Orange-Senqu Storytelling Mascots - Thabana Ntlenyana & Maluti – Origination: Pandora Schep

Working Out What To Do

Action Learning For a Living River

The Orange-Senqu River Learning Box

ORASECOM
THE ORANGE-SENQU RIVER COMMISSION

Background

The Orange-Senqu River Learning Box, Action learning for a Living River is an innovative and creative education response to the sustainable water resources management needs of the Orange-Senqu River Basin overseen by the **Orange-Senqu Youth River Learning and Programme Development (OSYRL&PD)**

The development of this project has been undertaken by the Orange-Senqu River Commission (ORASECOM). The project is being implemented by WESSA (the Wildlife and Environment Society of South Africa) in partnership with Mokolodi Nature Reserve in Botswana; the National Curriculum Development Centre (NCDC) in Lesotho, the Desert Research Foundation; Namibia (DRFN) in Namibia; and WESSA; Northern Areas Region in South Africa.

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Sharing the Water Resources of the Orange-Senqu River Basin

Prepared by:

In partnership with

In collaboration with

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1.1.6. Working out what to do

How much fresh water is there on Earth?

Demonstrate the amount of fresh water that is available on Earth using a 1 litre container.

In this activity, learners will see how water is distributed across different water sources and how much freshwater on Earth is available for use. They will discuss the importance of water and the availability of surface water in the Orange-Senqu Basin.

You will need:

- A container that can hold 1 litre of water.
- A set of measuring cups
- Plastic eye droppers
- Water (you can colour it with food colouring to make it more visible if you like)
- Salt

Preparation

Prepare one litre of coloured liquid using food colouring. This will just make it easier to see when demonstrating. Place the materials in front of the classroom where everyone can see them.

Introducing the topic

Using the Orange-Senqu River Basin map, discuss where surface water is found in the Basin and some of the many uses thereof. Eco-systems (plants and animals) need water to survive, just as people use water to drink, cook food, bath and wash clothes. It is used by mining, industry (to manufacture goods) and by farmers to produce food. Ask your learners to list the various sources of water in the Orange-Senqu Basin. These can include the Atlantic Ocean, the Orange River Mouth estuary, the Orange-Senqu River and its tributaries, the dams, lakes and wetlands. There is also ice and snow in the Lesotho highlands in winter! List these water sources on the board so that your learners can see them throughout the activity. Use the word vocabulary at the end of this unit to ensure that your learners know what each one means.

What to do

Divide your class into six groups. Show them the one litre of coloured water and explain to them that for this demonstration, the litre of water will represent all the water in the world. Tell your learners that you are going to divide the world's water among all six groups. Each group will have one source of water to provide for all their needs. One group will have all the water that is found as ice, one group the water in rivers, one group will have sea water. You can let your groups choose which source of water they would like to receive, or you can give each group a water source.

Before you hand out the water, let each group guess how much they think they will get. Then using the amounts listed below, distribute the water to the groups one by one. Use clear measuring cups so that it is easy for the whole class to see the amount of coloured water in them. Ask one learner to help you hand out the cup to the group and another learner to write the amount on the board next to the relevant water source.

- ICE: 20.6 ml
- GROUNDWATER: 9 ml
- LAKES & DAMS: 0.08 ml
- WETLANDS: 0.01 ml (about 5 drops)
- RIVERS: 0.002 ml (about 1 drop)

Hand out the remainder of the water to the last group

- OCEANS & SEAS: 970 ml

Congratulate this group on choosing a source that contains the most water, BUT before handing the container to them; put several heaped tablespoons of salt into the water. Tell your learners that even though the oceans hold most of the Earth's water, this has too much salt in it for us to use. Removing the salt to make the water fresh is very expensive and uses a lot of energy. This process is called **desalination**.

(Note: These numbers represent the real proportions as closely as possible but because they are rounded off, the amounts add up to 999,692 ml rather than exactly 1000 ml.)

Discussion

Referring to the numbers written on the board, remind the class that while there is a lot of water on Earth, 97% of that is found in oceans and seas and only 3% is fresh water. Only a small portion of that 3% is available as clean water for the various uses that you identified earlier in the Orange-Senqu Basin. Remind your learners about the four nations that form part of the Orange-Senqu River Basin and the one river that connects them all. Let your groups discuss how they can share their portion of water, considering all the water needs, including the eco-systems (plants and animals) as well as people and their activities. Ask how this water can be distributed equitably.

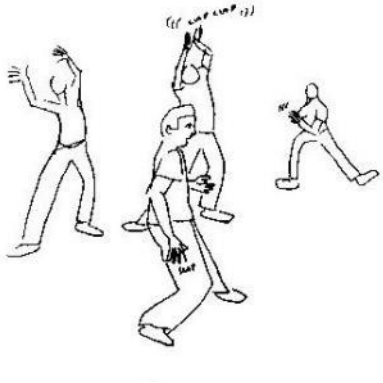
What if some groups have more water than others, is this fair? What can be done about it? What if some groups waste the water that they are given? What will this mean for others that need water? You can extend this lesson to include asking learners for ways of conserving water in our daily lives.

1.2.6. Working out what to do

Moving and Shaking - Enacting the Water Cycle

This activity follows on from the story of 'From Sea to Sky' (the Water Cycle story) with learners having fun expressing the story in different physical ways.

Preparation



Create a physical space that encourages participation. If you are in a classroom, move the desks and chairs to the side to create an open space. Make sure there is a place for everyone to move or sit in a circle.

Warming Up

It is a good idea to take the class through some warm-up activities. Warming up in drama is more than just a physical warm-up, it also helps to build a group spirit and encourages the learners to focus (if they are too active it helps calm them down; if they seem tired, it will help to energize them!)

Warming up 1: Walking around the space

Everyone in the class should walk around the space that you have created. Each child can walk in any direction they like and change direction as often as they want to. However, they must be careful not to bump into other learners.

Each time you clap your hands, the learners must change direction.

Explain to your learners that they are going to be rain drops and this is a warming up exercise. Ask your learners to:

- Walk
- Run
- Skip
- Hop
- Leap
- Jump
- Gallop (like a horse)
- Slide
- Move sideways
- Move backwards
- Move diagonally
- Turn around

Now call out different situations to your learners and they must change the way they are walking for each situation. *(They must also change their facial expressions!)*

- You are walking in the rain
- You are walking in a strong wind
- You are walking through snow, now you are sliding!
- You are walking through a river, now you are swimming!
- You are walking through a desert, now you are thirsty!
- You are walking towards a clean pool of water and take a wonderful drink!

Warming up 2: Making body shapes

1. While the children are walking around the room, call out a number. The children need to quickly get into a group of that number and keep walking. For example, if you call out "two", the children must pair up with someone, link arms, and keep walking. They must not stop walking or worry about who they have paired up with – they must pair up with the closest person. If you call out "four", the four closest children must pair up with each other.

2. After this has been done a few times with different numbers, get the children into groups of five or six. Call out different shapes, and each group should make that shape with their bodies, for example "square" …. "rectangle"… "triangle" …. "circle". The children can make the shape standing up, sitting or lying down but everyone in the group must be part of the shape.

3. Since our focus is the Orange-Senqu River and water, get the children to form the letters W A T E R or R I V E R.

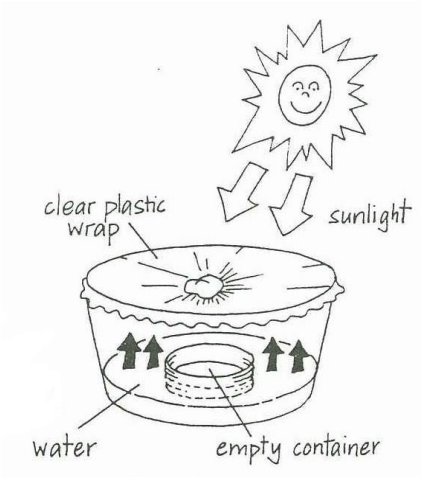
NOW USING THE STORY 'FROM SEA TO SKY' IN UNIT 2, ASK THE CHILDREN TO ACT OUT THE WATER CYCLE STORY AS YOU READ IT TO THEM. THEY NEED TO USE THEIR BODIES AND CHANGE THEIR FACIAL EXPRESSIONS AS YOU READ THE STORY BUT NOT UTTER A WORD! REMIND THEM TO BE CAREFUL NOT TO BUMP INTO OTHERS AS THEY PRETEND TO BE A LITTLE WATER DROPLET ON AN EXCITING ADVENTURE! HAVE FUN! DO THE WORKSHEET ACTIVITY TO FOLLOW.

1.3.6. Working out what to do

Create Your Own Water Cycle

You will need:

- A small bowl or container
- A large bowl
- Clear plastic wrap
- Small stone
- Water



What to do

- Place the small bowl or container into the middle of the larger bowl.
- Place water into the larger bowl, making sure that no water splashes into the small bowl.
- Cover the top of the larger bowl with clear plastic wrap and make sure it is firmly sealed.
- Place a small stone on top and in the middle of the plastic wrap, directly above the middle of the smaller container.
- Place the bowls in direct sunlight.

Discussion

Watch how the sun evaporates the water in the bowl that is in the direct sunlight. The water then condenses on the plastic wrap and drips into the smaller container like rain. Tell your learners that the large bowl can represent seawater and the small bowl can represent freshwater in the rivers and lakes. To extend this activity, place another set of bowls with the same amount of water in a cool and shady place. Talk about the rate of evaporation and why it differs in the two bowls.

Extension

Experiment with different liquids, different sizes of containers, and different colours of containers. What are some of the observations that you note?

Try these three variations:

1. Use salt in the large bowl and allow the bowls to stand in the direct sunlight until all the water has evaporated and condensed into the small container. (This will take several days to a week or more depending on the size of your container and amount of water) What is left in the large bowl? Is the water in the small container fresh or salty? Why is this?

2. Use food colouring or dirty water for the large bowl and allow the bowls to stand in the direct sunlight until all the water has evaporated and condensed into the smaller container. (This may take several days to a week or more depending on the size of your container and amount of water) What is left in the large bowl? Is the water in the small container clean or dirty? Why is this?

3. Measure the amount of water you place in the large bowl with a measuring cup or place exactly 1 litre into the bowl. Leave the bowls in the direct sunlight until all the water has evaporated and condensed into the small bowl. (This will take several days to a week or more, depending on the size of your container and amount of water) At the end of this period, measure the water in the small container. Record the results and discuss the outcomes. If your bowl is well sealed there should be the same amount of water in the small container as you started with in the large container.

Thabana Ntlenyana says: Children love to colour maps and fill in information about special places. Why not make a map of your own local area, city, town or village. The children can think of all the different things that make up your special place, then draw, colour and/or model them out of recycled paper and cardboard. Get the children to work out where everything goes and paste it all together onto a big sheet of paper. Add your local source of water. Is it a borehole, a well, or do you get your supply from a dam? Don't forget to add pictures of these just to remind us that everything we do, depends on a healthy supply of water. Have you remembered to put in the MOST important thing that connects all? Your own local rivers and streams! Don't forget to write in the names!

Thabana Ntlenyana says: Colour the water cycle diagram on this page. Can you add plants, animals and people into the water cycle picture? Label your diagram! Finding out about the water cycle has been an exciting journey. Now we all know about where water comes from and where it goes to, it's time to find out how a river is born!

1.4.6. Working out what to do

Make a Model Catchment Basin or Wetland

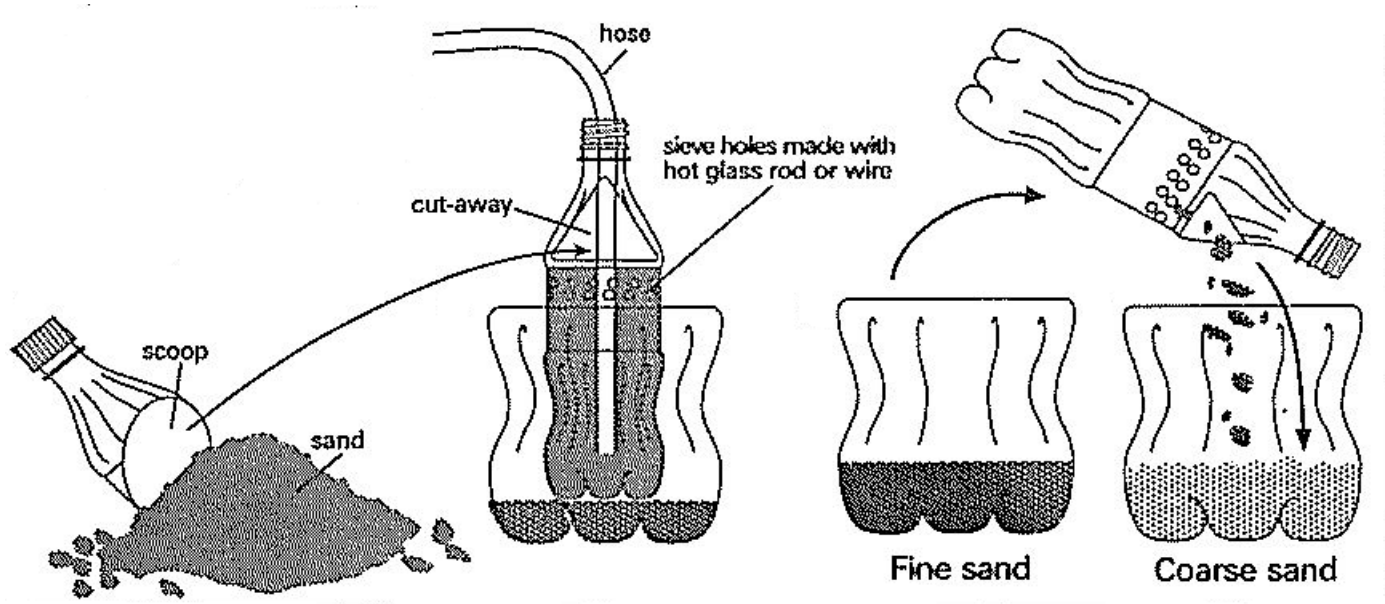
You will need:

- 2 litre plastic bottles
- 500ml plastic bottles
- Scissors
- Drinking straws
- Small syringe
- Sandi particles
- Stones
- Hose pipe
- Dry grass

Instructions

Wash and grade sand particles with a home-made separator.

1. Using a hot glass rod or wire, make a number of holes in the bottom of the 500ml plastic bottle.
2. Cut a triangle shape off the top so you can pour mixed sand into the 500ml plastic bottle.
3. Cut a 2 litre plastic bottle in half.
4. Use a second 500ml plastic bottle to make a sand scoop.
5. Place 500ml plastic bottle into 2 litre plastic bottle.
6. Fill up the 500ml plastic bottle with sand, about 2cm below the cut-away.
7. Run hose slowly using pipe to stir up sand.
8. The finer sand flows into the outside container.
9. The coarse sand cannot get through the sieve holes and stays in the 500ml plastic bottle.



Make a sand filter

1. Add one third fine sand
2. Fill to two thirds with coarse sand
3. Leave about a third for the water that will be held back in the filtration process.

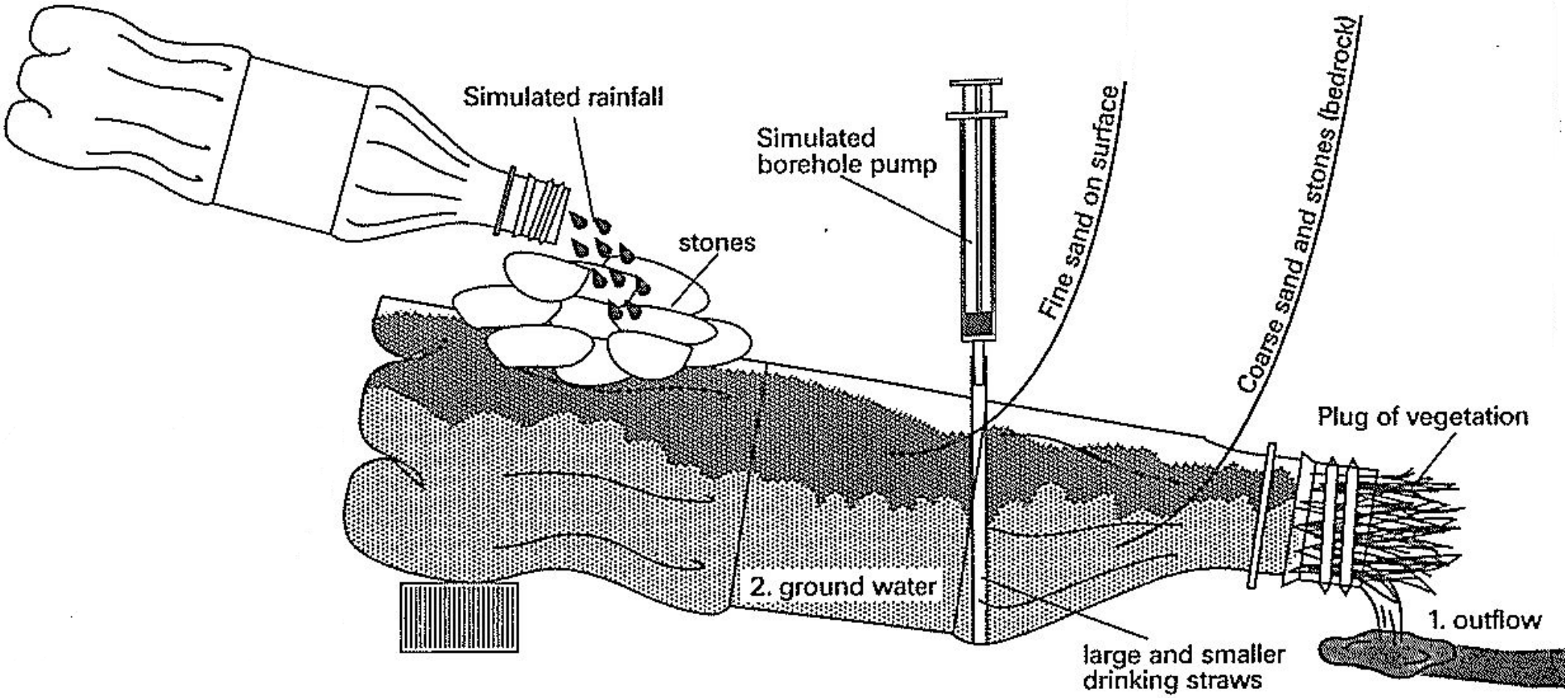
Now you're ready to make a model watershed or wetland

1 Cut a 2 litre plastic bottle carefully as shown in the diagram.

2 Using the graded sand particles that you made earlier, layer the bottle first with coarse sand and some stones (which will form the 'bedrock'. Then add fine sand on the surface.

3 Add larger stones on top and plug the top of the 2 litre bottle with dry vegetation.

Now pour water gently into the catchment area as if it were rain and watch how the water seeps (infiltrates) into the ground, filling up the spaces between the sand and rocks. When sufficient groundwater recharge has taken place, your system will begin to flow out through the vegetation plug. You can use a syringe to simulate a borehole drilled into the aquifer. If you measure the amount of rain water that you put into the system and the amount at outflow, you can get an idea of how much water is held in the system between the sand and rocks as groundwater.


Simulated rainfall
Simulated
borehole pump
stones
Fine sand on surface
Coarse sand and stones (bedrock)
Plug of vegetation
2. ground water
1. outflow
large and smaller
drinking straws

1.5.6. Working out what to do

A Water use Audit

Activity:

- In small groups, let the children discuss how their school gets water (do they 'harvest' water from the rain, does the school make use of a borehole, do they use reticulated [piped] water). They can also discuss how they get water at home.

- Now let the children carry out a personal water audit to see how much water they use each day. Ask your learners to work out how many litres of water their family uses per day for all of these different uses. Help them to work out how much water is used for a bath or shower. Talk about water that is not obvious, that is used in the process of making goods.

- One can see from the report-backs that there are so many different ways, each day, that we use water in our lives and different groups would have come up with differing amounts that their family uses per day. Using the worksheet that follows (either during the lesson or as a homework exercise), learners will be able to consolidate and think about other ways that freshwater plays a role in their lives.

WATER AUDIT

Answer the questionnaire below and then find out how much water you're using by filling in your very own 'water diary'!

WATER	YES	NO
1. Do you have water-on-tap?		
2. Is the drinking water safe and clean?		
3. Do you have tanks in your garden to collect rainwater?		
4. Do you water the garden each day?		
5. Can you name some of ways of saving water?		
6. Do you reuse any water e.g. bathwater?		
6. Do you wash cars and/or bicycles with buckets of water?		
7. How many flushing toilets are in your house?		
8. How many toilets are leaking?		
9. How many taps are there in your house?		
10. How many taps are dripping?		

The following amounts are rough estimates of water use,

that may help you when calculating your water usage.

- Cup of water/juice/tea/coffee – 250ml
- Flushing toilet - 13 litres
- Having a short shower (10 minutes) – 30 litres
- Having a long shower – (30–40 minutes) – 120 litres
- Washing hands (with water running) – 5 litres
- Washing hands (without the tap running) – 1 litre
- Brushing teeth (with water running) – 2 litres
- Having a bath – 90 litres
- Washing a sinkful of dishes – 18 litres
- Washing the car (with a hosepipe) - 50 litres
- Watering the garden (15 minutes) - 50 litres
- Washing clothes in an automatic washing machine – 250 litres
- Washing clothes in a twin tub machine – 40 litres
- Topping up the pool - 4 000 litres

Now let's find out how much water you use each day

Fill in the worksheet below, every time you use water. This is your very own 'water diary'!

Day	**Time**	**What did I do?**	**How much water did I use?**
e.g. Monday	*6pm*	*Had a bath*	*90 litres*

I used _____ litres of WATER today.

Scoring

- Up to 200 litres – well done! You're well below the average.
- 201 – 399 litres. A good start. Keep cutting down where you can.
- 400 – 500 litres. This is the average amount of water used by most people
- Over 500 litres. This is way too high. You need to see where you can cut down.

It may be a good idea to let learners do this audit once a term and see if they have managed to reduce their water consumption by using water more wisely.

If your school has access to municipal water, find and read the water meter. Record the daily use in the table below to find out how much water your school is using:

DAY	DATE	TIME	METER READING	LITRES USED
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				
TOTAL for the week				
Subtract meter reading for Tuesday from reading for Monday to get litres used on Monday				

Once the audit has been completed, and in small groups, let the children think and discuss ways that they can save water.

Some ideas to get the children thinking ….

- Don't leave a tap running
- Fix leaking taps
- Put the plug in the sink when washing dishes or vegetables.
- Greywater (water used for washing dishes, bath water or the washing machine) can easily be diverted into the garden
- Boil just the amount of water you need when making a cup of tea or coffee
- Turn the tap off when brushing teeth or washing hands
- Collect rainwater for watering plants
- Use a bucket to wash the car or one's bicycle rather than a hosepipe

Once again, each learner in the group will need to clearly report back to the rest of the class what they spoke about within their group. The rest of the class is encouraged to ask each group questions about their water saving ideas.

It may be a good idea to write all the ideas on the chalkboard.

Finally, from the list that is drawn up on the chalkboard, let the children decide which actions they can take to reduce their water use. Let them chose a simple one (such as making sure that the tap is not running when they

wash their hands or brush their teeth) and see, through the week that follows, if they manage to remember this environmental action.

You can celebrate these days:

1 ***World Water Day*** *was declared an international day in 1992 by the United Nations General Assembly and was first celebrated in 1993.*

2 ***International Day of Action for Rivers and Against Dams*** *is held on the 14th March each year. Choose that day to do some fieldwork at a river near your school.*

3 ***International Coastal and River Clean-up Day*** *takes place in the third week of September each year. Organise a litter clean-up of the banks of a stream near your school, or just around your own school yard. Remember everything that happens in a catchment basin affects the rivers!*

4 ***World Rivers Day*** *is a global celebration of the world's waterways, observed every last Sunday in September. Established in 2005, it highlights the many values of rivers and strives to increase public awareness while encouraging the improved stewardship of rivers around the world.*

For a calendar of special days see the annexure at the end of this workbook.

2.1.6. Working out what to do

Working Together: One River, Four Nations - Drama Activity

Preparation

Cut out enough pieces of paper for your whole class. Divide the papers into four and write one countries name from the Orange-Senqu basin on each piece. (South Africa, Lesotho, Botswana & Namibia) (If you have 40 children in your class, you will need 10 pieces of paper with "Botswana", 10 with "Lesotho", 10 with "Namibia" and 10 with "South Africa"

Introduction

If you are using this activity as a starting point to introduce the Orange-Senqu Basin then use the A0 map and catchment cards to explain what the basin is. If this is a follow on activity to other lessons about the Orange-Senqu Basin then first focus your learners' attention on the country borders and geographical divisions in the basin.

Discussion

The children guess where the rainwater from the roof of the school flows to. Connect that concept to build the knowledge that water flows into the Orange-Senqu River from many other school roofs, from other places in the basin and that the rainwater that falls in the Orange-Senqu River Basin flows through four different nations before it flows out into the sea at Oranjemund. Talk about where the river starts (source) and where it ends (Atlantic Ocean)

Action

Either hand out the pieces of paper randomly or allow the children to choose a piece of paper naming the country that they will represent. Collect them together in the centre of an indoor or outdoor space that has sufficient room for them to move about. Explain to them that they all represent the waters of the Orange-Senqu River that flow through the four nations in the Orange-Senqu River Basin. Ask the children to get into groups of the different countries and to join hands to form the 'Orange-Senqu River'. Where the Orange-Senqu River is the border between the southern part of Namibia and South Africa, two or three children stand facing each other. The children who represent the other countries from which water flows into the Orange-Senqu River stand on either side according to their country's geographical position. Now explain to your learners that it has started to rain hard in Lesotho. The water level in the river rises. When the water has flowed into the next country, the water level falls again.

Making "the wave"

In the first round, the children hear, for example: "It's raining in Lesotho". The water in this country rises. The children playing this country make a wave. They throw their hands up in the air for a few seconds and call out the name of the country into which the water flows on: "Hello South Africa. Here comes water for the Orange-Senqu River". The children who are playing South Africa throw their hands up together and call out at the same time: "Hello Botswana. Here comes water for the Orange-Senqu River". Thus the water from a heavy rainfall flows from country to country until it ends up bordering Namibia and South Africa and flows into the Atlantic Ocean.

Then all the children shout together: "Hello Atlantic Ocean! Here comes our water from the Orange-Senqu River".

In the second round, you can make it more difficult and make it rain at the same time in two different countries. In the third round, let it rains in three different countries! In the last round, it rains in an area where it hasn't rained before (Namibia). End this session with a discussion about the different geographical areas that the Orange-Senqu flows through and what countries these areas fall into. Ask your learners:

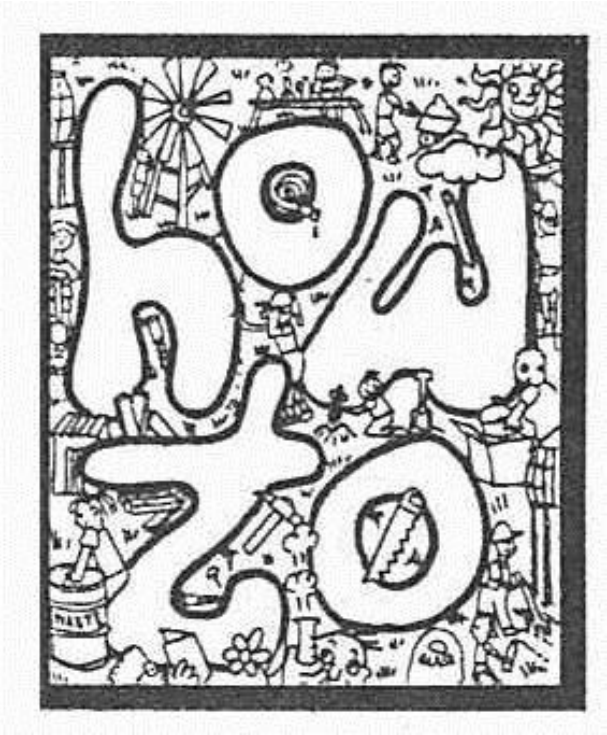
- Through what four nations does the Orange-Senqu River flow?
- What are the geographical regions in the Orange-Senqu basin?
- Do these areas all get the same amount of rain? What are the differences?
- What are the different water needs for people, plants and animals in these areas?
- To draw the flag of the country they were representing and put it on or around the A0 map.

** These activities have been adapted from the Danube Box: Teacher's Handbook*

2.2.6. Working out what to do

Make Your Own Tin Can Rain Gauge

This activity shows learners how to make an easy but accurate rain gauge, to measure and record the rainfall at school.

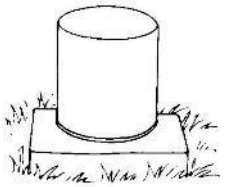


One of the ways we can measure how much rain falls in our area is by using a rain gauge and recording the rainfall daily. Learners need to work neatly, safely and carefully, ensuring minimum wastage of materials.

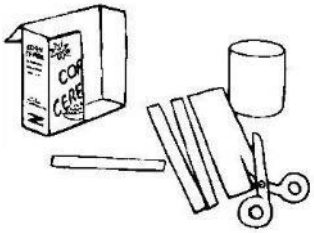
Preparation: Each learner will need:

- Tin can
- Breakfast cereal packet
- Glue
- Scissors
- Ruler
- Pencil

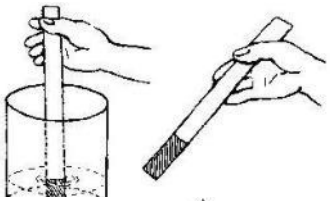
What to do



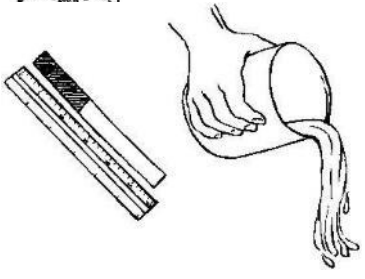
1. Put a large empty tin on a flat surface out in the school grounds, well away from overhanging trees, shrubs and sprinklers.



2. Make some rain dipsticks by cutting long 1cm-wide strips from the breakfast cereal box. The sticks must be longer than the height of the can.

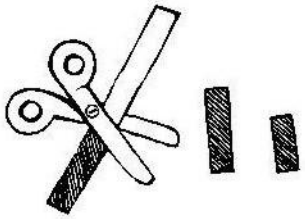


3. With your class, at the same time each day, measure the rainfall by dipping the dipstick into each can so that they touch the bottom. See how the rain leaves a wet mark on the cardboard.

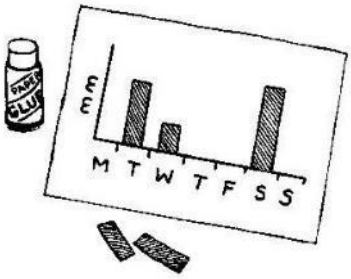


4. Use a ruler to measure the length of the wet part of the cardboard in millimetres – this is how much it has rained. Empty the cans.

5. Cut the wet piece off the dipstick and let it dry. Keep it flat and write the date and rainfall in millimetres on it.



6. When the piece of dipstick is dry, make a chart of the rainfall for a week. Glue each piece to paper to form a record of rainfall at your school.



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Place the tin can rain gauges in different places around the school to see if there is any difference in rainfall within the school grounds.

Discussion

1. Do you think your rain gauges worked well?

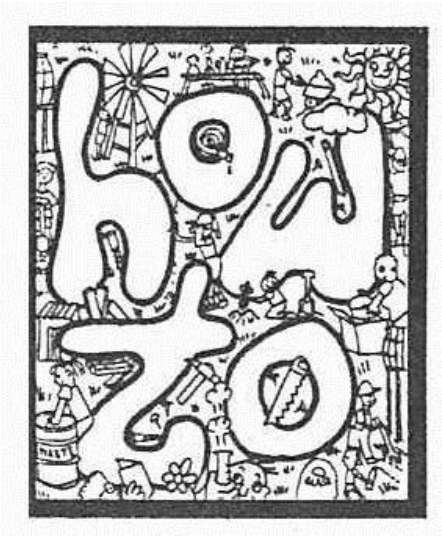
2. Could they have worked better? How?

3. Were your results accurate? (You can find out the correct rainfall figures for your area for that week, by contacting the local Weather Bureau. Compare this to your local rainfall figure)

4. If some of your learners live a distance from the school, why not get them all to make a rain gauge for their gardens at home and record the rainfall during the holidays or over a long weekend. You and your class can then plot and compare the different rainfall amounts in your area on the Orange-Senqu map.

Working out what to do

Make Your Own Cool Drink Bottle Rain Gauge

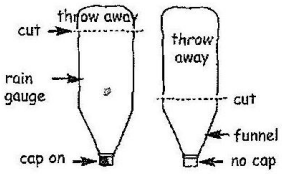


You will need:

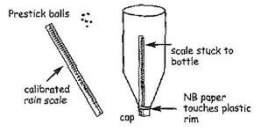
- Two empty 2 litre Fanta cool drink bottles
- Pair of scissors or cutting knife
- A photocopy of the calibrated rain scale (on pg. 108) at 160%. This is only for a 2 litre Fanta bottle
- Prestick
- A strong stick
- String
- Fine permanent marker

Instructions

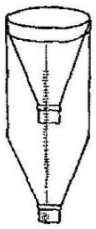
1. Keep the cap on and cut off the curved base of one bottle. Remove the cap and cut off the cone-shaped part off the second bottle to make a funnel.



2. Cut out the photocopied rain scale. Use tiny balls of Prestick to stick the scale to the rain gauge.

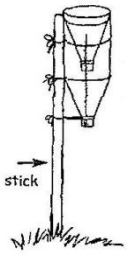


3. Use a permanent marker to copy the scale lines and numbers on to the bottle – be exact. Remove the paper.



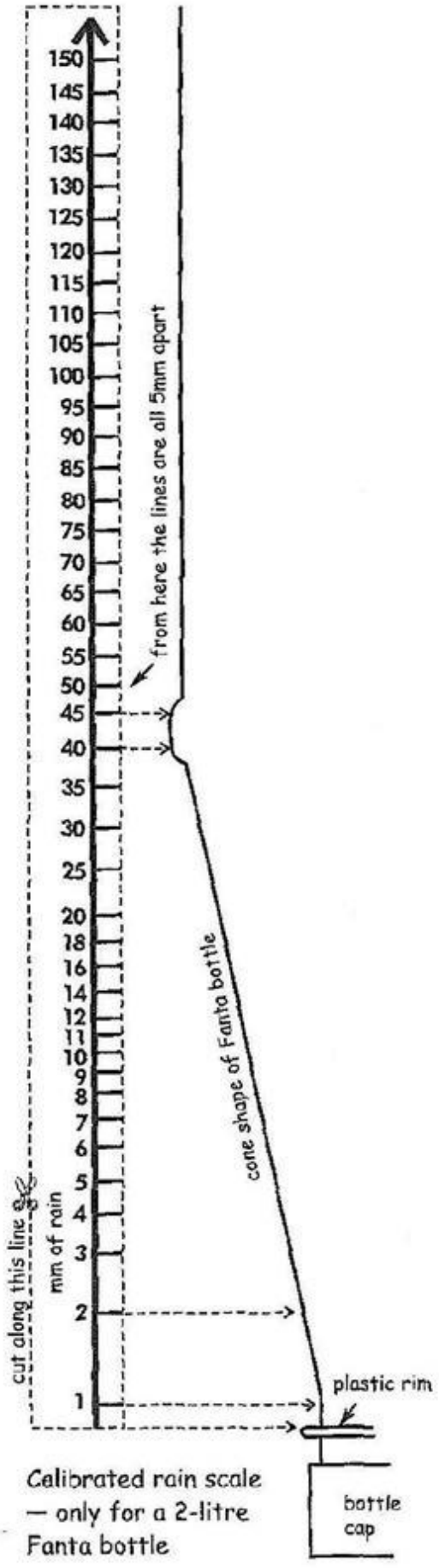
4. Insert the funnel into the top of the gauge. It keeps out debris and reduces evaporation.

   Tie the gauge to a stick. The funnel opening must be above the end of the stick. 'Plant' your gauge where there are no overhanging trees or bushes.



5. Take readings and empty the gauge at the same time each day. Make charts (graphs) of the weekly, monthly and annual rainfall. These records become very interesting when you can compare different months and years.

   Is climate change affecting rainfall in your area?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5
4
3
2
1
from here the lines are all 5mm apart
cone shape of Fanta bottle
cut along this line
mm of rain
plastic rim
bottle cap
Calibrated rain scale
— only for a 2-litre
Fanta bottle

2.3.6. Working out what to do

Make a Waterworks that Works

You will need:

- 2 litre plastic bottles
- A glass rod
- Fishtank plastic tube
- Plastic pipe clamp
- Gas lighter or spirit burner
- Turbidity disk
- Propettes
- Jik
- Alum flocculant
- Sand filter

Optional

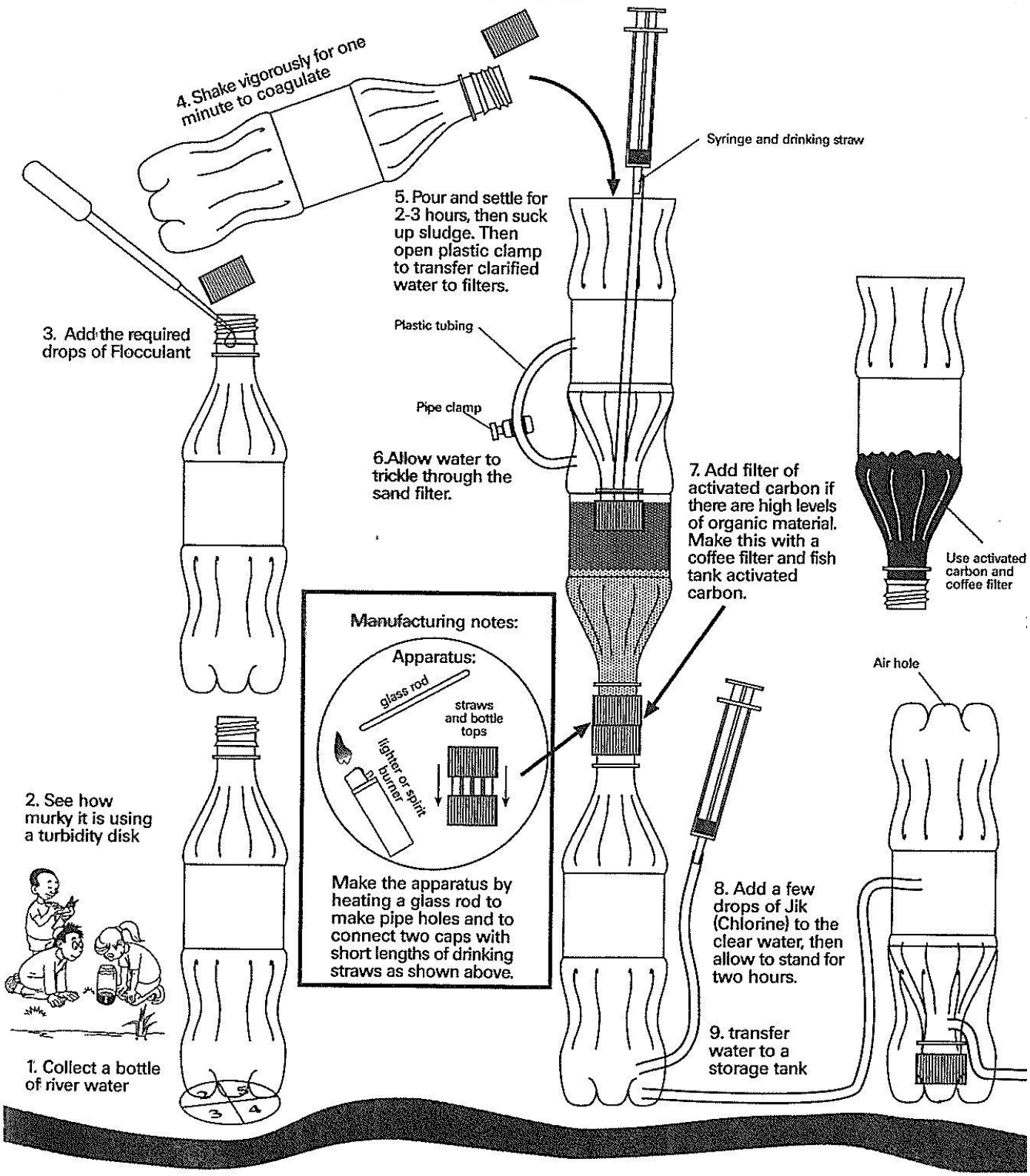
- Coffee filter paper
- Fishtank activated carbon to make a carbon filter
- Michrochem water test kit to test the various stages of the water purifying process.

Using the diagrams on the following two pages follow these instructions:

1. Collect a bottle of riverwater
2. See how murky it is using a turbidity disk (supplied)
3. Add the required drops of flocculant
4. Shake vigorously for one minute to coagulate
5. Pour and settle for 2 – 3 hours then suck up sludge. The open plastic clamp to transfer clarified water to filters.
6. Allow water to trickle through the sand filter (instructions after Audit activity sheets)
7. Add filter of activated carbon if there are high levels of organic material. Make this with a coffee filter and fish tank activated carbon.
8. Add a few drops of Jik (Chlorine) to the clear water, then stand for two hours.
9. Transfer water to storage tank.
10. Distribute to homes, business and schools.

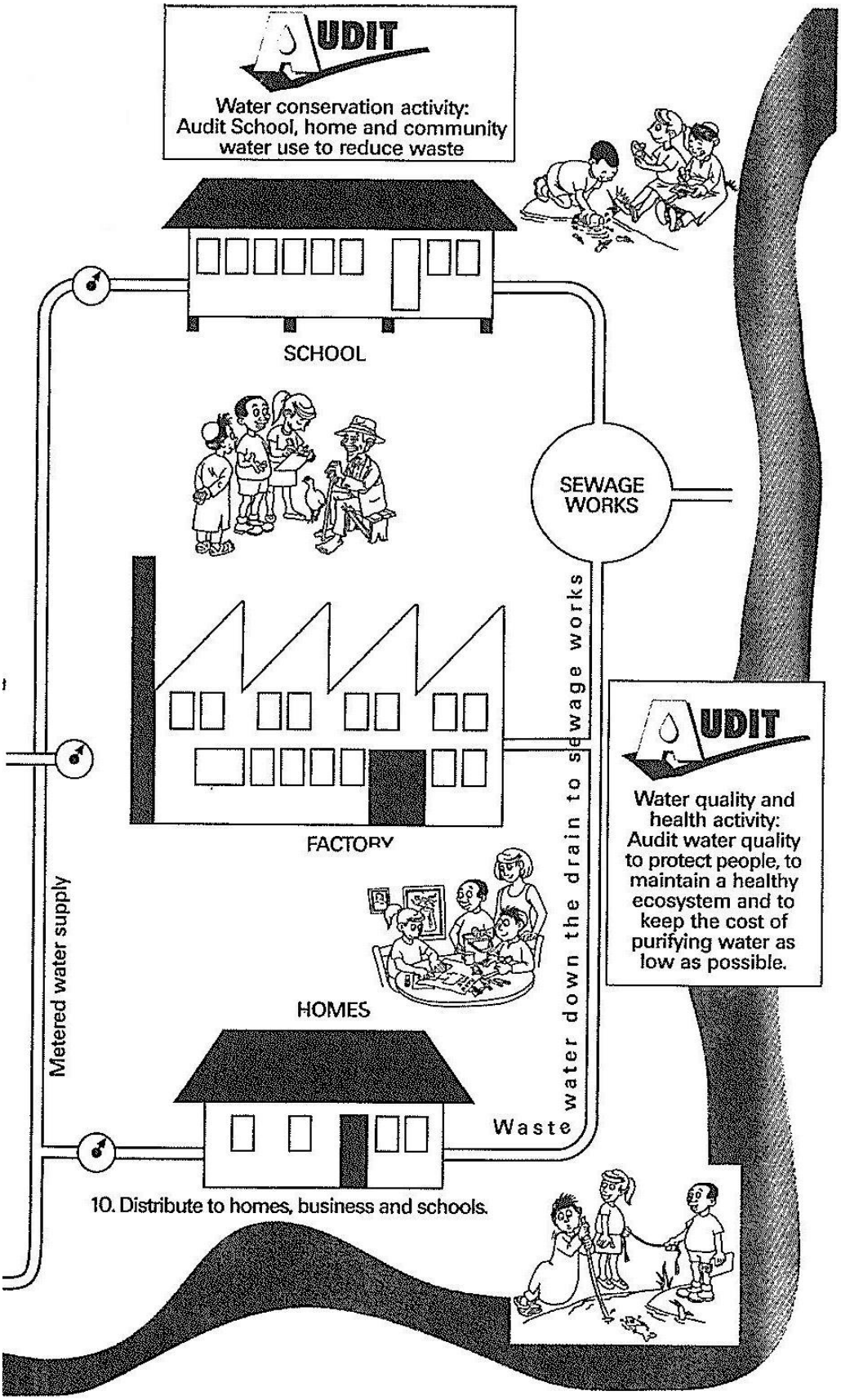
Waterworks Diagram and Instructions

Follow the instructions above or 1 - 9 (This page) and 10 (next page)



Join this page to the next page here so that your water reticulation pipes match up*

Water Conservation Activity: Audit page 2



Join here

*Join this page to the previous page so that your water reticulation pipes match up.

Make a Home-Made Sand Separator

Wash and grade sand particles with a home-made separator.

1 Using a hot glass rod or wire, make a number of holes in the bottom of the 500ml plastic bottle.

2 Cut a triangle shape off the top so you can pour mixed sand into the 500ml plastic bottle.

3 Cut a 2 litre plastic bottle in half.

4 Use a second 500ml plastic bottle to make a sand scoop.

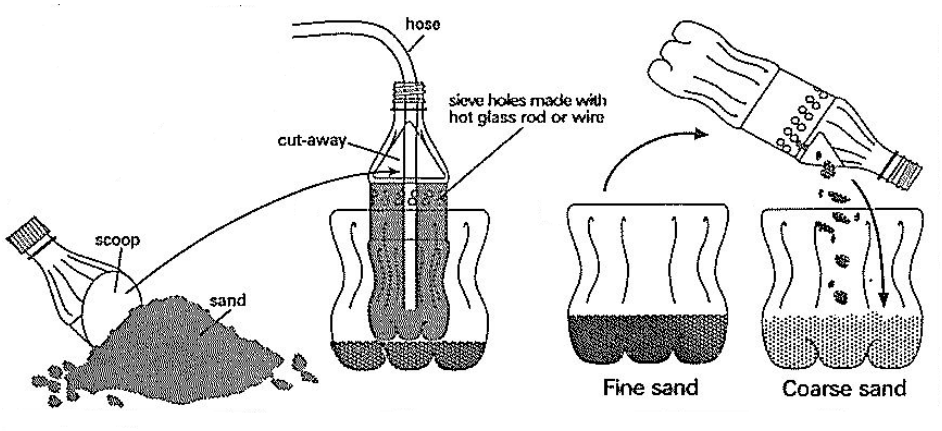
5 Place 500ml plastic bottle into 2 litre plastic bottle.

6 Fill up the 500ml plastic bottle with sand, about 2cm below the cut-away.

7 Run hose slowly using pipe to stir up sand.

8 The finer sand flows into the outside container.

9 The course sand cannot get through the sieve holes and stays in the 500ml plastic bottle.



Make a sand filter

1 Add one third fine sand

2 Fill to two thirds with course sand

3 Leave about a third for the water that will be held back in the filtration process.

2.4.6. Working out what to do

Create your own water cycle terrarium

Make your own terrarium to create the water cycle in a bottle

This activity shows learners the stages of the water cycle including evaporation, condensation and transpiration. It helps them understand that water remains in a constant cycle and demonstrates the role of plants in the water cycle. This is a helpful teaching aid, particularly in dry areas like the Northern Sub-Basin, where the role of plants in the water cycle may be a difficult concept.

You will need:

- A two litre plastic bottle
- small rocks,
- washed sand
- damp topsoil
- local water loving plants (ferns, moss etc.)
- alternatively succulents

What to do:

Carefully cut off the bottom of the 2 litre plastic bottle about one third up. Put the top section aside, this will be the top of your terrarium's 'dome'. Make four very small cuts into the bottom planter at each quarter point. This will help the top to fit tightly over the bottom section once you have finished planting.

Place a layer of small rocks or pebbles in the bottom of the planter, followed by a layer of sand and then a layer of topsoil. This represents the natural layers of the earth. You can use potting soil for the final layer as this is free of fungi and bacteria. While fungi and bacteria are an essential and healthy part of soil life, if the wrong kind grows, it could affect the health of your plant.

Plant your terrarium using one to three small plants of differing size but with the same water requirements (moss and fern like plants are water loving; succulents and cacti still need water, but like

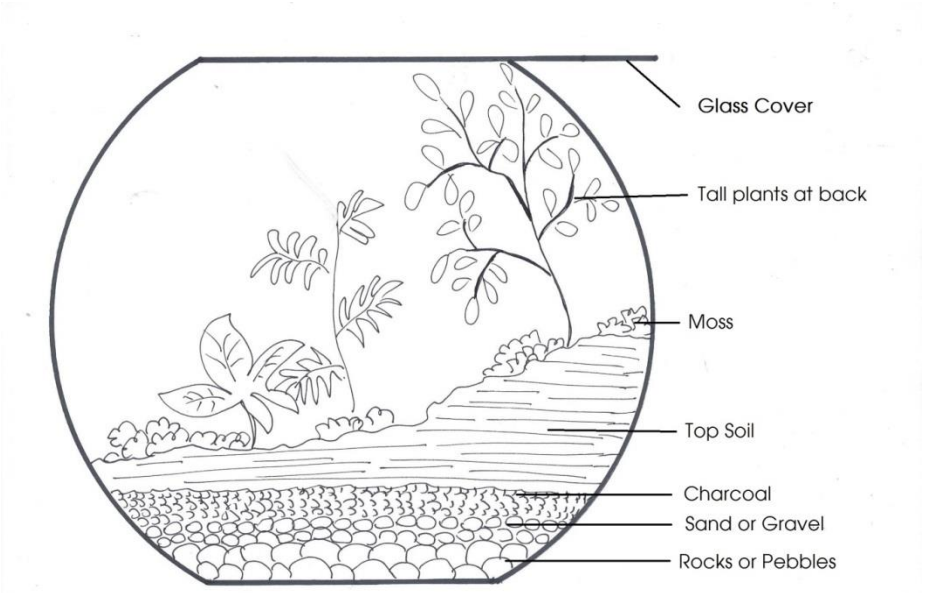
dry conditions). When you have planted your plants use a spray bottle of water (or water carefully with a container) to dampen the soil until you see some water penetrating into the layer of stones. These will provide good drainage.

Take the top part of the 2 litre bottle and place it firmly onto the bottom section. Place your terrarium in a sunny place but make sure it will not get too hot in the direct sun. Get your learners to observe the terrarium at intervals and to record what happens over time.

Some questions for discussion:

- Describe the journey that the water took through the terrarium.
- What happened to the water in the small container (dam/reservoir)?
- What happens to the water that the plant takes up through its roots?
- Will the amount of water remain constant in the terrarium?
- What will happen to the water if you take the lid off the terrarium?
- What is the role of plants in the water cycle?

You can make a terrarium for your class out of any large glass jar or container. Use the same method of construction and remember to seal the lid tightly or place a sheet of glass across the top. To avoid the wrong kinds of fungi and bacteria growing in your bottle you can place a thin layer of activated charcoal between the sand and the topsoil. Activated charcoal acts as a filter and water moving up through to the soil will pass through this cleansing layer. You can get activated charcoal from a pet shop that stocks aquarium supplies.



A planted terrarium demonstrates the water cycle and the role of plants in the cycle

2.5.6. Working out what to do

Make a model catchment basin or wetland

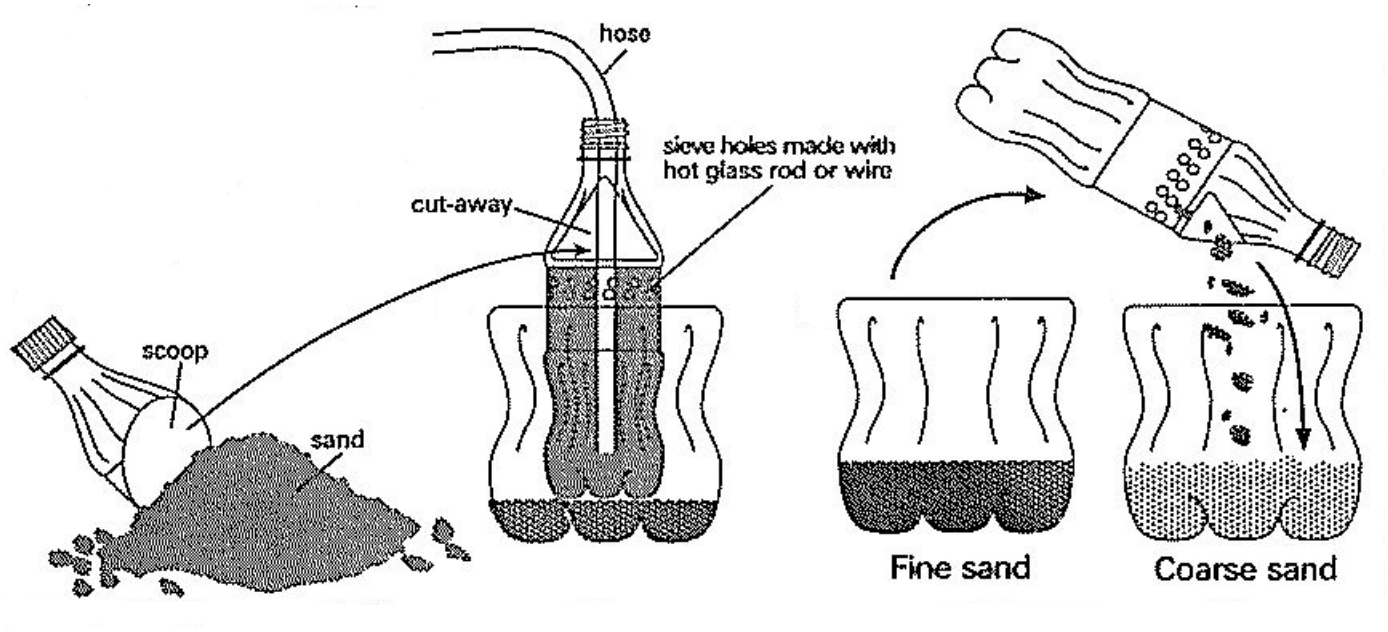
You will need:

- 2 litre plastic bottles
- 500ml plastic bottles
- Scissors
- Drinking straws
- Small syringe
- Sandi particles
- Stones
- Hose pipe
- Dry grass

Instructions

Wash and grade sand particles with a home-made separator.

1. Using a hot glass rod or wire, make a number of holes in the bottom of the 500ml plastic bottle.
2. Cut a triangle shape off the top so you can pour mixed sand into the 500ml plastic bottle.
3. Cut a 2 litre plastic bottle in half.
4. Use a second 500ml plastic bottle to make a sand scoop.
5. Place 500ml plastic bottle into 2 litre plastic bottle.
6. Fill up the 500ml plastic bottle with sand, about 2cm below the cut-away.
7. Run hose slowly using pipe to stir up sand.
8. The finer sand flows into the outside container.
9. The coarse sand cannot get through the sieve holes and stays in the 500ml plastic bottle.



Make a sand filter

4. Add one third fine sand
5. Fill to two thirds with coarse sand
6. Leave about a third for the water that will be held back in the filtration process.

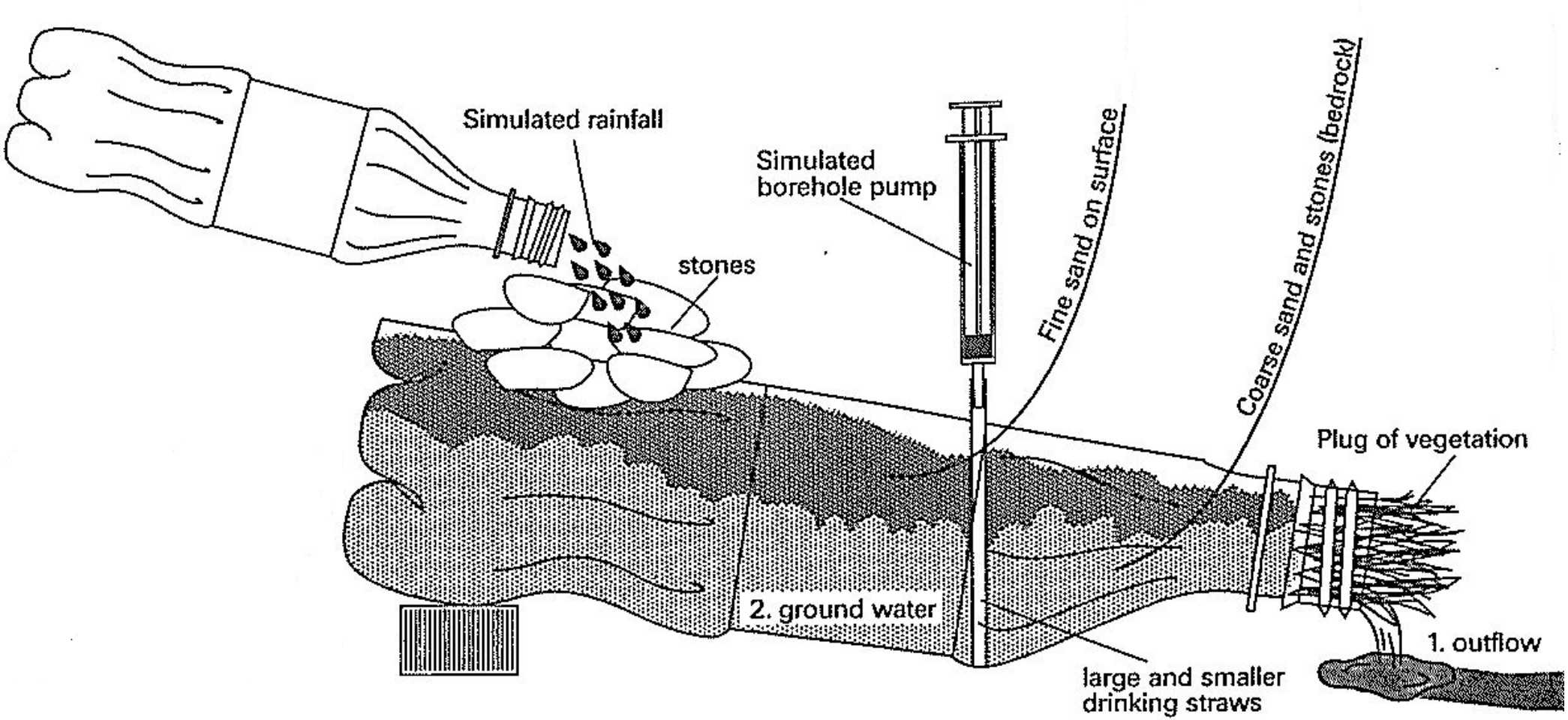
Now you're ready to make a model watershed or wetland

1 Cut a 2 litre plastic bottle carefully as shown in the diagram.

2 Using the graded sand particles that you made earlier, layer the bottle first with coarse sand and some stones (which will form the 'bedrock'. Then add fine sand on the surface.

3 Add larger stones on top and plug the top of the 2 litre bottle with dry vegetation.

Now pour water gently into the catchment area as if it were rain and watch how the water seeps (infiltrates) into the ground, filling up the spaces between the sand and rocks. When sufficient groundwater recharge has taken place, your system will begin to flow out through the vegetation plug. You can use a syringe to simulate a borehole drilled into the aquifer. If you measure the amount of rain water that you put into the system and the amount at outflow, you can get an idea of how much water is held in the system between the sand and rocks as groundwater.


Simulated rainfall
Simulated borehole pump
stones
Fine sand on surface
Coarse sand and stones (bedrock)
Plug of vegetation
2. ground water
1. outflow
large and smaller drinking straws

3.1.6. Working out what to do

The Water Conflict Game

Development in a sensitive wetland area! Is it a yes, is it a no? Can the environment, the culture, the people who live there and the economic future be considered, in a sustainable way, without one aspect compromising the other? This challenging lesson encourages learners to investigate an environmental situation and debate, discuss and communicate their ideas.

Read the following story to your class:

The mighty Orange-Senqu River rises in the majestic mountains of Lesotho. From its source in the mountains to its mouth in the Atlantic Ocean, the river journeys 2 300km. Just before it enters the Atlantic Ocean, it forms a large wetland area which flows into the river estuary. There are five groups of people involved in this area. They are:

- The **nomadic indigenous Bongo tribe** which has migrated between the floodplain and the mountains for over two thousand years. They are dependent on water and the land for their existence. Nomadic pastoralism, fishing and crop cultivation are some of their livelihood activities.

- **ORASECOM (the Orange-Senqu River Commission)** who are dedicated to managing the resources of the Orange-Senqu River Basin, a transboundary resource shared by Botswana, Namibia, Lesotho and South Africa. They want to install research facilities in the area to obtain a better understanding of the dynamics of the wetland system and how it can benefit all four countries.

- The **Goodgrip Tyre Company** wants to build a tyre factory in the area. Vast quantities of water will be consumed and the waste from the factory will need to be disposed of. No environmental impact assessment (EIA) has been conducted in the area where they want to build the factory. Three hundred job opportunities will be created.

- **The Fitness Fanatics Group** is planning to develop a huge sports centre which will provide accommodation, canoeing, golfing, yachting, hiking and fishing.

- **The Provident Engineering Firm** wants to build a dam to provide water and electricity to the tyre factory and the sports centre.

The Water Conflict Activity:

Divide the learners into groups to represent each of the five groups involved in the development of the area. Each group will need:

- a contour map (see next page)
- a marker (you can use stones, leaves, bark, a small piece of rubber (etc.)

Each group spends time planning where they would like to complete their development – this is then marked on their worksheet. They must consider the advantages and disadvantages of their choices. *(The groups need to consider all the other groups and the wetland eco-system itself and the goods & services it provides – they are more likely to make a better decision if they focus on a sustainable and long-term view rather than a quick, thoughtless decision which is based only on the money that will be made over a short period of time).*

- The groups then gather around a larger copy of the map (you can enlarge the A4 sheet to A3 size), and place their markers where they plan to develop.

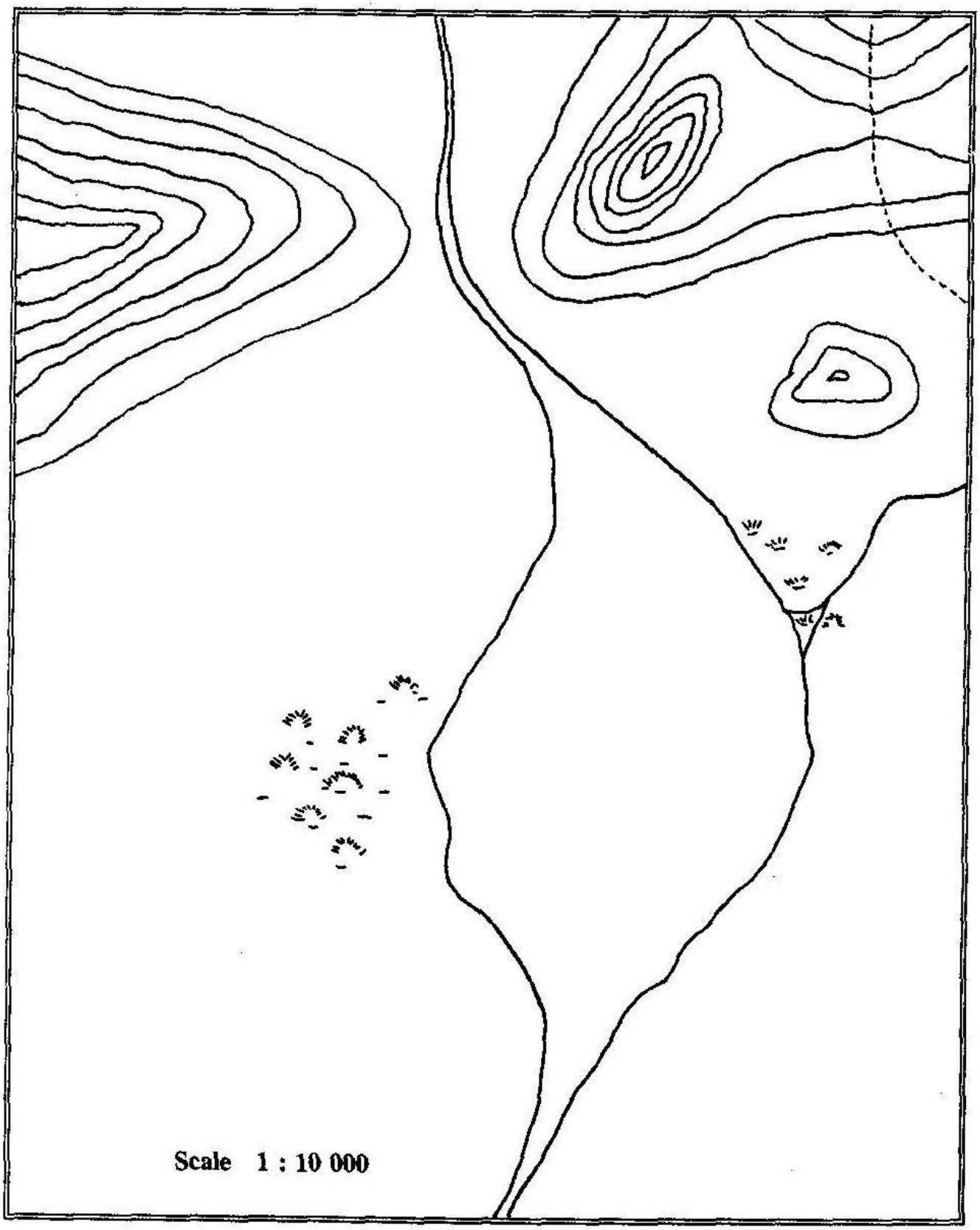
- Two or more groups can use the same space (if they have both decided on that during their earlier discussions).

- Each group is then given the opportunity to state the reasons for their choice. Through the guidance of the teacher, the groups argue their cases. It is important, that, despite conflicts that may arrive, the groups find a solution.

Some possible considerations are:

- Wetlands have buffer zones in which no development may take place without authorisation. This buffer is around 32m from the edge and needs to be determined by a specialist.
- Roads, bridges and other infrastructure should not be allowed to compromise a wetland.
- Some activities may affect breeding birds, migratory birds or other species that use the area as a habitat.
- Apart from water quality functions, wetlands provide materials for weaving mats and baskets, grazing for cattle and goats, as well as areas for recreation and research.
- A No-Go option is one when the impacts are too great and the developer is not allowed to develop.
- An offset wetland area is when the developer has to rehabilitate another wetland in place of the one that he is potentially going to do damage to.
- All developments need to go through an environmental authorisation and planning process, and if approved, will attach conditions thereto.

Wetland Contour Map for Activity 3.1.6.



Note: Contour lines are brown lines on topographic maps. Each contour line connects places that are the same height above sea level. The contour interval is 20 m on 1:50 000 topographic map. For the purposes of this exercise a very basic map has been given showing surface water and adjacent wetland areas and some spurs and hills. There are no roads other than a small foot track. The groups can put forward alternative sites for their developments; ask them to draw maps of the features in these alternative plans.

3.2.6a. Working out what to do - Fieldwork

Looking at River Health: miniSASS

mini Stream Assessment Scoring System

miniSASS can be used to monitor the health of a river and measure the general quality of the water in that river. It uses the composition of macro-invertebrates (small animals) living in rivers. miniSASS is based on the sensitivity (ability to live) of the various animals to water quality (water conditions). (note: miniSASS does **NOT** measure the contamination of the water by bacteria and viruses and thus does not therefore determine if the river water is fit to drink).

miniSASS is a citizen science tool, that means the data you collect can be used to help inform river health statistics in Southern Africa. Remember to record your findings.

SITE INFORMATION TABLE	
Date (dd/mm/yr):	
Collector's name:	
River name:	
Site description:	
GPS co-ordinates:	
Comments/notes:	

Co-ordinates as lat/long (e.g. 29°30'25" S / 30°45'10" E) or as decimal degrees (e.g. 29.50694°S/30.75277°E)

Getting Started

You will need: Net, white container or tray, ice-cream box, pencil, magnifying glass (optional), shoes or gumboots, gloves, soap, Hands on Stream & Pond Life, Photocopies or laminated sheets of the Macro-Invertebrates Key (Pg 170) For the follow activity, crayons and plasticine.

To make your own net:

Take a piece of wire, (for example a wire clothes hanger) and bend it into the shape of a net. Then tie the netting (which can be any porous material) to the wire by stitching with a thread or nylon string. Alternatively cut the bottom out of an ice cream container and staple netting to the bottom.

Choosing the site:

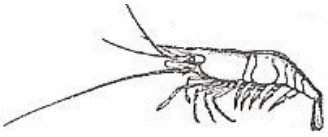
The best river sites are those steams with rocks in moving water. Not all sites have rocks (**rocky type** rivers), but may be largely sandy (**sandy type** rivers).

River Safety:

Take special care in polluted water. Beware of dangerous animals (crocs, hippo!) and fast flowing waters. Wear protective gear when necessary and wash your hands regularly with soap and clean water wherever possible!

What to do:

1. Give a general introduction to the activity using information in Finding out more Unit 1, to guide you. Also pay attention to safety in water as well as to ensuring adequate protection should the water quality be poor.
2. Hold a small net in the downstream current and **disturb** the stones, vegetation and sand with your feet or hands so that the net catches what has been disturbed.
3. You can also lift stones out of the current and **pick** insects and other creatures off gently with your fingers or use a toothbrush or tweezers.
4. Do this for about **5 minutes** whilst moving across the river to **different habitats** (biotopes).
5. Rinse the nets and turn the contents into a white plastic tray or container filled with a little water.
6. **Identify** each group using the identification guide (you could start with the dichotomous key and then use the identification guide for more information.)
7. **Mark** the identified macro-invertebrates off on the identification guide.
8. Fill in the site information and **add up** the sensitivity scores to determine the average score (see scoring sheet).
9. Remember to **WASH** your hands when done!



Macro-invertebrates

What are they? Macro-invertebrates are animals that have no backbone and can be seen with the naked eye.

Why are Macro-invertebrates used for biomonitoring?

- Different macro-invertebrates have different sensitivities to pollution. The higher their score, the more sensitive they are.
- They are generally easy to collect and identify.
- They don't move around a lot, which allows the source of pollution to be detected.
- They integrate the water quality conditions at a site, providing an overall measure of the "health" of a river.
- They can provide a picture of the historical water quality at a site.

Groups	**Sensitivity Score**
Flat worms	3
Worms	2
Leeches	2
Crabs or shrimps	6
Stoneflies	17
Minnow mayflies	5
Other mayflies	11
Damselflies	4
Dragonflies	6
Bugs or beetles	5
Caddisflies (cased and uncased)	9
True flies	2
Snails	4
Total Score	
Number of Groups	
Average Score	
Average Score = Total Score divided by the Number of groups	

Scoring

1. On the table above, circle the sensitivity scores of the identified macro-invertebrates.
2. Add up all of the sensitivity scores.
3. Divide the total of the sensitivity score by the number of groups identified.
4. The result is the average score. You can interpret it using the guide below.

Interpretation of the miniSASS score: Although an ideal sample site has rocky, sandy, and vegetation habitats, not all habitats are always present at a site. If your river does not have rocky habitats use the **sandy type** category above to interpret your scores.

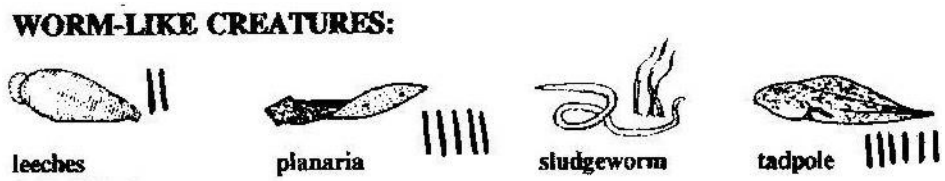
Ecological category (Condition)	River category	
	Sandy Type	**Rocky Type**
Unmodified **(natural condition)**	> 6.9	> 7.9
Largely natural/few modifications **(good condition)**	5.8 to 6.9	6.8 to 7.9
Moderately modified **(fair condition)**	4.9 to 5.8	6.1 to 6.8
Largely modified **(poor condition)**	4.3 to 4.9	5.1 to 6.1
Seriously/critically modified **(very poor condition)**	< 4.3	< 5.1

Release the macro-invertebrates back into the stream

During the activity make sure the children don't harm these little animals, they are very delicate. Once you have completed your miniSASS put the creatures carefully back into the stream.

Follow up activity

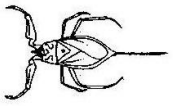
- Using their identification sheet get the learners to colour-in the creatures that they found. They can also keep a record of how many of each creature they found (see example below)
- Let the learners share their discoveries with one another. They can read the information about the creatures they have caught and discuss within their group what makes each group of creatures unique and successful in living in water and not on land. This is called 'adaptation'
- Lastly, using the plasticine, the groups each have to make a water creepy crawly that can live in water (it can be an imaginary, non-existent animal, never before seen by humans BUT it must be able to breathe in water, be strong enough not to be swept away by strong water currents and it must be able to eat in water).



Bring all the groups together, with their containers full of creepy crawlies, and ask the class the following questions:

1. What animals did each group find?
2. Why do you think these animals are better able to live in the water than on land?
3. How do the animals make sure that they are not swept away in the strong water currents?
4. If you were to sort these water creepy crawlies into different groups, using only one physical thing that you can see on the animals, what would you choose? *(Some of the learners may use legs to sort the insects, ie. those with none, two, four, or more than four, others may use the presence or absence of wings).*
5. If you lived in water, what would you need to live safely and happily?
6. Each group can now share their plasticine creepy crawly with the rest of the class. They need to explain what makes their creature so special and why it is able to survive in water.

Make sure that all the groups have coloured in all the creatures they found during the water study and have a 'total' next to each coloured-in animal.



Extending this activity with further river health tests

Use the **Fieldwork: Looking at River Health: Water Clarity** in Module 6 to investigate water clarity or turbidity in your stream or body of water, together with the laminated turbidity disks which are provided in your River Learning Box miniSASS kit.

Back in the classroom:

1. As a class, fill in the site information table on the miniSASS sheet.

2. Work out the miniSASS score and then 'interpret' your miniSASS score. Is your river or body of water in poor condition or in a good or even natural condition?

3. Find the place where you looked for creepy crawlies on your large colour A0 map. On coloured card, write the date and your miniSASS score, as well as your turbidity score and place the card on or around the map.

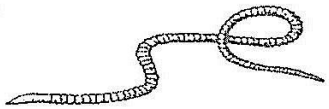
Flat worms

Flat worms are characterised by their flattened shape and soft bodied, worm-like form. They have an arrow-shaped head with two dorsal eyespots and are generally mottled or dark grey in colour. Flatworms move with a gliding action and are generally scavengers or carnivores.

Leeches

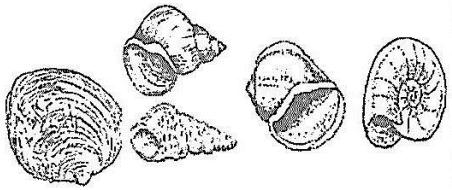
Leeches are segmented organisms that have very flexible bodies. When moving they expand to become long and thin, and then contract to become short and stubby. They have suckers on both ends of the body that are used for feeding and locomotion. Leeches are variable in colour, from grey, to red-brown and black. They swim with a fast, snaking movement and are found under stones, vegetation and debris.

Worms



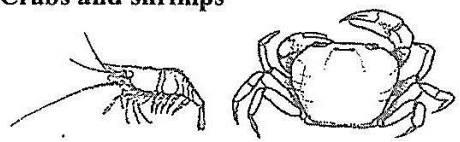
Worms are long and segmented and have a cylindrical shape much like small earth worms. Their colouring is usually pink to brown. They are usually seen writhing around in debris digesting the substrate they fed on.

Snails



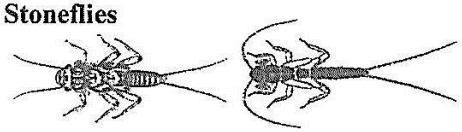
Snails are molluscs with hard shells that vary in size, shape and colour. Habitats vary, with some snails such as limpets clinging to rocks, whereas clams and muscles are found in sand. The more common snails move over stones and vegetation. Some snails are host to bilharzia, a serious health hazard for humans.

Crabs and shrimps



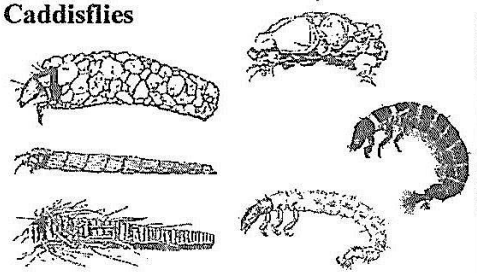
Crabs and shrimp form part of the order Decopoda (ten legs) and have bodies and legs hardened to form a tough shell. They have four or five pairs of legs and eyes that are carried on stalks and are movable. Crabs are scavengers that feed mainly on leaf litter but will feed on animals when given the chance. Shrimps are mostly scavengers or deposit feeders.

Stoneflies



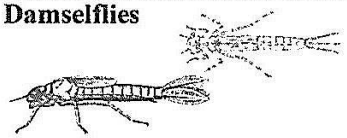
The nymphs of adult stone flies usually have two long tails and three pairs of legs each having two claws at the tip. A characteristic feature of stonefly nymphs are the tufts of gills on the side of the body as well as gills between the two tails. Wing pads on the thorax are often dark and obvious. Some species run across the substrate very efficiently and are potent predators on other invertebrates. Other species are smaller and feed on plant material. Most live in well oxygenated, clean water.

Caddisflies



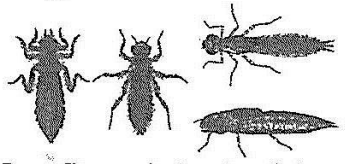
The aquatic larvae of adult caddisflies have a hard head with three pairs of legs which are attached to an elongated, soft body. Finger-like gills on the abdomen and anal appendages can be seen with the naked eye. Some caddisflies construct portable shelters/cases from sand grains, bits of vegetation and/or silk that are glued together to form a characteristic case shape. Most of the case-building types cannot swim whereas the case-less type swim freely across the substrate. Some feed on algae and detritus whereas others are predators.

Damselflies



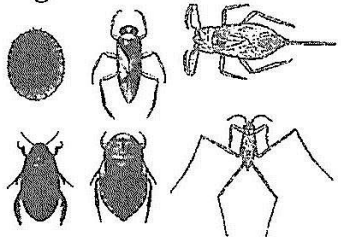
Damselflies have elongated bodies with generally three broad tails/gills on the tip of the abdomen. Damselflies are carnivorous and have a 'mask' over the lower part of the face which hinges out to reveal a pair of pincers with which they catch their prey. They are often to be found in vegetation growing on the edge of rivers.

Dragonflies



Dragonflies are robust creatures that are stout and have a large head and protruding eyes. Some have short legs whilst others have long legs. They do not have tails, but swim using 'jet propulsion' by forcefully ejecting water from the abdomen. Dragonfly nymphs are usually the largest organisms found in a sample and are the most powerful invertebrate predators in the water.

Bugs and Beetles



Bugs can be defined as having a piercing and sucking beak for mouthparts, and two pairs of membranous wings. Beetles on the other hand have 'jaws' and outer wings that are hardened to protect the inner wings. Some bugs and beetles are well adapted to swimming, such as water boatmen, backswimmers, pond skaters and water striders. Most bugs and beetles are carnivorous, but some feed on algae.

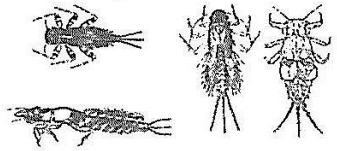
Mayflies

Mayfly nymphs vary greatly in shape and size and live only for a day or two. In this time they will never feed and live to mate and lay eggs in the water. Mayflies fly close to rivers and lakes, usually swarming in the early evenings.

Minnow mayflies

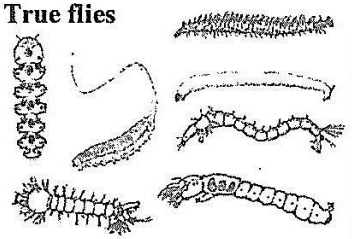
These mayflies have a narrow head and a small, slender, but not flattened body. They have leaf shaped gills on both sides of the abdomen and two but more commonly three tails, depending on the species.

Other mayflies



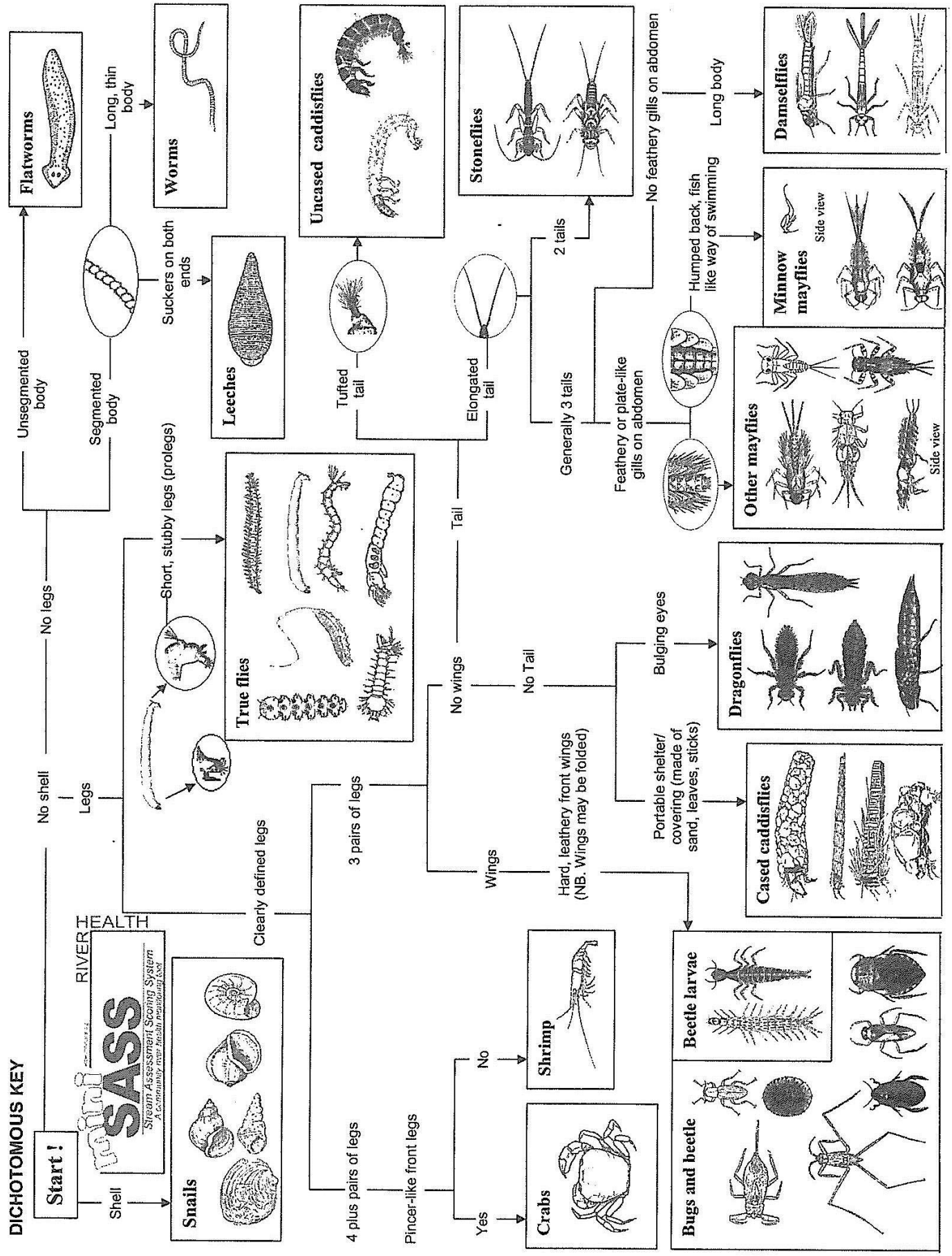
Other mayflies are characterised by an elongated body, large head, well-developed mouthparts and stout legs. They live in a variety of habitats including burrowing in mud, crawling amongst decaying leaves, and scurrying over stones in fast flowing currents.

True flies

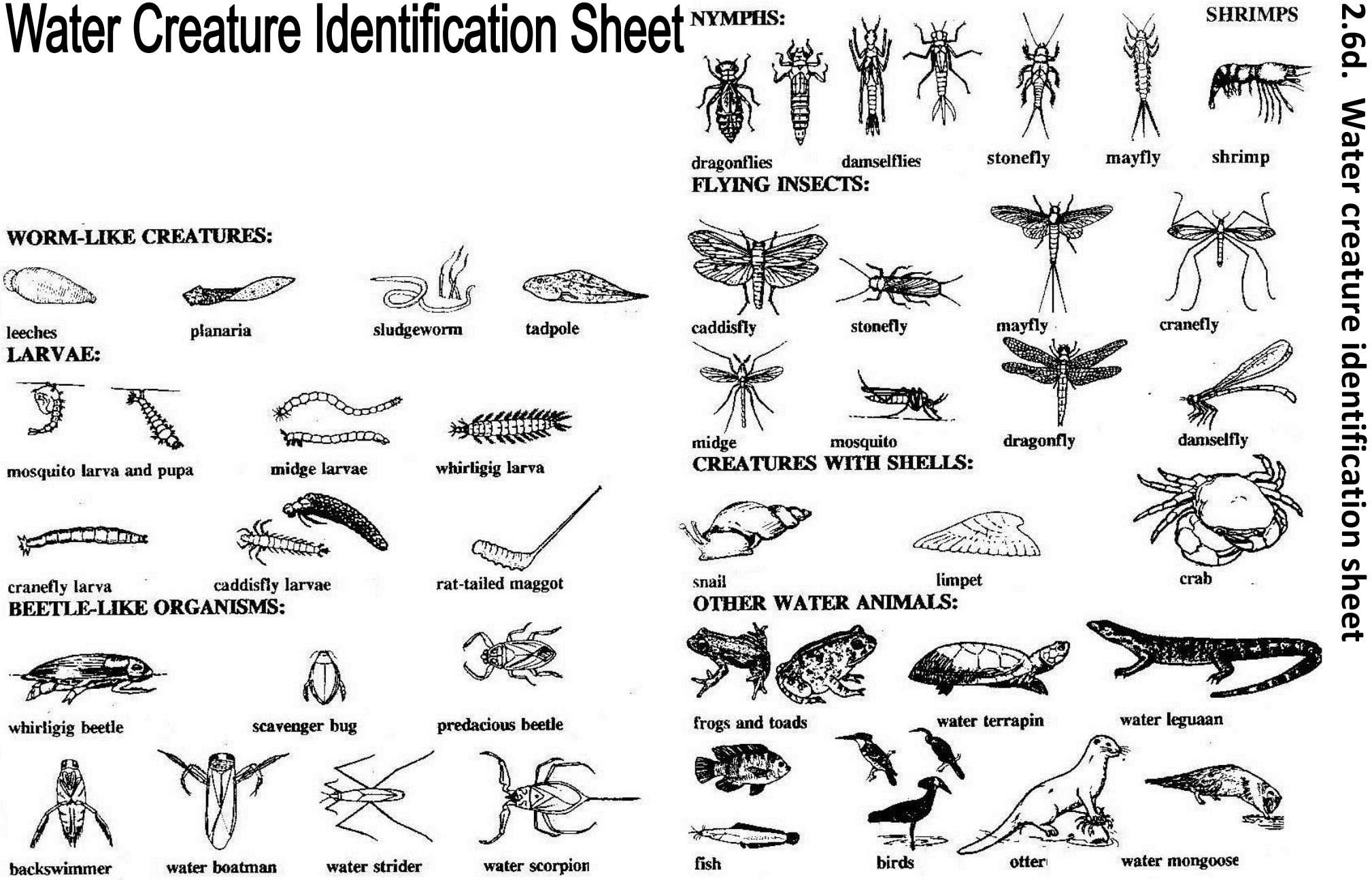


Most fly larvae have a fairly indistinct head but elaborate tail ends. They often have small, soft legs (prolegs), segmented bodies and have the appearance of maggots. Some have bristles/ spines and antennae. True flies live in a variety of habitats including sand, mud and stones in fast flowing water. They can either be carnivorous or filter feeders.

3.2.6c. miniSASS Macro-Invertebrate Groups

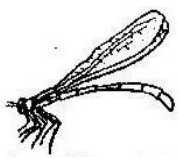


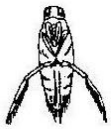
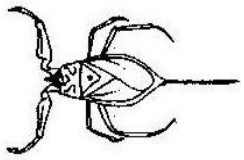
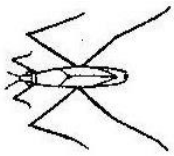
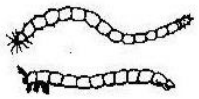
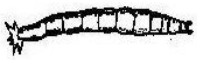
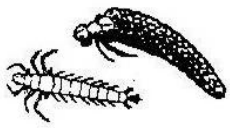
Water Creature Identification Sheet

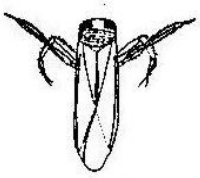
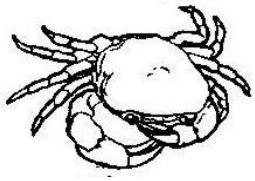
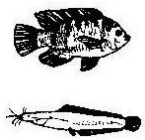
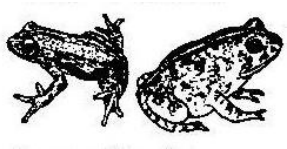


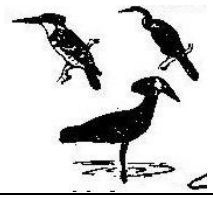
3.2.6d. Water creature identification sheet

3.2.6e. Water creature identification: Detailed Guide

	**Leech:** Leeches are small worm-like creatures that have suckers to suck the blood or body fluids from other animals. They like nutrient-rich water that is low in oxygen. They are mostly parasitic, which means they prey on other living animals, including people. If leeches stay on your body for too long they can cause your blood pressure to drop and make you feel ill. The suckers of a leech release a chemical, which stops blood from clotting, so that they can feed easily.
	**Planaria:** They are dark brown with flat bodies. Planarias live in clean, unpolluted water. If cut in pieces, they can re-grow, with each piece growing into a new creature!
	**Sludge Worm:** Their tails are used as gills to absorb oxygen. They are dark red due to the high oxygen levels in their bodies. Sludge worms like to eat mud, and they are able to live in polluted waters.
	**Water snail:** Water snails have a soft body protected by a coiled shell. They have a muscular foot that sticks out of the shell and is used to move. Snails eat water plants. They can live in slightly polluted water. Snails can carry very small (microscopic) animals, like bilharzia, inside their bodies, that can make people sick. Snails that carry bilharzia like slow moving waters and stay near reeds to keep from being washed away. People who have bilharzia often feel very tired and may have kidney damage.
	**Limpet:** Limpets have a flattish shell covering their body. This shell has a foot that sucks onto the smooth surface of rocks and plants. Limpets eat algae on rocks and on water plants.
	**Dragonfly:** The adults fly very fast. The nymphs of dragonflies are aggressive feeders who eat other insects. They can live in fairly polluted water. When they are ready to become dragonflies, they shed their skin emerging as an adult dragonfly.
	**Damselfly:** Adult damselflies are smaller and thinner than dragonflies. Nymphs are usually brown or green and have three large, flat gills at the end of the abdomen. They swim and run among stones at the bottom of streams.

	**Back swimmer:** They swim and rest on their backs. Their hind legs are used for movement. They breathe at the surface and an extra supply of air is trapped amongst the hairs on the upper side of the body.
	**Water scorpion:** This insect does not have a poisonous sting. It is usually brown and often looks like a dead leaf! It creeps around amongst water reeds or in the mud at the bottom of shallow pools. The water scorpion breathes through its tail – this is used like a snorkel.
	**Water strider:** The water strider has long middle and back legs for resting and skating on the surface of the water. Water striders eat insects which have fallen into the water. To find their prey, water striders have sensory areas in their feet. With these they can feel the vibrations of the insects that have fallen into the water.
	**Midge:** Adult midges or gnats are tiny insects that are usually seen flying in swarms above the water. Midge larva are often called 'bloodworms' because many have red or brown body fluids. The larvae are often found in mud in slow-flowing or still water. The red midge larvae are usually found in polluted water. The adult midge never eats anything! Its stomach remains an empty air sac. It lives for about 20 to 30 days. Generally midges are found in water that is slightly polluted.
	**Cranefly:** Cranefly larvae are found in water, in moist ground or in mud or under leaves. The larvae eat roots, dead plants and some small water animals like worms. The cranefly is often called a daddy-long-legs!
	**Rat-tailed maggot:** Rat-tailed maggots are usually grey with a fat wrinkled body and a long breathing tube. They can live in mud and polluted water.
	**Caddisfly:** The larvae have 6 long legs close to the head. Caddisflies like clean, unpolluted water.
	**Mosquito larvae:** Mosquito larvae live in stagnant (still) pools of water just below the surface of the water. They feed on tiny plants and animals. Male mosquitos suck plant juices when they are adults but adult female mosquitos suck blood from humans and other animals. If they are infected with malaria, the female mosquito will then pass it on to people, which can be deadly! Mosquito larvae are often found in poorly oxygenated ponds of water.

	**Whirlygig beetle:** The larvae look like small centipedes. Adult whirligig beetles are smooth and streamlined and are usually a shiny grey colour. They are named for their whirling or spinning movement on top of water. Adults and larvae both feed on dead or dying insects that have fallen into the water.
	**Water beetles and bugs:** All water beetles and bugs have flat, smooth bodies. They are usually found in clean streams and rivers.
	**Water boatman:** They swim mostly on the surface of the water and dive down deeper to feed on algae. They catch bubbles of air in their body hairs that they use to breathe from when they dive down deeper – similar to a scuba diver! These air bubbles give the boatman a silvery colour in the water.
	**Mayfly:** The nymphs (immature mayflies) have three long thin tails and have gills on the sides of their bodies. Mayflies need unpolluted water with plenty of oxygen to live in. They eat vegetable matter. The adult mayflies live for only one day once they hatch, and in this time they must find a mate and reproduce before they die. This is why mayflies often all hatch at the same time. This gives them the greatest chance of success.
	**Stonefly:** The nymphs have two thin 'tails'. They live under stones in running streams. They can only live in clean, unpolluted water. Nymphs eat small water insects and algae. If one finds stoneflies in a stream, it usually indicates good water quality as they are affected by small amounts of pollution.
	**Crab:** Crabs have a hard exoskeleton. An exoskeleton is the external skeleton that supports and protects an animal's body, in contrast to the internal skeleton (endoskeleton) of, for example, a human. Crabs have flat bodies and 5 pairs of legs. Crabs eat mostly dead or dying animals but also catch some live prey, such as tadpoles.
	**Freshwater fish:** Fish have streamlined bodies that are covered with slimy scales. Fins are used to move. Breathing is through their gills.
	**Frogs and toads:** Tadpoles (the larval stage in the life cycle of frogs and toads) have gills and live under water. Adult frogs and toads have lungs. Frogs spend their whole lives in moist areas or near water. Toads are stout, have short limbs and live in open country. Platanna (clawed toads) are neither true frogs or toads, they spend their whole lives in water.

	**Terrapin:** Water terrapins are usually a brown colour. They have a scaly skin and scales modified to form a leathery shell.
	**Water Monitor Lizard or Leguaan:** The water monitor is a very large lizard with a patterned scaly skin.
	**Water birds:** A wide variety of water birds are found in and around water systems. They have beak and feet adaptations for feeding in streams, rivers, ponds and wetlands.
	**Otter:** A fish-eating mammal, typically semi-aquatic, with a long body, dense fur, and webbed paws. Most otters have sharp claws on their feet and long, muscular tails. They are shy animals and not often seen. You may see their dropping which contain large quantities of crab shells.
	**Water mongoose:** This medium sized mammal has an overall length of 800 to 1000mm and weighs between 2.5 and 4.2kg. Their tails are 300-410mm long. They are brown in colour. Their bodies are relatively short and the tail is covered with long, shaggy hairs. Water mongoose are semi-aquatic and eat crabs and other hard-bodied prey. Like otters, they are shy animals and are seldom seen. You may see their droppings, which contain large quantities of crab shells.
	**Freshwater shrimp:** They feed on small animals and plants and are usually clear in colour, green or brown.

3.2.6f. Extending the miniSASS activity in class

Activity

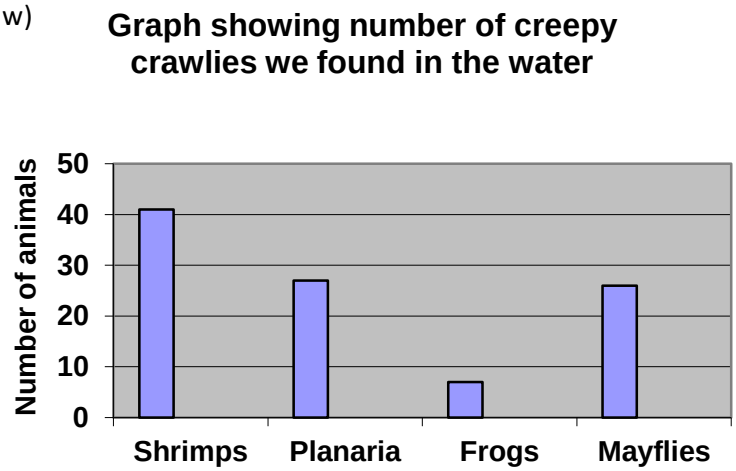
1. Using the coloured in miniSASS sheets from the previous activity, get each group to count up the totals of each different type of water creature that they found in the miniSASS activity. Write them down in a table provided on page 196.
2. Using the individual tables from each group, draw a large table on the chalkboard.
3. Let your learners add up all the numbers of creatures that were found as a class. (see table below)

Name of Water Creature	How many did we find?	Total found by class
EG: Shrimp	17 + 1 + 12 + 9 + 2	41
Planaria	2 + 3 + 7 + 11 + 3	26

i.e. Shrimp: Group A found 17; Group B 1; Group C 12; Group D 9 and Group E 2

Planaria: Group A found 2; Group B 3; Group C 7; Group D 11; Group E 3

4. Draw a bar chart of the types and amount of water creatures that were found in your group. (see example below)



5. How many water creatures prefer only clean water?
6. How many of the creatures you found can live in slightly polluted water?
7. How healthy do you think the river/stream is that we explored in the previous activity *(water creatures are very good indicators of water quality – certain creatures like mayfly nymphs and stonefly nymphs are only found in clean, unpolluted water).*

Name of Group: _____

Name of water creature	How many did we find?

e.g. Shrimp	*17*

Activity 2 Class Discussion

Did you know that creepy crawlies can tell us how healthy a stream is?

Certain water creatures are known as 'indicator species'. This means their presence in a river, stream or pond indicates polluted or unpolluted water. In this lesson, learners look at the relationship between water creatures and water quality, and water creatures and our health.

As a class, discuss the following questions:

1. Which water creepy crawlies can cause ill health or disease in people?
   - *Leech, Mosquito, Water Snail*

2. What illnesses can you get from each of the creatures in question 1 above?
   - *Low blood pressure (from the Leech), Malaria (from the Mosquito), Bilharzia (from the Water Snail)*

3. If you find a sludge worm in the water, what is it telling you about the health of the water?
   - *That the water is most likely polluted.*

4. Which water creatures tell us the water is unpolluted and clean?
   - *Stonefly, Planaria, Mayfly*

5. What type of water can a dragonfly larvae live in?
   - Fairy polluted water

6. Give 3 different ways that water can be polluted?
   - Litter & rubbish, Sewage, Chemicals

7. If you found two ponds of water and the one was filled with leeches, sludge worms, and mosquitos and the other had a few planaria and water boatman living in it, which one would you choose for your drinking water?
   - *Planaria pond*
8. Why is it important to ensure that the water we drink is safe to drink, wash in and use for cooking?
   - Dirty water can make people very sick.

9. How can we help to make sure our streams and rivers are not polluted?
   - *Some examples are: We can clean up our local wetlands, rivers and streams;*
   - *we can make sure we recycle our waste;*
   - *we can write to our local councillors and municipality;*

- *we can report people and businesses who we see are polluting our rivers and streams;*
- *we can decide never to use rivers or streams as a toilet.*

10. What can you do to make sure you do not get any diseases from water?
    - *Do not use water from dirty pools of water where cattle and human faeces (poo) can be found;*
    - *boil all water first when collecting from natural healthy water sources or use a teaspoon of Jik for every 25 litres of water (see page 19) ;*
    - *make sure that the water is collected from clean, fast flowing waters;*
    - *do not swim and play in rivers or streams that are very close to where people live (like a town or city) and have lots of litter and rubbish lying in and around them.*

My name is Ulrika Jemimah Tjiheruna. I am a learner at Nowak Primary School in the Karas region. I am 12 years old and I am in grade seven.

Something exciting that I learnt was that you get small insects in the water and it is amazing! I have never seen these in my life before!

In the future I would really like to become a water scientist so that I could tell other people more about water and the creatures that live in the water. I hope that in the future we go deeper into the river and look for more interesting and amazing types of small insects.

3.3.6a. Working out what to do - Fieldwork

Looking at school-yard life

Identification Guide adapted from: HANDS ON SCHOOL-YARD LIFE

(Complied by: DAVID L.CHRISTIANS, Edited by: ANDRE JOUBERT, Illustrated by: ROLENE ELLMAN and DAVID L. CHRISTIANS)

School-yard life – An investigation

You do not need to travel to a game reserve or natural area to do a biodiversity study! You can investigate the biodiversity in your own school yard!

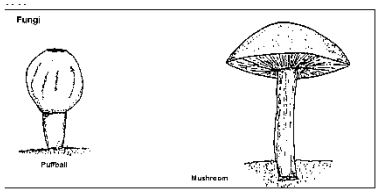
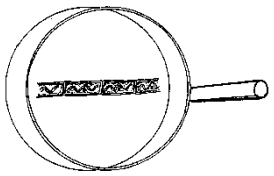
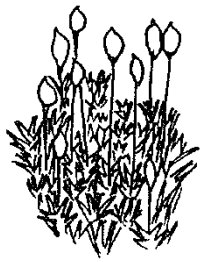
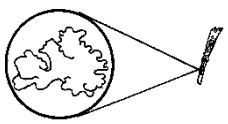
Using the guide to school yard life on the following pages discuss the different creatures that that may be found in your school yard. Discuss the habitat of each of these creatures and where they are most likely to be found.

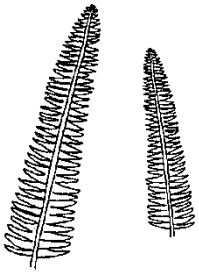
Explain to your learners not to disturb any creatures in their homes, only to observe and record them. It is important to explain that creatures that they may be afraid of, like frogs and snakes, are an important part of the eco-system and play a vital role in the food web, transferring energy through the system helping to keep it balanced. Snakes are very sensitive to vibration and will disappear when they sense a disturbance. If cornered they have warning signs that mean 'leave me alone' – they may hiss, Cobra's may raise their hood, some Cobra's may spit at something that is threatening them. Teach your children that snakes do not automatically want to bite them! A strike is a last resort when a snake is feeling threatened or if it is accidentally stepped on. Many snakes have no venom and it is important to learn to identify the different species that occur locally using a field guide. Discuss how you can create special habitats to invite different plants and creatures to take up residence in your school grounds.

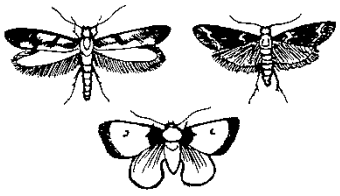
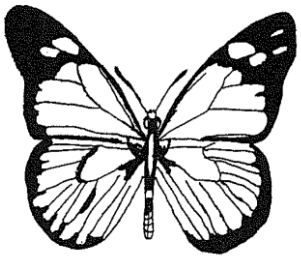
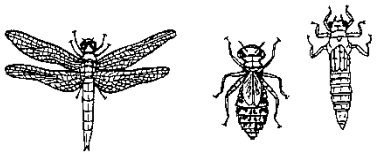
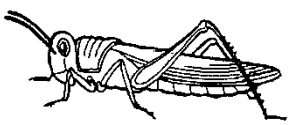
You can do this by creating a wetland area, a dry rockery, a vegetable garden and compost heap and even making an insect hotel using all sorts of materials that insects like to live in like hollow bricks, tiles, straw, tins filled with leaves, you can make it look very attractive by creating different areas and patterns with the materials!

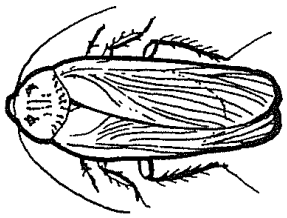
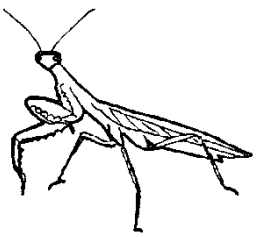
Use a copy of the Identification Guide and the worksheet in this unit to help structure and interpret this activity.

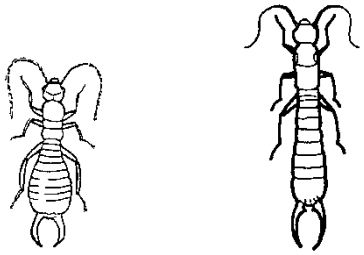
3.3.6b. School-yard Life: Detailed Guide

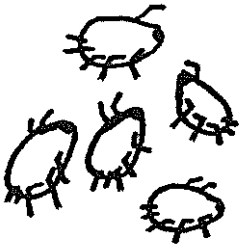
DIVISION: Eumycophyta **FUNGI**  	**DESCRIPTION:** Most fungi are colourless, have bodies (mycelia) and are soft. There are no leaves, stems, or roots. **WHERE FOUND:** You can look on any dead plant or animal matter such as wooden logs, compost heaps, fruit, bread, damp forest floors and grass areas. **IMPORTANCE TO MAN:** 1. Cause diseases of several important plants. 2. Cause spoilage of food. 3. Produce industrially important chemicals. 4. Production of antibiotics. 5. Some species are edible (some mushrooms and puffballs).
DIVISION: Phycophyta **ALGAE** 	**DESCRIPTION:** Algae range from **unicellular** forms such as *Chlamydomonas* to **multicellular** giant seaweeds, e.g. kelp, which may be over 30 m in length. They are often classified according to their colour: blue-greens, green, yellow, brown, and red. **WHERE FOUND:** Blue-green algae are found in salt and fresh water, on wet rocks and damp soil. Green algae are found in salt and fresh water, on wet soil, fence posts, moist stones tree bark etc. Brown algae are found chiefly in cooler ocean waters, a few in fresh water. They are attracted to rocks. Red algae are found chiefly in warm waters of oceans and a few in fresh water. **IMPORTANCE TO MAN:** Algae can **contaminate** water supplies, serve as fish and human food, increase soil fertility, are used in filters in industry, in toothpaste and dynamite and in insulation in refrigerators. Microscopic algae keep afloat by storing oil droplets.
DIVISION: Bryophyta **CLASS: Musci** **MOSSES** 	**DESCRIPTION:** Mosses are simple green land plants, and are small and **inconspicuous**. They have leaf-like and stem-like structures above ground and **rhizoids** below ground which anchor the plant and absorb materials from the soil. **WHERE FOUND:** Mosses are limited to moist habitats, because they need water for **fertilisation.** Mosses are world-wide in distribution and grow on rocks, on the bark of trees, on damp soil, on the roofs and in gutters of buildings. **IMPORTANCE TO MAN:** Mosses reduce soil erosion to a small extent and serve as food for certain kinds of animals. The leaves of mosses curl up as a way of survival.
DIVISION: Lichenes **LICHENS** 	**DESCRIPTION:** Lichens are **composite** plants. They are made up of algae and fungi in a **symbiotic** relationship. Within the body of the fungus is a layer of algal cells, which may be either a green alga **WHERE FOUND:** Lichens are common on rocks, tree bark, fence posts, but are also found under water and in desert soils. **IMPORTANCE TO MAN:** In the Arctic regions, *Cladonia alpestris* is an important food supply for reindeer and caribou. The absence of lichens on the outside of buildings in urban areas is an indication of high levels of pollution.
DIVISION: Pteridophyta	**DESCRIPTION:** Ferns have stems, leaves, and roots. The stems can be upright as in the

CLASS: Filicinae **FERNS** 	tree fern or horizontal underground stems called rhizomes, or stolons or climbing stems. The leave of most ferns are **compound** and the leaflets are called pinnae. Ferns do not form flowers or seeds but reproduce by means of **spores.** **WHERE FOUND:** Ferns are widely distributed over the earth. Land ferns grow chiefly in shaded, moist places, although there are some species which thrive in dry, exposed places. Some species are **aquatic.** **IMPORTANCE TO MAN:** Living ferns are of little importance to man, except as ornamental plants. Some species produce abundant, long, **epidermal** hairs which are used as a stuffing and packaging material. The trunks of tree ferns are used for construction purposes in the tropics. Many ferns and their relatives contributed to the formation of coal deposits.
WEEDS 	**DESCRIPTION:** Weeds are annuals. They grow in dense clumps, or singly among other plants. Most of them form rather attractive flowers. Weeds tend to invade the habitat of other plants, choking out these plants. **WHERE FOUND:** Weeds grow well in disturbed or trampled soil, in waste areas rich in nitrogen, or in cropland. On the school-ground you will find them growing in the rockery, garden, on the playing field and in cracks in the tarmac and cement surfaces. **IMPORTANCE TO MAN:** Weeds are considered to be a pest, especially by gardeners and crop farmers. They do however form an important part of fynbos, provide food for animals, and stabilise soil as **pioneers**. Some weeds have evolved seeds that are the same size as crop seeds, making it difficult to separate them from the crop seeds during threshing or sieving.
GRASSES 	**DESCRIPTION:** Grasses are low-growing plants. They are soft and non-woody. Some species grow as dense blankets on the ground while others grow in tufts. **WHERE FOUND:** On your school-ground you will find grass on the playing field, along fences, around the bases of shrubs and trees and growing in cracks in the tarmac. **IMPORTANCE TO MAN:** Grasses are probably the most important plant group for human survival. Grasses provide us with our staple foods such as oats, barley, maize, wheat for bread and sugar cane for sugar. Kikuyu grass was first grown in South Africa from a few stems brought from Kenya in a tin box.
SHRUBS AND TREES  	**DESCRIPTION:** Shrubs and trees are woody plants. Shrubs generally have a number of stems while trees have only one stem. Most shrubs do not grow as tall as trees. **IMPORTANCE TO MAN:** The list of products we obtain from trees is almost endless. Trees give us wood for furniture, fuel, and construction material. They provide us with fruit and medicine and many more.

PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Lepidoptera **MOTHS** 	**FEATURES:** Moths have scales on their bodies, legs and the four **membranous** wings. Coiled tubular mouth parts are used for sucking up liquids. **HABITAT:** Moths live in sheltered, shady places, but are attracted to lights. **REPRODUCTION:** Moths lay eggs on **vegetation** and windows. Eggs hatch into caterpillars. **FEEDING:** Caterpillars eat plants. Adults feed on sweet nectar from flowers and **pollinate** the flowers in the process. See section on Aphids. The antennae of Moths are thread-like or plumb-like and are far apart at their base.
HYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Lepidoptera **BUTTERFLIES** 	**FEATURES:** The body, legs, and wings of butterflies are largely covered with scales. They have four membranous wings, and the fore-wings are slightly larger than hind wings. Coiled tubular mouth parts are used for sucking up liquids. **HABITAT:** Inactive adults – due to cold and cloudy weather – rest on vegetation. They fly about in search of food in warm weather. Males may patrol territories or perch on prominent look-out posts to find a mate. **REPRODUCTION:** The female lays 3-4 eggs on one plant, then moves on to the next plant, avoiding overcrowding of caterpillars when they hatch 5-10 days later. **FEEDING:** Caterpillars eat plants. Adults feed on sweet nectar of flowers, pollinating the flowers in the process. The antennae of butterflies are knobbed and close together at the base.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Odonata **DRAGONFLIES** 	**FEATURES:** Dragonflies have two pairs of elongate, **membranous**, many-veined wings which are held outstretched when at rest. They have long, slender **abdomens**, large eyes, and short bristle-like antennae. Adults and nymphs have biting-chewing mouth parts – both are predators. Adults are very strong flyers – up to 80 km/hour. **REPRODUCTION:** The female lays her eggs in the stems of water plants or by skimming over the water to wash the eggs from her abdomen. The male sometimes accompanies her in tandem flight. The nymphs emerge after 3-4 weeks. After 11-15 moults, the nymph creeps out of the water, sheds its skin, and emerges as an adult. **FEEDING:** Nymphs eat water insects. Adults capture insects in flight. The largest known insect, the now extinct Meganeura, was a dragonfly with a wingspan of more than 600 mm.
PHYLUM: Arthropoda **ORDER:** Orthoptera **CLASS:** Insecta **SUBORDER**: Caelifera **SHORTHORNED GRASSHOPPERS AND LOCUSTS** 	**FEATURES:** They have relatively short antennae. The hearing organs are on the sides of first abdominal segment. Most species have red, yellow, or orange wings – of which there are 2 pairs. The first pair is leathery and not folded. The second pair is soft and folded like a paper fan, when not in use. The **thorax** and abdomen are clearly segmented. **REPRODUCTION:** The female makes a hole I the ground up to 100 mm with a short spade-like **ovipositor.** She lays 50 eggs in the hole and covers the eggs with a foamy substance which dries out and hardens to protect the eggs. Young hoppers emerge from eggs and moult 6 times. **FEEDING:** They are **herbivorous** with biting and chewing mouth parts.

PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Orthoptera **CRICKETS** Field Cricket & Mole Cricket 	**FEATURES:** Field crickets have long antennae. The first pair of legs of mole crickets are adapted for burrowing. All crickets have well developed hind legs for jumping, and they have biting and chewing mouth parts. **HABITAT:** Crickets live under stones and in burrows in soil. They are attracted into houses by light. **REPRODUCTION:** The male chirrups by rubbing his wings together. This attracts the female. She lays single eggs in holes in late autumn. Eggs hatch the following spring. **FEEDING:** True crickets are **omnivorous**. Mole crickets eat plants and their roots, including carrots, potatoes, and strawberries. Crickets have hearing apparatus on their front legs.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Blattodea **COCKROACHES** 	**FEATURES:** Cockroaches have flattened brown bodies. The thorax and abdomen are clearly segmented. They have two pairs of wings – the first pair is hard, thick, and straight. The second pair is soft, membranous, and folded under the first pair when not used. Three pairs of well-developed jointed legs. They have two long antennae and one pair of composite eyes. **HABITAT:** Cockroaches live in warm, dark, and protected places – under fridges, stoves and in kitchen cupboards. **REPRODUCTION:** The female produces 32 eggs in an egg case called an ootheca. The ootheca is glued to any protective spot, preferably near a food source for the nymphs when they hatch. Nymphs emerge from "zipped" side of the ootheca and are frail and white. **FEEDING:** Cockroaches are **omnivorous** – they eat almost anything – paper, glue, leather, plant material, hair, etc. Only 5 out of 1200 species have become cosmopolitan and only 3 of these have settled in South Africa.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Siphonaptera **FLEAS** 	**FEATURES:** The body is flattened from side to side. Fleas are wingless parasites of warm-blooded vertebrates. The mouth parts are adapted for piercing skin and sucking blood. The hind legs are developed for jumping. **HABITAT:** Fleas live on warm-blooded vertebrates. **REPRODUCTION:** Fleas lay eggs on the host animal. The eggs fall off the host and hatch. **FEEDING:** The larvae feed on organic material while adults suck blood. Adults can survive without food for up to four months. A flea can jump more than a hundred times its length.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Orthoptera **MANTIS** 	**FEATURES:** Mantids are green or brown in colour. The fore legs are adapted for catching and holding prey. They have two pairs of wings – the fore wings are long, straight, and leaf-like and serve as a form of **camouflage**. Hind wings are large and fan-like when extended, often brilliantly coloured, and used to frighten enemies. There are two large compound eyes and three simple eyes on top of the head. Neck joints are well developed and muscular, giving the mantis power to turn its head from side to side in a manner denied to almost all other insects. **HABITAT:** They live on **vegetation**, but may fly into houses at night. **REPRODUCTION:** Eggs are laid in separate compartments in a foam mass which congeals and hardens. Baby mantids emerge form the egg case through a little valve at the head end of each compartment.

	FEEDING: Mantids are predators, catching and eating other insects. The Bushman had many legends about the Mantis and called him Cagn. They hailed him the progenitor of their race.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Dermaptera **EARWIGS** 	**FEATURES:** Earwigs are elongated insects, sometimes with wings, sometimes without. Fore wings are short and square, covering membranous, many-veined hind wings. A pair of pincers occur at the end of the abdomen, used to fold hind wings under fore wings and to show aggression. **HABITAT:** These harmless creatures are found under stones, in rotting logs, under the bark of trees and in leaf litter. **REPRODUCTION:** The female lays 25 or more oval eggs in a heap in a secluded spot. She watches over them with passionate care and looks after the young until they can fend for themselves. **FEEDING:** Earwigs are **scavengers**, feeding on rotting fruit, organic debris, and dead insects. Earwigs do not crawl into people's ears as the Afrikaans name – Oorkruiper – implies. The name refers to the fact that their wings resemble minute human ears (earwig is a corruption of earwing)
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Diptera **FLIES** 	**FEATURES:** Flies are two-winged insects, the second pair being reduced to halters or balancers on the **metathorax**. The house fly is recognisable by its fleshy **proboscis** and four dark stripes on the **thorax**. The male house fly can be distinguished from the female by the larger compound eyes which almost meet on the head. **HABITAT:** They are commonly found in building and are considered to be **domestic** pests. **REPRODUCTION:** 100-10 eggs are produced at a time and on average one female can produce between 2 and 7 such batches. The eggs are laid in manure, grass heaps, rotting fruit and vegetables, refuse, human and animal **excreta**. The larvae feed on the **micro-**organisms responsible for the decaying of the material. **FEEDING:** Flies suck up liquids through the **proboscis.** From a study of 400 flies researchers have found an average of 125 000 bacteria on the flies with a maximum of 6 600 000.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Diptera **MOSQUITOES** Adult   Raft of eggs Lavae	**FEATURES:** They are slender, long-legged flies, with two membranous wings. A second pair is reduced to halters. The mouth parts of the female consist of sharp stylets and a proboscis. The male has a **proboscis** only. The male has heather-shaped antennae to receive the buzzing of the female. **HABITAT:** Mosquitoes live next to slow moving streams, in moist areas and in **stagnant** water. They are attracted to the warmth and light of houses at night. **REPRODUCTION:** Eggs are laid in water; *Culex* species in the form of a raft with eggs clinging together while the *Anopheles* species lays isolated eggs. If humidity and temperatures are favourable, the eggs hatch within 24-48 hours. **FEEDING:** Larvae feed on tiny plants and animals. The adult males suck plant and fruit juices and nectar from flowers. Only the female sucks blood and if she is infected she can pass on malaria. Mosquitoes are attracted to humans by the sweat on their bodies.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Hemiptera **APHIDS**	**FEATURES:** These well-known garden pests are very small – 1 – 6 mm and appear almost pear-shaped. Compound eyes and two antennae occur on the head. Aphids are most often wingless. They have piercing and sucking mouth parts.

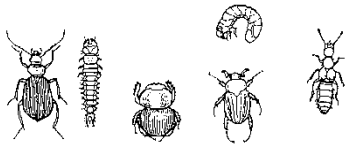


REPRODUCTION: 1) Mating between the two sexes results in fertilised females laying eggs. 2) Where no mating takes place in an entirely female colony, females give birth to live young. This method is called **parthenogenic** reproduction.

FEEDING: Aphids must consume great quantities of sap, which is mainly sugar and water, to obtain enough protein for growth. Most of the sugar solution is surplus to the aphid's nutritional needs and passes straight through its body. These liquid faeces form "honey dew" which is licked off the leaves by ants and many flying insects such as hoverflies and moths. See also section on Beetles.

The live young of an unfertilized female carry live young inside their bodies while they themselves are still inside the body of an unfertilized female!

PHYLUM: Arthropoda
CLASS: Insecta
ORDER: Coleoptera
BEETLES



FEATURES: Beetles have horny or leathery front wings covering and protecting the membranous hind wings. Mouth parts are of the biting and chewing kind. The two antennae have up to 11 segments.

HABITAT: Larvae can be found in soil and **humus**. Adults hide under stones.

REPRODUCTION: The female lays eggs in soil, humus or dung. Larvae feed on **dung**, decaying plant matter or plant roots. A definite pupal stage is present.

FEEDING: Dung beetles feed on dung. Chafer larvae eat plant roots, while adults eat flowers and fruit. Ground beetles prey on other **invertebrate** creatures.

Ladybird larvae and adults prey on Aphids.

The order Celeoptera is the largest of all insect orders, with some 300 000 known species in the world.

PHYLUM: Arthropoda
CLASS: Insecta
ORDER: Hymenoptera
WASPS

Potters Wasp

Paper Wasp

FEATURES: Wasps have four membranous wings. The thorax and abdomen are joined by a petiole. Mouth parts include jaws. Wasps are brownish or yellow in colour. Most of them have a sting.

HABITAT: They are often found under the edges of a roof or in the ground, in the case of the digger wasp.

REPRODUCTION: The female paper wasp lays eggs in paper nests (finely chewed tree bark).

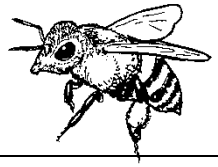
Potter wasps build neat clay pots on twigs, grasses, or stones. Cuckoo wasps lay their eggs in the nests of mud and spider wasps.

Parents feed the larvae. The potter wasp feed the larvae only once.

FEEDING: Wasps are **carnivorous**, feeding on other insects, caterpillars, and even spiders.

The metallic green or blue cuckoo wasp can roll itself into a ball as a defence against any inquisitive foe!

PHYLUM: Arthropoda
CLASS: Insecta
ORDER: Hymenoptera
BEES

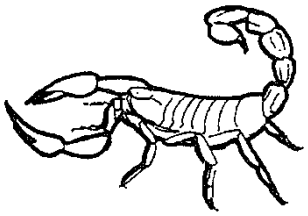
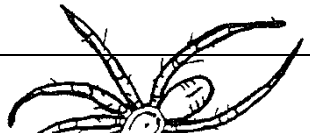


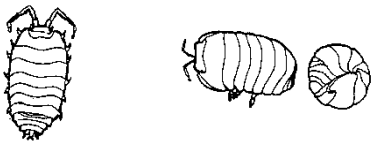
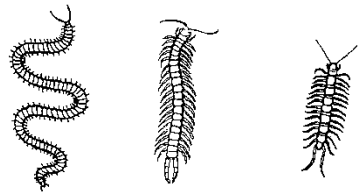
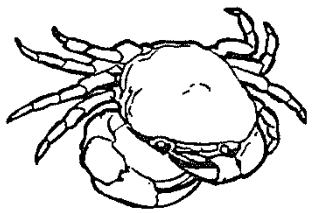
FEATURES: The hind wings are joined to the fore wings by hooks. The legs and abdomen are adapted to collect and carry **pollen**.

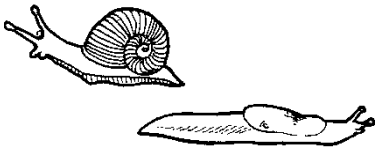
HABITAT: Bees make their nests in hollow trees, holes in rocks, underground tunnels, deserted insect nests, woodborer tunnels, dry bamboo stems, etc.

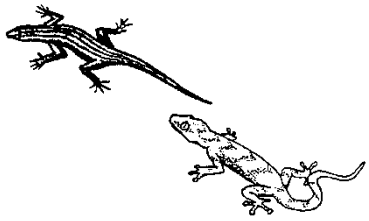
REPRODUCTION: (in case of honey bees) Waxen cells are constructed by workers to accommodate the larvae and pupae of different castes, and to store food. Drones mate with queens in flight. Selected larvae are fed on royal jelly only and develop into queens.

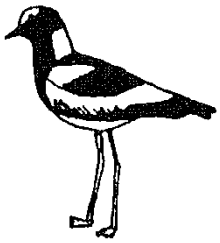
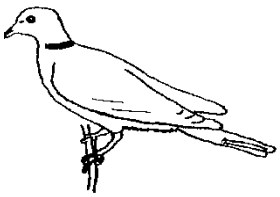
FEEDING: Worker bees collect nectar and **pollen.** Nectar is changed into honey in the

	honey sac of the workers. Bee bread is made from pollen and honey. After three days of eating royal jelly, larvae destined to be workers, are fed on honey, bee bread and water. During a shortage of food the drones are kicked out and left to starve.
PHYLUM: Arthropod **CLASS:** Insect **ORDER:** Thesauri **FISHMOTHS** 	**FEATURES:** Fishmoths are very agile, wingless insects. The body is covered in silvery scales. They have long antennae. On the hind led of the abdomen there are three many-jointed **appendages**. Fishmoths have compound eyes, but eyes are absent in some species. **HABITAT:** Some species live with ants or termites. Others are found in human dwellings or building where linen or papers are kept, others occur in soil, in rotting wood, under stones, or in leaf-litter on forest floors. **REPRODUCTION:** Males deposit sperm on silken threads attached to **substrate**. The female takes sperm up into her reproductive tract. Some species appear to reproduce **parthenogenically**. **FEEDING:** Cellulose, starchy glues, fungi, lichens, and decomposing vegetable matter all form part of the fishmoth diet. The domestic fishmoth was introduced into South Africa from Europe.
PHYLUM: Arthropoda **CLASS:** Insecta **ORDER:** Scorpionida **SCORPIONS** 	**FEATURES:** Scorpions have four pairs of legs, two powerful pedipalps (nippers), slender tails ending in a telson with poison glands and a sting. They have eight simple eyes and **tactile** hairs on parts of its body. **HABITAT:** These **nocturnal predators** live under rocks, bark and in burrows in soil. **REPRODUCTION:** The male deposits **sperm** on a suitable **substrate**. The sperm is then taken up into the female opening during a courtship dance. The **ova** are fertilised internally. The female gives birth to live young. **FEEDING:** Scorpions prey mainly on spiders and insects. The prey is seized with pedipalps and stung to death or paralysed. Chewing is done by the pedipalps and first two legs. Juices are sucked into the digestive system. Scorpions glo under ultra violet light.
PHYLUM: Arthoropoda **CLASS:** Insecta **ORDER:** Acari (na) **TICKS** 	**FEATURES:** Ticks have flat bodies which become swollen after feeding. They have eight legs as adults, six legs as larvae. **HABITAT:** They are found on animals and vegetation where they wait for passing animals. **REPRODUCTION:** Ticks lay between 100 and 20 000 eggs on the ground, in the sand or in cracks and crevices. Larvae take between 2 and 10 weeks to hatch and can live for longer than 6 months without food. Moulting takes place to allow growth. **FEEDING:** They are bloodsucking **parasites**, coming out at night to feed. A good meal of blood leads to egg production. Some species like *Amblyomma hebraeum* can live for two years without food.
PHYLUM: Arthropoda **CLASS:** Arachnida **ORDER:** Araneida **SPIDERS** 	**FEATURES:** The body is composed of two regions: the head region (prosoma) and the abdomen (opisthosoma). The mouth parts and eight legs are attached to the prosoma and the **spinnerets** are on the opisthosoma. **HABITAT:** Spiders live almost anywhere, even in the **intertidal zone** of our oceans. **REPRODUCTION:** Eggs are laid in silken egg cases which are suspended or carried around

	by the mother. **FEEDING:** Spiders are **predators** and catch their prey by running it down, leaping on it, ambushing it, netting it in a web or by ejecting sticky threads or a mixture of poison and silk over it. The Feather-legged spiders, *Uloborus,* are the only spiders that do not have poison glands.
PHYLUM: Arthropoda **CLASS:** Crustacea **ORDER:** Isopoda **WOODLICE** 	**FEATURES:** Woodlice are black, brown, or grey in colour. The body is **dorso-ventrally** flattened. They have seven pairs of legs. **HABITAT:** Woodlice are found under rocks, leaf litter, planks, and bark. **REPRODUCTION:** They lay eggs and the young look like the adults. **FEEDING:** Woodlice feed on **decomposing** organic matter. Woodlice are related to crabs, barnacles, lobsters and prawns!
PHYLUM: Arthropoda **CLASS:** Crustacea **ORDER:** Diplopoda **MILLIPEDE**  	**FEATURES:** Millipedes have segmented bodies – the first four are single segments, the rest are double. The double segments have two pairs of legs. They have antennae and simple eyes. **HABITAT:** They live in **decaying** vegetation. **REPRODUCTION:** Eggs are laid in nests or egg **capsules**. Larvae have only three pairs of legs and acquire more legs and body rings after each moulting. **FEEDING:** They are **herbivorous**, eating mainly decomposing plant material but also moulds, living plant material and seeds. Milipedes have, at most, 300 legs, nowhere near the 1000 suggested by their name!
PHYLUM: Arthropoda CLASS: Crustacea ORDER: Chilopoda **CENTIPEDE** 	**FEATURES:** Centipedes have segmented bodies with many-segmented legs. Adults have 15 or more pairs of legs. One pair of antennae and simple or **compound** eyes occur on the head. Eyes may be absent. **HABITAT:** They are found in decaying plant material like leaf litter and rotting wood or in the upper layer of rich soil. **REPRODUCTION:** Eggs are laid in a brood chamber and guarded by the female before hatching and for weeks after hatching. The young take 6 months to mature and can live up to 6 years or more. **FEEDING:** They are predators and prey on most soil animals**.** The bite of certain centipedes may be lethal, especially to small children.
PHYLUM: Arthropoda **CLASS:** Crustacea **ORDER:** Decapoda **CRABS** 	**FEATURES:** Crabs have a hard **exoskeleton**, flat bodies, and 5 pairs of legs. The first pair is modified to form pincers. Two antennules, two antennae, and two compound eyes on movable stalks occur on the head. **HABITAT:** A wide variety of habitats is used. They are found on sea shores, in ponds, pools, rivers, and streams. They hide under rocks. **REPRODUCTION: Fertilisation** is **internal**. Tiny larvae hatch from eggs which are carried around by the female on part of her abdomen. The larvae moult as they grow into adults. **FEEDING:** Crabs are **scavengers**, eating dead animals. They also catch live **prey.** Crabs move sideways so that their legs don't tangle!
PHYLUM: Annelida **CLASS:** Oligochaeta **ORDER:** Opsithopora	**FEATURES:** Earthworms have long segmented bodies. They are shades of brown or pink in colour. The slight thickening of the body from segment 32-37 is called clitellum. There

EARTHWORMS 	are four pairs of **bristles** for movement on each segment, except on the first and the last. Eyes are absent. **HABITAT:** Earthworms live in tunnels made in moist soil which has a high **humus** content. They come on to the surface in wet weather. **REPRODUCTION:** Earthworms are **hermaphrodites**. Two worms exchange **sperm cells. Fertilisation** occurs later in a cocoon when **egg cells** of one worm fuse with the sperm cells received from the other worm. **FEEDING:** Earthworms feed on **organic** matter and mineral particles in soil. They also eat fallen leaves. One of the largest Earthworms in the world, *Microchaetes*, is indigenous to the bushy parts of the Eastern Cape and KZN. It can grow to 1.5m!
PHYLUM: Mollusca **FAMILY:** Helicidae **CLASS:** Gastropod **GENUS:** *Helix* **ORDER:** Stylommatophora **SLUGS & SNAILS** 	**FEATURES:** Snails and slugs have unsegmented, slimy bodies. Snails have shells protecting the **visceral mass**. The shell of the garden snail has 4-5 whorls with irregular brown bands parallel to the sutures of the whorl. There are two pairs of **retractile** tentacles, the larger pair with an eye on the tip of the tentacles. **HABITAT:** They are found in moist, shady areas. Slugs can be found particularly under stones, and they often come into the house. **REPRODUCTION:** Snail and slugs are **protandrous hermaphrodites. Fertilisation** is **internal.** A cluster of 40-100 eggs are laid in small holes in the earth during autumn. **Hatching** takes a few weeks; the young resemble adults. **FEEDING:** They feed on fresh plant matter; but there is a **carnivorous** species that feeds on other snails. After insects - 500 000 species – Molluscs have the second most species – 100 000!
PHYLUM: Chordata **CLASS:** Osteichthyes **BONEY FISH**	**FEATURES:** Fish have spindle-shaped bodies, covered with scales. They have fins for movement, steering, and balance. There are two eyes without eyelids. A lateral line to determine depth in water runs from behind the gill covers to tip of the tail. Two nostrils for smell only, occur at the end of the snout. External ears are absent. **REPRODUCTION:** The sexes are separate. The male and female release their sperm and egg cells respectively into the water. Fertilisation occurs in the water – **external fertilisation.** The eggs contain a big yolk and are hatched by the sun. **FEEDING:** The smaller kind will feed on diatoms and small algae. Others will eat plants, and marine animals such as mussels, crabs, oysters, red-bait etc. Most fishes possess teeth, which are outgrowths of the jaws. In some fish the teeth are also found on the roof of the mouth. The smallest fish is 10mm and the biggest fish, (swordfish), can reach 4m!

PHYLUM: Chordata **ORDER**: Anura **CLASS:** Amphibia **TADPOLES & FROGS**   **TOADS & PLATANNAS**  	**FEATURES, HABITAT, and FEEDING:** Tadpoles have gills and live under water. A tails is used for movement. They are attached to plants by a sucking mount when very young. Frogs have lungs for breathing. They can live on land but near water. The skin is smooth and four legs are used for movement. They eat insects. **FEATURES, HABITAT, and FEEDING:** Toads have lungs for breathing. The skin is rough and bumpy. There are four short limbs for movement. They live in open country, but return to water to breed. Platannas have lungs for breathing. The skin is smooth and slimy. The hind feet are webbed with claws on the three inner toes. They spend their entire life in water. **REPRODUCTION:** Frogs and toads have loud and varied mating calls. Most adults lay eggs in clumps or strings of jelly. Tadpoles **hatch** in a few days and take about 8 weeks to reach adulthood. The biggest South African toad - *Pyxicephalus adspersus* - grows up to 20cm.
PHYLUM: Chordata **ORDER:** Squamata **CLASS:** Reptilia **SUBORDER:** Sauria **LIZZARDS & GECKOES** 	**FEATURES:** These reptiles have four strong legs for walking, running and climbing. Geckoes have adhesive pads under their toes to enable them to climb up walls and windows. The tails can be cast off when they are disturbed. **HABITAT:** Look for <u>lizards</u> in the grass along fences, in sunny spots in the rockery or garden. <u>Geckoes</u> you will find in and around buildings and in dark corners in storerooms. **REPRODUCTION:** They lay their eggs in warm, humid soil and cover it lightly with dead vegetation. The young emerge as miniature adults and moult as they grow. **FEEDING:** They are predators and feed on insects, e.g. moths, mosquitoes, crickets, etc. Some species of lizards are legless and look like snakes.
PHYLUM: Chordata **ORDER:** Squamata **CLASS:** Reptilia **SUBORDER:** Sauria **CHAMELEONS**     	**FEATURES:** This fascinating lizard has feet and a tail for gripping. The eyes are at the ends of **conical** turrets and can swivel around independently in all directions. It has a long darting tongue with a suction tip. (not sticky). **HABITAT:** Chameleons live on trees and shrubs. **REPRODUCTION:** Dwarf chameleons produce live young and common chameleons produce up to 58 eggs which are laid in a hole dug by the female. **FEEDING:** The tongue is shot out at the prey (insects), the suction cap is wrapped around the prey, and the prey is drawn into the mouth. Chameleons have little control over their colour changes which are due to light and shade, temperature and emotions!
PHYLUM: Chordata **ORDER:** Squamata **CLASS:** Reptilia **SUBORDER:** Serpentes **SNAKES** **Brown House Snake** 	**FEATURES:** The body is covered with scales. Eyelids and ear holes are absent. The forked tongue is sensitive to scents. **HABITAT:** Snakes live in trees, in holes in the ground and in buildings. **REPRODUCTION:** Some snakes lay up to 100 eggs at a time in holes, crevices, or in rotting vegetation. Others give birth to live young. **FEEDING:** Snakes feed on a variety of prey including rats, mice, frogs, snails, birds, birds' eggs, and other snakes. The prey is squeezed to death by the body or killed with poison

	when bitten. Snakes use their tongues to 'smell out' their prey, their mate, and even the way home!
PHYLUM: Chordata **SUBCLASS:** Neornithes **CLASS:** Aves **BIRDS**  **Blacksmith Plover**  **Turtle Dove**	**FEATURES:** The legs are covered with scales. Feet are adapted for running, paddling in water or catching and gripping prey. The body is covered by feathers for warmth. The wings are used for flight, warmth, and fighting off attackers. Skeletal bones are hollow but very strong. Lungs extend into the hollow limbs in some species. Beaks are adapted to the bird's particular feeding method, but also used for nest building and defence. **HABITAT:** The birds on your school-grounds will be found in the grass on the field, in trees, in and under the roof of buildings. **REPRODUCTION:** All birds lay eggs. For this purpose, most birds build nests. Others simply lay the eggs on the ground. The eggs are hatched by the warmth of the parents' bodies. **FEEDING:** Birds feed on many different kinds of food; fruit, seeds, leaves, meat, fish, carrion, table scraps, molluscs, insects, arachnids, caterpillars, reptiles, etc. Indigenous birds usually prefer indigenous trees to sit and nest in.
PHYLUM: Chordata **SUBPHYLUM:** Vertebrata **CLASS:** Mammalia **MAMMALS** 	**FEATURES:** Characteristics which distinguish mammals from other vertebrates are: 1) mammals are hairy rather than scaly, 2) mammals nurse their young, and 3) mammals maintain a constant body temperature. **HABITAT:** Most mammals live on land. Others live in water. **REPRODUCTION:** Sexes are separate. **Internal fertilisation** occurs. The female mammal gives birth to live young. **FEEDING:** Mammals are either **herbivorous, carnivorous** or **omnivorous.** External ears are exclusive to mammals!
Glossary Abdomen Appendages Bristles Capsules Carnivorous Composite Compound Conical Contaminate Decaying Decomposing Domestic Dorso-ventrally Egg cell Epidermal Excreta Exoskeleton External fertilisation Fertilisation Habitat Hatching Herbivorous	 *lower part of the body* *parts added on to* *stiff hairs* *container* *meat-eating* *made up of parts* *made of two or more parts* *shaped like a cone* *to make dirty* *wasting away, rotting* *breaking up into parts* *belonging to home* *from top to bottom* *female sex cell* *out of the outer covering* *waste material* *skeleton on outside of body* *fertilisation outside the body* *of sperm and egg cell* *natural home of plant or animal* *being born from an egg* *plant-eating*

Hermaphrodite	*an organism possessing both male and female reproductive organs*
Humus	*decomposing organic matter in soil*
Inconspicuous	*hardly seen*
Indigenous	*native to a country*
Internal fertilisation	*fertilisation inside the body*
Intertidal zone	*area between high and low tide mark*
Membranous	*like a membrane*
Metathorax	*middle segment of the thorax*
Micro	*very small*
Multicellular	*made up of many cells*
Nocturnal	*coming out at night*
Omnivorous	*plant- and meat-eating*
Organic	*compounds formed by living organisms, compounds containing carbon*
Progenitor	*forefather or ancestor*
Rhizoids	*filaments acting as roots*
Rhizomes	*underground, horizontal stems*
Parasites	*organism living on or in another, living organism and getting food from it*
Parthenogenetic reproduction:	*reproduction without fertilisation*
Pioneers	*first plants to come up in an area*
Pollen	*fine powder on the anthers of flowers*
Pollinate	*to transfer pollen from the anthers of the flower to the stigmas of the flower*
Predator	*animal that hunts, and kills other animals*
Prey	*animal that is hunted by the predator*
Proboscis	*tubular mouth part*
Retractile	*can be drawn back*
Scavengers	*animals living off dead animal matter and cleaning up in the process*
Sperm cells	*male sex cell*
Spinnerets	*external spinning organs near the rear of the abdomen*
Spore	*reproductive cell that can develop into an adult without joining with another cell*
Stagnant	*standing still and impure from not flowing*
Sterile	*unable to reproduce*
Substrate	*ground or surface*
Symbiotic	*an association of two different kinds of organism involving benefit to both*
Thorax	*section of body between head and abdomen*
Unicellular	*consisting of one cell*
Vegetation	*plants*
Vertebrates	*animals with a backbone*
Warm-blooded	*animals capable of maintaining a constant body temperature*

Extending the School-Yard Life Activities

1. Draw a map of your School premises and School yard.

2. Draw pictures of all the plants and animals that your group found in the school grounds.

3. Add labels to name and describe the characteristics of the life that you found.

4. Find pictures of the types of plants and creatures that you have found in newspapers or old magazines.

5. Using a large sheet of cardboard or paper and create a collage using all the above.

7. Choose one of the creatures as your main character and write a story about life in your School-yard from its point of view.

8. Invite a local expert to help you interpret your School-yard study.

9. Design a play about how all the plants and creatures in the school-yard interact together. Include the impact that school life has on these creatures and explore the relationships between the teachers and learners and life in the school-yard.

10. Write songs or poetry to go with the story, make props and costumes and put on your very own school production!

11. Get your learners to make posters and write an article for the local newspaper with biodiversity in your school-yard as the theme.

12. Invite the parents, local community leaders and supporting NGO's to watch the production and raise some funds for a project to improve biodiversity in your school-yard.

3.4.6. Working out what to do - Fieldwork

Looking at an aquatic eco-system

In rivers, as in the majority of other aquatic and terrestrial systems, the energy at the base of a food web comes from the solar energy fixed by plants (through photosynthesis) growing in the water or on land.

Energy derived from terrestrial plants enters the water in the form of plant parts, such as leaves or twigs, or in the form of dissolved organic matter. This material is used as a source of energy by microorganisms such as fungi and bacteria, and by invertebrates. Plants in the river are also important in food webs, microscopic algae are often eaten while alive, while larger aquatic plants enter food chains mainly after they have died.

Activity - Outdoor research on the stream

There is a lot to see and discover in a stream near your school. Arrange an outing and spend several hours outdoors by a stream where the learners can put the knowledge they have gained from working through this chapter into practice.

Look for a safe place on a stream with near-natural surroundings that has varied banks, fast and slow running water. Choose an unpolluted section of the stream to study.

Collecting a range of interesting objects serves to awaken curiosity and to encourage quiet,

concentrated work among the children. These can be used to discuss and explain how living and non-living things interact within the eco-system and the human impacts on this system.

Activity 1: The great search - terrestrial study

In small groups, allow your learner to go in search of interesting objects such as:

- different stones and/or soil types
- humus (organic matter in the soil) and/or leaf litter
- different signs of animals (for example feathers, quills, crab shells, droppings, snail shells or caddis fly cases)
- different leaves of plants along the river bank or water plants
- pieces of driftwood
- traces of human activity (fencing wire, rubbish, charcoal from fires, cigarette stumps, bottles)

Each group presents their findings on a sheet of newspaper or cloth

Use the following questions to direct an enquiry

- What kind of plants and animals were observed or evidence found?
- Is the eco-system in a natural state?
- What are some of the reasons for the answers?
- Where did the stones/soil types come from and where are they going to end up?
- What is the role of humus/leaf litter in the eco-system?

- What are the roles of plants on the river bank?
- What are the roles of the plants in the water?
- What is the origin of the piece of driftwood?
- What are the roles of trees in the eco-system?
- Is there evidence for reducers and decomposers in the eco-system that help break down organic matter like the piece of driftwood, back into nutrients for plants to use?
- Discuss the traces of human activity and the impacts relating it to upstream and downstream activities and effects.
- What does this mean for the ecology of the stream and stream banks?

Activity 2: Measuring the size of stones/collecting soil types

Divide the class into groups of three. Task some groups with measuring stones and some with finding soil types. Use a 2-m-long wooden pole (or mark the area with a piece of rope or string) and lay it out on a rocky area of the river bank. In groups of three, get the children to measure the stones lying adjacent to the pole. One learner can pick up the stone, and another measures its size with a tape-measure. The third learner can tick the size category from a list of options on a sheet. Instruct the groups finding soil types to look for different textures and colour soils in different areas in the stream and along the stream banks. Use cut-off two litre cool drink bottle containers to collect the samples in.

< 1mm (silt, loam, clay)

>1mm <5mm (sand, gravel)

>5mm <10mm (pebbles)

>10cm (stones, rocks)

Use these questions to direct your inquiry

- Is the river bed sandy or rocky?
- Why do you think this is?
- How would this effect the kind or organisms that you would find in the stream?
- What types of soils did you find in the stream and on the river banks?
- What are the differences that you observe?
- What is the role of humus or leaf litter in the soil?
- What is the evidence for different plants preferring different soil structures?
- Is there evidence of siltation in the water or on rocks? (See turbidity test)
- If yes, where could this siltation be coming from?

Activity 3: Mapping the bank structure

Put your learners into pairs and let them sit on opposite banks. Let each team member sketch what the edge of the bank looks like over a length of 10 metres. Let them mark the bank's structure by sketching steep and shallow sections, undermined (cut away) sections, stones, roots, trees, and so on.

Use these questions to structure your enquiry

- What was the difference in the vegetation on the steep and shallow sections?
- Are there animal or human paths and what is the impact?
- Are there places where animals cross the stream/drink water?
- What is the impact on the stream bank and stream from these places?
- How does the vegetation and roots protect the river banks?

Activity 4: Measuring current speed

Divide your learners into groups and give each group the task of measuring the speed of the current or flow. Let them measure a stretch of 2 metres along the stream bank with a tape measure and mark it with a straight stick or wooden post at each end. Instruct them to throw a piece of wood into the middle of the stream, and measure the time it takes to pass from the first to the second post. If your stream is sufficiently wide, repeat the process on the left and the right banks of the stream.

Use these questions to structure your enquiry

- What are some reasons for different flow rates in the river?
- What is the difference in the energy of the water in fast and slow running places?
- What happens to silt, sand and rocks in fast running places?
- What happens to silt, sand and rocks in slower running water or still pools?
- Do you notice a difference in the depth of the water along steep banks and shallow banks?
- Why do you think this is?
- Where does all this material end up eventually?

Activity 5: Measuring water temperature

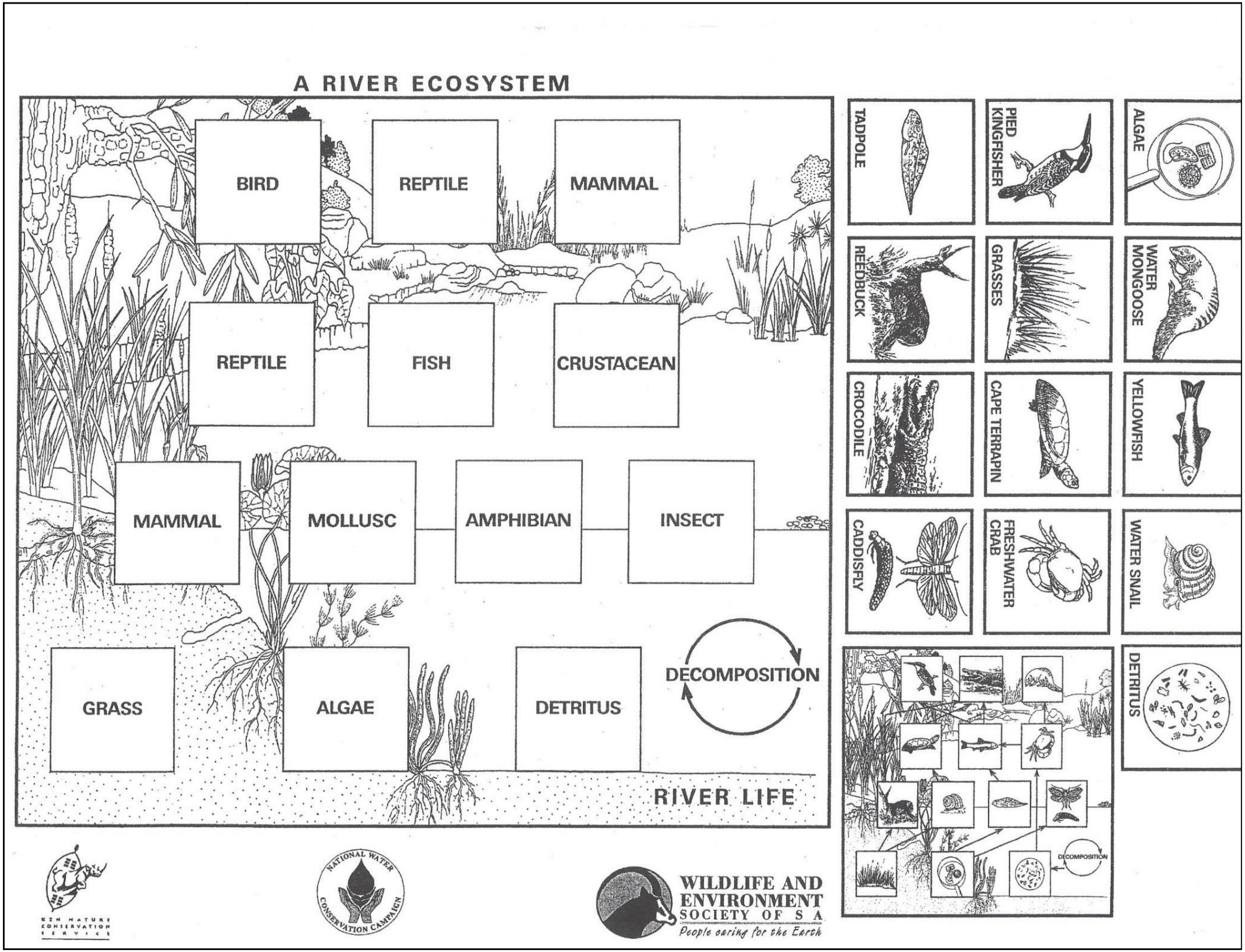
Let your learners choose a place to measure the water temperature. Ask several volunteers to put their hands in the water and guess the temperature. Help them to guess by telling them that water freezes at 0 degrees Celcius and boils at 100 degrees. Our body temperature is 37 degrees. Get one learner to note down what they say. Lower a thermometer into the water on a string with a stone tied to the bottom end. Leave it in a place with little current. Record the temperature. Repeat the experiment at various places if you like, choosing a shallow pool versus deeper water, if you want to show a variation.

Use these questions to structure your enquiry.

- Is the temperature likely to be the same all year round?
- Did you measure differences on one day? Why do you think this is so?
- What impact could temperature have on water?
- How would this effect the organisms in the eco-system?
- Does man impact on the temperature of rivers in any way? (Dams, Hydro-electric schemes, factory effluent, pollution, eutrophication)

To extend this enquiry to include life in the river, see Module 3.1.4 MiniSASS activity.

(Adapted from The Danube Box, Handbook)


A RIVER ECOSYSTEM
BIRD
REPTILE
MAMMAL
REPTILE
FISH
CRUSTACEAN
MAMMAL
MOLLUSC
AMPHIBIAN
INSECT
GRASS
ALGAE
DETRITUS
DECOMPOSITION
RIVER LIFE
TADPOLE
PIED KINGFISHER
ALGAE
REEDBUCK
GRASSES
WATER MONGOOSE
CROCODILE
CAPE TERRAPIN
YELLOWFISH
CADDISFLY
FRESHWATER CRAB
WATER SNAIL
DETRITUS
DECOMPOSITION
KZN NATURE CONSERVATION SERVICE
NATIONAL WATER CONSERVATION CAMPAIGN
WILDLIFE AND ENVIRONMENT SOCIETY OF S A
People caring for the Earth

Stream Research Sheet

Name _____ **Group** _____

Date _____ **Time** _____

Name of Stream _____

Location in Orange-Senqu Basin _____

Nature Reserve ☐ **Farmland** ☐ **Urban** ☐ **Rural** ☐

Stream banks (Describe)

Indigenous _____

Modified _____

Alien Invasives _____

Degraded _____

Stream bed **Rocky** ☐ **Sandy** ☐

Human Impacts _____

Width of Stream _____

Water Depth _____

Water Temp _____

Water speed _____

Species _____

MiniSASS Score _____ **Condition** _____

Other Observations

_____

3.5.6a. Working out what to do - Fieldwork

A VLEI OR MARSH STUDY

TRY THIS VLEI OR MARSH STUDY (WITH ANY NECESSARY MODICATIONS FOR YOUR AREA) IN A WETLAND NEAR YOU.

- **5/10 minute quiet time.** Here the learners sit quietly 10-20m apart in or near the wetland and absorb the environment. Reading or writing appropriate poetry may enhance the experience. The idea is to acclimatize the group.
- **Introduction.** Here the facilitator introduces the concept "habitat" and gives a brief outline of wetlands. Introduce the concept of adaptations of organisms to their environment, i.e. in terms of water plants, defence, flight, camouflage and feeding.
- **Instructions.** Photocopy or cut out the question cards hereafter. Hand these out and define the study area boundaries. The questions are discussed to ensure that all are understood. Discuss with the groups how they will collect their information and ideas. While the groups are busy collecting data, move from group to group assisting, where necessary.
- After the allotted time, (about 1 hour) groups report to the starting area, and **prepare their report-back sessions** (20 minutes). Everyone then reports their findings to the whole group again (15 minutes).

The role of the teacher/facilitator is to correct any serious errors, showing relevance to the topic or syllabus, the interdependence of the topics encouraging discussion and drawing the study to a logical conclusion.

CUT OUT OR COPY THESE CARDS FOR A VLEI OR MARSH FIELD STUDY

WATER (Card 1)

- Conduct a sensory water quality check: ie look, smell, touch. Record findings.
- How do the present water plants help influence conditions?
- Water organisms may indicate what the quality of the water is. Catch as many as possible, (and contain them in your ice-cream tub), ID your catches with the identification sheet in Module 3, Unit 2. Record these on your poster. Decide on the water quality based on the organisms found!
- Cross-check your results

PEOPLE (Card 2)

- What land use practices upstream influence THIS wetland? How and why?
- Identify (and collect where possible) 5 effects of people on THIS wetland (good and bad). Please explain their effects.
- Conduct an activity with your group (or the whole group) that will benefit THIS wetland.

PLANTS (Card 3)

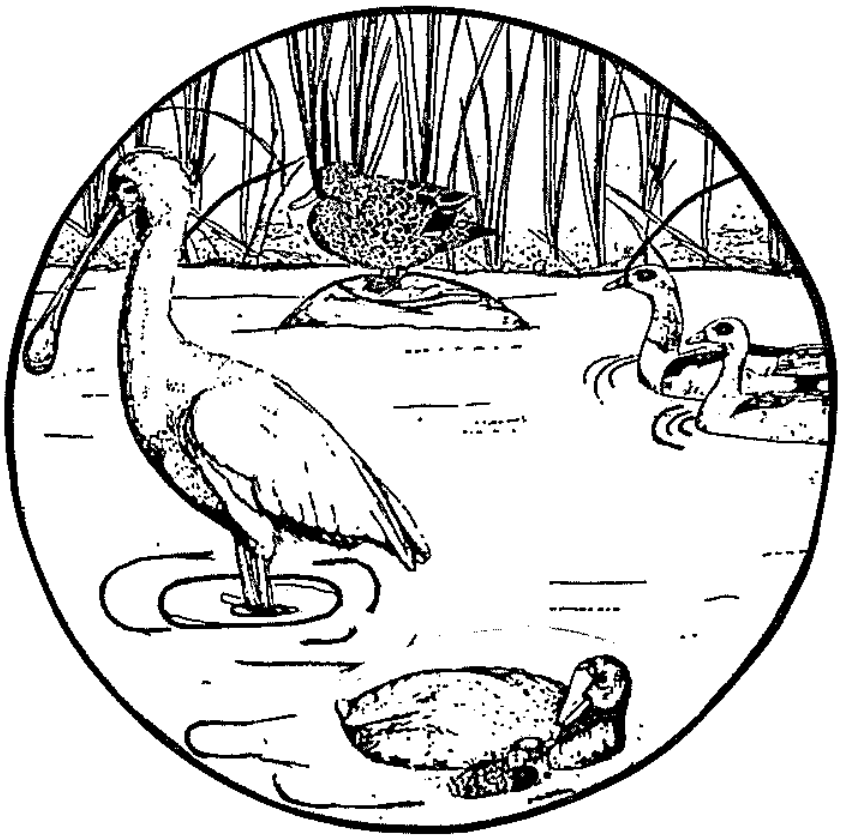
- Map the wetland area. Give it a scale, important landmarks, and show on the map where the different vegetation types are (make a poster).
- Identify the most common plants
- Use or develop a practical experiment to demonstrate two or more functions of the reed beds.
- Find and explain evidence that flooding occurs in your mapped out area (when and why?)

ANIMALS (Card 4)

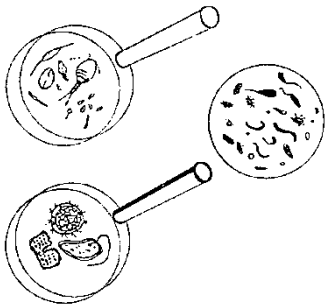
- Design an imaginary organism, using plasticene, that could be the perfect wetland organism. Explain the body parts and the uses thereof to the group. Use your imagination!
- Draw a cross-section of this wetland (on a poster). Look for, or find evidence of, six types of birds, mammals, and insects that use this wetland.
- Draw the animals you found onto your profile in the positions in which you found them. Now connect the animals with the lines that represent a food web.

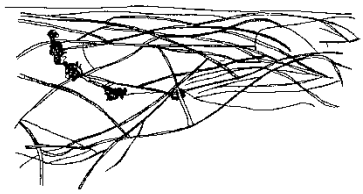
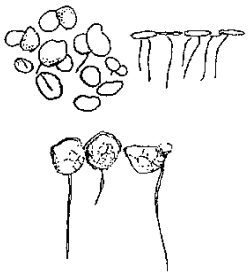
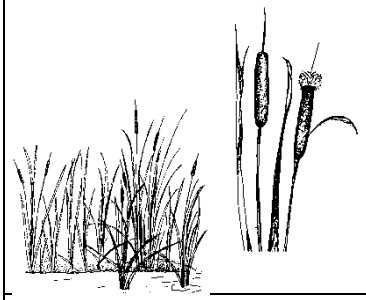
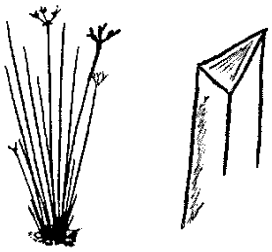
SOIL (Card 5)

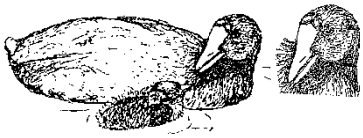
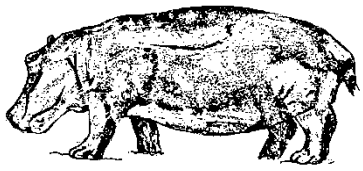
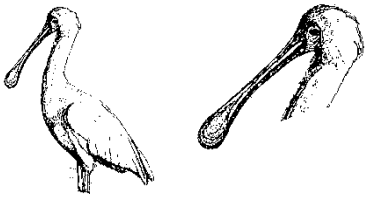
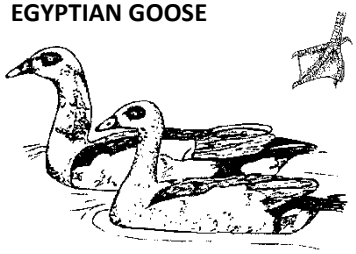
- Compare the soils of THIS wetland and adjacent areas in terms of the following features: texture of the soil; moisture content; fertility; organisms (S1)
- In each case explain why the conditions of the soil are different in the wetland to the land nearby.

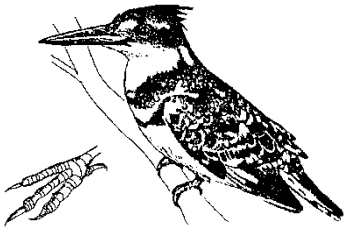
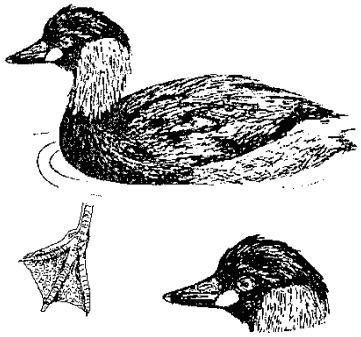
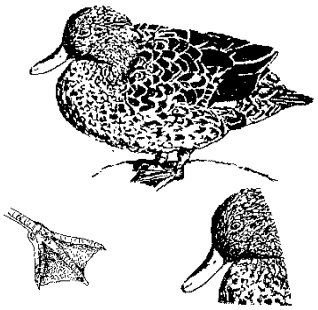
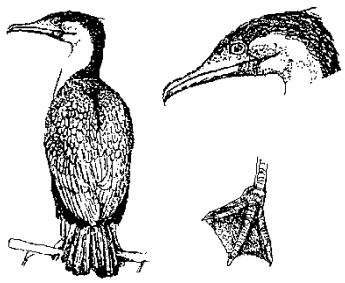


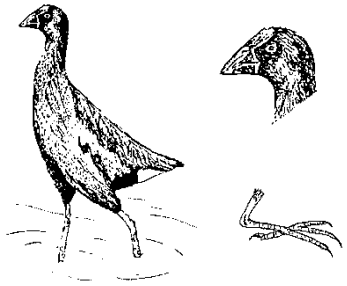
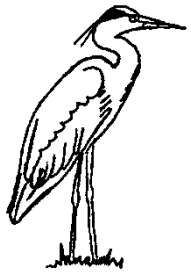
3.5.6b. Hands on Vlei and Marsh life: Detailed Guide

PHYLUM: CHORDATA Class: Amphibia SUB-PHYLUM: VERTEBRATA FROGS 	**FEATURES:** Frogs may have various colours both dull and bright, which serves to camouflage them. **HABITAT:** Frogs spend their lives in wet or moist areas. Some live in the water, others underground, whilst some, like reed frogs, spend a lot of time sitting on reeds above water. Toads, however, are adapted to living in drier terrestrial conditions but require water for breeding. **FEEDING:** Tadpoles feed on plant material like algae and plankton. The adults feed mainly on smaller insects, for example mosquitoes. If the opportunity presents itself, bullfrogs will take larger prey, even including small birds. **DID YOU KNOW?** Most frogs are nocturnal; and some can change colour!
PHYLUM: CHORDATA **Class: Pisces** **SUB-PHYLUM: VERTEBRATA** **CATFISH** 	**FEATURES:** Catfish (Barbel) have strong spines in the dorsal fins, which can be used for 'walking' overland. They can grow up to 1m in length, and are a brown/black colour. **REPRODUCTION:** Catfish lay eggs and are prolific breeders in ideal conditions. **FEEDING:** They are omnivorous and eat insects, vegetation and small fish which they hunt down in packs. They will also eat young birds that fall into the water. **DID YOU KNOW?** Catfish can survive in drying out ponds by gulping atmospheric air!
MICROSCOPIC PLANTS & ANIMALS 	**FEATURES:** Microscopic plants and animals are not visible to the naked eye. For identification purposes one would need to send a sample to a local water authority or well equipped laboratory. These organisms have many different shapes, and some have tails called flagella which are used for movement. **REPRODUCTION:** May be sexually or asexually. **FEEDING:** Bacteria feed on dead organic matter, known as detritus. The decomposition process is what gives wetland mud a characteristic odour. **DID YOU KNOW?** There may be millions of bacteria in one drop of water!!!
PHYLUM: CHORDATA **Class: Mammalia** **SUB-PHYLUM: VERTEBRATA** **WATER MONGOOSE** 	**FEATURES:** Water Mongoose are about the size of a domestic cat, and are usually dark-brown in colour. They have short hair on their feet and face and long shaggy hair on the abdomen. **HABITAT:** Water mongoose are found near fairly water-watered areas such as lakes, rivers and wetlands. **FEEDING:** Mongoose eat crabs and frogs as well as rodents, snakes, birds, fish and insects. **DID YOU KNOW?** Mongoose are active at night and in the early mornings.

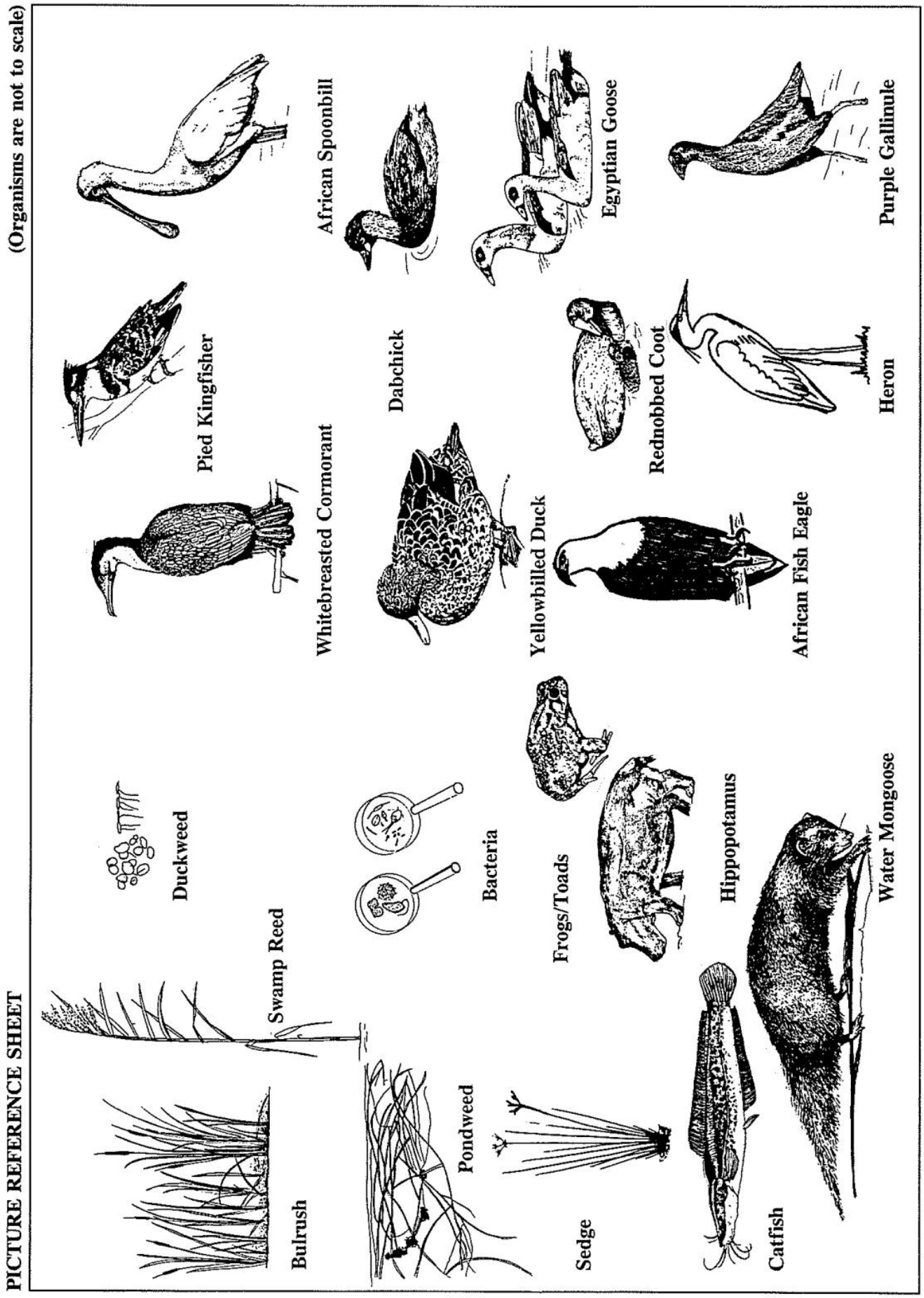
Class: Angiospermopsida **FENNELL LEAVED POND WEED** 	**FEATURES:** The leaves, as the name suggests, are long, thin and green. They are usually less than 3mm in width, and vary in colour from white on the stem to darker green at the ends of the leaf. **HABITAT:** This plant roots itself underwater on the stream bed and the leaves float in and on the water surface. It favours waters where surplus nutrients are available. **USES:** When pondweed is plentiful it may cause the water speed to slow down. This inhibits erosion of the stream banks and causes the deposition of silt. Eutrophication may occur. Pondweed is sometimes harvested as it makes good compost and mulching materials. **DID YOU KNOW?** This pondweed has special survival structures, called turions, which makes the plant resistant to drought!
Class: Angiospermopsida **DUCKWEED** 	**FEATURES:** Duckweeds may be placed in two general groups: those with roots and those without. This pretty and delicate water herb has a single leaf (5mm in diameter), which is free floating. **HABITAT:** This plant breeds at an astonishing rate and is usually found floating on the water surface. It can take up a large water surface area, blocking sunlight form the plants below. **DID YOU KNOW?** A limiting factor to its growth is the amount of nutrients available in the water. High loads of nutrients, such as runoff from recently fertilized crop lands, can result in massive growth 'blooms'.
Class: Angiospermopsida **BULLRUSH** 	**FEATURES:** These plants have a long brush-like seed. They have a thick, flattened bright green stem, from where the long wavy leaves grow. They grow in very dense stands. **HABITAT:** They grow in shallow water, and their main function is in the water filtering process. As the plant dies back seasonally, it contributes to the nutrient flow. Bulrushes grow from rhizomes and seeds. **USES:** They can be used for thatching and weaving, and in the basket-making trade. **DID YOU KNOW?** The plant is able to withstand domestic waste in the purification process, and is commonly found in sewerage farm purification ponds (artificial wetlands).
Class: Angiospermopsida **SEDGE** 	**FEATURES:** These plants usually have stems which are rounded and solid. Shapes include triangular or square. **HABITAT:** Sedges are found at the zone where the water and land meet. They are typically found in waterlogged soil. **USES:** Where sedges occur at a distance from open water, it may indicate the occurrence of water near the surface. **DID YOU KNOW?** If you chew the end of a sedge, it can then be used as a rudimentary paintbrush. It is thought that the San people used them for this purpose.
SWAMP REED *Phragmites australis var communis* 	**FEATURES:** This plant has a thin, round stem. They grow in very dense stands in nutrient rich water, and their seeds look similar to mealie flowers. **USES:** Also function to impede water flow, with the resultant deposition in the wetland of nutrients and silt. They can be used for thatching, weaving and craft work. **HABITAT:** Grows in shallow water, usually deeper than the bulrushes, and often forms rafts. They are adapted to cold temperatures and need less oxygen. **DID YOU KNOW?** The swamp reed and the bulrushes provide shade, protection from the

	wind, and the nesting materials for many species of waterfowl!
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **REDKNOBBED COOT** 	**FEATURES:** Coots seem to have no tails and are black. They have a red knob above the white shield and bill which becomes bright red in the breeding season. **HABITAT:** Redknobbed Coot are often found between reeds or swimming in open water. They make their nests on mounds of heaped vegetation on open water. **FEEDING:** Coot feed on submerged water plants and insects, and are often seen with their bottoms up! **DID YOU KNOW?** To gain lift off, they run and flap on the surface of the water.
PHYLUM: CHORDATA **Class: Mammalia** **SUB-PHYLUM: VERTEBRATA** **HIPPOPOTAMUS** 	**FEATURES:** These mammals may weigh up to 2 tons at adulthood and are large and barrel-shaped. **HABITAT:** Hippo prefer river pools and dams where they are able to submerge completely. They spend most of their day in the water, and graze in nearby grasslands by night. **FEEDING:** Hippo graze selectively, but consume large quantities due to their size. They often venture in croplands in search of food and may be a nuisance to farmers. **DID YOU KNOW?** Hippos help to keep wetlands alive by opening channels to increase the water flow.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **AFRICAN SPOONBILL** 	**FEATURES:** The spoon-shaped bill of this large white bird is a characteristic feature. **HABITAT:** Spoonbills are mostly found feeding in shallow open water and near the reed fringe. **FEEDING:** Spoonbill feed on water insects and small fish, which the bird finds in the mud either by moving its bill in a sideways sweeping motion, or by probing in the mud. It is called a “filter feeder”. **DID YOU KNOW?** The Spoonbill often sleeps with one leg raised and with its head tucked in.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **EGYPTIAN GOOSE** 	**FEATURES:** The Egyptian Goose looks like a domestic goose. It has a grey-white belly with a brown dot on the chest. This is not visible when the bird is swimming. It has a conspicuous brown collar around the neck. **HABITAT:** The Egyptian Goose often perches on cliffs or tall trees in the early morning, making a typical honking sound. **FEEDING:** They often feed in harvested maizelands, waterlogged fields and wetlands. **DID YOU KNOW?** They are highly territorial and mate for life.

PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **PIED KINGFISHER** 	**FEATURES:** The Pied Kingfisher is a small black and white bird, often seen hovering over open water. **HABITAT:** It nests in a burrow excavated in the earth or a sandbank and often perches in trees near the water or hovers overhead in search of prey. **FEEDING:** The Pied Kingfisher eats insects, small fish, frogs and tadpoles. It may batter its prey on a rock to soften it, before swallowing it. **DID YOU KNOW?** The male bird has a double black bar on the chest, whilst the female has one broken bar.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **DABCHICK** 	**FEATURES:** The adults are the smallest 'duck' (actually called grebes) in South Africa, and are of brown/rufus colour. They usually occur in pairs. **HABITAT:** They frequent open waters, and often stand up on the water making a trilling call. **FEEDING:** They feed on small frogs, mainly plantannas, Daphnia and water insects. **DID YOU KNOW?** Chicks are often carried on the back of the parent, even when diving!
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **YELLOW BILLED DUCK** 	**FEATURES:** The Yellowbilled duck has a black stripe on a yellow beak. While flying a green speculum is visible. **HABITAT:** It is found on open waters, in dams, pans, marshes and even sewage works. **FEEDING:** Eats mainly plant material including seeds, stems, tubers and leaves. It also eats insects. **DID YOU KNOW?** There is a danger that this duck will interbreed with the introduced domestic Mallard duck. Since the Mallard strain is dominant it is feared that the Yellowbilled duck will diminish in numbers or even be lost as an individual breed.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **CORMORANT** 	**FEATURES:** Whitebreasted Cormorant have a small crest and are mainly black with a white breast. They are often seen drying their wings whilst sitting on tree perches. **HABITAT:** They nest in reeds, in trees, on cliffs and the ground. Whitebreasted Cormorants are often seen swimming half submerged in inland and marine waters. **FEEDING:** They have webbed feet and are good swimmers, using their wings to swim and feet to steer, as they catch fish under the water. **DID YOU KNOW?** After swimming they become cold and drenched which is why they are often seen perched in the sun to dry, with their wings outstretched.
PHYLUM: CHORDATA **Class: Aves**	**FEATURES:** A purple bird with red legs. Their feathers are a green blue colour, and they

SUB-PHYLUM: VERTEBRATA **PURPLE GALINULE** 	have a red and yellow beak. **HABITAT:** Are very secretive and skirt along bulrush and swamp reed edges in the early morning and at dusk. **FEEDING:** They eat plants, insects, birds eggs and even young birds and carrion. **DID YOU KNOW?** Being mainly wading birds, they crash-land into the reeds after short, ungainly flying spurts.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **HERONS** 	**FEATURES:** The two larger species of Heron, the grey and black-headed, are both grey, with the blackheaded being black on top of the head. Both stand characteristically motionless, neck extended, waiting to catch their prey. **HABITAT:** They frequent reed edges, waterlogged lands and grasslands. **FEEDING:** They eat mainly frogs, snakes, insects and other small prey. **DID YOU KNOW?** These birds have been seen to stand motionless for over an hour in wetlands.
PHYLUM: CHORDATA **Class: Aves** **SUB-PHYLUM: VERTEBRATA** **FISH EAGLE** 	**FEATURES:** This striking bird of prey has a broad band of white around the neck, black wings and a chestnut chest. **HABITAT:** Found around most bodies of fresh water and estuaries that contain fish, but are most frequent if there are perches nearby. **FEEDING:** Whilst in mid-flight they swoop and pluck fish from just below the water surface. These are consumed at the nest or at a nearby perch. **DID YOU KNOW?** Fish eagles have even been seen to prey on fish in the sea.
Adapted from: Hands On Vlei and Marsh Wetlands (WESSA Sharenet Resource)	

3.5.6c. Vlei & Marsh Life: Picture Identification Sheet



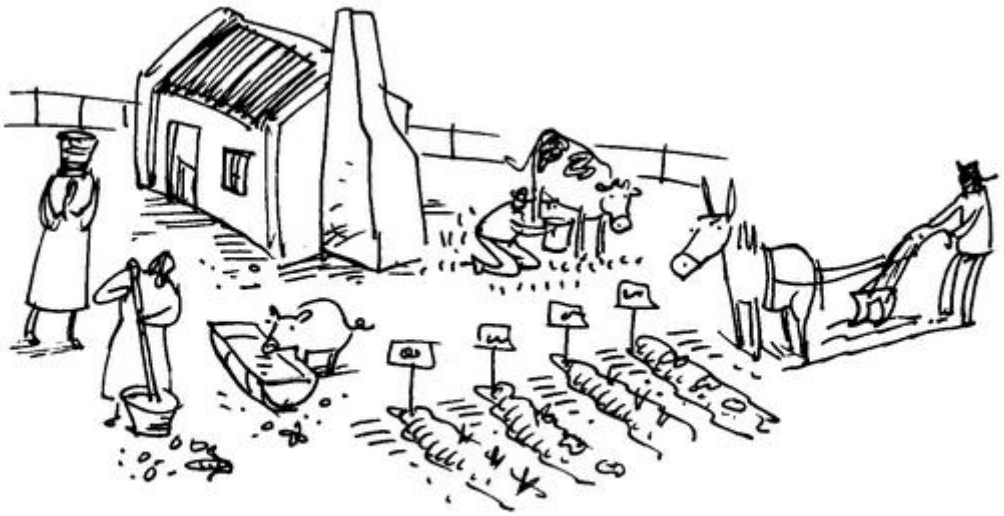
4.1.6. Working out what to do

Subsistence versus Commercial

Activity 1

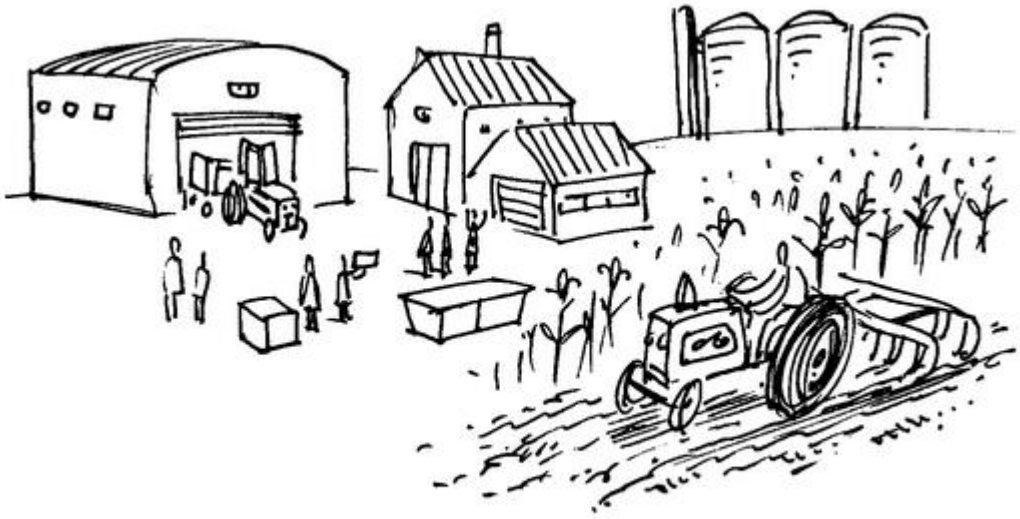
Print copies of sketch A & B and ask your learners to compare the two illustrations with regards the following criteria.

	Sketch A	Sketch B
Buildings		
Implements		
Farming methods		
Cultivated products		



A

In sketch **A** the people living on the land farm to meet their own needs only. They usually do not need a large piece of land. They only produce enough food for their own use. They sometimes have food left to exchange or sell to supply in the need of other people. A variety of crops is planted, and they also provide their own meat, eggs and milk. The farmer and his family do all the work themselves as they do not make a profit from farming and can therefore not pay wages. This kind of farmer is known as a **subsistence farmer**.



B

The farmer in sketch **B** farms with one main crop, namely maize. He produces large quantities that he sells at a profit. He is able to live on the money for a long time and can also buy seed for the next harvest. He does not produce his crop for his own use and therefore buys the food he wants to eat. These farmers are known as **commercial farmers** and their motive for farming is the profit they can make.

Activity 2 - Plan your own subsistence farm

1. **Make a list of the basic foods that you need for survival.**

1	**2**	**3**	**4**	**5**

You and your group are now a subsistence farmer. Suppose that you have been given a piece of land of approximately 5 000 square metres (70 x 70 metres or half a hectare) where the soil is very fertile. There is a farmhouse with all necessary services, a dam, a permanent river and fencing on the land. Remember what the basic foodstuffs that you need for survival are and start planning your farming activities. Draw a plan (map) with a key to show what your farm will look like from the air.

2. **Plan what you will need to ensure you have the above provisions.**

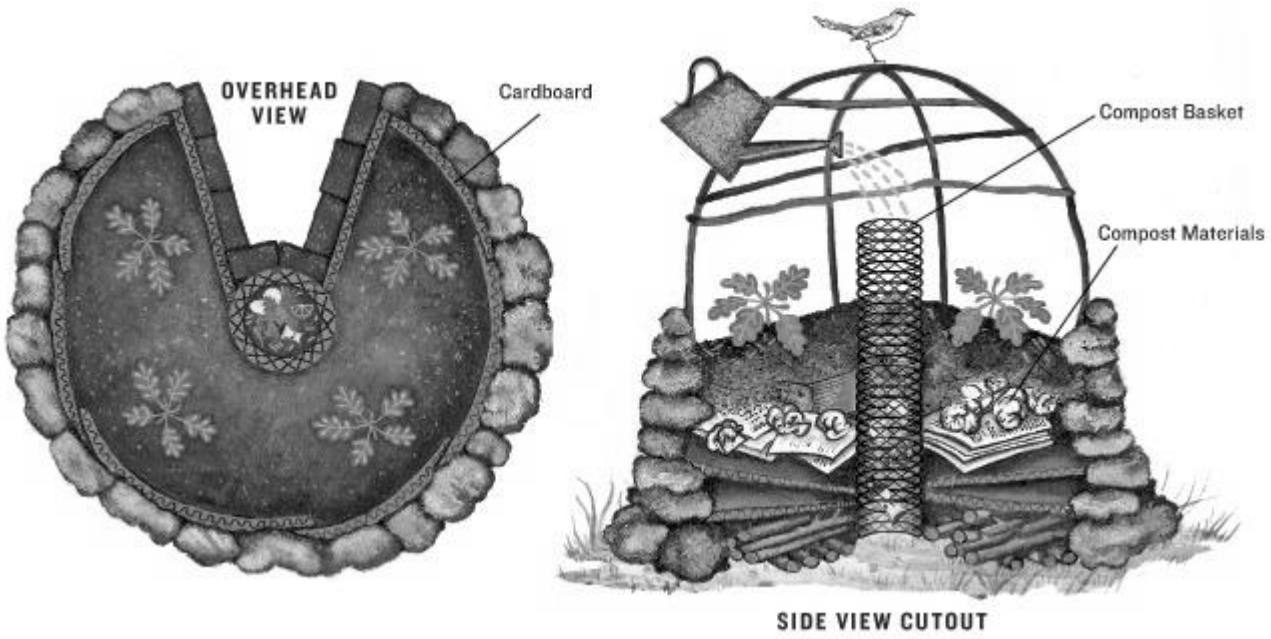
1	**2**	**3**	**4**	**5**

4.2.6. Working out what to do

Making a keyhole garden

Keyhole gardens are very suitable for hot arid areas. They hold moisture and nutrients due to an active compost pile placed in the centre of a round bed. Although most helpful in hot and dry locations a keyhole garden will improve growing conditions in just about any climate.

Looking from the top the garden is shaped as a keyhole. A notch is cut into a round garden bed, the notch makes for easy access to the centre compost well. (Note the first diagram below; to see keyhole.)



Keyhole gardens are circular raised bed gardens. The crops are planted in the larger outer circle. The centre area are used as active composting baskets. Small passageways are built to access the central compost baskets.

The composting basket is central to the success of keyhole gardens. Kitchen scraps and grey water are added to the compost basket daily and this constantly replenishes the soil. The soil for keyhole gardens in built in special layers to boost its ability to maintain moisture and nourishment.

Start this activity by discussing food and water security in the Orange-Senq basin with your learners.

You will need:

- Blocks, bricks, river boulders or rocks (take care not to disturb natural areas or create soil erosion by removing rocks from steep slopes.)
- Rubble or subsoil
- Topsoil
- Sticks
- rope
- Chicken wire or mesh
- Spades
- Garden fork
- Kitchen and garden waste (not cooked food)
- Poles
- Shadenet

Start by clearing and levelling a sunny circular area of about three metres in diameter. Position your composting basket in the centre of this area. Create your composting basket by using sticks, positioned vertically, rope and chicken wire. Out of these materials make a basket that can hold the composting material in the centre of your garden. To ensure good drainage of this area, place rocks on the ground at the bottom of the basket for drainage. Put a layer of small sticks onto this and layer with topsoil over the rocks. Feed this with kitchen scraps and garden waste. Construct a protective cover to shade and protect the compost basket in times of intense head to stop the garden from drying out too much. The cover can be used for rainy periods too. Too much moisture will wash the nutrients from the compost into the soil too quickly.

Using materials that you have on hand (bricks, blocks, rocks, crates, wood, tyres, bottles or other recyclable materials) The wall can be built as high as you choose depending on the materials that are on hand and what is a comfortable gardening height for your learners. The compost will increase soil volume over time, so you may want to raise the walls from time to time.

It is important to take special care when layering the soil as you add it to your garden area. The first layer should consist of broken plant pots, tin cans and twigs. These allow for good drainage. Next layer cardboard, straw, topsoil, ashes, compost and old animal manure. Slope the soil away from the central composting basket so that the nutrients can reach the outer area of the garden.

Leave the soil layers for about a week to settle before planting seeds or seedlings. Plant at least four different types of vegetables in your garden to help maintain fertility and to avoid pests and disease. Use companion planting and crops like garlic and onion to provide protection from pests. Plant leafy green vegetables next to root crops. The composting basket can provide support for tomatoes. Preferred root vegetables for keyhole gardens include carrots, beetroot and radish. Spinach, lettuce and herbs are all good choices for leafy vegetables.

Water the young plants directly until the roots are well established. Use kitchen and other grey water in the compost basket after the plants are beginning to mature. The water from the compost basket will be sufficient to sustain the garden.

Do not use any poisons in your garden, even those considered safe to kill pests. You want to encourage healthy balanced soils and invertebrate life in your garden as well as a good healthy microflora of bacteria and fungi. Using herbicides or pesticides in or near your garden will not only harm plant and animal life, it will harm the humans that work or consume the produce from the garden and can run-off and pollute your local stream. Here are some home-made recipes to help control unwanted insects in your garden. Remember that these may deter or kill wanted insects too, so use sparingly. The best protection against a population explosion of unwanted pests is to have areas with natural vegetation, companion plants and flowering plants that can attract a resident population of predators to keep the balance in check.

Make these recipes with your learners for use in your garden. Remember to test your mix first on the plants you are wanting to protect, to ensure that the concentration you have made does not harm plant growth. Don't spray on a hot sunny day or you will burn the leaves.

Organic Recipe 1

I head of garlic
1 tablespoon dish soap (use a soap that does not contain bleach)
2 tablespoons mineral or vegetable oil
2 cups water

Peel and puree (finely crush) the cloves of garlic along with the oil and water. Let it stand overnight and then strain the mixture. Add the soap and mix thoroughly. Pour into a spray bottle and use on the affected plants.

Organic Recipe 2

1 tablespoon vegetable oil
2 tablespoons baking soda
1 teaspoon dish soap (use a soap that does not contain bleach)
500ml of water

Combine the ingredients and pour into a spray bottle and use on the affected plants.

Organic Recipe 3

Half a cup of chopped hot peppers (the hotter the better)

2 cups water

2 tablespoons dish soap (use a soap that does not contain bleach)

Puree peppers and water and let it stand overnight. Strain the mixture carefully taking care that it doesn't burn your skin. Pour into a spray bottle and use this on the affected plants.

Please note that organic bug spray will kill any bug it comes into contact with, whether a pest or a beneficial bug. Think carefully about how much damage the bugs are actually doing and whether it is necessary to kill them or to find alternative means of control like companion planting and ensuring that you have a biodiverse area that can host predator species.

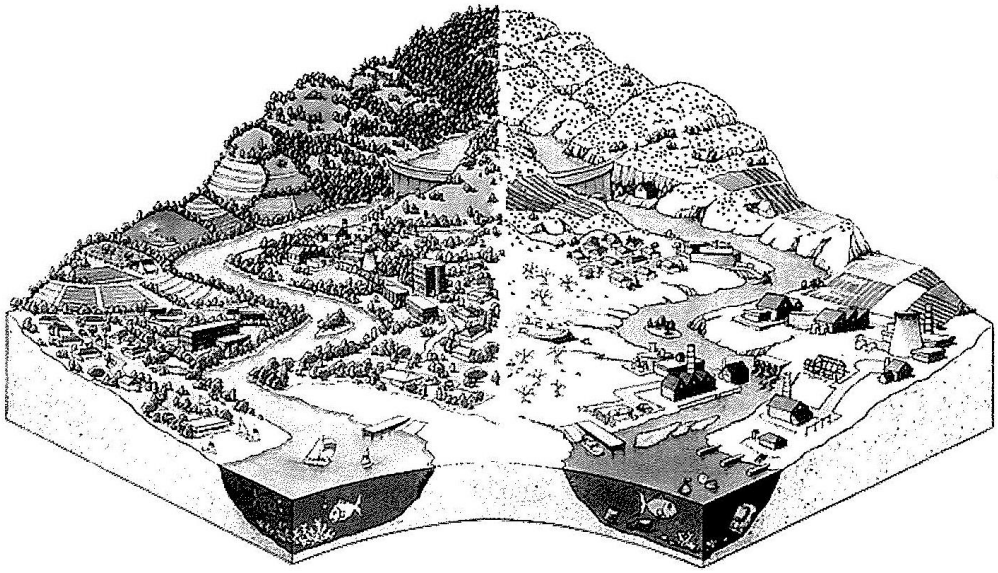
Photo: Catholic Relief Services

Adapted from :

http://www.inspirationgreen.com/keyhole-gardens.html http://www.gardingknowhow.com

4.3.6a. Working out what to do – Fieldwork

How healthy are our catchments? Infiltration



Infiltration rate

Infiltration rate is the length of time it takes for a known volume of water to be absorbed into the soil. The two processes causing infiltration to take place are gravity and capillary action. Gravity causes water to move quickly into the large and medium sized air spaces in the soil but the small spaces are filled more slowly using capillary action.

What is capillary action

To demonstrate the process of capillary action take 2 tubes, one thinner than the other and put them both into a glass of water.

Do you see how the water in the thinner one is pulled higher up the tube than the water in the thicker one? This is capillary action. The forces that hold the water molecules together (cohesion) and cause water to stick to other surfaces (adhesion) interact to pull the water up the tube, the thinner the tube, the stronger the pull on the water. This is how the small gaps in the soil pull water into them. Different types of soil have different size particles and so different size spaces between the particles

Activity- calculating the infiltration rate (done in groups of 3)

Equipment list

- 2 empty clear plastic 2 litre cool drink bottles
- 2 empty 500ml cool drink bottles
- Permanent marker
- Craft knife or scissors
- Ruler
- Measuring jug
- Stopwatch or a clock with a second hand

- Sandy soil
- Non-sandy soil (loam or clay)
- Kitchen scale (that can weigh 1kg)
- Paper
- Pencil

Method

1. Rinse out the empty cool drink bottles.
2. Take the 2 empty 2 litre cool drink bottles and cut the tops off.
3. Weigh 1kg of each soil.
4. Put the sandy soil into one 2 litre bottle and the non-sandy soil into the other.
5. Squash the soil down in the bottle to make sure that there are no big air spaces.
6. Draw a line on the 2 litre bottle with a permanent marker where the top of the soil is.
7. Using the ruler, make marks on the 2 litre bottle 1cm apart starting at the soil surface and going towards the top of the bottle.
8. Number the marks you have made on the bottle, starting from 0 at the soil surface. Do the same with the other bottle.
9. Take the 2 empty 500ml cool drink bottles and pour 300ml of water into each one using the measuring jug.

The Experiment

1. First take the 2 litre bottle with the sand in it. One person is in charge of timing (the timer), one of writing down data (the scribe) and one of pouring the water into the 2 litre bottle (the pourer).
2. When the timer is ready, he/she tells the pourer to start pouring the water from one of the 500ml bottles into the 2 litre bottle on top of the soil.
3. As soon as the 500ml bottle is empty, the scribe must record the water level in cm using the marks on the 2 litre bottle and the timer must start timing.
4. When the water has all been absorbed into the soil, the timer stops timing and the scribe writes down the number of seconds it took for all the water to be absorbed.
5. Do the same with the 2 litre bottle of non-sandy soil.

Calculating infiltration rate

To calculate the infiltration rate in cm per second, divide the volume of water used (so 300 for 300ml of water used) by the number of seconds it took for all the water to be absorbed into the soil (so if it took 1 ½ minutes, it would be 90 seconds).

Infiltration rate = volume of water (ml)/time taken to fully absorb (seconds)

This will give you the infiltration rate in ml per second (ml/s). You know that you used 1kg of soil for the experiment so you can say the infiltration rate is ***x***ml/s/kg.

Questions

1. How long did each soil type take to absorb the water?
2. Which soil type do you think has bigger air spaces?
3. Can you think of any other soil types that would be different

Grass and Infiltration

Grass and other plants slow rain water down as it moves across the soil surface. This gives the water a chance to be absorbed into the soil before it is lost as run-off. The roots of the grass and other plants also help to hold the soil together and prevent erosion.

Erosion

Erosion is a natural process that forms valleys and mountains. It takes place when soil and rocks are removed and transported somewhere else. Erosion can be caused by wind, water and human activity.

If it is natural then why is it bad?

Natural erosion takes place very slowly but human activities such as bad farming practices, deforestation and too many roads and pathways (especially dirt roads and tracks) has made erosion speed up. This means that large areas of the earth are losing valuable topsoil (the soil which is full of nutrients for plant growth).

Activity – Calculating run-off percentage (can be done individually or in groups)

Equipment list

- 2 empty ice-cream tubs
- Baking tray with a lip (larger than an ice-cream tub)
- 2 clear 1 litre plastic bottles of the same size and shape with labels removed
- Soil
- Small stones
- Grass seed
- A plank or small block of wood (about 4cm high)
- Watering can with a sprinkler head
- Funnel
- Measuring jug
- Stopwatch or clock
- Permanent marker
- Pencil
- Paper

Method

1. Clean the ice-cream tubs and jars or plastic bottles.
2. Punch some holes in the bottom of each ice-cream tub.
3. Line each ice-cream tub with a layer of small stones.
4. Fill each ice-cream tub with soil and press it down lightly.
5. Sprinkle the soil in the one ice-cream tub with grass seed but leave the other as soil only.
6. Place the 2 ice-cream tubs in a warm sunny place.
7. Water both ice-cream tubs of soil with 200ml of water.
8. Repeat this every day until the grass in the one ice-cream tub is about 1.5cm tall.

The experiment

1. Take the two ice-cream tubs outside where you can make a mess.
2. Take the soil and grass ice-cream tub and put the block of wood under the one end of the ice-cream tub.
3. Put the other end of the ice-cream tub into the baking tray.
4. Measure 1 litre of water and pour it into the water can.
5. Pour the water over the soil (mostly from the highest edge of the ice-cream tub).
6. When the water can is empty, wait for 5 minutes.
7. Take the baking tray and pour the water in it, into the measuring jug.
8. Write down how much water was in the baking tray in millilitres.
9. Now pour the water from the measuring jug into one of the clear 1 litre bottles using the funnel.
10. Write 'soil and grass' on the bottle in permanent marker.
11. Rinse the baking tray, the funnel and the measuring jug and repeat the steps above with the ice-cream tub with soil only.

Calculating run-off percentage

We know that we used 1 litre of water to pour onto each ice-cream tub for the experiment. We also know that 1 litre is equal to 1000 ml. Divide the volume of water in the baking tray (in ml) by the amount of water used for the experiment (1000ml) and multiply this by 100.

Run-off percentage = [run-off water volume (ml) / volume of water used (ml)]* 100

Do this for both the soil and grass, and the soil only measurements. This will give you the run-off percentage for each one.

Questions

1. Look at the colour of the water in the two bottles. Which one looks dirtier?
2. Which bottle has more water in it?
3. Which 'slope' lost more water to run-off?
4. Which one do you think would lose more soil to erosion?
5. What other things can you think of that would affect run-off?

4.3.6b. Rehabilitating eroded areas by planting trees and shrubs

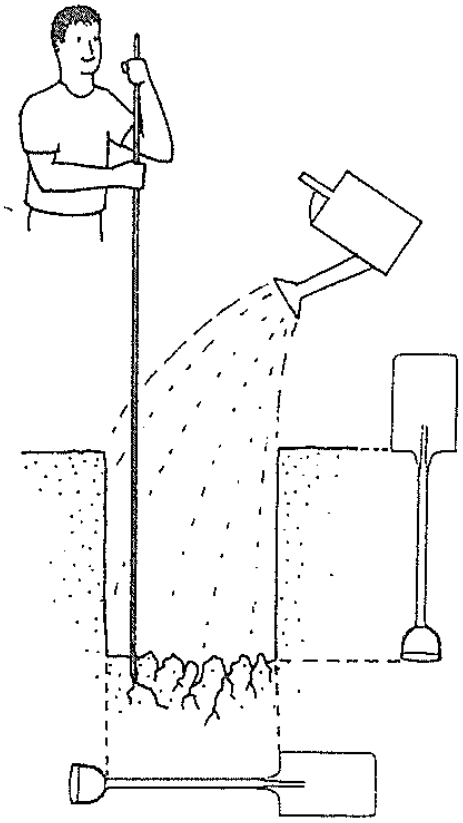
Trees, shrubs, sedges and grasses are used to help rehabilitate eroded areas. In addition to protecting and preventing soil from being washed away and improving percolation, these plants provide oxygen to breathe, habitat for birds and animals and absorb air and water pollutants. They help settle dust and smog particles and reduce reflected heat from buildings and bare ground. They provide shade and release moisture and can thus help to reduce summer temperatures.

The first step is to ask an expert to help you plan your project. Steps include assessing the damage and developing a rehabilitation plan. Identifying the local trees and plants that occur naturally in the area and planning to re-introduce the most desirable species into eroded areas. Consider growing these from seed or cuttings collected from trees and plants in the area. You may need to apply to your local conservation agency for a permit to do this. Working in wetland areas or on river banks may also require permission from your government agency responsible for water.

In most riparian areas trees are an integral component of a healthy eco-system and help to maintain the balance in nature. These guidelines apply equally well to areas around your school or community that have been degraded and need to be re-vegetated. Planting trees and plants is a wonderful investment into the future.

How do I grow trees from seed?

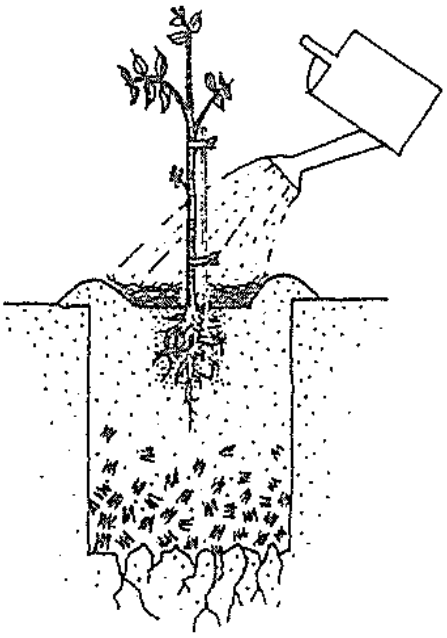
You can grow trees from seed if they are placed in a mixture of 2/3 topsoil and 1/3 river sand in a container with drainage holes in the bottom (an old milk carton cut in half is ideal). Seedlings require regular watering and some shade during the hottest hours of the day.



How do I plant a tree?

1. Choose a suitable place for your tree to grow.
2. Dig a hole as large as possible – not smaller than 50 cm square and 60 cm deep.
3. Break up the soil in the bottom of the hole and wet the sides and the bottom of the hole.
4. Mix about 6 spades full of compost or well-rotted manure with the soil at the bottom of the hole.
5. Plant the tree and then fill the hole (with as much topsoil as possible).
6. Tie the tree loosely to a stake.
7. Place a thick mulch of compost, newspaper and/or grass around the young tree making certain that it does not lie against the stem.

Water well. If your tree will not receive much water during the dry months, then it is best to plant it during spring and summer.



4.4.6a. Working out what to do

Prospecting for diamonds and other stones!

A young boy was the first person to find a diamond near Luderitz. He handed the diamond to his supervisor and very soon there was a diamond rush. Prospectors came from all over to see if they could find diamonds. Many people went away poorer than when they first came, but some prospectors did find diamonds and went on to establish the mining industry as its know today.

Geological processes, like the formation of diamonds, did not occur only in past. They take place all the time, all over the place. They have a decisive effect on shaping what the landscape looks like. Many of your learners may have collected pebbles on a river bank and been delighted by a particularly beautiful or outstanding example. Many have skimmed the flat stones over the surface of the water. Where do these stones come from, how did they get into the stream, how did they get their smooth rounded appearance. Where are they going to?

One does not necessarily need geological expertise to answer these questions. The Orange-Senqu and its tributaries come with a mass of rock, gravel, sand and fine particles. These materials have been taken away (eroded) from upstream areas and much of this material may never reach the mouth of the Orange river. Some of this material dissolves in water, some will form part of the riverbed. What remains or what is carried away tells us a lot about the geological zones the river has crossed and how resistant the individual rock elements are.

Activity 1 - Starting a stone collection

You will need:

- piece of paper with task list,
- buckets or tear-proof bags,
- a knife or pieces of broken glass (to check for hardness)

Plan an excursion in the school grounds or nearby vicinity. If you do have a rocky stream, that will make an ideal site for this activity. From experience one knows that when one collects stones one selects them for

standing out because of their beauty or other feature. Often we miss out what could be interesting stones. This task will ensure that the learners collect a wide variety of stones for comparison.

This task requires the learners to search for stones with different features. By doing so the learners also notice the unspectacular examples. Compile and copy a list of stones that you would like the learners to look for, eg:

- stones of a particular colour
- multi-coloured stones
- striped or speckled stones
- round, flat or stick-shaped stones
- particularly strangely shaped stones
- particularly smooth or rough stones
- particularly hard or soft stones (scratch test them with a knife or piece of glass)
- human detritus (concrete, glass, bricks, litter)

Compare the findings by discussing the following questions:

- What kind of stones (features) occur most often?
- Are any two features often found together i.e. colour, shape and surface characteristics, form and hardness
- How many different types of stone have been found?
- Can one categorise any with similar features into groups?
- What criteria could you use to separate stones into groups? Eg colour, shape, hardness, surface characteristics, form etc.

Tip: Dry stones all look somewhat similar. Differences are hard to make out, so one should always determine the features of stones when they are wet. For a permanent collection in class you can spray the surface with hairspray or colourless, soluble varnish.

Activity 2:

You will need:

- a selection of different stones,
- hammers,
- magnifying glasses,
- copper wire or copper
- coins, knife,
- pieces of broken glass

Activity 2: Only the hard get through.

On a riverbed, gravel is always being moved about by the water. The stones bang and rub up against each other. Some stones can stand this better than others. Some are completely worn away after a short time in the river. A simple hardness test shows which stones have a better chance of a long life in the river.

Divide the class into groups and give each group a collection of materials to score the stones with. Ask the learners to experiment. The first task is for the children to establish what sort of materials leaves a clear, visible and lasting scratch on a stone. You may need to tell them to wash the scratch and if necessary check it with a magnifying glass. They can record which materials were able to score the stone. Then ask them to carry out a cross check. If this is also positive, then the stones have the same degree of hardness. In most cases when stones have the same degree of hardness one sees no scratches on either of them. If the stone scratches the test material (for instance the piece of glass), on the other hand, it is harder. Stones can also be tested among themselves. Get our learners to create a usable scratching edge by breaking them with a hammer. Test the least weathered area of the stone otherwise you can get a false result because weathered stones are less hard.

Scratch individual stones with the test tools available and write the results into this table (tick where appropriate) Wash the scratch and where necessary check whether the scratch can still be seen under a magnifying glass. Start with the knife test to separate softer from harder stones.

Sort the stones according to their hardness and arrange them in order.

Stone (brief description	Matchstick 1	Fingernail 2	Copper 3	Wire 4	Brass 5	Iron 6	Nail 7	Glass 8	Quartz 9

Compare and discuss the findings by answering the following questions:

What degrees of hardness are most common amongst the selected stones?

1 Are some particularly hard?

2 Are some particularly soft?

3 Which stones will survive transport in the river the longest?

4 Other than hardness, what can also be important to the way that stones resist water? I.e. large stones form a valuable substrate holding the fines back and preventing erosion of the banks and bed.

Tip: With all minerals with a hardness of at least 6.5, such as pyrites or quartz. It is possible to strike a rock with steel. These were used to trigger gunpowder in old firearms. If one bangs these stones together, it is possible to make fire using suitable dry materials like bark or dried grass.

Activity 3: Testing for hardness - unexpected variety

You will need:

- a selection of different stones,
- a typeface box or other container with compartments,
- drip bottles with vinegar,
- lists for determining hardness or rock identification book,
- hammers,
- magnifying glasses,
- geological map,
- worksheets

Step one is to sort the stones according to their optical characteristics as per activity 1 (colour, form, surface and structure).

Step two is to test the hardness of the stones or their mineral components as per activity 2.

Step 3 is to test with vinegar by putting the stones into a container of vinegar. Very soft easily soluble stones such as chalk will form small bubbles of gas where the vinegar touches them. This is caused by the release of carbon dioxide from the calcium. One can carry out the test with ordinary vinegar, but vinegar is a weak acid, so the reaction is less pronounced and more protracted than when for example

hydrochloric acid is used. The compartments of the typeface box are filled with stones that each has the same or similar characteristics.

The following questions can be discussed in class:

Which stones are round, oval, stick-shaped or flat, and what can the cause be?

Are there structures in the stone of stratification, splintering?

1 Which stones have smooth surfaces, and which are rough or even knobbly?

2 Structures in the stones, big differences in grain size, components with very different characteristics.

3 Which stones are found frequently, which are found not so often?

4 What is the distance and size of the place of origin, selection through hardness and toughness?

5 What stones are the most resistant to water and can therefore be transported a long way?

6 Where do you think the stones have come from? Compare with a geological map.

Tip: Geological maps can be obtained from the geological office of the respective country or from universities where geology is taught, sometimes also from bookshops. Perhaps during the purchase one may also be able to receive help with not easily identifiable stones. Visiting geological collections in museums can also help.

Activity 3: Creative games with stones

Simple games in which learning is not the main object serve to introduce children to the diversity of stones and connect them to nature. By playing they learn to observe the features and differences more exactly and learn almost accidentally how many different types of stone there are.

Variation 1: Recognising stones

The children stand in a circle (as close together as possible) looking inwards. Each is handed a stone and they are told to remember its characteristics. The stones are collected again. Now the children hold their hands behind their backs and the stones are distributed again; this time the learners can‘t see the stones. The learners check by touch to find their stone. If it is not theirs they pass it on behind their backs to the next learner. If a learner recognises his stone he sits out and waits till the end of the game. Attempt to find out by touch whether the stone they have now is the same stone as before. The others close the gap. This is continued until everyone has found their original stone. Once everyone has found their stone they can look at them. If someone does not have his stone it means someone identified the wrong stone as their own.

Variation 2: Finding pairs - Alone or in groups the learners look for two almost identical stones. Then the class chooses the child who has found the best matching stones.

Variation 3: Making mandalas (stone pictures) alone or in groups the learners make a picture or a figure of their choice on the floor. Mandala is the word for a far-eastern technique that is used as an aid to meditation and simply means “circle”. Usually, it symbolises the cosmos and the structure of the world in the respective culture. The form of a mandala does not have to be a circle, however, it could also be square or spiral shaped. A mandala can be a picture that is observed or produced oneself, for example by drawing a picture or symbol, through putting down stones or using different-coloured sand.

Mandala’s can be made by laying down rocks into a spiral or other pattern
Source: Danube Box

4.4.6b. Energy Activities

We all need energy every day – mothers need it for cooking our food, we need it for heating the water we use when we have a bath or a shower, we need it if we want to watch our favourite television programme or play computer games. Every minute of every day, all of us do something that requires energy!

There are a number of sources that provide us with energy – some will eventually run out (non-renewable), like coal and oil, and others will last forever (renewable), like energy from the sun.

Today, coal provides most of South Africa's electricity. It won't last forever because it takes many millions of years for coal to form, under the surface of the earth. Burning coal can also cause many environmental problems, such as air pollution, global warming (increase in the temperature of the air around us) and acid rain (the rain which falls is no longer 'pure', clean water but is very acidic and can cause the death of plants and animals in dams, streams & lakes).

As a class, discuss the definitions of Renewable and Non-Renewable energy.

Non-renewable Energy	**Renewable Energy**
This energy comes from fossil fuels. Fossil fuels are regarded as non-renewable because they take millions of years to form but can used up by people over a few hundred years.	This form of energy cannot be used up because it is replaced all the time.
e.g. coal	*e.g. the sun*

Following the discussion, divide the class into groups of 4 or 5 learners and allow the groups to brainstorm as many examples of each energy source. This activity should take about 15 minutes. You may like to use the table on the previous page.

Each group can report back to the rest of the class on the list of energy sources they have come up with. You could prompt learners as to energy sources they may not have considered, based on the fact sheet below:

Non-renewable energy

- Coal originated in swamps where lack of oxygen prevented layers of dead, compacted vegetation from decaying. Most coal mined today was formed several hundred million years ago from vegetation that existed.
- Oil was formed in seas when millions of dead microscopic water organisms (plants and animals) collected

on sea beds and were covered in sand.

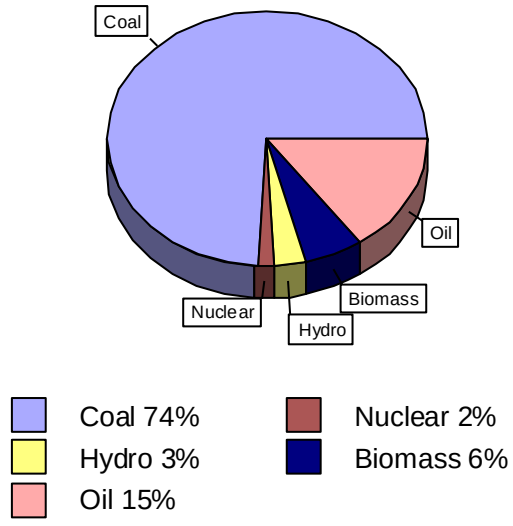
- Natural gas was formed when solid organic (once living) matter is changed into oil. Gas and oil are often found together.
- Nuclear power is generated when atoms of uranium are split. This releases huge amounts of energy.

Renewable energy

- Biomass energy is plant or animal matter that can be changed into fuel. Nearly half of the world's population depend on biomass, mostly wood. Wood is the main fuel for 80% of people in developing countries.
- Hydropower is energy from falling water. It generates 5% of the total energy demand of the world.
- Solar energy is energy from the sun. There has been a massive increase in harnessing and using this energy in recent years.
- Power from the sea comes in four forms – wave power, tidal power, current power and ocean thermal energy conversion (changes).
- Wind is caused by uneven heating of the Earth's surface and the atmosphere. Windmills can be used to either generate electricity or to do mechanical work.
- Geothermal energy, in the form of hot water or direct electricity, is a result of the rise of 1°C in the Earth's temperature every 30m down into its crust.

You may like to use the following questions as a recap and summary of what has been covered in this activity:

1. Why do we need energy?
2. What is the most commonly used energy source in our community?
3. What do you think is the most commonly used form of energy in South Africa? Compare this to the actual energy use for South Africa given in the chart below.



Source: Solar Energy, Solar Energy Society of Southern Africa

Did you know? Our major energy sources are coal and imported oil, both of which are non-renewable fossil fuels. The next major source of energy is biomass (wood, charcoal and dung).

Did you know? Nearly two-thirds of South Africans rely on firewood as their major source of energy.

ACTIVITY 2: THE IMPACT OF ENERGY IN OUR LIVES AND ON THE ENVIRONMENT

In groups, using the worksheet below, learners can consider the impacts of each of the energy sources, on people lives and the environment. They should consider both positive and negative effects.

	Advantage to people's lives	**Disadvantage to people's lives**	**Advantage to the environment**	**Disadvantage to the environment**
Coal				
Oil				
Natural gas				
Nuclear power				
Biomass energy				
Solar energy				
Power from the sea				
Geothermal energy				
Wind				
Hydropower				

A question to ask the class after this activity:

- Why is it so important to develop renewable resources in our country and in the rest of the world?

ACTIVITY 3: EXPERIMENTING WITH SOLAR ENERGY

One of the renewable energy sources available to us is solar energy. The following two experiments focus on energy from the sun as absorbed by different colours and materials. The more enthusiastic learners in the class could be encouraged to take these experiments further and use the results for designing energy saving devices.

Which material stores solar energy the best?

You will need:

- 9 small metal cans
- 9 bigger metal cans, wider but of the same height as the small cans
- Stop watch
- 9 thermometers
- Packing materials: sand, salt, water, torn-paper, wood shavings, sawdust, cottonwool, wool, steel wool or polystyrene granules
- Polystyrene lids to cover the cans. Make a small opening for a thermometer in each lid
- Very hot water.

What to do:

1. Place the small can in the big one.
2. Pack the space between the two cans with one of the packing materials. Do this with all cans, using a different packing material each time. Leave one pair of cans with the space empty.
3. Pour the same amount of hot water into each inner can.
4. Cover with lids.
5. Place a thermometer in each through the hole in the lid.
6. Using the thermometer, take the temperature of the water at the start and then every two minutes, up to 20 minutes.
7. Record your results in the table on the following page.

Time in minutes	**0**	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**
Sand											

Sawdust											
Torn paper											
Wool											
Salt											
Cotton wool											
Steel wool											
Polystyrene granules											

1. Which temperature falls the slowest?
2. Which material is best for keeping heat energy in the water?
3. Which material is the worst insulator?
4. Which material would you choose to put above your ceiling in your house to save energy and keep your house warmer?

Which colour holds heat the longest?

You will need:

- 5 cans or small jars with lids that can be pierced, e.g. plastic lids, thick pieces of cardboard or wads of cotton
- Poster paint – white, black, green and red – and paint brushes
- Very hot water
- 5 thermometers

What to do:

1. Paint each container a different colour.
2. Fill each container with the same amount of hot water.
3. Put a thermometer in each container.

4. Record the temperature every three minutes until the water has cooled.
5. Make a graph of your results.

	3 min	6 min	9 min	12 min	15 min	18 min	21 min	24 min
White								
Black								
Green								
Red								

ACTIVITY 4: TAKING ENVIRONMENTAL ACTION

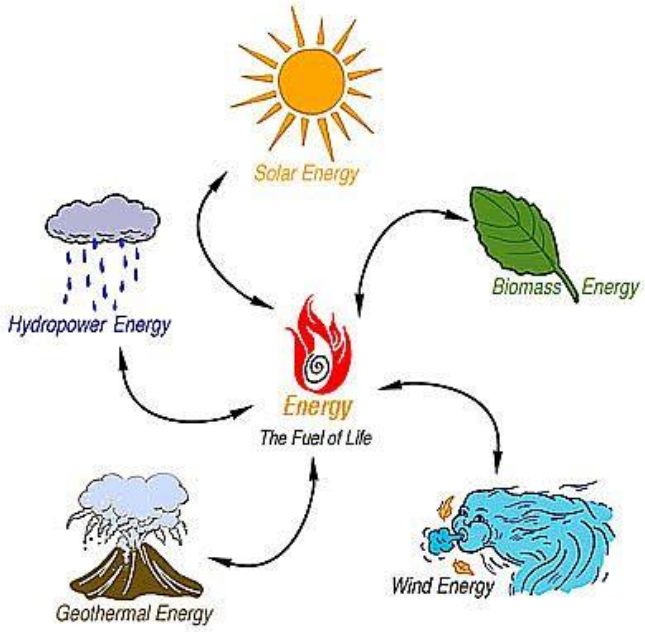
Leading on from the outcomes from Activity 2, Activity 4 encourages learners to design and make an environmental poster on how fellow learners can save energy, both at home and at school.

Learners should ensure that their posters are:

- bright, colourful and eye-catching
- carry a clear environmental message about how one can, as an individual, save energy
- contain minimal writing, i.e. a short, effective message

Posters can then be displayed throughout the school, in the local community library or during National Environment Week, which takes place in June each year.

Adapted from Sustainable Energy, Share-Net, P O Box 394, Howick, 3290



4.4.6c. Moving towards Green Energy

EASY	1. Place signs around the school buildings to remind everyone to switch off lights.	Putting up signs can be very effective in helping to put ideas into action."Last to leave please switch off" and "Please put on energy saver when done" are two of many signs that can be used and placed around the school.	Most of South Africa's electricity comes from fossil fuels – via coal power stations. The power we get from coal causes air pollution, acid rain and global warming.
	2. Use alternatives to projectors.	Whiteboards and chalk boards are ideal for replacing projectors and use no energy. Use projectors only when needed.	Projectors use an extremely high power halogen lamp that may consume up to 750watts, yet produces a very dim yellow image.
	3. Unplug and switch off all electricity at the wall plugs when appliances are not in use.	Appliances and other electronics use power even when switched off because of them being on standby mode. Unplugging these appliances and equipment will reduce monthly power usage.	You can reduce your electricity bill by 10%, simply by unplugging appliances or switching devices off at the power point.
TOUGHER	1. Change to energy-saving light bulbs and other energy saving electrical appliance options.	Energy-saving light bulbs use less than 20% of the energy of a conventional light bulb and can last up to 15 times longer. Fitting energy-saving light bulbs helps the environment and should reduce your school's lighting bills.	By reducing our use of fossil fuels, we can reduce air pollution, acid rain and global warming and also reduce our office costs.
	2. Reduce the school's computer brightness levels.	Turning down the brightness on school computer monitors can greatly reduce energy use.	The old CRT monitors use about three times more power than the newer LCD monitors.
	3. Turn down the thermostat by a few degrees.	Keeping doors closed to trap the heat and turning down the temperature of the thermostat will help save energy. Classrooms that are too warm make people feel drowsy.	Germs prefer warmth and winter is a prime time for flu. So if the classroom is too hot, the germs will spread and multiply more rapidly.
CHANGE	1. Install solar panels or windmills to run some of your school's electrical equipment.	Solar panels can lower your school's electricity costs and are easily installed.	By reducing our use of fossil fuels, we can reduce air pollution, acid rain and global warming and also reduce our school's electricity costs.
	2. Cut out air conditioning and add fans.	Fans use a lot less energy than air conditioners. Consider replacing the air conditioning system with ceiling or wall fans.	The average life expectancy for an air conditioning system is 8 to 15 years.
	3. Install geyser blankets and turn down the heat.	Wrapping a geyser blanket around the geyser will maintain the heat much longer; this way the geyser will use less energy to keep the water warm. Reducing the water temperature of the geyser will also save energy.	99% of homes in South Africa still use regular geysers. The other 1% use tankless green geysers or solar geysers.

4.5.6. Working out what to do

Activity - The Lesotho Highlands Dam Debate

Read the following story to your class:

The Lesotho Highlands Water Scheme is a project that diverts 40% of the collected water from the Senqu (Orange) to the Vaal River System transfer scheme. Water sales from the project are Lesotho's largest source of foreign exchange (75%). Two of the dams, the 180m high Katse Dam and the 145m high Mohale Dam have been built. Completing the other three proposed dams will see multiple tributaries in the watershed dammed. A research report states that the building of these dams could be delayed if water conservation measures are established.

When the Katse Dam was built more than 20 000 people either lost their homes, farm land or the use of communal grazing lands. The building of the Mohale Dam affected another 7 400 people. It took many years to give people replacement housing and restoring livelihoods has been troubled.

Downstream damage includes a reduction in wetlands habitat, less water available for people and wildlife, reduction in fisheries, and no more flooding (scouring from flooding helps keep rivers healthy). According to the EIA, (Environmental Impact Assessment) many important species could disappear from the area.

In South Africa there is inequality regarding the access of water. In some areas people waste domestic, industrial and agricultural water, while many others suffer from an inadequate supply. As much as 40% of South Africa's water is 'lost' through leaking pipes and non-metered use.

Although South Africa is a very dry country, water use in several sectors can be reduced significantly. RandWater estimates that more than half of water consumed in the Johannesburg-Pretoria Metropolitan area is wasted through inefficient uses and leaks.

- **Group 1: Representatives of the remote Lesotho communities** whose lives will be changed dramatically by the building of the new dams. Since the Katse and Mohale Dam's were built these communities have already felt the effects of dam building. Many relatives were displaced by the dam building and it was years before they were given replacement homes. They lost grazing and agricultural land and ties between families and communities were cut once the two big dams filled up with water. Furthermore the influx of construction workers brought social disruption to their way of life. Now they are faced with similar senarios.

- **Group 2: Representatives of the Lesotho Department of Economic Development.** Lesotho stands to increase its revenue from the sale of water from 75 per cent to 90 per cent. There will be government contracts that state that even should South Africa's dams be full, South Africa is still obliged to buy water from Lesotho. They want to get the dams built as soon as possible.

- **Group 3: Representatives of International Rivers,** an NGO that works towards protecting rivers and assisting communities make representation against the negative impacts of building dams. This organisation is asking for full disclosure of the base-line reports that were conducted as part of the environmental impact assessment. They say that negative impacts caused by the first two dams have still not been addressed. They are also concerned about the environmental and social impacts on the remote rural communities that will be displaced by the new dams. The Lesotho minnow and spiral aloe are two protected species that may be seriously affected.

- **Group 4: Representatives from the CSIR**. This group has been tasked with taking seismic data because of concerns that the building of the new dams will trigger earthquakes that will affect the safety of the first two dams built. This has the potential for both social and ecological disaster. Some experts are saying that the earthquakes that happened around the time that the first two dams were built had nothing to do with the tremendous pressure that they put on the earth's crust. Other experts are saying that the earthquakes were definitely triggered by the weight of the dams.

- **Group 5: Representatives from South African government.** RandWater are wanting to secure further water supplies for their rapidly growing industrial hub of South Africa. They have all the plans for the 200 km system of transfer tunnels that will form part of the water scheme. They have clients from business, industry, mining and the agricultural sector that are demanding more water in order to expand their operations in Gauteng Province, South Africa.

- **Group 6: Representatives of ORASECOM.** ORASECOM has been tasked with overseeing the cooperation and management of the water resources of the Orange-Senqu Basin. ORASECOM wants to ensure that the resources in the basin are used sustainably, that is they want to ensure that generations to come will still be able to have the benefits of clean water and functioning eco-sytems with the availability of harvestable natural resources. ORASECOM is made up of representatives of the four countries that form the geographical area of the Orange-Senqu basin, South Africa, Lesotho, Namibia and Botswana. They know that decisions taken to build more dams in the Lesotho Highlands will have both positive and negative impacts on the whole catchment. They need to be sure that these decisions will mean fair and equitable distribution of resources and the protection of eco-systems functioning in the Orange-Senqu River.

The Lesotho Highands Dam Debate Activity:

- Divide the learners into groups to represent each of the six groups listed above. Print and cut out the explanation for the involvement of the six groups and discuss it as a class so that the groups can prepare adequately based on accurate information and insights.

- Each group spends time deciding on what their key position will be with respect to the dam. This does not have to be an 'either/or' decision, groups can present 'mitigation measures' which are conditions or requirements for lessening the expected negative impacts that the dams are likely to have.

- Each group is then given the opportunity to state the reasons for their decision for the Lesotho Highlands Water Scheme phase B to go ahead or not. Through the guidance of the teacher, the groups argue their cases. It is important, that, despite conflicts that may arise, the groups find ways of meeting all the needs in a fair and satisfactory way.

5.1.6 Working out what to do

Fieldwork: Looking at River Health: The Sniff Test

Looking at River Health

In this fieldwork activity, we use our senses – to get a sense of what is in the water. This helps us get an idea of what kinds of environmental issues and risks we may encounter in our water.

We will need:

- 5 clean glass or plastic containers
- Plastic dropper
- Pure bottled water
- Different liquids, such as Jik, urine, dishwashing liquid, diesel

What to do?

1. Put pure bottled water (from the shop) into 5 clean containers.
2. Keep one as pure water, and label (A).
3. Use the dropper to add different liquids to the other four containers of water (each time, rinse the dropper afterwards). Label (B), (C), (D), (E).

   For example, you may use:

   - 1 drop Jik (chlorine)
   - 1 drop urine (from a volunteer)
   - 1 small drop of dishwashing liquid
   - 1 drop diesel

4. Let everyone sniff each container.
5. What odour could you smell?
6. Did your sense of what was there match with what was actually added into each container?
7. You may also wish to test the pH of each sample (how acid or alkaline it is).
8. For fun, someone else in the group may like to put a drop of one or two secret liquids (e.g. perfume, insecticide), or even cow dung, into a container of water. Then see if the rest of the group is able to identify it.
9. What happens if two or three smells are combined?
10. Discuss how our sense of smell can help us test water.
11. Take a careful look at the contents of each container. Can you see any difference between each one?
12. Are there any links between what you smell, and what you see?
13. Does it help to use a combination of different senses?
14. Is it wise to use your sense of taste to check the water?

Looking at our own water: take a look, have a smell, listen …

1. Now take a sample of water from your river/stream/pond and do the same sniff test activity.
2. Check the pH of the water.
3. How does the water look?
4. Can you see litter in the river or on the banks? What kinds of litter can you see? Where do you think it comes from?

Project: How important is water quality?

1. **Read the stories relating to the importance of water- the different ways of saving water, and the different ways of protecting the quality of water. Make sure you understand the information.**

2. **Complete the activities on the worksheet provided.**

Why is dirty drinking water dangerous?

Many water bodies have become breeding grounds for germs that can cause diseases such as diarrhoea, typhoid, cholera and hepatitis. These germs are dangerous for the people who are forced to draw their drinking water directly from rivers, dams or contaminated wells.

Children collecting whatever water they can – most children in Africa have no access to clean drinking water.

What are nitrates and phosphates?

Phosphates are still part of detergents in South Africa

Phosphates are still approved as active ingredients in washing detergents, and both nitrates and phosphates are found in fertilizers as well as in the excrement of animals and humans.

Unfortunately more and more of these nitrates and phosphates find their way into our water. These nutrients increase plant growth, like the toxic algae.

The toxins that this algae produces are not removed in the conventional water treatment works. This means they pose a real hazard to human as well as animal health.

Many people don't want to pay for water. They believe that access to water is a basic human right and that governments should provide their citizens with free clean water. But because of this people have no respect for the scarce water resources. Water to them has little value because they don't feel the value in their purse and so use water carelessly.

Carrying 20litres of water – part of women's daily hardship in southern Africa

We need to use the little water that we have left in the world more sustainably. We can no longer afford to use drinking water to wash cars, water gardens and clean driveways.

Schools, *YOU*, have a special role to play!

We need to learn how to use water wisely, and you can then go teach your friends and family. We need to develop sense of responsibility and encourage careful use of water in our schools and in our homes, not only because of the growing water scarcity in South Africa but also the rest of the world.

Did you know that by 2030 South Africa won't have enough fresh water to meet the growing needs of population and industry!

Cattle grazing near water bodies – a potential source of nitrate pollution.

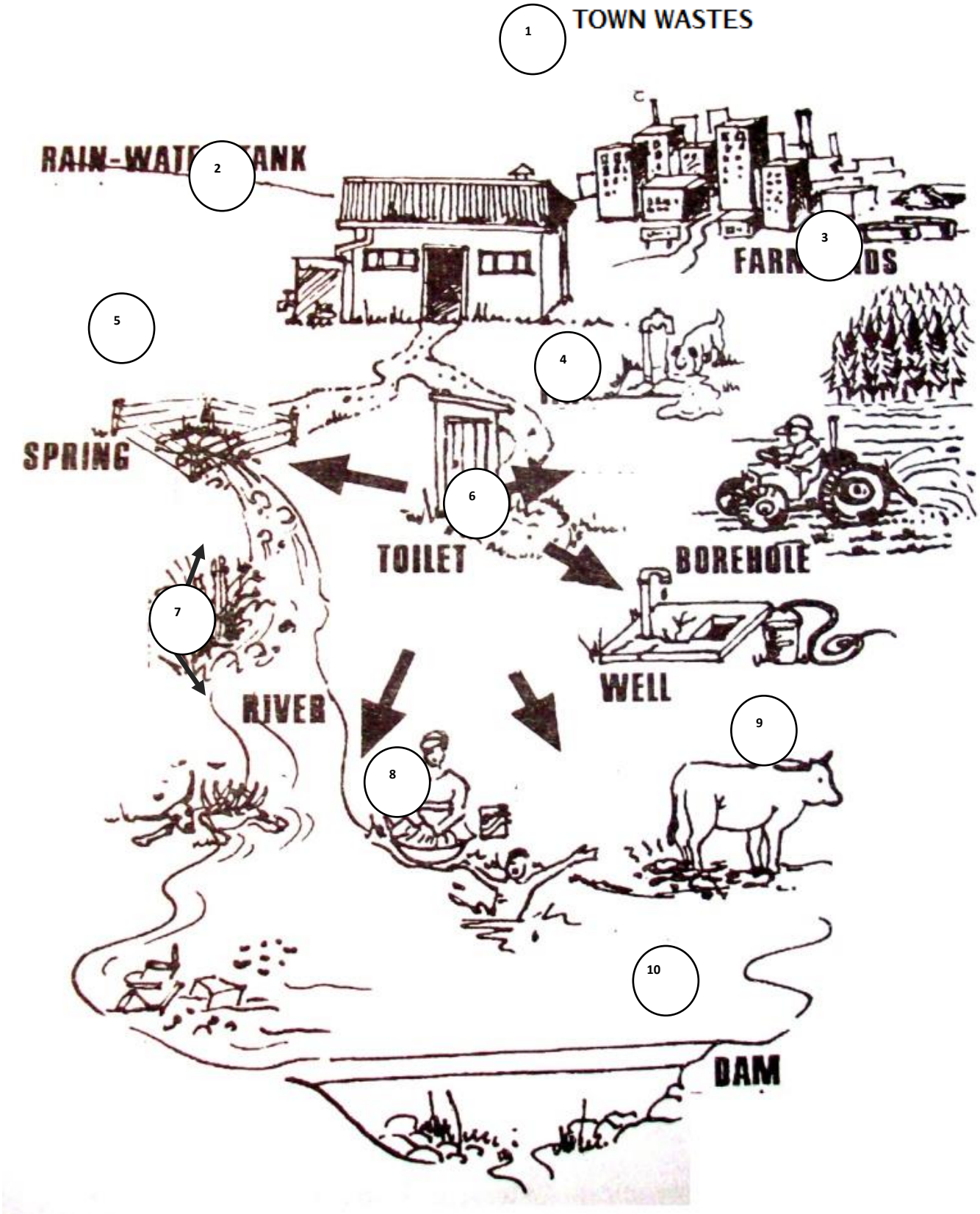
Threats to our water supply:

1. Uncontrolled consumption where there is no control on or limits on the use of water by agriculture, industry, mining and households.

2. The increasing levels of pollution and problem substances in the water supply because of things like:
   - Water waste from the large cities end up in the dams.
   - Many people simply throw their waste into the nearest river which means it interferes with water purification systems downstream.
   - Waters increase in temperature, which cause algae and bacteria to grow faster.
   - In South Africa, treatment plants are old and are not able to remove all toxins, and some of these end up in drinking water.

Did you know that up to 50% of available water in South Africa is being wasted? Experts believe that one day South Africa will have to ***desalinate seawater***, this is possible to do but will be very expensive. For now, local water suppliers will need to improve their pipe networks and encourage people to conserve water!.

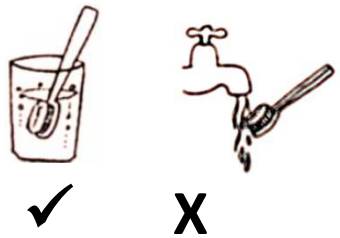
Activity 1: Protecting the Quality of Water



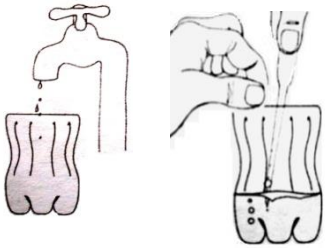
Activity: At each number, explain: what must be done or what must be changed or stopped to protect the quality of the water.

Activity 2: Different ideas to not waste water

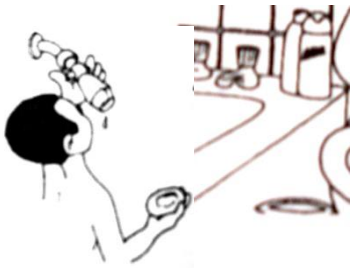
Toothbrush & cup



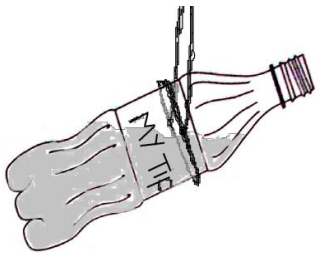
Dripping tap



Reusing grey water



Tippy hand wash



List or draw some other ways that YOU can save water.

Activity 3: Use a drip meter to record water loss

1. For a dripping tap (slow leak) collect the drips in a small container for a minute.
2. Use the calibrated propette to calculate the millilitres of wasted water per minute.

Calculations:

If there is _____ ml of water wasted **per minute**

= _____ **ml / hour** (ml /minute x 60)

= _____ ml **/ day** (ml /minute x 60)

= _____ **ℓ / day**

5.2.6. Working out what to do

How To... Recycle 2 litre cooldrink bottles

Background

Waste management is an area where everyone can make a contribution to living sustainably in the Orange-Senqu Basin. An integrated approach to waste management deals with waste in several different ways, with the aim of reducing the amount of waste that ends up in landfills, in the environment and in rivers.

Here are some practical projects that you can do with your learners. If you haven't already started, start a recycling project at your school where you can earn an income for your Orange-Senqu Basin conservation projects from unwanted waste by selling it to recycling depot's, upcycling it into new useful items or using it for creative projects and artworks. Where possible, re-use a product several times. Remember to Reduce, Reuse & Recycle.

- Glass and plastic bottles with deposits can be returned to shops for re-use.
- Wash and dry plastic bags for re-use.
- Re-use paper that has only been printed on one side.
- Staple together office paper that has been written on one side only, for scrap paper.
- Nursery schools make good use of the inside core of toilet rolls and paper towels, egg boxes, cereal boxes and jam jars.
- Post back refillable printer-cartridges to the manufacturer in the envelopes supplied.
- Charities welcome unwanted clothes, furniture, toys, books and magazines.
- Repair things rather than throw them away.
- Offer electrical devices in working condition to NGOs, charities or disadvantaged schools, before disposing of them.

Recycling a 2 litre cooldrink bottle

There are many ways to recycle a 2 litre cooldrink bottle - here are three.

1. Plastic bag screw-on lid

Often in a household, goods such as rice, sugar and frozen vegetables, are bought in a plastic bag. Once you have filled your sugar bowl, how do you seal the top so that the sugar

does not spill or the open bag of frozen vegetables does not fall over and spill into the deep freeze?

Step 1: Take a cooldrink bottle and carefully cut off the top section of the bottle, about 5 cm from the top of the lid.

Step 2: Unscrew the lid, and feed the open side of the sugar or frozen vegetables bag through the cut off section of the bottle, from the bottom side up through where the lid screws on. Fold about 2cm of the plastic over the lip of the bottle and then screw the lid back on. You now have a bag that won't spill its contents.

2. Mole-proof bulb planter

Step 1: Turn the bottle over and measure 12cm from the bottom and cut this section off carefully.

Step 2: If you have bulbs you need to plant in your garden, and don't want the moles to get to them, push this middle section into the ground, leaving about 1cm above the ground. Plant your bulb into this plastic tube. It will be mole proof.

3. Candle or pot plant holder

Step 1: Take the bottom section of the bottle and create a candle holder or pot plant holder. You can paint the container with paint that can be bought at any craft shop, or decoupage the outside to make it look special.

If you make a candle holder, you can put a handle on the top, by making a hole in either side of the bottle (directly opposite each other). Take a piece of fishing line or thin wire, thread some coloured beads through and secure onto the candle holder.

Adapted from a WESSA Sharenet 'How To' resource compiled by Michelle Craigie.

5.3.6a. Working out what to do

Group work – Alien Invasive Species

Write the following extracts on the board or onto cards and divide them amongst small groups. Ask each group to discuss the problem stated on the card and the effects on the environment. The group must also discuss various solutions to the problem. Ask the group to create a poster with their discussion points and present the problems, effects and solutions back to the class.

- **Invade land**

Alien Invasive Plants have invaded 10 million hectares of South Africa. This is 8% of South Africa's land. In the Orange-Senqu basin there is a particular problem along all the water courses. Both aquatic alien invasive species and riparian alien invasive species are problems. Species like water hyacinth, water fern and giant reed have taken over large areas of water bodies. Trees like Silver wattle, Black wattle, Grey poplar, Blue gum, Syringa, Jacaranda are all invasive species with Mesquite being extremely invasive.

- **Waste valuable water**

Invasive alien plants are often high water users that come from areas where there is a more abundant supply of available water for plants. IAPs generally have a deeper and more vigorous root system as compared to the surrounding wetland/ grassland vegetation where they are found, allowing them increased access to the available water. IAPs tend to grow along river banks and create thickets which slow the flow of rivers and intensify flooding.

- **Displace biodiversity**

IAPs upset the local ecology by displacing many indigenous species both plants and animals. Food webs become interrupted and the eco-systems start to break-down and populations become out of balance.

Draw botanical pictures of locally found alien invasive species and include them in the poster display. Invite a local expert to come and talk to the learners about alien invasive plants and organise an identification session thereafter. Ask a local environmental agency or NGO working in this field, like Working for Water to bring a team to your school and demonstrate how they eradication alien invasive species.

5.4.6. Working out what to do

An Animal Diversity Audit

Animal Diversity Audit: understanding the impact of land-use change

Most of the South African part of the basin is farmed commercially with medium to large stock units. To the west there are increasingly large rangeland-based livestock farms. Cattle and sheep are important in the east, while the dry land in the west is used to keep sheep and goats. Relatively few people live in the mountainous areas of Lesotho. In the Caledon River valley lots of people have settled on both sides of the Lesotho-South African border.

Along the Orange and Vaal rivers are big intensive, commercial, irrigated farmland. In the rest of the Orange-Senqu basin are small towns and villages that are widely scattered through the area and that serve mining and agricultural land-uses. In this audit you will look at the impact of the above on biodiversity and in particular, animal species, by doing an audit of how many animals you see in your area of the catchment and then linking your findings to land-use changes in the basin.

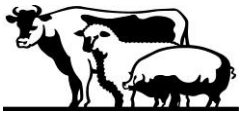
Individual Activity (equipment list)

- Pencil
- Data sheet

The Experiment

1. Walk around the catchment looking for animals.
2. When you see one, decide which group it fits into on the data sheet.
3. Make a mark (a tick or a cross) next to that group on the data sheet, e.g. if it is a brown lizard then put a mark in the row for lizards.
4. Now carry on looking for animals.
5. Note the different kinds of animals that you see adding extra columns on the data sheet if you need to. Remember to make notes about each animal you mark down on your datasheet so that you remember which kinds you have counted.
6. Do this for 30 minutes and see how many animals you can find.

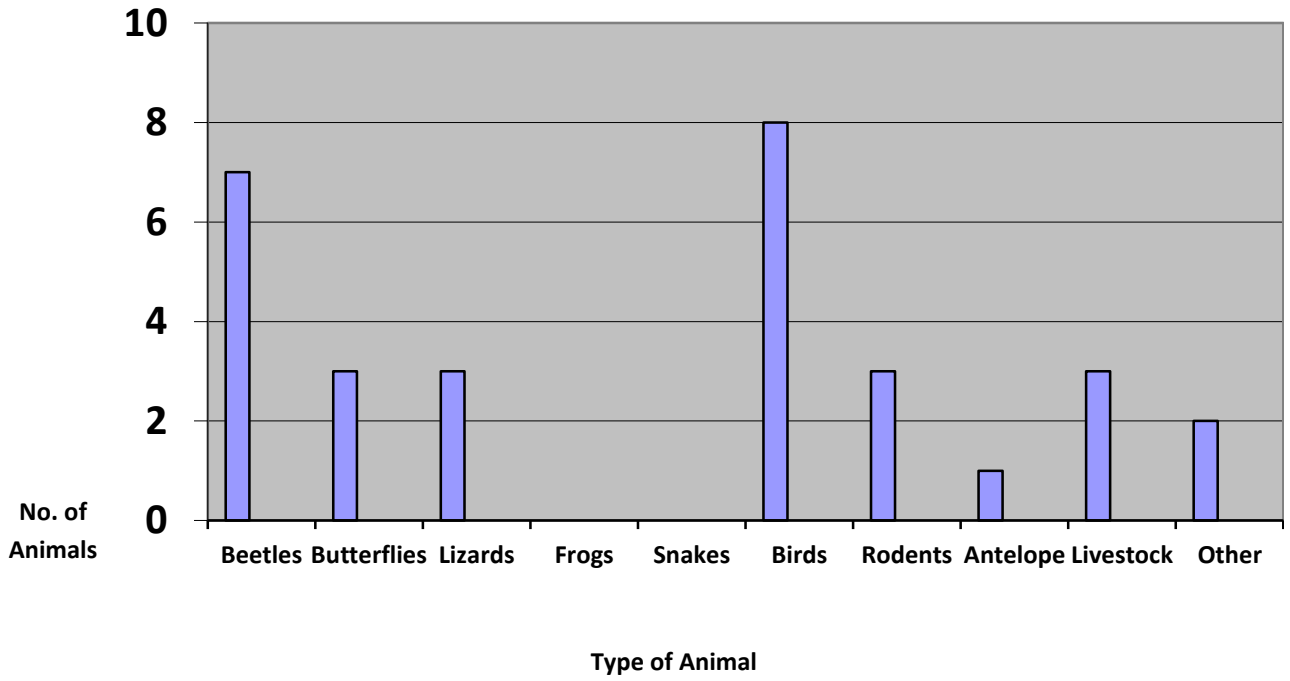
Example Data Sheet

Animal Group		**How many? What kind?**
Beetles		
Butterflies		
Lizards		
Frogs		
Snakes		
Birds		
Rodents		
Antelope		
Livestock		
Other	?	

Calculating...

Count how many different animals you saw in each category. Now draw a bar graph so that you can compare the differences.

Your graph should look something like this.



Questions

- Which animals did you see the most of?
- Which animals did you see the least of?
- Why do you think this is?

Extra activity

Choose one of the animals you saw and go to your nearest library to look up some information about it, how it lives and what it eats. Now write a short story about that animal. Try to imagine you are the animal and you are facing the environmental problems that many animals today have to deal with, habitat loss, pollution etc. How would this affect your life and what would you do about it?

Animals and the Environment

The animals you have seen in the catchment were grouped with animals that looked similar to them (all the lizards together) but animals can also be grouped using other characteristics. One characteristic is what they eat.

Activity (to be done individually)

Using the list of animals and the notes you made earlier, group the animals you saw according to which feeding category you think they fall into.

Remember that animals that were in the same group earlier might not be in the same group during this activity. Eg. Not all birds eat the same thing.

Calculating your results...

Count how many different animals you saw in each category. Now draw a bar graph so that you can compare the differences.

Animal Feeding Groups

Herbivores – Eat mainly plants (both trees and grass)

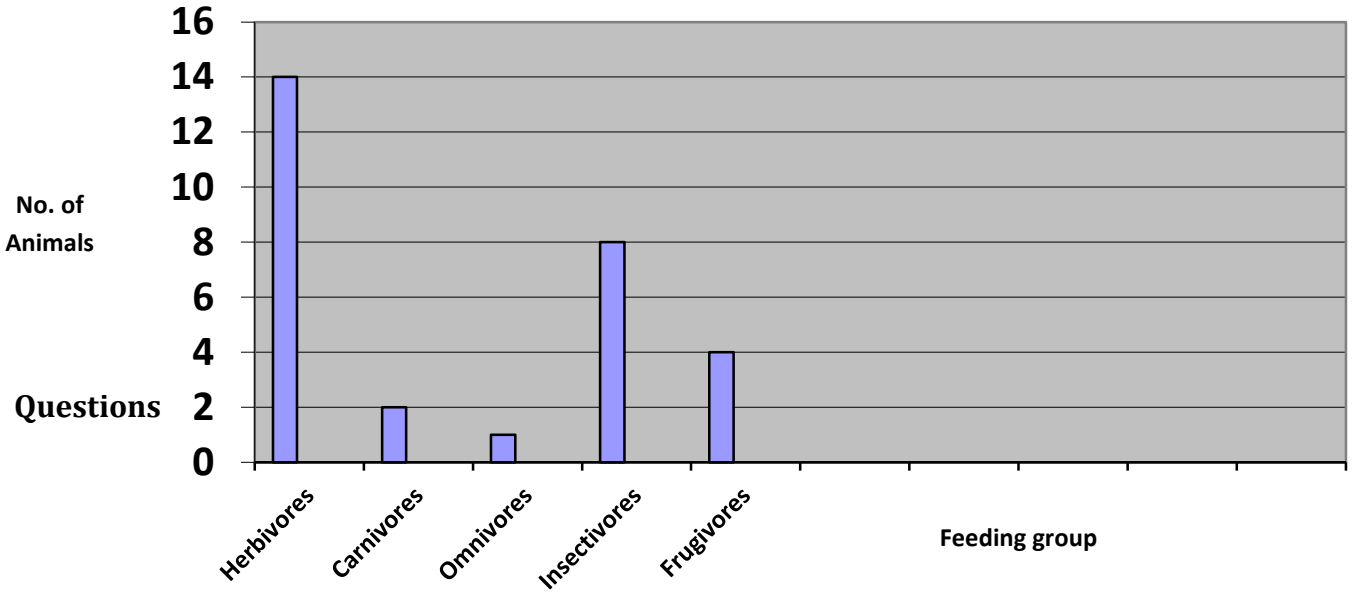
Carnivores – Eat mainly meat

Omnivores – Eat plants and meat

Insectivores – Eat mainly insects

Frugivores – Eat mainly fruit

Your graph should look something like this.

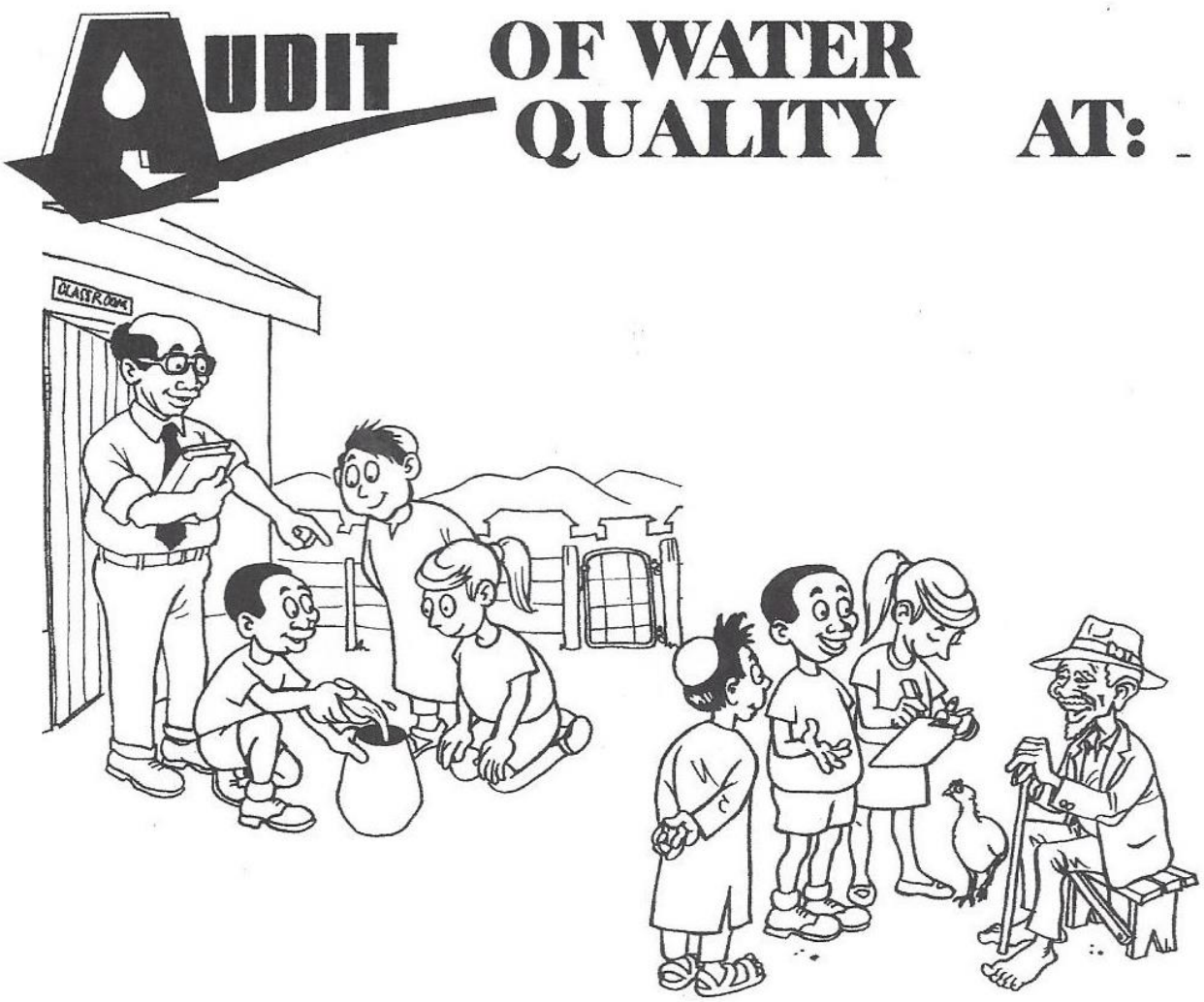


- What would happen to the catchment if there were populations of too many of one kind of animals there?
- Talk about the different feeding groups and what effect changes in one group may have on another.
- Discuss various senarios using an exploded population of various kinds of animals and link back to the feeding groups.
- Discuss various land use senarios and talk about what would happen to the animals in the catchment and what links there will be to other changes that take place as a result.
- Which feeding group do you think people fit into?
- What would happen to the Orange-Senqu Basin if there populations of too many people living there?!
- How would you know when populations of animals (or people) became 'too many' for the Orange-Senqu Basin?

Adapted: WESSA Sharenet

5.5.6a The 5 R's to River Health

We depend on the Orange-Senqu River for many things but the most important is clean water for people, crops, farm animals and wildlife.

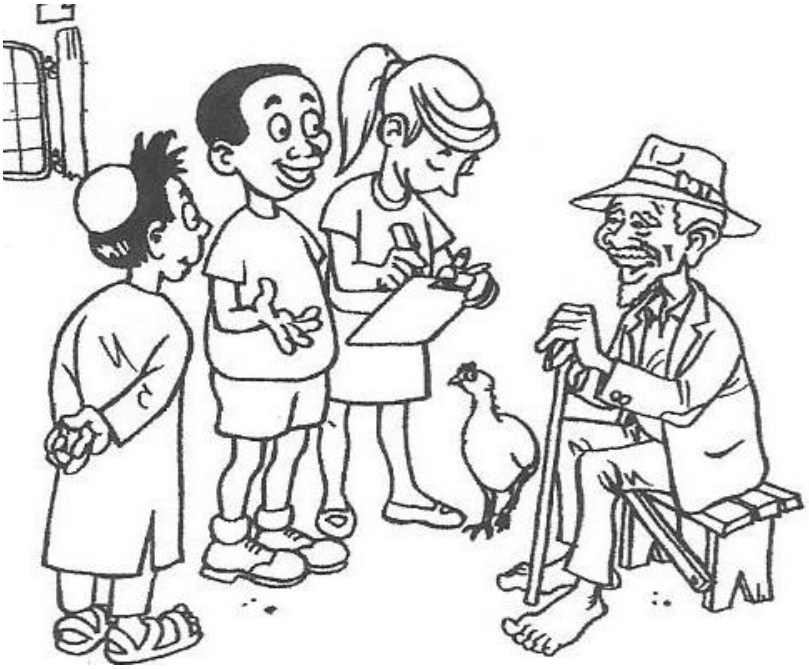


PUTTING TOGETHER A RIVER WARRIOR TEAM

As our population grows, there is an increasing demand for clean water and we are in danger of draining our river dry. We are also polluting our freshwater reserves with all our waste products. How can we protect our most precious water resources? Use the guidelines for an Eco-Club in Module 5 Unit 5 to put together a River Warrior Team. Undertake a river audit for a local stream and using the results develop a project to help restore river health!

The 5 Rs to River Action will help you care for your part of the Orange-Senqu River, whether you live in Lesotho, Botswana, Namibia or South Africa.

Local interviews, indigenous stories and change



Interviewing local people and collecting stories can develop a sense of how things have changed.

Local information and stories are thus essential for understanding local water quality issues.

Work out a set of questions to ask local people, particularly older folk who have lived in the area for many years. Record what you find out about historical change and local water quality problems in the space provided hereunder.

Historical (Ask older people about local stories and change)

Present conditions and possible problems (Ask local people about water quality problems)

Looking at River Health

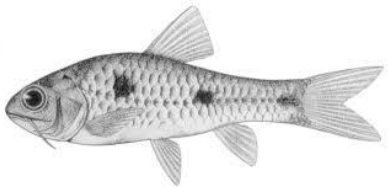
Why are healthy rivers important?

They supply us with clean drinking water and provide water for growing food crops, and for livestock. Healthy wetlands clean polluted water. River floodplains reduce flood damage and store water, releasing it slowly back to the river. Rivers and floodplains restock groundwater systems. In some places, rivers and pans provide fish for hungry rural communities. And don't forget that rivers are home to plants and water animals and provide a drink for thirsty wildlife!

Name three reasons why rivers are important to you.

What is a river basin (or catchment) audit and why should we do one?

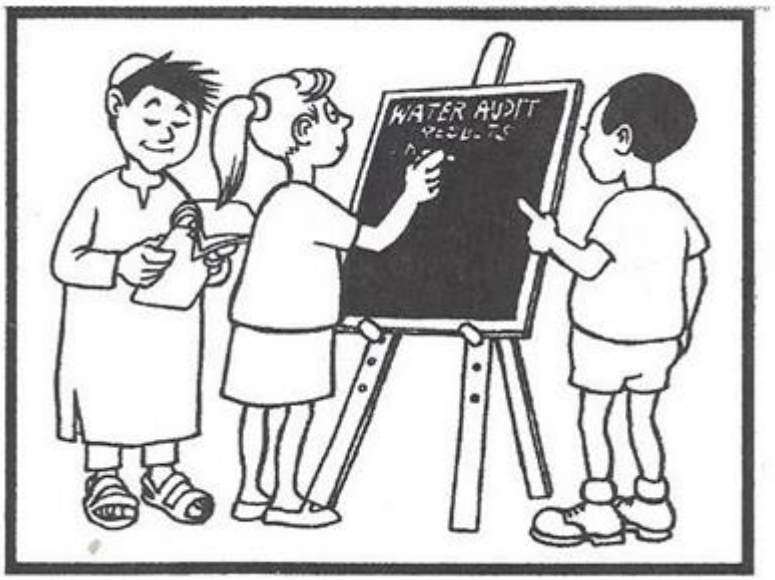
A watershed and its basin (or catchment) is the land from which rainwater flows into wetlands, streams or rivers. Many of the river catchments in southern Africa have been changed by historical land use practices, settlements and industrial growth to cater for a rapidly expanding population.



Barbus hospes

In many cases, wetlands have been destroyed and riverine vegetation removed, decreasing natural flood control so that the amount and quality of water released by our river catchments is decreasing.

Every action we take, every piece of equipment we buy, every kilowatt of electricity we use and every piece of waste we discard, has an impact on the environment. We all have a responsibility to contribute to better environmental management, especially of our rivers.



We use the term 'audit' to review the conditions as they are right now. We are literally taking a 'snapshot' of the situation at any one time.

Use the 'River Health Audit' on the following page to audit catchment conservation along your section of the Orange-Senqu River. Record your observations in the spaces provided. It is very useful, after doing this river health audit, to decide HOW you can take environmental action. Six months later, you could redo the same river health audit and see if things have improved.

Water monitor

1. LOOKING AT WATER LIFE

WATER LIFE	BAD	NOT SO GOOD	OK

***Research the river with miniSASS*.** Study river health with the miniSASS scoring system. This uses the presence or absence of invertebrates in a river to determine the health of the river.

(For full instructions and identification guide see Module 3, Unit 2) Safety: See Annexure: First Aid for Children

2. CATCHMENT CONSERVATION

Restore our water-wise plants. Most agricultural and forestry plants are aliens, introduced from other countries and many have spread into the Orange-Senqu River basin. Aliens like black wattle, bluegums and poplars crowd out indigenous plants, and the local birds, mammals, reptiles and insects move away. This leads to a decline in biodiversity. Alien plants also use much more water than our 'water-wise' indigenous plants. They reduce the flow of water through the soil and into our rivers.

(For information on alien invasive species and an identification guide see Module 5 Unit 3)

ALIEN INVASIVE	BAD	NOT SO GOOD	OK

3. CHECK SEDIMENTATION BY TURBIDITY TESTING

Water Clarity Test (Turbidity)

Turbidity refers to the relative clarity of water. Murky water stops light penetration and inhibits water life with a consequent loss of plant and animal diversity. Plants need light to grow and both large and small animals may suffer growth retardation or death because they cannot see to hunt and breed, or their gills may become clogged with particles of silt and organic matter. Suspended solid pollution can be caused by silt from soil erosion, by sewage and industrial waste or by excess microscopic life in the water.

Note: Some rivers are naturally turbid and many organisms can only live in turbid conditions. The key is to know the natural levels in your area.

How the test works

The turbidity sighting disk is based on an early technique of lowering a black washer into a long glass tube of water and noting the depth at which it is no longer visible. The turbidity disk has a circular washer (outer ring scored as 1) and numbers of differing density (scored 2-5). A measure of clear or murky water (turbidity) can be obtained by noting the image density visible in a 20 centimetre column of water.

Testing water clarity/turbidity:

1 Cut the lid off a 1.5 or 2 litre plastic bottle.

2 Fix the disk (see next page) to the inside bottom of the bottle.

3 Fill the bottle to 20cm with a debris-free sample of water.

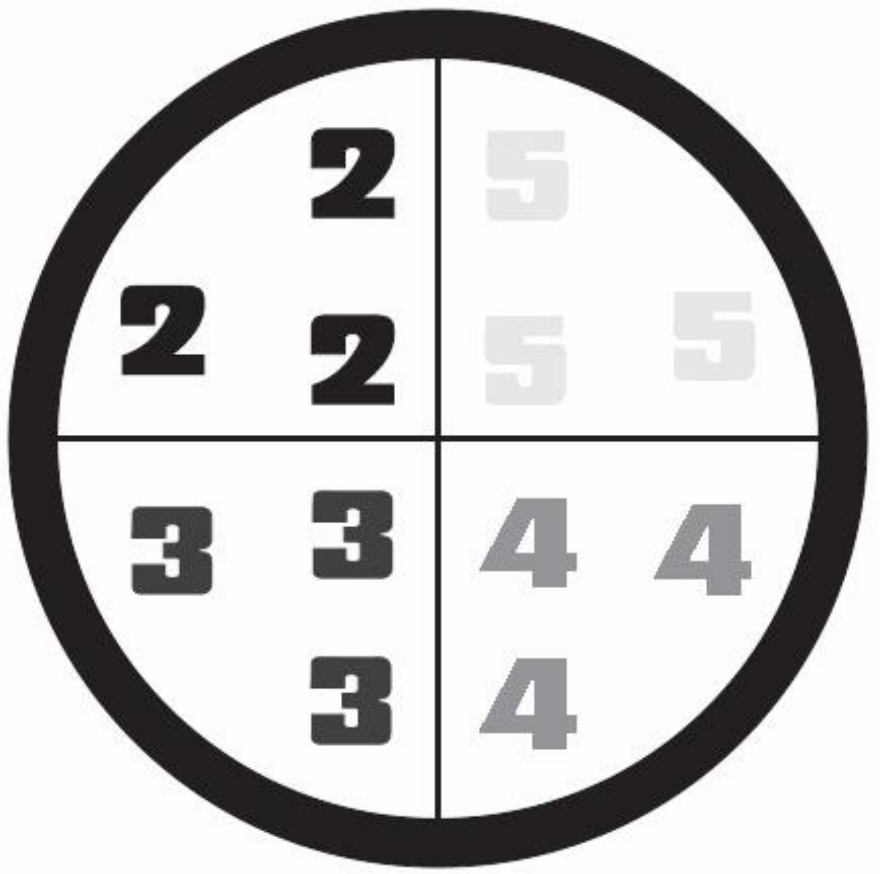
4 Look into the bottle and pick out the water clarity number that is visible (outer ring [1], 2, 3, 4 or 5).

5 Repeat to get a reliable result.

The water clarity is: _____

Disk not visible	1-3 visible	All visible
BAD	NOT SO GOOD	OK

Turbidity Disk - to make copies and cut out



TURBIDITY	BAD	NOT SO GOOD	OK

4. REPAIR ERODED AREAS

Check river banks, upper catchments, nearby farmlands and wetlands for erosion. Eroding areas need to be repaired by planting trees, indigenous grasses, reeds and other riverbank or wetland plants so that the roots can hold the soil together. In some cases, logs or rocks and netting are used to stabilise eroded areas before planting.

(See Module 4, Unit 3 for information on soil erosion, infiltration and planting trees and plants in eroded areas)

EROSION	BAD	NOT SO GOOD	OK

5. CHECK RIVER QUALITY

Organise a clean-up of your local river.

Take care to ensure the safety of your learners. Unfortunately, many people regard rivers and wetlands as dumping grounds. In known polluted streams wear protective clothing like gloves and gumboots. Wash hands after coming into contact with river water and/or litter. Now that we know how important these areas are to the future of our freshwater supplies, we need to spread the message about recycling.

Recycle as much as you can – especially plastics, as these choke our rivers and kill river and marine life. Do not litter. Street litter ends up in storm water drains and these often discharge into rivers. Implement a **Recycling project at school for litter and waste helps prevent unwanted waste getting into rivers and streams.**

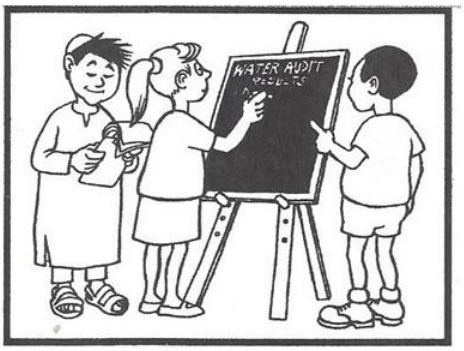
(See Module 5, Unit 1 for information on water quality and Module 5, Unit 2 on pollution)

RIVER QUALITY	BAD	NOT SO GOOD	OK

A Check for water quality. One of the simplest tests to perform to check on water is the 'sniff' test. Fresh water has no smell and no taste. Any unpleasant odours would mean that the water is contaminated. The 'sniff' test is not an indicator for the presence of bacteria and fungi which may cause disease. Any discolouration of the water should also be noted. **(See Module 5, Unit 1.6a for more information)**

OUR WATER SUPPLY IS	BAD	NOT SO GOOD	OK

SWAP RESULTS



Make comments next to your scores so that you can write up a report of what you observed while doing your river audit. Swap your results with the other groups through doing a presentation. Share your findings with partners and put a joint river restoration project together.

Remember to reduce water use. Southern Africa has a limited rainfall which does not always replenish our rivers and dams each year. It is also known that the people who have easy access to freshwater are the ones who waste the most. Our over-use of water is a problem as there is simply not enough for everyone and to maintain healthy rivers Measure the amount of water you use at home or at school by doing a water audit and see where you can use water more wisely. (See next section The 5 R's)

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River Health Audit

River health audit by:		**Site visited:**			**Date:**	
	Choose one column and tick	Tick here		Tick here		Tick here
WATER QUALITY	Slimy, oily, green or grey water. Would NOT swim in this.		Muddy or cloudy with sediment		Clear (transparent)	
ANIMAL LIFE	No life in water		A few species, but mostly worm-like animals		Lots of life, insect larvae, snails and fish etc.	
LITTER IN RIVER AND ON BANKS	Lots of litter		A small amount of litter		Little or no litter	
STATE OF THE RIVER BANKS	Banks concreted or walled – canalised		Earth banks steep and straight, may be over-grown with alien plants, weeds or grasses		Banks natural with rich indigenous vegetation	
* STATE OF THE RIVER FLOODPLAIN, WETLANDS AND MARSHES	Urbanised – mostly filled in or drained and covered with houses and roads		Agricultural – many fields, lawns or gardens, but some wetland areas still present		Natural – wetlands and floodplains mostly unaffected by people	
*ALIEN TREES AND PLANTS IN THE RIVER OR ON THE BANKS	Most plants are aliens		A mixture of alien and natural vegetation		Mostly natural vegetation with few aliens	
EROSION OF RIVER BANKS	River bank collapsing – many eroded dongas		Some erosion in places		Banks stable with very little or no erosion	
* STATE OF THE CATCHMENT	River flows through large towns and heavily populated areas – greatly affected by people		River flows through a mix of wilderness areas and small towns and farmlands		River flows mostly through wilderness areas with few people present	
HOW TO SCORE	**Count 1 point for every tick in this column & write it in the shaded block.**		**Count 2 points for every tick in this column**		**Count 3 points for every tick in this column**	

* Ask an adult to help with this information **SUM OF ALL POINTS:**

Your catchment health score

21-24= Your river stretch is in good condition. What can you do to ensure it stays that way?

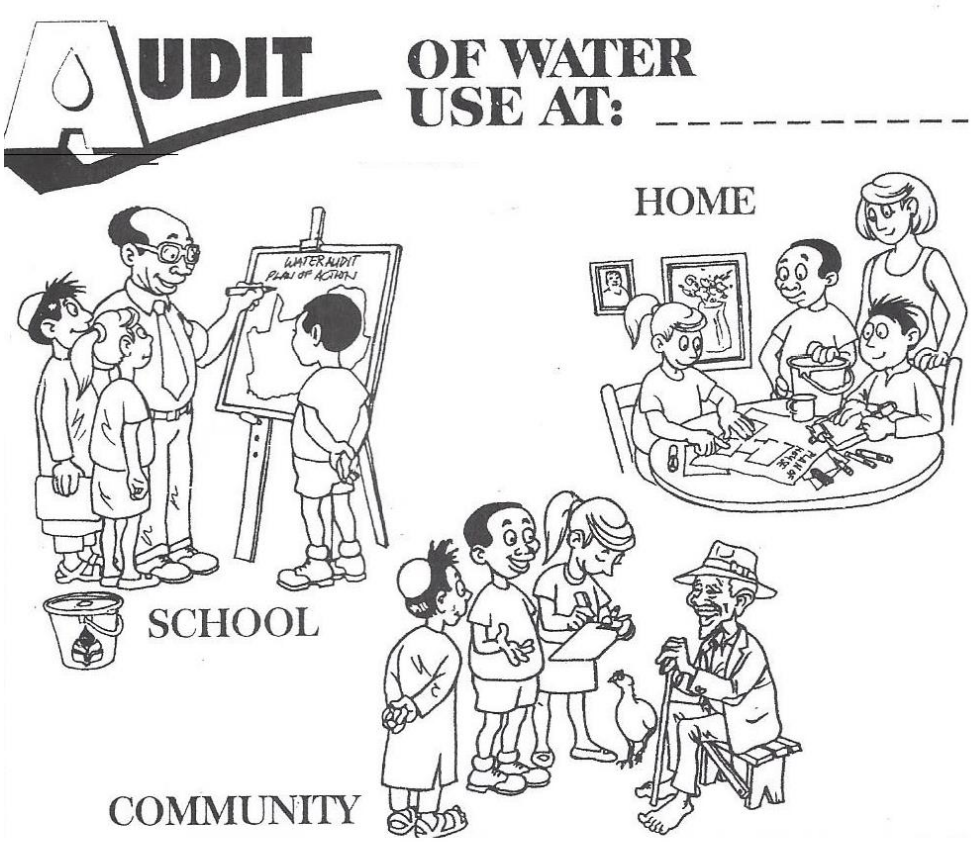
13-20 = Your stretch is not as healthy as it could be. With help, parts of it could be restored.

8-12 Your river stretch is sick and needs help urgently. You definitely need to 'adopt' your river and do what you can to help.

5.5.6b The 5 R's to Good, Better, Best Water Choices

Water – one of our most precious resources

Fresh water is essential for the daily lives of all aquatic and terrestrial organisms, including people. Although water can be a recyclable resource, it needs careful management and protection because of its vulnerability to over-exploitation and pollution. This is particularly true in southern Africa where we are a water-stressed, bordering on water-scarce region.



PUTTING TOGETHER A PROJECT TEAM

Set up a project team to conduct your school or home audit. Discuss the importance of water, the cost of purifying it and the impact of dams on the environment. Discuss your team values, like taking care of the environment, looking after rivers, being kind to people, helping others. Discuss what you would like to achieve with your audit and draw up a plan of action. Estimate the savings that you will make and plan what you will use this money saved for. Let others know about the audit and report often on your activities.

1. MEASURING DRINK AND SINK USE/WASTE

Did you know?
A dripping tap can waste between 30 and 60 litres of water each day.

Did you know?
According to the United Nations, every person needs 20-50 litres of safe freshwater a day to ensure their basic needs for drinking, cooking and cleaning. More than one in six people worldwide (894 million) do not have access to this amount of safe freshwater.

2. METRE READING & FINDING LEAK LOSS

3. MEASURING FLUSH & BATHROOM WASTE

Did you know?
Having a long shower of 35 to 40 minutes uses more water than taking a bath!

Did you know?
Reducing the amount of water needed for each toilet flush, by one litre can save hundreds of litres of water per day.

4. MEASURING OTHER USE/WASTE

5. TAKING WATER SAVING ACTION

Audit your school's water use. A comprehensive water audit of your school on a weekly or monthly basis will give you a good idea of where water is being used in your school. You can then plan ways of reducing unnecessary water usage in the school.

Replace showers with 'water-saving' shower heads. Fit low-pressure shower heads to reduce the amount of water forced out of the shower per minute.

Re-look at how the school grounds are watered. Most evaporation happens on windy days and also at noon. Consider not watering school grounds on windy days and consider watering during cooler parts of the day, like in the morning and late afternoons.

Fit aerator or spray ends to sink taps. An aerator mixes air with water and can reduce water consumption by up to 50%.

Report leaks. A dripping tap can waste between 30 and 60 litres of water each day.

Use "captured" (harvested) water. Linking "Jojo" tanks to the gutter system will help gain extra water from rain for watering gardens and other outside needs.

Plant indigenous. Indigenous plants are best suited to your school grounds and require little if any maintenance and water. The more water-wise your school grounds are, the easier and cheaper it is to keep them beautiful.

Upgrade school toilets to 'double' flush systems. Upgrading toilets to dual flush toilets reduces water usage dramatically, using minimum amounts of water for fluids and maximum for solids, thus saving water on the 'fluid' flushes.

Reduce toilet water usage. Adding a filled 2 litre plastic bottle into the toilet cistern to displace water reduces water usage during flushing.

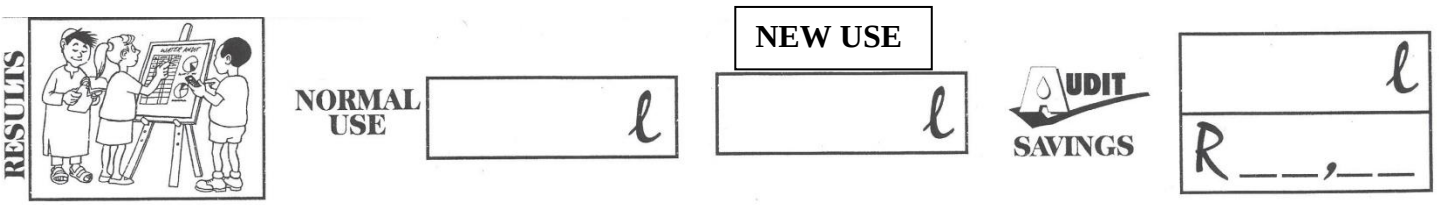
Install a bin. Throw sanitary products and other waste in the bin, not in the toilet.

Bring a water bottle to school. Bringing your own water bottles to school can help reduce water wastage. Drinking from a running tap often wastes a lot of water.

Reduce water usage. When washing your hands, do not let the water run while soaping up your hands.

Use a shower timer. Time how long you take to shower. If everyone in a family of four took one minute less to shower, your family could save 12 000 litres of water a year!

Save the cold water that comes through before a tap runs hot, and use it to water plants.



Encourage your whole school to get involved in auditing water use. Put together a bigger project team that includes the management and staff. Obtain a 12 month record of water consumption and get the maths learners to develop a graph of current water consumption trends. Do a water audit and develop a plan of action for conserving water and implement over an extended period. Monitor water use carefully and construct a new graph from incoming water utility bill information and your school meter reading. Reward water saving behaviour at school by celebrating water week and with other incentives. Keep it up!

Many schools do not have a good supply of water to waste! These school are very aware of the importance of water and actively conserve what water they have. Do share your water conservation tips with others! Well done!