LEARNING AND TEACHING ABOUT WATER IN OUR CLASSROOMS:

A SERIES OF LESSON PLANS FOR GRADES 8 - 12

Report to the
Water Research Commission

by

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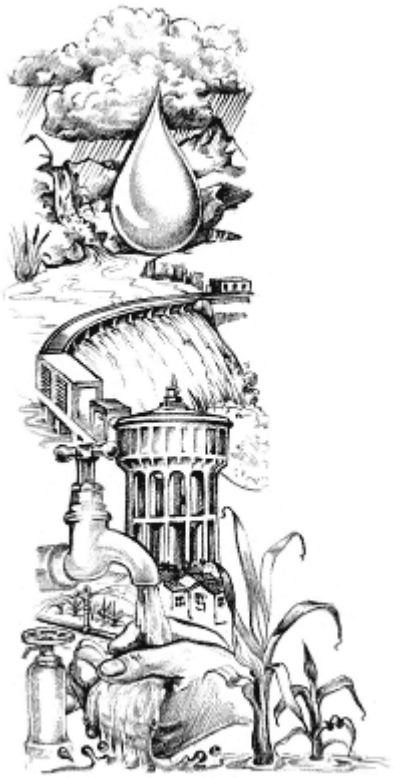
Executive Summary



South Africa is extraordinarily rich in natural resources – except for water. Water is a vital but scarce resource, distributed unevenly in time (frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is markedly wetter than the western half). Increasing demand for water, and decreasing water quality, make careful water management a priority in our country. It has been estimated that by the year 2025 South Africa's human population will have doubled, and there will not be sufficient water for domestic use, agriculture and industry.

Our average rainfall is less than 500 mm a year. The driest part of the country receives less than 200 mm a year and the wettest part receives more than 2 500 mm a year! Rain does not always fall where it is most needed, and some areas of high demand, such as Gauteng, receive less water than they need. Most rain falls in a narrow belt along the eastern and southern coasts. The rest of the country receives only 27% of South Africa's total rainfall. In addition, hot dry conditions result in a high evaporation rate.

Water is thus a very scarce resource in South Africa.

In support of learning and teaching about water and water-related issues, the Water Research Commission of South Africa and Share-Net (a project of the Wildlife and Environment Society of South Africa) have developed a series of lesson plans on water. These lesson plan packs, from Grade R to Grade 12 are linked to the South African National Curriculum.

Each pack contains five lessons, with each lesson focusing on a different learning area – these can either be used as they are, or adapted to suit the local context. Each lesson is concluded with a rubric of criteria to assess the learners. Learning Outcomes and Assessments Standards covered during each lesson are given in the summary at the beginning of the pack.

Did you know?

- the Northern Cape receives very little rain and many of the people living there rely on groundwater;
- the Western Cape, south western Cape and KwaZulu-Natal are areas with many RAMSAR wetland sites;
- the Free State is home to one of the most important river catchment areas in the country.

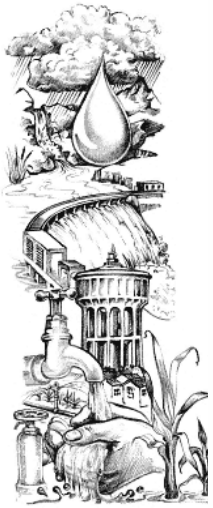
Use the map on the following page to, wherever possible, contextualise your lesson plans – in other words, if you live in the Northern Cape, bring groundwater and evaporation issues into your lessons, if you teach in KwaZulu-Natal or the Western Cape, wetlands could form the focus areas of your teaching lessons.

All these lesson plan packs are available on www.envirolearn.org.za Other useful websites are the Water Research Commission's website www.wrc.org.za and the Wildlife and Environment Society of South Africa's website www.wessa.org.za

WESSA

Share-Net

WATER IN SOUTH AFRICA



LIMPOPO
Limpopo is in the savanna biome, an area of mixed grassland and trees generally known as bushveld. A summer-rainfall region, the northern and eastern areas are subtropical with hot and humid summers and mist in the mountains. The bushveld is cattle country, where extensive ranching operations are often supplemented by controlled hunting. Sunflowers, cotton, maize and peanuts are cultivated in the Bela-Bela and Modimole areas. Tropical fruit, such as bananas, litchis, pineapples, mangoes and pawpaws, as well as a variety of nuts, are grown in the Tzaneen and Makhado areas. Tzaneen is also at the centre of extensive tea and coffee plantations.

LIMPOPO

GAUTENG
Rain does not always fall where it is most needed, and areas of high demand, such as Gauteng, receive less water than they need. Using several small rivers along the way, water moves from the Katse Dam in Lesotho to the Ash River that flows into the Vaal to supply industry and people in Gauteng.

GAUTENG

Johannesburg
800mm/year

MPUMALANGA
The province is a summer-rainfall area. An abundance of citrus and many other subtropical fruit as well as nuts and a variety of vegetables are produced in Mpumalanga. Nelspruit is the second-largest citrus-producing area in South Africa and is responsible for one third of the country's export in oranges. The Institute for Tropical and Subtropical Crops is located in the city.

NORTHERN CAPE
Huge areas of our country have few people living there because it is so dry. People must depend on water from boreholes that suck up water trapped by underground rock formations beneath the soil surface. We have about 30 000 billion litres of water underground. In some areas, groundwater is replenished by rainfall, but in many places the water is left from ages past when the climate was wetter. This water is called fossil water and once used, cannot be replaced.

FREE STATE

FREE STATE
Bloemfontein is the Afrikaans word for 'fountain of flowers'. It originated as a resting point for oxen next to a spring where water could always be found.
The Free State is home to one of the most important river catchment areas in South Africa, with more than 50% of the water supply for the country coming from the upper catchment area of the Little Caledon River.

KWAZULU-NATAL

Port Nolloth receives only
58 mm of rain per year!

NORTHERN CAPE

Durban 1100 mm/year

EVAPORATION
Why is the west coast so dry? Water that evaporates from the Atlantic Ocean condenses to form thick mists over the cold sea. But when these mists move in over the hot land, the water evaporates again instead of falling as rain.

KWAZULU-NATAL
The eastern part of country receives more rain than the rest of the country. It also has many RAMSAR wetland sites in the northern part of the province. Health and sanitation related to water-borne diseases, such as cholera, are serious issues for this region.

WESTERN CAPE
The Western Cape, unlike the rest of the country, receives its rain during the winter months. There are many important RAMSAR wetland sites in this part of the country.

East London
1400 mm/year

EASTERN CAPE

WESTERN CAPE

Indian Ocean

EASTERN CAPE
The province's diverse climates and landscapes range from the dry and desolate Great Karoo to the lush forests of the Wild Coast and the Keiskamma Valley, the fertile Langkloof, renowned for its rich apple harvests, and the mountainous southern Drakensberg region around the town of Elliot.

Cape Town
600 mm/year

Atlantic Ocean

Water use at home, school and in our community

Share-Net

This pack supports an introduction for learners to an Eco-School's focus on resource management

Grade 8

This pack contains:

Activity One: This **SOCIAL SCIENCES : HISTORY** reading and questioning activity looks at early Nguni people of southern Africa and their commonsense ways of collecting and storing "sweet" water.

Activity Two: In this **ARTS AND CULTURE** activity, learners conduct interviews in their local community and then share their findings with the rest of the class in small group role-plays.

Activity Three: This **NATURAL SCIENCES** activity allows learners to prepare for a water audit, collect data in and around their home, school and community and then develop a school water-wise management plan.

Activity Four: This **LANGUAGES** lesson encourages learners to investigate an environmental situation and debate, discuss and communicate their ideas.

Activity Five: This **TECHNOLOGY** and **NATURAL SCIENCES** activity can be used to highlight different phases of water as well as the outcomes of what occurs when water changes phase. This activity can be done in the classroom or learners could try it out at home.

WESSA

This pack of lesson plans is part of a series of lesson plans from Grade R to Grade 10 which focus on water and water-related issues. This resource development project has been funded by the Water Research Commission, Private Bag X03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).
This pack is available electronically on www.envirolearn.org.za

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. This reading and questioning activity looks at early Nguni people of southern Africa and their commonsense ways of collecting and storing "sweet" water.	Social Sciences: History	**Learning Outcome 1:** Historical Enquiry: The learner will be able to use enquiry skills to investigate the past and present. **Learning Outcome 2:** Historical knowledge and understanding. The learner will be able to demonstrate historical knowledge and understanding.	• Evaluates the source used (e.g. 'Who created the source?', 'Is it reliable?', 'How useful is the information?' [works with sources]. • Explains changes in a wider historical and environmental context [change and continuity].
2. Learners conduct interviews in their local community and then share their findings with the rest of the class in small group role-plays.	Arts and Culture	**Learning Outcome 2:** Reflecting: The learner will be able to reflect critically and creatively on artistic and cultural processes, products and styles in past and present contexts.	• Uses the Arts to demonstrate an awareness of environmental concerns. **Drama:** • Researches human rights and environmental issues and interprets these in small group role-plays.
3. Learners prepare for a water audit, collect data in and around their home, school and community and then develop a school water-wise management plan.	Natural Sciences	**Learning Outcome 3**: Science, Society and the Environment: The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.	• Understands sustainable use of the earth's resources: Identifies information required to make a judgement about resource use. (e.g. Plans and carries out an audit of all uses of water around the school premises and develops an implementation plan to improve water management at school.
4. This lesson encourages learners to investigate an environmental situation and debate, discuss and communicate their ideas.	Languages	**Learning Outcome 2:** Speaking: The learner will be able to communicate confidently and effectively in spoken language in a wide range of situations.	• Communicates ideas, facts and opinions on challenging topics clearly and accurately and with a greater degree of coherence, using a range of factual oral text types (e.g. discussions, debates). • Demonstrates a range of interaction skills by participating actively in group discussions, conversations, debates and group surveys and while doing so: tackles important issues; acknowledges others' opinions and disagrees politely when necessary; motivates own point of view; gives and receives criticism. • Persuades others.
5. This activity highlights different phases of water as well as the outcomes of what occurs when water changes phase. It can be done in the classroom or learners could try it out at home.	Technology and Natural Sciences	-	-

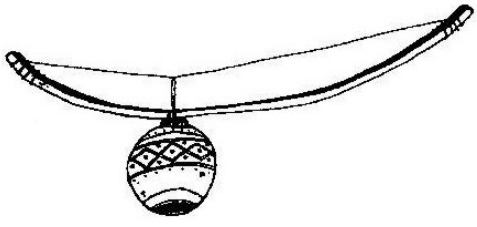
ACTIVITY ONE: SWEET WATER AND EARLY NGUNI PEOPLE

This SOCIAL SCIENCES : HISTORY reading and questioning activity looks at early Nguni people of southern Africa and their commonsense ways of collecting and storing "sweet" water.

(In the story that follows, comments and scientific observations are in brackets and italised so that the learners can see the practical wisdom behind some water collection myths and techniques of the past).

Before the time of the Zulu King, Shaka, sweet water was called "amanzi amnandi". Shaka's mother was called Nandi and it is said that because it was not considered respectful to use the queen mother's name in this way, Shaka referred to sweet water as "amanzi amtoti". *(This is how the town of Amanzimtoti, south of Durban, got its name).* Today both terms are used and many people of Nguni origin will sniff, smile and hold up "sweet" water, collected from a river, spring or well for their daily household needs. *(Water quality scientists today still have people smell and taste household water. Human senses give a refined indication of whether water is good and clean and fresh).*

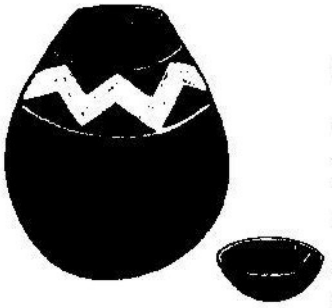
Historically, water was usually collected in areas where people could hear it running over stones or dripping down rocks *(well oxygenated water supports natural biological cleansing processes).* If a spring was for human use, it was protected by a circle of rocks with a small outlet. Cattle drank elsewhere.



An area nearby was cleared and the site soon became a meeting place for young people. Young men would hang around these water collection sites, playing musical instruments and admiring the maidens who came to collect water. The girls would saunter along slowly and gracefully, singing and flirting. Water collecting was rarely seen as a tiring or boring chore because of the prospect of courtship!!

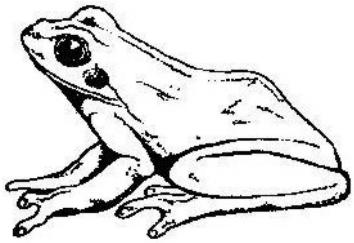
A water source would always be approached with care so as not to frighten crabs and other small water animals. When disturbed, their movement would stir up sediments and the collector would have to wait for the silt to settle. The surface film was brushed aside for "sweet water" to be collected. *(Sediments*

and surface films have higher bacteria numbers than the middle waters of pools and rivers. Today scientists take water samples below the surface film, taking care not to suck up sediments. In this way, scientists can get consistent and reliable measures of bacterial contamination).

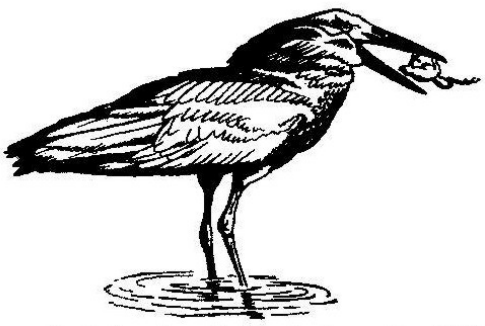


Clay pots were filled with water and covered with a collecting bowl, a piece of skin or a mat made from incema (*Juncas kraussii*) grass. The water would thus stay cool and fresh. *(Water evaporating through the sides of a porous clay pot cooled the contents. Most water bacteria cannot reproduce in cool, dark conditions. Some micro-organisms envelop themselves in a calcium secretion in the pores of clay pots. Scientists spoken to were uncertain about the detail of these issues but it is of note that, in earlier times, great care was taken to scour out a calcium-like scale in water pots. Also of note is that when the grass "lids" and head rings for carrying pots became old they were simply thrown away and new ones were woven. Discarded lids did not pollute the river like today's bottle tops and plastic waste).*

There were many other customs and traditional practices surrounding water. Children were warned that urinating in a river would change them to the opposite sex! *(This myth was probably sufficiently frightening to prevent people urinating in streams and rivers. This would have limited a disease like bilharzia. The bilharzia parasite is passed on from human urine and faeces to small water snails. From these, its life cycle takes the disease back to people through river water).*



Nguni water collectors say that where there are frogs, one does not find sweet water. Frogs are eaten by hammerkops (*uthekwane*, the "lightning bird") and the prospect of collecting water while being watched by a "witch-bird" must have been terrifying in earlier times when spirits, myths and mystery had a more central place in everyday social life. Children were told that if they killed this bird or stole its eggs, their homes would go up in flames. *(Where there are frogs, one will usually find snakes. Both animals are feared by many people today, not least the children who were told the Nguni myths of witches and lightening to fill their hearts with terror. Today, scientific tests suggest that many frog species need "sweet water" if they are to live and reproduce successfully. There must be some doubt about the Nguni suggestion that frogs are an indication of water that is not fit for human consumption).*



It is also said that it was not advisable to collect water from a river after heavy rain at the start of the annual rainy season. Indigenous commonsense told

people to put out pots to collect rain-water. River water would again be collected four days after the rains stopped and the water had cleared. *(Heavy rains wash human and animal wastes into rivers. There is thus a rapid increase in faecal bacteria and disease. In KwaZulu-Natal, health workers have to warn rural people not to collect river water after heavy rains as few remember the earlier Nguni practice of collecting rain-water only four days after the rains have stopped).*

Today human and livestock numbers have increased vastly, catchments have become degraded and rivers are often polluted dumping places. The best indigenous practices for the collection of "sweetwater" may not prevent people getting serious diseases from river water. Learning about historical water collection and storage practices can, however, develop a respect for early people and might also help our understanding of water quality issues.

Read the story of 'Sweet Water and Early Nguni People' to the class or make photocopies and allow the learners to read it on their own.

As a class, discuss the following questions:

1. How many of you have collected water from a nearby river? What was the water used for? (If for drinking, how were you certain that it was safe to drink?)

2. How many of you have heard the story that has just been read? Who told you this story?

3. Do any of you have stories of other ways of collecting water long ago?

4. Many stories from long ago are passed down orally from one generation to another. One does not find them written down in books and one has to ask the older people in a community who may remember how things were done long ago. How reliable is this information? What is the danger of not writing down stories from different cultures?

5. Why do you think it is important to look after our rivers and streams?

6. Does the class think that rivers and streams throughout South Africa have changed over the last 100 years? In what way? Why? Have any of you seen changes taking place in a river in your life-time? *(Keen young fishermen in the class may have noticed a decrease or increase in fish species and a change in the water quality or path of the stream/river).*

7. How can we find out what the rivers, streams and other water sources were like in our own community 50 years ago so that we can compare them with what we see today?

Criteria to assess learners during this social sciences: history lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner was able to discuss how reliable and useful stories told by older members in the community were (question 4)				
The learner was able to give reasons why we should conserve and look after our rivers and streams (question 5)				
The learner was able to discuss possible or real changes that have taken place in rivers or streams (question 6)				

ACTIVITY TWO: LOCAL INTERVIEWS, INDIGENOUS STORIES AND CATCHMENT HISTORY

In this ARTS AND CULTURE activity, learners conduct interviews in their local community and then share their findings to the rest of the class in small group role-plays.

A watershed and its catchment is the land from which rainwater flows into wetlands, streams or rivers.

Many of the river catchments of southern Africa have been changed by historical land use practices, settlements and industrial growth to cater for a rapidly expanding population. 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.

Interviewing local people and collecting stories can develop a sense of how things have changed. Local information and stories are essential for our understanding of local water quality issues.

ACTIVITY

- In small groups of 4 or 5, the learners must work out a set of questions to ask local people, particularly older folk, who have lived in the area for many years.

Some ideas for questions for older people could be:

1. How long have you lived here?
2. Have you noticed any changes, since you were young?

3. What are these changes?

4. How did you collect water long ago?

5. Have you noticed any change in the water? Quality? Amount of water?

6. Have you noticed any changes in the amount of rain that falls?

7. Do you know any local stories about water? (Or animals linked to water?)

Learners also need to work out another set of questions about the present conditions of their catchment and possible problems. These questions can be asked to their friends, parents and other members of the community.

1. How long have you lived here?

2. Where do you get your water?

3. Have you noticed any problems with the quality of water here, in this community? What are these problems?

4. Are the streams and rivers clean in this area? Can one drink from them?

5. Is the community involved in any river clean-up / alien plant eradication projects that you know of?

NB: Only use the questions above if learners are struggling to work out their own sets of questions

Time needs to be set aside, either during or after school, to conduct these interviews, using the questions prepared during the lesson. These local interviews will give the learners information on water and the water quality situation both in the past and today.

And now … it's time for some drama in our lives!!

What is role-play?

We use role-play to explore different situations and ideas. This is done by acting out a usually authentic situation, without a script.

Now that the water quality and catchment interviews have been completed, each group will role-play their experiences of:

- Deciding what questions the group was going to ask the interviewees;
- Deciding who they were going to interview;
- The interviews themselves;
- Some of the funny/sad/interesting/unusual things that may have happened during the interviews;
- Their interactions with one another during this activity – any conflicts that arose, any differing of opinions (how they were sorted out, or not!), any laughs and good times.

One of the first tasks of the role-play is for each group to decide who are the different characters involved. It is a good idea to use simple props for each character (such as a hat, wig, jacket or jewellery to help characters get into their 'role').

Role-play is a fun way of exploring environmental issues and concerns. At the end of the role-plays, a list of all the main points that emerged from the interviews can be drawn up and shared with the whole class, thus giving a broader and fuller overview of the water and water quality situation in your local catchment.

Criteria to assess learners during this arts and culture lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner was able to research the issue of water quality by conducting interviews within their local community				
The learner was able to work in a group and play a part in the role-play of water and water quality				

ACTIVITY THREE: AUDITING OUR WATER CONSUMPTION

Auditing our individual family's water consumption is a good start to investigating how we can all reduce water waste and together, as a community, develop a water-wise management plan. This NATURAL SCIENCES activity allows learners to prepare for a water audit, collect data in and around their home, school and community and then develop a school water-wise management plan.

To prepare for an audit of the school, home or community water-supplies, current patterns of use must be calculated and averaged. This makes an audit a simple matter of recording the number of times each activity happens. Preparation activities also point to wasteful practises that can be changed.

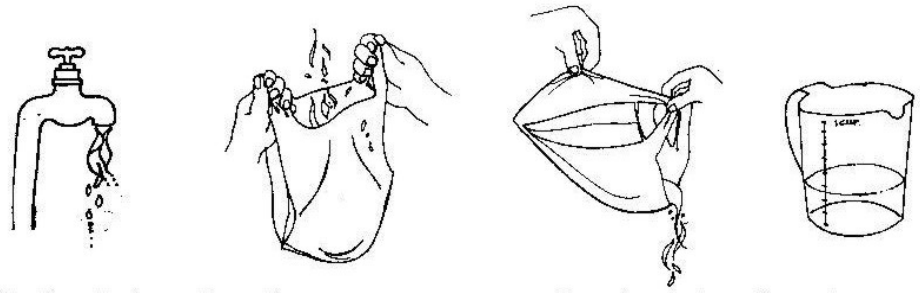
For example: People with piped water often clean their teeth or take a drink with the tap running. In this way, fresh water is wasted when it would have been more sensible to use a cup.

Let the learners try this activity:
Calculate the water used when brushing teeth or taking a drink from a running tap. Use a plastic bag to collect the wasted water and measure the amount wasted using the measuring equipment *(see box on the next page)*

Calculate the difference:

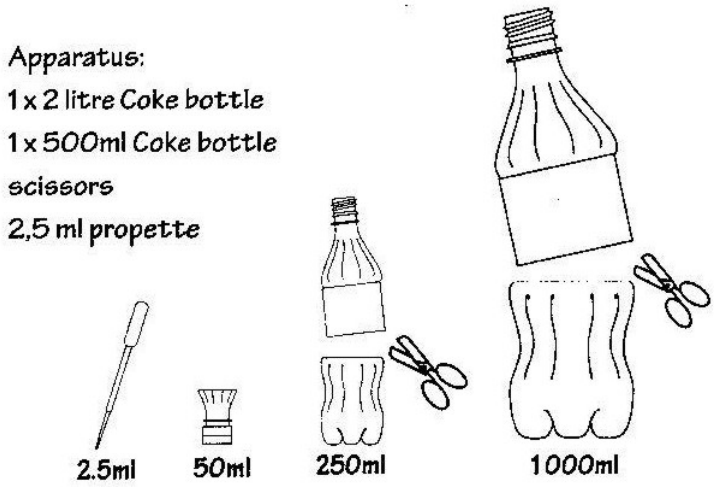
Water used with the tap left running	……/
Water used with a cup	……/
Difference (not wasted when cup used)	……/

BAG MEASURE



For fast leaks and running taps, use a supermarket plastic bag. Pour the water collected into a container and use a measuring jug to measure. A cheaper alternative is to make your own measuring equipment.

Making your own measures



- Cut the bottles as shown in the picture. This will give you 50ml; 200ml; 1 000ml; measuring apparatus.

- Accurate apparatus is important so check by filling the larger from the smaller:

* The 2.5ml is pre-calibrated
* 50ml is 20 x 2.5ml
* 250ml is 5 x 50ml
* 1 000ml is 4 x 250ml

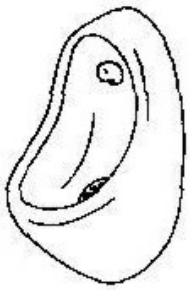
Although not as accurate as a measuring jug, this equipment is more than adequate for auditing water use.

To measure a bag of water, simply fill the 1 000ml, counting each time until a part-filled container remains. Pour this into the 250ml until a part-filled container remains and do the same right down to a part-filled 50ml measure which is determined by the propette. Written like this, it seems a little complex but with practise a bailing and counting method is both quick and accurate.

Make a list of common water use activities in preparation for doing an audit of water use.

Flushing toilet

.....ℓ



Urinal

.....ℓ

Washing hands

.....ℓ

brushing teeth

.....ℓ

Drinking

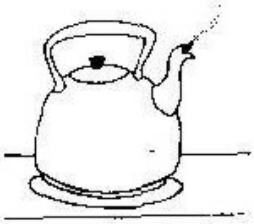
.....ℓ

Bathing

.....ℓ

Taking a shower

.....ℓ

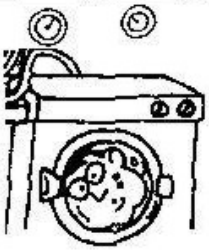


Kettle

.....ℓ

Hand washing clothes

.....ℓ

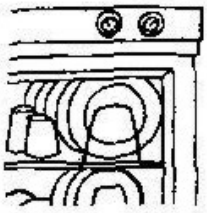


Washing machine

.....ℓ

Washing dishes

.....ℓ



Dishwasher

.....ℓ

Garden hose (litres per minute)

.....ℓ

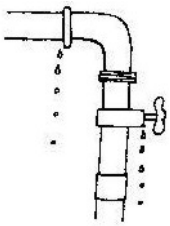
Cooking pots

.....ℓ

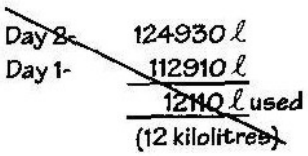
REMIND THE LEARNERS THAT …

Despite sound preparation and knowing how much water is used for each activity, a water audit is never an easy matter. You will only be successful if, from the beginning, you keep it simple and have ways of checking your work for accuracy.

For example:
If a check of results against the meter reading shows that more water is used that the audit records then:



1. There may be a leak in the pipes (check this by switching all the taps off and seeing if the meter keeps ticking)
2. You may have missed measuring an important water activity, or
3. Your calculations may be wrong!



In this way, an audit of water use will always present challenges and problems to be solved. Here are some ideas to help the learners plan an audit of the school, home and community water use.

SCHOOL: Start with each person in the class doing an audit of the water they use in a day. This can then be combined into an audit of the water used by the whole class. During National Water Week, try an audit of water use in the school and check the accuracy of your records using the water meter if there is one.

HOME: Get the learners to plan an audit with their family, using simple record sheets at each site of water use. Totals for the day should be matched with the meter reading or monthly water bill.

COMMUNITY: Patterns of use at home and at school can give the learners an idea of domestic water use in the community. Offices, industries and agriculture often use vast amounts of water when compared with domestic consumption. There are also many people in our communities who do not use piped water.

Remember that we need clean water for our health. Water conservation is not about people drinking or using less water but a challenge of working out ways to reduce unnecessary waste so there is more clean water to go around.

Let the learners adapt this table or develop their own to calculate school, home and community water use. Results should be compared with metered use. This is a good check of how accurate the audit has been:

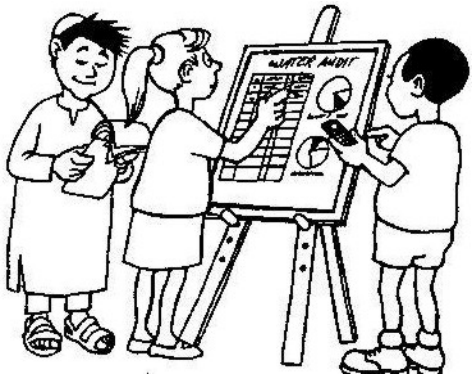
	Name of person	Washing hands	Drinking	Kitchen use	Washing machine	Toilet	Urinals	Hand basin	Shower	Garden hose	Washing carpets	Leaks detected	Other	Total Meter Reading *kl*		*l*
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
Total:																

Once the audits have been conducted – at school and home, discuss the results with the class.

Water audit actions can help us to reduce water wastage and thus save money. Many schools are now developing water wise management plans to make changes in their water consumption.

Has your school got a water wise management plan?

- If not, get the class to develop a plan for the entire school? Divide the class into small working groups and let them come up with five to ten ways of reducing water consumption in the school. As a class, go through the list and write down the most useful ones. Pass this plan to the head and management team of the school.



Criteria to assess learners during this natural sciences lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner adapted the water audit record sheet, where necessary, and added in more headings				
The learner was able to carry out a water audit around the school				
The learner contributed ideas in his/her group and during class to developing a school water wise management plan				

ACTIVITY FOUR: 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 LANGUAGES lesson encourages learners to investigate an environmental situation and debate, discuss and communicate their ideas.

Read the following story to your class:

The Strong River system rises in the majestic 7 000m peaks of the Molombi mountain range. After cascading down the mountain slopes it winds down into the Strong River valley where the river channel widens to form a large wetland area. From here, the river continues to flow into the river estuary and the ocean.

There are five groups of people involved in the 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.

- The Wildlife and Environment Society of South Africa (WESSA) who are dedicated to maintaining the social and ecological biodiversity of the wetland system. They want to install research facilities in the area to obtain a better understanding of the dynamics of the wetland system.

- 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. 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.

ACTIVITY:

- Divide the learners into groups to represent each of the five groups involved in the area.

- Each group will need:
    - a map (Worksheet 1),
    - a set of the enviro fact sheets (Enviro Fact 1 to 9)
    - a marker (you can use stones, leaves, bark, a small piece of rubber etc).

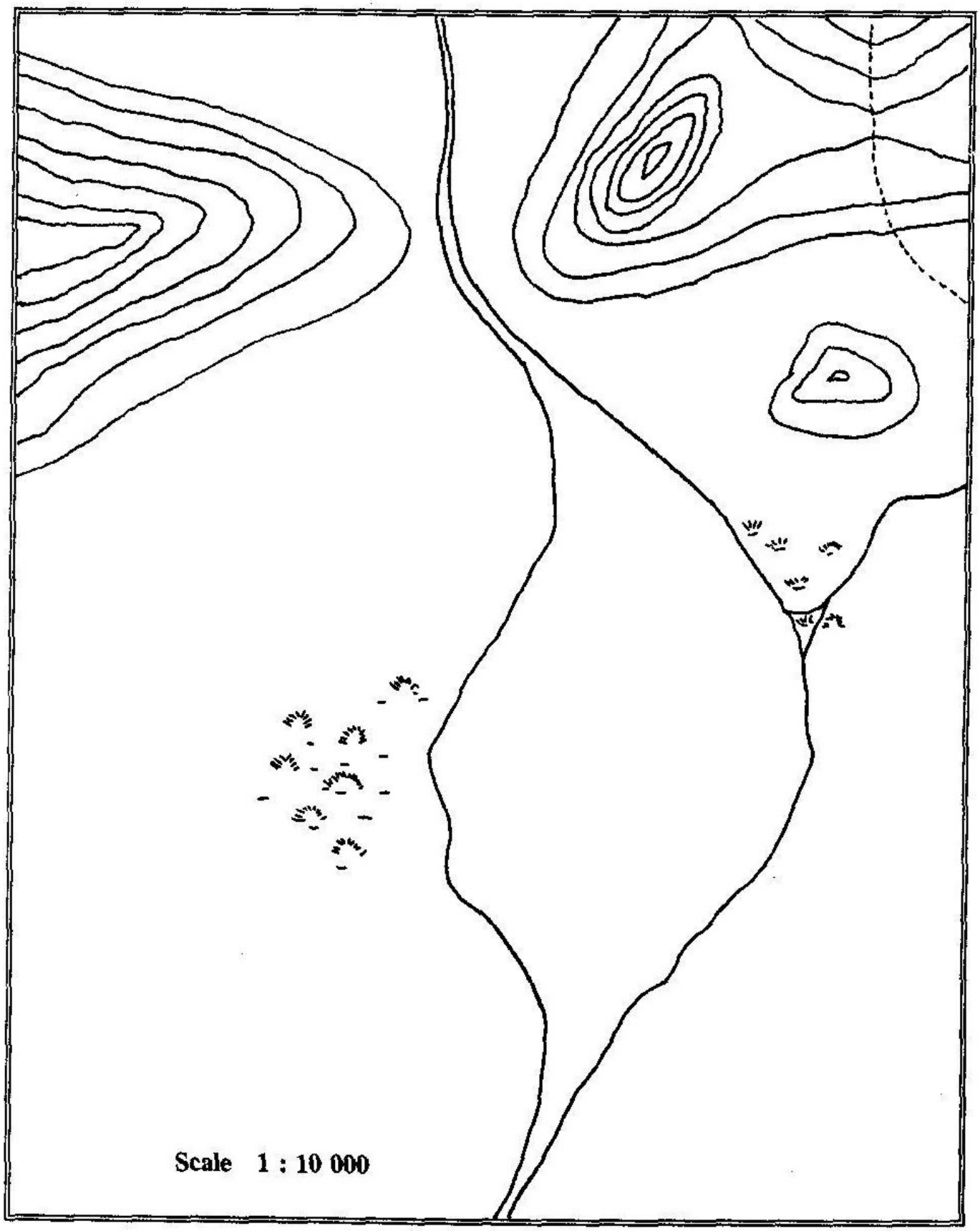
Each group spends time planning where they would like to complete their development – this is then marked on their worksheet. They must consider the advantages and disadvantages of their choices. *(The groups need to consider all the other groups – they are more likely to make a better decision if they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

1. 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.

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

3. 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.

Worksheet 1



Enviro Fact 1: Sustainable Development

Historically, development and conservation have been in conflict, because conservation has been understood as the protection of resources. Recognising the need for both, the United Nations appointed, in 1987, a commission on environment and development to advise on development and conservation. In the commission's report called "The Bruntland Report" or "Our Common Future", the concept of sustainable development was emphasised. The report's definition of sustainable development as "… development which meets the needs of the present without compromising the ability of future generations to meet their own needs", is one of many definitions of sustainable development, and is the most commonly used. There are many definitions, principles and criteria for sustainable development, however, the concept is seldom explained or deeply understood, and is thus difficult to put into practice.

Historical perspective. During the Industrial Revolution, development was associated with economic growth through industries such as mining, manufacturing and large-scale farming. Industrialisation began in Britain and spread to mainland Europe, North America and Japan, all of which became known as the First World. Characteristics of First World countries are high economic growth, many and varied job opportunities, and high incomes. The Soviet Union and its satellite states, governed under the economic system of communism, became known as the Second World. Third World countries, such as those in Africa, South America and parts of Asia, have slow, if any, economic growth, with a high level of unemployment and very low incomes, but often substantial natural resources. In fact, the wealth of many First World countries is founded in part on the exploitation of resources (natural and human) from Third World countries.

Environmental problems. The environmental problems of the First World are associated with economic wealth, high resource consumption and industrialization. These have contributed to, for example, ozone depletion and global warming. Environmental problems of the Third World, however, can be associated with poverty, high population growth rates, lack of food, shelter and water, and a lack of technical capacity.

Development as a solution? The solution to the devastating poverty, environmental problems of Third World countries is often seen as 'development'. For example, the development of Third World countries towards the First World ideas of economic growth through Industrialisation and high consumption patterns. However, many people have begun to seriously question the wisdom of this approach. Thabo Mbeki, South Africa' present president, believes Africa must use African resources, especially human, in order to achieve a strong, well-developed and competitive continent - he has called this process the 'African Renaissance'.

Limited resources. It is argued that the Earth's finite resources would not be able to support the entire world' s people if everyone had the high consumption patterns of those living in First World countries. Mahatma Gandhi, when asked if, after independence, India would attain British standards of living, commented that "… it took Britain half the resources of the planet to achieve its prosperity, how many planets will a country like India require?"

A different type of development? Development is conventionally seen as economic growth, dependant upon 'throughput growth', i.e. growth which depends on ever increasing consumption of energy and natural resources. This type of development is unsustainable. One alternative being suggested is qualitative development, with minimum inputs and outputs, maximum reuse, recycling and repair, and little or no growth in throughput. Organisations would thus try to deliver the same high standards of service, but use fewer material resources such as fossil fuels, minerals and water. Development programmes in Third World countries probably need both quantitative growth (to address poverty), and qualitative development. The First World also needs to minimise its throughput growth, and replace it with qualitative growth. For example, an industry-oriented economy (high throughput) might be characterized by coal mining and steel manufacture, whereas a service-oriented economy might focus on information technology including the use of fibre optics and electronics (low throughput).

Who benefits? Third World development programmes that focus on economic growth as a solution to widespread poverty, assume a 'trickle down' effect, i.e. the benefits of economic growth will trickle down to all members of society. However, economic growth does not always benefit the poor in a country. Many development programmes now give special attention to human needs, improved participation in programmes, and the distribution of development benefits, rather than focusing all efforts on economic development. A more people-oriented development should empower people to take greater control over all aspects of their lives: social, political, economic and ecological.

Indicators of economic performance. If we are to move towards sustainable development, we will need tools with which to measure our performance. At present the performance of an economy is measured in term of its gross domestic product (GDP). The GDP is the total value of all the money transactions that take place, and is a poor measure of the effect of economic policies and practices on people and the environment. The GDP does not differentiate between different kinds of economic activity. For example, if a new prison is built, this amount is added to the GDP - the more prisons built the better the GDP!

However, there are no simple answers to how sustainable development can be assessed. Many attempts endeavour to value, or put a price to, the depletion and degradation of natural resources as a way of ensuring that this is taken into account when assessing economic performance. Other approaches argue that valuing the environment is often impossible or undesirable, and maintain that environmental quality should be measured in purely physical terms, which should then be published alongside the GDP as an environmental account. As situations and conditions change, so will our understanding of sustainable development change. Sustainable development is not a model to be imposed, but can be seen as a process of learning how to live on the Earth. Ultimately the focus of sustainable living and sustainable development is to find a balance between the social, economic and ecological aspects of our existence.

Agenda 21
Agenda 21 is a global action plan for socially, economically and environmentally sustainable development. It was adopted at the United Nations Conference on the Environment and Development held in Rio de Janeiro in June 1992 (Earth Summit). The conference proposed that Agenda 21 be implemented at the local authority level, and this came to be known as Local Agenda 21. The principles guiding Local Agenda 21 in South Africa are: people-centred development, meeting basic needs, integrated planning and development. Several South African cities and provinces have developed Local Agenda 21 programmes.

Enviro Fact 2: Pollution

Pollution is an unwelcome concentration of substances that are beyond the environment's capacity to handle. These substances are detrimental to people and other living things. In an undisturbed ecosystem, all substances are processed through an intricate network of biogeochemical cycles, such as the nitrogen and carbon cycles. During these cycles, substances are taken up by plants, move through the food chain to larger and more complex organisms, and when the latter die, are decomposed (broken down) into simpler forms to be used again when they are taken up by plants. Biodegradable substances are those that can be broken down by the environment's biological systems. Pollution occurs when the environment becomes overloaded beyond the capacity of these normal processing systems.

Examples include:

- An excess of normally helpful substances, such as the nutrients, nitrogen and phosphorus.
- An excess of substances that are harmless, and perhaps even necessary in tiny amounts, but toxic in concentration. Copper, for example, is necessary in small amounts for healthy plant growth, but becomes a pollutant if it occurs in greater quantities.
- Synthetic (human-made) compounds that are poisonous in the environment, often even in trace amounts, such as DDT, dioxin, PCBs and organochlorines.
- Substances that, in any amount, are not biodegradable, such as plastics and highly persistent chemicals like DDT and other organochlorines.
- Some pollutants kill living organisms outright, other sub-lethal pollutants do not kill, but may cause long-term biological damage, interfere with organisms' reproductive cycle, or make them more vulnerable to disease.

Types of pollution. Pollutants can be grouped according to the main ecosystem which they affect. One pollutant often affects more than one ecosystem.

POLLUTANTS AND MAIN SOURCE	HEALTH AND ENVIRONMENTAL EFFECTS
AIR	
Sulphur dioxide - burning of coal	Acid rain and respiratory problems
Nitrogen oxides - vehicle emissions Volatile hydrocarbons - vehicle emissions	Combine to form photochemical smog; causes respiratory problems
Carbon monoxide – vehicle emissions	Restricts oxygen uptake, causes drowsiness, headaches, death
Carbon dioxide - burning of coal	Global warming
CFCs - aerosol, refrigeration, air-conditioning and foam-blowing industries	Destroy ozone layer
Methane - feedlots, rubbish dumps	Global warming
Noise - industry, traffic	Affects hearing, stressful
Asbestos dust - construction, mining, industry	Asbestosis, mesothelioma
FRESH WATER	
Sewage - inadequate sanitation	Pathogens cause typhoid, cholera, gastroenteritis; nutrients cause eutrophication
Fertilizers – agriculture	Eutrophication
Silt - agriculture, construction, mining	Smothers aquatic organisms; affects light penetration
Pesticides - agriculture, and health services	Toxic; interfere with breeding of mammals and birds
Toxic metals – industry	Health and life threatening
Salinisation - industry, agriculture, landfill	Reduced crop yields; scale and corrosion in domestic and industrial water systems
MARINE	
Sewage - inadequate sanitation	Pathogens cause typhoid, cholera, gastroenteritis; nutrients cause eutrophication
Fertilizers – agriculture	Eutrophication
Oil spills	Smother marine plants and animals
Plastics	Death of marine animals
Pesticides - agriculture, and health services	Toxic; interfere with breeding of mammals and birds
LAND	
Solid waste is classified as hazardous (radioactive, pesticides, medical, poisons), or non-hazardous (domestic, urban, mining, industrial, scrap metal)	Hazardous waste is health- and life-threatening; non-hazardous is unsightly and disposal takes up much space

Dealing with pollution
In the past, most approaches to handling pollution could be summed up by the phrase `dilution is the solution to pollution'. However, pollution levels have increased so much in amount and toxicity that this approach is no longer acceptable. An alternative approach is source reduction, i.e. a reduction in the amount of pollution where produced.

- Point source pollution: pollutants are produced from a stationary location, e.g. industrial plants, mines, and municipal sewage works.
- Non-point source pollution: this pollution cannot be traced to a specific spot, and is far more difficult to monitor and control. Common examples are veldt fires, motor vehicle emissions, fertilizer runoff, sediment from construction and erosion, plastic packaging, and gases from aerosol cans. Some non-point sources can be addressed by laws, such as banning CFCs (chlorofluorocarbons), or requiring car manufactures to install emission controls.

Polluter-must-pay principle
This means that a polluter should bear the costs of avoiding pollution, or remedying its effects. This principle is difficult to apply when the source of pollution cannot be identified, as is often the case with atmospheric pollution. The principle can be usefully applied following a pollution disaster, such as an oil spill from a tanker. However, the consumer often pays for such pollution costs. For example, Eskom estimates that the fitting of scrubbers on the chimneys of their power stations will increase the cost of electricity by 30%.

Movement of pollution
Pollution does not stay in one place but is moved around the world by air and water, as well as by living organisms. Even in Antarctica, birds and marine mammals show traces of pollutants such as DDT and PCBs. Some pollution is deliberately moved abroad. Companies restricted by pollution control regulations at home, sometimes move their plants to other less restrictive countries, as was the case with the plant involved in the Bhopal chemical disaster. Or while remaining at home, they may sell products abroad that are classed in their own countries as too dangerous for sale, such as banned pesticides. In some cases hazardous waste may also be shipped abroad, generally from industrialised countries to developing countries willing to accept such waste for a fee, despite the hazards. When such pollutants turn up again in the originating country, as when food is imported that contains banned pesticides, the process is said to be completing the `circle of poison'.

What can you do

- *Avoid the creation of waste.*
- *Find out all you can about pollution and protest loudly when you see it happening.*
- *Report air pollution to the Chief Air Pollution Control Officer (CAPCO), Department of Health.*
- *Report freshwater and land pollution to the Department of Water Affairs and Forestry.*
- *Report marine pollution to the Department of Environment Affairs and Tourism, Marine Pollution Division.*

Enviro Fact 3: Energy and Environment

Some of South Africa's most serious environmental problems are associated with our use of energy. Coal-fired and nuclear power stations for electricity generation, coal combustion in the townships, SASOL coal-to-oil processes, petrol and diesel use in vehicles for bulk transport, and over exploitation of fuelwood resources, all result in serious, long-term environmental damage.

Pollution from burning coal
More than three-quarters of South Africa's energy comes from coal, approximately half of which is used to generate electricity, a quarter to produce synthetic liquid fuels and another quarter directly by industry and in homes. Air pollution problems from coal combustion are serious. Medical studies are revealing increased rates of respiratory disease in residents in polluted areas.

Acid rain
Most of South Africa's power stations are concentrated within a 100 km radius in Mpumalanga and this leads to pollution problems. While all of Eskom's coal-fired power stations are designed to remove dust and other particles from waste gases produced during coal combustion, none are fitted with flue-gas scrubbers (cleaning equipment) to remove oxides of sulphur and nitrogen. Tall chimney stacks in power stations assist in releasing oxides of sulphur and nitrogen into the upper atmosphere where atmospheric conditions are more favourable for their dispersal and dilution. Although this reduces ground level concentrations of these pollutants, they may combine with moist air and rain at higher levels and cause acid rain in areas far from the source of pollution.

Whilst South Africa's coal has a relatively low sulphur content there is considerable concern about the potential environmental and economic impact of acid rain. Half of South Africa's agriculturally productive land, half of its commercial forests and a quarter of its surface water run-off are in Mpumalanga.

Pollution from vehicles
Motor vehicle fumes make air pollution problems worse and are the main cause of photochemical smog in cities. Unleaded fuel has recently been introduced to South Africa and this may reduce the amount of lead in exhaust fumes. Catalytic converters fitted to exhausts would result in a significant reduction in the release of carbon dioxide, hydrocarbons, and nitrogen oxides. However, South Africa lags far behind other countries (e.g. Japan, Germany) in legislation to control vehicle emissions. Solutions to transport pollution and vehicle congestion require long-term planning to introduce efficient public transport systems in our cities.

Deforestation
Another environmental concern associated with energy use is the reliance by a significant number of South Africans on fuelwood, once a renewable resource, but now being used at a rate much greater than that at which it is naturally regenerated. Fuelwood is an inefficient source of energy for cooking and heating and its use can cause increased respiratory illnesses. It has been estimated that if current consumption trends continue, all natural woodland in the former "homelands" will be denuded by 2020. In addition to the environmental consequences of deforestation, diminishing supplies of wood require rural people (particularly women) to travel further and further from home to gather wood, placing a great burden on them.

Global warming
South Africa uses a great deal of energy, very much more per unit of gross domestic product (GDP) than most other countries. The combustion of coal, oil and wood results in increased carbon dioxide production. This gas acts likes a greenhouse - it lets short-wave, natural light through but traps out going long-wave (infra-red or heat) radiation. The potentially devastating consequence is that the earth is slowly getting warmer, causing the climate to change and sea levels to rise. Although South Africa produces only a small percentage (1,6%) of the total, global carbon dioxide emissions, it plays a disproportionately large role per person in contributing towards the greenhouse effect and global warming. As a country needing rapid economic growth in the medium-term to satisfy the country's developmental needs, South Africa's potential contribution to global warming is an area of concern.

Nuclear energy
South Africa currently has one commercial nuclear power station at Koeberg near Cape Town. It provides 1 800 MW of Eskom's installed electricity generation capacity of 37600 MW, less than 5% of the total. There is intensive debate among energy planners as to whether nuclear energy should play a role in South Africa. In addition to being a costly option, nuclear fission produces dangerous radioactive by-products. There is considerable concern about their safe containment in the case of accidents at nuclear power stations, the closing down (decommissioning) of old power stations, and the storage of highly toxic wastes. At present, low-level radioactive wastes are stored in sealed containers which are buried underground at disposal sites. No long-term solution has been agreed on for the safe storage of high-level radioactive wastes, some of which remain harmful for thousands of years. At present there is no national policy to deal with radioactive waste.

Enviro Fact 4: Energy Options

Coal supplies most of South Africa's electrical energy. It is a finite, non-renewable resource. Burning coal to produce electricity causes serious environmental problems. Pollution from power stations contributes to global warming and acid rain. In addition to the environmental challenges associated with energy supply, South Africa faces significant social challenges. Although we produce half of the electricity on the African continent, 40% of South Africans do not have access to electricity and rely instead on fuelwood and other inconvenient fuels such as coal, paraffin, gas, or candles. It is important that South Africa addresses both the environmental problems associated with energy supply, and the inequalities in access to adequate and affordable energy.

How can we provide adequate and affordable energy for all, while promoting environmental sustainability?
Many of South Africa's medium- and long-term energy needs could be addressed through regional cooperation. This could include the establishment of a regional electricity transmission grid and a SADC power pool, and regional energy planning. Such coordination would create opportunities for SADC countries to provide their people with clean and sustainable energy into the next century. Regional cooperation does however require political and economic stability. There are also several technologies that could improve the sustainability of the regional electricity industry.

In addition to reducing pollution from coal-fired power stations, hydroelectric and solar power, natural gas, wind, tide and wave power may all help the region address its energy needs with minimum impact on the environment.

Reducing pollution from coal-fired power stations. This pollution can be reduced by using equipment which removes oxides of sulphur and nitrogen from the gases released when coal is burnt. This could result in electricity being more expensive, but this should be weighed against the benefits to the environment.

Hydro-power. Coal stocks are finite and sooner or later we shall have to rely on another source of energy. A possible medium-term alternative is to harness the huge hydro-electric potential of the sub-Saharan Africa region, estimated to be more than twice Eskom's current generating capacity. For example, the Zaire River alone is capable of providing in excess of 70 000 MW (megawatts) of hydroelectricity. There are many other rivers in Zambia, Zimbabwe, Angola and Mozambique suitable for hydroelectricity.

Hydroelectricity is renewable and does not pollute. However, it is expensive, and requires the construction of large dams which have significant social and environmental costs. In addition, this option requires regional co-operation and political stability.

Solar energy. Solar energy can be used to produce heat. In Israel more than two-thirds of houses are fitted with solar water heaters. South Africa experiences more sunshine than most places and there is much potential for widespread use of solar water heaters, particularly in mass, low-income housing projects. However, the initial outlay for solar panels is expensive as large areas of panels are needed to collect useful amounts of energy. Solar energy could be particularly useful in remote areas far from the electricity grid, such as farms, rural clinics, and water pumping stations.

Nuclear energy. There is much debate among energy planners in South Africa as to whether nuclear energy should play a role in this country's future. Using current technology it is a costly option, with unresolved environmental problems such as the disposal and storage of waste products.

Natural gas. Although natural gas is a non-renewable energy resource, it has great potential as a future energy source for South Africa. South Africa has a limited amount of natural gas reserves, but strong regional ties would allow us to import gas from Namibia and Mozambique. Natural gas produces less pollution that other fossil fuels. In fact, latest natural-gas-burning turbines can produce electricity 50% more efficiently than those burning coal. Natural gas can also be burned cleanly in co-generation (see below). Because of its advantages over coal and oil, some analysts see natural gas as the best fuel for the transition to energy efficiency and renewable energy.

Wind power. As global energy resources become more and more scarce, wind power is becoming increasingly attractive. Wind energy is freely available and poses less of a threat to the environment than fossil and nuclear energy sources. Wind energy can provide electricity for communities not linked to the electricity grid. Telecommunications companies currently use small wind turbines to support cellular networks in the region. In addition, wind energy can be exploited on a large grid-tied scale through the development of wind farms. However, wind is not a reliable source of energy, and its use is limited to areas with steady winds. These areas are often found near coastal regions and in some arid and semi-arid areas.

Energy efficiency. South Africa uses more energy per unit of economic output (GDP or gross domestic product) than many other countries. There is much potential for energy saving. European countries and Japan have shown in recent years that industrial production can be increased while using less energy through energy-efficient manufacturing processes. Passive solar design principles and more efficient lighting and insulation contribute to energy savings in buildings. Industry is able to save energy through cogeneration, advanced heat recovery systems and better control of energy usage. (Cogeneration is a process which produces both electricity and heat at the same time, while advanced heat recovery systems economize on, and use the heat generated in industrial and chemical processes). Recycling waste materials can also save energy, for example aluminium produced from scrap uses 95% less energy than when it is manufactured from ore. New motor vehicles are also becoming more fuel efficient.

Planning in towns and cities should encourage the use of efficient public transport systems rather than private motor vehicles. In the long term we shall also have to find alternative fuels for transport. Hydrogen offers a clean alternative and as one of the elements in water it is plentiful. But it still requires energy to separate hydrogen from oxygen in water. Nuclear fusion (the combination of hydrogen atoms to form helium, i.e. the reaction which powers the sun) may also be a future option, but scientists do not foresee major progress in this area for many years to come.

Enviro Fact 5: Soil Erosion

Soil erosion is a natural process. It becomes a problem when human activity causes it to occur much faster than under natural conditions, and it impacts on the lives of people and their environment.

Wind and water are the main agents of soil erosion. The amount of soil they can carry away is influenced by a number of related factors: rainfall intensity, speed of flowing water and blowing wind, slope steepness, soil erodibility and soil cover.

The importance of plants
Plants provide protective cover on the land and prevent soil erosion for the following reasons:

- Plants break the impact of raindrops before they hit the soil, improving rainfall infiltration into the soil, reducing the amount and rate of runoff and therefore its ability to erode.
- Plants slow down water as it flows over the land (runoff) and this allows much of the rain to soak into the ground.
- Plant roots hold the soil in position and prevent it from being washed or blown away.
- Plants in wetlands and on the banks of rivers are of particular importance as they slow down the flow of the water and their roots bind the soil, thus reducing erosion.

The loss of protective vegetation through deforestation, over-grazing, under-grazing, ploughing, and fire, makes soil vulnerable to being swept away by wind and water. In addition, over-cultivation and compaction cause the soil to lose its structure and cohesion and it becomes more easily eroded.

Erosion will remove the top-soil first. Once this nutrient-rich layer of soil is gone, few plants will grow in the soil again. Without soil and plants the land becomes desert-like and unable to support life - this process is called desertification. It is very difficult, very expensive, and often impossible to restore desertified land.

Politics, economics and soil erosion
To understand soil erosion we must be aware of the political and economic factors affecting land users.

In South Africa apartheid policies ensured that 42% of the people lived on 13% of the land (the 'homelands'). This overcrowding has resulted in severe erosion. As the land became increasingly degraded and thus less productive, subsistence farmers were forced to further overuse the land. The intensive agriculture and overgrazing that followed caused greater degradation. A reduced ability to produce, invest one's profit and increase productivity, contributes to increasing poverty, and can lead to desertification, drought, floods, and famine.

On commercial farmlands, overstocking, over-resting (plants become moribund and unproductive), injudicious burning, mono-cropping, and the ploughing of marginal lands unsuitable for cultivation, have led to soil erosion and desertification. Frequently these practices have been unwittingly encouraged by the state offering subsidies which made it profitable to exploit the land in the short-term. Economic pressure (caused, for example, by falling commodity prices and rising input costs) can also drive some farmers to over-exploit their land.

Preventing soil erosion
Preventing soil erosion requires political, economic and technical changes. Political and economic changes need to address the distribution of land in South Africa as well as incentives to encourage farmers to manage their land in a sustainable manner. Technical changes include:

- the practice of conservation tillage on cultivated land;
- the use of contour tillage, the construction of contour banks for runoff control, and the use of wind breaks;
- avoiding excessive cultivation that will deplete soil organic matter;
- ensuring that there are always plants growing on the soil, and that the soil is rich in humus (decaying plant and animal remains) - this is the glue that binds soil particles together and is significant in preventing erosion;
- the use of cover crops and crop rotations;
- withdrawal of low potential land from annual cultivation by establishing a suitable perennial crop;
- allowing indigenous plants to grow along the river banks instead of ploughing and planting crops right up to the water's edge;
- encouraging biological diversity by planting several different types of plants together;
- conservation of wetlands.

Did you know?

- An estimated 25 tonnes/ha of soil are lost from annually cultivated fields in KwaZulu-Natal. Where this has been carrying on for 50 years, the production potential of the land has been reduced by 20%.
- 27 000 ha of rangeland in the Weenen thornveld of KZN have been destroyed through overgrazing, while the grazing capacity of a further 34 000 ha has been halved.
- Major storage dams are under constant threat from sediment entering their basins through floodwaters. An example is that of Hazelmere Dam on the KZN north coast where 20% of its capacity has been replaced with sediment over a period of 12 years. The Welbedacht Dam on the Caledon River lost 32% of its capacity within 3 years of its construction.
- 45 of KwaZulu-Natal's 73 estuaries have been degraded through sediment from inland areas.

Enviro Fact 6: Water

South Africa is extraordinarily rich in natural resources - except for water. Water is a vital but scarce resource, distributed unevenly in time (frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is markedly wetter than the western half). Increasing demand for water, and decreasing water quality, make careful water management a priority in our country. It has been estimated that by the year 2025 South Africa's human population will have doubled, and that there will be insufficient water for domestic use, agriculture, and industry.

Rainfall
Our average rainfall is less than 500 mm a year, with the driest part of the country receiving less than 200 mm/year and the wettest receiving more than 2 500 mm/year! Rain does not always fall where it is most needed, and some areas of high demand, such as Gauteng, receive less water than they need. Most rain falls in the narrow belt along the eastern and southern coasts. The rest of the country receives only 27% of South Africa's total rainfall. In addition, hot, dry conditions result in a high evaporation rate.

Water is thus a very scarce resource in South Africa. Large-scale engineering has been used to store water behind dam walls, and to distribute water from regions of plenty to regions of need.

Rivers
There are few natural lakes in South Africa. We depend on rivers, dams and underground water for our water supply. Approximately 75% of the water flowing from South Africa into the sea occurs along the eastern and southern seaboards, where many short rivers occur. Flowing from east to west is the largest river in the country, the Orange River, which drains most of the rest of the country. Its water comes from sources in the Drakensberg and Maluti Mountains, and it flows into the Atlantic Ocean on the west coast.

Dams
About half of South Africa's annual rainfall is stored in dams. We have about 550 government dams in South Africa, with a total capacity of more than 37 000 million m^3.

Dams have both positive and negative impacts. They can be beneficial for people in that they regulate the flow of a river, reducing flood damage and contributing to perennial rather than seasonal flow. In addition, sediment is deposited in a dam, and the growth of aquatic plants means that nutrients are removed from the water. Thus water leaving a dam may be cleaner than water entering it. The riverine ecosystem is usually affected negatively by a dam. Alterations in flow regime (quantity of water and timing of periods of high and low flow), temperature and water quality may cause reductions in biodiversity of riverine organisms below dams. Reduction in water flow reduces the river's scouring ability and this can lead to silting of estuaries.

South Africa's landscape is not well suited to dams. There are few deep valleys and gorges, with the result that most dams are shallow with a large surface area. Together with the hot, dry, climate, this results in much water evaporating from dams. In addition, the high silt load (a result of an arid climate, steep river gradients and poor farming methods) of our rivers means that the capacity of South Africa's dams is quickly reduced as they become silted. The rivers of the western Cape carry relatively less silt than those in the rest of the country.

Water abstraction
A growing problem for South Africa's rivers is a lack of water! Reduction in river flow, owing to abstraction (removal), and damming, has affected many of our rivers, for example those flowing through the Kruger National Park.

Intercatchment transfer of water
This involves the transfer of water from catchments with good supplies and low demand, to those where demand for water is high and the supply is poor. There are numerous intercatchment transfer schemes already in operation, and more are under construction or proposed. A major scheme is the Orange-Fish River scheme, where water gravitates from the Orange River at the Gariep Dam, and is piped through tunnels and canals to the Sundays and then the Fish Rivers in the Eastern Cape.

Transfers of this nature will have far-reaching ecological, political and socio-economic implications. As yet, little research has been carried out to establish the ecological consequences of intercatchment water transfers. However, areas of concern include reducing streamflow and water levels in one system, changes in water temperature and chemistry, and the transfer of invasive species between catchments.

Water pollution
Industrial and agricultural pollutants common in South Africa include: agricultural fertilizers, silt, toxic metals, litter, hot water and pesticides. These pollutants affect aquatic ecosystems and human health. Disease-producing bacteria are common in urban waste water, particularly from informal settlements that lack sewage and water purification facilities. For example, typhoid, cholera and gastroenteritis are transmitted by water contaminated with untreated sewage. Gastroenteritis is one of three main causes of death in South African children under the age of five.

Did you know?
- South Africa has a National Water Bill that attempts to ensure an equitable and sustainable water supply.
- Some 12 - 14 million South Africans do not have access to safe drinking water and some 21 million have inadequate sanitation. As a result, about 50 000 children die each year from diarrhoeal infections.

Enviro Fact 7: Wetlands

Wetlands are difficult to define because of their great variation in size and location. The most important features of wetlands are: Waterlogged soils or soils covered with a shallow layer of water (permanently or seasonally), unique types of soil, and distinctive plants adapted to water-saturated soils. Marshes, bogs, swamps, vleis and sponges are examples of wetlands.

Why are wetlands important?
Wetlands associated with streams and rivers slow floodwaters by acting as giant, shallow bowls. Water flowing into these bowls loses speed and spreads out. Wetland plants, particularly reeds and sedges, play an important role in holding back the water. The wetland acts as a sponge as much of the flood water is then stored in the wetland and is slowly released to downstream areas, instead of it all rushing to the sea within a few days. This greatly reduces flood damage, particularly erosion, and ensures a more steady supply of water throughout the year.

Filters: Wetlands improve water quality as they are very good natural filters, trapping sediments, nutrients (e.g. nitrogen and phosphorus), and even pathogenic (disease-causing) bacteria. In addition, pollutants such as heavy metals (e.g. mercury, lead) and pesticides, may be trapped by chemical and biological processes. In other words, the water leaving the wetland is cleaner than the water entering it.

Wetlands and wildlife: Wetlands are filters where sediments and nutrients accumulate, so many plants, such as bulrushes, grasses, reeds, waterlilies, sedges and certain trees grow there. The plants, in turn, provide food and a place for attachment and shelter for many creatures. There is more life, hectare for hectare, in a healthy wetland than in almost any other type of habitat. These productive places support huge numbers of insects, fish, birds and other animals. Some animals are completely dependent on wetlands, whilst others use wetlands only for part of their lives. The wattled crane, for example, is dependant on wetlands for breeding. The rich diversity of waterbirds in southern Africa (totalling 130 species) is possible because of the many wetlands spread across the sub-continent. The wetlands of southern Africa are of international importance as they are the southern destination for many migratory water birds.

People and wetlands: Wetlands have been used for centuries as grazing for domestic stock, and as a source of reeds used for thatching, hut construction and basket weaving. They provide fishing and hunting, and the opportunity to observe wildlife, especially birds. Wetlands are appreciated for their beauty as open spaces and also for their educational value.

Wetlands in trouble: To many people the thought of a marsh, swamp, bog or vlei is associated with dampness, disease, difficulty and danger. Because of this wetlands are often seen as wastelands that should be converted to cropland, dams, commercial timber plantations of alien trees, waste disposal sites and pastures. Many wetlands have been "reclaimed" for industry and the construction of airports, harbours and sewage treatment plants. Historically wetlands have been drained in attempts to control malaria.

All wetlands in southern Africa are threatened. Botswana's magnificent Okavango Delta is threatened by the possible canalisation of the Boro River to supply South Africa with water for both domestic and industrial use. Throughout the region, smaller seasonal wetlands in urban areas have virtually disappeared, while riverine wetlands are constantly under threat of being turned into agricultural land.

What you can do?

- *Get to know the wetlands in your area and list the plants and animals living there. Draw a map of the wetland's position, size and use. Take photographs of the wetlands from fixed vantage points, and at different seasons of the year, to compare the changes between seasons and from year to year.*
- *Report the abuse of wetlands to your local nature conservation officer, agricultural extension officer or Department of Environmental Affairs and Tourism. Always make your report in writing to ensure that the officer concerned has to investigate.*

Enviro Fact 8: Protected Areas

South Africa has a remarkable diversity of animals, plants, vegetation communities, landscapes, geological features, and numerous sites of archaeological, historical and cultural significance. Arguably one of the most effective ways to preserve and conserve this diversity is through the establishment of protected areas

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Classification of protected areas. At present there are over 700 state owned protected areas, including more than 100 marine protected areas, covering about 75 000 km^2 (6.1% of S.A.). In addition there are over 200 privately owned protected areas, covering about 9 000 km^2 (0.8% of S.A.), thus bringing the total to about 7%. This proportion is small by international standards, being below the ideal of not less than 10% set by the Convention on Biodiversity

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An enormous variety of protected areas occur in South Africa ranging from large national parks to comparatively tiny, little known reserves. A range of authorities is involved in the management of these protected areas, including state departments, parastatal organisations, local authorities, non-governmental organisations, communities and private individuals. The situation is further complicated by legislation, as more than ten Acts of Parliament, numerous Provincial ordinances, and various local by-laws govern the administration of protected areas, and it is commonplace for two or more pieces of legislation to be relevant for one protected area.

To simplify the situation a classification system has been adopted for protected areas in South Africa. It follows the international guidelines devised by the IUCN (International Union for the Conservation of Nature). Six broad categories of protected areas are recognised and these are defined by the primary management aims of the protected area under consideration.

- Scientific reserves and wilderness areas are the most pristine of all protected areas where human intervention is non-existent or minimal. Scientific reserves are for the purpose of preserving areas of outstanding scientific importance for research. The only scientific reserve belonging to South Africa is the Prince Edward Island group (Marion Island and Prince Edward Island). Wilderness areas, e.g. Cedarberg Wilderness Area in the Western Cape, and Ntendeka Wilderness Area in KwaZulu-Natal, are large undeveloped and uninhabited areas where access is strictly controlled and only non-mechanised tourism is permitted.
- National parks and equivalent reserves are relatively large outstanding natural areas of land or sea, or both, which are not materially altered by human occupation or exploitation. They are managed mainly for ecosystem conservation and recreation. National Parks, e.g. Tsitsikamma National Park, are scattered throughout South Africa and are managed by the South African National Parks. Equivalent reserves refers to the large provincial reserves, e.g. De Hoop Nature Reserve, that have many similarities to national parks, the major difference being that they are managed by the relevant provincial authorities according to different legislation. A process is underway to ensure that all protected areas which qualify should be designated as national parks, and that an appropriate management authority operating within national policy and guidelines is appointed.
- National monuments and areas of cultural significance are areas containing at least one unique or outstanding natural feature recognised for its rarity, beauty or cultural significance. Natural monuments are established for the primary purposes of protecting and conserving the feature/s at the site, and making them available for education and tourism. Examples include botanical gardens, e.g. Kirstenbosch, and Paarl Mountain.
- Habitat and wildlife management areas are areas of land or sea where the protection and conservation of habitat is essential for the survival of important fauna and flora. Conservation of the habitats or species in these areas may require active intervention and even habitat manipulation. Most of the provincial reserves, e.g. Willem Pretorius Game Reserve, and many local reserves, belong in this category. Private nature reserves, e.g. Timbavati Game Reserve, proclaimed in terms of provincial ordinances, are distinct from conservancies, e.g. Bitterputs Conservancy, where landowners agree to combine resources to improve the conservation of a larger area, but which lack legal conservation status
- Protected landscapes or seascapes are scenic areas where traditional customs, lifestyles, and practices such as traditional fishing methods, exist in harmony with nature. They are managed to ensure that the integrity of the site is maintained, whilst allowing tourism, e.g. Kosi Bay
- Sustainable use areas are areas of land or sea, or both, which are predominantly natural and where harvesting of natural resources is permitted. These areas are established for the primary purpose of maintaining biological diversity whilst benefiting local communities by allowing them to harvest natural resources in a sustainable way.

Citizens' role. Protected areas are not only the responsibility of the state, and many have been established and managed by communities and private landowners. These can be designated formally in terms of the relevant legislation to provide greater protection. A developing trend is for partnerships to be forged among the state, communities and private sector interests to develop and manage protected areas and ensure that communities, especially in disadvantaged rural areas, benefit from the many opportunities which protected areas can generate. In some cases, e.g. in KwaZulu-Natal, statutory Local Boards for protected areas have been established, giving communities a direct say in the planning and management of these areas, e.g. the Hluhluwe-Umfolozi Park.

International recognition. Inter-governmental treaties or conventions to which South Africa is a signatory afford opportunities to register outstanding natural sites of international significance. The sites identified could belong to any of the categories of protected area described above. The special recognition accorded these sites through registration raises their conservation status and improves international support. Examples include Ramsar sites, e.g. Ndumo Game Reserve; Biosphere reserves, e.g. Kogelberg Biosphere Reserve; and World Heritage Sites, e.g. Robben Island, the Greater St Lucia Wetland Park, and the uKhahlamba-Drakensberg Park. The latter park is one of only 23 areas worldwide which has been listed as a World Heritage Site on both natural and cultural grounds.

Peace parks. Transfrontier parks (transboundary protected areas or peace parks) involve the collaboration of protected areas across an international border to form a single large protected area. The first transfrontier park in South Africa was created by linking the Kalahari Gemsbok National Park in South Africa with the Gemsbok National Park in Botswana to form one area now called Kgalagadi Transfrontier Park. There are initiatives to develop more transfrontier parks to enhance regional cooperation and biodiversity conservation, e.g. the Gaza-Kruger-Gonarezhou Transfrontier Park.

Did you know? The area under the jurisdiction of South African National Parks covers 50% of the total protected area network. Protected areas cover less than 7% of South Africa - significantly less than Botswana (18%), Namibia (14%), Zimbabwe (13%) and Mozambique (9%), and only 25th among countries in Africa. To rectify this a number of national parks (Karoo, West Coast, Addo, Mountain Zebra) have been enlarged recently, and new protected areas are being planned and developed.

Enviro Facts 9: Hazardous Waste

The widely used term hazardous waste is difficult to define. In this fact sheet it includes substances harmful to life and the environment, i.e. wastes with any of the following characteristics: infectious, poisonous (toxic), radioactive, flammable, explosive, corrosive, carcinogenic (cancer causing), mutagenic (damages chromosomes), teratogenic (causes defects in the unborn), or bio-accumulative (accumulating in the bodies of plants and animals and thus in food chains).

Hazardous wastes are produced during industrial, medical, chemical and biological processes. Even household, office and commercial wastes contain small quantities of hazardous wastes (e.g. batteries, pesticides, bleach, paint thinners and their containers).

Examples of hazardous waste

- **PCBs (polychlorinated biphenyls):** Non-flammable, insulating materials used by big electrical networks such as Eskom. South Africa lacks the technology to safely treat and dispose of waste PCBs.
- **Dioxins:** A by-product of industrial processes, e.g. incineration and refining of oil. Used to bleach paper in the paper and pulp industry.
- **Heavy metals:** Widespread industrial use, such as in cadmium and nickel plating. Found in batteries (e.g. mercury, cadmium, lead), fluorescent tubes, mercury thermometers, and leaded petrol.
- **Radioactive waste:** By-product of nuclear power generation; and used in medicine (e.g. cancer therapy).
- **Medical waste:** Waste generated by health-care institutions may contain infectious material, which can transmit diseases such as tuberculosis, hepatitis, and HIV/AIDS.

Options for treatment and disposal

There is no completely safe way of disposing of hazardous waste and the best option is the prevention and reduction of hazardous waste production, and the reuse of waste. Recently introduced minimum standards for the disposal of hazardous waste have decreased the risk of pollution, however no guarantees can be given. Some of the safer methods of dealing with hazardous waste are:

- ***Land-disposal:*** Waste is co-disposed (buried with domestic waste) and/or pre-treated in landfills that are designed with various layers of clay and plastic liners.
- ***Encapsulation:*** Waste, which cannot be pre-treated or does not biodegrade, is encapsulated in concrete.
- ***Incineration (burning):*** Incineration of hazardous waste is dangerous and should not be considered as an option for treating or 'disposing' of hazardous waste. Such incineration produces dioxins and furans, and releases heavy metals into the atmosphere. Most medical waste produced in South Africa is incinerated by private contractors or hospitals.
- ***Chemical or biological treatment:*** This treatment includes adding chemicals to waste to make it less hazardous, or adding bacteria to break it down into a less toxic residue. A good example of this is the use of algae to break down liquid hazardous waste from landfills and tanneries.
- ***Plasma arc conversion:*** This treatment subjects waste to temperatures of approximately 4 000 ^{O}C, thereby reducing it to its molecular form. This new and expensive technology produces virtually no hazardous by-products. Possible drawbacks of this process are yet to be investigated in South Africa.

International trade in hazardous waste

In the late 1980s, a tightening of environmental regulations in industrialised countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of the wastes, 'toxic traders' began shipping hazardous waste to developing countries and to eastern Europe. When this activity was revealed, international outrage led to the drafting and adoption of the Basel Convention. During its first decade (1989-1999), the Convention was principally devoted to setting up a framework for controlling the transboundary movements of hazardous wastes, that is, the movement of hazardous wastes across international frontiers. It also developed the criteria for environmentally sound management. A control system, based on prior written notification, was also put into place.

The Bamako Convention is an OAU (Organisation of African Unity) convention - this means that it applies only within Africa. It bans the importation of hazardous waste into Africa.

South Africa is a signatory to the Basel Convention, but not the Bamako Convention.

Shipping waste to other countries is no solution; it merely moves the problem. Each country should take responsibility for its own hazardous waste.

Hazardous waste and the law

Realising that pollution legislation (as well as other environmental legislation) was inadequate, the South African government embarked on a major reform of all environmental laws in 1994. Aspects of this reform process that are relevant to hazardous wastes include first, the establishment of the Integrated Pollution and Waste Management Committee (IP&WMC). This committee has been set up to streamline and co-ordinate pollution control and waste management legislation, and to develop a new National Pollution Control Act to co-ordinate pollution control.

Second, NEMA (National Environmental Management Act) increases the ambit of people who can be held responsible for pollution damage from not only any person, company or government department causing pollution, to any person, company or department owning, using or controlling the land on which the problem exists - even if the pollution causing activity was authorised by law.

What can industry do about hazardous waste?

The ultimate solution is the reduction of hazardous waste production. This can be achieved in a number of ways:

- substitution of non-polluting alternatives, e.g. the use of chlorine to bleach wood and paper results in the formation of dioxins - chlorine could be replaced with oxygen;
- efficient production processes and good maintenance of machinery can reduce waste production. This can be achieved through adopting one of a number of Environmental Management Systems, such as ISO14001, Life-Cycle analysis; cradle-to-grave, and the reduction of illegal dumping;
- recycling waste reduces pollution and can result in cost-savings, e.g. expensive, toxic heavy metals could be re-used.

Criteria to assess learners during this language lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner participated and contributed to the group discussions, prior to the debate				
The learner participated in the debate, putting forward his/her views and opinions				
The learner spoke confidently and expressively during the group discussions and the class debate/discussion				
The learner was able to acknowledge other people's opinions during the debate and agree or disagree politely				
The learner was able to give and receive criticism, during the debate of the 'Water Conflict Game'				

ACTIVITY FIVE: JUST FOR FUN! MAKING A JET-PROPELLED SPEEDBOAT

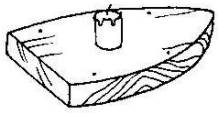
This TECHNOLOGY and NATURAL SCIENCES activity can be used to highlight different phases of water as well as the outcomes of what occurs when water changes phase. This activity can be done in the classroom or learners could try it out at home on their own.

You will need:

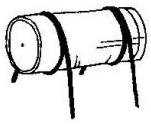
- A metal tube or small tin with a tight-fitting lid
- Wood (very light wood is best)
- Stiff wire (a coat-hanger works well)
- Candles and matches
- A nail

1. Make a hole in one end of the metal tube / tin

2. Saw a piece of wood to create the outline of a boat and make a shallow hole near each corner.

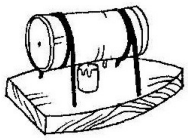


3. Using the wire, make a “cradle” for the tube – see drawing – and wind wire around the tube.



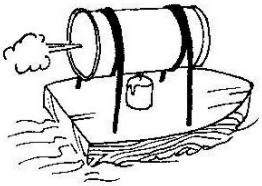
4. Place the feet into the holes in the wood.

5. Half fill the tube with water and replace lid.



6. Place the candle underneath the tube and light it.

7. Place the boat onto water.



Water power!

Share-Net

This pack supports an introduction for learners to an Eco-School's focus on resource management

Grade 9

This pack contains:

Activity One: Learners find out more about energy and energy options in South Africa during this **LANGUAGES** lesson and then debate whether water as an energy option is the way forward for our country.

Activity Two: During this **TECHNOLOGY** exercise, learners investigate, design, make and evaluate their own design based on water or steam power.

Activity Three: This **ARTS AND CULTURE** lesson looks at marketing and advertising our water or steam power designs that were made in Activity Two.

Activity Four: During this **NATURAL SCIENCES** activity, learners develop a school environmental policy to improve water management.

Activity Five: Just for fun – learners make a jet-propelled steam boat and a water-powered wheel.

WESSA

This pack of lesson plans is part of a series of lesson plans from Grade R to Grade 10 which focus on water and water-related issues. This resource development project has been funded by the Water Research Commission, Private Bag X03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).
This pack is available electronically on www.envirolearn.org.za

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. Learners find out more about energy and energy options in South Africa and then debate whether water as an energy option is the way forward for our country.	Languages	**Learning Outcome 2:** Speaking: The learner will be able to communicate effectively in spoken language in a wide variety of situations. **Learning Outcome 5:** Thinking and reasoning: The learner will be able to use language to think and reason, as well as to access, process and use information for learning.	• Demonstrates a range of complex interaction skills by participating actively in group discussions, conversations, debates, group interviews and surveys. • Extends sources and methods for locating relevant information (e.g. electronic and other media such as newspaper archives, documentary films, specialist libraries).
2. Learners investigate, design, make and evaluate their own design which makes use of water or steam power.	Technology	**Learning Outcome 1:** Technological processes and skills: The learner will be able to apply technological processes and skills ethically and responsibly using appropriate information and communication technology.	**Investigates:** • Identifies and explains a problem, need or opportunity from a given real-life context, and investigates the context, the nature of the need, the environmental situation, and the people involved. • Uses a variety of available technologies and methods to locate (e.g. use library referencing system, database searches, indexes). **Designs:** • Writes or communicates a short and clear statement or a design brief for the development of a product. • Lists product and design specifications and constraints. **Makes:** • Develops plans for making that include resource lists, formal drawings and manufacturing sequence. • Chooses and uses appropriate tools and materials to make designed products with precision and control by measuring, marking, cutting or separating, shaping or forming, joining or combining and finishing a range of materials accurately and effectively. • Demonstrates knowledge and understanding of safe working practices and efficient use of materials and tools. **Evaluates:** • Evaluates the product or system and suggests sensible improvement or modifications that would clearly result in a more effective or higher-quality end product.
3. This lesson looks at marketing and advertising our water or steam power designs that were made in Activity Two.	Arts and Culture	**Learning Outcome 4:** Expressing and communicating: The learner will be able to analyse and use multiple forms of communication and expression in Arts and Culture.	Applies skills of media production, while considering target group, purpose and design elements (e.g. create an advertisement, class newsletter, poster, T-shirt, logo or jingle).
4. During this activity, learners develop an environmental policy to improve water management at their school.	Natural Sciences	**Learning Outcome 3:** Science, society and the environment: The learner will be able to demonstrate an understanding of the interrelationships between science and technology, society and the environment.	Understands sustainable use of the earth's resources: responds appropriately to knowledge about the use of resources and environmental impacts: • Contributes to formulating a school environmental policy, including constructive ways to deal with waste material and to improve water management.
5. Just for fun – learners make a jet-propelled steam boat and a water-powered wheel.	Technology and Natural Sciences	-	-

ACTIVITY ONE: WATER POWER – THE WAY TO GO?

Learners find out more about energy and energy options in South Africa during this LANGUAGES lesson and then debate whether water, as an energy option, is the way forward for our country.

ACTIVITY:
Ask the learners:

1. Have you seen or taken part in a debate?
2. What was it about?
3. Where did it take place?
4. Who was taking part in the debate? *Prompt: Politicians, general public, members of a group or organisation.*

Ask the learners:

1. What is a debate?
2. If you were going to define it in a dictionary, what would you write? *Suggestion: A formal argument where groups or individuals present opposing views about a particular issue according to a set of rules.*

ACTIVITY:

- Explain that a debate is based around a suggestion or motion.

  An example of a motion is: The voting age should be lowered to 16.

- Explain that the people who are arguing to support the motion are called the proposers. The people arguing against the motion are the opposers. Print out copies of the worksheet on the following page which contains a muddled debating process and hand out to each learner.

- Ask learners to correctly order the stages of the debate.

See if you can un-muddle the steps in this debate…

An opposer sums up their group's main argument.

The first proposer presents the arguments for the motion.

The Speaker announces the result of the vote.

One of the proposers presents their arguments for the motion.

Everyone votes (apart from the Speaker) by leaving the debating chamber and coming back through a door marked 'aye' or 'no.'

The debate is chaired by the Speaker, who reads out the motion.

This side to side motion continues until everyone has had their say. You can only speak ONCE during the debate.

Two people, called tellers, count up the votes (bodies), as they come through each door.

A proposer sums up their group's main argument.

The first opposer presents the arguments against the motion.

An opposer presents their arguments against the motion.

The speaker re-reads the motion.

Check answers against the correct order:

1. The debate is chaired by the Speaker, who reads out the motion.
2. The first proposer presents the arguments for the motion.
3. The first opposer presents the arguments against the motion.
4. One of the proposers presents their arguments for the motion.
5. An opposer presents their arguments against the motion.
6. This side to side motion continues until everyone has had their say.
7. You can only speak ONCE during the debate.
8. An opposer sums up their group's main argument.
9. A proposer sums up their group's main argument.
10. The speaker re-reads the motion.
11. Everyone votes (apart from the Speaker) by leaving the debating chamber and coming back through a door marked 'aye' or 'no.'
12. Two people, called tellers, count up the votes (bodies), as they come through each door.
13. The Speaker announces the result of the vote.

Ask the learners:

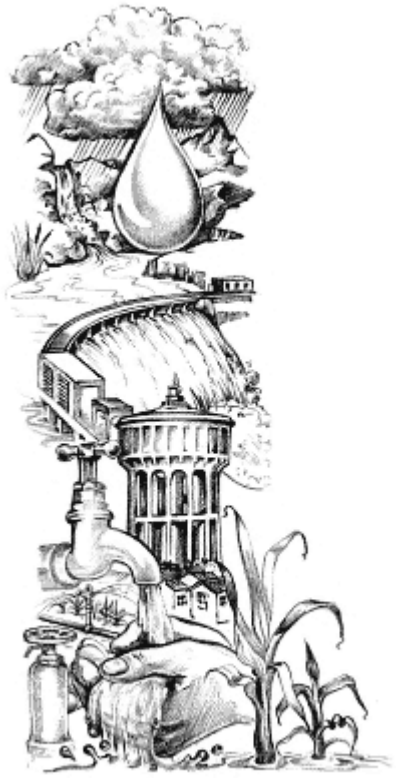
1. Why do you think there is a rule about people only speaking once during the debate?
2. What other rules do you think you will need to make the debate run smoothly?

Here are some rules of debate that we will follow:

1. The debate is chaired by the Speaker, whose decision on all matters is final.
2. You can only speak ONCE during the debate. Your speech should be about two minutes long. If you can, develop an argument rather than making a single point.
3. But you CAN 'intervene' as many times as you like. To intervene is to ask a question about a point being made, such as … are those statistics up-to-date?
4. You can use notes to help you with your speeches and make notes during the debate.
5. If you want to speak during the debate, you should catch the Speaker's eye by standing up as soon as someone has finished speaking. The Speaker will pick someone from those standing up.
6. If you spot someone breaking these rules you should tell the Speaker. This is called a point of order.

SO, WHAT ARE WE GOING TO DEBATE??

Read the following extract to the class:
Have you ever watched surfers riding the ocean waves at the coast? It is the power of water that moves them along.



People have used water-power for centuries. Since early days, it has been used to drive machines, and in the 18th century steam-power, a different form of water power, was invented.

Water-power
In the past, water-mills were built on the banks of streams to grind cereal to flour. These mills had huge paddle-wheels that were turned by the flowing water. Gears connected to the water-wheel turned the grindstones inside the mill.

The power of water is still used to turn wheels, but today they are turbines that drive generators to produce electricity. Power from water is an important source of renewable energy, unlike coal and oil that cannot be replaced once they are used up.

Steam power
Another source of water-power is steam. The steam is produced by boiling water over a fire and keeping the steam under pressure so that it has the power to drive engines. The first engines were all steam-engines and coal was used to boil the water. The engines were a good substitute for human muscle-power and increased the amount of work that could be done in factories.

CLASS ACTIVITY:

1. Divide the class into two groups.
2. Give them the following debate topic.

   Water as an energy option is the way forward for our country.

3. One group needs to prepare their debate agreeing with the topic (the proposers), the other needs to argue against it (the opposers).

4. Using the two enviro facts sheets (*Energy Options* and *Energy and Environment*) as an introduction to energy options, learners need to find out as much as they can about this topic. If you have a well-resourced library (school or community), make use of it; use the Internet; search for newspaper articles or magazines, see if there are any environmental films or videos on energy and energy options as well as energy issues (if possible, take out the movie 'An Inconvenient Truth' all about global warming and watch it as a class) as well as any other sources of information that will be useful. *(Learners need to keep*

a record of where they found their sources and what these sources were – this will help you, the teacher, when it comes to the assessment of this lesson). Some of the learners may have parents or relatives that work either for Eskom or for non-governmental organisations that are promoting the use of sustainable energy so they will be able to interview these people. Encourage the learners to make use of as many varied sources and methods of locating information as possible.

5. When the groups are ready and well prepared, you need to select seven learners to be:
    - Speaker. This person chairs the debate but cannot take part or vote.
    - First proposer to speak
    - First opposer to speak
    - Opposer to sum up
    - Proposer to sum up
    - Two tellers to count the votes

Hold the debate according to the formal order and rules.

Ask the learners:

1. What are the advantages of debating?
2. What are the disadvantages of debating?
3. Describe the strengths of a good debater. *Prompt: persuasive, confident, calm.*
4. Can you think of a better way to settle a difference of opinion?

Source: http://news.bbc.co.uk/cbbcnews/hi/newsid_4530000/newsid_4537100/4537177.stm

Criteria to assess learners during this languages lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner used a range of sources and methods (Internet, books, magazines, enviro facts) to prepare for the debate on water energy – *teacher, you may want to use the list of where and what the learners found and what sources they used*				
The learner took an active role in the preparation for the debate				
The learner took an active role in the debate				

Enviro Fact: Energy Options

Coal supplies most of South Africa's electrical energy. It is a finite, non-renewable resource. Burning coal to produce electricity causes serious environmental problems. Pollution from power stations contributes to global warming. In addition to the environmental challenges associated with energy supply, South Africa faces significant social challenges. Although we produce half of the electricity on the African continent, 40% of South Africans do not have access to electricity and rely instead on fuelwood and other inconvenient fuels such as coal, paraffin, gas, or candles. It is important that South Africa addresses both the environmental problems associated with energy supply, and the inequalities in access to adequate and affordable energy.

How can we provide adequate and affordable energy for all, while promoting environmental sustainability?

Many of South Africa's medium- and long-term energy needs could be addressed through regional co-operation. This could include the establishment of a regional electricity transmission grid and a Southern African Development Community (SADC) power pool, and regional energy planning. Such co-ordination would create opportunities for SADC countries to provide their people with clean and sustainable energy. Regional co-operation does however require political and economic stability.

There are also several technologies that could improve the sustainability of the regional electricity industry.

In addition to reducing pollution from coal-fired power stations, hydroelectric and solar power, natural gas, wind, tide and wave power may all help the region address its energy needs with minimum impact on the environment.

Reducing pollution from coal-fired power stations
This pollution can be reduced by using equipment which removes oxides of sulphur and nitrogen from the gases released when coal is burnt. This could result in electricity being more expensive, but this should be weighed against the benefits to the environment.

Hydro-power
Coal stocks are finite and sooner or later we shall have to rely on another source of energy. A possible medium-term alternative is to harness the huge hydro-electric potential of the sub-Saharan Africa region, estimated to be more than twice Eskom's current generating capacity. There are many other rivers in Zambia, Zimbabwe, Angola and Mozambique suitable for hydroelectricity.

Hydroelectricity is renewable and does not pollute. However, it is expensive, and requires the construction of large dams which have significant social and environmental costs. In addition, this option requires regional co-operation and political stability.

Solar energy
Solar energy can be used to produce heat. In Israel more than two-thirds of houses are fitted with solar water heaters. South Africa experiences more sunshine than

most places and there is much potential for widespread use of solar water heaters, particularly in mass, low-income housing projects. However, the initial outlay for solar panels is expensive as large areas of panels are needed to collect useful amounts of energy. Solar energy could be particularly useful in remote areas far from the electricity grid, such as farms, rural clinics, and water pumping stations.

Nuclear energy
There is much debate among energy planners in South Africa as to whether nuclear energy should play a role in this country's future. Using current technology it is a costly option, with unresolved environmental problems such as the disposal and storage of waste products.

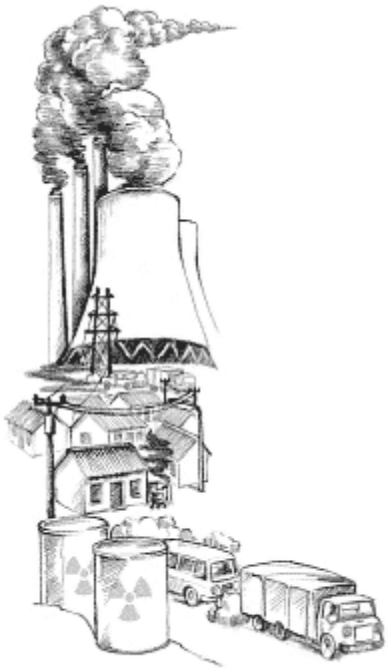
Natural gas
Although natural gas is a non-renewable energy resource, it has great potential as a future energy source for South Africa. South Africa has a limited amount of natural gas reserves, but strong regional ties would allow us to import gas from Namibia and Mozambique. Natural gas produces less pollution than other fossil fuels. In fact, latest natural-gas-burning turbines can produce electricity 50% more efficiently than those burning coal. Natural gas can also be burned cleanly in co-generation (see below). Because of its advantages over coal and oil, some analysts see natural gas as the best fuel for the transition to energy efficiency and renewable energy.

Wind power
As global energy resources become more and more scarce, wind power is becoming increasingly attractive. Wind energy is freely available and poses less of a threat to the environment than fossil and nuclear energy sources. Wind energy can provide electricity for communities not linked to the electricity grid. Telecommunications companies currently use small wind turbines to support cellular networks in the region. In addition, wind energy can be exploited on a large grid-tied scale through the development of wind farms. However, wind is not a reliable source of energy, and its use is limited to areas with steady winds. These areas are often found near coastal regions and in some arid and semi-arid areas.

Energy efficiency
South Africa uses more energy per unit of economic output (GDP or gross domestic product) than many other countries. There is much potential for energy saving. European countries and Japan have shown in recent years that industrial production can be increased while using less energy through energy-efficient manufacturing processes. Passive solar design principles and more efficient lighting and insulation contribute to energy savings in buildings. Industry is able to save energy through co-generation, advanced heat recovery systems and better control of energy usage. (Co-generation is a process which produces both electricity and heat at the same time, while advanced heat recovery systems economize on, and use the heat generated in industrial and chemical processes). Recycling waste materials can also save energy, for example aluminium produced from scrap uses 95% less energy than when it is manufactured from ore. New motor vehicles are also becoming more fuel efficient.

Planning in towns and cities should encourage the use of efficient public transport systems rather than private motor vehicles. In the long term we shall also have to find alternative fuels for transport. Hydrogen offers a clean alternative and as one of the elements in water it is plentiful. But it still requires energy to separate hydrogen from oxygen in water. Nuclear fusion (the combination of hydrogen atoms to form helium, i.e. the reaction which powers the sun) may also be a future option, but scientists do not foresee major progress in this area for many years to come.

Enviro Fact: Energy and Environment



Some of South Africa's most serious environmental problems are associated with our use of energy. Coal-fired and nuclear power stations for electricity generation, coal combustion in the townships, SASOL coal-to-oil processes, petrol and diesel use in vehicles for bulk transport, and over exploitation of fuelwood resources, all result in serious, long-term environmental damage.

Pollution from burning coal
More than three-quarters of South Africa's energy comes from coal, approximately half of which is used to generate electricity, a quarter to produce synthetic liquid fuels and another quarter directly by industry and in homes. Air pollution problems from coal combustion are serious. Medical studies are revealing increased rates of respiratory disease in residents in polluted areas.

Acid rain
Most of South Africa's power stations are concentrated within a 100 km radius in Mpumalanga and this leads to pollution problems. While all of Eskom's coal-fired power stations are designed to remove dust and other particles from waste gases produced during coal combustion, none are fitted with flue-gas scrubbers (cleaning equipment) to remove oxides of sulphur and nitrogen. Tall chimney stacks in power stations assist in releasing oxides of sulphur and nitrogen into the upper atmosphere where atmospheric conditions are more favourable for their dispersal and dilution. Although this reduces ground level concentrations of these pollutants, they may combine with moist air and rain at higher levels and cause acid rain in areas far from the source of pollution.

Whilst South Africa's coal has a relatively low sulphur content there is considerable concern about the potential environmental and economic impact of acid rain. Half of South Africa's agriculturally productive land, half of its commercial forests and a quarter of its surface water run-off are in Mpumalanga.

Pollution from vehicles
Motor vehicle fumes make air pollution problems worse and are the main cause of photochemical smog in cities. Unleaded fuel has recently been introduced to South Africa and this may reduce the amount of lead in exhaust fumes. Catalytic converters fitted to exhausts would result in a significant reduction in the release of carbon dioxide, hydrocarbons, and nitrogen oxides. However, South Africa lags far behind other countries (such as Japan and Germany) in legislation to control vehicle emissions. Solutions to transport pollution and vehicle congestion require long-term planning to introduce efficient public transport systems in our cities.

Deforestation
Another environmental concern associated with energy use is the reliance by a significant number of South Africans on fuelwood, once a renewable resource, but now being used at a rate much greater than that at which it is naturally regenerated. Fuelwood is an inefficient source of energy for cooking and heating and its use can cause increased respiratory illnesses. It has been estimated that if current consumption trends continue, all natural woodland in the former "homelands" will be denuded by 2020. In addition to the environmental consequences of deforestation,

diminishing supplies of wood require rural people (particularly women) to travel further and further from home to gather wood, placing a great burden on them.

Global warming
South Africa uses a great deal of energy, very much more per unit of gross domestic product (GDP) than most other countries. The combustion of coal, oil and wood results in increased carbon dioxide production. This gas acts likes a greenhouse - it lets short-wave, natural light through but traps out going long-wave (infra-red or heat) radiation. The potentially devastating consequence is that the Earth is slowly getting warmer, causing the climate to change and sea levels to rise. Although South Africa produces only a small percentage (1,6%) of the total, global carbon dioxide emissions, it plays a disproportionately large role per person in contributing towards the greenhouse effect and global warming. As a country needing rapid economic growth in the medium-term to satisfy the country's developmental needs, South Africa's potential contribution to global warming is an area of concern.

Nuclear energy
South Africa currently has one commercial nuclear power station at Koeberg near Cape Town. It provides 1 800 MW of Eskom's installed electricity generation capacity of 37600 MW, less than 5% of the total. There is intensive debate among energy planners as to whether nuclear energy should play a role in South Africa. In addition to being a costly option, nuclear fission produces dangerous radioactive by-products. There is considerable concern about their safe containment in the case of accidents at nuclear power stations, the closing down (decommissioning) of old power stations, and the storage of highly toxic wastes. At present, low-level radioactive wastes are stored in sealed containers which are buried underground at disposal sites. No long-term solution has been agreed on for the safe storage of high-level radioactive wastes, some of which remain harmful for thousands of years.

ACTIVITY TWO: WATER POWER!

During this TECHNOLOGY exercise, learners investigate, design, make and evaluate their own water or steam power designs.

Coal supplies most of South Africa's electrical energy. It is a finite, non-renewable resource. Burning coal to produce electricity causes serious environmental problems. Pollution from power stations contributes to global warming. In addition to the environmental challenges associated with energy supply, South Africa faces significant social challenges. Although we produce half of the electricity on the African continent, 40% of South Africans do not have access to electricity and rely instead on fuelwood and other inconvenient fuels such as coal, paraffin, gas, or candles. It is important that South Africa addresses both the environmental problems associated with energy supply, and the inequalities in access to adequate and affordable energy.

How can we provide adequate and affordable energy for all, while promoting environmental sustainability?

What the learners need to do:

1. Investigate whether water or steam can generate electricity

The investigation phase is the research phase. Learners need to understand and explain the energy problems that South Africans are facing today; they need to locate information on existing water or steam generators by looking at pictures of water wheels and steam engines and at books and any other material that they can find on water power. They can also discuss their ideas with friends, in small groups and with you, the teacher. Let the learners write a paragraph on their "research" which should include what sources of information they used, where they found these sources, what they found out, what they think they would like to design.

2. Design

- Each learner will need paper and pencils so that they are able to write and draw their design ideas. There needs to be a short, clear statement (or design brief) for their design. The design must be on paper and learners should make rough drawings first. When they are happy with their designs, they need to make a neat drawing with a heading and labels or a colour key. The dimensions of the design must be written down and the materials that will be used must be listed. Any constraints/restrictions that the learner can see/anticipate in the future must also be noted. In addition, the learner must work out the cost of the design, how safe it will be, what the product will do.

- It is very important that you, the teacher, guide the learners through this design phase. Some of the learners' designs may be wonderfully creative but very impractical, so you need to be on hand to make sure that their designs will work.

3. Make

- The learners need to gather together the materials they will need to construct their design. They will need to develop plans for their designs which include a resource list (the materials and tools needed and their costs; formal drawings showing dimensions or quantities (such as 'exploded views [An exploded view is a representative picture or diagram that shows the components of an object slightly separated by distance, or suspended in surrounding space]; orthographic views [orthographic drawings are front, side, top, etc views of an object. An orthographic view is only one side. It takes several views to show the whole object], isometric views [a method of visually representing three-dimensional objects in two dimensions]; sequence drawings [a drawing of each stage of manufacture and includes brief notes or instructions. It normally follows a flowchart which simply lists each stage]; and the sequence (by way of a flow chart) of how the product will be built.

- Encourage the learners to use recycled objects if possible. When they have all they need, the designs need to be constructed. Remind them that they need to make sure they are precise and careful when making their design and they need to work safely with any tools they use.

4. Evaluate

- Test the designs!! Do they work, how well? After testing individual designs, learners can set up their designs at the front of the class and demonstrate them to everyone. Learners need to ask themselves if their designs could be improved on – how? There may even be some constructive comments from the rest of the class during the demonstrations.

Criteria to assess learners during this technology lesson

Criteria	Exceeded requirements of the Learning Outcome	Satisfied requirements of the Learning Outcome	Partially satisfied requirements of the Learning Outcome	Not satisfied requirements of the Learning Outcome
The learner was able to identify that energy generation is an environmental problem in South Africa *(teacher, the learners will have written a paragraph on this during the investigation phase)*				
The learner located and made use of a number of references (such as books, used the Internet, newspapers) during the investigation process				
The learner wrote a clear statement (design brief)				
The learner listed the products and design specifications				
The learner made a note of any constraints				
The learner drew formal drawings of the design				
The learner drew a flow chart of how the design would be built				
The learner worked carefully and safely				

ACTIVITY THREE: MARKETING OUR WATER POWERED DESIGNS

This ARTS AND CULTURE lesson looks at marketing and advertising our water or steam power designs that were made in Activity Two!!

The term, MARKETING, was first academically defined in 1937 when the American Marketing Association (AMA) stated that:

> "*Marketing consists of those activities involved in the flow of goods and services from the point of production to the point of consumption.*

Although marketing is often interchangeably used with the word *advertising*, marketing can be more specifically described as the game plan by which the advertising will be carried out, as in a *marketing strategy*.

ADVERTISING is a paid form of communicating a message by the use of various media. It is persuasive, informative, and designed to influence people's purchasing behaviour or thought patterns.

DISCUSS WITH THE CLASS:

1. What are ways that a product can be advertised?
2. Are there any adverts (radio, television, in newspapers or magazines) that you remember from a long time ago?
3. Why do you think you remember them? Do you think that company that developed that advert, so many years ago and that you can still remember, had an effective marketing strategy?
4. Which ways are the most effective ways of advertising for teenagers (these will vary from learner to learner)?
5. Should one always 'tell the truth' in advertising? Why? Why not?

ACTIVITY:

You will need:

- Paper – white or coloured
- Paint
- Pastels
- Kokis
- Chalk
- Wax and / or wax crayons
- Plain T-shirts and fabric paint

WHAT TO DO:

Using your research information gathered in Activity Two, design and create a poster, T-shirt, logo or music 'jingle' to advertise your steam- or water-power

design. Those creating a T-shirt, will need to do the initial design on paper and then, time and the availability of T-shirts permitting, transfer the design onto the material.

Remember to consider your target group, the purpose of your design and design elements.

Criteria to assess learners during this arts and culture lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner participated in the discussions about advertising				
The learner considered target group, purpose and design elements				
The learner created a music jingle, poster, T-shirt or logo				

ACTIVITY FOUR: DEVELOPING A SCHOOL POLICY TO IMPROVE OUR WATER MANAGEMENT

During this NATURAL SCIENCES activity, learners develop a school environmental policy to improve water management.

A school environmental policy is a statement of intentions and principles for improving a school's educational and environmental performance. The policy development process involves learners, teachers and other stakeholders and encourages schools to audit existing practices, activities and other elements of the curriculum and to select, evaluate and review environmental education goals and management plans.

A simple school environmental policy is shown below:

At all times the staff, learners and community will try to:

- *Engage with environmental issues for more meaningful learning in a healthy, happy school*
- *Manage resources more wisely*
- *Minimise wastage*
- *Minimise water and electricity use*
- *Improve our school grounds and environment*
- *Share ideas, improve co-operation throughout the school community*

From Georgenau Primary, Pietermaritzburg

One way to further develop a school policy is to develop two sub-points for each of the main points in the policy. The sub-points should describe what you will do in more detail.

At all times the staff, learners and community will try to:

- ***Engage with environmental issues for more meaningful learning in a healthy, happy school:***
  - *Through developing and teaching environmental lesson plans, and*
  - *Through creating opportunities for learners to enjoy the school's natural environment in the context of lessons.*
- ***Manage resources more wisely***
  - *Reduce electricity consumption in the school*
  - *Reduce water consumption in the school*
- ***Minimise wastage***
  - *Reduce the number of resources used*
  - *Establish a recycling programme*
- ***Improve our school grounds and environment***
  - *Plant a food garden*
  - *Reduce soil erosion by planting indigenous water-wise vegetation in bare areas*
- ***Share ideas, improve co-operation throughout the school community***
  - *Involve parents in more environmental projects*
  - *Establish an environmental club for teachers and learners*

It is useful to assess the current status of our school by means of an audit. An audit can be described as a careful look at the way things are. A policy then attempts to address what has been discovered in the audit. In the following activity, we will start with an audit and this will lead to the development of a water policy for the school.

ACTIVITY:

- Divide the class into five groups. Every learner needs a copy of the water audit worksheet on the following page. All learners need to check the water meter (if your school has one) each day. Each group needs to do the audit on a different day of the week (one group of learners will do it on Monday, the next group on Tuesday etc) and report any leaking taps to the teacher.

Name: _____

Date of audit: _____

Time of audit: _____

WATER	**YES**	**NO**
1. Does the school have access to water-on-tap?		
2. Is the drinking water clean and safe for consumption?		
3. Does the school have tanks to collect rainwater?		
4. Are teachers and learners aware of ways to save water?		
5. Is water management recognised and promoted at your school?		
6. Who amongst teachers, school governing body members, learners and other staff members know how to change a tap washer?		
7. How many taps are dripping?		
8. How many taps including baths and showers are in the school and school grounds?		
9. How many flush toilets are in the school?		
10. How many toilets are leaking?		

If the school has access to municipal water, find and read the water meter in the school grounds. Record the daily use in the table below:

DAY	**DATE**	**TIME**	**METER READING**	**LITRES USED**
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Total for the school week (Monday to Friday)				

- Now that the audits are complete, learners (individually or in small groups) need to brainstorm ideas around how the water management in their school can be improved, based on what they discovered during their audits. Water management actions can include individual learner and teacher actions and whole class/grade/school actions.

- Learners then need to write down all the ideas on paper.

- Go round the class, asking individuals (or groups) for their contributions and ideas. List these on the board. As a class, decide which (between five and ten) are the most likely that your school will be able to implement. Eliminate the rest. If necessary, expand the initial idea to include two sub-points (see example on page 14).

- Once everyone is happy with the policy, write or type it up neatly and present it to the school governing body or headmaster. Your school may already have an environmental policy so your water management policy can become part of that.

Remember, we can ALL work towards managing our water resources more wisely, whether it is on an individual, group, class, grade or school level!

Criteria to assess learners during this natural sciences lesson

Criteria	**Exceeded requirements of the Learning Outcome**	**Satisfied requirements of the Learning Outcome**	**Partially satisfied requirements of the Learning Outcome**	**Not satisfied requirements of the Learning Outcome**
The learner carried out the water audit on her/his own				
The learner contributed ideas towards better water management at the school				

ACTIVITY FIVE: JUST FOR FUN – MAKE A JET-PROPELLED STEAMBOAT AND A WATER-POWERED WHEEL

These two TECHNOLOGY and NATURAL SCIENCES activities highlight water power as well as the outcome of what occurs when water changes phase. They can be done in the classroom or learners could try them out at home.

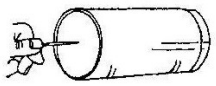
1. MAKE A JET-PROPELLED SPEEDBOAT

You will need:

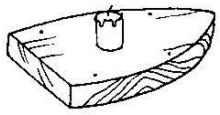
- A metal tube or small tin with a tight-fitting lid
- Wood (very light wood is best)
- Stiff wire (a coat-hanger works well)
- Candles and matches
- A nail

What to do:

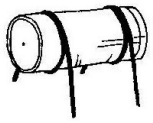
1. Make a hole in one end of the metal tube / tin



2. Saw a piece of wood to create the outline of a boat and make a shallow hole near each corner.

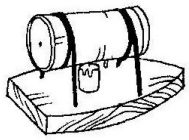


3. Using the wire, make a "cradle" for the tube – see drawing – and wind wire around the tube.



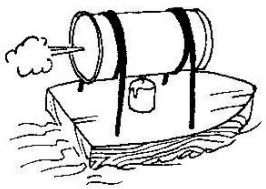
4. Place the feet into the holes in the wood.

5. Half fill the tube with water and replace lid.



6. Place the candle underneath the tube and light it.

7. Place the boat onto water.

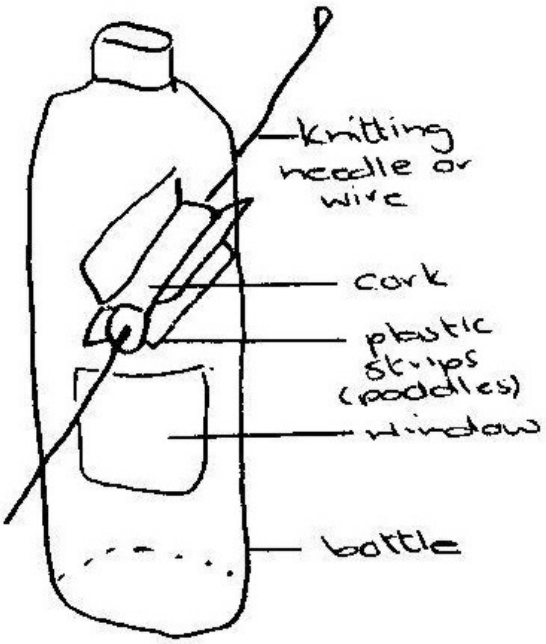


2. MAKE A WATER-POWERED WHEEL

You will need:

- A clear plastic cool-drink bottle
- Three pieces of cork
- Knitting needle

What to do:

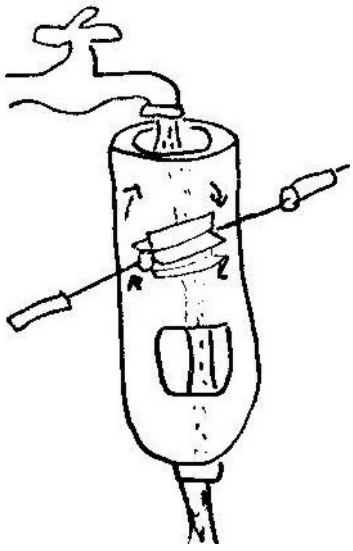


1. Cut a window out of one side of a clear plastic cold-drink bottle. Cut the window into four equal strips.

2. Make a hole in a cork by pushing a thin knitting needle down the centre. Remove the needle. Use a sharp knife to cut four slits down the sides of the cork and push a plastic strip into each one.

3. Use the needle to pierce the small holes opposite each other below the window. Push your needle through one hole, then through the waterwheel held inside the bottle and out the hole on the other side. See that the needle spins freely. Push a piece of cork onto each end of the needle to stop it from coming out.

4. Make a hole in the base of the bottle and push it onto a tap. Gently trickle water over your water-wheel to make it turn.



- *Note how fast the water-wheel turns. What happens when you increase the water flow?*

- *See how the outer corks turn as well. This part of the water-wheel would turn a grindstone or motor.*

Investigating water quality in South Africa

Share-Net

This pack supports an introduction for learners to an Eco-School's focus on environmental information and community knowledge

Grade 10

This pack contains:

Activity One: How healthy are our rivers? This **LANGUAGES** research and writing activity looks at water quality in South Africa. Learners research the topic of water quality, using a wide range of sources and methods. They then write up their information in essay format.

Activity Two: This **LIFE SCIENCES** lesson looks at visible animal life to determine the health of our rivers and streams.

Activity Three: This **PHYSICAL SCIENCES** lesson looks at water quality, water-borne diseases and some simple ways of purifying water. This is followed by a case study on the water collecting ways of Nguni people.

Activity Four: Water bodies in southern Africa suffer from many problems – all of which are linked to the way in which the catchment area is used. This **PHYSICAL SCIENCES** lesson looks at water use in a catchment and encourages learners to look at ways of conserving and caring for our water catchments.

Activity Five: 5. We all use water every day for things like drinking, cooking and washing. We could not survive without water! This **LIFE SCIENCES** activity looks at how small or large our eco footprint is.

WESSA

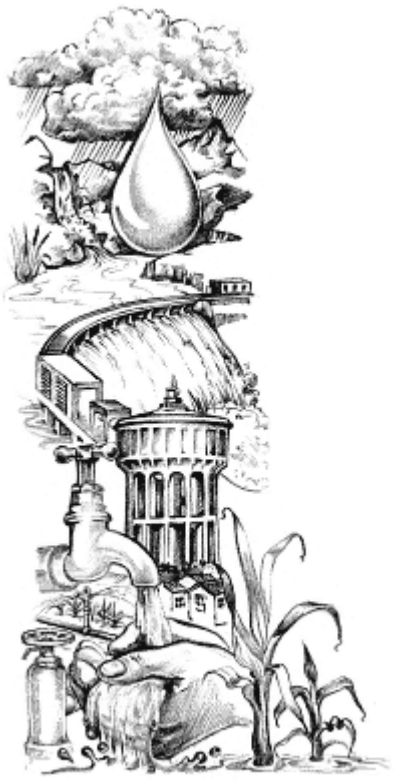
This pack of lesson plans is part of a series of lesson plans from Grade R to Grade 10 which focus on water and water-related issues. This resource development project has been funded by the Water Research Commission, Private Bag X03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).
This pack is available electronically on www.envirolearn.org.za

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. How healthy are our rivers? This research and writing activity looks at water quality in South Africa. Learners research the topic of water quality, using a wide range of sources and methods. They then write up their information in essay format.	Languages	**Learning Outcome 3:** Writing and presenting: The learner is able to write and present for a wide range of purposes and audiences using conventions and formats appropriate to diverse contexts.	Research topics from a variety of sources and records findings. Locate, access, select, organise and integrate relevant data from a variety of sources. Apply paragraph conventions to ensure coherence by using topic sentences, introduction and ending, logical progression of paragraphs, cause and effect, comparison and contrast. Prepare a final draft by proofreading and editing. Present final draft paying attention to appropriate style such as a neatly presented text.
2. This lesson looks at visible animal life to determine the health of our rivers and streams.	Life Sciences	**Learning Outcome 1:** Scientific enquiry and problem-solving skills: The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using enquiry, problem solving, critical thinking and other skills.	Plans an investigation using instructions. Systematically and accurately collect data using selected instruments and/or techniques and following instructions. Displays and summarises the data collected.
3. This lesson looks at water quality, water-borne diseases and some simple ways of purifying water. This is followed by a case study on the water collecting ways of Nguni people.	Physical Sciences	**Learning Outcome 3:** The nature of science and its relationships to technology, society and the environment.	Discusses knowledge claims by indicating the link between indigenous knowledge systems and scientific knowledge.
4. This lesson looks at water use in a catchment and encourages learners to look at ways of conserving and caring for our water catchments.	Physical Sciences	**Learning Outcome 3:** The nature of science and its relationships to technology, society and the environment.	Describes the interrelationship and impact of science and technology on socio-economic and human development. • States the impact of human demands on the resources and products in the earth's system.
5. We all use water every day for things like drinking, cooking and washing. We could not survive without water! This activity looks at how small or large our eco footprint is.	Life Sciences	**Learning Outcome 3:** Life Sciences, technology, environment and society: The learner is able to demonstrate an understanding of the nature of science, the influence of ethics and biases in Life Sciences, and the interrelationship of science, technology, indigenous knowledge and society.	Describe different ways in which resources are used and applied to the development of products, and report on their impact on the environment and society.

ACTIVITY ONE: FINDING OUT ABOUT THE WATER SITUATION IN SOUTH AFRICA

How healthy are our rivers? This LANGUAGES research and writing activity looks at water quality in South Africa. Learners research the topic of water quality, using a wide range of sources and methods. They then write up their information in essay format.

Hand out the following information on pages 1 and 2 to your learners:



Water in South Africa

South Africa is extraordinarily rich in natural resources – except for water. Water is a vital but scarce resource, distributed unevenly in time (frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is markedly wetter than the western half). Increasing demand for water, and decreasing water quality make careful water management a priority in our country. It has been estimated that by the year 2025 South Africa's human population will have doubled, and there will be insufficient water for domestic use, agriculture, and industry.

- **Rainfall:** Our average rainfall is less than 500 mm a year, with the driest part of the country receiving less than 200 mm/year and the wettest receiving more than 2 500 mm/year! Rain does not always fall where it is most needed, and some areas of high demand, such as Gauteng, receive less water than they need. Most rain falls in the narrow belt along the eastern and southern coasts. The rest of the country receives only 27% of South Africa's total rainfall. In addition, hot, dry conditions result in a high evaporation rate.

- **Rivers:** There are few natural lakes in South Africa. We depend on rivers, dams and underground water for our water supply. Approximately 75% of the water flowing from South Africa into the sea occurs along the eastern and southern seaboards, where many short rivers occur. Flowing from east to west is the largest river in the country, the Orange River, which drains most of the rest of the country. Its water comes from sources in the Drakensberg and Maluti Mountains, and it flows into the Atlantic Ocean on the west coast.

- **Dams:** About half of South Africa's annual rainfall is stored in dams. We have about 550 government dams in South Africa, with a total capacity of more than 37 000 million m^3.

  Dams have both positive and negative impacts. They can be beneficial for people in that they regulate the flow of a river, reducing flood damage and contributing to perennial rather than seasonal flow. In addition, sediment is deposited in a dam, and the growth of aquatic plants means that nutrients are removed from the water. Thus water leaving a dam may be cleaner than water entering it. The riverine ecosystem is usually affected negatively by a dam. Alterations in flow regime (quantity of water and

timing of periods of high and low flow), temperature and water quality may cause reductions in biodiversity of riverine organisms below dams. Reduction in water flow reduces the river's scouring ability and this can lead to silting of estuaries.

South Africa's landscape is not well suited to dams. There are few deep valleys and gorges, with the result that most dams are shallow with a large surface area. Together with the hot, dry climate, this results in much water evaporating from dams. In addition, the high silt load (a result of an arid climate, steep river gradients and poor farming methods) of our rivers means that the capacity of South Africa's dams is quickly reduced as they become silted. The rivers of the Western Cape carry relatively less silt than those in the rest of the country.

- **Water abstraction:** A growing problem for South Africa's rivers is a lack of water! Reduction in river flow, owing to abstraction (removal), and damming, has affected many of our rivers, for example those flowing through the Kruger National Park.

- **Intercatchment transfer of water:** This involves the transfer of water from catchments with good supplies and low demand, to those where demand for water is high and the supply is poor. There are numerous intercatchment transfer schemes already in operation, and more are under construction or proposed. A major scheme is the Orange-Fish River scheme, where water gravitates from the Orange River at the Gariep Dam, and is piped through tunnels and canals to the Sundays and then the Fish Rivers in the Eastern Cape. Transfers of this nature will have far-reaching ecological, political and socio-economic implications. As yet, little research has been carried out to establish the ecological consequences of intercatchment water transfers. However, areas of concern include reducing streamflow and water levels in one system, changes in water temperature and chemistry, and the transfer of invasive species between catchments.

- **Water pollution:** Industrial and agricultural pollutants common in South Africa include agricultural fertilizers, silt, toxic metals, litter and pesticides. These pollutants affect aquatic ecosystems and human health. Disease-producing bacteria are common in urban waste water, particularly from informal settlements that lack sewage and water purification facilities. For example, typhoid, cholera and gastroenteritis are transmitted by water contaminated with untreated sewage. Gastroenteritis is one of three main causes of death in South African children under the age of five.

Water Quality

Healthy streams and rivers support a wide variety of water life. Rainwater and cool, tumbling mountain streams contain high levels of oxygen. Low concentrations of nutrient substances which are washed into the system provide both key growth chemicals (such as nitrates) and food (like rotting plants – detritus). Water plants, in turn, photosynthesise to provide more life supporting oxygen and food sources for water organisms. All of these factors interact as a complex web of life both within the river itself and in its surrounding catchment. Much human activity has unfortunately disrupted these ecological processes and degraded water quality.

ACTIVITY:
How healthy are our rivers?

1. Learners research the water quality situation in South Africa. They need to use at least five different sources (excluding the fact sheet on 'Water in South Africa') to gather information. These can include, but are not limited to, books, journals, newspapers, the Internet, interviews, visits to local water suppliers (such as Umgeni Water or Rand Water) or documentaries. Once the research has been completed, learners present their findings in an essay.

2. The following points need to be considered when writing an essay:
    - The **introduction** should be designed to attract the reader's attention and give the person an idea of the essay's focus. You could begin your introduction with an attention grabber such as startling information (which must be true) or even an anecdote (a story which illustrates a point) – but make sure your anecdote is short, to the point and relevant to your topic.

    - Each main idea will become one of the **body paragraphs**. If you had three or four main ideas, you will have three or four body paragraphs. The topic can now be explained, described, or argued.

    - The **conclusion** sums up your points or provides a final perspective on your topic. All the conclusion needs is three or four strong sentences which do not need to follow any set formula. Simply review the main points (being careful not to restate them exactly) or briefly describe your feelings about the topic. Sometimes, even an anecdote can end your essay in a useful way.

Remember to:

- Read and reread your essay.
- Does it make logical sense?
- Leave it for a few hours and then read it again. Does it still make logical sense?
- Do the sentences flow smoothly from one to another?
  If not, try to add some words and phrases to help connect them. Transition words, such as "therefore" or "however," sometimes help. Also, you might refer in one sentence to a thought in the previous sentence. This is especially useful when you move from one paragraph to another.
- Finally, have you checked your spelling?

Criteria to assess learners during this languages lesson

Criteria	Outstanding	Meritorious	Satisfactory	Adequate	Partial	Inadequate
The learner used at least five sources when researching 'how healthy are our rivers'						
The learner organised and integrated their information into a concise, well-presented essay						
The essay had an introduction, paragraphs and conclusion and was in a logical order						
The final essay was neatly written and presented						

ACTIVITY TWO: INVESTIGATING THE HEALTH OF OUR RIVERS

This LIFE SCIENCES lesson looks at visible animal life to determine the health of our rivers and streams.

MiniSASS is a simplified form of the South African Scoring System. It is a technique that can be used to measure the health of a river and the general quality of the water in that river. Developed by Umgeni Water and Ezemvelo KZN Wildlife, it uses the composition of invertebrates living in rivers and is based on the sensitivity of the various animals to water quality. It does not, however, measure contamination of the water by bacteria and viruses and thus does not determine if the water is fit to drink without treatment.

The MiniSASS is a miniature version of the more sophisticated SASS method that is used as part of the National River Health Programme. The results produced using MiniSASS have been tested against the more rigorous SASS method and have been found to be sufficiently close to be of real value.

Are you ready for some environmental action?

Method:

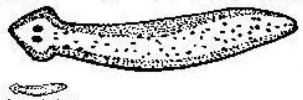
1. The best sites to find insects in a nearby river are where the current is fairly fast moving and where there is some vegetation growing in the water, along the sides of the river.

2. Look for invertebrates in as many of the different habitats (biotopes) you can find at a river site. Insects are collected holding a small net (a kitchen sieve will do) in the current, and then disturbing the stones, vegetation and sand using your feet (with boots on!) or hands just upstream of the net. Be bold in turning the stones over. The insects will be dislodged and will flow into the net. Do this for about 5 minutes while ranging across the river to a number of different habitats. You can also lift stones and pick off the insects with your fingers or you can brush off the underside of the stones with a clean paintbrush.

3. Rinse any mud out of the net then turn the contents into a plastic tray (a 2 litre ice-cream container is ideal). Identify each group using the sheet given on page 6 (keep a tally of the number of each group). If the river is in reasonable condition, you should have several hundred individual insects in the sample.

Flat worms

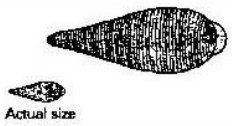
SCORE 3



Soft bodied worm-like form but flattened shape. Dark grey colour, head arrow shaped with a pair of dorsal eye spots. Move with a gliding movement over the substrate and are generally scavengers or carnivorous.

Leeches

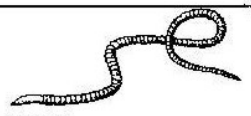
SCORE 2



Variable colour from grey to red, brown and black. Body very flexible, extending long and thin while moving but contracting into a short stubby shape when disturbed. Often uses suckers at front and rear to aid movement and will stick tightly onto the surface. Also swim with a fast snaking movement. Often found under stones, vegetation or debris and are common in polluted water. Mostly carnivorous on other invertebrates, with a few blood suckers occurring mainly in the more tropical regions.

Worms

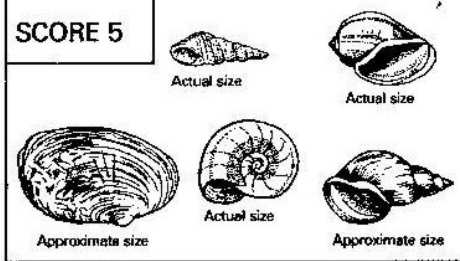
SCORE 2



Elongate cylindrical shape much like small earth worms. Colour usually pink to brown. Seen writhing around in debris where they feed on deposits. Tolerant of very polluted water.

Snails

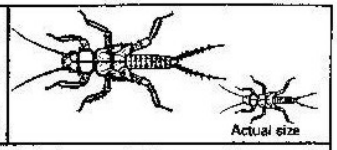
SCORE 5



There are a range of snails in rivers, including small black limpets which cling to rocks, clams or muscles found in sand, and the more common snails which move over stones and vegetation. Some of the latter are host to bilharzia, a most serious health hazard for humans.

Stoneflies

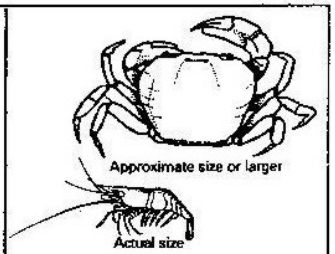
SCORE 14 (26)



The nymphs of an adult terrestrial fly, stoneflies usually have two long tails, robust bodies and legs each having two claws at the tip. Wing pads on the thorax are often dark and obvious. Some species (usually brown and yellow) 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. When confined in a bottle or sample container, they soon start to bob up and down as if doing "press ups" as they try to get oxygen.

Crabs and shrimps

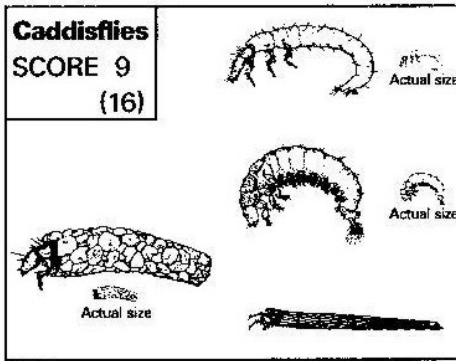
SCORE 6



A large diverse group including crabs, shrimps, water fleas, sand fleas and pill bugs. Crabs and shrimps are the largest and most commonly seen in rivers. Crabs are scavengers feeding mainly on leaf litter but will feed on animals when given the chance. Shrimps are mostly scavengers or deposit feeders.

Caddisflies

SCORE 9 (16)



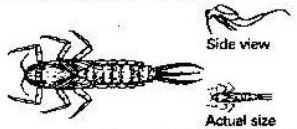
These are the aquatic larvae of adult caddisflies. Most caddisflies have a hard head with three pairs of legs. The abdomen is long and smooth except for some which have gills along the under surface. Some caddisflies swim freely in rivers, other take up a "house" made up of a reed or piece of grass, or construct a case of grains of sand or other matter. Still others construct nets under stones which they use for protection and also to catch food. Some feed on algae and deritus while others are predators.

Mayflies

These are the nymphs of small delicate mayflies that fly close to rivers and lakes, usually swarming in the early evenings. Most only live for a day or two, never feed, and live to mate and lay eggs in the water. The nymphs hatch from the eggs and take months to develop. Most mayflies have three tails although occasionally some have two which can lead to confusion with stoneflies. Mayflies have only a single claw at the tip of each leg and have visible gills on the side or back of the abdomen.

Minnow mayflies

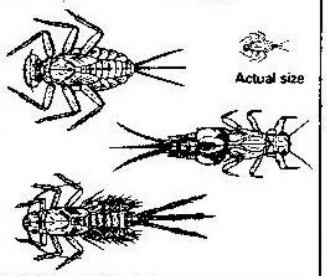
SCORE 5



Minnow mayflies all belong to the family Baetidae. These mayflies are most easily recognised by their strong, fish-like way of swimming, darting rapidly about in the container. They have a narrow head and a humped back which gives them an arched appearance when viewed from the side. Their bodies are slender but not flattened. Minnow mayflies are very common in rivers and feed in a variety of habitats. A few species are tolerant of some pollution but others are sensitive.

Other mayflies

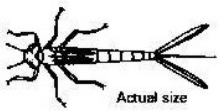
SCORE 13



Besides the minnow mayflies above, there are a number of other mayfly families present in rivers, many of which are less tolerant of pollution than the minnow mayflies. They occupy a variety of habitats, from burrowing in mud, to crawling amongst decaying leaves, to scurrying over stones in the fastest of currents. They have a variety of different shapes as illustrated and also feed on a range of foods.

Damselflies

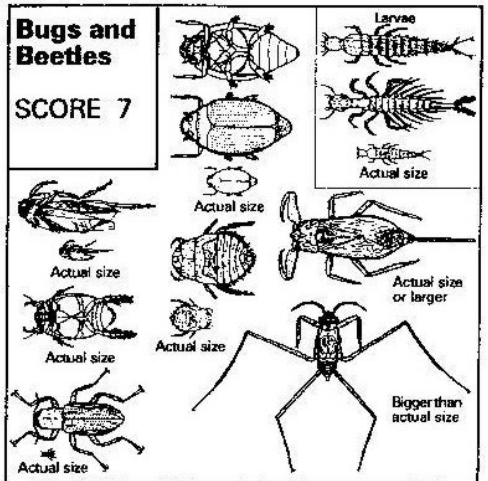
SCORE 4



The nymphs of damselflies are all carnivorous feeding on other invertebrates. They 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. Damselflies have elongated bodies with three broad tails on the tip of the abdomen. They walk slowly over the substrate, or swim slowly with a sideways flexing movement.

Bugs and Beetles

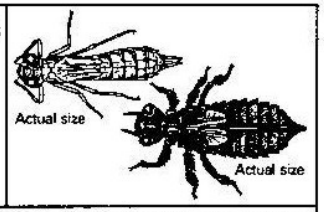
SCORE 7



These are two very distinct groups of insects, bugs having a piercing and sucking beak with two pairs of membranous wings, while beetles have "jaws" and the outer pair of wings are hardened.
In most of these insects, both the adult forms with wings, and the larvae, occur in water. There is a range of bugs including water boatmen, backswimmers, water scorpions, water bugs, pond skaters and water striders. Most are carnivorous but some like the backswimmers feed on algae. Others like the water scorpion and water bugs, catch prey with their front legs and pierce the body with the beak, sucking out the insides. The beetles have proper mandibles or "jaws" and feed on a range of foods including vegetation and other animals. Included here are whirligig beetles, predacious diving beetles and riffle beetles. They are often seen in the larval form which differs from the adult form. Some of these are illustrated.

Dragonflies

SCORE 6



Dragonfly nymphs are more robust than damselflies having stouter bodies with a larger head and "mask". Some have short while others have very long legs. They are generally large and will usually be the largest organism found in a sample with the exception of crabs. The do not have any tails and when disturbed, will swim using "jet propulsion" by forcefully ejecting water from the abdomen. Some species live under rocks while one common species crawls over sandy river beds making snake-like tracks in the sand. Dragonfly nymphs are probably the most powerful invertebrate predators in rivers, and will even take small fish and tadpoles.

miniSASS

RIVER HEALTH

UMGENI WATER · AMANZI

A community river health monitoring tool for South Africa.

March 2000

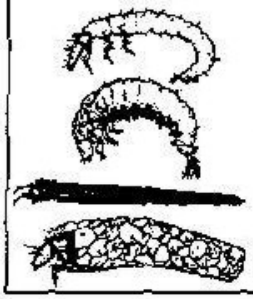
SCORE SHEET

Circle the score of each group found

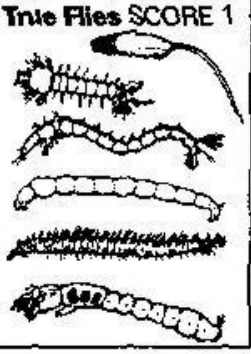
(Scores in brackets- to be used in Western Cape)

GROUPS	SENSITIVITY SCORE	
FLAT WORMS	3	
WORMS	2	
LEECHES	2	
CRABS OR SHRIMPS	6	
STONEFLIES	14	(26)
MINNOW MAYFLIES	5	
OTHER MAYFLIES	13	
DAMSELFLIES	4	
DRAGONFLIES	6	
BUGS OR BEETLES	7	
CADDISFLIES	9	(16)
TRUE FLIES	1	
SNAILS	5	
TOTAL SCORE		
Number of groups		
AVERAGE SCORE (divide total by number of groups)		

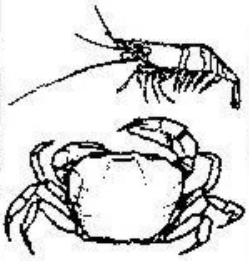
Caddisflies SCORE 9 (16)



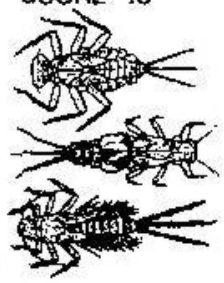
True Flies SCORE 1



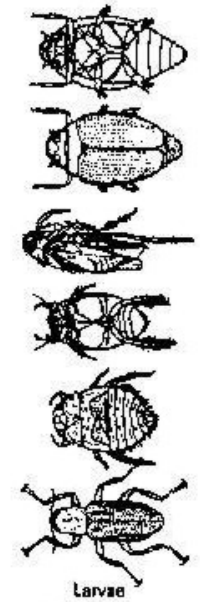
Crabs or shrimps SCORE 6



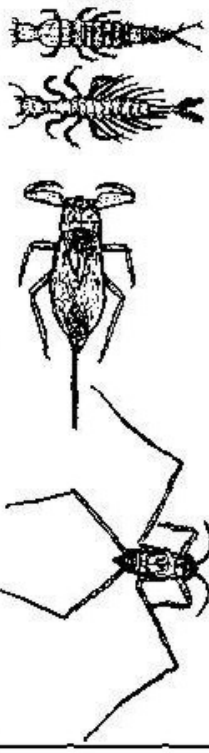
Other mayflies SCORE 13



Bugs or Beetles SCORE 7



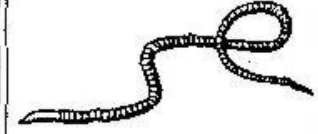
Larvae



Damselflies SCORE 4

Minnow mayflies SCORE 5

Worms SCORE 2



Stone flies SCORE 14 (26)

Leeches SCORE 2

Dragonflies SCORE 6

Snails SCORE 5

Flat worms SCORE 3

Calculating your river's MiniSASS score

1. For each of the groups found in your sample, circle the score on the table on page 8.
2. Total the scores and divide by the number of groups found. This will give you an average score. MiniSASS produces a single score which is similar and comparable to the average score which is produced by the more complex version of SASS.

Interpretation

0 – 2	Highly impacted stream (poor condition)
2 – 4	Impacted stream (fair condition)
4 – 6	Slightly impacted stream (good condition)
> 6	Good quality stream (probably approaching natural condition)

On rare occasions, an incorrect result will be obtained when the average score is high but the sample only contained a few (1 to 3) insect groups. When this happens this means that the river is impacted or disturbed but in a way that favours some organisms.

Now that you have calculated and interpreted your river's MiniSASS score, display a summary of your results in the form of a poster – be creative and add as much details as possible, without making the poster too text heavy.

Remember to return all the insects back to the river.

Criteria to assess learners during this life sciences lesson

Criteria	Outstanding	Meritorious	Satisfactory	Adequate	Partial	Inadequate
The learner followed the instructions given by the teacher						
The learner collected insects and added the data to a table						
The learner designed a poster to display a summary of their MiniSASS results						

ACTIVITY THREE: WATER QUALITY IN THE PAST

This PHYSICAL SCIENCES lesson looks at water quality, water-borne diseases and some simple ways of purifying water. This is followed by a case study on the water collecting ways of Nguni people.

READ THE FOLLOWING TO YOUR LEARNERS:

Water from rivers and dams is often not clean and may contain bacteria and dissolved substances, such as salts from the soil and gases from the air. Other contaminants include solid substances and debris, such as mud and refuse. Before we drink any water, we need to ensure that it is safe to drink and that solid substances and any bacteria have been removed.

Water often carries diseases that kill about 25 million people each year. The need to ensure clean adequate water supplies is one of the most urgent problems facing our country.

Some major water-borne diseases include:

- **Cholera** is an acute intestinal infection caused by the bacterium *Vibrio cholerae*. It causes watery diarrhoea and vomiting that can quickly lead to severe dehydration and death if treatment is not promptly given.

- **Typhoid Fever** is an acute illness associated with fever caused by the *Salmonellae Typhi* bacteria. The bacteria are deposited in water or food by a human carrier, and are then spread to other people in the area.

  Typhoid Fever is contracted by the ingestion of the bacteria in contaminated food or water. People with acute illness can contaminate the surrounding water supply through the stool, which contains a high concentration of the bacteria. Contamination of the water supply can, in turn, taint the food supply.

- **Bilharzia** is a human disease caused by parasitic worms called *Schistosomes.* Approximately 300 million people in the world are infected. Bilharzia is common in the tropics where ponds, streams and irrigation canals are home to bilharzia-transmitting snails. Parasite larvae develop in snails from which they infect humans, their ultimate host, in which they mature and reproduce.

  Within days after becoming infected, you may develop a rash or itchy skin. Fever, chills, coughing, and muscle aches can begin within 1-2 months of infection.

- **Gastroenteritis** is an infection of the guts (intestines). The severity can range from a mild tummy upset for a day or two with some mild diarrhoea, to severe diarrhoea and vomiting for several days or longer. Many viruses, bacteria, and other microbes (germs) can cause gastroenteritis. Food poisoning (infected food) causes some cases of gastroenteritis. Many different types of germs can cause food poisoning. Common examples are bacteria called campylobacter and salmonella. Water contaminated by bacteria or other germs is a common cause of gastroenteritis, particularly in countries with poor sanitation.

- **Dysentery** is an infection usually spread from person to person. It is caused by bacteria called "shigella". It causes inflammation of the bowel, which gives bloody diarrhoea, headaches, fever, nausea and sometimes vomiting and stomach cramps. These symptoms usually only last for a few days, and need no treatment other than rest and plenty to drink. After having dysentry, people may still carry the bacteria for a while, even though they feel better.

In South Africa, tap water is safe to drink as all the bacteria that may have been in it, are killed during the purification process. You should never drink water from rivers or dams without treating it first.

ASK THE LEARNERS:

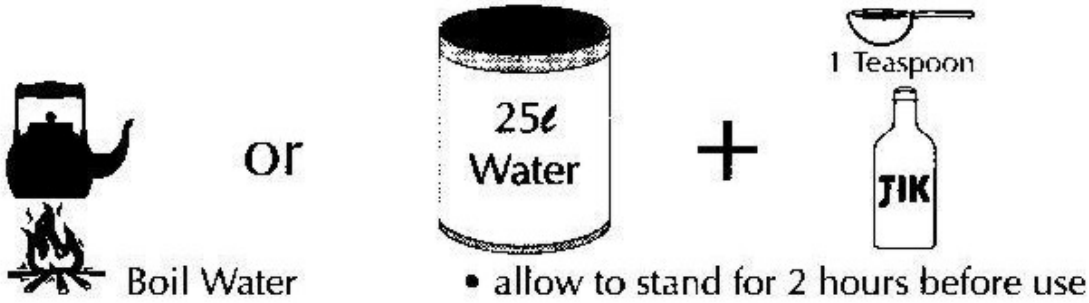
- Do they know of anyone who has had one of the diseases you have read about?
- Many water-borne diseases can be prevented through being careful about where water for drinking is collected and good hygiene practises. Where do the learners in the class get their drinking water? How can they be sure that it is clean and safe for drinking?
- What personal hygiene practises can your class adopt to prevent the spread of diseases *(such as washing hands before meals, when working with food, after going to the toilet, after changing babies' nappies)?*

ASK THE LEARNERS:

Do any of you know of any simple way that you can clean (purify) your drinking water (especially if you are collecting it from a river or spring and are not sure that it is clean)?

- A simple way of purifying water is to add a teaspoon of jik to every 25 litres of water. Jik is very strong and kills all the bacteria, making it safe to drink.

- You can also boil the water, and that will kill any germs or bacteria that may be living in it. The water can be left to cool. It does not need to be drunk hot.



- What are other good hygiene practises?

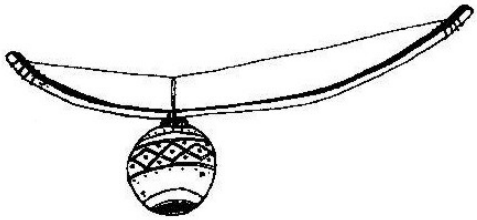
INDIGENOUS KNOWLEDGE AND WATER QUALITY

LEARNER ACTIVITY:
Read the case study below and then answer the questions that follow:

(In the story that follows, comments and scientific observations are in brackets and italised so that the learners can see the practical wisdom behind some water collection myths and techniques of the past).

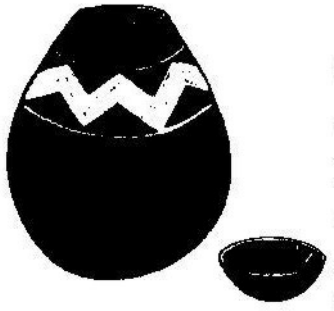
Before the time of the Zulu King, Shaka, sweet water was called “amanzi amnandi”. Shaka’s mother was called Nandi and it is said that because it was not considered respectful to use the queen mother’s name in this way, Shaka referred to sweet water as “amanzi amtoti”. *(This is how the town of Amanzimtoti, south of Durban, got its name).* Today both terms are used and many people of Nguni origin will sniff, smile and hold up “sweet” water, collected from a river, spring or well for their daily household needs. *(Water quality scientists today still have people smell and taste household water. Human senses give a refined indication of whether water is good and clean and fresh).*

Historically, water was usually collected in areas where people could hear it running over stones or dripping down rocks *(well oxygenated water supports natural biological cleansing processes).* If a spring was for human use, it was protected by a circle of rocks with a small outlet. Cattle drank elsewhere.



An area nearby was cleared and the site soon became a meeting place for young people. Young men would hang around these water collection sites, playing musical instruments and admiring the maidens who came to collect water. The girls would saunter along slowly and gracefully, singing and flirting. Water collecting was rarely seen as a tiring or boring chore because of the prospect of courtship!!

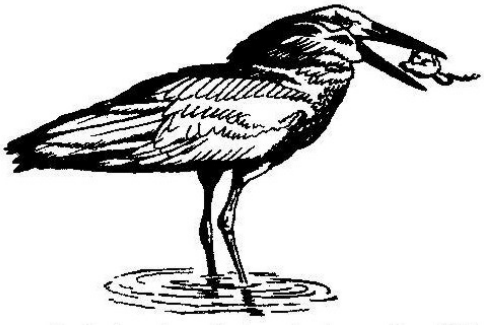
A water source would always be approached with care so as not to frighten crabs and other small water animals. When disturbed, their movement would stir up sediments and the collector would have to wait for the silt to settle. The surface film was brushed aside for “sweet water” to be collected. *(Sediments and surface films have higher bacteria numbers than the middle waters of pools and rivers. Today scientists take water samples below the surface film, taking care not to suck up sediments. In this way, scientists can get consistent and reliable measures of bacterial contamination).*

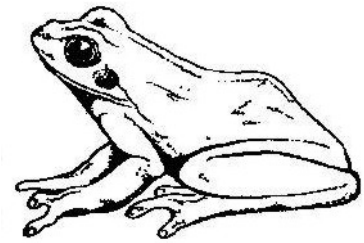


Clay pots were filled with water and covered with a collecting bowl, a piece of skin or a mat made from incema (*Juncas kraussii*) grass. The water would thus stay cool and fresh. *(Water evaporating through the sides of a porous clay pot cooled the contents. Most water bacteria cannot reproduce in cool, dark conditions. Some micro-organisms envelop themselves in a calcium secretion in the pores of clay pots. Scientists spoken to were uncertain about the detail of these issues but it is of note that, in earlier times, great care was taken to scour out a calcium-like scale in water pots. Also of note is that when the grass*

"lids" and head rings for carrying pots became old they were simply thrown away and new ones were woven. Discarded lids did not pollute the river like today's bottle tops and plastic waste).

There were many other customs and traditional practices surrounding water. Children were warned that urinating in a river would change them to the opposite sex! *(This myth was probably sufficiently frightening to prevent people urinating in streams and rivers. This would have limited a disease like bilharzia. The bilharzia parasite is passed on from human urine and faeces to small water snails. From these, its life cycle takes the disease back to people through river water).*





Nguni water collectors say that where there are frogs, one does not find sweet water. Frogs are eaten by hammerkops (*uthekwane*, the "lightning bird") and the prospect of collecting water while being watched by a "witch-bird" must have been terrifying in earlier times when spirits, myths and mystery had a more central place in everyday social life. Children were told that if they killed this bird or stole its eggs, their homes would go up in flames. *(Where there are frogs, one will usually find snakes. Both animals are feared by many people today, not least the children who were told the Nguni myths of witches and lightening to fill their hearts with terror. Today, scientific tests suggest that many frog species need "sweet water" if they are to live and reproduce successfully. There must be some doubt about the Nguni suggestion that frogs are an indication of water that is not fit for human consumption).*

It is also said that it was not advisable to collect water from a river after heavy rain at the start of the annual rainy season. Indigenous commonsense told people to put out pots to collect rain-water. River water would again be collected four days after the rains stopped and the water had cleared. *(Heavy rains wash human and animal wastes into rivers. There is thus a rapid increase in faecal bacteria and disease. In KwaZulu-Natal, health workers have to warn rural people not to collect river water after heavy rains as few remember the earlier Nguni practice of collecting rain-water only four days after the rains have stopped).*

Today human and livestock numbers have increased vastly, catchments have become degraded and rivers are often polluted dumping places. The best indigenous practices for the collection of "sweetwater" may not prevent people getting serious diseases from river water. Learning about historical water collection and storage practices can, however, develop a respect for early people and might also help our understanding of water quality issues.

QUESTIONS:

1. Have you collected water from a nearby river? What was the water used for? (If for drinking, how were you certain that it was safe to drink?)
2. What do you think 'well oxygenated water' means?
3. Why do scientists take water samples below the surface of the water?
4. Why did the Nguni scour their clay pots regularly?
5. Name the methods that the Nguni people used to reduce the contamination of their drinking water?
6. Do you think that these practices of collecting water are still relevant today?

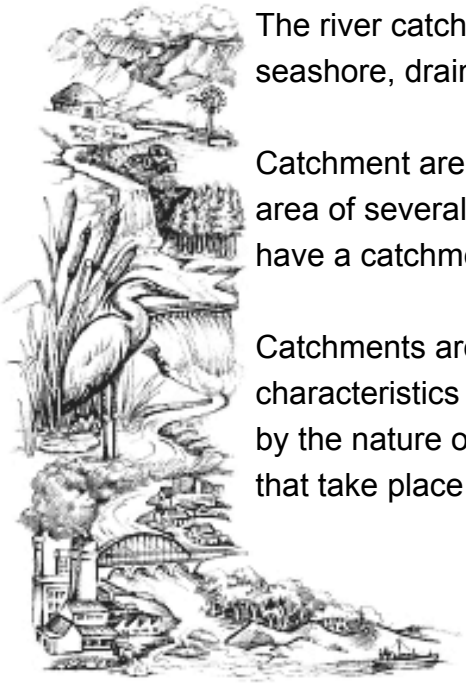
Criteria to assess learners during this physical sciences lesson

Criteria	Outstanding	Meritorious	Satisfactory	Adequate	Partial	Inadequate
The learner contributed to discussions about water-borne diseases and personal hygiene practises						
The learner adequately answered all six questions at the end of the reading (written answers)						

ACTIVITY FOUR: INVESTIGATING WATER QUALITY IN CATCHMENTS

Estuaries are silting up, inland wetlands are disappearing, some perennial rivers are drying up, and rivers, lakes and dams are polluted! Water bodies in southern Africa clearly suffer from many problems – all of which are linked to the way in which the catchment area is used. This PHYSICAL SCIENCES lesson looks at water use in a catchment and encourages learners to look at ways of conserving and caring for our water catchments.

What is the river catchment?



The river catchment, or drainage basin, is all the land from mountain top to seashore, drained by a single river and its tributaries.

Catchment areas vary greatly in size – a big river may have a catchment area of several thousand square kilometres, whereas a smaller tributary will have a catchment area of only a few hectares.

Catchments are separated from each other by watersheds. The characteristics of any river (physical, chemical, biological) are determined by the nature of the catchment and the activities, both human and natural, that take place in it.

The importance of plants

In catchments which have not been cultivated or developed, the ground cover or vegetation is still in place. Ground cover is important for the following reasons:

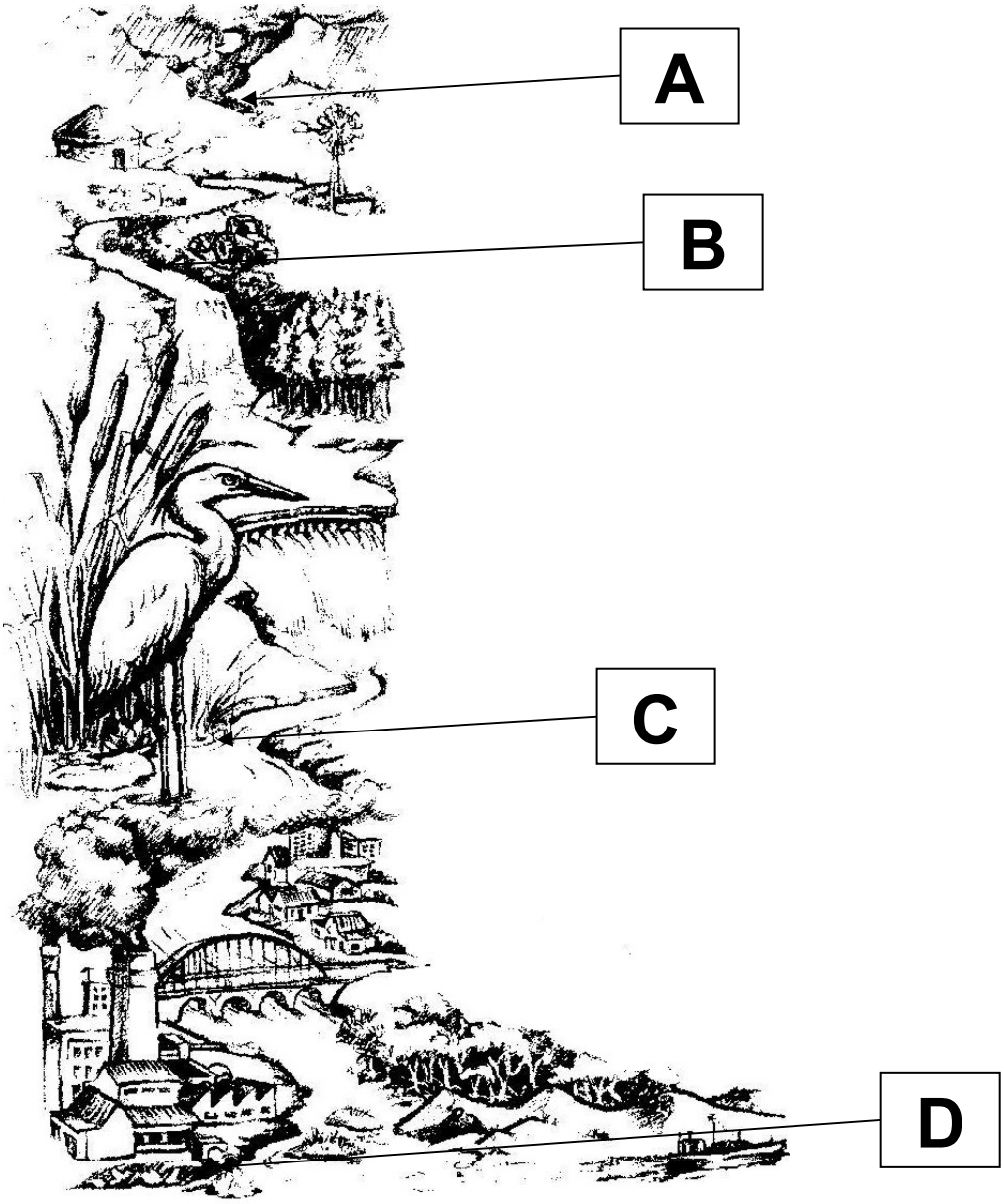
- Plants slow down water as it flows over the land (runoff) allowing much of the rain to soak into the ground and replenish underground waters (aquifers). Water seeps from these aquifers into rivers, which are therefore usually perennial (flow throughout the year).
- Plants prevent soil erosion as their roots hold soil in position, preventing it from being washed away. In addition, plants break the impact of a raindrop before it hits the soil, thus reducing its erosive potential. Rivers running through an undisturbed catchment are clean, erosion is slow and limited to periods of very high rainfall.
- Vegetation in wetlands and on the banks of rivers is of particular importance. The roots of the reeds, sedges, trees, shrubs and grasses growing in wetlands and next to rivers bind the soil of the riverbank and prevent erosion, whilst cleaning the water and regulating its flow.

Disturbed catchments

Where plant cover in river catchments has been disturbed by farming, industry or settlements, soil erosion increases. In addition, without plants, runoff increases and the supply of water to aquifers are reduced because less water soaks into the ground. Consequently rivers do not have a continuous supply of water from the aquifers and flow only in the rainy season. Much of the deposition of silt into estuaries results from erosion of riverbanks. When riverbank (riparian) vegetation is removed, the banks are at the mercy of the erosive forces of flood waters which scour away the river bank allowing the adjacent slope to collapse.

In many catchments the indigenous vegetation has been replaced by alien plants such as black wattle, pine and eucalyptus. These trees use large amounts of water from the rivers and streams that they thrive next to, thus reducing the amount of water available. In addition, invasive plants tend to smother the natural ground cover and this leads to soil erosion, and of course, a reduction in the biodiversity of that area. Invasive plants tend to be bigger than the indigenous vegetation, and when they burn the fires are very hot - this in turn damages the soil and contributes to more severe erosion.

ACTIVITY:



Results of tests carried out on samples of water taken from A, B, C and D are shown below:

Test	Sample A	Sample B	Sample C	Sample D
Temperature (ºC)	11	12	12	16
Dissolved oxygen (ppm)	16	14	16	4
pH	7	9	6.5	4.5

Temperature
Temperature is one of the most important and most influential water quality characteristics to life in water. An important physical relationship exists between the amount of dissolved oxygen in water and its temperature. The warmer the water, the less dissolved oxygen, and the colder the water, the more dissolved oxygen.

For this reason, heat or "thermal pollution" may be a problem, especially in shallow slow-moving streams or rivers. Most fish simply cannot tolerate warm water and/or low levels of dissolved oxygen. Thermal pollution may also result when industries release the water used for cooling

their machines into waterways. Water temperatures, even kilometres away from the release points, may rise dramatically. The result may be dead fish, fish eggs that won't hatch or a total change in the fish population as warm water varieties replace the original trout or other cold water fish.

Dissolved oxygen in fresh water

Waters with consistently high dissolved oxygen are usually considered to be healthy, capable of supporting many different kinds of water organisms. Much of the oxygen in water comes from the atmosphere through rainfall, through tumbling water in fast moving streams and from water plants (photosynthesis). In some dams dissolved oxygen may increase owing to photosynthesis during the day but at night it may decrease owing to plant respiration. Large daily fluctuations in dissolved oxygen may be found in rivers and dams choked with invasive water plants. Water temperatures also affect dissolved oxygen levels as oxygen is more easily dissolved and retained in cold water. Effluent and agricultural chemicals enrich water, promoting the growth of algae and other water plants. Sewage effluent promotes large populations of bacteria which consume oxygen as they decompose organic matter. Low oxygen levels are often associated with sewage effluent enrichment.

Ppm stands for parts for million and is a measure of concentration. This is a way of expressing very dilute concentrations of substances. Just as per cent means out of a hundred, so parts per million or ppm means out of a million. It usually describes the concentration of something in water or in soil. One ppm is equivalent to 1 milligram of something per litre of water (mg/l) or 1 milligram of something per kilogram soil (mg/kg).

pH

The "p" stands for "potenz" (this means the potential to be) and the "H" stands for Hydrogen. So you must write pH with a lower case (little) p and an upper case (capital) H.

Water (H_20) contains hydrogen ions (H^+) and hydroxyl ions (OH^-). Pure deionised water contains equal numbers of H^+ and OH^- ions and is considered neutral (pH 7), neither acid nor basic. If the sample measure has more H^+ ions it has a pH less than 7 and is considered acid. If it has more OH^- ions than H^+ ions it is considered basic and has a pH greater than 7.

Rainwater is naturally slightly acidic but the type of rocks and minerals in a catchment usually determines the pH. Atmospheric pollution (nitrogen oxides and sulphur dioxides) from vehicles and thermal power stations usually produce acid rain, a serious threat to aquatic systems. Sewage and industrial effluent discharges can also affect the pH balance of rivers.

ANSWER THE FOLLOWING QUESTIONS:

1. What would you imagine the water to be like at A?
2. What would you imagine the water to be like at D?
3. Suggest why the town’s water supply is taken from the river at C and not D.
4. What is the most likely reason for the high water temperature found D?
5. At B, the river is becoming choked with water plants. Suggest a reason why this is happening.
6. Why do you think the dissolved oxygen has increased at C?
7. Do you think you will find the same species of water creatures at D and A? Explain your answer.
8. What does ppm stand for?
9. If the pH at point D is 4.5, will it be acidic or basic? Will it have more hydrogen ions or more hydroxyl ions?
10. Do you think there is a human impact on this river catchment? Discuss.

Criteria to assess learners during this physical sciences lesson

Criteria	Outstanding	Meritorious	Satisfactory	Adequate	Partial	Inadequate
The learner was able to adequately answer all the questions in the exercise						
The learner was able to see the impact of human settlements and technology on a river catchment (question 10)						

ACTIVITY FIVE: JUST FOR FUN! YOUR ECO FOOTPRINT

We all use water every day for things like drinking, cooking and washing. We could not survive without water! This LIFE SCIENCES activity looks at how small or large our eco footprint is.

This activity can be done as a class with you, the teacher, reading the questions and learners writing down their answers, or the learners can work out their eco footprint on their own.

The ever-increasing pressures on our environment will have touched all of us in some way and we need to take a careful look at how the choices we make in our everyday lives impact on the Earth. That is, we need to ask “How big is my ecological footprint?” The following questions will encourage learners to think about different ways they impact on the Earth and ultimately stimulate ideas of ways that we can all make improvements to reduce our ecological footprint.

QUESTIONS TO ASK THE LEARNERS:

1. WATER USE

The amount of water used often depends on whether you have running water in your home, a tap in your yard, or whether you carry water from a river or dam. The way that you use water in your home can sometimes be very wasteful especially when that water is readily available on tap!

When you wash, do you use:
a. A bucket?
b. A shower?
c. A bath?

What points did you get for your answer to question 1?
a. 0 points b. 5 points c. 20 points

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2. RE-USING WATER

South Africa is a water-scarce country. It is believed that by the year 2025 we will have insufficient water for use in our homes, for agriculture and for industry.

By using water carefully, you can help to conserve our water sources.

When you have finished washing at home:
a. Does your water run straight down the drain?
b. Do you use the water on your plants?

What points did you get for your answer to question 2?
a. 20 points b. -10 points

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3. ENERGY USE

Whether you use electricity, coal or paraffin for energy in your home, you are polluting the air – which causes acid rain, global warming and health problems. You can conserve energy by using energy-saving devices (such as a hot box for cooking), solar-powered energy systems, and energy-saving bulbs.

In your home do you have at least one energy-saving method?
a. Yes b. No

What points did you get for your answer to question 3?
a. -10 points b. 20 points

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4. INDIGENOUS PLANTS

By growing indigenous plants in your garden, you can contribute to biodiversity because you will attract indigenous insects, birds and other animals. Indigenous plants have many advantages over alien plants, for example, they require less water.

Excluding your home-grown fruit and vegetables*, in your garden at home are:
a. Most of the plants are indigenous?
b. More than half the plants are indigenous?
c. Less than half the plants are indigenous?
d. None of the plants are indigenous?

What points did you get for your answer to question 4?
a. -10 points b. 0 points c. 10 points d. 20 points

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5. ANIMAL-BASED PRODUCTS

Producing animal products (beef, chicken, pork, eggs, fish, dairy etc) puts much more pressure on the environment than producing vegetables. Many people eat more meat than their bodies need. People who eat a lot of meat have more impact on the environment than those who eat less meat or no meat at all.

How often do you eat animal products?

a. Never
b. A few times a week
c. Once a day
d. Small amounts at every meal
e. A large part of every meal

What points did you get for your answer to question 5?

a. -10 points b. 0 points c. 5 points d. 10 points
e. 20 points

---

6. LOCALLY GROWN FOOD

Much of the energy cost of food production is spent transporting food from harvest to market, and for processing, packaging and storage. Growing food yourself or buying locally grown, in-season, unprocessed food can therefore reduce energy consumption. Buying food from local farmers can greatly reduce your ecological footprint.

How much of the food that you eat is locally grown, unprocessed and in-season?

a. Most b. About three quarters c. About half d. About a quarter e. Very little

What points did you get for your answer to question 6?

a. -10 points b. 0 points c. 5 points d. 10 points
e. 20 points

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7. LIVING SPACE

An unnecessarily large home uses more materials from the environment (for building and maintenance) and takes up more space (which could be better used for agriculture and nature reserves).

In your home, do you have:

a. More people than bedrooms?
b. The same number of people and bedrooms?
c. More bedrooms than people?

What points did you get for your answer to question 7?

a. -10 points b. 5 points c. 20 points

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8. POISONS IN THE HOME GARDEN

Poisons – more correctly called biocides – are often used to kill rats, insects and weeds. Many of the ingredients in these biocides cause allergies, trigger cancer growth and cause genetic defects.

Frequently we don't actually need to kill in the first place! The flat spider on the wall won't hurt you at all. But if we really do need to kill, we need to decide which option of removal is the most environmentally friendly.

In your home, when you have a problem do you:

a. Use the strongest insecticide or other poison and use until the problem is solved?
b. Buy specially designed environmentally friendly products?
c. First attempt to solve the problem with a less destructive alternative?

What points did you get for your answer to question 8?

a. 20 points b. 0 points c. -10 points

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9. RE-USING

Re-use of some of your waste helps to reduce the impact on the environment; reduces the amount of waste that goes into landfill sites (rubbish dumps) and reduces the amount of raw materials required.

At home do you re-use:

a. PAPER
Never Sometimes Often

b. GLASS
Never Sometimes Often

c. TINS
Never Sometimes Often

d. PLASTICS
Never Sometimes Often

What points did you get for your answers to question 9?

a. Never – 20 points, Sometimes – 5 points, Often – -10 points
b. Never – 20 points, Sometimes – 5 points, Often – -10 points
c. Never – 20 points, Sometimes – 5 points, Often – -10 points
d. Never – 20 points, Sometimes – 5 points, Often – -10 points

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10. RECYCLING

Recycling of some of your waste helps to reduce the impact on the environment, reduces the amount of waste that goes into landfill sites (rubbish dumps), and reduces the amount of raw materials required.

At home do you recycle:

a. PAPER
Never Sometimes Often

c. GLASS
Never Sometimes Often

c. TINS
Never Sometimes Often

d. PLASTICS
Never Sometimes Often

What points did you get for your answers to question 10?

a. Never – 20 points, Sometimes – 5 points, Often – -10 points
b. Never – 20 points, Sometimes – 5 points, Often – -10 points
c. Never – 20 points, Sometimes – 5 points, Often – -10 points
d. Never – 20 points, Sometimes – 5 points, Often – -10 points

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11. REDUCING

You can reduce your eco footprint by shopping carefully. Buy in bulk to reduce packaging; buy refills (e.g. deodorants); chose well-made articles that will last well and those with recycled content; and avoid over-packaged products.

When you buy products do you:

a. Always think of the amount you will throw away?
b. Often try – but take into consideration price and brand?
c. Sometimes – depending on the price and brand?
d. Never think of how goods are packaged or how long they will last?

What points did you get for your answer to question 11?

a. -10 points b. 0 points c. 5 points d. 20 points

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12. CONSUMER CHOICES

Some goods available in supermarkets pollute the environment more than others – a roll-on deodorant is better than a spray containing CFCs (which break down the ozone layer); a brightly coloured toilet cleaning liquid is not necessary as that colour doesn't clean the toilet!

When you shop do you choose the least polluting product?

a. Always
b. Often – depending on price, brand or what you have seen on television
c. Sometimes – depending on price, brand or what you have seen on TV
d. Never think about such things

What points did you get for your answer to question 12?

a. -10 points b. 0 points c. 5 points d. 20 points

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13. TRAVEL

Poisonous gases and substances released by cars and other motor vehicles include nitrogen oxides, hydrocarbons and lead which contribute to acid rain, smog, health problems and global warming.

How do you get to work/school/college?

a. On foot b. By bicycle c. By taxi d. By car

What points did you get for your answer to question 13?

a. -10 points b. 0 points c. 5 points d. 20 points

Add up all your points!!!

Your final ecological footprint

- Score less than 50: Green Footprint (You have a TINY ecological footprint)
- Score from 51-110: Yellow Footprint (You have a small ecological footprint)
- Score from 111-180: Blue Footprint (You have a medium ecological footprint)
- Score from 181-290: Orange Footprint (You have a large ecological footprint)
- Score from 291-400: Red Footprint (You have a HUGE ecological footprint)

With your class:

- Each learner to think of one product that they have, or one thing that they consume. What is its impact on the planet?
- Discuss ways that our school can practically reduce our ecological footprint.
- Discuss ways that our class can reduce our ecological footprint.
- Discuss ways that individual learners can reduce their ecological footprint.

Criteria to assess learners during this life sciences lesson

Criteria	Outstanding	Meritorious	Satisfactory	Adequate	Partial	Inadequate
The learner contributed to the discussion on the impact of products on our environment						

Water and Sanitation

Share-Net

This pack supports an introduction for learners to an Eco-School's focus on Healthy Living

Grade 11

This pack contains:

Activity One: During this **LANGUAGES** lesson, learners investigate how people's everyday activities in the past contributed towards the prevention of cholera. This is followed by an individual self-study on a health issue in the area, related to water.

Activity Two: Audits and surveys are systems that allow us to look and examine things the way they are. This enables us to understand something better and improve it if need be. This **LIFE SCIENCES** activity allows learners to conduct a pre-designed audit on their school toilets, and then develop a survey around how the current situation can be improved.

Activity Three: This **DRAMATIC ARTS** lesson encourages learners to look for different solutions and appropriate courses of action around access to water and sanitation, through forum theatre.

Activity Four: During this **LIFE ORIENTATION** lesson, learners find out more about State of the Environment Reporting. The class then chooses three themes, one of them around water access and sanitation which they would like to investigate either in their school or community. Learners take their findings further by developing action plans.

Activity Five: Just for fun! Making soap - this **PHYSICAL SCIENCES** lesson gives instructions on how to make 'Settlers Soap'.

WESSA

This pack of lesson plans is part of a series of lesson plans from Grade R to Grade 12 which focus on water and water-related issues. This resource development project has been funded by the Water Research Commission, Private Bag X 03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).
This pack is available electronically on www.wrc.org.za

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. Learners investigate how people's everyday activities in the past contributed towards the prevention of cholera. This is followed by an individual self-study on a health issue in the area, related to water.	Languages	**Learning Outcome 1**: Listening and Speaking. The learner is able to listen and speak for a variety of purposes, audiences and contexts**.**	The learner is able to demonstrate planning and research skills for oral presentations: • Research a topic by referring to a range of sources; • Organise material coherently by choosing main ideas and relevant and accurate details or examples for support; • Prepare effective introductions and endings; • Incorporate appropriate visual, audio and audio-visual aids such as charts, posters, photographs, slides, images, music, sound and electronic media.
2. This activity allows learners to conduct a pre-designed audit on their school toilets, and then develop a survey around how the current situation can be improved.	Life Sciences	**Learning Outcome 1:** Scientific inquiry and problem-solving skills. The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.	The learner is able to systematically and accurately collect data using selected instruments and / or techniques. • As a member of a team (class) carries out a survey in selected areas; • Recognises that people responding to the survey may not give accurate answers for a variety of reasons. Analysing, synthesising, evaluating data and communicating findings. • The learner prepares and submits an article for the school newspaper or newsletter describing the research and findings.
3. Learners look for different solutions and appropriate courses of action around access to water and sanitation, using forum theatre	Dramatic Arts	**Learning Outcome 4**: Reflect and Evaluate. The learner is able to reflect on and evaluate own and others' dramatic processes, practices and products.	The learner is able to analyse how a drama relates to: • own personal experience; • human commonality and diversity.
4. Learners find out more about State of the Environment Reporting. The class chooses three themes, one of them around water access and sanitation, which they would like to investigate either in their school or community.	Life Orientation	**Learning Outcome 2:** Citizenship Education: The learner is able to demonstrate an understanding and appreciation of the values and rights that underpin the Constitution in order to practice responsible citizenship, and to enhance social justice and environmentally sustainable living.	The learner is able to participate in a community service that addresses a contemporary social or environmental issue, indicating how it can harm certain sectors of the society more than others.
5. Just for fun! Making soap - how to make 'Settlers Soap'.	Physical Sciences	-	-

ACTIVITY ONE: HOW PEOPLE'S EVERYDAY PRACTICES CONTRIBUTED TO THE PREVENTION OF CHOLERA

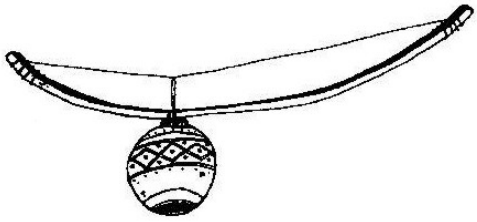
Learners investigate how people's everyday activities in the past contributed towards the prevention of cholera during this LANGUAGES lesson. This is followed by an individual self-study on a health issue in the area, related to water.

ACTIVITY:
Photocopy pages 1 and 2 and hand out to your learners.

How People's Everyday Practices Contributed to the Prevention of Cholera

The way people disposed of rubbish was different before sophisticated rubbish such as plastic bags became popular. An area called 'etaleni', which lay a short distance from the huts, is where rubbish was dumped. This would be piled up with leaves swept from the cleared sitting space around the huts, ash from old fires, chewed sorghum stalks, pumpkin skins and seeds. The rainy seasons would come and the pumpkin seeds shooted and produced the best pumpkins.

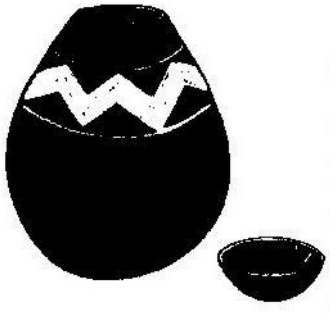
People did not construct pit latrines, and they defaecated in the veld or the forest. They were very discrete in terms of disposing bodily waste. They never defaecated or spat where their faeces and saliva could be discovered for fear that their enemies could use it for witchcraft. This meant grass and forestlands were favoured. Busy places like water collection places were avoided because of their potential as meeting areas for males and females. Males hung around them in anticipation of meeting young ladies who had come to fetch water.



Not defaecating in water contributed to making sure that water, which was drunk by people, was clean and this contributed to preventing cholera.

'Kuhabula' (the breathing in of bad air/bad spirits) was guarded against and new mothers took great care that their children were safe from bad air. They never left the house unless the family felt they were strong enough and necessary ceremonies had been performed. Right after the baby had been delivered, they were discouraged from cooking and performing any household chores so that they did not infect other members of the homestead nor pick up infections. Breastfeeding was compulsory except in times of extreme sickness. A mother had to first wash her breasts and squeeze out the first milk before breastfeeding her baby. Children suckled until they were toddlers, which strengthened their immunity systems. Runny tummies were always associated with teething and elders said that it was because children chewed on anything they came across, relieving their itching gums like puppies. Care was taken immediately when a swelling was noted on a child's gums as an indicator of teething. A mother, who had been away from the house, was forbidden to pick up her baby before washing her hands and her breasts and she had to squeeze out the first milk before breastfeeding. *This was most likely done to prevent the spread of disease before they fed their babies.*

Visitors were always offered something to eat or drink and out of politeness after announcing his/her arrival, he/she would say ‘isisu somhambi asingakanani singange nso yenyoni’ (the stomach of a traveler is not much, it is the size of a bird’s sac). People would shake hands and sit down to chat, which would be followed by a bowl of hot water for washing hands before food was served. People ate with their hands and children usually ate together out of one big bowl. The food was not touched before hands had been washed.



After pouring the local beer into a smaller clay pot, the pot was cleaned with water before the wife would take a sip to display that it was good to drink and at passing it on, she would wipe the spot where she drank with her wet hand. *This is a cultural practice to show someone that the beer is safe to drink*.

People were sensitive about handshaking. People avoided shaking the hands of their enemies and if they had no choice, they always washed their hands immediately after. This was because an enemy could bewitch you through your hands. When one had been out of the house, people would always wash their hands before returning and doing anything in the house.

There was a popular use of wood ash to purify water. Ash was used when one had hiccups and to cook vegetables such as okra. When faeces were spotted in an area where it should not be, it was covered up with soil or ash. Ash was popularly known to purify things.

Animals were never allowed to drink water from water collection points. This was another way of preventing the spread of disease as animals often defaecate near water, thus contaminating the water and increasing the chances of the spread of disease.

Cholera is an acute intestinal infection caused by ingestion of food or water contaminated with the bacterium *Vibrio cholerae*. It has a short incubation period and produces an enterotoxin that causes a copious, painless, watery diarrhoea that can quickly lead to severe dehydration and death if treatment is not promptly given. Vomiting also occurs in most patients.

Most persons infected with *V. cholerae* do not become ill, although the bacterium is present in their faeces for 7-14 days. When illness does occur, about 80-90% of episodes are of mild or moderate severity and are difficult to distinguish clinically from other types of acute diarrhoea. Less than 20% of ill people develop typical cholera with signs of moderate or severe dehydration.

Cholera remains a global threat and is one of the key indicators of social development. While the disease no longer poses a threat to countries with minimum standards of hygiene, it remains a challenge to countries where access to safe drinking water and adequate sanitation cannot be guaranteed. Almost every developing country faces cholera outbreaks or the threat of a cholera epidemic.

Source: World Health Organisation, www.who.int/topics/cholera/about/en/index.html

CLASS ACTIVITY:
With your class, discuss the following two questions:

1. In the story it appears that people could not shake hands with their enemies because they were afraid of being bewitched. How has this myth assisted with the prevention of cholera? What are the disadvantages in terms of creating relationships with others?

2. Study the illustration above. What do you see? If you were living with these people, how would you make sure that you follow health safety practices but at the same time maintain a good relationship with them?

INDIVIDUAL ACTIVITY:
Planning and Research Skills for Oral Presentations

Find out about **a health issue related to water in your community** (some examples include levels of *E-coli* bacteria in the water, diarrhoea, cholera or bilharzia - see two news articles, at the end of Activity 1, from *The Witness* newspaper).

Once you have decided what you are going to research, gather as much information as possible. You need to make use of at least five sources (such as the Internet, personal communications with people or interviews [such as visiting a water board or a river scientist], newspapers, books, magazines, films or documentaries). List these sources carefully as you will have to show them to your teacher. Remember to acknowledge every source you use and keep a record of what you did at each step (i.e. what made you chose your particular topic – perhaps you know someone personally who has been affected by a river health issue? What sources did you use? Did you have trouble finding information?)

Once you have done all the research, decide how you are going to present your findings to the class. Your presentation must include at least one appropriate visual, audio and audio-visual aid (these could be charts, posters, photographs, slides, music, sound and electronic media).

Your presentation to the rest of the class will be 10 minutes and then there will be five minutes for questions from the class. Remember that to hold the class's attention, you need to have a dynamic and interesting presentation. Consider different ways to make your introduction and ending effective. Make sure that the content is sound and you have researched your topic thoroughly. Your aids will help with the presentation.

Note to teacher: The learner does not need to be able to answer all the questions asked during the five minute question period. If the answer is not known, he/she may offer the question to the class to see if anyone else knows the answer. The important consideration is that the questions are heard, considered and responded to in some positive way.

Criteria to assess learners during this languages lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
The learner was able to follow instructions						
The learner chose a relevant topic						
The learner used five sources for their research						
The learner used at least one visual, audio and audio-visual aid						
The learner was able to respond to all questions asked of him/her						

Duzi toilet time bomb

31 Jan 2008

Stephanie Saville

This is a time bomb.

Stuart Knight, a local pathogenic bacteria control specialist, has spoken to The Witness on the dangers that he said are lurking in the murky depths of the uMsunduzi River.

The E.coli count of 29 000 measured in the river before the start of the Duzi Canoe Marathon was 3 000 higher than the 26 000 that is acceptable in a functioning septic tank.

Knight, who has worked in the field of toilet systems for the past 30 years, said he warned Msunduzi Municipality years ago to sort out the city's pit latrine toilets and septic tanks to avert a major health disaster.

He said local people are dying from sewage-borne diseases like hepatitis and severe diarrhoea, but "it is always put down to simply natural causes". Cholera is also transmitted via raw sewage.

The extremely unhealthy situation that has developed around the presence of human waste in and around townships and surrounding rivers is having a devastating effect on HIV-positive people and on the elderly and young children, he said.

Knight said he was asked by Msunduzi to do an audit of waste materials flowing into the Duzi in 2005/2006. "I went through town from Vulindlela, the Edendale Valley and to most of the informal settlements looking at pit latrines, pit toilets and septic tanks." What Knight found was a dire lack of knowledge from locals on how such toilet systems should be cared for. "Almost every pit toilet was being used as a rubbish dump with plastics, steel hard wood, carpets, you name it, being chucked into the holes."

He said that as a result, they became over-full and people stopped using them. Many just went to the toilet on the ground. He found that many toilets and septic tanks are built over underground water courses that flow into the Duzi.

Knight was also concerned to find that those with septic tanks were medicating them with solutions like chlorhexidine gluconate and chloroxylenol, (found in Dettol and Savlon), which kill all the enzymes, worms and bacteria needed to break down the solid matter, and destroy the healthy pH system of the septic tank. The result of all this, said Knight, is that when it rains, the toilets and tanks, overflow and the run-off ends up in the Duzi.

Knight said a massive drive is needed to educate people on how to use and care for their toilet systems and that existing ones should be rehabilitated and restored and have the correct bacteria reintroduced into them. "Most of the systems are running at an acidic pH of nought — we need to get these back to six."

Knight said that instead of heeding his advice, the municipality went ahead and built 500 new toilets. "That was two years ago and they are all full now and unusable in many cases. The current situation with the Duzi now is their own fault." Knight said he told the municipality that if there was a cyclone or heavy rain, they would end up with a septic tank in every river.

He said temporary measures like cleaning toilets out with "honey suckers" are pointless as they are full within a month again. "The problem will carry on exacerbating itself again and again, but if we rehabilitate the toilet systems, it would save millions of lives and clean up the Duzi."

Approached for comment, municipal manager Rob Haswell said the problem is not that simple. He said the contamination is caused by a combination of factors, including the age of pipes, the lack of toilets and adequate storm water drainage. Msunduzi Municipality no longer employs a dedicated medical officer of health, but Haswell said they have a "highly qualified person" in the form of Dr Nomasonto Nkosi as an acting process manager in the health department.

Haswell referred The Witness to Phil Mashoko, manager for infrastructure, services and facilities for further comment, but Mashoko was unreachable yesterday.

Source: The Witness

Dusi threat

31 Jan 2008

There are three sporting events in and around this city which have put Pietermaritzburg on the national sporting agenda. The first is the famous Comrades Marathon, run between Durban and the capital city every year. The second is the increasingly popular Midmar Mile, swum on the nearby dam of that name. The third is the annual canoe marathon, contested over three days on the Msunduzi and Umgeni rivers as they flow towards the Indian Ocean. There was special jubilation this year when Michael Mbanjwa was the first black South African canoeist to come in as a winner with his paddling partner, Martin Dreyer.

News has now broken that over half the paddlers who participated in this year's race have suffered from gastric illnesses, such as diarrhoea, as a result of contaminated river water. "Dusi guts" has been a well-known phenomenon over the years, but not to this extent. The organisers are threatening that if the problem is not adequately resolved, the race could be cancelled next year.

There were acknowledged problems ahead of this year's race, with unacceptable E. coli levels caused in part by recent heavy rains which washed sewage from the Edendale valley into the river. Efforts were made to rectify the problem and a difficult decision was taken to go ahead with the race. Now it seems that this decision was probably unwise.

It is clearly important that all interested parties, including the municipality and the Department of Water Affairs and Forestry, should get together with a view to resolving this problem before next year's race. Socio-economic deprivation and an absence of proper sanitation in portions of the city lie at the heart of the problem and this needs to be addressed with vigour. For here is an opportunity for a focusing of the mind in microcosm just as, in macrocosm, the nation as a whole, electricity outages notwithstanding, is seeking to focus its mind around the hosting of the Soccer World Cup in 2010 and all the infrastructural work that this will entail.

Source: The Witness

ACTIVITY TWO: WATER AND SANITATION: SURVEYING OUR SCHOOL ENVIRONMENT

Audits and surveys are systems that allow us to look and examine things the way they are. This enables us to understand something better and improve it if need be. The following LIFE SCIENCES activity allows learners to conduct a pre-designed audit on their school toilets, and then develop a survey around how the current situation can be improved.

INDIVIDUAL ACTIVITY:
Learners complete an audit of their school toilets, using the template below:

Name: _____

Name of School: _____

Date of Audit: _____

Please complete ALL sections of the following checklist:

Number of learners in the school?	

SECTION A: Water and Sanitation	Yes	No
1. Is clean drinking water available?		
2. Is there enough water available for drinking and washing?		
3. Number of toilets available for learners?	Males	Females
4. Which of the following toilets are used in your school?	Mark with a ✔	
a. Flush toilet – full water-borne sewerage		
b. Pit latrine – pit toilet with no vent pipe		
c. Ventilated Improved Pit Latrine – pit toilet with vent pipe		
d. Bucket system – ½ bucket of water used to wash away sewerage		
	Yes	No
5. Are there adequate toilet facilities for learners?		
6. Are all of the toilets working?		
7. Is there enough privacy when using the toilets?		
8. Are there rubbish bins in the toilets?		
9. Is there enough toilet paper available?		
10. Is there clean water and a basin for hand-washing in or near the toilets?		
11. Is soap available for washing hands?		
12. Is there a towel available for drying hands?		
13. Are the toilets clean and hygienic at all times?		
14. Are there many flies around the toilets?		
15. Are there staff attending to the maintenance of the toilets?		
16. Are the school grounds free from faecal (poo) matter?		
17. Is there a place in the school grounds that is used as an alternative toilet?		
18. **Boys** – Do you know how to use a urinal correctly?		
19. **Girls** – Do you know about menstruation?		
- Are there sanitary bins in your toilets?		

GROUP AND CLASS ACTIVITY:

1. Discuss your findings in groups of 5. Give reasons for why you are satisfied or dissatisfied with your findings? Each learner should then summarise and comment on the findings of the audit in a written paragraph.
2. As a class, discuss the findings and comments from each group.
3. In the same groups of 5, draw up a survey, with at least 10 questions, to find out how the rest of the school feels about how the school toilets are managed. Have a variety of questions, not only those of the 'yes' and 'no' type. Remember that this is a survey to see how things can be improved – even if your toilets are in very good condition, there are always little ways that we can make things even better! *(A hint: Get positive feedback in terms of how the toilets could be improved; also remember that people responding to a survey may not give accurate answers for a variety of reasons).*
4. Conduct your survey.
5. Discuss the group findings with the rest of the class. Compile all the information into an article and submit it to the editor of your school's annual / quarterly magazine / newspaper.

Criteria to assess learners during this life sciences lesson

Criteria	**Rating Code 6 (Outstanding)**	**Rating Code 5 (Meritorious)**	**Rating Code 4 (Satisfactory)**	**Rating Code 3 (Adequate)**	**Rating Code 2 (Partial)**	**Rating Code 1 (Inadequate)**
The learner carried out the audit on the school's toilets						
The learner participated in designing a survey for feedback around the school's toilets						
The learner carried out the survey with the rest of his/her group						
The learner prepared an article on their findings of the toilet audit and survey						
The learner submitted an article of their findings of the toilet audit and survey to the school's newspaper editor						

ACTIVITY THREE: SO MUCH DRAMA IN OUR LIVES!!

This DRAMATIC ARTS lesson encourages learners to look for different solutions and appropriate courses of action around access to water and sanitation.

For the teacher:

An introduction to drama in your lessons:
Drama can offer you various skills and techniques which raise awareness and transform awareness into real-life action. Your role, as teacher, is to stimulate ideas and act as a catalyst. Instead of offering an education package which has pre-prepared solutions, the teacher who uses participatory drama offers a process so that learners can come to terms with many of the issues themselves. Through the drama process, learners are given the chance to 'rehearse' solutions to real-life challenges.

These are some of the principles on which participatory drama is based:

- **Learning through experiencing:** Learners are taken through an experience in which they participate actively. Such experiential learning means that the learner has to engage with issues, to make decisions, to take action, to reflect and to collaborate with others in the group. It also puts the learner in the position of having to draw on his or her real life experience.

- **Learner-centred education:** The participatory nature of drama challenges the idea that the teacher or facilitator is the 'all knowing' authority. Rather, it acknowledges that learners have knowledge and life experience which they can share, build on and use. Drama brings out what learners know, but don't yet know they know.

- **Action and Reflection:** For the learning process in drama to be effective, active participation is not enough – what is important is that participants are given the opportunity to reflect. Such reflection could take place in the form of a discussion after the drama, or it could be built into the drama itself. By action, reflection on that action, and then modifying the action based on the reflection, the learner is able to make conscious and informed decisions relating to his or her life.

- **The real and fictional worlds:** This refers to the ability to keep in mind the real world and the fictional world (the world of the story being told) at the time. So even when playing a role, the learner will draw on his or her real life experience.

- **The safety of role:** Through role-playing, the learner often feels more free to say or suggest things. This is because it is the character putting him or herself on the spot, rather than the learner personally. It is very important that the teacher creates a 'safe' atmosphere in which learners feel comfortable to take on roles and enter into the fiction.

- **Process and Product:** In participatory drama, the emphasis tends to be on the process that learners go through. Where in conventional theatre, the final play (the product) is the most important, in participatory drama it is the engagement with each other through a process of experience that is important. It is in such process-oriented drama that action and reflection can most effectively take place.

Getting Started

A Space for Drama: Create a physical environment that encourages participation. If you are in a classroom, clear the desks and chairs to the side to create an open space. Or find an open space, outdoors in a clearing, or in a community hall. Whatever space you choose, make it a special place – a space in which there is place for everyone to move, to sit in a circle, and to work in small groups.

Warming Up: It is a good idea to take the group through some warm-up activities at the start of each session. 'Warming up' in drama is more that just a physical warm-up – it fulfils a number of functions:

- It builds a group spirit and constructive group dynamic by getting people to work together.
- It stimulates creativity allowing learners to contribute interesting and creative ideas to the drama.
- It gets learners to participate actively using their minds, bodies and emotions imaginatively.
- It helps the group to focus – if they are too active it helps you to calm them down and focus their attention. If they seem lethargic and lazy it helps you to energise them!

Warm-ups can take a number of forms ranging from physical shake-outs of the body to songs and dances that everyone in the group might know, to games and imagination activities.

It is often a good idea to use performance forms that your community or group already knows. Use these as warm-ups, or integrate them into the process in some way.

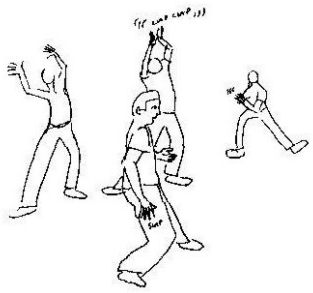
Here is an example of a warm-up

ACTIVITY:
Walking Around the Space

1. Everyone in the group should walk around the space. Learners should not all walk in the same direction, each person can walk in any direction they like and change direction as often as they want to.

2. Learners should walk with an attitude …know where they are going … they are walking with a purpose. Every time you clap your hands, learners change direction.

3. Call out the following different situations. Learners must change the way they are walking for each situation.
    - You are walking on hot coals
    - You are taking an energetic dog for a walk
    - You are wading through syrup
    - You are walking on ice
    - You are wading through a river
    - You are jumping from puddle to puddle



4. Learners must take note of how their walk changes for each situation. Sometimes it becomes faster or slower (the pace changes), or it changes the shape of the body. They start to express themselves physically. They also start to draw on their imagination and memory – for example, the feeling of wading through a river, or what ice feels like.

Start collecting various games and exercises that you can use for your various sessions. In this way you can start to build a 'basket of activities' that you can draw from whenever you need to do a warm-up. There will be a number of books in your local library that have details of various games that you can use (see the list at end of Activity Three).

The Teacher-Learner Relationship:
In this kind of work, the teacher becomes part of the learning community rather than an all-knowing figure. This means that you, as the teacher, need to:

- be a good listener – listen carefully to what each learner offers and acknowledge their contribution;
- create an enjoyable atmosphere during your sessions; this does not mean that the work you do is only about 'fun', but that you create an atmosphere which allows learners to be creative, to try things out and to take initiative;
- be more of a facilitator than a 'teacher', guiding the learners' activities;
- ask the right questions – instead of telling the learners everything they need to know, see if you can draw out many of the ideas and perspectives from the learners themselves;
- be motivating, flexible, creative and encouraging;
- create a 'safe environment' in which learners feel free to participate. This means an atmosphere which is non-judgmental and in which the learners feel they can make a contribution without being laughed at, scolded or ignored. Encourage and nurture the learners.

Read the following to your learners:

What is forum theatre?
Forum theatre is a dramatic game played between actors and the audience. A group of actors will develop a drama around a particular issue. The drama should be structured in a way so that it contains a point of conflict or unresolved tension which does not get resolved by the end of the drama. The conflict must be clearly expressed and carefully rehearsed. This means that the audience must be clear, from the action, what the issue is and what the characters' mistakes are. Once the drama has been performed for an audience, they are encouraged to participate in re-making the drama by taking the role of certain characters in the drama. The drama can be re-enacted many times with different members of the audience trying out solutions. The aim of the game is to try out different solutions or find appropriate courses of action for the community by trying to find a different ending for the drama that looks towards resolving the conflict.

Aims of Forum Theatre

- To encourage dialogue around issues.
- To practice action for the "real" world.
- To search collectively for solutions to issues.

The Process of Forum Theatre

1. The play is performed for the audience as if it were a conventional play.

2. The audience is asked whether they agree with the way in which the character dealt with the issue. The audience will probably answer no. The audience is then told that the drama will be done a second time. This time it will be in the form of a game between the actors and the audience where the audience have to try and get the drama to end differently so that the conflict is resolved. The actors will, within reason, attempt to get the drama to end in the same way. For example, the actors represent a vision of the world as it is, whereas the audience represent an image of the world as it could be. If the plays ends the same way, the world will stay the same.

3. The play is restarted. When the audience sees a moment in the play where they could potentially influence a change, a learner cries out “Stop”. The learner will say where he/she wants the play to start from, the actors re-start the play with the learner playing the role of the character. He/she puts forward his/her solution to the problem in the play. The actor who has been replaced stays on the sidelines to encourage and support the learner. The other actors will still remain agents of oppression to get the play to end in the same way. This is to demonstrate to the audience how difficult it is to change reality.

4. Different attempts can be made to change the play. At some point the audience may eventually break the oppression imposed by the actors and the play ends differently. This also may not happen as the audience may not agree on which action brings about the desired ending to the play. This is okay as the forum will still highlight potential ways forward for learners to discuss.

5. One of the actors should take on the role of “joker”. This person will be responsible for facilitating the process by explaining the rules of the game and encouraging everyone to participate.

6. Once the forum is over, it is important to develop a proposed play of action which the audience accepts. The audience play the changed drama from beginning to end.

These techniques are used to start dialogue around particular issues. They are not about producing an amazing piece of theatre. Forum theatre aims at finding potential solutions to problems. If the group comes up with a solution that they all agree on, it is important you and the learners begin looking for ways in which this solution can be enacted in “real life”.

> *A tip: The joker should explain to the audience that they should try out actions which are “real” and not “magic”. For example, if a person is starving, a magic action would be for him to find a R20 note on the street. This changes his situation briefly but does not address the reason for his position of poverty and thus is an unlikely solution to the problem the character faces.*

CLASS ACTIVITY:

1. Put on a play around the theme of sanitation. The class can choose to develop their own play around the issues and challenges of sanitation and healthy living or they can use the scenario given.

The example given explores different peoples' experience of access to water and how our behaviour, whether informed or uninformed, can influence the health of other people and our relationship with members of our community. It also challenges us to consider how we can best deal with the situation.

The scenario:
An official see a large group of women washing their clothes in a river. He also sees many pit latrines which have been built near the river. He is very angry as he has already told this community that there are people further downstream who use the water for drinking and that washing clothes in the river and building toilets so close to the water, is very bad, not only for themselves but for others. He shouts at the women and says that a bulldozer will be coming in a few days to bulldoze the pit latrines and that if he catches them washing in the river again, he will fine them. Next scene, we see the official at home, in the nearby town which has piped water, preparing a bath for himself and putting his laundry into an automatic washing machine. This is followed by a third scene where we see one of the woman from the nearby community, arguing with her husband as his clothes are not clean for the next day since the washing has not been completed. She has also told him about the visit from the official and the removal of the pit latrines. The play ends with the man shouting that he doesn't know what to do, shoving his wife aside and leaving the house.

Divide the class into two – one group will enact the play and the other group will be the audience.

2. Once the play has been performed to the learners, explain the rules of the game again and begin the play once more. Remember the key here is to explore different ways in which all the actors can deal with the problem of no access to water and the health risks that are being faced, both by in a realistic and favourable way.

3. At any given point, an audience member can call for the play to stop. He/She should take the place of the person in the drama and try and resolve the situation. Members of the audience can encourage the learner from the sides but it is important to allow him/her to try out his/her idea to its conclusion.

4. Depending on the result of the learner's actions, other audience members can try out their solutions. Continue replaying the play until you run out of time or until everyone is satisfied with the way the play has ended.

5. After the play:
    a. ask the learners how the drama relates to their own personal experiences;
    b. ask the learners how the drama relates to their community or a community nearby;
    c. reflect on what ideas and issues have arisen and together come up with a proposed plan of action for addressing the issue of access to water and better sanitation for all.

Further readings for Warm-Ups and Forum Theatre

- Boal, A. 1977. *Games for Actors and Non-Actors.* Routledge: London and New York.
- Brandes, D. and H. Phillips. 1977. *Gamesaters' Handbook: 104 Games for teachers and group leaders*. Hutchinson: London and Johannesburg.
- Hayes, S.K. 1984. *Drama as a Second Language.* National Extension College Trust, Ltd: Cambridge.
- Wessels, C. 1987. *Drama (resource books for teachers)*. Oxford University Press: Oxford.
- Brady, M. and P. Gleason. 1994. *Artstarts: Drama, Music, Movement, Puppetry and Storytelling Activities.* Teachers Ideas Press: Colorado.

Criteria to assess learners during this dramatic arts lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
The learner was actively involved in the forum theatre, either as an actor or as an audience member						
The learner was able to relate the drama to his/her personal experiences						
The learner was able to discuss the drama within the context of his/her community or a nearby community						
The learner contributed towards ideas of how access to water and better sanitation for all could be addressed						

ACTIVITY FOUR: THE STATE OF OUR SCHOOL ENVIRONMENT

During this **LIFE ORIENTATION** lesson, learners find out more about State of the Environment Reporting. The class then chooses three themes around water access and sanitation which they would like to investigate either in their school or community. Learners take their findings further by developing action plans.

ACTIVITY:
Read and discuss the following information on State of the Environment Reporting with your learners.

Our school should be a healthy environment for us to learn, share together, and enjoy ourselves. Sometimes this is not the case and the best way to make things better is to investigate what needs attention and then take action to make those things better.

What is a State of Environment Report?
Before we can take action to make our world better, we need to understand how the environment around us is coping.

The State of Environment (SoE) Report describes the state of the environment for a city, region or country. These reports then become one of the tools used to assess and monitor changes in the environment and enable us to plan for effective environmental management.

A SoE Report provides action ideas on how to improve our environment through investigation.

Who writes State of Environment Reports?
Anyone can! Different sections of the report are written by those who are the most informed about the topic. Some of the authors include government institutions, universities, specialist consultants, research centres, non-governmental bodies and even YOU can be an author!

State of Environment reporting should be a two-way communication, with the public getting involved in both preparing the State of Environment Report AND finding solutions to environmental problems.

The first SoE Reports in South Africa
The first attempt to produce a **National SoE Report** was in 1992, when a report was submitted to the United Nations Environment Programme in Rio de Janeiro, describing the South African environment and resource base. The first comprehensive National SoE Report was launched in 1999 by the Department of Environmental Affairs and Tourism (DEAT) and was made available on the Internet together with the city SoE Reports of Johannesburg, Durban, Cape Town, Midrand and Pretoria.

Why is a SoE Report useful?
A State of Environment Report is considered to be one of the most valuable means of informing policy makers, the public and other interested parties on the status of the natural resources and the sustainability of their use. It includes:

- the condition of the environment and information on issues and trends in the quality of the environment;
- the causes of environmental change and how to respond to these changes;
- what is being done to improve environmental conditions, whether these actions are effective and what more could be done.

However, the effectiveness of any State of Environment Report relies on the constant updating of information so that trends in environmental conditions can be monitored as accurately as possible. This helps to ensure that well-informed decisions regarding the environment can be made.

CLASS OR GRADE ACTIVITY:
As a class or grade, learners need to conduct a SoE Report for their school or community. Because the focus of this pack of lessons is on water and sanitation, the learners need to choose at least one of their three focus areas around this issue.

Before you commence this activity, decide whether there will be one SoE Report, conducted by the entire class, working together or whether the class will break into smaller groups. You may even like to work with other teachers and do this across the entire grade! If you decide to do this activity as a grade activity, it would be preferable to assign separate investigations to learners who take specific subjects, to acquire the most accurate insight into that topic. For example, learners who

are taking physical and life sciences could focus on water testing and social sciences learners could investigate socially related issues.

Remember that three issues need to be identified for the SoE Report so if the class does break up into smaller groups, make sure there are enough learners in each group to effectively cover each issue.

Hand out the following information to your learners.

How do I go about conducting a SoE Report?
First of all, you need to determine what the purpose of your SoE Report will be:

- What do you want to achieve by writing the report?
- How can it be used? and,
- Who will be able to use it?

It would be very ambitious to report on all environmental and developmental issues in any region. Therefore you need to establish simple key issues to work on.

Are you going to produce a SoE Report with a focus on your:

- school or
- local environment e.g. focusing on the area around your school?

The following questions will help you decide what kind of SoE Report will be most suitable for your school.

- **What information do we need to convey?** Broad environmental concepts, the reasons for environmental change, how to improve sustainability of resources in our school/local area; how to improve our school or local environment.
- **Why do we want to report on this information?** To raise awareness in our school or our community; to provide a starting point for collaboration and action.
- **Who can benefit from this information?** Our school; our community; other schools; the local council.
- **How can they use it?** To gain a better understanding of their school and / or local environment, so that they can take actions to improve their environment.

Indicators
Indicators are specific measurements or records for monitoring environmental conditions. They are used in SoE Reports to present large amounts of detailed information in a format that is easy to understand.
For example, to see how good water is for drinking, we could measure the amounts of unhealthy substances it contains. If measured over time, we would know whether water quality is improving or getting worse.

Themes and Issues
Every country, society, community or school has its own themes and / or issues, which it may feel are important to report on by means of indicators.

A theme can be described as a key area of concern e.g. atmosphere, waste management or water, whereas an issue represents an item of concern surrounding an environmental problem e.g. air quality, waste reduction or water quality. Indicators are measurable properties of the environment and are derived from environmental data. Data is derived from direct measurements and observations.

When choosing your indicators keep the following guiding points in mind:

Indicators should represent an environmental aspect that is important to your school / community.

- They should help focus information to answer important questions.
- They should be scientifically valid.
- They should provide a picture of environmental conditions.
- They should show patterns or trends over time.

Some examples are:

Theme: Human Well-being
Issue: Population
Indicators:

- Number of children per family
- Access to basic needs like water, education and health

Theme: Water
Issue: Freshwater systems
Indicators:

- Availability of water
- Accessibility of water
- Quality of water
- Evidence of waterborne diseases

Theme: Human Well-being
Issue: Health Care
Indicators:

- Prevalence of illnesses in the community
- Types of illnesses people are suffering from
- Accessibility to medical assistance
- Available of adequate sanitation

Theme: Land Use
Issue: Land condition
Indicators:

- Land degradation
- Soil loss
- Soil fertility
- Mineral content

Theme: Energy
Issue: Cars
Indicators:

- The number of people who use a car/bus/bicycle/walk to get to school/work
- The number of vehicles per family
- The number of people per vehicle

Theme: Water
Issue: Water wastage
Indicators:

- Water lost through leaking taps
- Water lost through dripping taps
- Amount of water used per month

Reporting Framework
The SoE Report for South Africa uses the 'Driving Forces, Pressure, State of Environment, Impacts of Ecosystems and Responses to Environmental Changes' (DPSIR) reporting system to describe environmental issues:

Look for human activities that are **Driving Forces....**

These are underlying social, political and economic activities that lead to environmental change.

that may put **Pressure.....**

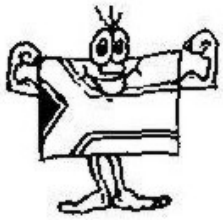
These are pressures on the environment that result from the driving forces.

on the **State of the Environment .....**

This describes the current state of the environment and recent trends by exploring what makes up an ecosystem.

and **Impact .....** *on our country*

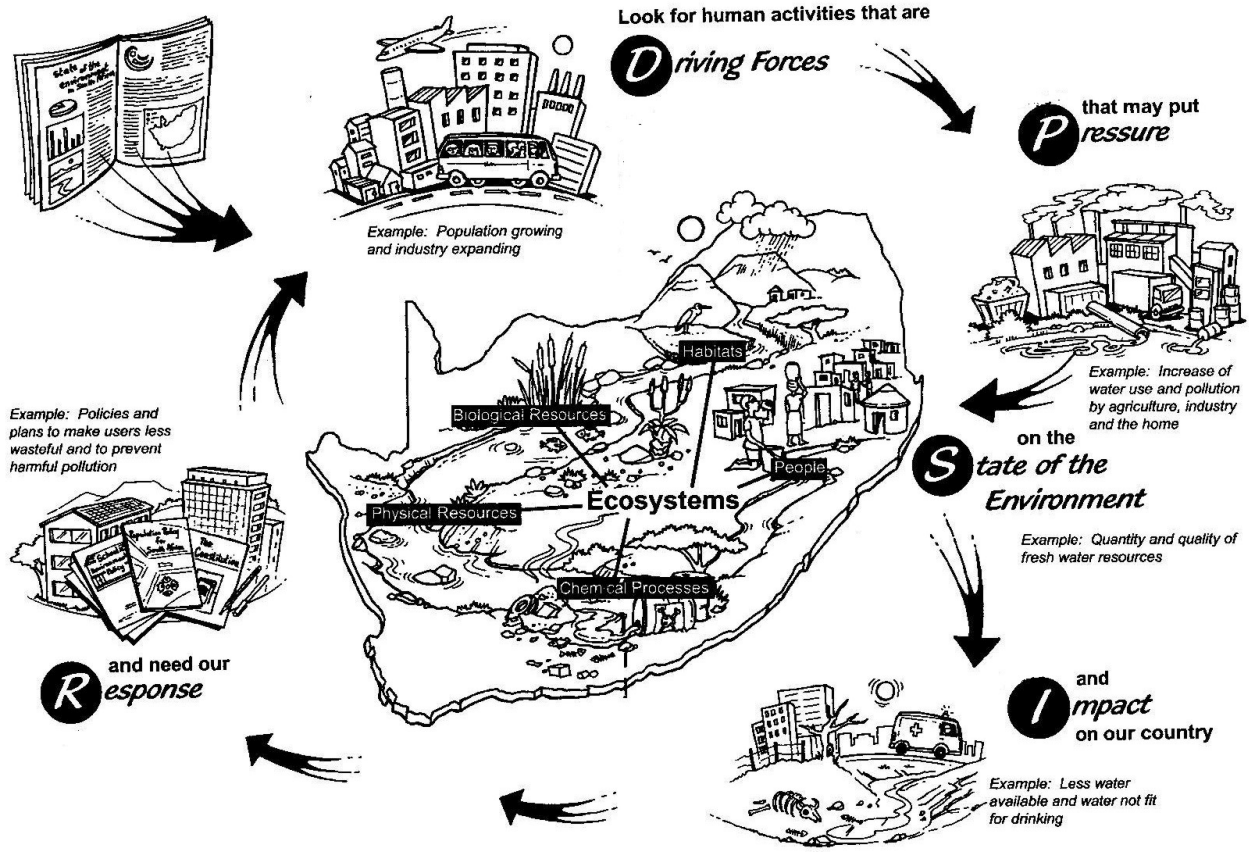
These are the consequences or results of the pressures on the environment in terms of capacity for human development.



and need our **Response .....**

This describes human responses to environmental change, including policies and plans to reduce environmental damage, and encourage sustainable development.

This is an example of using water as a theme within the DPSIR reporting system



Drafting the report

The next step is to collect, interpret and present the information. There are 4 main steps in this process:

Step 1:
Conducting the investigation, e.g. doing a sanitation audit, looking at water consumption. This will depend on which issues/themes/topics you have selected to investigate.

Step 2:
Integration of the material, i.e. linking your findings to one another as demonstrated in the DPSIR reporting system (on pages 18 and 19).

Step 3:
Editing and reviewing your report.

Step 4:
Presentation.

Conducting the Investigation
A State of the Environment Report should reflect the views of all people, those affected by environmental change, as well as those causing it, and those attempting to manage environmental change.

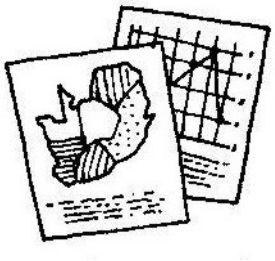
Integration of the material
Once the individual 'specialist' studies have been completed they will need to be integrated to ensure consistency in data, highlighting links, reduction of repetition and flow of writing styles. For example, impact of dripping taps or leaking toilets in the school could be covered under a section on ecology or resource management – these need to be worked out.

Do not be surprised if you find that the different work groups have come up with the same issues. For example, a group may have been investigating water quality and found it to be of poor quality as a result of inadequate sanitation in the area. Similarly a group investigating social issues may find that illness in the community is caused by poor water quality. These overlaps will help you to clarify the issues.

Editing and review
Your group should review the final draft report, to confirm that all perspectives have been included. Obviously it will not be possible to consult every member of your school or local community, but you should try to create opportunities for representatives of different grades at your school or sectors in your local community to give input.

Presentation
The presentation of the information in your SoE Report is almost as important as the information itself. The purpose of the report is to effectively communicate information, in order to support the informed management of resources. Therefore the report should be presented in a way that is meaningful to users. It should be presented as a document, which is clear, simple and relevant. Consistency in format is very important, so if you choose to type it on a computer, make sure that each group is using the same font and style. If your group is writing it up by hand, use the same colour ink and choose either cursive or print, keeping it neat and tidy.

Try to use as many illustrations, photographs, maps and graphs as possible. This always helps in emphasising or demonstrating an issue and makes the report more appealing.



Use the following format as a guideline to the layout of your report:

Title – Give a short and concise title to your report.

Introduction – Give a brief introduction about your report so that those reading it will gain insight into the report. Also describe the objectives and aims of your study.

Study Area – Describe your school grounds and the surrounding area.

Methods – Describe the methods you used to identify and carry out the audits and obtain your results.

Results and Discussion – These may be reported on together as they are interlinked. Provide data, in the form of graphs, tables, charts, maps etc. and then discuss your findings. Be critical, offer possible solutions and state whether your objectives have been met.

Conclusion – A summary of your findings. Include here at least three practical and do-able action plans to improve the way things currently are.

Acknowledgements- Acknowledge any person who may have contributed to your report i.e. technical assistance, financial support, valuable comments or information.

References – Make sure all the learning support materials you have referred to in the text are noted under references.

Summary: The Structure, Investigation and Planning of your SoE Report

→ What kind of SoE Report are we going to investigate: our local surroundings, our school?

→ Who is the report for: our school management, our local council, our municipality, our community?

→ Organise our reporting team, according to classes, learning areas etc?

→ What do we report on?
- Identify issues
- Identify indicators
- Understand our reporting systems

→ Where do we find other information? Libraries, Internet, environmental education resource centres, government departments

→ Drafting the report
- Conduct our investigation: collect data
- Integrate our findings and researched information
- Edit and review

Once complete, present your final SoE Report to your headmaster and school, school governing body, parents, local council, municipality or Department of Environmental Affairs and Tourism.

Criteria to assess learners during this life orientation lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
The learner and his/her group identified three environmental issues within the school/community						
The learner participated and contributed to the group's SoE Report						
The SoE Report followed the format given						
The SoE Report was well planned and well presented						
The SoE Report had at least three practical and do-able action plans to improve the school/community						

ACTIVITY FIVE: JUST FOR FUN! MAKING SOAP

Just for fun! Making soap - this PHYSICAL SCIENCES lesson gives instructions on how to make 'Settlers Soap'.

Did you know that Andrew Pears started making Pears Soap in 1789 and we still find it in our supermarkets today. He developed the soap using pure ingredients – glycerine, natural oils, rosemary, cedar and thyme.

Soaps have been made for many many years but not much was known about the chemistry at the molecular level.

A fat or vegetable oil provides the long non-polar 'tail'. This reacts with an alkali, such as potassium hydroxide (KOH) for softer soaps, or with sodium hydroxide (NaOH) for harder soaps.

Animal fats and vegetable oils are esters and therefore the reaction with NaOH is as follows:

R and R^1 are hydrocarbon chains.

Making Settlers Soap:
This is a fun class activity. The ingredients for the soap can be obtained from your local chemist and supermarket.

This recipe makes 10 bars of soap

- 425 g vegetable fat (Holsum)
- 285 g sweet almond oil
- 198 g olive oil
- 57 g white beeswax, coconut oil or castor oil
- 283 g distilled water or spring water
- 142 g caustic soda (*caustic soda is sodium hydroxide (NaOH) – a very strong base so be careful when you are handling it).*
- 30 g honey

What to do?

1. Place vegetable fat, oils and beeswax in a glass container and heat in the microwave to 55-60°C. Alternatively heat over a warm bath.
2. Add caustic soda to spring water and stir till dissolved.
3. Both the caustic solution and oils must be approximately 60°C. Pour caustic solution into the oils and stir with a wooden spoon for about 20 minutes until the spoon leaves a trail behind it.
4. Add honey and stir well.
5. Pour into moulds and cover with a blanket for 24 hours to set. Then cut the soap into pieces and wash quickly under running water.
6. Cure for a further four weeks before using.

Source: Unilever. Adapted from the Unilever soap making course

Water and our Health

Share-Net

This pack supports an introduction for learners to an Eco-School's focus on Healthy Living

Grade 12

This pack contains:

Activity One: During this **LIFE ORIENTATION** lesson, learners consider safe and healthy living in our communities.

Activity Two: This **LIFE SCIENCES** lesson looks at the effects of biodegradable waste on dissolved oxygen. Learners conduct an experiment and then graph and write a report on their investigation which they present to the rest of the class.

Activity Three: This **LANGUAGES** lesson focuses on the art of speech making. Learners choose three water and water-related topics from a given list and then write and deliver introductions for each chosen topic.

Activity Four: During this **LANGUAGES** lesson, learners debate whether or not intercatchment transfers will solve South Africa's water problems.

Activity Five: Just for fun! This **LIFE SCIENCES** lesson encourages learners to explore a nearby water source and assess the water quality by looking at visible animal life.

WESSA

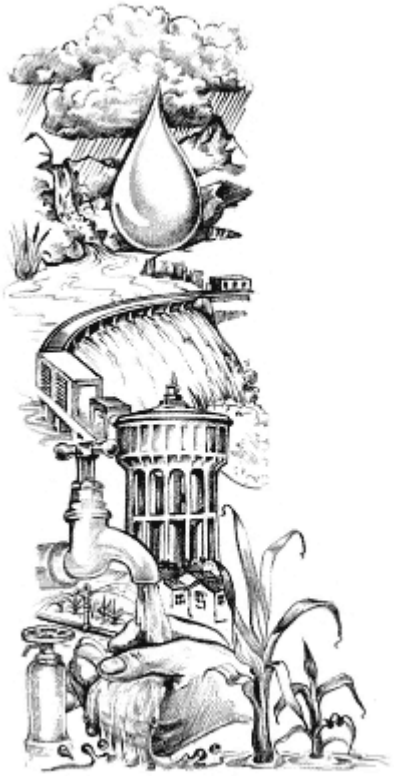
This pack of lesson plans is part of a series of lesson plans from Grade R to Grade 12 which focus on water and water-related issues. This resource development project has been funded by the Water Research Commission, Private Bag X 03, Gezina, Pretoria, 0031 (Website: www.wrc.org.za).
This pack is available electronically on www.wrc.org.za

Activity	Learning Area covered in this activity	Learning Outcomes covered in this activity	Assessment Standards covered in this activity
1. This lesson encourages learners to consider safe and healthy living in our communities.	Life Orientation	**Learning Outcome 1:** Personal Well-being: The learner is able to achieve and maintain personal well-being. **Learning Outcome 2:** Citizenship Education: The learner is able to demonstrate an understanding and appreciation of the values and rights that underpin the Constitution in order to practice responsible citizenship, and to enhance social justice and sustainable living.	Investigate the human and environmental factors that cause ill health, accidents, crises and disasters, and explore appropriate ways to deal with them. Evaluate services offered by a community project on a contemporary social or environmental issue, and evaluate own contribution to the project.
2. This lesson looks at the effects of biodegradable waste on dissolved oxygen. Learners conduct an experiment and then graph and write a report on their investigation which they present to the rest of the class.	Life Sciences	**Learning Outcome 1:** Scientific inquiry and problem-solving skills. The learner is able to confidently explore and investigate phenomena relevant to Life Sciences by using inquiry, problem solving, critical thinking and other skills.	Analysing, synthesising, evaluating data and communicating findings: • Critically analyse, reflect on and evaluate the findings; • Suggest specific changes that would improve the techniques used; • Presents a report to the class in which they communicate their findings.
3. This lesson focuses on the art of speech making. Learners choose a few water and water-related topics from a given list and then write and deliver introductions for each chosen topic.	Languages	**Learning Outcome 1:** Listening and speaking. The learner is able to listen and speak for a variety of purposes, audiences and contexts.	Demonstrate planning and research skills for oral presentations: • Research a topic by referring to a wide range of sources; • Organise material coherently by choosing main ideas and relevant and accurate details or examples for support; • Prepare effective introductions; • Use tone, voice projection, pace, eye contact, posture and gestures correctly and respond appropriately.
4. During this lesson, learners debate whether or not intercatchment transfers will solve South Africa's water problems.	Languages	**Learning Outcome 1:** Listening and speaking. The learner is able to listen and speak for a variety of purposes, audiences and contexts.	• The learner is able to participate in panel discussions, debates, forums and formal meetings, following correct procedures. The learner demonstrates planning and research skills for oral presentations: • Researches a topic by referring to a wide range of sources; • Organises material coherently by choosing main ideas and relevant and accurate details or examples for support; • Prepares effective introductions and endings.
5. Learners explore a nearby water source and assess the water quality by looking at visible animal life.	Life Sciences	-	-

ACTIVITY ONE: WATER AND OUR HEALTH

This LIFE ORIENTATION lesson encourages learners to consider safe and healthy living in our communities.

CLASS ACTIVITY:
After reading the following short article to your learners, divide your class into groups of 4 learners and give each group a photocopy of the newspaper article "Dusi Guts hampers the Drak" and accompanying questions.



Precious Water – every drop counts!

South Africa is extraordinarily rich in natural resources – except for water. Water is a vital but scarce resource, distributed unevenly in time (frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is markedly wetter than the western half). Increasing demand for water and decreasing water quality, make water management a priority for our country.

Industrial and agricultural pollutants common in South Africa are agricultural fertilizers, silt, toxic metals, litter, hot water and pesticides. Some of the most common pollutants come from urban wastewater, particularly from informal settlements which lack sewage and other purification facilities. The resulting pollution contributes to serious health issues.

’Dusi Guts’ hampers the Drak

SAPA Published: Feb 12, 2008

Several elite canoeists’ preparations for the Hansa Powerade Drakensberg Challenge at the end of the month are being hampered by ongoing after effects of the notorious “Dusi Guts” picked up during the three day Dusi marathon.

Hank McGregor and Jacques Theron are amongst those that are still struggling to get over the effects of the crippling stomach complaints picked up from the dirty water in the Umsindusi and Umgeni Rivers.
“I would love to do the Drak — it’s one of my favourite races — but I am still battling with “Dusi Guts”,” said McGregor. “I still had it when we raced the Umkomaas Marathon two weeks later, and I am still really weak now, despite two courses of antibiotics.”
McGregor, like many others, fell prey to the gastric problems from the dirty Dusi water shortly after the three-day race.

“I really want to try and win the Drak, because I have had my fair share of bad luck in this race over the last three years. Especially with the river being so full and clean, I want to be able to say that I will be there.”

Theron, who was runner-up last year and has been a perennial star performer on the Umzimkulu, is also a doubtful starter. He was an early victim of the “Dusi Guts” and first fell ill two weeks before the big race in January.

“I am still not right,” admitted the Gauteng star. “This might be my last chance for a serious challenge because I have other priorities in the year ahead, but I am still flat from my “Dusi Guts” problems,” he said.

Surveys conducted shortly after the Hansa Powerade Dusi showed at just less than 50% of the participants in the race experienced stomach ailments from the polluted water. Since the race survey was completed, more paddlers have gone down with similar ailments triggered by bacteria ingested during the race.

“Fortunately the Umzimkulu in Underberg is very clean, to the point that canoeists happily drink the water straight out of the river,” said Canyon Canoe Club chairperson Patrick Reid.

Entries have been pouring into the race office in Underberg, with the eventual entry likely to top 1000 canoeists, particularly with the news that the steady rainfall in the Southern Drakensberg has left the Umzimkulu at a superb racing level.

While the Dusi problems have left several top class paddlers as doubtful starters, most of the top river racers have indicated their intentions of being on the startline at Castleburn bridge on Saturday 23 February.

Five times winner Ant Stott returns to the race after a two-year lay-off caused by his pursuit of a place at the Beijing Olympics with the national K4, and will start as a popular favourite to bag a sixth Drak title.

Defending women’s champ Abbey Miedema will also be there, while her Dusi partner and chief K1 rival Alexa Lombard has also indicated that she would like to be there as well.

Source: The Times newspaper

Additional information for the teacher:

Dusi Guts is caused by high amounts of bacteria called *E.coli* in the river water. *E. coli* is a common type of bacteria that can get into food, like beef and vegetables and is short for the medical term *Escherichia coli*. The strange thing about these bacteria — and lots of other bacteria — is that they are not always harmful to you.

E. coli normally lives inside your intestines, where it helps your body break down and digest the food you eat. Unfortunately, certain types (called strains) of *E. coli* can get from the intestines into the blood. This is a rare illness, but it can cause a very serious infection.

Someone who has *E. coli* infection may have these symptoms:

- bad stomach cramps and belly pain;
- vomiting;
- diarrhoea, sometimes with blood in it.

If someone has symptoms of *E. coli* poisoning, the doctor will run some blood tests and take a sample of the person's stool (poo). The blood and stool can be checked to see if a harmful strain of *E. coli* is present. Even though diarrhoea is one of the main symptoms, the person should not take anti-diarrhoea medicines because they can slow down recovery time. Some people recover at home, while others need to be in hospital. In some cases, *E. coli* poisoning can cause life-threatening kidney problems.

GROUP ACTIVITY:

In groups, discuss and record the following:

1. Does someone in the group know what Dusi guts is and how you get it? If not, ask your teacher.
2. Has any one in the group had a similar and unpleasant experience like the canoeists in the newspaper article? How did it happen? What did you do?
3. Who is responsible for the polluted state of the Dusi River water? Explain your answers.
4. What are the sources of water in or near your area or community?
5. Are the rivers in your community polluted? Explain your answer. What are the effects of the pollution?
6. What can one do, as an individual, to improve the quality of river water?
7. What can one do, as a community, to improve the quality of the river water?
8. What organisations are there in your community that are involved with water issues?

CLASS ACTIVITY:

Using the reports from the previous group activity, let learners share with each other what their groups discussed.

A Community Service Assignment

1. Your group needs to identify an existing organisation / community project that is already working within the field of water and water-related issues and one that you would like to work with to find out more about what they do.
2. You will need to make arrangements with the organisation concerned by writing, phoning or visiting them.
3. Spend some time working there (possibly during the weekend or a day in the school holidays, find out when it is convenient).
4. Write a report which will be assessed by your teacher (each learner in the group needs to write a separate report) and shared with the rest of the class. See details that follow of what to cover in your report.

You will need to report on:

1. **Your involvement with your chosen organisation / project / programme**
   - How much time you spent with the organisation / project / programme?
   - What you did while you were there?
   - Who did you work with?
   - What did they do?

2. **Your evaluation of your chosen organisation / project / programme**
   - What are the aims of the organisation / project / programme?
   - Who does it serve?
   - What is it achieving?
   - Is it sustainable?
   - Is it relevant?
   - What problems / challenges does it face?

3. **Your findings and recommendations for your chosen organisation / project / programme**
   - What would improve the project with its services?
   - What could assist with some of the problems (if any)?

4. **Implementation of your findings and recommendations**
   - How could I implement one of my findings and recommendations? (You need to draw up a plan with time frame, specific objectives or outcomes and how you will implement this plan. Include any financial costs or other expenses).

5. **Evaluating my involvement with the organisation / project / programme**
   - How did I feel before I started – was I nervous, enthusiastic – why?
   - What was the most useful thing I learnt?
   - What was the most useful thing I contributed?
   - What could I have done differently?
   - Will I continue to be involved in this organisation / project / programme? Why?

Criteria to assess learners during this life orientation lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
The learner was able to present a report to the class in which they communicated their group discussions (*Dusi Guts group activity*)						
The learner was able to identify an existing organisation working within the water field						
The learner was able to evaluate the services offered by this organisation						
The learner was able to evaluate their own involvement in the organisation						
The learner was able to record and report, following the given format, on their work experience with the organisation						

ACTIVITY TWO: TESTING OUR WATER QUALITY

The following LIFE SCIENCES lesson looks at the effects of biodegradable waste on dissolved oxygen. Learners conduct an experiment and then graph and write a report on their investigation which they present to the rest of the class.

ACTIVITY:
Read the following paragraph to your learners and then let them continue with the experiment that follows. Depending on the level of your learners, they can either do the experiment individually or in small groups.

Waters with consistently high dissolved oxygen are usually considered to be healthy, capable of supporting many different kinds of water organisms. Much of the oxygen in water comes from the atmosphere through rainfall, through tumbling water in fast moving streams and from water plants (photosynthesis). In some dams, dissolved oxygen may increase owing to photosynthesis during the day but at night it may decrease owing to plant respiration. Large daily fluctuations in dissolved oxygen may be found in rivers and dams choked with invasive water plants. Water temperature also affects dissolved oxygen levels as oxygen is more easily dissolved and retained in cold water. Effluent and agricultural chemicals enrich water, promoting the growth of algae and other water plants. Sewage effluent promotes large populations of bacteria which consume oxygen as they decompose organic matter. Low oxygen levels are often associated with sewage effluent enrichment.

Experiment
What are the effects of biodegradable waste on dissolved oxygen?

Purpose: To understand the relationship between biodegradable waste and dissolved oxygen found in polluted waters in your area.

Background: When micro-organisms (bacteria and fungi) eat biodegradable wastes, they use large amounts of oxygen. Thus, a lot of biodegradable waste means very little dissolved oxygen for fish and aquatic life. In this experiment, we will investigate that relationship. Yeast will represent the micro-organisms, milk is the biodegradable waste, and methylene blue (a dye) will indicate when oxygen is used up. Methylene blue shows the presence of oxygen in water and if there are bacteria in water, they use up the oxygen and cause the methylene blue to change to a colourless liquid. The more bacteria a water sample contains, the faster the methylene blue loses its colour. The methylene blue will change from blue to white when no more oxygen is present in the test tubes. (The colour change is actually from blue to colourless. The white colour you will observe in the test tubes is due to the milk's colour).

Materials:
- 2 small beakers or baby food jars
- stirring stick
- 2 ml (about ½ teaspoon) dry yeast
- one 5 ml pipette or an eye dropper
- one 10 ml graduated cylinder
- methylene blue solution
- 3 test tubes in rack
- masking tape

Procedure:

1. Fill a baby food jar about half full of milk. Take it to your lab table.
2. Place the three test tubes in the rack and put masking tape numbers (1,2,3) on them.
3. Use the pipette or eye dropper to add the amount of materials to each test tube as shown below. (Approximately 15 drops equals 1 ml.)

Test tube	Milk ml or drops	Water ml or drops
1	2.5 or 37	0 or 0
2	1.0 or 15	1.5 or 22
3	0.2 or 3	2.3 or 35

Before you continue, check the liquid's height. It should be the same in all three tubes. You should have exactly 2.5ml of solution in each tube.

4. Add three drops of methylene blue to each test tube. The methylene blue is an "indicator" solution. It will change from blue to white when the oxygen is used up.
5. Mix each tube by putting your thumb over the top and inverting it (turning it upside down) quickly four times.
6. Prepare a sample of yeast by adding 2 ml (about ½ teaspoon) dry yeast to 20 ml of water in a beaker or baby food jar. Mix the yeast and water thoroughly with your mixing stick.
7. You are now ready to mix the yeast and milk solutions. Follow these directions *very* carefully:
   a. Watch the clock for exact timing. Proceed to the next step (b) when the second hand passes the "12". Record the *exact* time of mixing - on the minute - in the table below, next to test tube 1.

Test tube	Time of mixing (on the minute) (A)	Time when colour changes (B)	Total time for the colour change to occur (B-A)
1			
2			
3			

   b. Mix the yeast solution vigorously with the tip of your pipette or eye dropper. Then carefully put exactly 2.0 ml (30 drops) of yeast solution into test tube 1.
   c. Mix by inverting four times.
   d. Now repeat the procedure with test tubes 2 and 3. Be sure you record the *exact* time you added the yeast to each tube.
8. Wait until each tube's colour changes from blue to white. (It usually takes about 15 minutes). Note: the surface of each test tube will always remain blue. Can you guess why?

9 When the colour change is complete, work out the total time by subtracting the time of mixing from the time the tube changed colour (column B-A). Record this time to the nearest minute. It may take several minutes for this change to occur.

Questions:

1. Name the gas "inhaled" (taken in) by micro-organisms.
2. Name the gas "exhaled" by micro-organisms.
3. Where do micro-organisms living in water get the oxygen they need to live?
4. Where do green plants living in water get the carbon dioxide they need to live?
5. Shake one of the test tubes that turned white. What happens to the colour? Why does the colour change?
6. Oxygen is dissolved naturally in rivers when water goes through rapids and over falls. How does shaking the test tube prove that oxygen is dissolved in water when it tumbles over rocks?
7. Why is the oxygen in the experiment "used up?"
8. Name the part of the experiment that represents micro-organisms.
9. Name the part of the experiment that represents waste.
10. In which test tube did you have the most waste? The least waste?
11. *Graph* your results on a separate sheet (time for colour change to occur, in minutes versus ml of milk) and answer the following questions:
    a. What does the line you plotted tell you about the relationship between the amount of waste and oxygen in a body of water?
    b. If large amounts of waste were dumped in a river, what would be the effects of the dissolved oxygen in the water?
    c. What conclusion was reached?
12. How could you improve your investigation?
13. Some bacteria, given large amounts of food and water, can double every 20 minutes. *Calculate* the number of bacteria present after twelve hours at this rate (starting with one bacteria cell).
14. Write a full report on your investigation which you can present to the rest of the class.

Teacher notes about this experiment:

- You may use fresh or powdered milk. Learners will get faster colour changes if you *dilute* the milk to 50% strength and warm slightly before the experiment.
- Many learners make mistakes in volume measurements - be careful!
- Since colour changes take up to 15 minutes, consider the length of your life sciences period.
- Learners must know graphing skills before this experiment.
- All glassware must be *clean* and free of soap residue. *Soap residue may kill the yeast.*
- All variables in this experiment are relative to one another. For example, shaking two times, instead of four will change the results.
- The yeast solution should be well-mixed before it is added to the test tubes. It is important to get approximately the same number of yeast cells in each test tube.

Criteria to assess learners during this life sciences lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
Ability to follow instructions						
Ability to observe safety precautions						
Ability to work neatly and tidily						
Ability to use allocated time properly						
Ability to use equipment						
The learner was able to draw a graph from the experiment						
The learner was able to suggest specific changes that would improve the experiment						
The learner was able to write up a report on the findings						
The learner was able to present a report to the class in which they communicated their findings						

ACTIVITY THREE: SPEAK TO US!

This LANGUAGES lesson focuses on the art of speech making. Learners choose three water and water-related topics from a given list and then write and deliver introductions for each chosen topic.

An introduction is very important to use in a speech or piece of writing to warm the audience to what is to come. It should grab the audience's attention. It should always arouses interest about the subject, and provide important background information. A speech without an introduction is like a train without an engine, you are not leading your audience anywhere. Your introduction also needs to provide a smooth transition into the body of the speech. The introduction is what the audience hears or listens to first, so make it interesting!

INDIVIDUAL AND GROUP ACTIVITY:

Ways to make an introduction to your speech more interesting could include the following:

- Make a surprising or thought-provoking statement at the start of your speech.
- Use visual, graphic or audio aids to illustrate part of your speech.
- Use gestures and body language that are consistent with the speech.
- Involve the audience in a practical activity (where appropriate).
- Step into the audience during your speech.
- Tell an appropriate anecdote, a humorous story or even a joke.
- Quote a famous person or expert – remember, however, that quotes must be relevant to your speech and not over-used.

Look at the list below and choose three water or water-related issues. Write and deliver introductions for each. Remember to use the school library and as many other sources of information as possible.

a. Water pollution
b. Water and our health
c. Water quality in South Africa
d. Planet Earth in 2050
e. The joy of water
f. Water water everywhere and not a drop to drink
g. Every South African has the right to a clean and healthy environment
h. Wetlands
i. Water is life
j. Cholera
k. Diarrhoea

Now, in groups of five, assess each other's introductions. When assessing each other and one's self, consider:

- the volume of the speaker's voice (varied, clear, too loud, too soft, not varied enough);
- the speaking rate (was it well-paced, too fast, too slow);
- the pitch (was the voice varied, too high, too low, monotone);
- the tone of the speaker's voice (natural and pleasant, artificial);
- the vitality with which the speaker spoke (powerful, dynamic, unenergetic);
- was there eye contact of the speaker with his/her audience?
- how did the speaker stand? Relaxed, nervous, pacing etc;
- was the attention of the group held by what was being said?
- did the introduction introduce the rest of the speech clearly so that the listeners knew what they were going to hear?
- how many sources (e.g. the library, Internet, newspapers) did the speaker use to prepare their introduction?

Criteria to assess learners during this languages lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
A number of sources (at least 3) were used during the preparation of the learner's introduction						
The introduction was succinct						
During the introduction, a rapport was established with the audience						
Presentation of the introduction was confident and motivated the audience to listen						
The speaker gave the audience a clear idea of what the body of the speech would be about						
Tone, voice projection, pace, eye contact, posture and gestures were correctly used						

ACTIVITY FOUR: INTERCATCHMENT TRANSFERS – THE ONLY WAY TO SOLVE SOUTH AFRICA'S WATER SHORTAGE

Conservationists say that water is a limited resource. Water scientists say that by the year 2025, there will be insufficient water for all our country's domestic, agricultural and industrial needs. During this LANGUAGES lesson, learners debate whether or not intercatchment transfers will solve South Africa's water problems.

CLASS ACTIVITY:

Ask the learners:

1. Have you seen or taken part in a debate?
2. What was it about?
3. Where did it take place?
4. Who was taking part in the debate? *Prompt: Politicians, general public, members of a group or organisation.*

Ask the learners:

1. What is a debate?
2. If you were going to define it in a dictionary, what would you write? *Suggestion: A formal argument where groups or individuals present opposing views about a particular issue according to a set of rules.*

CLASS ACTIVITY:

- Explain that a debate is based around a suggestion or motion.

  An example of a motion is: The voting age should be lowered to 16.

Explain that the people who are arguing to support the motion are called the proposers. The people arguing against the motion are the opposers.

The correct order for a debate is as follows:

1. The debate is chaired by the Speaker, who reads out the motion.
2. The first proposer presents the arguments for the motion.
3. The first opposer presents the arguments against the motion.
4. One of the proposers presents their arguments for the motion.
5. An opposer presents their arguments against the motion.
6. This side to side motion continues until everyone has had their say.
7. You can only speak ONCE during the debate.
8. An opposer sums up their group's main argument.
9. A proposer sums up their group's main argument.
10. The speaker re-reads the motion.
11. Everyone votes (apart from the Speaker) by leaving the debating chamber and coming back through a door marked 'yes' or 'no.'
12. Two people, called tellers, count up the votes (bodies), as they come through each door.
13. The Speaker announces the result of the vote.

Ask the learners:

1. Why do you think there is a rule about people only speaking once during the debate?
2. What other rules do you think you will need to make the debate run smoothly?

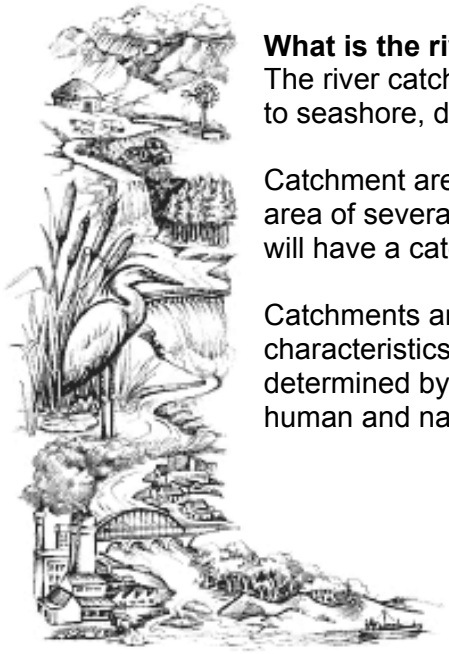
Here are some rules of debate that we will follow:

1. The debate is chaired by the Speaker, whose decision on all matters is final.
2. You can only speak ONCE during the debate. Your speech should be about five minutes long. If you can, develop an argument rather than making a single point.
3. But you CAN 'intervene' as many times as you like. To intervene is to ask a question about a point being made, such as … are those statistics up-to-date?
4. You can use notes to help you with your speeches and make notes during the debate.
5. If you want to speak during the debate, you should catch the Speaker's eye by standing up as soon as someone has finished speaking. The Speaker will pick someone from those standing up.
6. If you spot someone breaking these rules you should tell the Speaker. This is called a point of order.

The motion that the class will be debating is …

- **Intercatchment transfers – the only way to solve South Africa's future water shortage.**

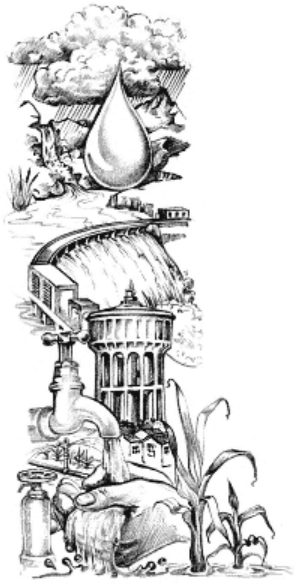
Read the following extract to the class:



What is the river catchment?
The river catchment, or drainage basin, is all the land from mountain top to seashore, drained by a single river and its tributaries.

Catchment areas vary greatly in size - a big river may have a catchment area of several thousand square kilometres, whereas a smaller tributary will have a catchment area of only a few hectares.

Catchments are separated from each other by watersheds. The characteristics of any river (physical, chemical, biological) are determined by the nature of the catchment and the activities, both human and natural, that take place in it.



Intercatchment transfer of water
This involves the transfer of water from catchments with good supplies and low demand, to those where demand for water is high and the supply is poor. There are numerous intercatchment transfer schemes already in operation, and more are under construction or proposed. A major scheme is the Fish-Sundays River Canal Scheme which comprises a canal and tunnel system which supplies Orange River water from the Great Fish River valley to the Sundays River valley to supplement existing water supply in the Eastern Cape. The massive Lesotho Highlands Water Project is a multi-billion water transfer and hydropower project implemented by the governments of Lesotho and South Africa. It transports water from the upper reaches of the Orange system in Lesotho to the Vaal River for use in Gauteng.

CLASS ACTIVITY:

1. Divide the class into two groups.
2. Give them the following debate topic.

   Intercatchment transfers – the only way to solve South Africa's future water shortage.

3. One group needs to prepare their debate agreeing with the topic (the proposers), the other needs to argue against it (the opposers).

4. Using the information (*Enviro Fact 1: River Catchments, Enviro Fact 2: Water, Internet Article 1 and Internet Article 2*) as an introduction, learners need to find out as much as they can about this topic. If you have a well-resourced library (school or community), make use of it; use the Internet; search for newspaper articles or magazines; see if there are any environmental films or videos on river catchments and intercatchment transfers; as well as any other sources of information that will be useful. *(Learners need to keep a record of where they*

found their sources and what these sources were – this will help you, the teacher, when it comes to the assessment of this lesson). Encourage the learners to make use of as many varied sources and methods of locating information as possible. Remind the learners to also remember what was learnt about effective introductions in the previous lesson (Activity Three: Speak to us!)

5. When the groups are ready and well prepared, you need to select seven learners to be:
    - Speaker. This person chairs the debate but cannot take part or vote.
    - First proposer to speak
    - First opposer to speak
    - Opposer to sum up
    - Proposer to sum up
    - Two tellers to count the votes

Hold the debate according to the formal order and rules.

Ask the learners:

1. What are the advantages of debating?
2. What are the disadvantages of debating?
3. Describe the strengths of a good debater. *Prompt: persuasive, confident, calm.*
4. Can you think of a better way to settle a difference of opinion?

Source: *http://news.bbc.co.uk/cbbcnews/hi/newsid_4530000/newsid_4537100/4537177.stm*

Criteria to assess learners during this languages lesson

Criteria	Rating Code 6 (Outstanding)	Rating Code 5 (Meritorious)	Rating Code 4 (Satisfactory)	Rating Code 3 (Adequate)	Rating Code 2 (Partial)	Rating Code 1 (Inadequate)
The learner participated in the debate and followed the correct procedures						
The learner used a number of sources whilst researching his/her topic						
The introduction, speech and conclusion presented by the learner during the debate was well organised and effective.						
The learner participated in the class questions asked after the debate						

Enviro Fact 1: River Catchments

River Catchments
Estuaries are silting up, inland wetlands are disappearing, some perennial rivers are drying up, and rivers, lakes and dams are polluted! Water bodies in southern Africa clearly suffer from many problems - all of which are linked to the way in which the catchment area is used.

What is the river catchment?
The river catchment, or drainage basin, is all the land from mountain top to seashore, drained by a single river and its tributaries. Catchment areas vary greatly in size - a big river may have a catchment area of several thousand square kilometres, whereas a smaller tributary will have a catchment area of only a few hectares.

Catchments are separated from each other by watersheds. The characteristics of any river (physical, chemical, biological) are determined by the nature of the catchment and the activities, both human and natural, that take place in it.

The importance of plants
In catchments which have not been cultivated or developed, the ground cover or vegetation is still in place. Ground cover is important for the following reasons:

- Plants slow down water as it flows over the land (runoff) allowing much of the rain to soak into the ground and replenish underground waters (aquifers). Water seeps from these aquifers into rivers, which are therefore usually perennial (flow throughout the year).
- Plants prevent soil erosion as their roots hold soil in position, preventing it from being washed away. In addition, plants break the impact of a raindrop before it hits the soil, thus reducing its erosive potential. Rivers running through an undisturbed catchment are clean, erosion is slow and limited to periods of very high rainfall.
- Vegetation in wetlands and on the banks of rivers is of particular importance. The roots of the reeds, sedges, trees, shrubs and grasses growing in wetlands and next to rivers bind the soil of the riverbank and prevent erosion, whilst cleaning the water and regulating its flow.

Disturbed catchments
Where plant cover in river catchments has been disturbed by farming, industry or settlements, soil erosion increases. In addition, without plants, runoff increases and the supply of water to aquifers is reduced because less water soaks into the ground. Consequently rivers do not have a continuous supply of water from the aquifers and flow only in the rainy season. Much of the deposition of silt into estuaries results from erosion of riverbanks. When riverbank (riparian) vegetation is removed, the banks are at the mercy of the erosive forces of flood waters which scour away the riverbank allowing the adjacent slope to collapse.

In many catchments, the indigenous vegetation has been replaced by alien plants such as black wattle, pine and eucalyptus. These trees use large amounts of water from the rivers and streams that they thrive next to, thus reducing the amount of water available. In addition, invasive plants tend to smother the natural ground cover and this leads to soil erosion, and of course, a reduction in the biodiversity of that area. Invasive plants

tend to be bigger than the indigenous vegetation, and when they burn the fires are very hot - this in turn damages the soil and contributes to more severe erosion.

Catchment conservation
A catchment conservation programme should include:

- protection of wetlands such as vleis and marshes;
- sound conservation practices on agricultural and forestry lands, e.g. all ploughing and planting should be on the contour; riverbank vegetation should not be disturbed; lands should be strip cropped;
- prevention of water pollution from informal settlements, industry or agriculture;
- protection of riverbank vegetation.

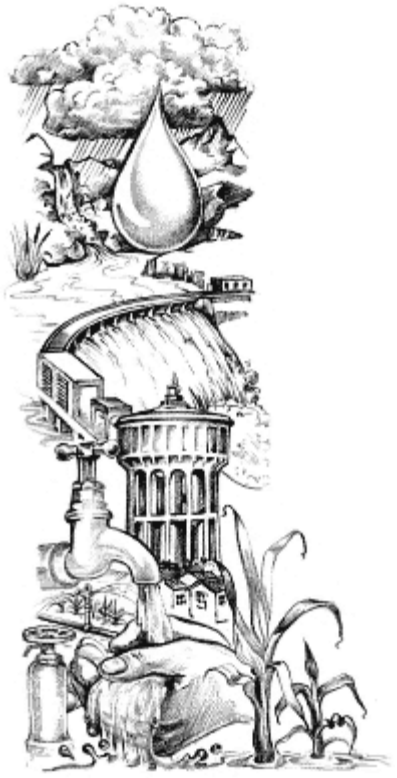
What you can do

- Alert your local land use authority regarding misuse of a catchment.
- Start a catchment conservation project for a river in your area.
- Read "Vanishing Waters"* which has a very useful chapter entitled "You and Water".
- Participate in the South African Youth Water Prize. Contact the Project Manager: South African Youth Water Prize, Department of Water Affairs and Forestry, Private Bag X313, Pretoria, 0001. Tel 012 336 7127 or 0800 200 200.

Further reading:

- *Davies, B.R. and J. Day. 1988. *Vanishing Waters*. 1998. University of Cape Town Press.
- Camp, S. *A Guide to Water Saving in South Africa.* Umgeni Water, Pietermaritzburg.
- *How your school can be water wise*. 1997. Jacana Education, Johannesburg.

Enviro Fact 2: Water



South Africa is extraordinarily rich in natural resources - except for water. Water is a vital but scarce resource, distributed unevenly in time (frequent droughts alternate with periods of good rainfall) and space (the eastern half of the country is markedly wetter than the western half). Increasing demand for water, and decreasing water quality, make careful water management a priority in our country. It has been estimated that by the year 2025 there will be insufficient water for domestic use, agriculture, and industry.

Rainfall

Our average rainfall is less than 500 mm a year, with the driest part of the country receiving less than 200 mm/year and the wettest receiving more than 2 500 mm/year! Rain does not always fall where it is most needed, and some areas of high demand, such as Gauteng, receive less water than they need. Most rain falls in the narrow belt along the eastern and southern coasts. The rest of the country receives only 27% of South Africa's total rainfall. In addition, hot, dry conditions result in a high evaporation rate.

Water is thus a very scarce resource in South Africa. Large-scale engineering has been used to store water behind dam walls, and to distribute water from regions of plenty to regions of need (see "Intercatchment transfer of water").

Rivers

There are few natural lakes in South Africa. We depend on rivers, dams and underground water for our water supply. Approximately 75% of the water flowing from South Africa into the sea occurs along the eastern and southern seaboards, where many short rivers occur. Flowing from east to west is the largest river in the country, the Orange River, which drains most of the rest of the country. Its water comes from sources in the Drakensberg and Maluti Mountains, and it flows into the Atlantic Ocean on the west coast.

Dams

About half of South Africa's annual rainfall is stored in dams. We have over 550 government dams in South Africa, with a total capacity of more than 37 000 million m^3. Dams have both positive and negative impacts. They can be beneficial for people in that they regulate the flow of a river, reducing flood damage and contributing to perennial rather than seasonal flow. In addition, sediment is deposited in a dam, and the growth of aquatic plants means that nutrients are removed from the water. Thus water leaving a dam may be cleaner than water entering it. The riverine ecosystem is usually affected negatively by a dam. Alterations in flow regime (quantity of water and timing of periods of high and low flow), temperature and water quality may cause reductions in biodiversity of riverine organisms below dams. Reduction in water flow reduces the river's scouring ability and this can lead to silting of estuaries.

South Africa's landscape is not well suited to dams. There are few deep valleys and gorges, with the result that most dams are shallow with a large surface area. Together with the hot, dry, climate, this results in much water evaporating from dams. In addition, the high silt load (a result of an arid climate, steep river gradients and poor farming methods) of our rivers means that the capacity of South Africa's dams is quickly reduced as they become silted. The rivers of the western Cape carry relatively less silt than those in the rest of the country.

Water abstraction
A growing problem for South Africa's rivers is a lack of water! Reduction in river flow, owing to abstraction (removal), and damming, has affected many of our rivers, for example those flowing through the Kruger National Park.

Intercatchment transfer of water
This involves the transfer of water from catchments with good supplies and low demand, to those where demand for water is high and the supply is poor. There are numerous intercatchment transfer schemes already in operation, and more are under construction or proposed. A major scheme is the Orange-Fish River scheme, where water gravitates from the Orange River at the Gariep Dam, and is piped through tunnels and canals to the Sundays and then the Fish Rivers in the Eastern Cape. The massive Lesotho Highlands Water Project is a multi-billion water transfer and hydropower project implemented by the governments of Lesotho and South Africa. It transports water from the upper reaches of the Orange system in Lesotho to the Vaal River for use in Gauteng.

Transfers of this nature will have far-reaching ecological, political and socio-economic implications. As yet, little research has been carried out to establish the ecological consequences of intercatchment water transfers. However, areas of concern include reducing streamflow and water levels in one system, changes in water temperature and chemistry, and the transfer of invasive species between catchments.

Water pollution
Industrial and agricultural pollutants common in South Africa include: agricultural fertilizers, silt, toxic metals, litter, hot water and pesticides. These pollutants affect aquatic ecosystems and human health. Disease-producing bacteria are common in urban waste water, particularly from informal settlements that lack sewage and water purification facilities. For example, typhoid, cholera and gastroenteritis are transmitted by water contaminated with untreated sewage. Gastroenteritis is one of three main causes of death in South African children under the age of five.

Did you know?

- South Africa has a National Water Bill that attempts to ensure an equitable and sustainable water supply.
- Some 12 - 14 million South Africans do not have access to safe drinking water and some 21 million have inadequate sanitation. As a result, about 50 000 children die each year from diarrhoeal infections.

Further reading:
Davies, B. R. and J. Day. 1998. *Vanishing Waters.* University of Cape Town Press.
Camp, S. *A Guide to Water Saving in South Africa.* Umgeni Water, Pietermaritzburg.

Internet Article 1

The Lesotho Highlands Water Project
Katse and Mohale Dams

This is a major long term project, the aim being to pump water from the rivers draining the Lesotho Highlands, north into South Africa, and eventually into the Vaal Dam, the main water supply for the Johannesburg region. This region is growing so large and so fast that it is fast outstripping its water supply. There is already a smaller scheme pumping water from the Tugela river in KwaZulu-Natal, but the needs are great.

The project will eventually include four large dams, several smaller ones and many kilometres of tunnel. The entire project is scheduled for completion by the year 2020. At present Phase IA is nearing completion and Phase IB is in the infrastructure development stage. Phase IA involved the building of the first major dam, the Katse Dam, located on the Malibamatso River north of Thaba Tseka. It also involved the building of transfer tunnels for the water and a hydro-electric power station. The dam is currently filling up and is nearly full.

The Katse Dam wall has a height of 180m and dams the course of the river for many kilometres. The river valleys in Lesotho are deep and narrow, so the dam does not form a huge shallow lake but rather a deep, narrow one. Since most of the population live in villages at the mid-level, very few people have been displaced, though much arable land and grazing land has been lost. The company has promised to compensate those dispossessed.

The transfer tunnel from the dam to Muela (near Butha Buthe) is 45 km long and over 4 m in diameter. Since Muela is lower in altitude than the dam, the water flows by gravity and at Muela a hydro-electric power station is being built. It is projected that this will supply all of Lesotho's needs as well as a small surplus. From Muela, another tunnel 37 km long takes the water across the border to near the town of Clarens, where it flows into the Axle River, a tributary of the Vaal River.

Phase IB of the project is the building of Mohale Dam on the Senqunyane River, and the tunnels linking it to Katse Dam. The access roads, staff villages and other infrastructure are currently under construction.

The next three major dams of the project are further down the course of the Senqu River. Most of the project is being paid for by South Africa through a complex loan servicing agreement and the South Africans will also pay for each unit of water received. Thus Lesotho is assured of a large boost to its infrastructure and a long term source of income.

There are, however, several unanswered questions surrounding the project.

- What will its impact be on the environment?
- Will the dams silt up? (A look at Lesotho's rivers after a good rain shows how much silt they carry).
- What will the effect be on the Orange River downstream in South Africa since half its flow will now be diverted?
- And, what will its impact be on the people living around it? Will the company make good their promise of compensation?

The dam construction has brought roads, people and technology into previously remote, subsistence farming areas. A look at the villages around Katse, with shanties springing up and litter everywhere raises serious questions. It is the question of "progress". Is it always positive? Only time will tell.

The project has certainly improved Lesotho's infrastructure greatly. This is especially evident in terms of roads. There is now a beautiful tar road all the way from Hlotse, over the mountains to the Malibamatso river valley and all the way south to the Katse. From there the dirt road to Thaba Tseka has been upgraded.

Extract from The Lesotho Highlands Water Project: Katse and Mohale Dams
www.seelesotho.com/travel/info/waterproject.htm

Internet Article 2

Fish-Sundays Transfer Scheme
Water Transfer Schemes in the Middle Orange

The Fish-Sundays River Canal Scheme comprises a canal and tunnel system which supplies Orange River water from the Great Fish River valley to the Sundays River valley to supplement existing water supply in the Eastern Cape. Since 1992 water from the Sundays River valley has been supplied to Port Elizabeth. It is estimated that up to 200 million m^3 of Orange River water could eventually be transferred to the Port Elizabeth metropolitan area annually.

Orange River water is diverted from the Great Fish River by a weir at Elandsdrift into an aqueduct which winds approximately 65 km along steep slopes and cuts through the Bosberg chain between Cookhouse and Somerset East. The main feature of this aqueduct is the 13,1 km Cookhouse Tunnel through the Bosberg, which was completed in 1978. The canal discharges into the Little Fish River near Somerset East via a multi-stepped chute, from where the water flows down the Little Fish River for some 40 km to the De Mistkraal Weir.

The droughts of the past have created a critical situation in the Darlington Dam (formerly Lake Mentz) region which, despite being a fertile area, requires an assured water supply. The serious drought of 1966 and 1967 emphasized the necessity to commence work on the Skoenmakers Canal with a capacity of 22 m^3/s to link the Great Fish River to Darlington Dam as soon as possible. In view of an expected increase in irrigation below Darlington Dam and the demand for water in the Port Elizabeth metropolitan area, it was decided to replace the Wellington Grove pumping station with De Mistkraal Weir upstream of Wellington Grove and a short section of connecting canal to the beginning of the Skoenmakers Canal.

With the completion of the De Mistkraal Weir in 1987 the possibility of transferring water to Darlington Dam at the full design capacity of the Skoenmakers Canal was created. This water dilutes the salinated water of Darlington Dam and therefore presents an immediate benefit by improving the water quality for citrus farming in the lower Sundays River valley. A long-term economic benefit of the weir is the development of irrigation potential in the lower Sundays River valley. As a result of the developments, a further 16 500 ha can now be utilized for citrus farming.

A further extension of the scheme was launched in 1989 in order to provide water to Port Elizabeth where supplies were limited due to a severe drought. Water from Darlington Dam and the Sundays River irrigation canals flows to the Scheepersvlakte Dam, the main balancing dam for the irrigation scheme. From there water is conveyed by means of a gravity pipeline to a point on the right bank of the Sundays River where a purification works has been constructed. From the purification works, the water is pumped to a balancing dam on the plateau which separates the Port Elizabeth metropolitan area from the Sundays River, from where it flows to the municipality's existing reservoir at Motherwell. Apart from the increase in available water to the Port Elizabeth-Uitenhage metropolitan area, the municipality is less dependent on the Kouga Dam (formerly Paul Sauer Dam). This is to the advantage of the irrigators in the Gamtoos Government Water Scheme as it will increase the assurance of supply for irrigation.

The lower Fish River Scheme was initiated in 1985 and completed in 1992. The purpose of this scheme is to provide sufficient water of a suitable quality to irrigation developments along the Great Fish River in the vicinity of Committees Drift. The scheme consists of the Hermanuskraal Weir in the Great Fish River with a tunnel to discharge flood water and water released from the Orange River into an off-channel storage dam, the Glen Melville Dam in the Ecca River. The distribution system consists of a canal and pipelines to the irrigation areas on both sides of the river. The scheme will enable further irrigation expansion and will ensure that water of an acceptable quality is supplied.

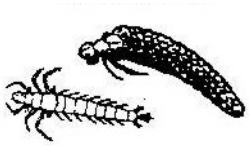
The scheme also makes provision for Grahamstown's increasing requirements. When the scheme was started, Grahamstown was already experiencing problems in meeting its growing demand for water and the Fish River was the obvious source to serve as a supplement. The scheme ensures that a stable supply of good quality water is available, which can be linked to the municipal water supply network. The scheme also benefits rural communities in the Great Fish River catchment (including portions of the former Ciskei) by improving the quality and availability of water.

Source: www.dwaf.gov.za/orange/Mid_Orange/fish-sun.htm

ACTIVITY FIVE: JUST FOR FUN!

Learners can quickly assess the quality of a nearby stream or river and its catchment by looking at visible animal life. This LIFE SCIENCES lesson encourages learners to explore a nearby water source.

ACTIVITY:
You can assess the quality of a river or stream and its catchment by looking at:

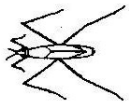


1. Stream bank vegetation;
2. The colour, smell and taste of the water;
3. The types of water life; and,
4. Chemical tests.

To quickly judge river water quality, pick up 10 medium sized rocks and see:

1. what organisations live in the water (species present) *(use the Water Organisms Picture Reference Sheet)*
2. the variety of different kinds of water life (diversity)
3. the total number of each type (populations)

Clean water with balanced proportions of different kinds of plants and animal life usually indicate a healthy system.



Questions to guide your observation
Common questions to guide the observation of plants and animals that live in and near water are:

What is it like?	adaptation
What is it doing?	behaviour
With what does it interact?	interdependence
Where is it found?	distribution
How much or how many are there?	abundance
How many different types are there?	diversity

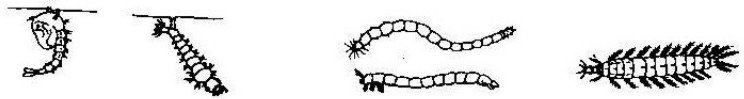
A diversity of animal species in a stream usually indicate good water quality. Some species cannot tolerate even the slightest amount of pollution and if found alive in a stream, these indicate clean water that is probably drinkable.

Water Organisms: Picture Reference Sheet

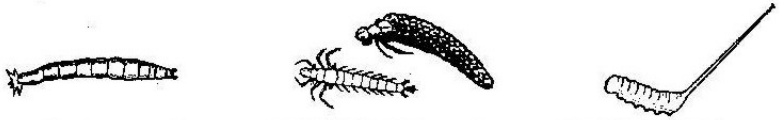
WORM-LIKE CREATURES:

leeches planaria sludgeworm tadpole

LARVAE:



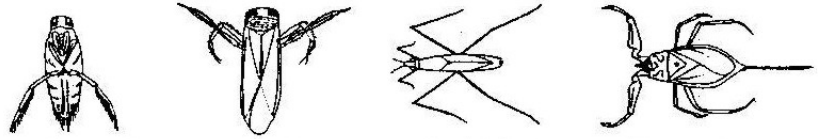
mosquito larva and pupa midge larvae whirligig larva



cranefly larva caddisfly larvae rat-tailed maggot

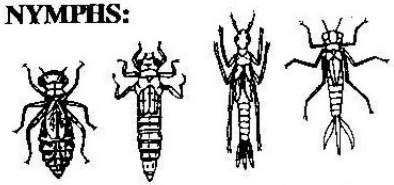
BEETLE-LIKE ORGANISMS:

whirligig beetle scavenger bug predacious beetle



backswimmer water boatman water strider water scorpion

NYMPHS:

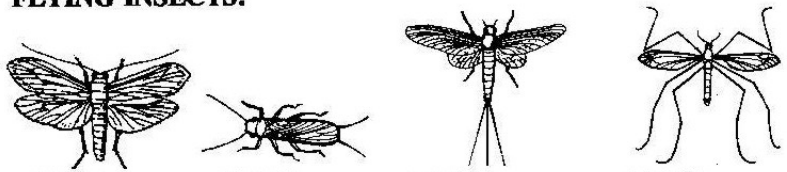


dragonflies damselflies stonefly mayfly

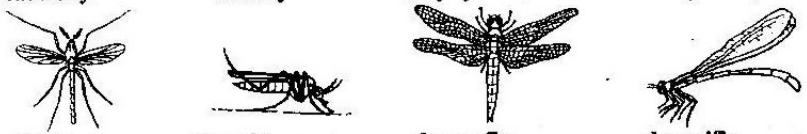
SHRIMPS

shrimp

FLYING INSECTS:



caddisfly stonefly mayfly cranefly

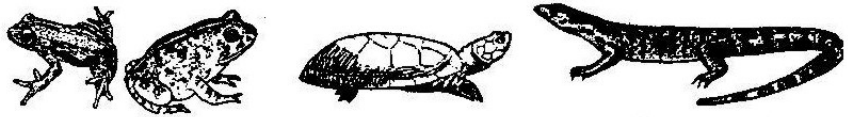


midge mosquito dragonfly damselfly

CREATURES WITH SHELLS:

snail limpet crab

OTHER WATER ANIMALS:



frogs and toads water terrapin water leguaan

fish birds otter water mongoose

More information on each of the Water Organisms on the Picture Reference Sheet

Back swimmer: *(Phylum: Arthropoda, Class: Insecta, Order: Hemiptera).* They swim and rest on their backs. The 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.

Caddisfly: *(Phylum: Arthropoda, Class: Insecta, Order: Trichoptera).* The larvae have 6 long legs close to the head. Caddisflies like clean, unpolluted water.

Crab: *(Phylum: Arthropoda, Class: Crustacea, Order: Decapoda. Prawns and crayfish are also in the class Crustacea).* Crabs have a hard exoskeleton. They have flat bodies and 5 pairs of legs. Crabs eat mostly dead or dying animals but also catch some live prey, such as tadpoles.

Cranefly: *(Phylum: Arthropoda, Class: Insecta, Order: Diptera).* 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!

Damselfly: *(Phylum: Arthropoda, Class: Insecta, Order: Odonata).* 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.

Dragonfly: *(Phylum: Arthropoda, Class: Insecta, Order: Odonata).* The adults fly very fast. Nymphs develop in the water and crawl amongst weeds and stones. Folded underneath their jaw they have a modified lower lip or “mask”. This is used to catch prey. Water is drawn in and out of the body through an opening at the rear end. This provides a supply of oxygen to the rectal gills, just inside the opening. The nymphs live in fairly polluted water. Nymphs eat water insects. Adults capture insects in flight. In emergencies, the nymph is able to expel water from its rear end – propelling itself forward like a jet!

Freshwater fish: *(Phylum: Chordata, Sub-Phylum: Vertebrata, Class: Pisces).* Fish have streamlined bodies that are covered with slimy scales. Fins are used to move. Breathing is through their gills.

Freshwater shrimp: *(Phylum: Arthropoda, Class: Crustacea, Order: Decapoda).* They feed on small animals and plants and are usually transparent, green or brown.

Frogs and toads: *(Phylum: Chordata, Sub-phylum: Vertebrata, Class: Amphibia).* Tadpoles have gills and live under water. Adult frogs and toads have lungs. Frogs spend their whole lives in very moist areas or near water. Toads are stout, have short limbs and live in open country. Platanna (clawed toads) are neither true frogs nor toads. They spend their whole lives in water.

Leech: *(Phylum: Annelida, Class: Hirudinea. The earthworm also belongs to this phylum).* 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 properly.

Mayfly: *(Phylum: Arthropoda, Class: Insecta, Order: Ephemeroptera. Adults emerge in MAY in the northern hemisphere, hence the name).*The nymphs (baby mayfly) 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 only live for 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.

Midge: *(Phylum: Arthropoda, Class Insecta, Order: Diptera. The order Diptera includes all flies).* 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. Generally midges are found in water that is slightly polluted.

Mosquito larvae: *(Phylum: Arthropoda, Class: Insecta, Order: Diptera).* Mosquito larvae live in stagnant (still) pools of water just below the surface. 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, the female mosquito will then pass on malaria to people, which can be deadly! Mosquito larvae are often found in poorly oxygenated ponds of water.

Otter and water mongoose: *(Phylum: Chordata, Sub-Phylum: Vertebrata, Class: Mammalia. Dogs, cats, lions etc all belong to the class Mammalia – this class includes all animals that suckle their young).* Otters and water mongoose are shy animals and are seldom seen. You may see their droppings, which contain large quantities of crab shells.

Planaria: *(Phylum: Platyhelminthes, Class: Turbellaria. This phylum also includes the tape-worm).*They are dark brown with flat bodies. Planarias live in clean, unpolluted water. They can regenerate themselves if cut in pieces, with each piece growing into a new individual.

Rat-tailed maggot: *(Phylum: Arthropoda, Class: Insecta, Order: Diptera).* Rat-tailed maggots are usually grey with a fat wrinkled body and a long breathing tube. They can live in mud and polluted water.

Sludge Worm: *(Phylum: Annelida, Class: Oligochaetae, Order: Lumbriculidia)*. 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.

Stonefly: *(Phylum: Arthropoda, Class: Insecta, Order: Plecoptera).* 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.

Terrapin and leguaan: *(Phylum: Chordata, Sub-Phylum: Vertebrata, Class: Reptilia).* Water terrapin are usually a muddy brown colour. They have a scaly skin and scales modified to form a leathery shell. Water leguaans are very large lizards with a patterned scaly skin.

Water beetles and bugs: *(Phylum: Arthropoda, Class: Insecta).* All the water beetles and bugs have flat, smooth bodies. They are usually found in clean streams and rivers.

Water birds: *(Phylum: Chordata, Sub-Phylum: Vertebrata, Class: Aves).* 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.

Water boatman: *(Phylum: Arthropoda, Class: Insecta, Order: Hemiptera. The order Hemiptera includes all bugs).* 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! This air bubble is what gives the boatman a silvery colour in the water.

Water snail and limpet: *(Phylum: Mollusca. Oysters, octopus, mussels and garden snails also belong to this phylum).* 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. Limpets have a flattish shell covering their body. This shell has a foot that sucks on to the smooth surface of rocks and plants. Snails eat water plants. Limpets eat algae on rocks and on water plants. Snails 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.

Water scorpion: *(Phylum: Arthropoda, Class: Insecta, Order: Hemiptera).* 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: *(Phylum: Arthropoda, Class: Insecta, Order: Hemiptera).*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.

Whirlygig beetle: *(Phylum: Arthropda, Class: Insecta, Order: Coleoptera. The order Coleoptera includes all the beetles).*The larvae look like small centipedes. Adult whirligig beetles are smooth and streamlined and are usually a shiny grey colour. Adults and larvae both feed on dead or dying insects that have fallen into the water.