)**

(Total: 20)

(*This total mark out of 20 counts 5% towards the portfolio mark)*

Make sure that students know ahead of time exactly how their portfolios should be presented. You can give them each a copy of the assessment criteria outlined above, including any specific criteria or layout preferences that you wish to add.

2. Written report on Activity – Activity 7: Make your own terrarium

Develop your own assessment criteria and/or a marking schedule for the individual reports. Make sure that you provide students with clear guidelines and specific assessment criteria for their reports, as well as guidelines for the report presentation.

3. Written Report on Individual Activity – Activity 8: Water Catchments

Develop your own assessment criteria and/or a marking schedule for the individual reports. Make sure that you provide students with clear guidelines and specific assessment criteria for their reports, as well as guidelines for the report presentation.

4. Written Report on Group Activity – Activity 17: Conduct a Soil pH Test

It is suggested that for assessment purposes you add further questions to Activity 17. For example:

1) What was the name of the soil test kit you used, where was it obtained, and how much did it cost?
2) What exactly did the soil test kit consist of?
3) How did you use the kit to test the soil? (i.e. exactly what steps did you follow?)
4) List five plants which you would not try to grow in this type of soil (refer to Table 5.5).

Develop your own assessment criteria and/or a marking schedule for the individual reports. Make sure that you provide students with clear guidelines and specific assessment criteria for their reports, as well as guidelines for the report presentation.

5. Written Report on Group Activity – Activity 18: A-frames

Develop your own report requirements as well as specific assessment criteria and/or a marking schedule for the reports. Make sure that you provide students with clear guidelines and specific assessment criteria for their reports, as well as guidelines for the report presentation.

Suggestions:

Reports can include a section where students reflect on their experience as a group member participating in this particular activity. For example:

- Describe you experience as a member of your group.
- What specific challenges did you face personally, and how did you address these?

- What positive experience/s did you have as a member of this group? (e.g. what did you particularly enjoy doing and why; what did you learn; and how can and/or will you use this knowledge in the future?).

Reports can also include a section where students reflect on the activity itself. For example:

- Did you/the group find the instructions easy to follow? Did you all have a similar understanding as to what the instructions meant and entailed? How did the group resolve any differences which arose?
- How easy or difficult was it to measure the percentage of three different slopes? How did group members interact and work together during this step?
- What was your personal contribution to the activity? (i.e. what task/s did you carry out during the activity?). How were the tasks assigned? Did you find it easy or difficult to perform your assigned tasks?
- If your group had to do the activity again, what suggestions would you make in order for your group to carry out the activity more efficiently and effectively?, etc.

6. Critical Analysis and Self-Reflection – Course Reflection

Develop a set of questions around WHC that call for a critical analysis of the course and for in-depth self-reflection in relation to the course (the answers to which should be presented in the form of a written report). Develop and provide students with clear and specific assessment criteria for their reports, as well as guidelines for the report presentation.

Some examples of questions which you could include are:

- Describe/name the most important thing that you learned on this course (in relation to WHC), and explain why this specific thing was so important for you to learn.
- What aspect of this course did you find the most difficult, and why? Explain in detail.
- What aspect of this course did you find the most interesting, and why? Explain in detail.
- What aspect of WHC facilitation do you find most challenging, and why? Explain how you plan to meet and/or overcome this challenge if/when you work as a WHC facilitator.
- If you had to do this course again, is there anything that you would do differently, and why? Explain in detail.
- If you had to teach this course to a group of students, is there anything that you would do differently, and why? Explain in detail.
- Describe your experience of being a member of this class (i.e. being one of this group of students). In what ways was this experience positive, and in what ways was it negative? Provide reasons for your answers.

7. Assessment Rubrics

The assessment rubrics which follow can be photocopied and used as is, or adapted to suit a specific activity or your own preferences. You can also design and use your own rubrics.

7.1 Assessment Rubric 1

ASSESSMENT RUBRIC

Activity _____ **Assessor** _____

Student/Group _____ **Date** _____

The /group:	1	2-3	4-5	6
followed instructions accurately and completed all tasks				
showed evidence of research/planning				
showed evidence of originality/creativity				
presented information in a clear and convincing manner				

Comments _____

_____

_____

_____

_____

KEY:		
	1	Assessment criteria were not achieved
	2-3	Assessment criteria were partially achieved
	4-5	Assessment criteria were achieved
	6	Assessment criteria were exceeded

7.2 Assessment Rubric 2

ASSESSMENT RUBRIC

Activity _____ **Assessor** _____

Student/Group _____ **Date** _____

	1 (0-24%)	2 (25-49%)	3 (50-74%)	4 (75-100%)
Creative thinking	no evidence of creative thinking	some evidence of creative thinking	fairly creative thinking	excellent creative thinking
Accuracy	inaccurate	some accuracy	adequate accuracy	extremely accurate
Research	no research done	some evidence of research	adequate research	thorough research done
Presentation	poor presentation	presentation not clear	fair presentation	clear and convincing presentation

Comments _____

_____

_____

_____

7.3 Assessment Rubric 3

ASSESSMENT RUBRIC – GROUP PRESENTATION

Activity: _____

Name/s: _____ _____ _____

_____ _____ _____

Assessor: _____ **Date:** _____

The group:	1	2-3	4-5	6
showed active and balanced participation from all members				
sustained the interest of the audience throughout the presentation				
referred to all research aspects and answered all questions				
used clear and correct language throughout the presentation				
displayed good time management				
provided intelligent responses to questions from the audience				

Comments _____

_____

_____

_____

_____

KEY:		
	1	Assessment criteria were not achieved
	2-3	Assessment criteria were partially achieved
	4-5	Assessment criteria were achieved
	6	Assessment criteria were exceeded

7.4 Assessment Rubric 4

ASSESSMENT RUBRIC – INDIVIDUAL PRESENTATION

Activity: _____

Name: _____

Assessor: _____ **Date:** _____

The :	1	2-3	4-5	6
showed evidence of thorough planning and preparation				
sustained the attention/interest of the audience throughout the presentation				
presented all relevant information in a logical order				
used clear and correct language throughout the presentation				
displayed good time management				
provided intelligent responses to questions from the audience				

Comments _____

_____

_____

_____

_____

KEY:		
	1	Assessment criteria were not achieved
	2-3	Assessment criteria were partially achieved
	4-5	Assessment criteria were achieved
	6	Assessment criteria were exceeded

7.5 Assessment Rubric 5

ASSESSMENT RUBRIC – INDIVIDUAL PARTICIPATION IN A TASK/ACTIVITY

Activity: _____

Name: _____ **Group:** _____

Assessor: _____ **Date:** _____

The student:	1	2-3	4	5
displayed enthusiasm and/or a positive attitude towards the task				
demonstrated sustained/ongoing interest in the task				
actively participated in the task				
interacted with other group members in a constructive and meaningful manner				

Comments _____

_____

_____

_____

_____

KEY:		
	1	Assessment criteria were not achieved
	2-3	Assessment criteria were partially achieved
	4	Assessment criteria were achieved
	5	Assessment criteria were exceeded

8. Additional Tools

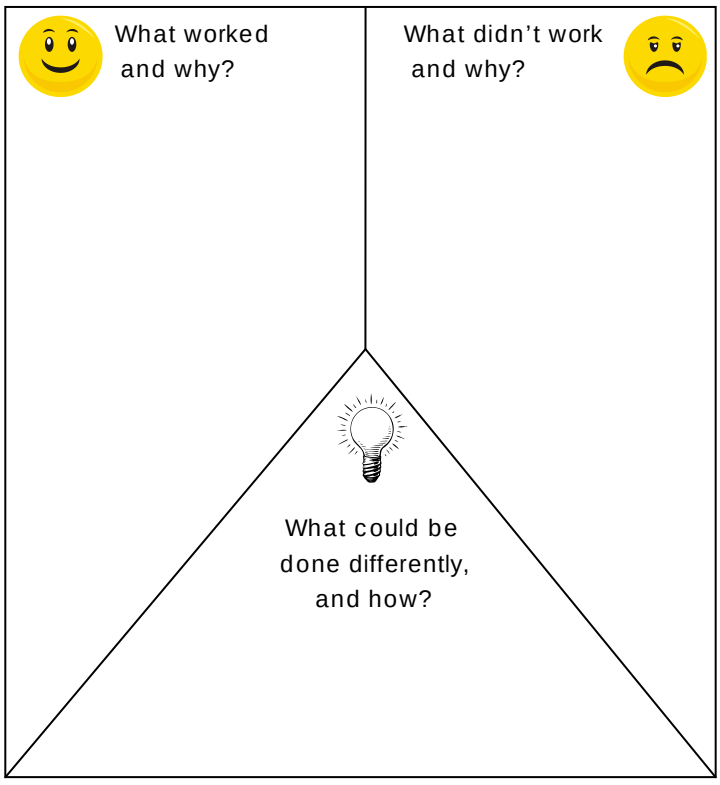
8.1 Unanswered Questions

It is important to encourage students – particularly those who are reticent – to seek clarity on issues and answers to questions that they have about the content of the course. A facilitation tool that can be very useful for this purpose is a (sometimes brief) activity which can be called "Unanswered Questions". The activity entails asking students if they have any unanswered questions which they would like to address, and then addressing them. This can be done at the beginning and/or end of a lesson, or at any time during a lesson when you think it may be useful.

The activity serves two important purposes: it provides an opportunity for students to clarify issues/information that is not clear to them, and it ensures that students feel their learning needs are being recognised. If the activity is done regularly and sensitively, it can be a powerful learning tool for students and can really helping bring a class up to speed. It's worth the investment in time, and it works against the situation where some students are left feeling like they've "missed the boat" along the way.

8.2 Critical Evaluation and Constructive Feedback

The following chart can be used to help students provide you or each other with constructive feedback. It can also be used to help students critically evaluate their own performance.



When using the chart with a class, draw it on the board, or on a piece of newsprint or flipchart paper (use paper if you want to keep a record of the feedback or evaluation).

Getting feedback on a class session

You can use the chart to get feedback on your teaching sessions. At the end of each session, ask students to brainstorm:

- What they liked / found useful, and ***why***.
- What they didn't like / didn't find useful, and ***why***.
- What they would change about the session, and ***how***.

Write up their feedback in the appropriate segment of the chart. Conduct the activity as a brainstorm and limit discussion on the feedback. After each point is made, you can hold a quick vote to see whether the statement is supported by the majority of students, or a minority. If the statement appears to be a minority sentiment, you can record it as such.

Getting feedback on an activity (such as a group or individual presentation)

At the end of the activity, ask students to brainstorm:

- What they liked / what was good, and ***why***.
- What they didn't like / what wasn't good, and ***why***.
- What they would change / what could be improved on, and ***how***.

Write up their feedback in the appropriate segment of the chart. Conduct the activity as a brainstorm and limit discussion on the feedback. After each point is made, you can hold a quick vote to see whether the statement is supported by the majority of students, or a minority. If the statement appears to be a minority sentiment, you can record it as such.

Critically evaluating ones' own performance

Individuals can use the chart to critically evaluate their own performance (for example, their performance on a presentation or demonstration, or your own performance as a facilitator).

At the end of their performance, individuals can ask themselves:

1. What did I do well / what was good, and ***why***?
2. What did I not do well / what was not good, and ***why***?
3. What could I change or improve on, and ***how***?

8.3 Energizers

Energizers are games which can be used to give participants a break from the focus of the session. Experienced educators know how useful it is to be able to offer such games to participants when it seems that energy is slowing down, or when it is time for a change of focus.

Elephant and Paw-Paw Tree

The facilitator gets participants to stand around him/her in a circle.

He/she points to someone and says: "Elephant!"

The person pointed to must put her hands together, put her arms out straight in front of her and bend over to make the trunk of the elephant. The person on her left and the person on her right hand side must bend towards her with their arms outstretched to make the two ears of the elephant.

The person in the middle may alternate "elephant" with "paw-paw tree".

The person in the centre of the circle points to someone and says: "Paw-paw tree!"

That person must put his arms together and point upwards to make the trunk of the paw-paw tree. The person on the left and the person on the right hand side of him must bend away from him with their arms outstretched, waving their hands to make the branches of the paw-paw tree.

Whenever any person makes the wrong move – for example, if a person makes a move to be the ears of an elephant when s/he should be the branches of a paw-paw tree, then that person comes to the middle of the circle. This rule also applies to any person in the circle who makes a wrong move; for example, when the person in the middle points to someone and calls out "elephant" or "paw-paw tree," only the person pointed to and the person to the right and the person to the left must respond. If anyone else makes a move, that person can also be asked to come into the middle and take a turn.

As a facilitator, you stop the action when you judge participants have had enough of the game or when it is time to move on.

Big Wind Blows

Place just enough seats in a circle for everyone but you, the facilitator. You are the big wind, and whoever you "blow" on, has to move. Instead of actually blowing, you call out:

"The big wind blows on everyone who ..... ." You must think of something which is true for you and which might also be true for at least some of the other people in the room. For example, you could say: "The big wind blows on all those who drank tea with their breakfast this morning".

Then everyone who drank tea with their breakfast must jump up and look for another seat. The rule is that you are not allowed to take the seat next to you, and you are not allowed to announce a big wind on people who have – for example, white shirts, or black shoes – if you do not have on a white shirt, or black shoes. In other words, whatever you call out must apply to you as well.

You might also say things like:

"The big wind blows on all those people who are wearing white socks (or black shoes, or a red shirt, etc.).

Whoever is left standing without a seat gets to be the big wind and must do the same.

As the facilitator, at a time when you judge that participants have had enough of the game, you quietly bring an extra seat into the circle so that when everyone sits down, there are enough chairs for everyone – that ends the game.

One variation (especially if you are the big wind and can't think of anything to say) is to say: "Hurricane!"

Then, everyone has to jump up and look for a seat. Remember to announce this variation when you are explaining the rules of the game in the beginning!

Heel to Heel, Toe to Toe

Ensure that there is an odd number of participants. If the number is even, you can ask one person to volunteer to sit out or to be the observer.

The facilitator gives instructions, and each participant has to find a partner to obey the instructions with – the rule is that participants must choose *a different partner every time.*

The facilitator calls out, for example: "Heel to heel" (or "toe to toe" or "knee to knee" or "elbow to elbow," and the participants must quickly find a partner. Each time, a different person will be left out and that person then takes a turn to give the instruction.

Advice: As facilitator, please ensure that you are *culturally sensitive* when using this energiser, as some cultures forbid this kind of physical contact between the sexes.

Zip Zap Boing!

Participants stand in a circle facing into the middle. The facilitator should join the circle. The facilitator should demonstrate and explain how the game works. It can start with anyone.

The first person to start calls out "zip" and nods to the person on his/her right. This person passes the "zip" on, by calling out "zip" and nodding to the person on his/her right. And so each person passes the "zip" on in this way, to the right around the circle, until someone decides to have

some fun – instead of calling out "zip" and passing it on to the right, anyone can decide to nod back at the person passing on the "zip" and call out: "boing". Then the person who passed the "zip" has to change direction immediately, turn around and call out "zap" while nodding to the person on her left. The "zap" then passes around the circle to the left in the same way until someone nods back and calls out "boing". Then the "zip" resumes again to the right around the circle and so on.

Each time a person calls out "boing" in response to being passed a "zip" or a "zap", the direction and sound changes and goes in the opposite direction.

Facilitator ends the game when he/she judges participants are refreshed or have had enough.

Boerewors

This energiser really gets people laughing! Tip: it works best with groups who have been together for a day or two, or with groups where participants know each other fairly well.

Participants form a circle facing into the middle. The facilitator stands in the middle of the circle and starts the game. S/he chooses any participant, walks up to him/her and fires questions at the person:

For example: "What's your name? Where do you live? What's your wife/husband/boyfriend's name? What did you eat for breakfast? What's your favourite movie?", etc.

The rule is that the person being addressed may not smile, may not laugh and may not say anything else but the word "boerewors". If the person being addressed smiles, laughs, or says anything other than "boerewors", that person must come to the middle of the circle and play the role of questioner.

If the questioner is unable to make a person laugh or smile, then s/he moves onto another person and repeats the questioning until s/he gets someone to laugh.

Here I Sit…

Participants and the facilitator sit on chairs placed in a circle. The facilitator adds one extra chair directly to his or her right, and begins the activity by explaining how it works:

The person next to the open chair jumps into the chair calling "Here I sit!"

The person sitting next to the vacated chair jumps into the vacant chair calling "On this chair".

The next person sitting next to the newly vacated chair jumps into the chair, calling: "With my friend _____ (the name of any member of the group)".

The person whose name has been called must run across the circle to jump into the vacant chair.

As the person whose name is called jumps up, a chair will become vacant between *two* members of the group. The idea is that the two participants on either side of the vacated chair must try to jump into the empty chair first.

Whoever succeeds starts a new round by calling "Here I sit," and the game continues.

The game ends when the facilitator judges that participants are ready to continue with other activities.

8.4 Additional Resources for Energizers

For more energizers and icebreakers, go to the websites listed below or do an internet search using keywords such as "classroom energizers", "workshop energizers" or "free energizers".

http://www.businessfundamentals.com/IceBreakers/ice_breakers_energizers.htm

http://www.kimskorner4teachertalk.com/classmanagement/icebreakers.html#Murder

http://www.reproline.jhu.edu/english/5tools/5icebreak/icebreak1.htm

http://adulted.about.com/od/icebreakers/tp/toptenicebreakers.htm

http://www.archertraining.co.uk/energisers.htm

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[10] Lancaster, 2008. *Rainwater Harvesting for Drylands and Beyond. Volume 1: Guiding Principles to Welcome Rain into Your Life and Landscape.* Arizona: Rainsource Press.

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[13] IWMI, 2005. *Multiple Use Water Systems (MUS), Models for implementing multiple-use water supply systems for enhanced land and water productivity, rural livelihoods and gender equity. Information Worksheet,* International Water Management Institute.

[14] Answers.com Reference Answers [Online] Available from: http://www.answers.com/topic/water-conservation [Accessed on 30 July 2009].

[15] *National Water Act (Act 36 of 1998)* [Online]. Available from: http://www.dwaf.gov.za/Documents/Legislature/ nw_act/NWA.pdf [Accessed 30 July 2009]

10. Worksheet & Handouts

HANDOUT 1

PERCENTAGE (%)

What is a percentage?

A percentage means *anything out of 100*.

Example 1: There are 100 apples in the box. 60 are red, and 40 are green.

This means that 60% of the apples in the box are red, and 40% of the apples in the box are green.

Example 2: *You get 80 out of 100 for your class test. This means that you got 80% for the test.*

$\frac{80}{100}$ means 80 ÷ 100, which equals 0.80.

To present this as a percentage, we have to multiply it by 100.

$\frac{80}{100}$ X 100 = 80%

Example 3: *You can convert any fraction into a percentage by multiplying it by 100:*

$\frac{26}{50}$ X 100 = 52%

Calculate the following:

1. There are twenty students in the class. 8 are wearing red shirts. What percentage of students are wearing red shirts?

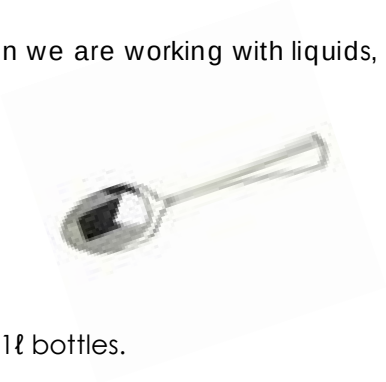
2. There were 40 birds sitting in a tree. 10 flew away.

   2.1 What percentage of birds flew away?
   2.2 What percentage of birds remained sitting in the tree?

3. You achieved 32 out of 40 for your class test. What was your percentage?

VOLUME

Volume refers to the amount of space that an object occupies. When we are working with liquids, such as water, we measure volume in milliliters (mℓ) and litres (ℓ).



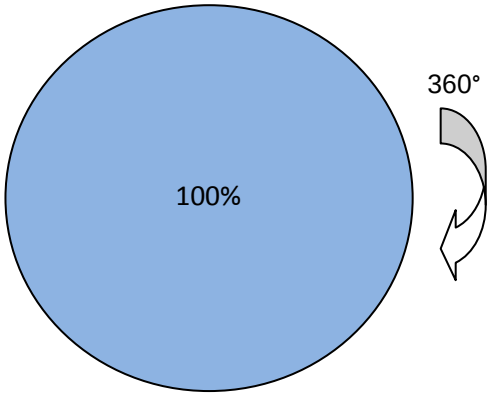
1 mℓ is a very small amount of water – it doesn't even fill a teaspoon.
A normal teaspoon holds about 5 mℓ of water (or any other liquid).

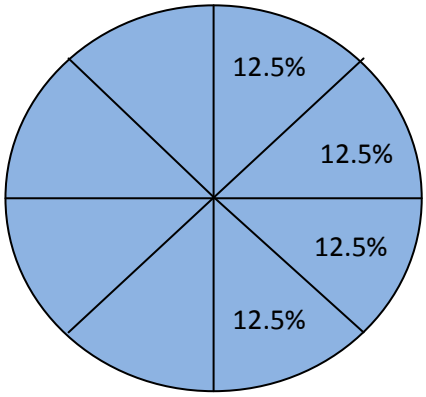
There are 1000 mℓ in one litre (1ℓ). Milk and coldrinks are often sold in 1ℓ bottles.

QUESTION: How many teaspoons of water will it take to fill a 1ℓ bottle?

HANDOUT 2

PIE CHARTS





Pie charts are used to represent data as portions (segments) of a whole.

If a pie chart is divided evenly, each portion is the same.

All segments of a pie chart added together equals 100%.

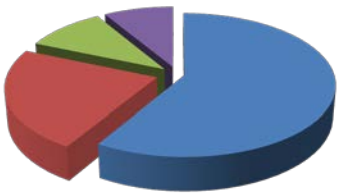
You can calculate the degree of the angle for each segment by using the total number of degrees of a circle (360°).

Formula to convert a % into a degree:
3.6° x X% = Y°
(Example: 25% = 3.6° x 25% = 90°)

Question: Why would you need to know the degree of the angle for each segment?

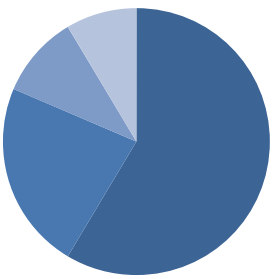
Once a pie chart has been divided into segments, each segment is coloured and labeled with the percentage that it

1. Draw a pie chart which represents the following data:
   50 cabbages, 10 onions, 5 carrots, 5 potatoes and 30 beans.



2. Draw a pie chart which represents the following data:
   8 chickens, 12 sheep, 10 pigs, 4 dogs, 7 cows and 9 ducks.

3. Draw a pie chart which represents the following data:
   mielies 58%, spinach 17%, tomatoes 11%, beetroot 8% and lettuce 6%.



Handout 3

Water pollution: an introduction

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it. At such low levels, the chemicals in the ink probably would not present any real problem. However, if you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly have an effect on the quality of the water. This, in turn, could affect the health of all the plants, animals, and humans whose lives depend on the river.

Sewage

With over 8 billion people on the planet, disposing of sewage waste is a major problem. In developing countries, many people still lack clean water and basic sanitation (hygienic toilet facilities). Sewage disposal affects people's immediate environments and leads to water-related illnesses such as diarrhoea that kills 3-4 million children each year. (According to the World Health Organization, water-related diseases could kill 135 million people by 2020.) In developed countries, most people have flush toilets that take sewage waste quickly and hygienically away from their homes.

Yet the problem of sewage disposal does not end there. When you flush the toilet, the waste has to go somewhere and, even after it leaves the sewage treatment works, there is still waste to dispose of. Sometimes sewage waste is pumped untreated into the sea. Until the early 1990s, around 5 million tons of sewage was dumped by barge from New York City each year. The population of Britain produces around 300 million gallons of sewage every day, some of it still pumped untreated into the sea through long pipes. The New River that crosses the border from Mexico into California carries with it 76-95 million litres of raw sewage each day.

In theory, sewage is a completely natural substance that should be broken down harmlessly in the environment: 90% of sewage is water. In practice, sewage contains all kinds of other chemicals, from the pharmaceutical drugs people take to the paper, plastic, and other wastes they flush down their toilets. When people are sick with viruses, the sewage they produce carries those viruses into the environment. It is possible to catch illnesses such as hepatitis, typhoid, and cholera from river and sea water.

What are the effects of water pollution?

Some people believe pollution is an inescapable result of human activity: they argue that if we want to have factories, cities, ships, cars, oil, and coastal resorts, some degree of pollution is almost certain to result. In other words, pollution is a necessary evil that people must put up with if they want to make progress. Fortunately, not everyone agrees with this view. One reason people have woken up to the problem of pollution is that it brings costs of its own that undermine any economic benefits that come about by polluting.

Sewage is a good example of how pollution can affect us all. Sewage discharged into coastal waters can wash up on beaches and cause a health hazard. People who bathe or surf in the water can fall ill if they swallow polluted water – yet sewage can have other harmful effects too: it can poison shellfish (such as cockles and mussels) that grow near the shore. People who eat poisoned shellfish risk suffering from an acute – and sometimes fatal – illness called paralytic shellfish poisoning. Shellfish is no longer caught along many shores because it is simply too polluted with sewage or toxic chemical wastes that have discharged from the land nearby.

Pollution matters because it harms the environment on which people depend. The environment is not something distant and separate from our lives. It's not a pretty shoreline hundreds of miles from our homes or a wilderness landscape that we see only on TV. The environment is everything that surrounds us that gives us life and health. Destroying the environment ultimately reduces the quality of our own lives – and that, most selfishly, is why pollution should matter to all of us.

http://www.explainthatstuff.com/waterpollution.html

Water quality threatens SA beaches

2010-10-28 20:37 – **Cape Town** – The quality of bathing water at South African beaches was slowly deteriorating due to poor sewerage management, the Wildlife Society of SA (Wessa) said on Thursday. “We are noticing slow deterioration in bathing water quality along most of the coast and this appears to be related to poor sewerage and storm water management within the broader catchment that leads to the beaches,” said Wessa Blue Flag programme manager Alison Kelly. She said water quality in rivers and estuaries was deteriorating markedly.

http://www.watersense.co.za/2010/11/01/water-quality-threatens-sa-beaches/

Broken sewage info not for public

2010-09-15 20:03 – **Cape Town** – Information on hundreds of dysfunctional sewage treatment plants will not be made public, the government said on Wednesday. In a written reply to parliamentary questions, Water and Environmental Affairs Minister Buyelwa Sonjica said revealing such information could lead to “serious misinterpretation” of the data. “What is available and was published... in the 2009 Green Drop Report, is the summary of the performance of each of the 449 WWTWs (waste water treatment works) that were assessed,” she said.

The Green Drop Report – an audit of 449 of South Africa’s 852 municipal WWTWs, conducted between August 2008 and July 2009 – was released, after long delays, in April this year.

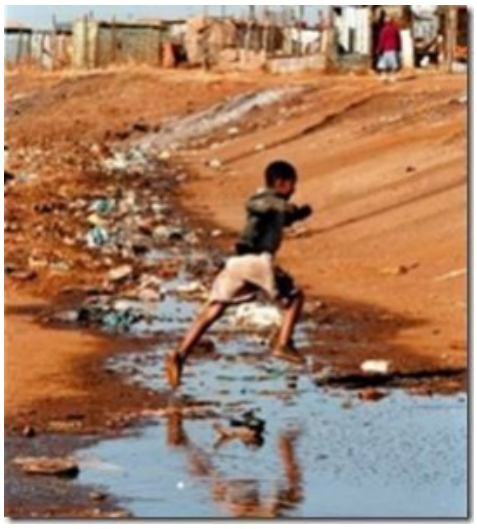
According to the document, a total of 403 facilities were not assessed due to, among other things, “municipal officials not sufficiently confident in their levels of competence” and “municipalities not managing waste water services according to expected requirements”. It also found that of the 449 works that were assessed, skills shortages had resulted in many not being operated correctly and “the effluent water quality is no longer compliant”. Among the parliamentary questions posed to Sonjica – by Democratic Alliance MP Annette Lovemore – was whether information for all WWTWs would be made available to the public, and if not, why not. The minister replied: “No, such detail (sic) information is not available to the public. Revealing details of such a high technical nature will lead to unnecessary additional administrative challenges and serious misinterpretation.”

Speaking to Sapa, Lovemore said not making public information on potential threats to people’s health was unacceptable. “It’s not acceptable. Each municipality is required to report on results (from WWTWs) each month. If there is a health risk, people should be told.” She said that over and above the risks to human health of sewage water finding its way into rivers and streams, the contaminated water also affected crop irrigation, drinking water for livestock and the health of the environment. In her reply, Sonjica further said that not all WWTWs had been issued licences or permits to operate. She did not say how many. Reasons for municipal sewage works not having operating licences included that some had not applied for one, some did not meet the standard required for a licence, and others had “insufficient capacity” to submit the application. Her department had launched a special project “to address the current backlog in licences”, she said. – SAPA

http://www.watersense.co.za/2010/09/15/broken-sewage-info-not-for-public/

Sewage works neglected – govt

2010-05-11 16:07 – **Cape Town** – The government on Tuesday admitted it has for years failed to properly regulate municipal sewage works, many of which are discharging untreated or only partially-treated human waste into rivers around the country.



“The regulation function was to some extent neglected,” water affairs acting chief director of regulations Helgard Muller told members of Parliament’s water affairs portfolio committee. “Let me admit, I think that immediately after 1994, and for some years, this function was not getting the right attention... We had to prioritise due to limited resources,” he said. Muller’s admission comes a fortnight after the release of his department’s Green Drop Report, which assessed 449 of the country’s 852 waste water treatment plants. It found only 32 of them qualified for so-called Green Drop status, broadly equivalent to them complying with international standards. Further, it found that “the bulk of the (sewage) plants can be described as poor to non-functional”, implying that hundreds of millions of litres of inadequately-treated sewage was being illegally discharged each day, mainly by small town municipalities.

Among its recommendations was that the department complement its incentive-driven approach to getting municipalities to comply with provisions of the Water Act with a more regulatory one, including, where necessary, punitive measures. Briefing committee members, department legal adviser Harish Jhupsee indicated that this process had commenced. In the past, water affairs had only "monitored" compliance. "The enforcement aspect seemed to be lacking most of the time. It never really happened. It's only since April 1 (this year)... that it's being fast-tracked and we have established a directorate." Such action had now become a priority.

The department had issued 56 directives to municipalities around the country, calling on them to ensure their waste water treatment plants complied with regulations. In seven cases, criminal charges had been laid. "Following up on those directives will be a very important aspect, and the criminal aspect to it as well. This will be a deterrent and (will send) a message to non-conforming, non-complying officials... We cannot allow criminal activity to carry on," he said.

Muller told MPs there were discussions underway with the Treasury to try and ensure the portion of municipalities' equitable share earmarked for water and sanitation was actually used for this purpose. "The equitable share is quite substantial, but the money doesn't reach the water and sanitation component. We are working with Treasury to engage with them at the time municipal budgets are determined, to look at why can't we engage with that process. "So that from a national side, we force them to ringfence the water and sanitation budget, and ensure that the money that's given from the equitable share actually gets allocated to the right point," he said.

MPs at Tuesday's briefing questioned whether R23bn – the amount Water Affairs Minister Buyelwa Sonjica says she needs to patch up the country's collapsing sewage works – was enough. Democratic Alliance MP Annette Lovemore said the Western Cape alone required R8bn to solve its waste water problems. "The Western Cape is by far one of the better-performing provinces, so R23bn for the country – I wonder if this is not a serious under-estimation," she said.

Tuesday's briefing comes only days after TAU-SA and the National Water Forum laid criminal charges against three ministers, including Sonjica, for failing to stop pollution in South Africa's rivers. The others who were charged are Agriculture, Forestry and Fisheries Minister Tina Joemat-Pettersson and Mineral Resources Minister Susan Shabangu. South Africa's extensive network of sewage treatments plants, pipe networks and pump stations treats about 7.5bn litres of waste water a day. – SAPA

http://www.watersense.co.za/2010/05/12/sewage-works-neglected-govt/

Worksheet 1

Soil Texture: Using the Textural Triangle

Soil texture can also be determined scientifically by taking a soil sample to a laboratory for a **particle size analysis**. When lab data is available, the **Textural Triangle** is used to determine the textural class of the soil (there are twelve major classes of soil texture).

You can use the Textural Triangle if you know the percentages of any two of the three soil separates (clay, sand, silt) in a soil sample. (You only need to know two of the percentages because all three must total 100%). For example, if your soil sample consists of 20% clay and 45% sand, do the following to determine its class:

Step 1: Locate the 20% mark for clay on the left side of triangle and draw a line across, parallel to the base of the triangle (follow the arrow under the word **clay**).

Step 2: Locate the 45% mark for sand at the base of the triangle, and draw a line up, parallel to the right side of the triangle (follow the arrow next to the word **sand**). The point at which the two lines intersect indicates the textural class of the soil, which in this case is **loam**.

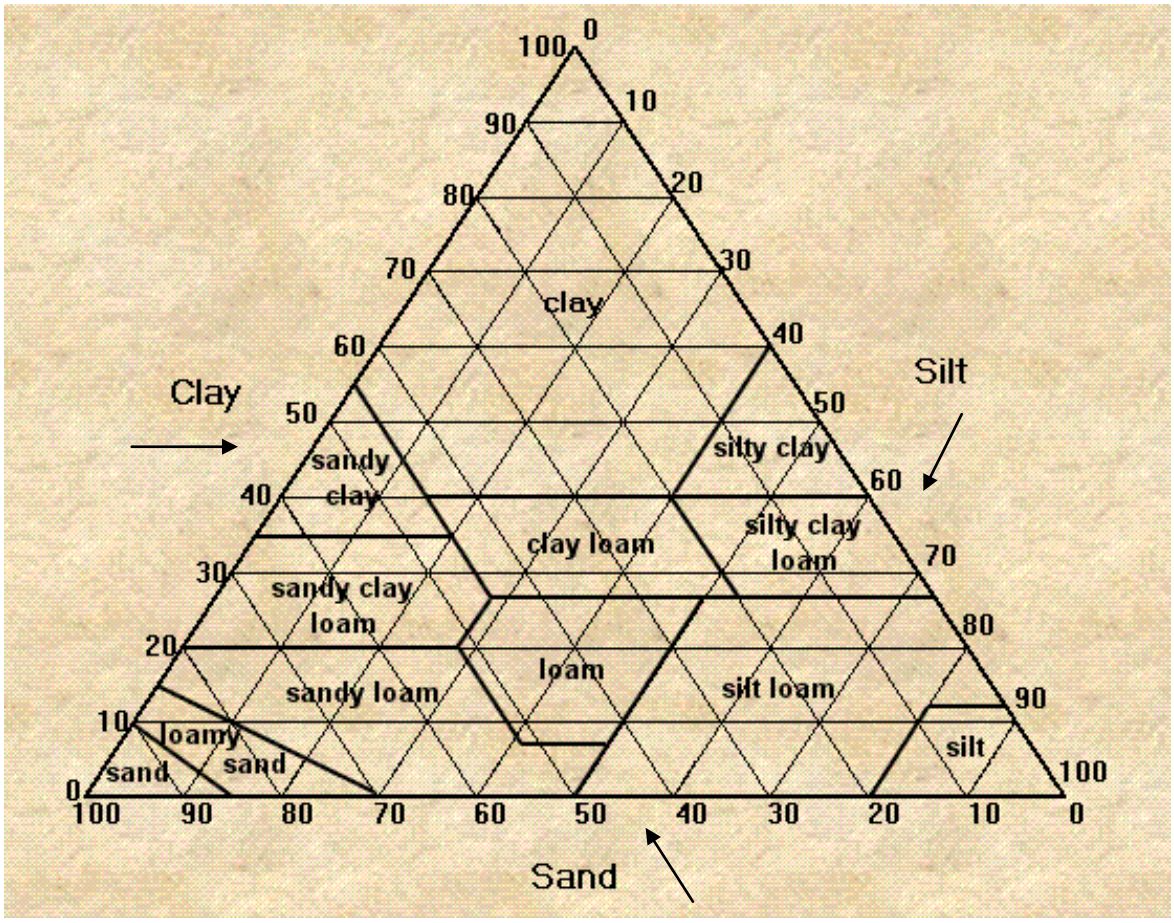


Figure 1 Soil Textural Triangle

EXERCISE

Use the Textural Triangle to complete the following:

1. Your soil sample consists of 50% sand and 50% clay. What type of soil is it?

2. Your soil sample consists of 30% silt and 35% sand. What type of soil is it? What percentage of clay is in the soil?

3. Your soil sample consists of 45% clay and 45% silt. What type of soil is it? What percentage of sand is in the soil?

4. Your soil sample consists of 62% clay and 34% sand. What type of soil is it? What percentage of silt is in the soil?

5. Your soil sample consists of 68% sand and 23% silt. What type of soil is it? What percentage of clay is in the soil?

6. Your soil sample consists of 70% silt and 10% clay. What type of soil is it? What percentage of sand is in the soil?

Answers:

1. *sandy clay*
2. *clay loam; 35%*
3. *silty clay; 10%*
4. *clay; 4%*
5. *sandy loam; 9%*
6. *silty loam; 20%*